E001

Commercial Vegetable Production Recommendations

New Jersey

2014

RUTGERS
New Jersey Agricultural Experiment Station

NOT TO BE USED BY HOME GARDENERS

The use of any pesticide inconsistent with the label directions is a violation of Federal law.

Preface

This copy of the *New Jersey Commercial Vegetable Production Recommendations for 2014* replaces all previous editions. Information presented in this publication is based on research results from Rutgers, The State University of New Jersey; University of Delaware; University of Maryland; The Pennsylvania State University; Virginia Polytechnic Institute and State University; West Virginia University; and the U.S. Department of Agriculture, combined with industry and grower knowledge and experience.

This vegetable production guide is intended for the commercial vegetable grower who has to make numerous managerial decisions. Although the proper choice of the variety, application, pesticide, equipment, fertilizer, and cultural practice is the individual vegetable grower's responsibility, it is intended that these recommendations will facilitate decision-making. Recommended planting dates will vary across the six-state region. Local weather conditions, grower experience, and variety may facilitate successful harvest on crops planted outside the planting dates listed in this guide. This can be evaluated in consultation with the local agents and state specialists. Government agencies and other organizations administrating crop insurance programs or other support programs should contact local Extension agents and/or state vegetable specialists for guidance.

The publication will be revised annually to include new information that evolves in the rapidly changing vegetable industry. Important changes and updates will be posted in real time on the website www.njveg.rutgers.edu.

The Editors welcome constructive criticism and suggestions from growers and industry personnel who may wish to help improve future editions of this publication.

Days Wait between Last Pesticide Application and Harvest

Minimum days between last application and harvest for insecticides and fungicides are listed in tables at the end of the Insect Control section for each crop. *The minimum number of days between last application of herbicide and harvest is listed in Table E-4.*

To avoid deleterious chemical residues from occurring on harvested crops, heed this warning.

Trade or Brand Names

The trade or brand names given herein are supplied with the understanding that no discrimination is intended and no endorsement by Rutgers Cooperative Extension is implied. Furthermore, in some instances the same compound may be sold under different trade names, which may vary as to label clearances. For the convenience of our users, both product names and active ingredients are provided and any product name omissions are unintended.

Pesticide-User Responsibility

Always follow the label and use pesticides safely. For special Local-Needs Label [24(c)] registrations or Section 18 exemptions, do not use the material without a copy of the special label or written instructions from your Rutgers Cooperative Extension Agent or another recognized authority. Remember, the user is always responsible for the proper use of pesticides, residues on crops, storage and disposal, as well as for damage caused by drift.

State and federal pesticide regulations are constantly under revision. Be sure to determine if such changes apply to your situation. Using the material inconsistent with label directions is illegal.

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DISCLAIMER

**THE LABEL IS A
LEGALLY-BINDING CONTRACT
BETWEEN THE USER AND THE
MANUFACTURER.
THE USER MUST FOLLOW
ALL RATES AND RESTRICTIONS
AS PER LABEL DIRECTIONS.**

Cover Photos

Thank you to everyone who submitted photos for the cover.

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ABBREVIATIONS

A - acre(s)
/A - per acre
AFR - anthracnose and *Fusarium* wilt resistant
ai - active ingredient
ALS - acetolactate synthase
ALS - angular leaf spot resistant
AMS - ammonium sulfate
AMV - alfalfa mosaic virus
AR - anthracnose resistant
ASCR - Alternaria stem canker resistant
BAW - beet armyworm
BLSR - bacterial leaf spot resistance
BLT black light trap
BRR - black rot resistant
BRT - black rot tolerant
BSR - bacterial speck resistant
Bt or B.t. - *Bacillus thuringiensis*
Btu - British thermal unit
bu - bushel(s)
BV-1 - bean common mosaic virus resistant or tolerant
BV-2 - bean yellow mosaic virus resistant or tolerant
BWMS - bacterial wilt moderately susceptible
BWR - bacterial wilt resistant
BWS - bacterial wilt susceptible
^{o}C - degrees Celsius
CB cucumber beetles
cc - cubic centimeter(s)
CEC - cation exchange capacity
CEW - corn earworm
CL - cabbage looper
CLS Cercospora Leaf Spot
CMS - cucumber mosaic susceptible
CMV - cucumber mosaic virus
COC crop oil concentrate
CPB - Colorado potato beetle
CRR - corky root resistant
cu ft - cubic foot (feet)
cu yd - cubic yard(s)
cwt - hundredweight
D - dust
DBM - diamondback moth
DF - dry flowable
DMR - downy mildew resistant
DMMR - downy mildew moderate resistance
DP - dry prill
DS - dry salt
E - emulsion
EBDC early blight disease control
EBR - early blight resistant
EC - emulsifiable concentrate
ECB European corn borer
ELB Eggplant Lacebug
ES - emulsifiable suspension
ESLI End-of-service life indicators
EVR - enation virus resistant or tolerant
EW - emulsion in water
F - flowable
^{o}F - degrees Fahrenheit
F_1 - hybrid
FAW - fall armyworm
FB - flea beetle
FC - flowable concentrate
fl - fluid
FM - flowable microencapsulated
FR - *Fusarium* wilt resistant
FRAC - Fungicide Resistance Action Committee
FR 0,1,2 - *Fusarium* wilt resistance to race 0,1,2
FR 2 - *Fusarium* wilt resistance to race 2
FS - *Fusarium* and *Stemphylium* wilt resistant
ft - foot (feet)
FT - *Fusarium* tolerant
g - gram
G - granule(s)
gal - gallon(s)
GMO - genetically modified organism
GPA - green peach aphid
gpm - gallons per minute
GS - green stem
HW Hornworm
ICW - imported cabbageworm
in - inch(es)
IDLH immediately dangerous to life or health
INSV - impatiens necrotic spot virus
IRAC - Insecticide Resistance Action Committee
K - potassium
K_2O - available potash
L - liquid
lb - pound(s)
LBR - leaf blight resistant
LBT - leaf blight tolerant
LC - liquid concentrate
LF - liquid flowable
LM Leafminers
LMV - lettuce mosaic virus
LR - leaf roll resistant
MA - melon aphid
MDMR - maize dwarf mosaic resistant
ME - microencapsulated
min - minimum
MMR - mildew and mosaic resistant
mph - miles per hour
MoA - mode of action
MR - mosaic resistant
MSDS Manufacturers Safety Data Sheet
MSO methylated seed oil
MT - mosaic tested
N - nitrogen
NIOSH National Institute for Occupational Safety & Health
NTL - no time limitation
NY-15 - resistant or tolerant to NY-15 strain of bean common mosaic virus
OF - oil formulation
OLF - other labeled formulations
OMRI Organic Materials Review Institute
opt - optimum
OS - ozone sensitive

ABBREVIATIONS *(continued)*

OT - ozone tolerant
oz - ounce(s)
% - percent
P - phosphorus
PGR - plant growth regulator
PHI - preharvest interval
POA - potato aphid
pl - plant(s)
PMR - powdery mildew resistant
PMT - powdery mildew tolerant
ppi - preplant incorporated
ppm - parts per million
Pr - processing
PR - *Phytophthora* resistant
PRR - pink root resistant
PRSV - papaya ring spot virus
PRT - pink rot tolerant
psi - pounds per square inch
pt - pint(s)
PT - *Phytophthora* tolerant
P_2O_5 - available phosphoric acid
PVX - potato virus X
PVY - potato virus Y
Py - premature yellow
PYO - pick-your-own
qt - quart(s)
RKR - root-knot nematode resistant
RR - rust resistant
RSR - red stele resistant
S - sprayable
SB - sap beetle
SC - spray concentrate, soluble concentrate
SCN - soybean cyst nematode
SG - soluble granules
SMR - scab and mosaic resistant
SmR - smut resistant
SMV - squash mosaic virus
SP - soluble powder
SpR - split resistance
sq ft - square foot (feet)
SR - scab resistant
St - Stemphylium resistance
SWV- spotted wilt virus resistant
T - trial
TAW - true armyworm
TBR - tipburn resistant
tbs - tablespoon(s)
TEV - tobacco etch virus
TMV - tobacco mosaic virus
tsp - teaspoon(s)
TSSM - two-spotted spider mite
TSWV - tomato spotted wilt virus
TuMV - turnip mosaic virus
VF - *Verticillium* and *Fusarium* wilt resistant
VFN - *Verticillium*, *Fusarium*, and nematode resistant
VFFN - *Verticillium, Fusarium* race, 0, 1, nematodes
VFS - *Verticillium*, *Fusarium*, and *Stemphylium* wilt resistant
VR - *Verticillium* wilt resistant
VS - *Verticillium* wilt susceptible
W - wettable
WBE - water-based emulsion
WDG - water dispersible granules
WDL - water-dispersible liquid
wk - week(s)
WMV - watermelon mosaic virus
WMV2 - watermelon mosaic virus race 2
WP - wettable powder
WRR - white rust resistant
WRT - white rust tolerant
WSB - water-soluble bag
WSP - water-soluble packet
yr - year(s)
YR - yellows resistant
ZYMV - zucchini yellow mosaic virus
ZYMVR - zucchini yellow mosaic virus resistant

Plant Diagnostic Laboratory and Nematode Detection Service for New Jersey Residents only*

The Plant Diagnostic Laboratory is a full-service plant health diagnostic facility of Rutgers New Jersey Agricultural Experiment Station (NJAES). Located on the Cook Campus, the Plant Diagnostic Laboratory provides plant health diagnostic services in cooperation with Rutgers NJAES Cooperative Extension faculty and staff. Sample submission forms can be obtained from your local county Rutgers New Jersey Agricultural Experiment Station (NJAES) Cooperative Extension office or directly from the laboratory via phone request (732-932-9140) or fax request (732-932-1270). The laboratory will fax back the appropriate form. Completely fill out the submission form. Collect the appropriate sample. Carefully follow the directions on the submission form. Whole plants work best. Properly package the sample, form, and payment. Mail the sample to the appropriate address.

Mailing Address:
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*Delaware, Pennsylvania, Maryland, Virginia, & West Virginia's information is posted on your covers of this publication. If the information is not there, check with your local Extension office.

NOTES

GENERAL PRODUCTION RECOMMENDATIONS

VARIETIES

New varieties and strains of vegetables are constantly being developed throughout the world and it is impossible to list and describe all of them, only those that are available and are adapted to the mid-Atlantic region are listed in this publication. While all efforts are made to have comprehensive lists, not all varieties that are adapted will be listed. Varieties are listed for each specific crop in Section F, either alphabetically or in order of relative time to maturity from early to late (see table footnotes). The variety tables in Section F also indicate if there are demonstrated geographical differences in varietal performance within the mid-Atlantic Region. Those varieties that are new or that have had limited release will have the designation "trial" and should be evaluated in smaller plantings before being grown more extensively. The ultimate value of a variety for a particular purpose is determined by the grower: performance under his or her management adaptation to specific environmental conditions, and having desired horticultural characteristics.

Some Variety Selection Criteria:

Yield - The variety should have the potential to produce crops at the same or better yield and quality to those already grown. Is should be noted that harvested yield may be much less than potential yield depending on markets and quality factors.

Days to Harvest - Choose varieties that meet grower or processor requirements based on days to harvest. Earliness is a major selection factor for first spring plantings and days to harvest is a critical selection factor for late summer and fall maturing crops, especially in shorter season areas of the region. Days to harvest in seed guides are based on the most common planting date and may be considerably longer in cooler periods or shorter in warmer periods. A more accurate guide to maturity will be Growing Degree Days which are calculated for a specific crop using daily highs and lows and a base temperature.

Disease and Insect Resistance - The most economical and effective means of pest management is through the use of varieties that are resistant or tolerant to diseases including those caused by fungi, bacteria, viruses, or nematodes.. When all other factors are equal, select a variety with needed disease resistance or tolerance. In some vegetables, such as sweet corn, insect resistant varieties are also available and should be considered where they fit grower requirements. The continuous or intense production of herbicide or pest-resistant varieties can potentially lead to herbicide-tolerant weeds and new, more virulent pest strains. Adherence to vender or Extension recommendations and a long-term crop rotation plan should minimize this risk.

Resistance to Adverse Environmental Conditions - Choose varieties that are resistant to environmental conditions that are likely to be encountered. This includes heat or cold tolerance; low levels of heat induced defects such a tuber heat necrosis; drought tolerance; resistance to cracking, edema, and other wet weather disorders; low occurrence of nutrient disorders such as blossom end rot, leaf tip burn, or hollow stem; and low occurrence of hollow heart.

Horticultural Quality – Choose varieties that meet grower or processor quality requirements. Quality attributes such as taste, texture, size, shape, color, uniformity, and amount of defects will often dictate variety selection. Grades, percentage by grade, or pack-outs are key quality attributes for some markets or processors. Variety test data such as soluble solids (sugars or sweetness), acidity, pungency, fiber content and consumer taste panel information can assist in variety selection where available. Processing performance is of major concern for frozen, canned or pickled vegetables. Other considerations include the ability to handle mechanical harvest or the ability to be packed and shipped distances with minimum damage in contrast to vegetables that are adapted only to hand harvest and local sales or short distance shipping. Other quality characteristics to consider include holding or storage ability, ripening characteristics, nutritional content, and culinary qualities.

Plant Characteristics – Plant characteristics that may be considered in variety selection include plant form such as bush, upright, or vining; plant height; plant size; location of harvested part on the plant; and ease of harvest.

Adaptability – Successful varieties must perform well under the range of environmental conditions and production practices usually encountered on the individual farm. Seasonal adaptation is another selection consideration.

Market Acceptability – The harvested plant product must have characteristics desired by both the grower and the buyer. Consider the requirements or desires of the consumer, packer, shipper, wholesaler, retailer, or processor. Included among these qualities are flavor, pack out, size, shape, color, culinary qualities, nutritional quality or processing quality. Specialty markets such as ethnic buyers, restaurants, or gourmet sales will have very specific variety requirements. Many vegetable seed companies offer varieties that are "transgenic" or "GMO" (genetically modified organism). GMO varieties feature a small amount of DNA from a source outside of the crop species gene pool; another plant species, bacterium, virus, or even animal. This foreign DNA is either the direct source of a new trait such as herbicide, or disease or insect resistance or is needed to assist the gene insertion process. GMO products in the food chain are highly controversial, and effects are ongoing to regulate and label them. The grower is urged to be aware of current and pending regulations and adverse public sentiment before growing and marketing GMO varieties of vegetable crops.

Variety selection is a very dynamic process. Some varieties retain favor for many years, whereas others might be used only a few seasons if some special situation, such as plant disease or marketing change, develops. Companies frequently replace older varieties with new varieties. Variety selection in the Mid-Atlantic often requires special regional consideration due to the wide range of climatic variations.

There are many sources of information for growers to aid in choosing a variety. University trials offer unbiased comparisons of varieties from multiple sources. Commercial trials from seed distributors also offer multiple source comparisons. Seed company test results offer information about that company's varieties. Look for results from replicated trials and multiple sites if available. Trials conducted in similar soils and growing environments and local trials are the most reliable indicators of what will have potential to perform well on a grower's farm. Visits to local trials can provide good visual information for making decisions. Where quality is a prime concern, look for trials with quality data. Small trial plantings for 2 to 3 years are suggested for any variety or strain not previously grown. For a true comparison, always include a standard variety, one with proven consistent performance in the same field or planting.

Plant Resistance or Tolerance

Vegetable crops are naturally resistant to most but not all plant pathogens. In cases where diseases are a serious threat, genetic resistance is an effective and low cost strategy of disease avoidance. Pathogens are highly changeable, and a resistant variety that performs well in one year may not necessarily continue to do so.

On rare occasions, predicted resistance to pathogens breaks down. This may be due to different strains and races of disease-causing organisms and environmental conditions that favor the organism or reduce natural plant resistance. In the Section F variety tables, letters in parentheses ( ) appearing after the listed variety names refer to the genes for disease resistance or tolerance they contain and are decoded in the "Abbreviations" section in the front of this book.

SEED STORAGE AND HANDLING

Both high temperature and high relative humidity will reduce seed germination and vigor over time. Do not store seeds in areas that have a combined temperature and humidity value greater than 110 (for example 50°F [12.8°C] + 60 percent relative humidity). Ideal storage conditions for most seeds are at a temperature of 35°F (2°C) and less than 40 percent relative humidity. In addition, primed seeds pretreated with salt or another osmoticum do not usually store well after shipment to the buyer. Seed coating/pelleting may or may not reduce germination rate. Therefore, if you do not use all coated/pelleted seed, perform a germination test to assess viability before using in subsequent seasons.

Corn, pea, and bean seed are especially susceptible to mechanical damage due to rough handling. Seed containers of these crops should not be subjected to rough handling since the seed coats and embryos can be damaged, resulting in nonviable seeds. If you plan to treat seeds of these crops with a fungicide, inoculum, or other chemical application, apply the materials gently to avoid seed damage.

SPECIALTY VEGETABLES

Highly perishable specialty or "gourmet" vegetables offer promise for increased net profits. Before planting the crop, however, **growers must determine that specific retail, wholesale, restaurant, or processing markets exist.** Specialty vegetables often require investment in specific types of equipment, and new field preparation or management techniques.

Growers should also be aware that fewer pesticides are registered for many specialty vegetables and herbs. Successful pest control in these crops is more dependent on sanitation, seed treatment, crop rotation, planting site, mechanical cultivation, and the use of resistant varieties than pesticides. Other methods include the release of biological control agents, conservation of natural and introduced biological control agents through strip cropping, intercropping, and borders with habitats, physical exclusion or repulsion of pests, trap crops, and mechanical cultivation.

Promising perishable specialty crops are asparagus, Belgium endive, dandelion (blanched), greens (collard, kale, mustard, turnip, and tyfon), herbs, oriental vegetables, specialty lettuce types, scallions, sugar snap peas, snow peas, edamame, ethnic curcurbits, peppers, and sweet corn types with enhanced sugar and high quality.

Less perishable types that offer promise are bok choy/ pak choi, Chinese cabbage, endive and escarole (blanched), garlic (pink skin), leeks, red radicchio, rhubarb, sweet onions, and specialty potatoes (moist types with unusual color).

Miniature or "baby" vegetables that can be grown are beets, cucumbers (harvested less mature), eggplant "little fingers" type, pickling corn ears, snap beans (small sieve harvested less mature), and summer and acorn squash (immature with blossom attached).

In general, market demand for "heirloom" vegetables and types of commodities that cater to the special needs and preferences of ethnic groups has also expanded.

See the "Specialty Vegetables and Herbs" subsection of Section F for more details.

ORGANIC PRODUCTION

Vegetable growers may wish to consider organic production. The initial investment is high, due mainly to certification costs. However, returns can be higher than for conventionally produced products. The USDA regulates the term 'organic' to protect the sector from unscrupulous profiteers. To become certified organic, growers must follow production and handling practices contained in the National Organic Standards (NOS see www.usda.gov) and be certified by a USDA accredited certifying agency such as the Northeast Organic Farmers Association (NOFA) and the Organic Materials Review Institute (OMRI). Growers whose annual gross income from organic products is $5,000 or less can be exempted from certification. In this case growers must continue to use production and handling practices in accordance with the NOS and some restrictions regarding labeling and combination with other organic products apply. Certified organic production is typically preceded by a three-year transition phase during which the soil and farming practices are adapted to NOS.

Growers should recognize that successful organic production is a long-term proposition. It usually takes a couple of years, and may take as many as four years, for a site managed organically to reach full potential for profitability. Organic production is management-intensive, and requires careful attention to the maintenance of a biological equilibrium favorable for crop production. Organic certification gives growers increased market access, but requires learning new production methods and documenting production practices through careful record keeping. However, when implemented well, organic methods can improve soil fertility and tilth through increased soil microorganisms and improved organic matter recycling. Organic farming is replete with products and methods that do not necessarily work. Growers should test new products and methods on a small scale prior to large scale adoption.

Growers may wish to consider the following questions before initiating organic production.

- Does a market for organic vegetables exist?
- Are adequate resources available?
- Would you be able to ride out possible reduced yields without premium prices during 3 or more years of the transition phase?
- Are you willing to devote more time to monitoring pests?
- Are you willing to devote more time to managing soil fertility?
- Are you willing to devote more time to record keeping?

If you answered "yes" to all of the above questions, then organic production may be for you.

Growers who are beginning the transition phase from non-organic to organic production may wish to consider a pre-transition phase if pest pressures are high in the planting area. A pre-transition phase is intermediate between organic and non-organic production. During the pre-transition phase conventional pest management tactics are used along with organic tactics to reduce pest pressures. Once pest pressures are reduced, organic pest management tactics are used exclusively.

The steps for becoming certified organic can be found in the publication *Organic Vegetable Production* at http://pubs.cas.psu.edu/FreePubs/pdfs/ua391.pdf

TRANSPLANT GROWING

These recommendations apply only to plants grown under controlled conditions in greenhouses or hotbeds. Field-grown plants are covered under the specific crop in Section F.

Producing quality transplants starts with disease free seed, a clean greenhouse and clean planting trays. Many of our vegetable disease problems including bacterial spot, bacterial speck, bacterial canker, gummy stem blight, bacterial fruit blotch, tomato spotted wilt virus, impatiens necrotic spot virus, and Alternaria blight can start in the greenhouse and be carried to the field. Further, a number of virus diseases are transmitted by greenhouse insects.

Buy disease-indexed seeds when they are available. To reduce bacterial seed-borne diseases in some crops such as tomatoes, peppers, and cabbages, seeds can be hot water treated. Chlorine treatment can also be useful on some seeds as a surface treatment but will not kill pathogens inside the seed. See Section E, Disease Management/Seed Treatment for seed treatment recommendations.

Transplants are affected by such factors as temperature, fertilization, water, and spacing. A good transplant is grown under the best possible conditions. A poor transplant usually results in poor crop performance. In certain instances, however, the timely exposure of transplants to specific stresses can enhance later performance by the crop in the field.

Table A-1 presents optimum and minimum temperatures for seed germination and plant growing, the time and spacing (area) required to produce a desirable transplant, and number of plants per square foot.

Table A-1. Optimum and Minimum Temperatures and Planting Recommendations for Transplant Production

Crop	°F Opt. Day	°F Min. Night	Weeks to Grow	Sq In per Plant	Plants per Sq Ft
Broccoli	65-70	60	6-7	3	48
Cabbage	65	60	6-7	3	48
Cauliflower	65-70	60	6-8	3	48
Celery	65-70	60	9-12	3	48
Cucumber[1]	70-75	65	2-3	4	36
Eggplant	70-85	65	7-9	6-9	24
Endive, Escarole	70-75	70	5-7	2	72
Lettuce	60-65	40	5-6	1	144
Melon[1]	70-75	65	2-3	6	24
Onion	65-70	60	9-12	--	--
Pepper	70-75	60	8-9	4-6	36
Summer squash[1]	70-75	65	2-3	4	36
Sweet potato	75-85		4-5	in bed	in bed
Tomato	65-75	60	5-6	6-9	24

[1] Seed directly in container; do not transplant prior to setting in the field.

Seedless watermelon has specific requirements: germination at high temperatures for 48 hours (to achieve even germination) then move immediately into a cooler greenhouse to grow out. See the Watermelon subsection of Section F for more details.

Making a Plant-Growing Mix. Many pre-mixed growing media products are available commercially (see below). A good, lightweight, disease-free, plant-growing material can also be made from a mixture of peat and vermiculite. The main advantage of making one's own mix is uniform and consistent composition, but it can also be less costly than commercial products. Formulas for a very simple mix are now located in the Resource Section (R) of this publication.

Commercial Plant Growing Mixes. A number of commercial media formulations are available for growing transplants. Most of these mixes will produce high quality transplants when used with good management practices. However, these mixes can vary greatly in composition, particle size, pH, aeration, nutrient content, and water-holding capacity. Commercial growing media will haveadded lime and may or may not have a starter nutrient charge (added fertilizer). Those without fertilizer will require supplemental liquid feedings after seedling emergence. Those with added fertilizers will require liquid feeding starting 3-4 weeks after emergence. If growers experience problems with transplant performance, the growing medium (soil) should be sent to a soils laboratory for testing.

For greenhouse growing areas, remove any weeds and dead plant materials and clean floors and benches thoroughly of any organic residue prior to seeding.

Treatment of Flats and Trays. Flats used in the production of transplants should be new to avoid pathogens that cause damping-off and other disease problems. If flats and trays are to be reused, they should be thoroughly cleaned after use and disinfested as described below. Permit flats to dry completely prior to use. One of the following methods of disinfestation should be used:

Chlorine bleach. Dip in **a** chlorine bleach solution **(3.5 fl. oz. Clorox™ or equivalent product per gallon of water)** several times. Cover treated flats and trays with a tarp to keep them wet overnight. Wash flats and trays with clean water or a Q-salts (see below) to eliminate the chlorine. It is important that the bleach solution remains below pH 6.8 and that new solutions be made up every 2 hours or whenever it becomes contaminated or diluted. Organic matter will deactivate the active ingredients quickly.

Q-salts (Quaternary ammonium chloride salts). Compounds such as Greenshield, Physan and Prevent can be applied in the final wash of flats and trays during the chlorine treatment. Additionally, they can be used to wash exposed surfaces (benches, frames, etc.) in greenhouses.

Chlorine Dioxide. This strategy for surface disinfestaton has been adopted by many practitioners, but no independent scientific evidence is available yet on comparative efficacy of this method. Refer to the following web sites for more information:
http://www.epa.gov/ogwdw/mdbp/pdf/alter/chapt_4.pdf
http://www.osha.gov/SLTC/healthguidelines/chlorinedioxide/recognition.html
http://www.safeox.com/chlorine-dioxide-clo2

Transplant Trays and Containers. Most transplants are grown in plastic trays with individual cells for each plant. Trays vary in size from 32 cells to over 500 cells per standard 12 x 24 inch tray. Larger cell sizes (32, 50, or 72) are best used for vine crops and for rooting strawberry tips. 72 cell and 128 cell trays are suitable for tomatoes, peppers, eggplant, and cole crops. Smaller cell sizes (128, 200, 288) may be appropriate for crops such as lettuce and onions. Larger styrofoam transplant trays are also available in similar cell sizes. Larger cell sizes have better holding ability and survivability in the field but use more greenhouse space and take longer to produce the root ball in the cell. Individual plant-growing containers may also be used for vine crops and early market crops of tomatoes, peppers, and eggplant. Various types of fiber or plastic pots or cubes are available for this purpose. If plastic pots are reused, disinfest as described for flats.

Seed Germination. Normally, one seed is planted per cell. Seeds that are over-sown in flats to be "pricked out" (thinned to a uniform stand) at a later date should be germinated in 100% vermiculite (horticultural grade, coarse sand size) or a plant growing mix. However, it is recommended that no fertilizer be included in the mix or the vermiculite until the seed leaves (cotyledons) are fully expanded and the true leaves are beginning to unfold. Fertilization should be in the liquid form and at one-half the rate for any of the ratios listed in the Liquid Feeding paragraph below. Seedlings can be held for 3 to 4 weeks if fertilization is withheld until 3 to 4 days before "pricking out." Seed that is sown in tray cells, pots or other containers and will not be "pricked out" later can be germinated in a mix that contains fertilizer.

For earlier, more uniform emergence, germinate and grow seedlings on benches with bottom heat or in a floor-heated greenhouse. Germination rooms or chambers also insure even germination where higher temperatures can be maintained for the first 48 hours. Trays may be stacked in germination rooms during this period but must be moved to the greenhouse prior to seedling emergence.

Plant Growing Facilities. Good plant-growing facilities (greenhouses) provide maximum light to the seedling crop. The greenhouse cover material (glass, plastic, or fiberglass) should be clean, clear, and in good repair. The ideal greenhouse will also have floor-on bottom-heating capabilities, either on the benches or on the floor, and provide good heating and ventilation systems for effective environmental control. Proper growing medium temperature ensures uniformity of crop throughout the greenhouse by moderating normal temperature variations experienced with hot air heating systems. Bottom heating provides for a significant energy savings because the greenhouse does not have to be operated 10°F higher than the required growing medium temperatures for good germination and seedling growth. Internal combustion heating units located inside the greenhouse must be vented and have outside fresh-air intake and exhaust systems to provide air to and from the heater. Ventilation units must be adequate in size, providing 1.2 to 1.4 sq ft of opening for each 1,000 cubic feet per minute (cfm) fan capacity. Seedlings should not be grown or held in areas where pesticides are stored.

Liquid Feeding of transplants. In most instances, additional nutrients will be needed by growing transplants; commercially available 100% water soluble greenhouse fertilizer formulations are recommended for this purpose. This is also referred to as “fertigation” (see Section C). For most crops use a formulation with lower P levels than N and K (for example 21-5-20, 13-2-13, 20-10-20, 17-5-17, 18-9-18). If you plan to fertilize with every watering, begin with N concentrations in the 30 to 50 ppm range and modify the concentration as needed. Use higher rates for tomato, pepper and cole crops and lower rates for cucurbits (watermelon and squash, etc.). Use higher rates when temperatures are high (late spring and summer) and lower rates when temperatures are cooler. Fertilizer requirements may vary substantially with crop and growing conditions. For example, if fertigation is scheduled only once a week, N concentrations of 200 to 250 ppm may be required. Some growers may use a growing medium with no starter fertilizer. If that is the case, use 50 ppm N from emergence to first true leaf every 3 days, 200 ppm N every other day from first true leaf to second true leaf)

If concentrations are above recommended levels, they can cause excessive growth, reducing transplant quality. Highly concentrated nutrient solutions are often can causesalt injury to plants and leaf burning. Over-fertilized transplants will often “stretch” and have impaired field survival. For less sophisticated growers the following materials dissolved in 5 gallons of water and used over an area of 20 square feet are recommended for general use on transplants:

20-20-20---1-2 oz/5 gal water or
20-10-15---2 oz/5 gal water

Rinse leaves after liquid feeding. Applications should be made weekly using these rates.

When using starter solutions for field transplanting, follow manufacturer's recommendation. **Caution**. High rates of starter solution can become concentrated and burn transplant roots when the soil becomes dry.

Watering. Keep mix moist but not continually wet. Water less in cloudy weather. Watering in the morning allows plant surfaces to dry before night and reduces the possibility of disease.

Transplant Height Control: One of the most important considerations is managing "stretch" or height of transplants. The goal is to produce a transplant of a size that it can be handled by mechanical transplanters without damage and that are tolerant to wind.

Most growth regulators that are used for bedding plants are not registered for vegetable transplants. One exception is Sumagic® registered for use as a foliar spray on tomato, pepper, eggplant, groundcherry, pepino and tomatillo transplants (no other crops are registered at present). The recommended label rate is 0.52 to 2.60 fluid oz per gallon (2 to 10 ppm) and one gallon should be sprayed so it covers 200 sq ft of transplant trays (2 quarts per 100 sq ft). The first application can be made when transplants have 2-4 true leaves. One additional application may be made at the low rate, 0.52 fluid oz per gallon (2 ppm), 7-14 days later, but you cannot exceed 2.60 fluid oz of total product (per 100 sq ft) for a season. Growers are advised to perform small-scale trials on a portion of their transplants under their growing conditions before large scale adoption.

For other crops alternative methods for height control must be used. One such method that is successful is the use of temperature differential or DIF; the difference between day and night temperatures in the greenhouse. In most heating programs, a greenhouse will be much warmer during the day than the night. The critical period during a day for height control is the first 2 to 3 hours following sunrise. By lowering the temperature during this 3-hour period, plant height in many vegetables can be modulated. Drop air temperature to 50° – 55°F for 2-3 hours starting just before dawn, and then return to 60° – 70°F. Vegetables vary in their response to DIF. For example, tomatoes are very responsive, while curcurbits are is much less responsive.

Mechanical movement can also reduce transplant height. This may be accomplished by brushing over the tops of transplants twice daily for with a pipe or wand made of soft or smooth material. Crops responding to mechanical height control include tomatoes, eggplant, and cucumbers. Peppers are damaged with this method.

Managing water can also be a tool to control stretch in some vegetables. After plants have reached sufficient size, expose them to stress cycles, allowing plants to approach the wilting point before watering again. Be careful not to stress plants so much that they are damaged.

Managing greenhouse fertilizer programs is yet another method for controlling transplant height. Most greenhouse growing media come with a starter nutrient charge, good for about 2-3 weeks after seedling emergence. After that, you need to apply fertilizers, usually with a liquid feed program. Greenhouse fertilizers that are high in ammonium forms of nitrogen will induce more stretch than those with high relative proportions of nitrate nitrogen sources. Fertilizers that are high in phosphorus may also promote stretch.

Exposing plants to outside conditions is used for the hardening off process prior to transplanting. You can also use this for transplant height control during the production period. Roll out benches that can be moved outside of the greenhouse for a portion of the day or wagons that can be moved into and out of the greenhouse can be used for this purpose (see below).

Hardening. It is recommended that transplants be subjected to a period of "hardening" prior to incorporation in the production field. Reducing the amount of water used, lowering temperatures, and limiting fertilizers cause a check in growth (hardening) to prepare plants for field setting. When hardening vine crops, tomatoes, peppers, or eggplants, do not lower temperature more than 5°F (3°C) below the recommended minimum growing temperatures listed in Table A-1. Low temperature causes chilling that can injure plants and delay regrowth after transplanting. Do not harden rosette vegetables (e.g. endive, escarole, celery) by lowering the temperature because low temperature exposure increases early bolting.

Common Problems: Poor growth, yellow plants, or stunted plants are often attributable to the greenhouse growing medium. Greenhouse media manufacturers have good quality control measures in place but things can go wrong on occasion – inadequate mixing, critical components missing or in the wrong proportions (such as wetting agents, fertilizers, lime), or defective components (poor quality). Media can also be affected by poor storage and handling. This occurs most commonly when media are stored outside and bales or bags get wet. In addition, all growing media have a specific shelf life – old media often dry out and are hard to rehydrate.

If the medium is over a year old or possibly compromised, it should not be used. Contact your supplier and have them inspect and run tests on any suspect media. Avoid using overly dry or caked media, media that are difficult to loosen, media with a bad odor, water logged media or media that are resistant to wetting.

Most (but not all) media include a starter lime and fertilizer charge. The fertilizer is designed to provide 3-4 weeks of nutrients. If the fertilizer is missing, improperly mixed, or in the wrong proportions, seeds will germinate but seedlings will remain stunted. In this case, liquid fertilizer applications should start early.

Peat-based media are acidic in nature. Plants will perform well from pH 5.4 to 6.4. Lime is added to peat-based media and reacts over time with water to increase pH. Above pH 6.4, iron deficiencies in transplants are common. This also occurs if irrigation water is alkaline (has high carbonates).

In high pH situations (over 7.5), use an acidifying fertilizer (high ammonium content) for liquid feeds. Use of iron products such as chelated iron as a foliar application on transplants can accelerate plant recovery prior to the pH drop with the acid fertilizer. In cases with very high media pH, use of iron sulfate solutions may be needed to more rapidly drop the pH. Addition of dilute acid solutions to greenhouse irrigation water may also be considered in cases of excess alkalinity (e.g. diluted muriatic acid).

If lime is missing or inadequate from the growing medium, and pH is below 5.2, plants may exhibit magnesium deficiencies or iron or manganese toxicities. This also occurs in media that have been saturated for long periods of time.

To correct this situation, apply a liquid lime solution to the medium and irrigate liberally.

A good publication on media pH management can be found on the web at: http://www.greenhouse.cornell.edu/crops/factsheets/pHGreenhouseCrops.pdf

Media that are difficult to hydrate may not have sufficient wetting agent or the wetting agent may have deteriorated. Additional greenhouse grade wetting agent may be needed in such cases.

If the initial medium fertilizer charge is too high, or if excessive liquid or slow-release fertilizer feed is used, high salt concentrations can build up and stunt or damage plants. Leaf edge burn, "plant burn", or plant desiccation will be the symptoms of this condition. Test the media for electrical conductivity (EC) to see if salt levels are too high. The acceptable EC will depend on the type of test used (saturated paste, pour through, 1:1, 1:2) so the interpretation from the lab will be important. If salts are too high, then leaching the growing media with water will be required.

Poor transplant growth or injury can also result from the following:

- Heater exhaust in the house caused by cracked heat exchanger, inadequate venting, use of non-vented heaters
- Phytotoxicity from applied pesticides
- Use of paints, solvents, wood treatments, or other volatiles inside the greenhouse
- Use of herbicides in the greenhouse or near greenhouse vents
- Low temperatures due to inadequate heater capacity or heater malfunction or excessively high temperatures due to inadequate exhaust fan capacity or fan malfunction.

Grafting Vegetables: Utilizing rootstocks for grafting has resulted in increased yields, fruit quality, and tolerance to abiotic and biotic stresses. The technique can also help meet the challenge from new strains of soil-borne disease pathogens. There has been limited research on annual vegetable crops until the last decade when the grafting movement started in Asia and Europe. Japan now utilizes extensive grafting in the production of watermelon, cucumber, melon, tomato and eggplant. Grafting can overcome tissue damage and/or plant mortality caused by the soil-bone diseases Fusarium and Verticillium wilt, bacterial wilt and nematodes. Grafting may reduce or eliminate the use of certain pesticides (especially soil fumigants) because the appropriate rootstocks will provide tolerance to many soil insect and disease pests.

Some commercial nurseries are starting to feature grafted transplants. As a rule, they are substantially more expensive than conventional transplants, so there should be reasonable assurance of the economic benefit. Any grower seeking to perform large-scale grafting should first consult technical resources, such as the website that is cited below. Upgraded facilities and employee training will likely be necessary.

Two successful and easily performed grafts are the tube graft and cleft graft. The tube graft utilizes a 45° cut in the rootstock as well as the scion. The two pieces are subsequently joined together with the angles complimenting each other and held together with a grafting clip.

The cleft graft utilizes a 90° cut in the rootstock perpendicular to the soil surface. The rootstock stem is then cut in half down the center; this cut should be around one half inch depending on the size of the rootstock stem and scion. The base of the scion is then cut to form a "V" that will fit the notch that was cut into the rootstock. A grafting clip is secured around the graft junction. This type of graft often requires a larger grafting clip than the tube graft. A schematic of the cleft graft is illustrated in the eggplant production subsection (Section F). It is important that both the scion and rootstock stem diameter are similar. Several trial seedlings should also be grown prior to any large grafting operation to insure that the rootstock and scion seedlings grow at the same rate; if not, the stem diameters may not coincide, which can lead to a poor graft union.

One of the most crucial aspects of producing grafted seedlings is healing the graft junctions. After the grafts are clipped back together they need to be placed in a high humidity environment known as a healing chamber. A healing chamber can be constructed in various ways using wooden or metal frames and a plastic covering. The goal is to create a closed environment in which the humidity can increase and the temperature can be controlled. Open water pans can be placed in the chamber or commercial humidifiers can be used to increase humidity. Propagation heat mats can also be placed in the floor of the chamber to control temperature and as well as warm water pans to increase humidity. For the first several days in the healing chamber, light should be excluded as much as possible. The increase in humidity and decrease in light slow transpiration to keep scions from desiccating while vascular tissue reconnects the scion and rootstock.

After five to seven days in the healing chamber, seedlings can be moved back into a greenhouse to harden off for several weeks before moving to the field. Grafting generally adds two weeks to seedling production. Grafting can be performed at various plant growth stages ranging from the two true leaf stage on. More information on grafting can be found at:

www4.ncsu.edu/~clrivard/TubeGraftingTechnique.pdf

CONSERVATION TILLAGE CROP PRODUCTION

(Also referred to as No-Till Crop Production)

Conservation tillage crop production systems are beneficial for a variety of reasons. Soil compaction is reduced, water infiltration is improved, soil organic matter is increased, microbial biodiversity is increased, disease and weed pressure may be reduced, and soil erosion from wind and water is reduced in conservation compared to conventional tillage systems. Contamination of waterways with nutrients and pesticide residues is also reduced by eliminating or curtailing nutrient and sediment loads in runoff. Crop and cover crop residue on the soil surface can provide mulch that may suppress weeds and reduce herbicide needs. Improvements in soil quality from organic matter additions assist with soil structure formation that increases water infiltration, microbial populations, and reduces compaction.

Conservation tillage crop production systems can also pose several crop management challenges. Soil temperatures will be several degrees cooler then for conventional tillage and it will take longer to warm soils with surface residue. Cooler soil temperatures may impact seed germination, nutrient cycling from crop residues, slow fumigation volatilization, and reduce transplant vigor. Type of crop residue, residue amount, and desiccation timing all impact soil temperature and should be taken into consideration.

Conservation tillage systems may eliminate the mechanical weed control option for managing unwanted vegetation in a field. Weeds are typically controlled using biological, cultural, or chemical practices. Reliance on chemical weed control options in conservation systems increases the possibility of herbicide resistant weed populations. Consequently, the grower should expect to invest more time identifying local weed populations and planning herbicide rotation programs (herbicides with varying modes of action to reduce herbicide resistant population development). High residue cultivators have also been used with some success in conservation tillage programs for weed management.

Nitrogen fertilizer must be managed properly when utilizing a conservation tillage production system. Crop residues contain typically an enzyme, urease, which can increase nitrogen volatilization from urea containing fertilizer sources such as urea, liquid urea ammonium nitrate, or a variety of blends currently available. Management practices such as banding or incorporation using irrigation or rainfall should be considered to reduce urea containing fertilizer contact with urease. Another nitrogen management strategy in conservation tillage systems needs to include the application rate. As soil organic matter increases over time, more nitrogen fertilizer is needed to bring the conservation tillage system into equilibrium. Microbes will assimilate nitrogen when breaking down crop residue and immobilize plant available nitrogen pools. Research has shown that 25% or more nitrogen fertilizer may be necessary in the initial conversion years of a production system from conventional to conservation tillage. Previous crop residue amount and type, current soil nitrogen concentrations, fertilizer sources, application timing, and application methods all need to be considered when making necessary nitrogen rate calculations.

Maintaining proper soil pH is one of the most important crop production consideration in conservation tillage and has significant impacts on nutrient availability and toxicity. Special care needs to be directed to maintaining pH to the optimal level prior to initiating a continuous conservation tillage system. Lime has relatively low water solubility and leaches slowly through the soil profile. Therefore, lime should be applied based on soil testing recommendations and incorporated prior to initiating a long-term conservation tillage plan. Eventually, fertilizer, organic matter decomposition, and rain will acidify the soil surface, but subsoil will continue to be at optimal (pH=6.0 to 7.0) levels. Continued liming based on soil test recommendations will maintain the proper pH.

MULCHES AND ROW COVERS

A favorable environment for a plant's root system can be achieved with the use of plastic mulches and trickle irrigation. Early in the season, additional advantages can be obtained by the use of row covers, which increase the daytime air temperature and hold ground heat during the night. This improvement in temperature early in the plant's life cycle can speed plant growth, resulting in earlier harvest. Mulches also discourage weeds and, depending on the type used, insect pests.

Mulches. The most popular mulches are black and white polyethylene film (0.75 – 1.25 mil). Another popular product is metalized film. Metalized mulches have a very thin layer of aluminum extruded onto one side of the mulch. Black mulches are generally used in the spring of the year to warm the soil and white or metalized mulches are generally used in the fall to cool the soil. Because of the warming effect of black mulch, it should only be used for spring crops. The use of this mulch for fall crops will likely raise the soil temperature above optimum for most warm season crops. The transition from black to white or metalized mulches should be around June 1st transplant or seeding dates, depending on geographic location (earlier in southern and later in northern zones). Soil fumigation may be used in conjunction with any type of plastic for weed, disease, and insect control, depending on the fumigant label. Clear plastic will result in the highest soil temperatures and should be used with caution, only in early spring plantings Different colors and compositions impart new functional properties to mulch. Green 'IRT' types of plastic mulch increase soil temperatures more than black plastic and also suppress most weed growth. Other color mulches such as red, blue, and orange are available. Results with these mulches have been inconsistent. Metalized or aluminized mulches repel certain insect pests (aphids, thrips, whiteflies) early in the crop growing cycle due to the reflectance of UV rays. This benefit is lost once the crop canopy covers the mulch. This can be useful in cucurbit and tomato crops to delay the onset of certain virus diseases vectored by thrips, aphids, and whiteflies.

Yellow mulches attract cucumber beetles and may also attract other insect pests. Note that planting date and environmental conditions influence crop responses to color of mulch films.

As the cost of soil fumigation increases, growers will likely need to reduce application rates to maintain profitability. New mulches have been developed that have decreased permeability to fumigants. These mulches keep the fumigant in the ground longer which allows for reduced application rates while maintaining efficacy of the material. These mulches are known as “virtually impermeable film” (VIF). There are several manufacturers of these mulches and they come in various colors for fall and spring plantings. Consult the fumigant label for the allowable reduction in use rate under VIF mulch. One factor that must be taken in to consideration is the plant-back period when using VIF mulches. Consult the label from plantback period when using VIF mulch. The cost of VIF mulch is also higher than low density mulches but this increase is usually offset by the saving gained from reduced fumigant rates. Another type of mulch has been developed that is more retentive than VIF mulch. This is known as “totally impermeable film” or TIF. Soil fumigant use rates may be further decreased with used in combination with TIF. Consult fumigant labels for allowable use rate reductions with TIF.

Fertilization. Before considering a fertilization program for mulched crops, the grower should have the soil pH measured. If a liming material is needed to increase the soil pH, the material should be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, the soil pH should be at or near 6.5. If the pH is below 5.5 or above 7.5 nutrients may be present but not available to the plants.

Calculating Fertilizer Rates Applied in Strips Where Plastic Mulch will be Laid. When using plastic mulch **without** trickle irrigation, all plant nutrients recommended for standard cultural practices should be incorporated in the top 5 to 6 inches of soil before laying the mulch. If equipment is available, apply all the fertilizer required to grow the crop to the soil area that will be covered with mulch. This is more efficient and effective than a broadcast application over the entire field. Non-localized nutrients may promote weed growth.

All essential plant nutrients, including major nutrients (N, P, K) as well as secondary and micronutrients, should be applied according to needs from soil test results and incorporated in the manner described above. Placing some of the required N under the mulch and then sidedressing the remainder of the needed N along the edge of the mulch or in the row alleys after the crop becomes established has been found to be ineffective. When trickle irrigation is used, see "Drip/Trickle Fertilization" in the specific crops sections (i.e., eggplants, muskmelons, peppers, tomatoes, and watermelons) of Section F for crop-specific modifications.

Soil conditions for laying mulch. Before any mulch is applied, it is extremely important that the soil moisture level be at or near field capacity. This moisture is critical for early growth of the crop plants, because soil moisture cannot be effectively supplied by rain or overhead irrigation to small plants growing on plastic mulch without trickle irrigation. The soil texture should be even and plastic should be laid so that it is tight against the soil in a firm bed for effective heat transfer. Plastic can be laid flat against the ground or on raised beds. Raised beds offer additional drainage and early warming. Use of a bed shaper prior to laying plastic allows for fertilizer and herbicide incorporation and can assist in forming a firm bed. Combination bedder-plastic layers are also available.

Biodegradable mulches: Biodegradable plastic mulches have many of the same properties, and provide comparable benefits, as conventional plastic mulches. They are made from plant starches such as corn or wheat. These mulches are weakened by exposure to sunlight, but are designed to degrade into carbon dioxide and water by soil microorganisms when soil moisture and temperatures are favorable for biological activity. Soil type, organic matter content, and weed pressure are other factors affecting break down of biodegradable mulches. Unlike petroleum-based mulches biodegradable mulches will usually be retained on the surface of the soil rather than be blown away from the application site. In addition, all of the biodegradable mulch will eventually degrade or fragmentize, including the tucked edges buried in the soil. Biodegradation is often unpredictable and incomplete. It is recommended that biodegradable mulch be incorporated into the soil at the end of the harvest or growing season. Cover crops can be planted the next day after biodegradable plastic mulch has been disked into the soil. In November, 2012, the National Organic Standards Board approved the use of biodegradable plastic mulches (officially referred to as “biobased mulch film”) for use in organic crop production. Any biobased mulches from GMO starch sources are still prohibited. Organic growers are urged to be alert to improved cultural methods for insuring the rapid decomposition of biobased mulches.

Field research has demonstrated that biodegradable mulches produce comparable crop yields to non-degradable plastic mulches. Two issues that growers may be apprehensive about are the initial cost of the biodegradable mulch compared to non-degradable mulch and the unpredictability of degradation rate. The initial cost is somewhat offset because disposal costs are eliminated.

Below are some tips on using biodegradable mulch (excerpted from A. Rangarajan, Cornell University):

Storage

- Buy what you need each year. Product performance will be best with new product. More rapid degradation may be seen with older product.
- Store mulch rolls upright, on ends. Pressure created from stacking may lead to the mulch binding together or to degradation.
- Store mulch rolls in a cool, dark and dry location. These products will start to degrade if stored warm, in sunlight and if rolls get wet.

Application

- Do not stretch biodegradable mulch as tightly over the bed as standard black plastic (contrary to recommendations for black plastic that performs best when laid tightly over the bed).
- Stretching starts the breakdown of the biodegradable mulch.
- Stretching will increase the rate of breakdown
- The product will mold to the bed like commercial food wrap soon after application.
- Apply immediately prior to planting
- Sunlight and moisture will start breakdown.
- If applied too far in advance of planting, the mulch may not last as long as needed.

Incorporation into soil

- Chisel or till the mulch into the soil as soon as possible after harvest to maximize breakdown
- Breakdown requires warm soil temperature and moisture. If mulch is incorporated after soil temperatures have dropped the mulch may still be visible in the spring. However, as the soil warms, the product will further degrade and fragment

.

- Rototilling will result in smaller mulch pieces that breakdown faster
- Rototilling will result in smaller mulch pieces that breakdown faster
- Mulches will break down more quickly in soils with higher organic matter

Row covers. These materials are being used for frost protection, hail protection, to hasten the maturity of the crop and also to effectively exclude certain insect pests. Currently, vented clear and translucent plastic covers are being used. Row covers are supported by wire hoops placed at 3- to 6-foot intervals in the row. Porous floating row covers are made of lightweight spun fibers (polyester or polypropylene) placed loosely over the plants without wire hoops or plastic placed loosely over the plants without wire supports. Floating covers are more applicable to the low-growing vine crops and strawberries than upright plants like tomatoes and peppers. Upright plants have been injured by abrasion when the floating row cover rubs against the plant.

The clear plastic can greatly increase air temperatures under the cover on warm sunny days, resulting in a danger of heat injury to crop plants. Therefore, vented materials are recommended. Even with vents, clear plastic has produced heat injury, especially when the plants have filled a large portion of the air space in the tunnel. Heat injury has not been observed with the translucent materials.

Row covers are usually put out over plastic mulch using a combination of mechanical application and hand labor. Research and development is under way on equipment that will cover the rows in one operation. However, farmer-made equipment in conjunction with hand labor is currently the most prevalent method.

Each grower considering mulches, drip irrigation, and/or row covers must weigh the economics involved. Does the potential increase in return justify the additional costs? Are the odds in the grower's favor of getting the most benefit in terms of earliness and yield from the mulch, drip irrigation, or row covers? Does the market usually offer price incentives for the targeted earlier time window? Are you competing against produce from other regions? Each grower must obtain the costs for his situation, calculate the potential return, and come to a decision as to whether these strategies are beneficial.

Mulch removal. Several methods of removing the plastic have been tried, but on small acreages it is removed by hand by running a coulter down the center of the row and picking it up from each side. Commercial tractor mounted mulch removal equipment is also available.

High-quality, black plastic mulch can be used for two successive crops during the same season when care is taken to avoid damage to the mulch film. Thin wall (4 to 8 mil) trickle irrigation tape cannot be removed and reused. However, high-quality, 16-mil trickle tubing can be used a second season provided that damage is minimal and particles are excluded, allowing pores to be open when carefully removed.

Crop foliage and weeds may increase the difficulty of mulch removal. Eliminate vegetation prior to replanting or removing mulch with herbicides (see Section E), or delay removal until after frost.

Disposal. Dispose of used plastic in an environmentally responsible manner. Regulations on disposal vary according to State and municipality. Contact your local solid waste authority for recommended methods of disposal in your area. Some states have developed specific programs for recycling of agricultural plastics. Individual state authorities should be consulted to learn the specifics.

STAKING AND TRELLISING

Many vegetable crops benefit from the addition of structural supports on which they are grown in the field. The benefits include: 1) better utilization of available space and light; 2) improved air flow for more rapid drying of foliage; 3) reduction in certain disease pathogens; 4) protection against plant breakage; 5) protection of developing fruits and other plant parts against rain, dew, and sun; 6) ease of harvest, and 7) possible higher net yields. The disadvantages include mainly cost of materials and installation, and disposal. Each grower must assess his/her broad situation on a case-by-case basis in deciding whether a structural support system is desirable.

Vegetable crops in which structural support systems have been used successfully include fresh market grape and cherry tomatoes, peppers, eggplants, legumes, cucumbers, and okra. The types of materials and how they are assembled differ for each crop. Specifics of the design and installation of structural support systems are included in Section F. If materials fail during the growing phase, the resulting damage can be catastrophic. It is advisable, therefore, to utilize high quality materials in the construction of all structural support systems, and to adhere to minimum size and spacing recommendations. For wooden stakes, it is recommended that a clear hard wood source be used.

It is a common practice to re-use wooden stakes over many production seasons in the field. Since they are in contact with the environment and plant material while being used, there is a significant probability that surfaces will become infested with pathogens, especially bacteria. If left untreated, re-used infested stakes may re-introduce diseases into the field, although the extent of this problem has not been determined. Therefore, it is recommended that re-used stakes be thoroughly disinfested.

The preferred (and most expensive) method of stake disinfestation is heat treatment. Pathogens are completely eliminated from wooden stakes with exposure to $\geq 220^{o}$F for $\geq$ 15 minutes. This can be accomplished in a large capacity autoclave, or seed dryer. It is unlikely that most growers will have access to such equipment. Alternatively, therefore, stakes may be exposed to disinfectants such as commercial bleach (sodium hypochlorite) or Oxidate® (hydrogen dioxide; see below). Research has shown that a 20-minute soak in a solution made of 5 – 20 parts by volume sodium hypochlorite (commercial bleach) to 80 – 95 parts by volume water is effective in eliminating pathogens ***only from the surface*** of wooden stakes. It is crucial to maintain the pH of the bleach solution within the 6.0-6.5 range, as effectiveness decreases at lower and higher pH levels.

Studies on stakes treated with bleach solutions show that pathogens may still be present beneath the surface at depths $\geq 1/16^{th}$ inch. Pathogens embedded deep within the stake may be able to migrate back to the surface and re-infest plants, although this possibility has not yet been demonstrated. To improve the effectiveness of strategies to remove microbial pathogens from the surface of re-used stakes, consider the following: Add a non-ionic surfactant to the disinfesting solution; increase the soaking time to ≥1 hour; apply a vacuum during the stake soak; use a higher concentration or more potent source of hypochlorite (such as “heavy duty” or swimming pool grade chlorine); or use stakes comprised of non-absorbent stake materials (such as plastic or metal). Many growers have successfully used the commercial product Oxidate® or chlorine dioxide to disinfest stakes. Oxidate® is OMRI certified and had been demonstrated to be an effective control agent for several important plant pathogens is available, however no research to establish the efficacy as a stake of this disinfesting agent as compared to heat or commercial bleach.

HIGH TUNNELS

High tunnels are designed to improve growing conditions during the early spring and late fall growing seasons and to accommodate workers and equipment. In the Mid-Atlantic region. year-round production of specialty crops is possible using a freestanding high tunnel (Table A2). High tunnels are either freestanding or connected at the gutters to cover larger areas. Freestanding tunnels are between 14 and 30 feet in width and up to 100 feet in length. High tunnels are typically tall enough so that a person can stand straight up in at least part of the structure. While high tunnels are not greenhouses (generally no heat or automatic ventilation), the greenhouse principle is the basis for the function and design of a high tunnel.

Taking the time to level the tunnel site prior to construction will make subsequent steps much easier. Spacing between high tunnels should be at least the width of the tunnels to facilitate snow removal to provide for cross ventilation, and to reduce mutual shading. For freestanding high tunnels, metal bows approximately 1.75 to 2 inches in diameter are used as the support frame for a single layer of polyethylene covering (typically 6 mil greenhouse plastic that lasts 3-4 years). These bows are spaced 4 feet apart and are connected to metal posts, which are driven at least 2 feet into the ground. The end walls generally have removable framing (Penn State design) to allow the use of power tillage equipment within the tunnel (see high tunnel component list at the following website: http://plasticulture.cas.psu.edu).

Once the high tunnel is covered with plastic film, prepare the soil, apply and incorporate lime and preplant fertilizer as recommended for the intended crop or crops (See section F). High tunnels can considerably increase yield potential, thereby increasing nutrient requirements. Plant tissue testing should be conducted at important growth stages during the season to ensure adequate fertility requirements are maintained. See section B for more details. Make beds, if needed, and install drip irrigation to supply moisture. Using a small bedmaker/mulch layer, cover soil or beds with black or clear polyethylene to warm soil for spring crops. When transplanting crops into tunnels during July and August, use white or silver polyethylene mulch on the soil or beds rather than black polyethylene to reduce soil temperature and excessive heat buildup in the tunnels.

For freestanding high tunnels, snow removal from the top of the tunnels may be necessary after heavy, wet snowfalls. In addition, it is recommended that heavy snowfall be removed from the sides of the tunnels as needed to reduce/eliminate outside water intrusion into the tunnel and collapse of the tunnel sidewalls. Gutter-connected high tunnels are constructed with much lighter posts and bows and cannot be used for crop production during the winter. During the winter season, the plastic on gutter-connected high tunnels must be bundled and moved to the gutters for storage. Hence, freestanding high tunnels allow for year-round production while gutter-connected tunnels do not.

The keys to successful production of vegetable and other horticultural crops in high tunnels are crop scheduling, ventilation and moisture control. Table A-2 provides a relative planting and harvest schedule for some vegetable crops produced using freestanding high tunnels in the Mid-Atlantic region. When planting high tunnel crops in the spring, it is generally recommended to transplant the vegetable crop about two to four weeks earlier compared to the earliest planting date in the field on bare ground. If unusually cold night temperatures are experienced several days to weeks after planting the vegetable crop in the high tunnel, floating row covers, low tunnels, thermal blankets and/or portable clean burning propane heaters (11,000 to 44,000 Btu per hour) can be placed in the high tunnel until more seasonal temperatures return to the location.

The most critical component of the system is ventilation. In freestanding high tunnels, ventilation is accomplished by rolling up the sides of the tunnel to the batten boards, approximately 5 to 6 feet above the ground on each side of the tunnel. In gutter-connected high tunnels, ventilation is accomplished by sliding the plastic covering aside creating ventilation openings in the roof bows, as well as by opening the end walls. Maintaining optimum growing conditions inside high tunnels without having extreme fluctuations in temperature and/or high humidity conditions will guarantee early, high yielding and high quality horticultural crops. Checking and adjusting high tunnel internal temperature and humidity conditions several times a day will help ensure increased crop yields and profitability.

Depending on the crop to be grown, there are several production systems that can be used in a high tunnel. Conventional tillage and establishment of the crop in soil may be efficient for cool season crops that can be direct seeded or transplanted, Swiss chard, spinach, collards or kale. For warm season crops, especially cucurbits (cucumbers, squash, cantaloupe and watermelon) and solanaceous crops, (potato, tomato, pepper and eggplant) use of raised beds with plastic mulch and drip irrigation is required for optimum yield, maturity and quality. Warm season vegetable crops dramatically benefit from higher soil temperatures in early spring in high tunnels. In addition, multiple cropping is possible from the initial raised bed/plastic mulch – drip irrigation system established in the spring. Permanent raised beds with a width of 24 inches may also be constructed in the high tunnels using wooden boards measuring 2 by 12 inches. Use of permanent raised beds may limit crops grown on them depending on the distance between raised beds (center to center) within the high tunnel. Some growers successfully use 30-36 quart potting soil bags that are drip irrigated to grow their high tunnel crops. These bags are placed end-to-end in rows and on a landscape fabric. Either one or two drip irrigation lines are inserted through each bag. High tunnel culture minimizes some diseases by reducing splash dispersal. In addition, appropriate adjustment of the plastic sides also will minimize leaf wetness duration.

Some diseases are prevalent in high tunnel environments. Leaf mold, powdery mildew, timber rot and Fusarium wilt can become problematic. Cultural practices such as sanitation (removal of plant refuse), grafting and compost amendment can minimize disease. Fumigants can be used to reduce levels of soilborne pathogens. Conventional fungicides and several OMRI approved fungicides are available for in-season management. When high tunnel sides are raised, fungicides and bactericides labeled for field use are allowed. When sides are lowered, fungicides and bactericides labeled for greenhouse use should be used (see Table E-15 "Selected Fungicides and Bactericides Labeled for Greenhouse Use" for specific disease and crop recommendations). See also Rutgers Cooperative Extension Fact Sheet No. 358 titled: "Important diseases of tomatoes grown in high tunnels and greenhouses in NJ". This can be found at the website njaes.rutgers.edu/pubs/ and select All Fact Sheets and Bulletins. This information is applicable to all states in the Mid-Atlantic U.S. region.

Table A-2. Relative planting and harvest schedule for freestanding high tunnel vegetable crop production in

Crop	Planting Method[2]	High Tunnel Planting Date	High Tunnel Harvest Date
Beet	TRP or DS	February-April; August-October15	October-May
Bean (snap)	DS	April-September	June-October
Broccoli	TRP or DS	March-April; August	May-June; October-November
Cabbage (green)	TRP or DS	March 15-May15 August	May-December
Cabbage (Chinese)	TRP or DS	February15-April 15	April-June; October-December 10
Carrot	DS	February 1-April 15 August-October	March-June November-December
Cauliflower	TRP or DS	March 15-April 15 August	May-June October-December10
Chard	TRP or DS	Year-round	Year-round
Cucumber	TRP or DS	April-September 1	May-October
Eggplant	TRP	April 15-August 15	July-October
Garlic	DS	October-November	June-August
Kale	TRP or DS	January-April 15 August-October 15	February-June September-January
Kohlrabi	TRP or DS	August	October-December
Leek	TRP or DS	February 15-November 1	Year-round-
Lettuce	TRP or DS	February 1-October 1	February-December
Onion (green)	TRP or DS	October-December February-June	March-December
Pea	TRP or DS	February 14-April 15 August-September 10	May-June October-November
Pepper	TRP	April-July 20	June-November
Potato (Irish)	DS	February 14-March 15 August	May-June October-November
Radish	DS	February-April October-December	February-May November-January
Spinach	DS	January 1-May 1 August-December	January-May October-December
Summer Squash	TRP or DS	April-May	May-June
Tomato	TRP	March 25-July 15	June 15-December 5
Watermelon	TRP	April	June-July

(table continued next column)

Table A-2. Relative planting and harvest schedule for freestanding high tunnel vegetable crop production in

GREENHOUSE PRODUCTION

Many growers have an interest in increasing productivity as well as having a seasonal product such as tomato and sweet pepper year round. To do this in the mid-Atlantic U.S., a temperature controlled structure such as a greenhouse is needed. Greenhouse production requires a much greater level of and often entirely different strategies of management compared to field production. Greenhouse production generally requires different varieties, nutrient sources, and pest management than field production. The extensive differences between greenhouse and field production preclude the inclusion of these techniques in this guide. There are many complete guides for the production of vegetables in greenhouses that have been developed and distributed through the cooperative extension service in various states. Links to several have been provided below. This list is not all inclusive and does not indorse these guides exclusively.

http://www.caes.uga.edu/publications/pubDetail.cfm?pk_id=6281

http://msucares.com/pubs/publications/p1828.pdf

http://edis.ifas.ufl.edu/topic_book_florida_greenhouse_vegetable_production_handbook

WILDLIFE DAMAGE PREVENTION

Farms provide food and shelter for a variety of wildlife species. Although many wildlife species do not cause damage to agricultural crops, some can inflict serious economic losses on growers. What often makes effective resolution more difficult is that surrounding private lands and suburban neighborhoods provide refuge for wildlife that may be causing damage on farms and to which a grower has no access.

A wildlife damage management plan that proactively prevents or reduces conflict is recommended. As a part of your plan, you should delineate areas of your property where zero tolerance for damage exists, while other areas most likely can tolerate some damage. In most instances, wildlife of damage represents another cost of doing business; it's the severely damaging episodes must be avoided. The plan also should specify what management techniques you want to utilize and when they would be employed. Wildlife damage management practices can be divided into 3 major categories: husbandry methods, non-lethal techniques, and lethal techniques. This also is the order in which application should be implemented; lethal techniques are methods of last resort. Growers should recognize that many approaches will have varying levels of effectiveness and acceptable risk. Generally, an integrated wildlife damage management approach that employs several damage abatement techniques proactively over time will be more effective than a reactive strategy that relies on only a single approach.

A wide variety of damage management options exists, but not all may be suitable for use in all cases. Some options are more effective than others; some are temporary and intended for short-term, localized use, whereas others are more suited to permanent, long-term needs. Each situation where conflict between wildlife and people is occurring is likely to be unique, so management options usually need to be tailored to a specific site.

Capital and implementation costs associated with each management option also vary. Before you make any decisions regarding the management technique you may choose to employ, estimate the direct and indirect annual losses you actually experience from wildlife damage. An example of a direct cost would be the yield lost by consumption of the crop by wildlife. An indirect cost would be the amount of time you spend, over the course of a year, trying to reduce or eliminate wildlife damage. Calculating an estimated total annual cost, in terms of actual economic loss due to wildlife, will help you decide which strategies are the most cost-effective. In some instances, it may be more practical to simply tolerate damage than to attempt to manage it. To determine the need for control, to select the most appropriate control technique, and to evaluate the techniques' effectiveness, it's always best to conduct pre- and post-treatment surveys.

Prior to employing any damage abatement practice, you must assure that you have correctly identified the species doing the damage. Do not assume that because you see an animal on your farm that it is causing damage. Wildlife populations are regarded a public resource and many of the animals that may cause damage to your farm are protected by state and federal laws. In addition, many damage management practices (e.g., trapping, shooting, pesticide applications) are species specific and based on established regulation or code. If you mistakenly assign blame for damage to the wrong wildlife species, in addition to employing a technique that may not be effective, you also may find you are using an illegal approach. Therefore, before implementing any management practices, check with your county extension agent, local conservation police officer, or your district wildlife biologist to review depredation permit requirements and/or legal issues related to "take" or use,

Deer Damage

Deer damage may occur in the form of feeding, antler rubs, and/or trampling of crops. Browsing (feeding) damage from deer can be recognized by a torn, jagged appearance on vegetation or a ragged break on woody material. Most browsing damage occurs from ground level up to 6 feet above ground level. Residual damage may occur from the trampling or matting down of vegetation as deer travel through crop fields or bed down to rest. Antler rub damage, which occurs as males shed the velvet from their antlers each autumn, can be identified as scarred saplings, broken limbs, bruised bark, and/or exposed wood. Rubs usually are located on the trunks of trees up to 3 feet above ground level.

An effective deer management strategy should incorporate several alternatives, considering the full suite of available husbandry, non-lethal, and, where warranted, lethal options. Recognize that each method carries with it both benefits and drawbacks; therefore, an accurate assessment of management needs and likely outcomes is critical.

Habitat Modification is a form of husbandry that involves changing the landscape to make an area less attractive to deer. White-tailed deer are creatures of edges; they prefer habitats where two or more vegetation types or age classes meet. Habitat modification usually involves eliminating vegetation, planting non-palatable ("deer-resistant") species, or creating cover or foraging areas to attract deer away from managed areas. This strategy has been used effectively to reduce incidences of deer-vehicle collisions and also browsing on residential vegetation and commercial landscaping.

Harassment or scare tactics are intended to persuade deer to leave an area where they are not desired. Examples of scare techniques include dogs, auditory deterrents, such as propane cannons and sonic devices, and visual deterrents, such as bright lights. Although audio and visual deterrents are used more often on farms, dogs contained within invisible fencing have been used with some success on farms, depending on the number and aggressiveness of dogs and size of area needing protection. Dogs tied to chains or ropes are not effective because deer can detect that the dog's movement is restricted. Hazing campaigns generally are better suited for areas where damage from deer is minor or where other strategies may be prohibited (e.g., hunting).

Fencing can be an effective management tool for eliminating or reducing deer damage and, in some cases, may be the preferred damage abatement option. When attempting to protect large areas, permanent high-tensile wire (HTW) fences are recommended. These fences consist of a series of electrified smooth wires spaced about 8 inches apart and extend about 8-10 feet in height. HTW fences are durable and long-lived, but do require periodic maintenance and monitoring to assure maximum cost-effectiveness. Temporary HTW electric fencing or fences that use polytape strands are other alternatives, usually best suited to for smaller acreages. When using any form of electrified fencing, the unit should be charged at all times to prevent deer from becoming habituated to it and gaining confidence by testing it during down times. Electric fences that have been baited with an attractant (for example peanut butter) demonstrate noticeable enhanced success over non-baited fences, as deer are more likely to develop an immediate association between the fence and its negative consequence when drawn in by baiting. The addition of cloth strips, flagging, and reflectors certainly increase visibility, but have displayed only marginal improvement in efficacy over fences lacking such visual cues. Although other fencing alternatives exist, such as double-barrier fencing (2 rows of fence placed approximately 4 feet apart), heavy plastic fencing, and strands of monofilament line decorated with flagging tape streamers, none provide the level of protection or cost-effectiveness of a well designed and properly installed and maintained electric HTW fence. It is important to note that no type of HTW fence will eliminate all penetration by deer. If complete and absolute protection from deer is desired, the only fence design that can guarantee that outcome is a 10 foot tall (minimum) woven wire fence. However, in most situations, producers typically cannot justify the costs of procurement and installation of such a fencing system.

Repellents produce tastes, odors, or a combination of taste and odor that animals find offensive and thus are encourage deer to avoid the area being protected. There are 2 types of repellents: contact repellents and area repellents. Contact repellents are applied directly to vegetation or objects by spraying, shakable powders, or using a brush and repel by taste and/or odor. Area repellents are applied in the general vicinity of the protected object and repel primarily by odor. Repellents are can be expensive, based on initial cost of materials, but more so by the need for frequent reapplication. Rain can wash repellent off of protected vegetation, even if a "sticker" is used. The attractiveness of the food resource to deer, the density of deer in the area, and the availability of other natural foods in the area all influence effectiveness. Many repellents are labeled for use only on dormant vegetation or on non-consumable products, so growers must be sure to follow the manufacturer's instructions. Repellents used during the growing season must be applied as new plant growth emerges to assure for maximum effectiveness. Regardless of the type of repellent used, all repellents are intended to reduce, rather than eliminate, deer damage; repellents should be used in conjunction with other damage abatement techniques to maximize overall success.

Reproductive Abatement

Although there is great interest in and much research being conducted on the use of **Contraceptives** (chemicals given to female deer to disrupt reproductive behaviors), only specially trained wildlife professionals are permitted to administer this treatment (typically through use of a dart gun). To date, no effective reduction in population numbers, and thus a concurrent reduction in damage, has be achieved using contraceptives in free-roaming populations of deer. Success has been realized only in isolated contained populations where access to nearly all members of the population can be attained (e.g., on islands, in confined city parks, etc.). This is a labor-intensive and costly strategy, and because individuals consistently move into and out of a population, is extremely difficult to treat a sufficient number of individuals or to know which individuals already may have been treated. Research to improve fertility control methods is ongoing.

Trap and transfer involves trapping deer in a specific area and physically moving them to another location. There are several techniques for trapping deer, including box traps, Clover traps, netted cage traps, drive nets, drop nets, rocket nets, corral traps, net guns, and immobilization drugs delivered through a dart. This strategy is labor-intensive, costly, and impractical at large scales due to poor survival of translocated individuals, a lack of suitable relocation sites, and the risk of spreading disease. Most states now ban the translocation of deer. **This practice is not permitted in some jurisdictions (e.g. Virginia). Consult your local Wildlife Management Authority.**

Trap and euthanasia involves trapping deer and euthanizing the animal according to methods approved by the American Veterinary Medical Association. Deer are baited to a trap site and captured using box traps, Clover traps, drop nets, or rocket nets. Once captured, deer may be chemically immobilized prior to euthanasia. Approved methods for inducing death are barbiturate injections delivered intravenously or into the abdominal cavity, inhalant anesthetics, or potassium chloride in conjunction with general anesthesia. Use of a penetrating captive bolt gun is also approved if the animal is restrained to allow for accuracy. Captive bolt gun euthanasia is considered controversial because deer euthanized in this way can experience trauma if the process does not occur quickly. This method also is labor intensive and more expensive than other management strategies. Chemically or captive bolt gun euthanized deer cannot be consumed by humans. **This practice is not permitted in some jurisdictions (e.g. Virginia). Consult your local Wildlife Management Authority.**

The Community-Based Deer Management Program addresses the need for deer population reduction in environments where traditional management methods are not an option. Under this program the state Fish and Wildlife authority cooperates with municipal, county, and federal agencies to provide technical assistance in developing alternative deer management options. Some options include sharpshooting, noise-suppressed firearms, and controlled hunting. State authorities have issued permits for special deer management areas where alternative control methods may be employed. Alternative control methods may only be employed after a series of municipal and state approvals are granted. **This practice is not permitted in some jurisdictions (e.g. Virginia). Consult your local Wildlife Management Authority.**

Regulated hunting involves the use of hunters to harvest deer in accordance with defined seasons, bag limits, and population objectives. Hunting legally takes place during any of the various deer hunting seasons (archery, muzzleloaders, shotguns, and general firearms) established by the state Fish and Wildlife authority. Regulated hunting is the most cost-effective and efficient method to manage deer populations and is the only means to manipulate deer numbers statewide. See your state Fish and Wildlife authority for details on these permits.

Permits to Shoot, commonly referred to as a "Depredation Permit" or "Kill Permit" are issued by the state Fish and Wildlife authority to owners or lessees of land who are experiencing crop damage. Localized or conditional hunting permits are highly variable among jurisdictions, **consult your local authority**. These permits allow growers a mechanism to manage damage situations during times of the year when the regulated hunting season is closed and "take" normally would not be allowed. Depredation permits also may help regulate local deer populations, particularly in areas that receive only limited hunting pressure (i.e. farms surrounded by residential properties). For more information or to apply for a depredation permit, contact your state Fish and Wildlife authority.

Controlled hunts combine conventional deer hunting methods with more stringent controls and restrictions on hunter activities. Participants in controlled hunts are chosen by various methods, ranging from random lotteries of licensed hunters to rigorous hunter-selection processes designed to determine hunting proficiency and disposition as means to reduce conflicts with the public or other hunters. Specific restrictions and controls applied to hunting activities will depend upon the needs and concerns of landowners, elected officials, and other stakeholders, but they usually involve measures similar to hunting regulations during normal deer hunting seasons.

Because deer populations range over multiple parcels or farms, management of deer numbers cannot be implemented effectively on single properties. Research clearly indicates that greater success in attaining population objectives can be achieved by developing and implementing a comprehensive **Community-Based Deer Management Program,** especially in environments where traditional management methods are not an option. Under such a program, the state Fish and Wildlife agency works with municipal, county, and federal agencies to develop alternative deer management options tailored to that specific community. Some options include sharpshooting, noise-suppressed firearms, and controlled hunting. State authorities have issued permits for special deer management areas where alternative control methods may be employed. Alternative control methods may only be employed after a series of municipal and state approvals are granted.

Woodland and Meadow Vole Damage

It is important to determine which species of vole occurs in your crop production sites. The two species of voles most commonly associated with depredation issues in the Mid-Atlantic region are the meadow vole (*Microtus pennsylvanicus)* and the woodland vole (*Microtus pinetorum*). Meadow voles, also called meadow mice, are about 5 ½ to 7 ½ inches long, with fur that ranges from gray to yellow-brown with black-tipped hairs; they also display a bi-colored tail. Woodland voles are about 4 to 6 inches in length, have red-brown fur, and a tail about the same length as the hind foot. Vole populations are cyclic, where cycle peaks last approximately 1 year before the population abruptly crashes. It is during these peak times where the potential for significant crop damage is greatest.

Because voles remain active year-round, the damage they cause to crops can occur at any time, depending upon the crop being grown. In vegetable crops, damage usually occurs in spring, as young plants are emerging from the ground. Voles are generalist herbivores, so they feed on roots, shoots, tubers, leaves, and seeds of many different plants. Meadow voles spend much more time above ground than do woodland voles, but both species inflict serious damage by feeding on the subsurface root systems of plants. Aboveground damage frequently consists of their gnawing on woody perennial plants, sprouts, and suckers that emerge from the base of such plants. Meadow voles construct surface runways (approx. 1 ½ to 2 inches wide) under or within the accumulated organic matter and duff layer that exists in fields; these runs often terminate at a 1" diameter wide hole that drops into an underground burrow network. In contrast, pine voles remain underground and inflict damage in the form of root girdling, which often goes unnoticed until severe damage already has occurred and the plant is in rapid decline. Both species are known for constructing burrows that follow trickle irrigation lines or areas where the soil has been loosened by mechanical planters.

Cultural Practices and Habitat Modification measures are helpful in deterring vole populations. Voles avoid areas with few food resources and little protective cover. Control of ground vegetation with herbicides, mowers, or disking is effective, although voles will travel under snow cover in these areas. Herbicides are the preferred method to eliminate sod. Cultural practices that reduce the amount of organic litter around plants is essential. All areas should be kept clear of debris, stored objects (such as bags, boxes, pruned branches) because these items provide protection to voles and can hinder mowing and proper bait placement. Plastic or synthetic weed barriers will encourage the establishment of vole populations, so use of these materials should be avoided. A final close mowing of the row middles, after harvest, should be utilized annually to further reduce habitat and cover for rodents and to enhance the effectiveness of natural predators (such as hawks and owls).

Exclusion methods are feasible only at small scales and to protect high-value crops. Hardware cloth or woven wire fences (≤ ¼ inch) can be installed to a height of 1 foot above ground and buried to completely contain the rooting system of the plant. There are some newer products composed of sharp-edged rock or pumice granules that can be used to line the planting hole and will act much like a barrier against digging. This requires significant hand installation, so an analysis of cost-effectiveness is necessary before considering such methods.

Repellents that contain predator urine (coyote and fox) have demonstrated limited effectiveness in reducing vole numbers, primarily through the effects of stress on reproduction rates. However, repellents are expensive and offer only short-term relief from damage. Repellents that contain thiram and capsaicin are not approved for use on plants grown for human consumption.

Trapping may be useful only where vole damage is localized (<1 acre). Place snap traps perpendicular to the runway with triggers in the runway at a frequency of 2 to 3 traps per runway. All traps should be covered by a weighted box or pail to prevent non-target captures. Multiple-catch mouse traps also have been used to trap voles. Because the trap holds multiple individuals, fewer traps are necessary. In addition, non-target animals can be released unharmed. Bait multiple-catch trap entrance points with seed. If a trap is unsuccessful for 2 consecutive nights, move the trap to another location.

Toxicants are used to control large vole populations and most are classified as Restricted Use Pesticides (RUP); these products can be applied only by a pesticide applicator who possesses both a general applicator certification and the advanced certification for vertebrate application (Category 7D). The only General Use Pesticide (GUP) approved for use in vole control is warfarin (alone or in combination with imidacloprid). Individual voles must ingest the bait 3 times to sustain a lethal dose. Therefore, bait stations must be continually maintained to ensure success.

Zinc phosphide is a single-dose RUP available as a concentrate or in pelleted or grain bait applications. Because of its foul taste, voles may avoid bait stations. Pre-baiting stations with untreated food for 2 to 3 days prior to applying the pesticide may increase success. Anticoagulants may also be effective in controlling vole damage. However, anticoagulant baits are slow acting and may take up to 15 days to be successful. Furthermore, most anticoagulants require more than one feeding for maximum effectiveness.

To avoid injury to non-target species, the use of bait stations is recommended and may be required in some states. Broadcasting bait across the area, or placing bait in piles or on bare soils, is not allowed. Shingles and tires used as bait stations are acceptable under state Pesticide Laws. However, the bait may not stay dry for long and quickly becomes ineffective when wet. In-furrow placement of zinc phosphide pellets is approved for corn and soybeans under a no-tillage management system. Hand placement of baits directly in runways and burrow openings within the tree drip line is essential for woodland vole control because of their subterranean behavior

To ensure the legality of a particular toxicant in your state, information can be obtained by calling your Pesticide Control Program. As with all use of toxicant products, follow the product's labeling guidelines.

Rabbit Damage

Rabbits can damage vegetation by clipping branches, stems, and buds. Damage may become especially pronounced during the heavy snow cover on overwintering vegetables or in the spring when plants are emerging from the ground. Vegetation that has been clipped by rabbits is characterized by a cleanly snipped, 45-degree angle cut where the damage has occurred. Rabbit tracks and their pelleted scat are easily recognizable.

Growers should adopt **Cultural Practices** and conduct **Habitat Modification** to maintain well-groomed plots and eliminate brush piles, heavy vegetation, and other cover in and adjacent to crop production sites that serve as nesting sites. However, removal of cover may be detrimental to other desirable wildlife species that also depend on brush piles for protection or shelter. Habitat modification techniques that enhance the success of rabbit predators (i.e. fox, coyote, and raptors) will help to regulate rabbit numbers. Planting alternative crops in adjacent tracts has been suggested as a means to deter them from high-value crops, but this approach typically serves to attract or support higher numbers of rabbits.

Exclusion of rabbits through use of fencing can be effective. A 2-foot high fence consisting of 1-inch or smaller mesh and constructed of any metal (rabbits will gnaw through plastic) will eliminate most rabbit damage. To prevent rabbits from accessing snow-covered fields, consider increasing the height of the fence. The bottom of the fence should be buried 12 inches in the ground and bent outward away from the crops at a 90-degree angle. Larger areas can be protected with double-strand electric fencing.

Rabbit guards made of metal wire with ¼- to ¾-inch mesh may be effective in protecting individual high value specimens. Hardware cloth can also be used. Rabbit guards should be placed 1 to 2 inches away from the plant. Do not allow debris to accumulate inside these screen guards as this creates an ideal environment for borer infestation and may attract voles. All guards should be anchored at ground level. A good way to do this is with several shovel-fulls of pea-sized gravel, placed inside and outside the guard. The gravel will also prevent mice from injuring plants.

Miscellaneous Methods. Harrassment techniques, such as dogs and water-driven scarecrows, provide only short-term protection. Contact (e.g., thiram-based) and area (e.g., naphthalene) repellents have also been used for rabbit control with variable effectiveness; however, most rabbit repellents are not approved for use on foods grown for human consumption, so check the active ingredients of any product before use. Rabbits are classified as a game species and, as such, can usually be hunted during open rabbit seasons. Finally, trapping rabbits using either homemade or commercial live-traps may be a viable option if damage is not too extensive. Consult the state Wildlife agency prior to implementing any hunting or trapping program to assure compliance with existing regulations.

Groundhog Damage

The most obvious signs of groundhog presence, aside from actually seeing the animal, are the entrances to a groundhog burrow system. Groundhog burrow systems are characterized by a large mound of excavated earth at the main entrance. The diameter of the main entrance may measure 10 to 12 inches. There are usually 2 or more additional entrances to a burrow system, and the secondary entrances usually will be well hidden. Groundhogs prefer leafy vegetable crops, but will utilize any crop throughout the growing season Seasonal or cyclic reproductive patterns may influence population numbers and the extent of damage.

Habitat modification is not a feasible strategy for minimizing groundhog damage.

Exclusion with fencing can be an effective short- or long-term strategy, depending on the type of fence used and the size of the area to be protected. An electric wire placed 3-4" above the ground can deter groundhogs from entering a desired area. However, a determined groundhog eventually will dig under the wire and gain access to the protected area.

Woven mesh or chicken wire fencing provides a more permanent solution. Mesh openings should be ≤ 2.5 inches, and the fence should extend at least 3 feet from the ground. The top 15 inches of the fence should extend backward at a 45^o angle to prevent individuals from climbing over the top. To prevent groundhogs from digging under the fence, the bottom edge of the fence should be buried at least 10 inches beneath the ground, with an additional 6-8" section bent outward at the bottom of the trench. Groundhogs are excellent climbers, so fence posts should be placed on the inside of the fence and greater deterrence has been achieved where the fence material is not drawn taut or rigid, but instead left somewhat loose.

Fumigants are effective in reducing groundhogs. Gas cartridges (sodium nitrate) currently are registered for this purpose. Ignited gas cartridges are placed in the burrow system after all but the primary entrance are sealed. As the cartridge burns, thick fumes are emitted and fill the burrow system. Burrows can be treated with gas anytime of the year, but this method is most effective in the spring before the young emerge. Gas cartridges are a GUP and can be purchased at most farm supply stores. A note of caution when using gas cartridges – because the gas cartridge must be ignited for proper use, a fire hazard does exist. Therefore, gas cartridges should not be used in burrows located under wooden sheds, buildings, or near combustible materials. Newly resident animals may recolonize empty burrow systems, so continued vigilance in recommended.

Aluminum phosphide tablets, placed deep inside the main burrow entrance, are another type of fumigant that can provide effective groundhog control. The tablets react with the moisture in the soil, creating hydrogen phosphide gas. Soil moisture and tightly sealed burrow entrances are important for the fumigant to be used effectively. The tablets are approved for outdoor use on non-cropland and orchards. Aluminum phosphide should not be used within 15 feet of any occupied building or in areas where gas could escape into areas occupied by animals or humans. Aluminum phosphide is a RUP and can be applied only by a certified pesticide applicator.

Trapping is effective in removing particularly problematic individuals. However, new groundhogs from the surrounding area quickly will reoccupy the territory. Steel leghold traps are illegal in some states, so check with your state wildlife agency to determine what is legal. However, a medium-sized live trap baited with a variety of baits (e.g., lettuce, apples or plum tomatoes) can effectively trap groundhogs. Traps should be placed at main entrances or along major travel corridors and checked at least once every 24 hours. Once captured, the groundhog may be killed humanely or released off-site. If the groundhog is released, some states regulate where and how the live animal is handled. No releases are allowed on federal, state, county, or municipal land. **This practice is not permitted in some jurisdictions (e.g. Virginia). Consult your local Wildlife Management Authority.**

Shooting groundhogs that are damaging crops or farmland is approved at any time of the year. Although groundhogs are considered a game species in some states (it is a “nuisance species” in VA), farmers do not need a valid hunting license to shoot nuisance groundhogs. Growers should verify with the state wildlife agency which weapons that are legal for this purpose in your state.

Bird Damage

Blackbirds refer to a group of 10 species, including common grackle (*Quiscalus quiscula*) and brown-headed cowbird (*Molothrus ater*). The damage these birds inflict most often consists of holes and/or surface blemishes from the pecking of fruits, bulbs, or stems. Proper identification of the bird species doing the damage is relatively easy since it is common to see blackbirds in and around farming operations. European starlings (*Sturnus vulgaris*) and common pigeons (*Columba livia*) also are common to farms, where they inhabit the rafters of barns, warehouses, and other structures. Birds inside packinghouses represent a serious source of fecal contamination, which may violate USDA food standard guidelines. Fecal contamination of fruits and vegetables in the field can occur if fields are located near a bird roost where large numbers of birds congregate.

Blackbirds are considered migratory species and thus are granted protection under the federal Migratory Bird Treaty Act. Therefore, it is imperative to check with the state Fish and Wildlife authority before implementing any management to ensure compliance with state and federal wildlife laws.

Cultural Practices and Habitat Modification may provide some reduction of crop damage. Because the most severe instances of blackbird damage commonly occur within 5 miles of roosts, planting highly attractive crops outside of this radius is recommended. Blackbirds generally do not prefer soybeans, hay, wheat, or potatoes. By planting crops that are more attractive to blackbirds farther from known roost sites, damage from birds to these higher value crops may be reduced. Planting multiple crops at the same time in other nearby fields may to reduce damage overall as the abundance of resources simply overwhelms the birds' needs. Modifying or relocating roost areas may reduce the number of birds in the area. For example, eliminating stands of bamboo or thinning dense conifer stands have been shown to reduce crop damage by dispersing blackbirds away from crop fields. Removal of about of 1/3 of a tree's crown or a 1/3 of a stand of trees has been successful in reducing or dispersing birds from a roost. Keep in mind, however, that you are also modifying habitat used by other non-destructive bird species. Providing hunting perches for raptors may reduce blackbird numbers as a result of the threat of predation.

Exclusion typically is practical only on small acreages or for high-value crops. Lightweight netting has been used successfully to prevent bird damage either by draping it over individual plants or constructing a frame stretching netting over an entire block of plants. To prevent birds from entering packinghouses, netting or some other type of barrier, should be placed over openings larger than 1/2 inch. In doorways where frequent pedestrian, vehicle, or machinery traffic occurs, hang heavy plastic or rubber strips, or install self-closing doors to prevent birds from accessing the building.

Repellents can be used to mitigate bird damage. Methyl anthranilate, the primary ingredient of artificial grape flavoring, is registered by EPA for use as a bird repellent. However, methyl anthranilate remains viable for only approximately 3 days, so it loses maximum efficacy quickly when exposed to UV radiation and weathering. Sucrose solutions may be applied to fruits to deter birds, but the efficacy of this method is not well documented and actually may attract other pests, such as Japanese beetles.

Scare tactics have been shown to be effective for relatively short-term protection of vegetable crops. Blackbirds are intelligent animals and quickly will habituate to repetitive or predictable patterns and disturbances. Frightening methods must be changed and/or relocated often to maintain the desired effect. Frightening devices include both visual and auditory deterrents. Pyrotechnics (e.g., propane cannons and shotguns), mylar balloons and tape, raptor-shaped kites, scarecrows, flashing lights, water sprayers, and tape-recorded bird-distress calls or predator attack calls all represent examples of harassing techniques, but success of these devices varies substantially. In general, scare tactics should be activated early to mid-morning and mid- to late afternoon, when birds are most active. For maximum effectiveness, it is best to use two or more devices in combination with each other, vary the times and places they are employed, and be persistent.

Chemical frightening agents mixed into bait piles may be applicable in specific situations. Birds that ingest the treated bait fly in an erratic fashion, produce distress calls, and usually die. This unusual behavior triggers an alarm response the remaining birds in the flock, causing them to vacate the area. Dead birds should be collected and disposed of properly. However, use and application of such chemical agents is restricted only to certified applicators (usually representatives of USDA APHIS-WS). Check with your local county extension agent about the possibility of employing chemical frightening agents on your farm.

Miscellaneous Notes. Some states allow growers to shoot crows that are in the act of damaging crops, but this may not be universal in all states. Also, European starlings are considered to be a non-native species and thus do not have protection under migratory bird laws. Therefore, farmers are allowed to shoot starlings without need for any permit or further authorization, but it is recommended that farmers alert their municipality and/or neighbors to avoid negative consequences from the public.

Bear Damage

The damage caused by black bears to field crops often is characterized by localized, circular patches where nearly all stems or plants have been trampled, pulled down, or broken. In corn fields, bears usually will consume all the corn on a cob before moving on to another. Scat and footprints typically are present in the area of feeding activity. There are no guaranteed bear management strategies that offer complete protection against crop damage, but several strategies used in combination may offer some relief.

Cultural practices and habitat modification can help to deter bears from entering fields. Restricting access to potential food resources, such as storing feed in bear-resistant containers, disposing of animal carcasses, and removing organic wastes, will lessen the overall attractiveness of the property to bears. Containing livestock in pens away from wooded areas may reduce negative interactions, particularly during calving/lambing season. Because bears generally avoid open areas away from protective cover, maintaining a mowed buffer approximately 50 yards wide around crop fields, particularly where fields are adjacent to the woods, may reduce bear activity. Alternating or strip planting row crops may help reduce protective cover afforded to bears.

Fencing is very effective in reducing bear damage; however, fencing can be expensive and may not be cost-effective for all farmers. Electric fencing is the most effective design and thus is recommended in most instances. To be most effective, fences should utilize high voltage ~6,000 volts), low-impedance (short-pulsed) systems. When first installed, bears should be lured to the fence with an attractant (e.g., peanut butter, sardines) so they learn to associate the fence with a negative consequence. Fences should be baited at approximately 3 feet along the entire perimeter to encourage shock delivery to the muzzle.

Sensory deterrents have been used to deter black bears from crop fields. Pyrotechnics, horns, bright lights, propane cannons, and other such devices provide both visual and auditory stimulation. The success of these techniques is highly variable, and bears usually become habituated to consistent or repetitive disturbance. Sensory deterrents should be switched and relocated often to maximize effectiveness. Where bears have become tolerant of human activity, sensory deterrents often will not be effective. Human-conditioned bears can be dangerous, and caution is advised.

Shooting problematic black bears should be viewed as a last resort management practice, but may be necessary as means to reduce persistent crop damage caused by a single returning individual or family group. Special kill permits are required to "take" bears, so farmers need to work closely with their state wildlife agency. Farmers having persistent damage should develop relationships with local bear hunters or chase clubs to increase the level of pursuit activities on or adjacent to the farm as a means of reducing future losses. **This practice is not permitted in some jurisdictions. Consult your local Wildlife Management Authority.**

POLLINATION

Insect pollinators are essential or desirable for the successful production of many vegetables and strawberries. The most common insect pollinators are European honeybees, wild bees, wasps and flies. Crops that require pollination possess specific flowers that require insects pollination. For example, cucumbers, squash, pumpkins, and watermelons have separate male and female flowers, while muskmelons have male and hermaphroditic (perfect or bisexual) flowers. The sticky pollen of the male flowers must be transferred to the female (or hermaphroditic) flowers via insect pollinators to achieve fruit set. Multiple bee visits of eight or more per flower are required to produce marketable cucumber fruit. When hybrid cucumbers are grown at high plant populations for machine harvesting, 15 to 20 bee visits per flower are needed for maximum fruit set.

Strawberries require multiple pollination events for normal fruit to develop. Generally, as the number of bee visits increases, there will be an increase in strawberry fruit set, number of seed per fruit, fruit shape and fruit weight. Delay in pollination affects the timing of fruit set, and lack of adequate pollination usually results in small or misshapen strawberry fruit in addition to low yields. The size and shape of the mature fruit is usually related to the number of seeds, and each seed requires pollination.

Movement of honeybees or wild bees into the crop at the correct time will greatly enhance pollination. Individual cucurbit and strawberry flowers are usually open and attractive to bees for only a day or less. The opening of the flower, release of pollen, and commencement of nectar secretion normally precede bee activity. Pumpkin, squash, and watermelon flowers normally open around daybreak and close by noon, whereas, cucumbers, strawberries, and muskmelons generally remain open the entire day. Pollination must take place on the day the flowers open, due to the short periods of pollen viability and stigmatic receptivity.

Both wild bees and managed honeybees can be effective pollinators. Populations of wild bee species vary in their abundance from year to year. In addition, regular pesticide applications may reduce the abundance and diversity of these pollinators, and some agricultural practices, such as soil tillage may destroy wild bees that nest in the soil. Honeybees can be managed to provide consistent pollinator abundance from year to year. The most reliable way to ensure adequate pollination is to own or rent strong colonies of European honeybees from a reliable beekeeper.

Activity and behavior varies with the species of pollinator. Squash bees are active soon after sunrise. Most of the feeding of female squash bees is completed by mid-morning (9 or 10 am) after which they return to their nests in the soil. Male squash bees will continue to stay in the flowers, often overnight. Bumblebees are active over a wide range of weather conditions and can tolerate foraging in cooler temperatures. Honeybee activity is determined, to a great extent, by weather and conditions outside the hive. Honeybees rarely leave the hive when the outside temperature is below 55°F (12.8°C). Flights seldom intensify until the temperature reaches 70°F (21.1°C). Wind speed in excess of 15 mph seriously impedes bee activity. Cool, cloudy weather and threatening storms greatly reduce honeybee flights. Ideally, colonies should be protected from and exposed to sunlight. An east or southeast hive entrance encourages bee flight. The hives should be elevated and the front entrances kept free of grass and weeds. A clean water supply should be available within a quarter mile of the hive. The number of honeybee colonies to ensure adequate pollination varies with location, attractiveness of crop, density of flowers, length of blooming period, colony strength, and competitive plants in the area. In vine crops and strawberries, recommendations are one to two colonies per acre, with more hives required for higher density plantings.

With the introduction of parasitic honeybee mites (mainly *Varroa destrector*), the pollination picture has changed. Abundant colonies of feral honeybees (wild colonies nesting in trees or other cavities) once provided pollination security for fruit and vegetable growers, but this is no longer the case. Feral honeybee colonies are now nearly nonexistent in most areas.

Despite intense efforts to protect bees, beekeepers are losing large numbers of colonies to mites and the diseases they transmit. In addition, the recent dramatic disappearance of honeybee colonies has left many beekeepers devastated and some growers without the quantity and quality of bees needed to pollinate crops. This phenomenon, known as CCD or Colony Collapse Disorder, is under investigation and pesticide exposure is one of the possible contributing factors being studied. As a result of mites, diseases and CCD, fewer beekeepers are providing honeybee colonies for pollination services. In addition, the quality of honeybee colonies may be marginal for pollination. The Mid-Atlantic Apiculture Research andExtension Consortium (http://maarec.psu.edu) is a regional group focused on addressing the crisis facing the beekeeping industry. Additional relevant websites are www.beeccdcap.uga.edu and ento.psu.edu/pollinators. Also see the Resource Section Appendix A for more information.

Honeybees are vulnerable to many of the chemicals, used to control insects, pathogens and weeds. If insecticides must be applied, select one that will give effective control but pose the least danger to bees (see Table D-6 in this publication, also Tables D1-D3 in the Mader handbook listed above). Apply pesticides at dusk **when the bees are not actively foraging and avoid spraying adjacent crops.** Give the beekeeper 48 hours tice, if possible, when you expect to spray so that precautions can be taken to protect the hives and beneficial insects.

Commercially Available Bumblebees

Common Eastern bumblebees (*Bombus impatiens*) may be purchased commercially to use as pollinators in vegetables and small fruits. The behavior, physiology and morphology of bumblebees make them ideal pollinators because of the speed at which they transfer pollen, the efficiency with which they gather pollen within various crops, and the increased endurance to fly in adverse weather for longer periods of time. The bumblebee also has the ability to buzz pollinate the flower for pollen, a pollination technique not seen in honey bees. Buzz pollination occurs by bumblebees vibrating the flower by pumping their wings at a certain frequency, to dislodge pollen. Bumblebee foraging activity starts earlier and ends later in the day than managed honeybees and they forage in lower temperatures. Bumblebees have been shown to be effective in greenhouse and high tunnel settings to pollinate tomatoes and strawberries. They also have been successfully used for field pollination in crops such as blueberries and watermelon. Because they are more active in cold weather than honeybees, early flowering crops may benefit from their use as pollinators.

Place bumblebees in the field after crops have begun to bloom. Like honeybees, bumblebees need access to forage to sustain themselves. Bees that have found on unintended forage in the beginning of the season are likely to continue to forage on this unintended source, especially if it is more favorable than the intended crop. Place bees in the middle of the field to encourage in field foraging.

Allow time for bees to settle before opening units. Always follow instructions provided by the bumblebee supplier when placing bees within the field. Give the allotted time before opening up the colonies for the first time. Although bumblebees will need to chew out of the hole in order to begin foraging, colonies should be given at least 30 minutes to settle after being handled during shipment and placement. Also, be sure to check on each colony 2-3 hours later to make sure that the bees have successfully chewed out of the hole and exited the nest. On occasion, bees will not successfully chew out of the hole and will need to be cut out of the colony. Although this has been known to occur, it is not common and most colonies will successfully find their way out of their colony and into the crop, on their own.

Close bumblebee units before each pesticide application. During the season, change each bumblebee colony entrance to one open hole at least two hours before all pesticide applications. This will allow time for bumblebee foragers to return and be kept in the colony in order to limit forager exposure to pesticides.

Place bumblebees under shade, to increase their productivity and longevity. Bumblebee units placed in natural shade (along forest/field edges) or fitted with a shade structure last longer and are significantly more productive than units in the sun. Placing bees under shade is especially important during the warm summer months. Bumblebees constantly and actively strive to keep their colony temperature at around 86°F. Colonies exposed to direct sunlight have to work harder and use more energy to thermo-regulate. Colonies placed in full sun without shade cannot maintain normal worker activity (pollen and nectar foraging and duties within the colony) for as long as the colonies with shade.

Keep bumblebees away from honeybees. Bumblebees should be placed as far from honeybee hives as possible. This is especially true when crops are not in bloom. When forage is low for the commercial pollinators they should be greater than 1 mile from each other. Honeybees are very resourceful and a bumble bee colony is a great source of pollen and nectar which honeybees are constantly seeking. If surrounding forage is low or not agreeable to honeybees, bumblebees will be susceptible to honeybee pollen theft causing a weakened colony and overall loss in productivity from both pollinator species.

Bumblebee units should be weighed or strapped down, especially when placed within a shade structure. These units may be susceptible to being flipped or carried by strong winds. Not only does this disrupt the normal orientation of the colony, causing helpless larvae, nectar, and pollen to fall out of their individual waxen cells, but can cause blockage to the unit openings, trapping bees within the unit.

Bumblebees may be transferred to another field for additional pollination services throughout a season. Before moving, close the plastic opening tab to the one-hole open position. Allow forager bees at least two hours to return to the colony. The bumblebee colony may then be transferred to another site.

Seal the colony enclosure prior to each pesticide spray. Bumblebees very easily accumulate pesticides within the wax of their brood clump and their bodies by foraging in crops that have been treated with various chemistries. Although bumblebees will inevitably have some exposure to sprayed pesticides within the field, growers can limit exposure by using the plastic opening tab within each colony box. Growers are urged to close up the commercial nests at least two hours before spraying to decrease the exposure of bees to the pesticides.

Follow the commercial supplier's recommendations for number of hives to use in a particular crop. Commercial bumblebee hives have a longevity of 6-12 weeks and must be replaced each year.

Dispose of bumblebee colonies in a timely and humane fashion. There is a risk of commercial bees breeding with native populations. Commercial bumblebees are mass reared, and therefore the genetic diversity of the commercial bees does not mirror what is naturally found and occurring in the wild bees. The integrity of this wild genetic stock is important because it allows for the bees to be adapted to a wide variety of environmental conditions and exposure to various pathogens that they may encounter. If commercial bees mate with wild bees, the commercial bees will be diluting the genetic stock of the wild bee population.

Using Wild Bees

Other wild bumblebee species (*Bombus*, *sp.,* mainly *B. importicus*) squash bees (*Peponapis pruinosa*), and some other wild bees are excellent pollinators. In mid-Atlantic and northeastern states, populations of these native pollinators have been shown to provide sufficient pollination for small, diversified farms located in complex landscapes that include wood lots and unmanaged (fallow) lands in close proximity. In diversified farmscapes with a history of growing cucurbits, squash bees and/or bumblebees have consistently been shown to provide sufficient pollination to pumpkins and squash, regardless of whether honeybees were present. Farms utilizing conservation tillage tend to have higher populations of squash bees. Excellent information for managing native bees, along with the biology of relevant bee species can be downloaded at:

- http://dda.delaware.gov/plantind/forms/publications/FarmManagementforNativeBees-AGuideforDelaware.pdf
- http://maarec.psu.edu/pdfs/WilliamsWinfree_NativeBees2009%201.pdf
- http://ohioline.osu.edu/cv-fact/pdf/1003.pdf

Methods have not yet been well defined for establishing whether reliance on wild bees will be adequate for pollination of large acreages grown for commercial production. The Xerces Society provides guidelines for developing landscapes and farmscapes that encourage conservation of communities of pollinators at www.xerces.org/pollinator-conservation/. Alternative managed pollinators are described in "Managing Alternative Pollinators: A Handbook for Beekeepers, Growers, and Conservationists" (Mader et al.; see Xerces web site).

Recommendations for Growers

- Know the pesticides you are using and their toxicity to bees (do not depend on third party to provide this information).
- READ THE LABEL AND FOLLOW THE LABEL DIRECTIONS
- **Never** use a pesticide on a flowering crop or on flowering weeds if honeybees are present.
- The use of a pesticide pre-bloom, just before bees are brought onto a crop **is not recommended**. If one of these materials MUST be used pre-bloom, select a material that has a lower toxicity to bees and apply only when bees are not foraging, preferably late evening.
- Do not apply these materials post bloom until after the bees are no longer present.
- Flowering time varies depending on varieties. Bees pollinating one variety or crop may be at risk while another post-bloom crop or variety is being treated with insecticides. Also while crops may have completed flowering, bees may be visiting flowering weeds in and around crops. Be aware of these situations and avoid the application of pesticides on a non-blooming crop if there is risk of drift onto blooming crops and weeds if bees are present. If a spray must be applied, use the least toxic material and apply only when bees are not foraging.
- Honeybees need water for temperature regulation and brood production. Provide a clean water supply near the hives. Keep wheel ruts and areas around the pesticide sprayer fill point drained to eliminate a possible insecticide-laden water source.
- Many fungicides are known to interact antagonistically with insecticides and can be highly toxic to bees. Avoid the application of fungicides on flowering crops when bees are present.
- Give beekeepers at least 48 hours' notice of sprays to allow for the movement of bees onto or off the crop. Insecticides applied on or near the crop before or during bloom is a serious threat to bees.

To ensure adequate quality and numbers of colonies, growers should:

- Contact beekeepers early since colonies may be in short supply. If you do not have a past relationship with the beekeeper, make initial contact the previous fall. Beekeepers usually assess the survival and strength of their colonies from mid-February to mid-March. Any request for hive relocation should be given 48 hours or more in advance.
- Have a written and signed contract between the grower and the beekeeper to prevent misunderstandings. This will ensure that enough pollinators are provided and that beekeepers are protected from pest control practices that may injure bees. The contract should specify the number and strength of colonies, the rental fee, time of delivery, and distribution of bees in the field. Obtain an adequate number of colonies. The number of honeybee colonies you will need will vary depending on the crop, location, attractiveness of the crop, density of the flowers, length of the blooming period, colony strength, and competitive plants in the area. A good rule of thumb is to start with one colony per acre and make adjustments from there. Areas well populated with wild solitary bees or bumblebees will not need as many rented honeybee hives.
- Obtain bees at the appropriate time. For melons, cucumbers, squash, strawberries, honeybees should be moved in when the crop **flowering adequately to attract bees.** Competing bloom from other flowers in the field, such as dandelions, should be eliminated by mowing, cultivation, or the use of herbicides.
- Locate colonies for maximum effect. Place colonies in groups of four to eight in favorable locations throughout the farm or field to provide an even distribution of the bees. In large fields, pollination is effective if groups of 10 to 20 hives are strategically distributed in sunny, wind-protected spots. Bales of straw or packing boxes stacked behind colonies can offer wind protection.
- Be sure you are getting strong colonies. It is important that the colonies you rent are healthy and contain a large enough population to do the job. For pollination, packaged bees (bees purchased through the mail) and small hives are inferior to strong, overwintered colonies. Two weak colonies are not equal to one strong colony! See the Penn State website at MAAREC.cas.psu.edu for more information.
- Consider the use of bee attractants. Sugar-based attractant sprays for improving pollination are generally ineffective. The bees collect the sugar off the leaves, usually without visiting the flowers. Although this brings more bees into the field or orchard, more pollination does not necessarily occur.

  In addition, the sugar may serve as a medium for the growth of sooty molds. Other attractants containing bee-derived communication pheromones, such as geraniol, have proven more successful, but further testing is needed before a full recommendation can be made. One of the newest and most promising attractants, Fruit Boost, contains honeybee queen mandibular pheromone. Research has shown that when it is sprayed on flowering crops, queen mandibular pheromone can result in dramatic increases in yields for some crops. This product is currently being marketed mainly for use on fruits and in vegetable seed production. See Appendix A in the Resource for more information on sources of pollinator attractants.

FOOD SAFETY CONCERNS

In recent years, the importance of fruits and vegetables in the diet has received a considerable amount of attention. Fresh or processed products supply vitamins, fiber, and phytochemicals that are known to decrease the risk of several chronic diseases, including heart disease and cancer. Consumers are purchasing more product than ever before, and between 1970 and 2008, per capita consumption of fresh fruits increased 19 percent, while per capita consumption of fresh vegetables increased 67 percent.

However, reports of foodborne illness attributed to consumption of these products have also increased. Unlike processed foods, fresh fruits and vegetables are not heat-treated to eliminate potentially harmful microorganisms. Larger and more centralized farming and improved storage methods have resulted in the distribution of product over vast geographic areas. Raw fruits and vegetables are also handled more frequently in the distribution chain. Cases of foodborne illness that once were limited to localized areas can now be spread over many states or countries. In addition, new minimal processing technologies have brought to the marketplace fruits and vegetables that have been washed, peeled, and cut into convenient ready-to-eat products. Since these products are subject to more handling and typically are not heat-processed to eliminate harmful bacteria, they are at a greater risk for becoming contaminated and causing foodborne illness. The vast majority of fresh fruits and vegetables are grown, harvested, and packed under safe and sanitary conditions. However, several highly publicized cases of foodborne illness have been associated with consumption of lettuce, salad mixes, green onions, tomatoes, sprouts, cantaloupe, cabbage, and carrots. Implicated in most of these outbreaks have been the human pathogens *Salmonella enterica*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, and *Shigella* bacteria; *Cryptosporidium* and *Cyclospora* parasites; and Hepatitis A and Norwalk viruses.

In response to increasing concerns about the safety of fresh produce grown in the United States, in 1998 the Food and Drug Administration (FDA) published *The Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables*. Many internet resources on food safety are also available that feature updated information from this guide and other sources (e.g. www.foodsafety.gov). See the Records and Resources section of this publication. The 1998 guide is intended to assist growers, packers, and shippers of unprocessed or minimally processed fresh fruits and vegetables by increasing awareness of potential food safety hazards and providing suggestions for practices to minimize these hazards. In 2002, the United States Department of Agriculture (USDA) developed an audit/certification program known as "Good Agricultural Practices" (GAPs) to verify conformance to the 1998 guide. This is a voluntary program, although an increasing number of distribution networks are mandating GAPs certification from each participating grower. More recently, in 2011, the Food Safety Modernization Act (FSMA) was signed into law. FSMA (http://www.fda.gov/FSMA/) establishes mandatory practices growers must take to prevent microbial contamination of fresh produce. Increased record-keeping and adherence to strict procedures of human hygiene are inevitable. All three resources (the 1998 guide, GAPs and FSMA) identify potential hazards and discuss possible control methods in different aspects of pre-harvest, harvest and post-harvest production, including: 1. Water, 2. Manure and Municipal Biosolids, 3. Worker Health and Hygiene, 4. Field Sanitation, 5. Packing Facility Sanitation, 6. Transportation, and 7. Product Traceback. Each section is summarized below.

1. **Water.** Water is used for irrigation, pesticide application, cooling, transporting, washing, and processing. It also has the potential to be a source of microbial contamination. Growers and packers, therefore, should be aware of the source and quality of water that contacts fresh produce and consider practices that will protect water quality. Growers should periodically test irrigation water for fecal indicator organisms such as generic *E. coli*. If the irrigation water exceeds the agricultural water standards, water treatment with effective disinfectants would be necessary before continuing to use the water source. Application of SaniDate 12.0 MicroBiocide (at 1:50,000 dilution level) and calcium hypochlorite tablets have been shown to be efficient on the decontamination of bacterial foodborne pathogens, like *Salmonella*, in irrigation, pond and well water. In addition, SaniDate 12.0 is approved by the Organic Materials Review Institute for use in irrigation water, which would be allowable for both conventional and organic production. Growers may also reduce contamination from human and plant pathogens by filtration (such as a biosand or diatomaceous earth filter).

   Growers often irrigate field crops using water obtained from rivers, lakes, ponds, or irrigation ditches. However, surface water can become contaminated by upstream animal operations, sewage discharge, or runoff from fields. Drip, furrow, underground, or low volume spray irrigation techniques are ways to minimize irrigation water contact with edible portions of the crop. Groundwater is less likely to become contaminated, although wells should be maintained in good working condition and be constructed and protected so that surface water or runoff from manure storage areas cannot enter the system.

   In packing operations, changing dump tank and flume water regularly, and cleaning and sanitizing water contact surfaces will help to prevent cross-contamination. Antimicrobial chemicals such as chlorine and peroxyacetic acid may be added to water, but should be routinely monitored and recorded to ensure they are maintained at appropriate levels.
2. **Manure and Municipal Biosolids.** Manure may be contaminated with human pathogens and should be properly treated and stored before field application. Store manure and compost away from produce fields and packinghouses to protect the vegetable crop from seepage and runoff. Physical barriers such as ditches, mounds, grass/sod waterways, diversion berms, and vegetative buffer areas may also help to prevent runoff. Current recommendations are to maximize the time between application of manure to production areas and harvesting. For non-composted or raw manure that may come into contact with the edible portion of fruits or vegetables, the USDA National Organic Program (NOP) stipulates at least 120 days (4 months) between manure application and harvest, while FSMA proposes at least 270 days (9 months). For composted manure that may come into contact with the edible portion of fresh produce, the (NOP) does not require an interval between application and harvest, while FSMA proposes a 45 day application interval. Growers should be aware that because FSMA's regulations have not yet been finalized, the interval between manure application and harvest may change. Consequently, growers are encouraged to consult relevant online resources (see the Records and Resources section of this publication) or county extension offices about up to date manure recommendations.

   Domestic animals (including livestock and pets) are another source of contamination and should be excluded from fields during the growing and harvesting season. Growers who use animals (such as horses) during vegetable production are advised to do a risk assessment of their operation and have a written plan in place to address possible sources of contamination. Wild animals, though more difficult to control, should be discouraged from entering fields where crops are destined for fresh produce markets. Federal, state, and local animal protection requirements must also be considered.

   Although municipal biosolids (sewage sludge) are approved for certain agricultural uses, they are not recommended for application to soils used for vegetable production. This is due to the potential for human health issues. Refer to: www.epa.gov/owm/mtb/biosolids/index.htm for an explanation of human health risks. See "Sewage Sludge" in the Plant Nutrient Recommendations section of this manual.
3. **Worker Health and Hygiene.** Human pathogens can be transferred to vegetables by workers who harvest or pack fresh produce. Growers should provide sanitary facilities that are accessible, clean, and well equipped (adequate supply of toilet paper; handwashing stations including a basin, potable water, liquid soap, disposable paper towels or other appropriate hand drying device, and a waste container). Also train employees to use toilet facilities and wash their hands properly. Workers at distribution centers, farm stands, or farmers' markets who handle produce should also follow good hygiene practices. Any worker who shows signs of an infectious disease such as diarrhea, boils, sores, or infected wounds should not be allowed to handle produce.
4. **Field Sanitation.** Fresh produce can become contaminated through contact with soils, pests, equipment, and chemicals such as fertilizers and pesticides. Growers should clean harvest equipment and containers or bins prior to use and keep harvesting and packing equipment as clean as practical.
5. **Packing Facility Sanitation.** In packing facilities, clean pallets, containers, or bins before use and discard damaged containers. Keep equipment, packing areas, and storage areas clean and store empty containers in a covered location to prevent them frombecoming contaminated. Use an antimicrobial product, such as chlorine or peroxyacetic acid, to prevent cross-

contamination of produce during washing or transporting in water flumes, and change the water when it becomes excessively soiled. Clean and sanitize food contact surfaces at the end of each day.

Establish a pest control program that prevents rodents, birds, and insects from entering packing and storage facilities, and safely exterminate or remove pests once they have entered the facility.

6. **Transportation.** Fresh produce can become contaminated during loading, unloading, and shipping. Inspect transportation vehicles for cleanliness, insects, other pests, odors, and obvious dirt or debris before loading. Make sure that fresh produce is not shipped in trucks that have previously been used to transport animals, fish, chemicals, or refuse. Refrigeration units in trucks should be turned on before loading to insure that proper temperatures are maintained during transit.
7. **Traceback.** The ability to trace the distribution history of food items from grower to consumer will not prevent a foodborne illness outbreak from occurring. However, being able to quickly trace a food back to its source can limit the public health and economic impacts of an outbreak. Growers should be able to trace each package with the date of harvest, farm identification, and who handled the produce from grower to receiver.

In addition to the sections mentioned above, several recent scientific studies have shown that, in laboratory or greenhouse settings, foodborne pathogens could be transmitted from seeds to seedlings of different vegetable crops, including sprouts, leafy greens and tomatoes, even though the contamination chance is low. Growers who grow high-risk crops (such as sprouts and microgreens), may consider treating the seed for foodborne bacterial pathogens, and similar seed treatments for plant bacterial pathogens would be suggested. These effective ingredients for seed sanitation include sodium hypochlorite (commercial bleach), hydrochloric acid and trichloromelamine.

Additional information to help vegetable growers practice GAPS on the farm and in the packinghouse can be obtained from extension offices or the governmental agriculture authority in your state.

POSTHARVEST HANDLING

Vegetables that are fresh and have good flavor bring repeat sales and may bring higher prices. How you handle your produce directly affects freshness and, with some vegetables, how well they retain peak flavor.

For most vegetables, maintaining cool temperatures to slow deterioration and high humidity to prevent moisture loss are the most effective means of preserving quality. Different vegetable commodities, however, respond differently to temperature (Table A-4). Listed below are several ways producers, handlers, and retailers can assure that vegetables going to the market or into storage are of high quality.

Harvesting and handling.

1. Provide gentle harvesting and handling to avoid cuts, abrasions, and bruising damage that allow decay-causing microorganisms to enter the tissue.
2. Harvest produce when consumers will be provided with the peak of quality. This assures greatest value at the time the commodity begins a sales period or storage period for later sale. Vegetables begin to deteriorate at the time of harvest and the highest quality produce will have the greatest shelf life.
3. Harvest during the cool part of the day, if possible. Since temperature controls the rate at which produce deteriorates, harvesting when the vegetables are coolest (usually just after sunrise) will extend their quality as long as possible. This will also reduce energy costs (see "cooling" below).
4. If storage facilities are not available, harvest only as much produce at one time as you can pack or sell while the quality is optimal. This will also allow you to replenish displays at roadside markets with freshly harvested produce throughout the day, ensuring the highest quality is available to your customers.
5. Make successive plantings and use several varieties of varying maturity to spread the harvest season. This allows you to have freshly harvested produce available over an extended period.
6. Use a shade cover on harvest bins, trailers, trucks and market areas. Perform sorting and packing operations in a shaded location. Vegetables exposed to the sun will absorb solar energy and become warmer than those in the shade. This is especially true of dark-colored vegetables, such as zucchini squash, eggplants, peppers, watermelons, green beans, and tomatoes that are often harvested during the middle of summer when solar energy is at a maximum. Workers will be more comfortable and, thus, work more efficiently in a shaded area. Shade may be provided by an open shed, shade cloth over a simple framework, or even by a large tree.
7. Display only good quality vegetables for sale. Those of poor quality will never improve. Frequent sorting to remove poor quality material will present the best display possible to your customers. Shade the sales display from the sun to reduce losses.
8. Remind your customers to keep produce cool (see Table A-4) and prevent moisture loss during transportation and storage at home.
9. For commodities that lose quality rapidly and those to be shipped to market, special postharvest washing, handling, and cooling are required to maintain quality (see Table A-4).

Washing, and chlorination. Bacteria and fungi are present on the surface of all freshly harvested vegetables. Where wash water is used, the temperature of the water should be warmer (ideally 10^{o}F warmer) than the pulp temperature of the produce to prevent decay-causing micro-organisms from being drawn into the tissue. Addition of chlorine to the wash water is effective in destroying decay-causing microorganisms on the surface of vegetables and extending shelf life. Chlorine can be added as a liquid concentrate in the form of sodium hypochlorite (commercial bleach) or as a dry powder in the form of calcium hypochlorite. The optimum concentration of available chlorine in the wash water depends on the commodity. Chlorination is most effective at pH 6.5 to 7.5. Buffers should be added to wash water to keep the pH in the desired range. Monitor dump/wash tanks and spray wash with commercially available test kits to verify that the correct pH and concentration of available chlorine are present. Consult the label for information on adjusting chlorine levels. **Note: pH (Acidity and alkalinity) is best controlled using automated machinery and not manually. Consult with a water treatment specialist about availability, installation, and operation of this type of equipment.**

Cooling. Two types of heat are present in vegetables. *Field heat* is the heat content of the vegetable that is due primarily to heat energy absorbed from the surrounding environment. *Heat of respiration* is the heat produced in the cells of the vegetable when sugars, fats, and proteins are oxidized to produce high-energy intermediate compounds, carbon dioxide, water, and **heat**. Quality is reduced more quickly by vegetables with high respiration rates and heat production. High produce temperatures also increase evaporation and transpiration of moisture for fruits and vegetables resulting in more rapid wilting and loss of quality. Cooling vegetables removes field heat, slows respiration, metabolic rates, and heat production. Slowing respiration and metabolic rates of the vegetable slows the rate of development, senescence, ripening, and tissue breakdown. Lowering the temperature also slows the growth rate of microorganisms, thus decreasing and delaying decay.

Methods for Cooling Produce (from Precooling Fruits and Vegetables in Georgia by Changying "Charlie" Li, Extension Agriculture Engineer, University of Georgia).

Room Cooling - Room cooling is a common and simple precooling method that exposes produce to cold air in a refrigerated room. Room cooling is usually used for products that have a relatively long storage life, These products are cooled and stored in the same room. In general, a simple and effective arrangement is to discharge cold air into a cooling room horizontally just below the ceiling. The air sweeps the ceiling and returns to the cooling coils after circulating through the produce on the floor. There should be enough refrigerated air volume to provide adequate cooling. The air velocity should be kept between 200 and 400 feet per minute around and between cooling containers. When cooling is complete, air velocity should be reduced to the lowest level that will keep produce cool – usually 10 to 20 feet per minute. One benefit of room cooling is that both the cooling and storage can be done in the same room and the produce does not need to be re-handled. In addition, room cooling requires a lower refrigeration load than other, faster cooling methods.

Forced-air cooling – Forced-air cooling is the most widely used precooling method in commercial practice. It is particularly popular among small operations because of its ability to handle a wide variety of products. It can rapidly aircool produce by creating an air pressure difference on opposite faces of stacks of vented containers. This pressure difference forces air through the stacks and carries heat away. Forced-air cooling has several advantages over room cooling. Forced-air cooling is much faster than room cooling because the cold air generally cools the produce by flowing around the individual fruits or vegetables in the containers. Forced-air cooling usually cools fresh produce in one to ten hours, which is one-tenth the time needed for room cooling. Rapid cooling can be accomplished with adequate refrigeration and a large volume of airflow per unit of produce. An existing room cooling system can be converted to forced-air.

Hydrocooling - Hydrocooling is one of the fastest precooling methods. Fruits and vegetables can be cooled rapidly by bringing them in contact with cold moving water. One main advantage of hydrocooling is that it does not remove water from the produce and may even revive slightly wilted produce. For efficient hydrocooling, water should come in contact with as much of the surface of each fruit or vegetable as possible. Water also must be kept as cold as possible without endangering produce. In commercial practices, water temperature is usually kept around 31°F except for chilling sensitive commodities. Conveyor hydrocoolers are the most common. Produce in bulk or in containers is carried on a conveyor through a shower of water. To avoid "channeling" (water pouring through larger openings where there is less resistance), it is necessary to either use a heavy shower over a shallow depth of produce or proportion the shower and the drainage from the bottom of containers so that the containers fill partly or entirely with water. Drainage must be sufficient to keep the water in the containers moving and to remove all water before containers leave the hydrocooler. To achieve optimal cooling and save energy, hydrocoolers should be insulated.

Package-icing - Packing crushed ice in containers with produce is one of the oldest and fastest cooling methods, and is particularly useful for cooling field-packed vegetables such as broccoli. It offers the advantage of fast cooling when the product directly contacts the ice, although the cooling rate could be significantly reduced when the ice melts. Another advantage is that the excess ice on the top of the product provides cooling during and after transportation. The product must be tolerant of the wet condition at 32°F for a prolonged time. The package-iced container should also be able to withstand wet conditions.

Vacuum cooling - Vacuum cooling cools fresh produce based on the principle of evaporation cooling: The moisture evaporates and takes heat away from the fresh produce when the atmospheric pressure is reduced below the boiling temperature of water. Leafy vegetables with a large surface area to mass ratio (such as iceberg lettuce) are well suited for this cooling method and can be cooled on a large scale by putting them in air-tight chambers and pumping out air and water vapor using steam-jet pumps. This method can cool packed produce quickly and uniformly in large loads (usually in 20 minutes to two hours), but container walls or other barriers that slow down evaporation can seriously inhibit cooling.

Choosing your ideal method for cooling vegetable products epends on the size of your operation and the commodities you handle. Products that are the most sensitive to heat damage are lettuce and greens, cole crops and legumes. Curcurbit fruits also benefit greatly from rapid heat removal. Root crops such as carrots, parsnips, radish, daikon, turnip, rutabaga, etc. benefit from hydrocooling to maintain tissue turgidity. Solanaceous fruits such as bell pepper and eggplant are less susceptible to heat, and maybe cooled by room or forced air. Care must be exercised when removing field heat from tomatoes. The internal temperature should not be less than 50°F. Vacuum cooling or hydro-vac is generally the most expensive, followed by hydrocooling, forced air, and top-icing. Room cooling is the most inexpensive method.

The length of time required to cool produce depends on method (air-, hydro-,or vacuum-cooled) and temperature of the medium used, initial temperature of the produce, final desired temperature, type of vegetable (i.e., fruit, leaf, or root), use and design of boxes or containers, and flow of cooling medium around the produce or containers. Thus, specific recommendations for cooling times for individual vegetables cannot be made. Growers can determine the cooling time required in their own operations by measuring the initial product temperature and the temperature during and after cooling. Temperatures of produce (head, cob, or pulp) must be measured because the temperature of air in cartons or cooling/storage room does not accurately indicate the internal temperature of the produce.

The term *half-cooling time* is the time required to cool produce to one-half the difference between initial and final (or cooling medium) temperature. Half cooling time will vary according to the crop, temperatures, and cooling method used. For example, if muskmelons with a pulp temperature of 80°F (26.7°C) are to be cooled to 40°F (4.4°C), the half-cooling time (t minutes) is the time required to cool the melons from 80°F (26.7°C) to 60°F (15.6°C). The time required to cool the melons from 60°F (15.6°C) to 50°F (10°C) is also equal to the half-cooling time of t minutes. This principal is illustrated in the Table A-3 and Figure A-1.

Table A-3 The Concept of Half Cooling Time

Produce Temperature, °F	Proportion of Cooling Completed	Relative Time to Cool to Indicated Temperature
80.0 (26.7°C)	--	--
60.0 (15.6°C)	1/2	t min
50.0 (10°C)	3/4	t min
45.0 (7.2°C)	7/8	t min
42.5 (5.8°C)	15/16	t min
		4t min

It can be seen from Figure A-1 that rate of cooling is most rapid during the early stages of cooling, and declines as temperature of the vegetable approaches the desiredtemperature or the temperature of the cooling medium. Cooling for a time equal to 4 times the half-cooling time or 15/16 of the desired cooling is sufficient for short-term holding and transit and when additional cooling will take place in transit or storage. For example, if a grower wishes to use hydrocooling (chilled water) to reduce the temperature of carrots from 80° to 34°F, the time necessary to reach 57°F would be determined (e.g. 15 minutes), then the cooling would continue for at least 4 times longer (e.g. 60 minutes). Some vegetative tissues and many fruits of vegetable crops are sensitive to chilling temperatures [between 35°F (1.7°C) and 55°F (12.8°C)]. Avoid holding chilling-sensitive crops at these temperatures. See Table A-3 for information on chilling sensitivity of vegetable crops. Monitor temperatures during transit and storage to determine if optimum temperatures are being maintained.

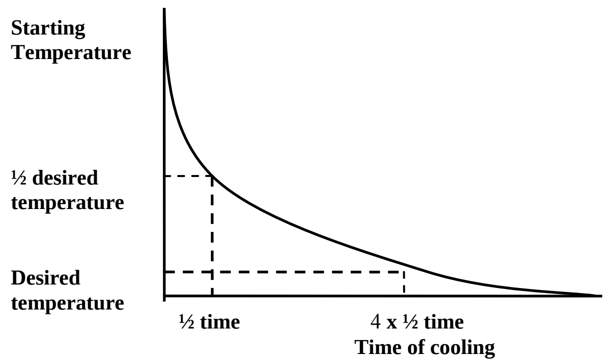

Figure A-1: Relationship of Half Cooling Time and Desired Temperature

Ethylene gas effects. Many vegetable crops lose quality, have reduced shelf life, and show specific symptoms of injury when exposed to ethylene at concentrations of 1 to 100 ppm after harvest. Some examples of ethylene effects include: russet spotting of lettuce along the mid-rib of the leaves, loss of green color in snap beans, increased toughness in turnips and asparagus spears, and development of bitterness in carrots and parsnips. Ethylene also causes yellowing and abscission of leaves of broccoli, cabbage, Chinese cabbage, and cauliflower; more rapid softening and yellowing of cucumbers, acorn and summer squash; and softening and development of off-flavor in watermelons. Ethylene increases browning and discoloration in eggplant pulp and seed and discoloration and off-flavor development in sweet potatoes. Ethylene can also cause sprouting of potatoes and increase ripening and softening of mature green tomatoes.

To avoid the detrimental effects of ethylene on vegetable quality and shelf life:

1. Do not store or transport ethylene-sensitive crops indicated above with ripening fruits such as apples, pears, peaches, plums, melons, avocadoes, bananas, and tomatoes that produce ethylene naturally.
2. Use electric forklifts in storage and transport areas because internal combustion engines may emit ethylene in the exhaust fumes.
3. Vent storage areas (one air exchange per hour) to reduce ethylene levels, or install ethylene absorbers in storage areas.
4. Consider the installation of equipment that selectively removes, absorbs or inhibits ethylene from your storage facility. This website contains information and links to potential vendors of such equipment: www.postharvest.ifas.ufl.edu/postharvest%20resources/ ethylene.htm

Table A-4. Handling Produce for Higher Quality and Longer Market Life[1]

	Recommended Cooling Methods[2]				Important Handling Factors				
Vegetable Crop	**Forced Air or Room Cooling**	**Hydrocooling**	**Package Ice or Liquid Icing**	**Vacuum Cooling**	**Transit Icing[3]**	**Recommended Transit and Storage Temperature, °F**	**Recommended Transit and Storage Relative Humidity, %**	**Expected Marketable Life Under Best Conditions**	**Sensitivity to Chilling Injury[4]**
Asparagus		+		+	N	32-36	95	1-2 weeks	L
Basil	+				N	46-50	90-95	4-7 days	H
Beans, lima & pod	+	+			N	38-42	90-95	7-10 days	M
Beans, snap	+	+			N	40-45	90-95	7-10 days	M
Beets, bunched		+			R	32	95	1-2 weeks	I
Broccoli			+		E	32	90-95	1-2 weeks	I
Brussels sprouts	+	+	+	+	R	32	90-95	3-5 weeks	I
Cabbage	+				N	32	90-95	3-6 weeks	I
Cabbage, Chinese	+		+	+	R	32	90-95	4-8 weeks	I
Carrots, bunched	+		+		E	32	90-95	1 month	I
Cauliflower	+		+	+	R	32	90-95	2-4 weeks	I
Celery		+			R	32	90-95	2-3 weeks	I
Collards & kale		+	+		R	32	90-95	1-2 weeks	I
Cucumbers	+	+			N	50	90-95	1-2 weeks	H
Eggplant	+				N	50	90-95	1 week	H
Endive & escarole				+	R	32	90-95	2-3 weeks	I
Horseradish	+				N	30-32	90-95	1 year	I
Kohlrabi	+	+	+		R	32	90-95	2-4 weeks	I
Leeks		+	+	+	R	32	90-95	1-3 months	I
Lettuce, crisphead				+	N	32-36	95	2-3 weeks	I
Lettuce, leaf & bibb			+	+	R	32-36	95	1 week	I
Lettuce, romaine				+	R	32-36	95	1-2 weeks	I
Muskmelon, 3/4 slip	+		+		R	36-40	85-90	1-2 weeks	M
Muskmelon, full slip	+		+		R	32-36	85-90	4-7 days	M
Okra		+			N	45-50	95	1 week	VH
Onions, dry					N	32	65-70	1-8 weeks	I
Onions, green		+	+		N	32	90-95	7-10 days	I
Parsley		+	+		E	32	95	1-2 months	I
Parsnips	+				N	32	90-95	2-6 months	I
Peas		+	+		E	32	90-95	1-2 weeks	I
Peppers	+			+	N	45-50	90-95	2-3 weeks	M
Potatoes, early	+				N	40	90	2-4 months	L
Potatoes, late	+				N	40-45	90	5-8 months	L
Pumpkins					N	50-55	70-75	2-3 months	H
Radishes, bunched		+	+		E	32	95	1-2 weeks	I
Rhubarb		+	+		R	32	95	3-4 weeks	I
Rutabagas	+				N	32	95	2-4 months	I
Spinach		+	+	+	E	32	90-95	7-10 days	I
Squash, summer	+	+			N	50	90-95	4-7 days	H
Squash, winter	+				N	50-55	50-75	2-6 months	M
Strawberries	+				N	32	95	1 week	L
Sweet potatoes	+				N	55-60	85-90	3-5 months	VH
Sweet corn	+	+	+		E	32	90-95	5-7 days	I
Tomatoes, green	+				N	60-70	85-90	1-3 weeks	H
Tomatoes, pink	+				N	55-65	85-90	5-10 days	M
Tomatoes, ripe	+				N	55-60	85-90	4-7 days	M
Turnips	+				N	32	95	4-5 months	I
Turnip & mustard tops		+	+	+	E	32	90-95	1-2 weeks	I
Watermelons		+			N	45-50	85-90	3-4 weeks	M

1 Information on optimum temperatures, relative humidity, and storage life was adopted from USDA Handbook 66 and modified by experience under eastern conditions.

2 *Cooling Method*: + = cooling method is suitable for the crop.

3 *Transit Icing*: The importance of transit icing depends on time in transit, transit conditions, and outside temperature. N - not recommended, R = recommended, and E = essential.

4 *Sensitivity to Chilling Injury*: I = insensitive, L = low sensitivity, M = medium sensitivity, H = high sensitivity, and VH - very high sensitivity.

TROUBLESHOOTING: DIAGNOSING VEGETABLE CROP PROBLEMS

When visiting a vegetable field, follow the steps outlined below to help solve any potential problems.

1. Determine whether there is a pattern to the symptoms.
   a. Does the pattern correlate with a certain area in the field, such as a low spot, poor-drainage area, edge of field or sheltered area? Does the pattern correlate with concurrent field operations, such as time of planting, pesticide application, method of fertilization, and rate of fertilization?

2. Try to trace the history of the problem.
   a. On what date were the symptoms first noticed?
   b. What fertilizer and liming practices have been used?
   c. What pest-management practices have been used to suppress or control diseases and undesirable insects and weeds--what chemicals (if any), when applied, and what application rates?
   d. What were the temperatures, moisture conditions, and level of sunlight?

3. Examine the plants affected to determine whether the problem is related to insects, diseases, or cultural practices.
   a. Do the symptoms point to **insect** problems? (A hand lens is usually essential to determine this.)
      (1) Look for the presence of insects on foliage, stems, and roots.
      (2) Look for feeding signs such as chewing, sucking, or boring.
   b. Do the symptoms suggest **disease** problems? These symptoms are usually not uniform; rather, they are specific for certain crops.
      (1) Look for necrotic (dead) areas on the roots, stems, leaves, and flowers.
      (2) Look for discoloration of the vascular tissue (plant veins).
      (3) Look for fungal or bacterial growth.
      (4) Look for virus patterns; often these are similar to injury from 2,4-D or other hormones.
   c. Do the symptoms point to **cultural** problems? Look for the following general characteristics, may be different on specific crops:
      (1) Nutrient deficiencies.
         - Nitrogen--light green or yellow foliage. Nitrogen deficiencies are more acute on lower leaves.
         - Phosphorus--purple coloration of leaves; plants are stunted.
         - Potassium--brown leaf margins and leaf curling
         - Magnesium--interveinal chlorosis (yellowing between veins of older/lower leaves).
         - Boron--development of lateral growth; hollow, brownish stems; cracked petioles.
         - Iron--light green or yellow foliage occurs first and is more acute on young leaves.
         - Molybdenum--whiptail leaf symptoms on cauliflower and other crops in the cabbage family.
      (2) Nutrient toxicities. (Perform leaf tissue analysis and soluble salt test of soil)
         - Toxicity of minor elements--boron, zinc, manganese.
         - Soluble salt injury--wilting of the plant when wet; death, usually from excessive fertilizer application or salts in the irrigation water.
      (3) Soil problems. (Take soil tests of good and poor areas.)
         - Poor drainage.
         - Poor soil structure, compaction, etc.
      (4) Pesticide injury. (Usually uniform in the area or shows definite patterns.)
         - Insecticide burning or stunting.
         - Weed-killer (herbicide) burning stunting or abnormal growth.
      (5) Climatic damage.
         - High-temperature injury.
         - Low-temperature (chilling) injury.
         - Lack of water.
         - Excessive moisture (lack of soil oxygen excessive water and fruit cracking, edema)..
         - Frost or freeze damage.
         - . Low light to high light intensity damage.
         - . Sunscald and leaf scorch
      (6) Other Physiological damage.
         - Physiological leaf curl.
         - Air-pollution injury.
      (7) Poor fruit or seed set due to inadequate pollination

In summary, when trying to solve a vegetable crop problem, look for a pattern in the symptoms, trace the history of the problem, and examine the plants and soil closely. Publications and bulletins designed to help the grower identify vegetable problems are available from your county Extension Agent.

SOIL AND NUTRIENT MANAGEMENT

SOILS

The best soils for growing vegetables are well drained, deep mineral topsoil, and relatively high (greater than 2.0%) in organic matter. The pH has been modulated through cycles of cultivation as needed with lime and gypsum and fertility levels (N-P-K) have been augmented as needed. Soil textures, such as sandy loam or loamy sand, are generally best suited for growing early market crops, since they are more accessible to machinery and workers during periods of high moisture. Loam and silt loam soils are generally better suited for growing crops for later fresh-market use or for processing. Deep, well-drained muck soils are ideally suited for growing leafy vegetables, bulb, and root crops. The better suited the crop is to your soil, the greater chance you will have of producing a successful crop. For example, if you plant crops that require well-drained soils on poorly drained soils, you are doomed to failure regardless of your growing skills.

A typical BMP (Plan of best management practices) includes a good soil management program, proper liming and fertilization, good tillage practices, crop rotation, annual supplements of organic matter, and adequate irrigation. Using winter cover crops and periodically resting the land with the use of summer cover crops between vegetable plantings are essential to prevent the deterioration of soil structure and to retain topsoil. Note: The BMP is similar to the GAP described in Section A, and shares many of the same elements. The BMP is aimed at consistently high crop yields and quality, whereas the GAP is focused on avoidance of food safety deterrents.

Soil Tests

The most economical means of determining the lime and fertilizer needs of your vegetable soils is to have your soil tested. You can generally obtain soil sample kits or containers and instructions through your local Extension office**.**

If you do not know the present fertility level of the soil in a field, your application rates of lime and fertilizer materials are likely to be inaccurate. For most efficient production, application rates of lime and fertilizer materials should be matched to the existing soil fertility level, past cropping and soil management practices, and the crop to be grown. A controlled soil fertility program of this nature also minimizes the potential for soil damage and water pollution. Knowledge of soil nutrient content renders it less likely that ill-advised monetary investments will be made into unnecessary inputs.

Lime and fertilizer recommendations from a soil testing laboratory are based on the soil test results and past cropping, liming, and fertilization practices you supply with the soil sample questionnaire when submitting the sample. For this reason, it is very important that you supply accurate information about the history and future use to be made of the field along with the soil sample.

If you have a special problem related to soil drainage, tillage, or past history, inform your Extension Agent when you pick up the soil sampling kit or container, so he/she can advise you if any special tests are needed. The Agent will also be aware of costs of the various soil testing services performed by the Soil Testing Laboratory.

LIMING SOILS

Most soils in the Mid-Atlantic Region are naturally acidic or become acidic under crop production systems and rainfall. If soils become too acidic (pH generally less than 6.0), crop performance is hindered by many factors – including reduced availability of plant nutrients. A regular liming program is required to neutralize soil acidity and to supply crops with calcium and magnesium. The first step in a liming program is knowing the optimum or target value of the crop to be grown. Many crops will grow over a wide range of soil pH but most vegetable crops perform best when soils are in the pH 6.0 to 7.0 range. The grower should also plan rotations such that all crops grown on a given field have similar pH and nutrient requirements. The target pH values and the low pH limits suitable for vegetable crop production are listed in Table B-1.

Table B-1. Target Soil pH Values for Vegetable Crop Production

Crop	Target pH	Lime when pH Falls Below
Asparagus	6.8	6.2
Beans, lima, snap	6.2	6.0
Beets	6.5	6.2
Broccoli	6.5	6.2
Brussels sprouts	6.5	6.2
Cabbage	6.5	6.2
Carrot	6.0	5.5
Cauliflower	6.5	6.2
Collards	6.5	6.2
Cantaloupes	6.5	6.0
Celery	6.5	6.0
Cucumber	6.5	6.0
Eggplant	6.5	6.0
Endive, escarole	6.5	6.0
Horseradish	6.5	5.5
Kale	6.5	6.2
Kohlrabi	6.5	6.2
Leeks	6.5	6.0
Lettuce - leaf, Iceberg	6.5	6.0
Mixed vegetables	6.5	6.0
Muskmelons	6.5	6.0
Okra	6.5	6.0
Onions - green, bulb, scallions	6.5	6.0
Parsley	6.5	6.0
Parsnips	6.5	6.0
Peas	6.5	6.0
Peppers	6.5	6.0
Potatoes, sweet	6.2	5.5
Potatoes - white, scab susceptible	5.2	5.0
Potatoes - white, scab resistant	6.2	5.5
Pumpkins	6.5	6.0
Radish	6.5	6.2
Rhubarb	6.5	5.5
Rutabaga	6.5	6.2
Spinach	6.5	6.0

(table continued next page)

Table B-1. Target Soil pH Values for Vegetable Crop Production *(cont'd.)*

Crop	Target pH	Lime when pH Falls Below
Squash - winter, summer	6.5	6.0
Sweet corn	6.5	6.0
Strawberries	6.2	5.8
Tomatoes	6.5	6.0
Turnips	6.5	6.0
Watermelon	6.2	5.5

Soil pH alone cannot be used to determine the amount of liming material to apply to correct soil acidity. Information on soil texture and fertility is also required. Soil test results provide all of the data needed to determine the lime requirement and the type of lime to use when using water pH. Alternatively, many state and private labs now use buffer solutions to extract active and reserve acidity for pH determination. Buffer solutions reduce interference that commonly occurs when substantial amounts of soluble salts are in soil solution. When using buffer pH, calibrated charts along with the buffer pH can solely be used for lime requirement determination.

Lime Requirement

The lime requirement of a soil depends on total acidity that must be neutralized to raise pH to the desired level. It is important to understand that a water soil pH measurement only indicates the concentration of active acidity in soil solution. Total acidity represents the active acidity in solution plus the amount of exchangeable acid cations bound to clay and organic matter (reserve acidity). For the purpose of lime recommendations using water pH, total acidity is estimated from soil texture plus soil pH or it is measured directly by titration (which is referred to as buffer pH or lime requirement index). Buffer pH or lime requirement index measurements that appear on soil test reports are used to determine lime requirement and should not be confused with soil water pH. The interpretation of buffer pH is specific to the buffer method employed by the laboratory and the properties of the soils in the region.

Lime requirement is also commonly determined by soil pH measurement and soil texture. Soil texture classifications (i.e. loamy sand, sandy loam, loam, silt loam, or clay loam) may be considered a fixed property of a soil because it is not readily changed. Thus, once soil texture is known and soil pH is measured, the lime requirement of a soil can be determined by referring to the appropriate table for the crop to be grown without any reevaluation of soil texture. Once growers know the soil texture, they may find portable pH meters or colorimetric paper strip kits to be helpful in the planning of their liming program. A reliable portable pH meter will cost over $100, while the paper strip kits are much less expensive than meters, but also less precise.

For the majority of crops that have a target pH in the range of 6.3 to 6.5, refer to Table B-2 for lime requirement. For scab susceptible potatoes that have a target pH of 5.2, refer to Table B-3 for lime requirement. For snap beans grown on sandy Coastal Plain soils, the target pH should not exceed 6.2 (Table B-4). Excessively high pH increases the possibility of manganese deficiency in sensitive crops.

On soils with high organic content (greater than 6 percent) many crops with a desired pH of 6.5 can tolerate a lower soil pH (typically pH 5.6) than on mineral soils.

The typical soil test will include a summary of pH, and relative availability of Magnesium (Mg) and Calcium (Ca). While most vegetable crops grow best in soils that are slightly acid (soil pH 6.0 to 7.0) some crops such as sweet potato and some white potato varieties are best grown at soil pH 5.2. The soil test report will usually report Mg and Ca levels as "above optimum", "optimum", or "below optimum" and may further specify "low/high" and "very low/very high". This indicates relative need to remediate the soil by adding or withholding supplements of the indicated nutrient.

Table B-2. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre for Crops with a Target pH of 6.5

	Soil Texture and Fertility				
Initial Soil pH	Loamy Sand	Sandy Loam	Loam	Silt Loam	Clay Loam
4.1-4.4	4,500	5,400	9,800	11,600	23,300
4.5-4.8	3,600	4,500	8,100	9,800	18,800
4.9-5.2	2,700	3,600	6,300	8,100	15,200
5.3-5.6	1,800	2,700	4,500	6,300	12,500
5.7-6.0	900	1,800	3,600	4,500	8,100
6.1-6.4	500	900	1,800	3,600	5,400
Above 6.5	0	0	0	0	2,700

Table B-3. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre for Potato Varieties with a Target pH of 5.2

	Soil Texture and Fertility			
Initial Soil pH	Loamy Sand	Sandy Loam	Loam	Silt Loam
4.5	630	990	1,350	1,790
4.6	540	810	1,160	1,520
4.7	450	630	940	1,250
4.8	360	540	760	990
4.9	270	450	540	760
5.0	180	270	400	490
5.1	90	100	180	270
5.2	0	0	0	0

Table B-4. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre for Crops with a Target pH of 6.2

	Soil Texture and Fertility				
Initial Soil pH	Loamy Sand	Sandy Loam	Loam	Silt Loam	Clay Loam
4.1-4.4	4,000	4,500	8,000	8,900	20,600
4.5-4.8	3,100	3,600	6,300	7,100	16,100
4.9-5.2	2,200	2,700	4,500	5,400	12,500
5.3-5.6	1,300	1,800	2,700	3,600	9,800
5.7-6.0	500	900	1,200	1,800	5,400
Above	6,500	0	0	0	2,700

Calcium Carbonate Equivalent

Calcium carbonate is a popular form of liming material. Soil test recommendations for liming should be given in pounds of calcium carbonate equivalent per acre (lb CCE/A). Pure calcium carbonate ($CaCO_3$) has a CCE of 100 percent and is the standard against which all liming materials are measured. Since the CCE of liming materials may vary from 40 to 179 percent, the amount of liming material needed to supply a given quantity of CCE will vary considerably.

Table B-5 Conversion for Pounds of Calcium Carbonate Equivalent to Pounds of Actual Liming Material Applied

Pounds/Acre CCE Recommended by Soil Test	Percent Calcium Carbonate Equivalent (% CCE) of Liming Material							
	70	**75**	**80**	**85**	**90**	**95**	**100**	**105**
	Actual Limestone Recommendation (lb/acre)[1,2]							
1,000	1,400	1,300	1,200	1,200	1,100	1,100	1,000	1,000
2,000	2,900	2,700	2,500	2,400	2,200	2,100	2,000	1,900
3,000	4,300	4,000	3,700	3,500	3,300	3,200	3,000	2,900
4,000	5,700	5,300	5,000	4,700	4,400	4,200	4,000	3,800
5,000	7,100	6,700	6,200	5,900	5,600	5,300	5,000	4,800
6,000	8,600	8,000	7,500	7,100	6,700	6,300	6,000	5,700
7,000	10,000	9,300	8,700	8,200	7,800	7,400	7,000	6,700
8,000	11,400	10,700	10,000	9,400	8,900	8,400	8,000	7,600
9,000	12,000	12,000	11,200	10,600	10,000	9,500	9,000	8,600
10,000	14,300	13,300	12,500	11,800	11,100	10,500	10,000	9,500
11,000	15,700	14,700	13,700	12,900	12,200	11,600	11,000	10,500
12,000	17,100	16,000	15,000	14,100	13,300	12,600	12,000	11,400
13,000	18,600	17,300	16,200	15,300	14,400	13,200	13,000	12,400
14,000	20,000	18,700	17,500	16,500	15,600	14,700	14,000	13,300

[1] The amount of CCE recommended in the table are for increasing the pH of an 8-inch soil layer to the desired pH value. Multiply the numbers in the table by 1.25 to adjust a 10-inch plow layer to the desired pH.

[2] It is not advisable to apply more than the following pounds of CCE per acre as a topdressing: loamy sand 2,000, sandy loam 3,000, loam 4,000, and silt loam 5,000. When fields are to be plowed and the CCE recommendation exceeds 3,000 pounds per acre, plow under half the needed amount and apply the other half after plowing and then disk in as deeply as possible.

By law, the CCE of a liming material must be stated on the product label.

To determine the application rate of liming material in CCE, refer to Table B-5 or use the following calculation:

Actual amount of liming material =

$$\frac{\text{(Soil test CCE recommendation)}}{\text{(\% CCE of liming material)}} \times 100$$

Example: Soil test recommendation is to apply 2,000 lb CCE per acre

Liming material purchased as 80% CCE

Actual amount of liming material required:

(2,000 ÷ 80) x 100 = 2,500 lb liming material per acre

Table B-5 may be used instead of the formula to convert soil test recommendations for pounds CCE per acre to pounds of the actual liming materials to be applied. To use Table B-5, find your soil test limestone recommendation in the left hand column, then read across the table on the line until you come to the column headed by the percent CCE nearest to that of your liming material. Application rates may be rounded off to the nearest 500 pounds per acre practical for spreading equipment. Although liming recommendations should now be given in pounds CCE per acre, recommendations that are given as total oxides can be converted to CCE by multiplying by 1.79.

Suppose the recommendation calls for 2,000 pounds per acre of total oxides; then, to convert the recommendation to CCE:

2,000 x 1.79 = 3,580 pounds CCE per acre

Selection of Liming Material

Liming materials neutralize soil acidity, supply Ca, and supplies or increases available Mg. Selection of the appropriate liming material based on its Ca and Mg concentrations is a key to furnishing crops and soils with sufficient amounts of these nutrients. The goal of a liming program is to establish the desired soil pH and to maintain the soil fertility levels for Mg and Ca in the *optimum* range.

Fine-sized liming materials are recommended when rapid neutralization of soil acidity is desired. Medium and coarse-sized liming materials are best suited for maintenance of soil pH once the desired soil pH range has been attained through the use of fine-sized liming material.

When the soil pH is low, the soil test levels of Ca and Mg may be *below optimum*, it is important to choose a liming material that contains a significant concentration of Mg such liming materials are commonly referred to as dolomitic type or dolomite. If the soil Mg level is *below optimum—very low* or *low*, use a liming material that has a minimum concentration of 9% Mg. If the soil Mg level is *below optimum—medium*, use a dolomitic liming material that has 3.6 to 9% Mg. If the soil Mg level is *optimum* or *above optimum*, use a calcitic or calcite liming material that has less then 3.6% Mg.

Occasionally soils test *below optimum* in Mg or Ca, but do not need lime for pH adjustment. For soils needing Mg, apply Epsom salt (9.9% Mg) or sulfate of potash magnesia (21.8% Mg). If soil pH is appropriate for the crop, but the soil test Mg level is *below optimum—very low*, apply 30 pounds Mg per acre from a Mg fertilizer. If Mg is *below optimum—low*, apply 15 pounds Mg per acre.

If soil pH is satisfactory for the crop, but the Ca level is *below optimum—very low*, apply 350 pounds Ca per acre (=1500 pounds per acre of gypsum). If the pH is satisfactory, but Ca is *below optimum—low*, apply 175 pounds Ca per acre (=750 pounds per acre of gypsum)

Timing of Application

Lime is slow to react in soil. The desired increase in soil pH may require several months. Thus, it is important to plan ahead and apply lime several months in advance of planting. Lime can be applied at any time of the year. Plan ahead and apply lime well in advance of planting crops that are sensitive to soil acidity. Fall applications have the advantage of allowing the lime to react in the soil prior to the start of the next growing season.

Careful attention to liming prior to planting perennial crops such as asparagus is important. Once the crop is established, it is virtually impossible to correct a soil acidity problem using surface applications of lime. Lime should be applied at least six months to a year in advance of planting to insure that the target pH has been achieved.

Soils naturally become more acidic over time. The frequency of prescribed lime application varies with soil characteristics, cropping system, and fertilizer practice. Heavy use of ammonium and urea nitrogen fertilizers accelerates soil acidification. Soil testing for pH measurement should be performed every one to three years. Relime soils before pH drops below the desired range to avoid development of excess acidity.

Lime Placement

Lime applications are most effective at neutralizing acidity when they are spread uniformly and thoroughly mixed with the soil by plowing, disking, and harrowing. When applying large amounts of lime, it is best to use split applications. Apply half the lime and plow it under. Next apply the other half to the plowed surface and disk it into the soil as deeply as possible up to 24 inches.

Whenever conventional tillage is not practiced (e.g. perennial crops, conservation tillage systems), surface applications are recommended but the rate of pH change is much slower than for conventionally tilled soils. Monitor soil pH change and the need for lime to avoid higher lime requirements. Surface lime application rates should not exceed 3,000 pounds CCE per acre.

For crops utilizing plastic organic or mulches, lime should be applied and incorporated prior to bedding rows. It is ineffective to apply lime after plastic mulch has been laid and is not recommended.

Special Considerations

Potato scab is caused by a soil-inhabiting fungus (*Streptomyces scabies*). The disease is suppressed in acid soils (pH <5.2), so increase of soil pH with lime favors development of scab. When lime is needed, therefore, it is best to apply the lime after potato harvest and before the other crops grown in rotation. The optimum soil pH for growing scab susceptible potato varieties is about 5.0 to 5.2. Scab resistant potato varieties may be grown at pH 5.5 to 6.2.

Cabbage, broccoli, and leafy greens are subject to infection by the clubroot fungus *Plasmodiophora brassicae*. If clubroot is known to be present, cole crops should be grown at pH 6.5 to 7.0. The disease is also suppressed at pH 7.2 to 7.4 but crop production and/or quality may be decreased at the higher pH range.

Spinach requires an initial pH of 6.5 to 6.7 for good growth and leaf quality. Calcium levels in the soil should be medium or optimum and in balance with magnesium. Plan ahead and adjust pH, calcium, and magnesium the season before planting spinach.

Lime and Fertilizer

Lime and fertilizer work together as a team to produce high yields and better crops. Lime is not a substitute for fertilizer, and fertilizer is not a substitute for lime. The proper use of the two together makes for profitable vegetable crop production. The rate and frequency of their use depends on the crop to be grown, type of soil, soil acidity, and past use of fertilizer materials. Remember also that availability of nutrients is adversely affected by pH less than 5.0 or greater than 8.0.

PLANT NUTRIENTS

Many factors influence the nutrient requirements for optimum yield and quality of a given vegetable crop. The original source of soil particles, textural classification, cation exchange capacity, organic matter content, and drainage are important soil properties that influence the rates of nutrients applied to vegetables. In addition, rainfall amounts and distribution, irrigation types and management, and soil and air temperatures during the growing season can alter the retention, availability, and uptake of nutrients. Varieties of the same crop species often differ significantly in their nutrient requirements. Growers are encouraged to test soils to determine the kinds and amounts of preplant fertilizer nutrients required for optimum production. During the growing season, sap and tissue testing should be used when they have been shown to be effective to adjust nutrient applications to current growing conditions and the nutrient status of the crop.

Pennsylvania growers will receive soil test results directly from the Agricultural and Analytical Services Laboratory, College of Agriculture, The Pennsylvania State University. Growers in Delaware, Maryland, New Jersey, Virginia and West Virginia should use Tables B-8, and as described below.

See important notes and discussion in the following Plant Nutrient Recommendations section to adjust nutrient rates and timing based on soil type, cation exchange capacity, cropping and manure history, and soil temperatures.

Soil Fertility Test Interpretation

A soil fertility test evaluates the nutrient-supplying power of a soil. The results of the test are used to predict if, or how much fertilizer is required for optimum plant growth. Soil fertility categories include: "*Deficient*", "*Optimum*", and "*Exceeds crop needs*". *Deficient* is divided into subcategories: *very low*, *low*, and *medium*. These soil fertility categories gauge the probability of a beneficial response to the addition of a given nutrient (assuming that other factors such as temperature, moisture and disease are not limiting growth). The critical factor is the soil test level; below which a crop response to a nutrient application may be expected, and above which no crop response is expected. Crop yields may decrease at very high soil test nutrient levels.

Soil Test Categories

The basic soil test categories for management of soil Calcium (Ca), Magnesium (Mg), Phosphorus (P) and Potassium (k) are: "Deficient", "Optimum", and "Exceeds Crop Needs". For limestone recommendations, these categories indicate the concentrations of calcium (Ca) and magnesium (Mg) most suitable for use as a liming material. Soil test categories, along with crop nutrient requirements, are the basis for nutrient recommendations.

For example, when the soil test category for K is *deficient—low* the recommendation will indicate how much K to apply. The amount of K recommended however, depends on the crop. Various crops accumulate different amounts of nutrients. Generally, crops that produce large yields of harvestable material will remove large amounts of nutrients from the soil and will have a higher nutrient recommendation. When the soil fertility category is *deficient*, the nutrient recommendation for a particular crop is designed to achieve its full crop yield potential and to build the soil fertility level into the *optimum* range over time. If the soil fertility level is already in the *optimum* range, the nutrient recommendation is designed to replace the amount of nutrient removed by the crop to maintain *optimum* soil fertility. No nutrient application is generally recommended when the soil test category is *Exceeds crop needs.* This allows "draw-down" of the nutrient level to the *optimum* range. However, certain crops (ex. potatoes and tomatoes) still benefit from low fertilizer applications of root stimulating nutrients (ex. phosphorus) and should be applied as a "starter" fertilizer. These concepts are illustrated in Figure B-1.

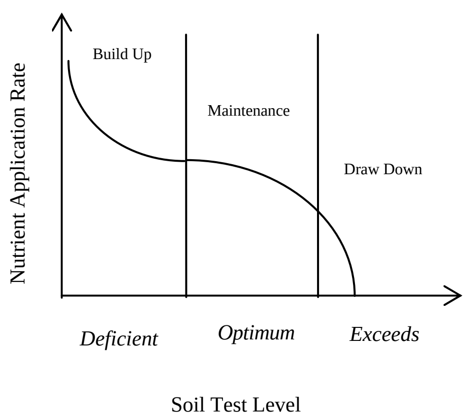

Figure B-1. Nutrient application rates vary in relation to soil test category.

Soil Test Method and Interpretation

A common misconception is that a soil fertility test is a direct measurement of the total nutrient content of a soil that is available to the plant. Soil test values have historically been expressed in units of pounds per acre, but they have no meaning in terms of actual quantity of nutrients available to crop plants. A soil test only provides provides an index of soil nutrient availability that is correlated with plant response. This correlation is determined by soil test calibration research and is the foundation for soil test interpretation.

Many different types of soil test extraction methods are in use, but only a few are appropriate for our local soils. The Mehlich-1 and Mehlich-3 soil tests are most appropriate for soil types found in the Mid-Atlantic Region. Soil test results and interpretations are specific for the soils of a region and for the particular soil test method employed. The soil test values for the Mehlich-1 and Mehlich-3 categories (Table B-8) were established based on research conducted on soils in the Mid-Atlantic Region. The categories were developed from crop yields that were observed during nutrient response studies conducted over a range of soil test levels.

Reading and understanding the soil report from any particular laboratory depends on knowing what soil test method is being used and what units are used to express the soil nutrient levels. If the soil test report does not state the method used, call the laboratory to find out. This information is needed before interpreting the soil test results.

Plant Nutrient Recommendations

To obtain highest yields with least negative environmental impacts, ALWAYS base plant nutrition decisions on a current soil test. Fertilizer is expensive and soil tests are relatively cheap and the only indicator of true nutrient needs. Refer to Table B-8 to interpret the relative levels of phosphorus and potassium in the soil based on the soil test report from the laboratory.

When a current soil test is available, use recommendations for the specific commodity listed under Recommended Nutrients Based on Soil Tests located in Section F

The following adjustments to the nutrient recommendations in section F are recommended based on soil type and cation exchange capacity.

1. For most vegetables grown on light-textured soils, apply the total recommended P_20_5 and K_20 together with 25 to 50 percent of the recommended nitrogen before planting. The remaining nitrogen can be sidedressed or applied with drip irrigation using a fertilizer containing nitrogen only. Sidedressing or topdressing potash (K_20) is recommended only on extremely light sandy soils with very low cation exchange capacities.
2. It may be desirable to build up the phosphorus and potassium levels in very low-fertility loam and silt loam soils more rapidly than provided by these recommendations. In such instances, add an additional 40 to 50 pounds of P_20_5 and K_20, respectively, to the recommendations listed in the table for soils testing low in phosphorus and potassium. Apply the additional amounts in broadcast and plow down or broadcast and disk-in application.
3. ***For Pennsylvania growers producing vegetables on clay loam soils:*** If you use the recommendations in the tables in section F, reduce the recommended nitrogen and potassium rates by 20 percent and increase the phosphorus rate by 25 percent of the rates indicated in the table.

Plant nutrient recommendations listed in tables in Section F under Recommended Nutrients Based on Soil Tests are expressed in terms of nitrogen (N), phosphate (P_2O_5), and potash (K_2O), rather than in specific grades and amounts of fertilizer.

When soil test results are available, the phosphate (P_2O_5) and potash (K_2O) needs for each cropping situation can be determined by selecting the appropriate values under the relative soil test levels for phosphorus and potassium-low, medium, optimum, or excessive.

The cropping and manuring history of the field must be known before a fertilization program can be planned. This history is very important in planning a nitrogen fertilization program. Certain crop residues and animal manures release nutrients into the soil over a long period of time as they are degraded.

Plant nutrient recommendations listed in tables in Section F under Recommended Nutrients Based on Soil Tests were developed for fields where no manure is being applied and where no legume crop residue is being incorporated prior to the planting of a new crop. If manure and/or legume crops are being used, the plant nutrient recommendations in the specific commodity should be reduced by the amounts of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) being contributed from these sources. See Table B-11 for value credits to be allowed for manure applications and legume crop residues.

When warm season crops, such as sweet corn, tomatoes, peppers, eggplants, and the vine crops are seeded or transplanted and soil temperatures are below 65°F (18.3°C), 20 pounds per acre of P_2O_5 may be applied to replace the phosphorus removed by the crop when soil test levels for phosphorus are above optimum.

Once the final fertilizer-plant nutrient needs are determined, it will then be necessary to determine the grade and rate of fertilizer needed to fulfill these requirements. For example, if the final plant nutrient requirements that need to be added as a commercial fertilizer are 50 pounds of nitrogen (N), 100 pounds of phosphate (P_2O_5), and 150 pounds of potash (K_2O), you would need a fertilizer with a 1:2:3 ratio, such as a 5-10-15, 6-12-18, 7-14-21, etc. Once you have selected the grade of fertilizer you need to use, the quantity needed to fulfill the plant nutrient requirements can be determined by dividing the percentage of N, P_2O_5, or K_2O contained in the fertilizer into the quantity of the respective plant nutrient needed per acre and multiplying the answer by 100.

In another example, if you choose a 5-10-15 fertilizer grade to supply the 50 pounds of N, 100 pounds of P_2O_5, and 150 pounds of K_2O needed, you can calculate the amount of 5-10-15 fertilizer needed as follows: Divide the amount of nitrogen (N) needed per acre (50 pounds) by the percentage of N in the 5-10-15 fertilizer (5 percent), and multiply the answer (10) by 100, which equals 1,000 pounds.

This same system can be used for converting any plant nutrient recommendations into grades and amounts of fertilizer needed. When you use this system, it is possible for you to select your fertilizer needs based on the most economical fertilizer grades available to you. In cases where the preferred grade is not available, it is also possible to change from one fertilizer grade to another, providing the plant nutrient ratio is the same. This flexibility may be necessary because of a shortage of some fertilizer materials.

NUTRIENT MANAGEMENT

Plants remove substances from the soil and air to enable them to grow and reproduce. The specific substances they remove are termed nutrients. Certain of these are generally required in larger quantities, and termed macronutrients. Those needed in smaller quantities, micronutrients, are often as important as macronutrients for achieving desired results. Most commercial fertilizers feature macronutrients nitrogen (N), phosphorus (P), and potassium (K), expressed as a weighted percentage (N-P-K). Micronutrients may be supplied along with macronutrients.

Nitrogen Management

Nitrogen is one of the most difficult nutrients to manage in vegetable production systems. Nitrogen is readily leached in sandy textured soils that dominate vegetable production regions or can be immobilized by soil microbes, can volatilize if not quickly incorporated, and is lost via denitrification under water-saturated soil conditions. Due to the numerous nitrogen loss pathways, nitrogen is not routinely tested by state soil testing laboratories for making crop recommendations. Instead, nitrogen recommendations are based on years of fertilizer trials and yield potential. Nitrogen application timings, application methods, and sources are also commonly tested in state fertilizer trials and have resulted in recommendations for splitting nitrogen fertilizer for increased fertilizer use efficiency.

Heavy rainfall, higher than normal yield, and following non-legume cover crops are just a few examples of situations where nitrogen fertilizer may be immobilized, lost from the production system, or another application of nitrogen is warranted. Tissue testing is the best option when deciding if and how much more nitrogen is needed to meet expected yields. Soil testing laboratories can provide nitrogen concentrations of plant materials with quick turnaround times to aid in nitrogen application decisions.

Phosphorus Management

In general, crops are very likely to respond to P fertilization if dictated necessary by soil tests. Crops grown in a soil testing P level of *deficient—very low, low, or medium* indicates a strong response to P fertilizer additions. Crops in soils testing *optimum* may or may not respond to further additions, but P may be applied to maintain the fertility level in the *optimum* range (P fertilizer applied at crop removal rates). Crops in soils that *exceeds crop needs-very high* may also see a response to P fertility if conditions are favorable for high yields or plants have slow growing and/or shallow root systems. Tomato and potato are classic examples of crops benefiting from P fertilizer additions on very high soil test P concentrations.

It is often recommended that a band of P fertilizer be placed near the seed/transplant as a starter fertilizer regardless of the P fertility level. Banded P is especially helpful at low soil test P levels; however, overall field rates should not be decreased. When the soil test level is *deficient*, P should generally be applied as a combination of broadcast and banded methods. Even at P soil test levels that are *"very high-exceeds crop needs"*, a small amount of banded P may benefit crop establishment. Many test results describe the soils as "*exceeds crop needs"* category due to previous fertilizer and manure applications. When applied in excess of crop removal, P accumulates in the soil. Phosphorus is strongly adsorbed to soil particles and very little is subject to loss via leaching. In high concentrations, soil phosphorus will also interact with ionic micronutrients, such as zinc, to alter availability of P to the plant. Deciding to fertilizer if the soil test report indicates that P "*exceeds crop needs*" should be based on a crop and geographic specific case. However, the general recommendation is that soils “exceeding crop needs” for P should receive very little or no P fertilizer.

Potassium Management

Crops are very likely to respond to K fertilizer when the soil test indicates that K is *deficient—very low* or *low*. A soil testing *deficient—medium* in K may or may not respond to K fertilizer. Soils testing *optimum* or *exceeds crop needs* are unlikely to respond to K fertilizer, but K may be applied to maintain the soil fertility level in the *optimum* range.

In general, most of the K fertilizer should be broadcast. When the fertility level is *deficient*, it may be advantageous to apply a portion of the total K application as a band. There is generally no benefit to applying banded K when soil fertility levels are *optimum* or *exceeds crop needs.* In loamy sand and sand textured soils, split applications of K may be beneficial and may be applied using sidedress applications or applied through trickle irrigation.

Crops remove larger amounts of K than P from the soil during a growing season. In addition, sandy soils have low reserves of K, and K is susceptible to leaching. Therefore, frequent applications of K are needed to maintain K at an optimum fertility level.

Secondary and Micronutrient Management

Calcium (Ca), magnesium (Mg), and sulfur (S) are included in the secondary element group. Calcium may be deficient in some soils that have not been properly limed, where excessive potash fertilizer has been used, and/or where crops are subjected to drought stress. Magnesium is the most likely of these elements to be deficient in vegetable soils. Dolomitic or high-magnesium limestone should be used for liming soils that are low in magnesium. Magnesium should be applied as a fertilizer source on low-magnesium soils where lime is not needed. Magnesium may be applied as a foliar spray to supply magnesium to the crop in emergency situations. Contact your county Extension agent for recommendations regarding scenarios that do not conform to these common soil nutrient ranges..

Sulfur is an important nutrient for plants, especially those in the onion family and cole crops. Sulfur may become deficient on light, sandy soils. Sulfur deficiencies may develop as more air pollution controls are installed and with the continued use of high-analysis fertilizers that are low in sulfur content. Sulfur concentrations greater than 5 ppm associated with increased pungency in sweet Spanish onions. Likewise, low soil sulfur will result in reduced pungency. Sulfur can be supplied by application of sulfur-containing nitrogen fertilizers, gypsum, or Epsom salts. See Tables B-6, B-7, and B-10.

Table B-6 Composition of Principal Macronutrient Fertilizer Materials

Material	N Nitrogen	P_2O_5 Phosphorus	K_2O Potassium	Mg Magnesium	Ca Calcium	S Sulfur	$CaCO_3$ Equiv.
	PERCENT (%)						lbs/ton
Ammonia, Anhydrous	82						-2960
Ammonium Nitrate	33 to 34						-1180
Ammonium Phosphate Sulfate	13 to16	20 to 39				13	-1520 to -2260
Ammonium Polyphosphate (APP)	10 to 11	34 to 37					+1000 to 1800
Ammonium Sulfate (Granular)	21					24	-2200
Ammonium Sulfate (Liquid)	8					9	
Ammonium Sulfate Nitrate	26					15	-1700
Ammonium Thiosulfate	12					26	-2000
Calcium Nitrate	19				19		+400
Calcium Sulfate (Gypsum)					23	17	
Diammonium Phosphate (DAP)	18	46		3			-1400
Limestone, Calcite				11	32		+1700 to 2000
Limestone, Dolomite				11	22	24	+1900 to 2160
Magnesium Oxide (Magnesia)				55			
Magnesium Sulfate (Epsom Salt)				10	2.2	14	
Monammonium Phosphate (MAP)	11	52					-1160
Nitric Phosphates	14 to 22	10 to 22			8 to 10	0 to 4	-300 to -500
Phosphoric Acid		52 to 54					-2200
Potassium Chloride (Muriate)			60 to 63				
Potassium Magnesium Sulfate			22	11		22	
Potassium Nitrate	13		44				-460
Potassium Sulfate			50 to 53			18	
Potassium Thiosulfate			25			17	
Rock Phosphate		30 to 36			33		+200
Sodium Nitrate	16						+580
Sulfur Elemental						32 to 100	
Superphosphate, Concentrated (Triple)		44 to 53			14		-3200
Superphosphate, Normal		16 to 22			20		
Urea	45 to 46						-1680
Urea Formaldehydes	35 to 40						-1360
Urea-Ammonium Nitrate Solutions	21 to 49						-750 to -1760

Table B7. Chemical Sources of Secondary and Micronutrients

Calcium Sources Material	**Chemical Formula**	**% Ca**
Calcitic lime	$CaCO_3$	31.7
Calcium nitrate	$Ca(NO_3)_2$	19.4
Dolomitic lime	$CaCO_3$+$MgCO_3$	21.5
Gypsum	$CaSO_4.2H_20$	22.5
Hydrated lime	$Ca(OH)_2$	46.1
Superphosphate, normal	$Ca(H_2PO_4)_2$	20.4
Superphosphate, triple	$Ca(H_2PO_4)_2$	13.6
Sulfur Sources Material	**Chemical Formula**	**% S**
Ammonium sulfate	$(NH_4)_2SO_4$	24
Gypsum	$CaSO_4.2H_2O$	16.8
K-Mg-sulfate	$K_2SO_4.2MgSO_4$	22.0
Sulfur, elemental	S	32 to 100
Potassium thiosulfate	$(NH_4)_2S_2O_3$	17
Ammonium thiosulfate	$K_2S_2O_3$	26
Boron Sources Material	**Chemical Formula**	**% B**
Borax	$Na_2B_4O_7.10H_2O$	11
Boric acid	H_3BO_3	17
Sodium pentaborate	$Na_2B_{10}O_{16}.10H_2O$	18
Fert. borate-46	$Na_2B_4O_7.5H_2O$	14
Fert. Borate-65	$Na_2B_4O_7$	20
Solubor	$Na_2B_{10}O_{16}.10H_2O$ +$Na_2B_4O_7.5H_2O$	20
Molybdenum Sources Material	**Chemical Formula**	**% Mo**
Ammonium molybdate	$(NH_4)_6Mo_7O_{24}.2H_2O$	54
Molybdenum trioxide	MoO_3	66
Sodium molybdate	$Na_2MoO_4.2H_2O$	39
Copper Sources Material	**Chemical Formula**	**% Cu**
Copper ammonium phosphate	$Cu(NH_4)PO_4.H_2O$	32
Copper chelates	$Na_2CuEDTA$ NaCuHEDTA	13 9
Copper sulfate	$CuSO_4.5H_2O$	25

(table continued next page)

Table B7. Chemical Sources of Plant Nutrients (continued)

Magnesium Sources Material	**Chemical Formula**	**% Mg**
Dolomitic lime	$MgCO_3+CaCO_3$	11.4
Epsom salt	$MgSO_4.7H_2O$	9.6
Magnesia	MgO	55.0
Potassium-magnesium sulfate	$K_2SO_4.2MgSO_4$	11.2
Manganese Sources Material	**Chemical Formula**	**% Mn**
Manganese chelate	MnEDTA	12
Manganese sulfate	$MnSO_4.4H_2O$	26 to 28
Manganese oxide	MnO	41 to 68
Zinc sources Material	**Chemical Formula**	**% Zn**
Zinc carbonate	$ZnCO_3$	52
Zinc chelates	$Na_2ZnEDTA$ NaZnHEDTA	14 9
Zinc Oxide	ZnO	78
Zinc sulfate	$ZnSO_4.H_2O$	35
Iron sources Material	**Chemical Formula**	**% Fe**
Iron sulfate	$FeSO_4.7H_2O$	19
Iron ammonium phosphate	$Fe(NH_4)PO_4.H_2O$	29
Iron ammonium polyphosphate	$Fe(NH_4)HP_2O_7$	22
Iron chelates	NaFeEDTA NaFeDTPA NaFeEDDHA	5 to 14 10 6

Table B-8. Soil Test Categories for Nutrients Extracted by Mehlich 1 and Mehlich 3

	Soil Test Category	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Calcium (Ca)[1]
Mehlich 3		Mehlich 3 Soil Test Value (lbs/acre)[2,3]			
	Deficient (very low)	0-24	0-40	0-45	0-615
	Deficient (low)	25-45	41-81	46-83	616-1007
	Deficient (medium)	46-71	82-145	84-143	1008-1400
	Optimum (high)	72-137	146-277	144-295	1401-1790
	Exceeds Crop Needs (very high)	138+	278+	296+	1791+
Mehlich 1		Mehlich 1 Soil Test Value (lbs/acre)[2]			
	Deficient (very low)	0-3	0-15	0-24	0-240
	Deficient (low)	4-11	16-75	25-72	241-720
	Deficient (medium)	12-35	76-175	73-144	721-1440
	Optimum (high)	36-110	176-310	145-216	1441-2160
	Exceeds Crop Needs (very high)	111+	311	217+	2161+

[1] Calcium values are for sandy loam soils. Multiply the calcium values in the table above by 0.625 to use for loamy sand soils; by 1.25 for loam soils; by 1.5 for silt loam soils, and by 1.75 for clay loam soils.
[2] Values are reported in elemental forms.
[3] .Soil tests that are based on Bray-1 extractable P and neutral, 1N ammonium acetate extractable, K, Ca, and Mg are very similar to the Mehlich-3 extractable concentrations of these nutrients.
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Micronutrients

Boron (B) is the most widely deficient micronutrient in vegetable crop soils. Deficiencies of this element are most likely to occur in the following crops: asparagus, most bulb and root crops, cole crops, and tomatoes. See Table B-12 for boron recommendations for various crops based on soil or plant tissue test results. Use of excessive amounts of boron can be very toxic to plant growth. **DO NOT** exceed recommendations listed in Table B-12 and in specific commodity recommendations section for Plant Nutrient Recommendations Based on Soil Tests for Vegetable Crop Production.

Manganese (Mn) deficiency often occurs in plants growing on soils that have been over-limed with a pH above 7.0. A broadcast application of 20 to 30 pounds or a band application of 4 to 8 pounds of manganese per acre will usually correct the deficiency. When manganese is applied as manganese sulfate, foliar application of 0.5 to 1 pound of manganese in 20 gallons of water per acre in one to three applications usually will help relieve the deficiency. Use a sulfate or chelate of manganese. Do not apply lime or poultry manure to such soils until the pH has dropped below 6.5, and be careful not to overlime again.

Molybdenum (Mb) deficiency in cauliflower (whiptail) may develop when this crop is grown on soils more acid than pH 5.5. Liming acid soils to a pH of 6.0 to 6.5 will usually prevent the development of molybdenum deficiencies in vegetable crops.

Deficiencies of other micronutrients in vegetable crops in the Mid-Atlantic U.S. region rare; and when present, are usually caused by overliming or other substandard soil management practices. Contact your county Extension agent for advice if you suspect a deficiency of zinc, iron, copper, or chlorine in your crops. Sources of fertilizers for the essential plant nutrients may be found in Tables B-6 and B-7.

Plant Tissue Testing

Plant tissue testing is an important tool in assessing vegetable nutrient status during the growing season. Three methods are commonly used for tissue testing and include 1. Testing leaf tissue, 2. Testing whole petioles, and 3. Testing petiole sap.

1. For collecting leaf tissue, for analysis:
   - Sample the most recently matured leaf from the growing tip. The sample is a whole leaf sample and it should not contain any root or stem material. For sweet corn or onions, the leaf is removed just above the attachment point to the stalk or bulb. For compound leaves (carrots, peas, tomatoes, etc.), the whole leaf includes the main petiole, all the leaflets and their petioles. For heading vegetables, it is most practical to take the outermost whole wrapper leaf. When sampling particularly young plants, the whole above-ground portion of the plant may be sampled.
   - A proper leaf sample should consist of about 25 to 100 individual leaves. The same leaf (i.e., physiological age and position) should be removed from each sampled plant. Plants damaged by pests, diseases, or chemicals should
   - be avoided when trying to monitor the nutrient status of the crop.
   - Sample across the field, from different rows, and avoid problem areas (low spots, ridges, washed out areas, etc.).
   - Sample when the plants are actively growing (typically between 9 a.m. and 4 p.m.).
   - Do not collect samples from water stressed plants.
   - Send samples to a laboratory in a paper bag. DO NOT SEND SAMPLES IN A PLASTIC BAG. Plastic bags will cause your samples to spoil and will impact results.
2. For collecting whole petiole samples for analysis:
   - Sample the most recently matured leaf. Throw away the leaflets. (Figure B-2)
   - Sample from 30 to 50 plants.
   - Sample across the field, from different rows, and avoid problem areas (low spots, ridges, washed out areas, etc.).
   - Sample between 10 a.m. and 2 p.m.
   - Do not collect samples from water stressed plants.
   - Send samples to a laboratory in a paper bag. DO NOT SEND SAMPLES IN A PLASTIC BAG. Plastic bags will cause your samples to spoil and will impact results.
3. For collecting petiole sap samples:
   - Sample petioles from most recently matured leaf. Throw away the leaflets. (Figure B-4) Sample 30 to 50 plants.
   - Sample across the field, from different rows, and avoid problem areas (low spots, ridges, washed out areas, etc.).
     - Sample between 10 a.m. and 2 p.m.
   - Do not collect samples from water stressed plants.
   - After collection, squeeze collected petioles with a garlic press to extract sap.
   - Use a handheld nitrate meter, available widely from nutrient management supply companies, to read the sap nitrate concentration. Make sure you record the correct units as either NO_3^{-1} or NO_3^{-1}-N.
   - Petiole sap sufficiency ranges are found in Table B10.

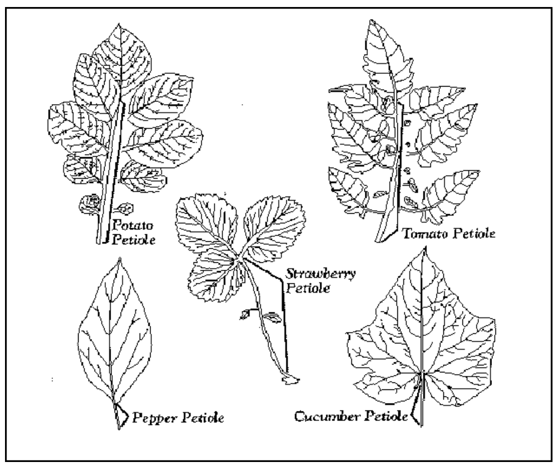

Figure B-2 Petiole delineation for several plant species.

Interpreting Tissue Tests

Tissue tests will be reported as adequate or sufficient in a range; low or deficient below that range; high or excessive above that range; and toxic (if applicable) if in excess. Test interpretation for most vegetable crops can be found at this website at the University of Florida: http://edis.ifas.ufl.edu/ep081. Tissue test interpretations for selected crops are also found in Section F. Petiole sap sufficiency ranges are found in Table B10. The concentrations representing the adequate range (sufficiency range) are those nutrient concentrations to be found in plants that have adequate nutrients available to them. Plants with nutrient concentrations in the high range are indicative of over-fertilization. Excessive values for micronutrients may result in phytotoxicity.

Correcting Deficiencies

Recommendations for correcting specific crop deficiencies are presented in the previous sections and in table B9 below.

Table B9. Recommendations for correction of vegetable nutrient deficiencies.

Nutrient	**Fertilizer**	**Method**	**Application Rate (nutrient) lb. per acre**
Nitrogen (N)	Urea-ammonium nitrate solutions Calcium nitrate	T,S,D[2] T,S,D	30 to 40
Phosphorus (P_2O_5)	Ammonium phosphates Triple superphosphate Phosphoric acid	T,S,D T,S S,D	20
Potassium (K_2O)	Potassium chloride Potassium nitrate	T,S,D T,S,D	30
Calcium (Ca)	Calcium nitrate Calcium chloride	T,S,D D	30
Magnesium (Mg)	Magnesium sulfate Potassium magnesium sulfate	T,S,D T,S	20
Sulfur (S)	Ammonium Sulfate Gypsum	T,S,D T,S,D	20
Boron (B)	Borax, Solubor[1]	D,F	0.1 to 0.2
Copper (Cu)	Copper sulfate	D,F	0.1 to 0.2
Iron (Fe)	Ferrous sulfate, chelated iron	D,F	0.2 to 0.5
Manganese (Mn)	Manganous sulfate, chelated manganese	D,F	0.5 to 1.0
Molybdenum (Mo)	Sodium molybdate	D,F	0.01 to 0.05
Zinc (Zn)	Zinc sulfate, chelated zinc	D,F	0.1 to 0.2

[1] Mention of a trade name does not imply a recommendation compared to similar materials.
[2] T,S,D,F are topdress, sidedress, drip irrigation, and foliar, respectively.

Table B10. Sufficiency levels for petiole sap concentrations in vegetable crops.

Crop	Stage of Growth	Fresh Petiole Sap Concentration (ppm)	
		K	NO_3-N conc.
Cucumber	First blossom Fruits three inches First harvest	N/A	800 to 1000 600 to 800 400 to 600
Broccoli	Six-leaf stage Just prior to harvest At first harvest	N/A	800 to 1000 500 to 800 300 to 500
Eggplant	First fruit (two-inches long) First harvest Mid harvest	4500 to 5000 4000 to 5000 3500 to 4000	1200 to 1600 1000 to 1200 800 to 600
Muskmelon (Cantaloupe)	First blossom Fruits 2 inches First harvest	4000 to 5000 3500 to 4000 3000 to 3500	1000 to 1200 800 to 1000 700 to 800
Pepper	First flower buds First open flowers Fruits half-grown First harvest Second harvest	3200 to 3500 3000 to 3200 3000 to 3200 2400 to 3000 2000 to 2400	1400 to 1600 1400 to 1600 1200 to 1400 800 to 1000 500 to 800
Potato	Plants 8 inches tall First open flowers 50% flowers open 100% flowers open Tops falling over	4500 to 5000 4500 to 5000 4000 to 4500 3500 to 4000 2500 to 3000	1200 to 1400 1000 to 1400 1000 to 1200 900 to 1200 600 to 900
Squash	First blossom First harvest	N/A	900 to 1000 800 to 900
Tomato (Field)	First buds First open flowers Fruits one-inch diameter Fruits two-inch diameter First harvest Second harvest	3500 to 4000 3500 to 4000 3000 to 3500 3000 to 3500 2500 to 3000 2000 to 2500	1000 to 1200 600 to 800 400 to 600 400 to 600 300 to 400 200 to 400
Watermelon	Vines 6-inches in length Fruits 2-inches in length Fruits one-half mature At first harvest	4000 to 5000 4000 to 5000 3500 to 4000 3000 to 3500	1200 to 1500 1000 to 1200 800 to 1000 600 to 800

Sustainable Nutrient Management

A major objective of nutrient management is to bring the soil fertility level into the optimum range and to sustain that fertility level during the crop growth phrase. Once soil fertility has reached the *optimum* level, the nutrient application rate should be only large enough to maintain the *optimum* level. This can be accomplished by applying nutrients at a rate that closely matches the rate of nutrient removal in the harvested crop. The rate may need to be slightly higher to account for other losses such as leaching.

Keeping records of soil test results enables growers to track changes over time and to adjust recommendations as needed to maintain soil fertility in the *optimum* range. Meaningful records require a consistent approach to soil testing in terms of sample collection, sampling depth, and laboratory submission. Soil test levels can vary somewhat from sample to sample and having records helps to spot unusual soil test values that should be rechecked.

Although soil fertility levels naturally fluctuate from year to year due to crop rotation and manure application, the average levels of nutrients over time should remain in the *optimum* range, as shown in Figure B-3. If soil fertility levels are observed to fall in the *deficient* category, under-fertilization is indicated. The nutrient recommendation should be adjusted so that the nutrient application rate is sufficient to meet the needs of the current crop and also gradually rebuild the nutrient supply to the *optimum* level. If soil fertility levels are observed to climb into the *exceeds crop needs* category, good crop yields may be obtained without adding the nutrient; however, yield and quality are likely to be reduced by reapplying a nutrient already present in very high amounts. Over a period of time, nutrient removal by crops should allow the soil fertility level to fall back into the *optimum* range (see Figs. B-1, B-3).

Very high soil nutrient levels can be as detrimental to crop performance as low or deficient levels. High soil nutrient levels may not only result in an economic loss but they may also cause problems to animals or the environment. Very high P levels (above about 370 lbs

P_2O_5/acre or 160 lbs P/acre) in the soil may lead to deficiencies of other nutrients, especially of iron and zinc. High K levels (above about 205 lbs K_2O/acre or 170 lbs K/acre) can induce magnesium or calcium deficiency through competition for plant uptake and vice versa. Use best management practices to avoid increasing soil nutrient levels that are already high.

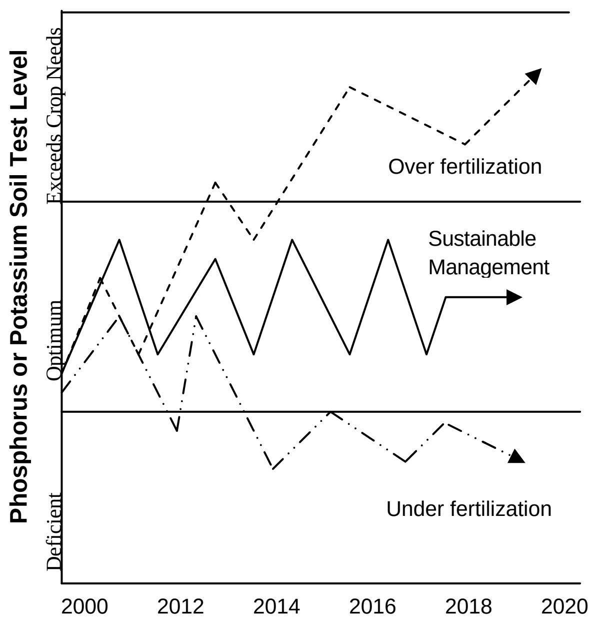

Figure B-3. Changes in soil test levels over time under different nutrient management scenarios.

Sewage Sludge

Sewage sludge, or biosolids, is a by-product of the purification of waste water. This type of material has significant organic matter content and contains micro- and macronutrients essential for plant growth. Sewage sludge can also contain contaminants such as heavy metals, organic contaminants, and human pathogens. Before it can be used for land application, sewage sludge must undergo additional treatment to stabilize and disinfest it. After appropriate treatment, federal and some state regulations allow the use of sewage sludge on vegetables. However, due to our lack of knowledge and biosolids and perishable food commodities. **Cooperative Extension does not recommend the application of sewage sludge/biosolids to soils used for vegetable production.**

If the grower elects to use biosolids despite this warning, the material should not be applied to steeply sloping land, soils with bedrock near the surface, highly leachable soils, soils having a pH less than 6.0, soils with high water tables, or fields near surface water. When considering the land application of biosolids, carefully review the regulations and consult USDA/NRCS.

Foliar Fertilization

Plants usually obtain nutrients from the soil through roots. It is known that plants can also absorb a limited amount of some nutrients through aerial organs such as leaves. Properly managed soils are usually able to supply the essential mineral nutrients the crop will need during its development. If one or more soil-supplied nutrients become deficient or unavailable during the development of the crop, foliar nutrient applications may then be beneficial. Care should be taken to use approved tank mixes if nutrients are combined with fungicides, insecticides, herbicides, or any other additive. Often, chelated nutrient sources are optimal for most tank mixes; however, care should be taken to read the label and conduct a jar test. Generally, it is difficult to supply ample macro and secondary nutrients as a foliar fertilization, and focus should be directed towards application of this strategy micronutrients only. If deficiency occurs, efforts should be made to correct any deficient nutrient via soil fertilization prior to the next growing season.

Soil Improvement and Organic Nutrient Sources

Cover Crops

Cover cropping is an important practice for sustainable vegetable production. The following are some reasons to consider using cover crops in vegetable rotations.

- Return organic matter to the soil. Vegetable rotations are tillage intensive and organic matter is oxidized at a high rate. Cover crops help to maintain organic matter levels in the soil, a critical component of soil health and productivity.
- Provide winter cover. By having a crop (including roots) growing on a field in the winter you recycle plant nutrients (especially nitrogen), reduce leaching losses of nitrogen, reduce erosion by wind and water, and reduce surface compaction and the effects of heavy rainfall on bare soils. Cover crops also compete with winter annual weeds and can help reduce weed pressure in the spring.
- Reduce certain diseases and other pests. Cover crops help to maintain soil organic matter. Residue from cover crops can help increase the diversity of soil organisms and reduce soil borne disease pressure. Some cover crops may also help to suppress certain soil borne pests, such as nematodes, by releasing compounds that affect these pests upon decomposition.
- Provide nitrogen for the following crop. Leguminous cover crops, such as hairy vetch or crimson clover, can provide significant amounts of nitrogen, especially for late spring planted vegetables.
- Improve soil physical properties. Cover crops help to maintain or improve soil physical properties and reduce compaction. Roots of cover crops and incorporated cover crop residue will help improve drainage, water holding capacity, aeration, and tilth.

Small Grains and Ryegrasses

Seeding spring oats at 60 to 100 pounds per acre during August or early September provides a good cover crop that will winter-kill in the colder areas but may overwinter in warmer areas. Rye, triticale, barley or winter wheat can be seeded at 80 to 110 pounds per acre after early September. These crops can also provide strips for wind protection during the early part of the next growing season. Spring oats also works as a spring planted cover. Annual and perennial ryegrass or a mixture of the two seeded at 15-20 pounds per acre by early September are also good cover crops.

Legumes

Research has demonstrated that certain legumes are also effective cover crops for vegetable rotations. Hairy vetch, crimson clover, field peas, subterranean clover, and other clovers are excellent cover crops and can provide significant nitrogen for vegetable crops that follow. Good examples are hairy vetch drilled at 25-60 lbs/acre, crimson clover at a rate of 15-30 lbs/acre, or field peas such as Austrian Winter planted at 50-70 lbs/acre. Subterreanean clover is an option for the southern part of the region. Hairy vetch works very well in no-till vegetable systems where it is allowed to go up to flowering and then is killed by herbicides or with a roller-crimper. It is a common system for planting pumpkins in the region but also works well for late plantings of other vine crops, tomatoes and peppers. Hairy vetch, crimson clover, field peas and subterranean clover can provide from 80 to well over 100 pounds of nitrogen equivalent. Remember to inoculate the seeds of these crops with the proper Rhizobia inoculants for that particular legume. All of these legume species should be planted as early as possible – from the last week in August through the end of September to get adequate fall growth. Legume cover crops should be planted a minimum of 4 weeks before a killing frost.

Red clover planted late winter or early spring can be used ahead of early summer vegetables. Summer legume cover crops can be used for soil improvement and provide nitrogen prior to planting fall vegetable crops. These include sun hemp, cowpeas, soybeans, annual lespedeza, and a number of medic (alfalfa) species.

Summer Annual Grasses

Summer grass cover crops such as sudangrass, forage sorghum or sorghum x sudangrass crosses , seeded at 20 to 40 pounds per acre, are good green manure crops. Several millet species including forage-type pearl millet, teff, German or foxtail millet, and Japanese millet are also good cover crops. They can be planted as early as field corn is planted and as late as August 15 in Maryland and Virginia, and July 25 to August 1 in cooler areas of New Jersey and Pennsylvania. These crops should be clipped, mowed, or disked to prevent seed development that could lead to weed problems. Summer cover crops can be disked and planted in wheat or rye in September or allowed to winter-kill and tilled in the spring.

Brassica Species

There has been an increase in interest in the use of certain *Brassica* species as cover crops for vegetable rotations. These include both fully hardy overwintering species and species that will winter kill but that can be planted in the spring ahead of crop production. They provide significant organic matter, recycle nitrogen, can reduce compaction (larger rooted types), and offer the potential for biofumigation (mustards and rapeseed). Plant by September 15 in the fall or in March-April in the spring.

Brassica types available:

Rapeseed and Canola – overwinter and are good biofumigants

Forage Radish, Oilseed Radish, and Daikon Radish – very good for reducing compaction in soils; forage radish winter kills, oilseed radish is hardier.

Mustards (brown and yellow mustards as well as garden mustard) – offer good biofumigant potential; half hardy

Turnips (forage and garden types) – good biomass production; half hardy

Kale (forage and garden types) – winter hardy; good biomass production

Hybrid Forage Brassicas (such as ‘Typhon’) – these are hybrid crosses of two or more species that will produce excellent fall growth and some will overwinter Rapeseed has been used as a winter cover when planted by early September and has shown some promise in reducing certain nematode levels in the soil acting as a biofumigant. Several mustard species also have biofumigation potential to take advantage of the biofumigation properties of rapeseed and biofumigant mustards you plant the crop in late summer or in spring. Allow the plant to develop until just before it goes to seed. It is the leaves that break down to release the fumigant-like chemical. Mow using a flail mower and plow down the residue immediately. Never mow down more area than can be plowed under within two hours. Mowing injures the plants and initiates a process releasing biofumigant chemicals into the soil. Failure to incorporate mowed plant material into the soil quickly, allows much of these available toxicants to escape by volatilization.

Several mustard species can be used for fall cover but not all varieties and species will winter over into the spring. As stated above, several mustard species have biofumigation potential and a succession rotation of an August planting of biofumigant mustards that are tilled under in October followed by small grain can significantly reduce diseases for spring planted vegetables that follow.

Make sure to mow and disk rapeseed and mustard in advance of seed maturation, since they can become serious noxious weeds.

Other Cover Crops/Special Considerations

A number of other cover crops may be useful. Buckwheat is a quick summer cover crop noted for its ability to smother out weeds, Marigold species have been used as nematode controls.

Many soils that are not very productive due to poor physical properties can be restored and made to produce good crops through the use of a good rotation program. This practice also helps to counteract the buildup of many diseases and insects that attack vegetable crops. Small grains, sudangrass, sorghum x sudangrass, timothy, orchardgrass, ryegrass and other grass hay species are good soil-resting crops. Consult your state field crop or agronomy recommendations for details on seeding rates and management practices.

Intensive cropping, working the soil when it was too wet, and excessive traffic from using heavy-tillage equipment has severely damaged many soils. These practices cause the soils to become very hard and compact, resulting in poor seed germination, loss of transplants, and shallow root formation. Also, such soils crust easily and compact severely, making them very difficult to irrigate properly. This results in poor plant stands, poor crop growth, low yields, and loss of income. Subsoil tilling in the row may help improve aeration and drainage of soils damaged by several years of excessive traffic from heavy equipment.

Alfalfa can aid in breaking up deep soil compaction. It is useful as a soil-resting crop and in crop rotations. However, it should not be used in rotation with other legumes such as soybeans; peas; and snap, dry, and lima beans; and especially where soil-borne diseases have been a problem.

Forage radish and oilseed radish are also very well suited to improving compacted soils.

Proper management of living cover crops can reduce nutrient loss during the winter and early spring. Living cover crops should be disked or plowed to return nutrients to the soil and before they seriously deplete soil moisture.

Compost and Manure

Application and incorporation of compost to soils will increase soil organic matter and certain soil nutrient levels. Since compost ingredients can include animal manures, scrap table foods, food wastes, leaves, grass, and sawdust, both microbial and nutrient content (phosphorus) of the compost become extremely important considerations in field applications. Microbial populations (*E. coli 0157:H7, Listeria, Salmonella*, etc.), heavy metals such as nickel, lead, or cadmium and excessive nutrient levels such as nitrogen may be present in the composts containing human or animal waste so it should not be used for edible food production. Also, the ingredients which make up specific compost may be highly alkaline, resulting in a high compost pH of 7.5 to 8.5. Therefore, application rates of compost must be determined by considerations of nutrient content, microbial content, crop use, and pH before field applications are made. Applications should be made at low rates (1 to 3 tons per acre) since high rates of compost (10+ tons per acre) can result in soil pH problems, nutrient imbalance in the soil, or microbial contamination.

A good extension web reference on the making and use of compost for vegetable production is https://aggie-horticulture.tamu.edu/vegetable/guides/composts-vegetable-fruits-production/.

For more information on nutrients in organic production see the guide *Using Organic Nutrient Sources* at: http://pubs.cas.psu.edu/FreePubs/pdfs/uj256.pdf.

Herbicide Carryover in Compost

It is important to know the source and composition of any soil amendment or compost that is used on or around vegetable crops. Compost that contains hay, straw, grass clippings, and cow or horse manure may potentially be a carrier of herbicide residue. Several herbicides commonly used in pasture and turf production may be present in straw or hay and can pass through the digestive system of animals and remain in manure. These herbicides are toxic in very low concentrations to many vegetable crops. Symptoms are often similar to growth regulating herbicides and include twisted or cupped leaves, misshapen fruit, reduced yields, or plant death. Additional information can be found at: http://www.ces.ncsu.edu/fletcher/programs/ncorganic/special-pubs/herbicide_carryover.pdf.

Organic Production

Nutrient sources used for certified organic production must be included in the National List of Allowed and Prohibited Substances, which can be found on the web, (www.ams.usda.gov/AMSv1.0/nop). The Organic Materials Review Institute (OMRI) reviews products submitted by companies against the National Organic Standard (NOS) and is a good place to identify which products are allowed in organic production (visit omri.org for more information). Certifying agencies also review products for compliance with the NOS. Before using any product it is best to check with your certifying agency to make sure the product is allowed and thereby avoid compromising your organic certification. See Table B-13 for a list of various products useable on organic farms.

Table B-11. Plant Nutrient Value Credits to Be Allowed for Manure Applications and Crop Residues

	N	P_2O_5	K_2O
	----------- *Pounds per Ton*	----------------	
Cattle manure	5-10[1]	3	3
Poultry manure	25-50[1]	40-80	30-60
Pig manure	5-10[1]	2	2
Horse manure	6-12[1]	3	6
Liquid poultry manure (5-15% solids)	7-15[1]	5-10	5-10
	------------ *Pounds per Acre*	-------------	
Alfalfa sod	50-100[2]	0	0
Hairy vetch	50-100[2]	0	0
Ladino clover sod	60	0	0
Crimson clover sod	50	0	0
Red clover sod	40	0	0
Birdsfoot trefoil	40	0	0
Lespedeza	20	0	0
Soybeans			
Tops and roots	40	0	0
Grain harvest residue	15	0	0

1 Lower values for fall- and winter-applied manure, and higher values for spring applied manure. Use these figures only if manure being used has not been analyzed.

2 75% stand = 100-0-0, 50% stand = 75-0-0, and 25% stand = 50-0-0

Table B-12. Boron Recommendations Based on Soil Tests for Vegetable Crops

Interpretation of Boron Soil Tests: Parts per Million	Pounds per Acre	Relative Level	Crops that Often Need Additional Boron[1]	Boron (B) Recommendations Pounds per Acre[2]
0.0-0.35	0.0-0.70	Low	Beets, broccoli, brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips	3
			Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash strawberries, sweet corn, tomatoes, and white potatoes	2
			Peppers and sweet potatoes	1
0.36-0.70	0.71-1.40	Medium	Beets, broccoli, brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips	1½
			Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash, strawberries, sweet corn, tomatoes, and white potatoes	1
>0.70	>1.40	High	All crops	0

[1] If boron deficiency is suspected in vegetable crops not listed above, a soil and/or plant tissue test should be made and used as a basis for treatment recommendations.

[2] Approximate conversion factors to convert elemental boron (B) to different boron sources: Boron (B) x 9 = borax (11.36% B); boron (B) x 7=fertilizer borate granular (14.3% B); boron (B) x 6.7 = fertilizer borate-48 (14.91% B); boron (B) x 5 = fertilizer borate-65 (20.2% B) or Solubor (20.5% B); boron (B) x 4.7 = fertilizer borate-68 (21.1% B).

Note. The most practical way to apply boron as a soil application is as an additive in mixed fertilizer bought specifically for the crop or field where it is needed. Do not use fertilizer containing more than 0.5 pound of boron (B) per ton of fertilizer for crops not listed above, unless specifically recommended. To avoid possible boron toxicity damage to crops, apply boron in broadcast fertilizer rather than in bands or as a sidedressing. Boron may be broadcast preplant as a soluble spray alone or with other compatible soluble chemicals.

Table B-13. Mineral nutrient value, relative availability and status for organic production of various nutrient sources. Before using any of the listed materials, it's best to check with your certifying agency because some of the materials may be removed from or added to the list in the future.

Materials[a]	Status for Organic Production[b]	Percent Nutrients[c]			
		N	P_2O_5	K_2O	Relative Availability
Animal Tankage (dry)	Allowed	7	10	0.5	Medium
Bone Meal (raw)	Allowed	2 to 6	15 to 27	0	Slow
Bone Meal (steamed)	Allowed	0.7 to 4.0	18 to 34	0	Slow Medium
Cocoa Shell Meal	Allowed	2.5	1.0	2.5	Slow
Compost (not fortified)	Allowed[d]	1.5 to 3.5	0.5 to 1.0	1.0 to 2.0	Slow
Cottonseed Meal (dry)	Allowed[e]	6	2.5	1.7	Slow Medium
Dried Blood (dry)	Allowed	12	1.5	0.57	Medium Rapid
Fish Emulsion	Allowed	5	2	2	Rapid
Fish Meal (dry)	Allowed	14	4	0	Slow
Fish Scrap (dry)	Allowed	3.5 to 12	1 to 12	0.08 to 1.6	Slow
Garbage Tankage (dry)	Allowed	2.7	3	1	Very Slow
Grain Straw	Allowed	0.6	0.2	1.1	Very Slow
Guano (Bat)	Restricted[f]	5.7	8.6	2	Medium
Kelp[g]	Allowed	0.9	0.5	4 to 13	Slow
Manure[h] (fresh)	Restricted[i]	0.25	0.15	0.25	Medium
Cattle		0.25	0.15	0.25	Medium
Horse		0.3	0.15	0.5	Medium
Sheep		0.6	0.33	0.75	Medium
Swine		0.3	0.3	0.3	Medium
Poultry (75%)		1.5	1	0.5	Medium Rapid
Poultry (50%)		2	2	1.0	Medium Rapid
Poultry (30%)		3	2.5	1.5	Medium Rapid
Poultry (15%)		6	4	3	Medium Rapid
Marl	Allowed	0	2	4.5	Very Slow
Mushroom Compost[j]	Allowed[k]	0.4 to 0.7	5.7 to 6.2	0.5 to 1.5	Slow
Peanut Hulls	Allowed	1.5	0.12	0.78	Slow
Peat and Muck	Allowed[l]	1.5 to 3.0	0.25 to 0.5	0.5 to 1.0	Very Slow
Pomaces[m]					
Apple (fresh)	Allowed	0.17 to 0.3	0.4 to 0.7	0.2 to 0.6	Slow
Apple (dry)		0.7 to 0.9	1.2 to 2.1	0.6 to 1.8	Slow
Castor		5.0	1.0	1.0	Slow
Winery		1.5	1.5	0.80	Slow
Sawdust	Allowed[n]	4	2	4	Very Slow
Soybean Meal (dry)	Allowed	6.7	1.6	2.3	Slow Medium
Tobacco Stems (dry)	Allowed	2	0.7	6.0	Slow
Wood Ashes[o]	Allowed[p]	0	1 to 2	3 to 7	Rapid

[a]Some materials may not be obtainable because of restricted sources.
[b]Must be produced in accordance with the National Organic Standard to be allowed. Organic status was determined through listing with the Organic Materials Review Institute (OMRI; www.omri.org). Brand used may affect allowability; check with your certifier before using any product to avoid compromising your certification.
[c]The percentage of plant nutrients is highly variable, mean percentages are listed.
[d]Must be produced in accordance with the National Organic Standards to be used in organic production.
[e]Brand used must not be derived from genetically modified cotton or contain prohibited substances.
[f]Allowed guano is decomposed and dried deposits from wild bats or birds. Must meet requirements for using raw manure.
[g]Contains common salt, sodium carbonates, sodium and potassium sulfates.
[h]Plant nutrients are available during year of application. Nutrient content varies with the amount of straw and method of storage.
[i]Uncomposted or raw animal manure must be used on fields with crops not to be consumed by humans **or** incorporated into the soil a minimum of 90 days before harvesting a product to be consumed by humans provided that the edible portion of the crop does not contact the soil **or** integrated into the soil a minimum of 120 days before harvesting a product to be consumed by humans that does come into contact with the soil. Using sewage sludge is prohibited in certified organic production.
[j]Use only after composting in compliance with the National Organic Standard. Fresh mushroom compost is usually too high in soluble salts.
[k]Must meet compost requirements.
[l]Not allowed if contains synthetic wetting agents.
[m]Plant nutrients are highly variable, depending on the efficiency and the processing techniques at the processing plant.
[n]Allowed only if wood is untreated and unpainted.
[o]Potash content depends upon tree species burned. Wood ashes are alkaline, contain about 32% CaO.
[p]Only from untreated and unpainted wood. Wood stove ash – only if not contaminated with colored paper, plastics, or other synthetic sources.

IRRIGATION MANAGEMENT

BASIC PRINCIPLES

Moisture management throughout the growing season is a critical factor for production of high quality vegetables. Even relatively short periods of inadequate soil moisture can adversely affect crops. Thus, supplemental irrigation is beneficial in most years, since rainfall in the Mid-Atlantic Region is rarely uniformly distributed, even in years with above-average precipitation.

Moisture stress has varying effects on plants according to developmental stage and type of stress. Moisture deficiencies occurring early in the crop cycle may delay maturity and reduce yields and quality. Shortages later in the season often decrease quality, as well as yields, or even result in irreversible crop damage. Over-irrigating, especially late in the season, can reduce quality and postharvest life of the crop. Table C-1 shows the periods of crop growth when an adequate supply of water is critical for high quality vegetable production.

Applying the proper amount of water at the correct time and location is critical for achieving the optimum benefits from irrigation. The crop water requirement, termed evapotranspiration or ET, is equal to the quantity of water lost from the plant (transpiration) plus that evaporated from the soil surface. ET is the most important factor for effective irrigation management. Numerous factors must be considered when estimating ET. The amount of solar radiation, which provides the energy to evaporate moisture from the soil and the plant, is the major factor. Other important factors include air temperature, wind speed, and humidity level. Different crops also have different rates of transpiration.

Instruments that measure soil moisture content are commonly used to measure changes in soil moisture and adjust irrigation schedules (see the following section "Scheduling Irrigation with Tensiometers and Resistance Meters").

Table C-1. Critical Periods of Water Needs by Crops

Crop	Most Critical Period
Asparagus	Brush (period following fern mowing)
Beans: lima	Pollination and pod development
snap	Pod enlargement
Broccoli	Head development
Cabbage	Head development
Carrots	Root enlargement
Cauliflower	Head development
Corn	Silking and tasseling, ear development
Cucumbers	Flowering and fruit development
Eggplants	Flowering and fruit development
Lettuce	Head development
Melons	Flowering and fruit development
Onions: dry	Bulb enlargement
Peas	Seed enlargement and flowering
Peppers	Flowering and fruit development
Potatoes: white	Tuber set and tuber enlargement
sweet	Root enlargement
Radishes	Root enlargement
Strawberries	Establishment, runner development, fruit enlargement
Squash: summer	Bud development and flowering
Tomatoes	Early flowering, fruit set, and enlargement
Turnips	Root enlargement

Table continued next column

Table C-1. Critical Periods of Water Needs by Crops *(cont'd)*

Plant factors that affect the crop water requirement are crop species and variety, canopy size and shape; leaf size, shape, wax coating and orientation; plant population density; rooting depth; and stage of growth and development of the crop. The plant canopy size and shape influences transpiration, light absorption, reflection, and the rate that water evaporates from the soil. Crops that feature a canopy with more surface area for transpiration (mature corn, potatoes, snap beans) use more water than crops which do not have an extensive canopy (immature plants, recently transplanted crops). Leaf architecture affects the transpiration rate from individual leaves. Rooting depths vary with crop species and may be affected by soil compaction or hard pans. Rooting depth determines the volume of soil from which the crop can draw water and is important when determining to what depth the soil must be wetted by irrigation.

Plant growth stage also influences susceptibility to moisture stress. Irrigation is especially beneficial when establishing newly seeded or transplanted crops. During seedling or transplant growth, especially the first 1-2 weeks, the root system is not yet established in surrounding soil. Irrigation after transplanting can significantly increase plant survival, especially when soil moisture is marginal and ET is high. Irrigation can also increase the uniformity of emergence and final stand of seeded crops. For seeded crops, reduce the rate of application and the total volume of water per application to avoid crusting (cohesion of soil particles at the surface). If crusting is present, continue to apply low rates and volume of irrigation water to soften the crust while seedlings are emerging.

Cultural practices also influence ET. Cultivation, mulching, weed growth, and method of irrigation are factors to consider. Cultivation generally increases soil evaporation but if crop roots are pruned or damaged by the cultivator, water uptake and, thus, transpiration may be reduced. Shallow cultivation may help eliminate soil crusts and, therefore, improve water infiltration from rainfall or irrigation. Weeds compete with the crop for water and increase the volume lost through transpiration. Sprinkler irrigation wets the entire crop area and, thus, has a greater evaporation loss than does trickle irrigation that wets only the area in the region of the plant root system.

Soil factors must also be considered. Soils having high levels of silt, clay, and organic matter have greater available water-holding capacities than do sandy soils or soils that are compacted (Table C-2). Available water refers to the amount of water that a plant is able to withdraw from the soil. Soils with high available water-holding capacities require less frequent irrigation than soils with low available water-holding capacities. A greater volume of water must be applied per application on silty soils.

Table C-2. Available Water Holding Capacity Based on Soil Texture

Soil Texture	Available Water Holding Capacity (inch of water/inch depth of soil)
Coarse sand/compacted sands	0.02 - 0.06
Fine sand	0.04 - 0.09
Loamy sand	0.06 - 0.12
Sandy loam	0.11 - 0.15
Fine sandy loam/compacted loams	0.14 - 0.18
Loam and silt loam	0.17 - 0.23
Clay loam and silty clay loam	0.14 - 0.21
Silty clay and clay	0.13 – 0.18

Another soil factor that influences irrigation practices is the soil infiltration rate. Water should not be applied to soils at a rate greater than the rate at which soils can absorb water. Excessive water conditions may lead to erosion from runoff and promote disease development. Table C-3 lists the typical infiltration rates of several soils.

Table C-3. Soil Infiltration Rates Based on Soil Texture

Soil Texture	Soil Infiltration Rate (inch/hour)
Coarse sand	0.75 - 1.00
Fine sand	0.50 - 0.75
Fine sandy loam	0.35 - 0.50
Silt loam	0.25 - 0.40
Clay loam	0.10 - 0.30

There is no simple method to accurately schedule irrigations since all the above factors interact to determine actual ET. In some instances, leaf canopy temperature has been shown to be an effective tool for irrigation management. In the absence of reliable methods to estimate ET, the following factors should be kept in mind when deciding when and how much to irrigate.

1. Soils vary greatly in water-holding capacity and infiltration rate. Silt and clay soils and those high in organic matter can hold much more water than sandy soils low in organic matter.
2. Water loss from plants and the soil surface is much greater on clear, hot, windy days than on cool, overcast, humid days. During periods of hot, dry weather, ET rates may reach 0.25 inch/day or higher. The evaporation component of ET can be estimated by the use of a standard evaporation pan (check with your extension office or consult on-line resources such as www.aecdatalog.com/irrigation/evappan for information on using these devices).
3. Results from research show that maintaining soil moisture levels in a narrow range, just slightly below field capacity (75 to 90 percent soil moisture), maximizes crop response. Therefore, frequent irrigations of smaller amounts are better than delaying irrigations until the soil moisture reaches a lower level (40 to 50 percent soil moisture) and then applying a heavy irrigation.
4. Mulches reduce evaporation from the soil but also reduce the amount of water that can reach the root zone from rains. Thus, much of the natural precipitation should be ignored when scheduling irrigations for crops grown under plastic mulch.
5. In general, apply 0.25 inch or more of water in any one irrigation, except during early season when establishing crops. This will ensure that water reaches active areas of the root zone.
6. If irrigation water has a high salt content (for example wells in coastal aquifers), excess water should be applied per irrigation to leach any salts before they are concentrated by evaporation.

DRIP/TRICKLE IRRIGATION

Drip (or trickle) irrigation is used on a wide range of vegetable crops. Drip (or trickle) irrigation is a method of slowly applying small amounts of water directly to the plant root zone. Water is applied frequently, often daily, to maintain favorable soil moisture conditions. The primary advantage of drip irrigation systems is that less water is used than with sprinkler or surface irrigation systems. In many cases, one-half or less of the water applied with sprinkler or surface systems is required with drip systems. In addition, substances applied through the drip irrigation system, such as pesticides, fertilizers, and growth regulators, are conserved along with water. Further, water applied via drip irrigation is more available to crop plants and less available to weeds.

Drip irrigation systems also have several other advantages over sprinkler and surface irrigation systems. Low flow rates and operating pressures are typical of drip systems. These characteristics lead to lower energy and equipment costs. Once in place, drip systems require little labor to operate, can be automatically controlled, and can be managed to apply precisely the amount of water needed by the crop. These factors also reduce operating costs. With most drip systems, disease and insect damage is reduced because leaves are not moistened by irrigation water. The areas between rows also remain dry, thus reducing weed growth between rows and reducing the amount of water lost to weeds. Consequently, fewer pests and pathogens are encouraged in these areas of the field. In addition, field management operations can continue during irrigation.

There are also several potential problems which are unique to drip irrigation systems. Most of these require that a higher level of management be used with drip systems than is used with other irrigation systems. Moisture dispersal throughout the soil is limited with drip systems. In most cases, a smaller soil water reserve is available to plants. Under these conditions, the potential to stress plants is greater than with other types of irrigation systems. Drip systems must be carefully managed to avoid localized moisture stress.

The equipment used in drip systems also presents potential problems and drawbacks. Drip irrigation equipment can be damaged by insects, rodents, and laborers, and often has a higher initial investment cost than other system types. Pressure regulation and filtration require equipment not commonly found on sprinkler or surface systems. The drip system, including pump, headers, filters, and connections must be checked and ready to operate before planting. Failure to have the system operational could result in costly delays, poor plant survival or irregular stands, and reduced yield. In addition, it is not practical to use drip systems for frost control and the irrigation of solid-stand crops, such as forages and cereals. Calculating the length of time required to apply a specific depth of water with a trickle irrigation system is more difficult than with sprinkler systems.

Drip irrigation is especially effective when used with plastic film or organic mulches. Unlike sprinkler systems, trickle systems apply water to only a small portion (mulched) of the total crop acreage. Usually, a fair assumption to make is that the mulched width approximates the extent of the plant root zone and should be used to calculate system run times for medium and fine textured soils (loamy and clay soils). Table C-4 has been prepared to calculate the length of time required to apply one inch of water with a drip irrigation system, based on the drip tube flow rate and the mulched width. The use of this table requires that the drip system be operated at the pressure recommended by the manufacturer.

Table C-4. Hours Required to Apply 1 Inch of water (use this table for fine-textured or heavy soils)

Drip Tube Flow Rate		Mulched Width/ Bed Width (ft)				
(gph/100 ft)	(gpm/100 ft)	2.0	2.5	3.0	3.5	4.0
8	0.13	15.5	19.5	23.5	27.0	31.0
10	0.17	12.5	16.5	18.5	22.0	25.0
12	0.20	10.5	13.0	15.5	18.0	21.0
16	0.27	8.0	10.0	11.5	13.5	15.5
18	0.30	7.0	8.5	10.5	12.0	14.0
20	0.33	6.0	8.0	9.5	11.0	12.5
24	0.40	5.0	6.5	8.0	9.0	10.5
27	0.45	4.5	6.0	7.0	8.0	9.5
30	0.50	4.0	5.0	6.0	7.0	8.5
36	0.60	3.5	4.5	5.0	6.0	7.0
40	0.67	3.0	4.0	4.5	5.5	6.0
42	0.70	3.0	4.0	4.5	5.0	6.0
48	0.80	2.5	3.0	4.0	4.5	5.0
50	0.83	2.5	3.0	4.0	4.5	5.0
54	0.90	2.5	3.0	3.5	4.0	4.5
60	1.00	2.0	2.5	3.0	3.5	4.0

On coarse-textured sandy soils, more water volume is required than for finer-textured soils. Table C-5 summarizes the length of time required to apply 1-inch of water with a drip irrigation system based on the drip tape flow rate and the crop row spacing. The use of this table requires that the drip system be operated at the pressure recommended by the manufacturer. Because water is not absorbed as much by coarse than by fine-textured soils, it moves below the plant root zone, carrying nutrients and pesticides beyond the reach of the plant roots. Table C-6 presents the maximum recommended irrigation period for drip irrigation systems. The irrigation periods listed are based on the assumption that 50 percent of the available water in the plant root zone is depleted (see next section on the use of tensiometers for determining when this occurs). Soil texture directly influences the water-holding capacity of soils and, therefore, the depth reached by irrigation water.

Table C-5. Hours Required to Apply 1 Inch Water (use this table for course-textured or light soils)

Trickle Tube Flow Rate		Row Spacing (ft)				
(gph/100 ft)	(gpm/100 ft)	4	5	6	8	10
13.2	0.22	19	24	28.5	38.0	47.5
20.4	0.34	12.5	15.5	18.5	24.5	31.0
27.0	0.45	9.5	11.5	14.0	18.5	23.5
40.2	0.67	6.5	8.0	9.5	12.5	15.5
80.4	1.34	3.5	4.0	5.0	6.5	8.0

Table C-6. MAXIMUM APPLICATION TIMES FOR DRIP IRRIGATED VEGETABLES (use this table in combination with Table C-4 OR C-5)

Available Water Holding Capacity (inch of water / inch depth of soil)[1]	Tubing Flow Rate (gpm per 100 ft) 0.2	0.3	0.4	0.5	0.6
	(maximum minutes per application)[2]				
0.02	20	14	10	8	7
0.04	41	27	20	16	14
0.06	61	41	31	25	20
0.08	82	54	41	33	27
0.1	102	68	51	41	34
0.12	122	82	61	49	41
0.14	143	95	71	57	48
0.16	163	109	82	65	54
0.18	183	122	92	73	61
0.2	204	136	102	82	68
0.22	224	150	112	90	75

[1] Refer to Table C-2 for available water holding capacity based on soil texture.

[2] Assumes 10-inch deep root zone and irrigation at 25% soil moisture depletion.

Scheduling Irrigation With Tensiometers and Resistance Meters

Irrigation scheduling is a management practice used to determine how often to irrigate and how much water to apply with each irrigation. Irrigation duration was discussed in the previous section, and should be based on soil available water-holding capacity, soil moisture depletion level, and drip tube flow rate.

Tensiometers

Tensiometers are excellent tools for determining irrigation frequency because they measure water available in the crop root zone. Tensiometers are glass tubes with a porous tip submerged in the soil, and pressure gauge at the other end. These devices can be purchased at irrigation equipment suppliers. If handled properly, they can remain in service for many years. Tensiometers directly measure soil tension. This is also often referred to as "soil suction" or "vacuum". Soil tension is a measure of how tightly water is held in the soil, and is measured in pressure units of centibars (cb) or kilopascals (kPa). These are different units of measurement of the same condition: soil vacuum. To convert cb to PSI, multiply by 0.15; to convert PSI to cb, multiply by 6.67.

Soil tension increases as moisture in the soil is depleted. This force also draws water out of the tensiometer through its porous tip, creating a vacuum inside the tensiometer. This negative pressure, or tension, is registered on the tensiometer vacuum gauge. The soil tension measured with tensiometers is an indirect indication of soil moisture content and can be used as an indicator of irrigation need.

Table C-7 contains guidelines for using soil tension data to schedule irrigation events. Field capacity is the moisture content at which a soil is holding the maximum amount of water it can against the force of gravity. This moisture content is reached 24 to 72 hours after a saturating rain or irrigation. Field capacity corresponds to soil tension levels ranging from 5 to 10 cb in coarse-textured soils and as high as 40 cb in fine-textured soils.

Table C-7. Irrigation Guidelines When Using Tensiometers

Soil Texture	Soil Tension (cb)	Soil Moisture Status and Irrigation Requirement
Sand, loamy sand	5 - 10	
Sandy loam, loam, silt loam	10 - 20	Soil at field capacity; no irrigation required
Clay loam, clay	20 - 40	
Sand, loamy sand	20 - 40	
Sandy loam, loam, silt loam	40 - 60	50% of available water depleted; irrigation required
Clay loam, clay	50 - 100	

The soil tension range corresponding to the time when irrigation should begin is also influenced by soil texture. In coarse-textured soils, irrigation should begin at soil tensions of 20 to 40 cb. In extremely coarse-textured soils, irrigation may be necessary at even lower tensions (Table C-7). Conversely, medium- and fine-textured soils do not need to be irrigated until soil tensions reach higher values, as shown in Table C-7. For all soil types, irrigate when a maximum of 50 percent of available water has been depleted. Lower depletion allowances may be used depending upon specific crop and management needs.

The utility of tensiometers in fine-textured soils is limited due to range of detection. When soil dries beyond the 80 cb tension level, the column of water in the tensiometer "breaks," allowing air to enter the device. After breaking tension, the device ceases to operate correctly until it is serviced. Thus, tensiometers are most practical in sandy or coarse-textured soils where normal soil tension levels are well below the point of breaking tension.

Ideally, four tensiometers per management zone should be used to account for variability in soil texture and other factors within the field being tested. Install at least one tensiometer in the area of the zone that will likely require water sooner than other areas of the field e.g. (sandier soils, higher elevations). The remaining tensiometers should be placed to inscribe a triangle within the area to be irrigated, but inside field edges. Irrigation decisions are based on the average of all the readings.

Tensiometer placement influences measured soil tension levels. Tensiometers should be placed where plant roots are actively growing. Therefore, it is appropriate to monitor soil tension 6-12 inches below the soil surface and within 6-12 inches from the plant base. If using drip irrigation, place the tensiometer axis close to the drip tape or hose and the sensor (tip) buried 6-12 inches below the soil surface. This will insure that tensiometer readings reflect moisture in the root zone and decrease when an irrigation occurs. Placement near the drip tape is even more important when growing in coarse-textured soils and on raised, mulched beds. In these situations, the bed shoulders often remain very dry and placing tensiometers there will not give an accurate measure of soil tension in the active crop root zone.

Tensiometers can also be used in other ways. Placing tensiometers at various soil depths at the same location is useful for determining whether or not an irrigation or rainfall has reached a certain depth. Placing tensiometers at various depths is also useful for determining the depth from which plants draw the most water.

Resistance Meters,

Electrical resistance meters determine soil water by measuring the electrical resistance between two wire grids are embedded in a porous matrix such as gypsum, ceramics, glass fibers, or nylon cloth. These sensors are embedded in the soil. The electrical resistance of the sensor varies with its water content, which in turn is dependent upon the water content of the soil in contact with it. As the soil dries, the sensor loses water and the electrical resistance increases. Therefore, resistance changes within the sensor as measured by the meter can be interpreted in terms of soil water content. New generation “matrix” sensors are more accurate and consistent than are older “gypsum” sensors. The sensors, which have stainless steel electrodes imbedded in them, are installed at desired locations and depths in the soil during the growing season. Insulated wires from each sensor are brought above the soil surface where they can be plugged into a portable meter for reading.

Resistance sensors are generally calibrated in terms of soil water tension so as to make readings applicable across soil textures. Sensors should be calibrated for each soil type. The way different commercial sensors respond to changes in soil water tension varies considerably. For this reason each manufacturer furnishes calibration curves for their own instruments and sensors.

Prepare resistance matrix sensors according to manufacturer’s recommendations before installation. This normally requires soaking in water. Soaking removes air from the sensors and insures accurate meter readings. Using a soil probe or auger, bore a hole in the row slightly larger than the sensor. Make a separate hole for each sensor to desired depth. Crumble up at least 3 inches of soil removed from the hole and put it back into the hole. Pour about ½ cup of water into the hole to form a slurry of mud in the bottom. Push the sensor firmly to the bottom of the hole, forcing the slurry to envelop the sensor. A good way to do this is to use a section of ½-inch electrical conduit or pipe; slip the conduit over the lead wire and against the top of the sensor. Back fill the holes with soil 3 or 4 inches at a time, tamping firmly as the hole is filled. Drive a stake midway between the filled holes and tie the wire leads to the stake. Be sure to mark the wires in some manner so that you can identify which one is for the shallow sensor and which one is for the deeper sensor.

Install and locate resistance sensors and meters in a similar manner as for tensiometers to give accurate information of soil water depletion.

Maintaining Trickle/Drip Irrigations Systems

Water is carried through plastic tubing and distributed along the tubing through orifices or devices called emitters. The emitters dissipate the pressure from the system by forcing the water exiting from an emitter through orifices, tortuous flow paths, pressure reducing flow paths, or long flow paths, thus allowing a limited flow of water to be discharged. The pressure-reducing flow path also allows the emitter diameter to remain relatively large, allowing particles that could clog an emitter to be discharged.

Insect damage to thin-walled polyethylene drip tubing or “tape” is a major problem. Ants, wireworms, earwigs, mole crickets, field crickets, grubs and other insects typically damage drip tape by chewing holes through the side walls. This damage destroys the integrity of the tape, resulting in small to massive leaks that may result in poor moisture distribution and soil erosion.

Other types of drip tape damage may be mistaken for insects. For example, rats, mice, gophers and birds can chew, gnaw or peck holes in thin walled polyethylene tapes. Damaged tape should be inspected under magnification to provide clues to the source prior to taking action to remediate the responsible agent.

To protect drip tape from insect damage, either chemical control agents or thicker walled tapes are typically used. Ant damage to drip tape is most severe in tubing having wall thicknesses of less than 15 mils (0.015 inches). In some cases, 8-10 mil products are sufficient to minimize such damage.

Although modern emitter design reduces the potential for trapping small particles, emitter clogging remains the most serious problem with trickle irrigation systems. Clogging can be attributed to physical, chemical, or biological contaminants. Filtration and occasional water treatment may both be necessary to keep trickle systems from clogging.

Bacteria can grow inside trickle irrigation tubes and form a slime that can clog emitters. Algae present in surface waters can also clog emitters. Bacteria and algae can be effectively controlled by chlorination of the trickle system. Periodic treatment **before** clogging develops can keep the system functioning efficiently. The frequency of treatment depends on the quality of the water source. Generally, two or three treatments per season is adequate.

Irrigation water containing high concentrations of iron (greater than 1 ppm) can also result in clogging problems due to types of bacteria that "feed" on dissolved (ferrous) iron. The bacteria secrete a slime called ochre that may combine with other solid particles in the trickle tubing and plug emitters. The precipitated (ferric) form of iron, known commonly as rust, can also physically clog emitters. Treating water containing iron with chlorine will oxidize the dissolved iron, causing the element to precipitate so that it can be filtered and removed from the system. **Chlorine treatment should take place upstream of filters** in order to remove the precipitated iron and microorganisms from the system. Take care when adding chlorine to trickle irrigation systems, however, since concentration at or above 30 ppm can be toxic to growing plants.

Chlorine is available in either gas, liquid, or solid forms. Chlorine gas is extremely dangerous and not recommended for agricultural purposes. Solid chlorine is available as granules or tablets containing 65 to 70 percent calcium hypochlorite. Liquid chlorine is available in many forms, including laundry bleach and postharvest wash materials. Liquid forms typically contain between 5 and 15 percent sodium hypochlorite. **Use chlorine only if the product is labeled for use in irrigation systems.**

Since chlorination is most effective at pH 6.5 to 7.5, some commercial chlorination equipment also injects buffers to maintain optimum pH for effective kill of microorganisms. This type of equipment is expensive but more effective than simply injecting sodium hypochlorite solution. The rate of chlorine injection required is dependent on the number of microorganisms and the amount of iron in the water source, and the method of treatment being used. To remove iron from irrigation water, start by injecting 1 ppm of chlorine for each 1 ppm of iron present in the water. For iron removal, **chlorine should be injected continuously.** Adequate mixing of the water with chlorine is essential. For this reason, be certain to install the chlorine injector 50 to 100 feet upstream from filters. An elbow between the injector and the filter will also promote adequate mixing.

For treatment of algae and bacteria, a chlorine injection rate that results in the presence of 1 to 2 ppm of "free" chlorine at the end of the lateral most distant from the point of injection will ensure that the proper amount of chlorine is being injected. Free, or residual, chlorine can be tested using an inexpensive DPD (diethyl-phenylene-diamine) test kit. A swimming pool test kit can be used but it must measure free chlorine and not total chlorine.

For managing dissolved iron and microbes in the water source, one of the following basic strategies is suggested as a starting point:

For iron treatment:

- Inject liquid sodium hypochlorite continuously at a rate of 1 ppm for each 1 ppm of iron in irrigation water. In most cases, 3 to 5 ppm is sufficient.

For bacteria and algae treatment:

- Inject liquid sodium hypochlorite continuously at a rate of 5 to 10 ppm where the biological load is high.
- Inject 10 to 20 ppm during the last 30 minutes of each irrigation cycle.
- Inject 50 ppm during the last 30 minutes of irrigation cycles one to two times each month. Super chlorinate (inject at a rate of 200 to 500 ppm) once per month for the length of time required to fill the entire system with this solution and shut down the system. After 24 hours, open the laterals and flush the lines.

Chlorine can be injected using many types of fertilizer/pesticide injectors, including positive displacement injection pumps. These types of pumps are powered by gasoline or electric motors and include piston, diaphragm, gear or lobe, and roller (or peristaltic) types.

The injection rate for positive displacement injection pumps can be calculated from the following equation:

Injection rate of chlorine solution in gallons per hour

=

[(0.006) x (desired chlorine concentration in ppm) x (irrigation gallons per minute)]

÷

% chlorine in bleach or concentrate

As an example, assume household bleach (5.25% sodium hypochlorite) is being used as a chlorine solution, that a treatment level of 5 ppm of chlorine is desired, and that the trickle system has a 200-gallon-per-minute flow rate.

Injection rate of chlorine solution in gallons per hour

=

[(0.006) x (5 ppm) x (200 gallons per minute)]

÷

5.25%

= 1.14 gallons chorine per hour

Proportional injectors are also commonly used to inject chlorine. Proportional injectors are powered by the water pressure of the irrigation system and inject materials at a rate which is proportional to the irrigation system flow rate or system pressure. Injection rates are often adjustable and are usually specified as ratios, percentages, or ppm. Table C-7 lists equivalent values of these injection rate units.

For proportional injectors, the following equation can be used to calculate the required chlorine solution injection rate:

Injection rate of chlorine solution in ppm concentrate

=

[(100) x (desired chlorine concentration in ppm)]

÷

% chlorine in bleach or concentrate

As an example, assume postharvest wash material (12.5% sodium hypochlorite) is being used as a chlorine solution and that a treatment level of 10 ppm of chlorine is desired.

Injection rate of chlorine solution in ppm concentrate

=

[(100) x (10 ppm)]

÷

12.5%

= 80 ppm

It is important to note that both liquid and solid forms of chlorine will cause water pH to rise. This is critical because chlorine (sodium hypochorite) is most effective in water at pH 6.5-7.5. If water pH is above 7.5, it must be reduced to 6.5 – 7.5 for chlorine injection to be effective as a disinfectant.

Table C-8. Equivalent Injection Proportions

Ratio	ppm	Percent
1:10,000	100	0.01
1:5,000	200	0.02
1:2,000	500	0.05
1:1,000	1,000	0.1
1:500	2,000	0.2
1:200	5,000	0.5
1:100	10,000	1
1:50	20,000	2
1:20	50,000	5
1:10	100,000	10

Important Notes.

1. **Approved backflow control valves and interlocks must be used in the injection system to prevent contamination of the water source. This is an absolute requirement if a public water source is being used.**
2. **Chlorine concentrations above 30 ppm may cause phytotoxicity.**

Fertigation

Crops that are drip-irrigated are usually fertilized during the growing phase through the irrigation system, termed fertigation. Before considering a fertilization program for mulched-drip irrigated crops, the grower should have the soil pH checked. If a liming material is needed to increase the soil pH, the material should be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, adjust the soil pH to around 6.5 (see Table B-1).

When using drip irrigation in combination with mulch, apply the recommended amount of preplant fertilizer and incorporate 5-6 inches into the soil before laying the mulch. If equipment is available, apply the preplant fertilizer only to the soil area that will be covered by the mulch. This is more efficient than a broadcast application to the entire field.

The most efficient method of fertilizing an established mulched row crop is through a drip irrigation system that is usually installed during the mulching operation (see below). Due to the very small holes or orifices in the drip tubing, a completely soluble fertilizer or liquid solution must be used through the irrigation system. While in the past a 1-1-1 (N-P_2O_5-K_2O) ratio of completely soluble fertilizer, such as a 20-20-20 has been used successfully, in most cases, lower phosphorus concentrations are now recommended (for example 2-1-2 or 4-1-4 ratio). Solutions often are being used with no P_2O_5 (1-0-1 ratio) and this is specifically recommended where there is a high likelihood of phosphorus precipitating out of irrigation water and clogging drip emitters (hard irrigation water supplies). Including the essential micronutrients with the completely soluble N-P_2O_5-K_2O fertilizer has resulted in positive yield responses. Including boron with the completely soluble N-P_2O_5-K_2O fertilizer on sandy loam soils testing low to low-medium in boron is highly recommended for medium and high boron demand vegetable crops.

Nutrients to be applied to plants through the drip irrigation system are first completely dissolved in water to produce a concentrate. This concentrate is usually introduced into the irrigation system following filtration using a passive injector that is available from irrigation suppliers. Positive displacement pumps may also be used but be certain that internal surfaces are able to withstand corrosive fluids. Care should be taken when applying phosphorus through drip irrigation. If water sources contain high levels of calcium, calcium phosphate may precipitate which can clog drip emitters.

Fertigation Rates for Trickle Irrigated Plasticulture Crops

All rates of soluble fertilizers applied through the drip irrigation system are based on crop recommendations (see individual vegetable crops in Section F). Suggested fertigation programs for common drip irrigated crops are given in Section F for the standard between row spacings.. Rates are adjusted if crops are planted in row widths different from the standard. Fertigation can occur with each irrigation event, weekly, or prior to important crop growth stages.

Calculating the fertilizer requirements for a fertigated acre based on 6 foot bed centers

a. ***Example for a soluble dry fertilizer to be dissolved and distributed through trickle fertigation.***

If 40 pounds of nitrogen (N), 40 pounds of phosphate (P_2O_5), and 40 pounds of potash (K_2O) per fertilized-mulched acre per application are recommended, select a dry, completely soluble fertilizer with a 1-1-1 ratio,

such as a 20-20-20. To determine the amount of 20-20-20 needed per acre, divide the percent N, P_2O_5, or K_2O contained in the fertilizer into
the quantity of the respective plant nutrient needed per acre and multiply the answer by 100:

[40 lbs. nitrogen needed

÷ 20% nitrogen in fertilizer]

x 100

= 200 lbs.20-20-20 per acre

b. ***Example for a liquid fertilizer distributed through trickle***.
Assume the same 40 lb N-P_2O_5-K_2O and a 6-6-6 liquid is used. If a gallon of this fertilizer weighs 10 pounds, 67 gallons of 6-6-6 liquid fertilizer per acre per application is required.

1 gal (10 lb) of 6-6-6 contains:
10 lb x .06 (6% N) = 0.6 lb N in each gallon

40 lbs. nitrogen per acre needed

÷

0.6 lb. nitrogen per gallon 6-6-6

=

67 gallons of 6-6-6 needed per acre

SHORT-TERM AND LONG-TERM SDI SYSTEMS

Sub-surface drip irrigation, most commonly known as SDI, is the practice of utilizing drip tape buried at depth for multi-year irrigation applications.

SDI systems offer precise efficient delivery of water, deliver nutrition or crop protection, and achieve uniform plant production. These systems are easily automated, and can significantly decrease labor requirements. It is essential that SDI system operators be provided with adequate education to ensure they develop the necessary management skills. Water quality is a critical component of the success of an SDI system. Maintaining adequate water quality will maximize both system performance and longevity.

SDI is best addressed in two separate categories: Short-term SDI and Long-term SDI:

Short-term SDI (ST SDI) is defined by a life expectancy ranging from 3 to 10 years. However system life alone does not define Short-term SDI. These systems are typically used on mid-valued vegetable crops (for example: processed crops). ST SDI systems are commonly designed to deliver peak ET water demand to crops giving the grower greater control in meeting the crop's water needs. Typically, drip tape is installed between 3" and 10" in depth, along each crop row on the raised bed. The headers of the drip tape can be supplied with water via surface hose or permanently buried PVC pipe; the other end of the drip lateral is typically left exposed for flushing. ST SDI offers many of the advantages of surface drip irrigation without the annual expense of drip tape replacement.

Long-term SDI (LT SDI) is characterized by a life expectancy of 10 years or greater. These systems are primarily designed for commodity crops (for example: corn, cotton). The LT SDI systems are designed to efficiently deliver water to large expanses of acreage. Due to limited water availability and high crop water demand, Long-term SDI systems are not typically designed to replenish peak volume needs, but rather used to manage soil moisture profile during periods of peak water demand. Drip tape is installed from 12" to 18" in depth depending primarily on soil characteristics. Drip tape is typically centered between rows of the crop along the raised bed. The drip tape is attached on each end to permanently buried PVC pipe; with one pipe serving as the water supply and the other pipe providing the flushing function. LT SDI offers many of the advantages of surface drip irrigation, however water is applied in a manner to best economize the application while fulfilling the needs of crops.

CHEMIGATION

Chemigation is the application of any pesticide through any irrigation system and includes furrow, border, overhead and drip irrigation systems. Posting of areas to be chemigated is required when (1) any treated area is within 300 feet of sensitive areas such as residential, labor housing, businesses, hospitals, or any public zones such as schools, parks, playgrounds, etc., or (2) when the chemigated area is open to the public such as golf courses or retail greenhouses.

Prior to chemigation, first start irrigation with water to wet the root zone, then introduce the pesticide uniformly over the crop being irrigated. After chemigation, flush the irrigation system with fresh water. Do not overwater during the flush phase to retain the pesticide in the root zone.

The pesticide label must allow the use of chemigation before any pesticide can be applied in the irrigation system. Consult label for all rates and restrictions before use.

Chemigation Systems Connected to Public Water Systems

These systems must contain a functional, reduced-pressure zone, backflow preventer or the functional equivalent in the water supply line upstream from the point of pesticide introduction. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent flow of fluid back toward the injection pump.

- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down.
- A functional interlocking control, to automatically shut off the pesticide injection pump when the water pump motor stops is also required, or in any situation where the water pressure decreases to the point where pesticide distribution is adversely affected.

Chemigation systems must use a metering pump, such as a positive displacement pump capable of being fitted with a system interlock.

Chemigation with Drip and Overhead Irrigation Systems

A safe and effective chemigation system must include the following components: a functional check valve, vacuum relief valve and low pressure drain on the irrigation pipeline to prevent water source contamination from backflow. The pesticide pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back to the injection pump.

- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down.
- Further, the system must contain a functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stops.
- Finally, the water pump must include a functional pressure switch which will stop the water pump when the water pressure decreases to the point where pesticide distribution is adversely affected.

Insecticides with Labels for Chemigation, Using:

Note: Read and understand all chemigation instructions on label before use on any crop.

Drip/trickle Systems

azadirachtin (Aza-Direct or OLF)
chlorantraniliprole (Coragen)
clothianidin (Belay)
dimethoate (Dimate)
diazinon (Diazinon)
dinotefuran (Venom)
imidacloprid (Admire PRO or OLF)
malathion (Malathion 8 Aquamul)
oxamyl (Vydate)
rosemary oil + peppermint oil (Ecotec)
thiamethoxam (Platinum)
thiamethoxam + chlorantraniliprole (Durivo)

Overhead and Sprinkler Systems

acetamiprid (Assail)
azadirachtin (Aza-Direct or OLF)
bacillus thuringiemsis (DiPel, XenTari)
beta-cyfluthrin (Baythroid XL)
bifenthrin (Capture or OLF)
bifenthrin + imidacloprid (Brigadier)
carbaryl (Sevin or OLF)
chlorantraniliprole (Coragen)
chlorpyrifos (Lorsban)
chlorpyrifos + gamma-cyhalothrin (Cobalt)
clothianidin (Belay)
cryolite (Kryocide)
cyfluthrin (Renounce, Tombstone or OLF)
deltamethrin (Battalion)
diazinon (Diazinon)
dimethoate (Dimate or OLF)
dinotefuran (Venom)
endosulfan (**potato only)** (Thionex)

Overhead and Sprinkler Systems (continued)

esfenvalerate (Asana)
flonicamid (Beleaf)
flubendiamide (Belt, Synapse)
gamma-cyhalothrin (Proaxis)
imidacloprid (Admire PRO or OLF)
imidacloprid + beta-cyfluthrin (Leverage 2.7)
indoxacarb (Avaunt)
lambda-cyhalothrin (Warrior II)
lambda-cyhalothrin + chlorantraniliprole **(potato only**) (Voliam Xpress)
lambda-cyhalothrin + thiamethoxam (Endigo ZC)
malathion (Malathion 8 Aquamul)
methomyl (**green/bulb onions, potatoes only) (**Lannate LV)
methyl parathion (Penncap-M)
novaluron (**potatoes only)** (Rimon)
permethrin (Pounce or OLF)
propargite (**sweet corn, potatoes only**) **(**Comite**)**
pymetrozine (**potato only)** (Fulfill)
pyrethrins (PyGanic)
spinetoram (Radiant)
spinosad (Entrust, SpinTor)
spinosad + gamma-cyhalothrin **(corn only)** (Consero)
spiromesifen (Oberon)
spirotetramat (Movento)
thiamethoxam (Platinum, **potato only) (**Actara**)**
thiamethoxam + chlorantraniliprole (**potato only)** (Voliam Flexi)
thiodicarb (Larvin)
zeta-cypermethrin (Mustang Maxx)
zeta-cypermethrin + bifentrin (Hero)

PESTICIDE SAFETY

GENERAL INFORMATION

Laws and Regulations

Be sure to check current state and federal laws and regulations regarding the proper use, storage, and disposal of pesticides before applying these chemicals. For restricted-use pesticides, an applicator is required to be certified or to work under the direct supervision of a certified individual.

Certification-Pesticide Applicators

The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA) required each state to set up a program to certify users of pesticides. This certification is designed to show that users of pesticides know how to use pesticides safely in order that they do not endanger the user, his coworkers or the environment.

Users of pesticides are classified as either private applicators or commercial applicators. The certification process is somewhat different for each group. The definitions of private and commercial applicators are as follows:

Private Applicator. Any person who uses, or supervises the use of, pesticides for the purpose of raising some type of agricultural commodity. The application can be done on land owned or rented by the applicator or the applicator's employer. However, any applications done on a "for-hire" basis are considered commercial applications. Examples of private applicators are dairy farmers, vegetable or fruit growers, greenhouse growers, and ranchers that apply pesticides only within their own confines. Private applicators who purchase and apply restricted-use pesticides must be certified and registered. In New Jersey, private applicators must be certified and licensed to apply **any** pesticide, including organic and general use pesticides.

Commercial Applicator. Any person who uses, or supervises the use of, pesticides on a "for-hire" basis; any person who applies pesticides for nonagricultural purposes; any person who applies pesticides as a part of his job with any governmental agency. Examples of commercial applicators are: exterminators; landscapers; tree services; crop dusters; weed control firms; and owners of apartments, motels, nursing homes, restaurants, etc., who do their own pest control work. Commercial applicators must be certified and licensed to use **any** pesticide in New Jersey, including organic and general use pesticides.

For detailed information on certification of pesticide applicators, call your state agency or Extension agent. See the back cover of this publication for phone numbers of pesticide certification agencies.

Pesticide Operator Registration (*New Jersey*)

Anyone applying pesticides under direct supervision of a commercial licensed pesticide applicator must be licensed as a pesticide *operator* unless the certified applicator is *always* physically present when the uncertified individual is handling pesticides. Contact the Pesticide Control Program for more information on pesticide operator training and licensing (see back cover).

NEW REQUIREMENTS FOR SOIL FUMIGANTS

EPA is requiring important new safety measures for soil fumigant pesticides to increase protections for agricultural workers and bystanders -- people who live, work, or otherwise spend time near fields that are fumigated. These measures are currently for the soil fumigants chloropicrin, dazomet, metam sodium/potassium, and methyl bromide.

EPA has required that the pesticide manufacturers incorporate new specific Fumigant Management Plan (FMP). safety measures on these labels. It requires each manufacturer to develop EPA-approved applicator training for each of their soil fumigant products. Training must be completed every 3 years. Currently EPA-approved soil fumigant training is found at www.epa.gov/pesticides/reregistration/soil_fumigants/soil-fum-handlers.html.

Soil fumigant labels also require users to prepare a site-specific. EPA has a robust website with many templates and tools at www.epa.gov/oppsrrd1/reregistration/soil_fumigants/index.htm

Some states are creating new pesticide applicator certification categories. These states may develop separate manuals, or they may use a national manual/certification study guide, the “Soil Fumigation Manual”. A low-resolution copy can be viewed/downloaded at www.ctaginfo.org/pdf-documents/Fumigation_low.pdf. Additionally, some states will be requiring applicators to notify their state’s licensing agency prior to use of these fumigants.

***New Jersey*:** Currently, New Jersey does not have a separate license requirement for use of soil fumigants. Private applicators do not have to have an additional license to apply soil fumigants in New Jersey. However. Private applicators are still required to read and follow all elements of the soil fumigant label, just like any other pesticide.

In New Jersey there is no requirement for notification of soil fumigant use to the NJDEP. Rutgers has a limited stock of the national Soil Fumigation Manual (cited above) available to NJ applicators to use as a reference.

Please contact your state’s applicator certification agency or your state Extension pesticide safety program for state–specific regulations. You may contact either for further assistance.

HANDLING PESTICIDES

Before opening a pesticide container, all applicators should read the label carefully, and accurately follow all directions and precautions specified by the label. Using a pesticide for any other uses or in any other manner than what is on the label information is against the law. Determine in advance the proper safety equipment, protective clothing and measuring equipment you will need for the pesticide task that you will be performing. The protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label. Consult the Precautionary Statements of pesticide label for the minimum Personal Protection Equipment (PPE) required by law. See the protective equipment paragraphs later in this section for more detail. Your physician should be advised of the types of pesticides you use in your work and if you will be using a respirator. Before the start of the spray season, each applicator should have a blood cholinesterase level determined. Every 4 to 6 weeks during the spray season, the level of blood cholinesterase should be reevaluated.

When applying pesticides, be sure to have a supply of clean water and liquid detergent available for drenching and washing in case of an accident. A single drop of certain pesticides in the eye is extremely hazardous. If the label requires goggles for eye protection, the handler must have immediate access to eyewash container with a minimum of one pint per person at all times. Be prepared to wash a contaminated eye with clean water for as long as 15 minutes.

Only an experienced applicator wearing the protective clothing and safety equipment prescribed by the manufacturer should handle highly toxic pesticides, such as concentrated organophosphates or carbamates.

Applying Pesticides

Before using a pesticide, read and obey all labeling instructions. Always have the label readily available when applying a pesticide.

Do **not** handle or apply pesticides if you have a headache or do not feel well. **Never** smoke, eat or drink (or use cell phones!) while handling pesticides. **Avoid** inhaling pesticide sprays, dusts, and vapors. If the pesticide is dangerous to your respiratory system, the label will tell you to wear a respirator and specify which type (see Respiratory Protection Devices for Pesticides in this Section).

Thoroughly wash exposed areas of yourself before eating, drinking, using tobacco products, using the bathroom, or using your cell phone. Wash your gloves with soap and water before you take them off. Then wash your hands and face.

If hands, skin, or other body parts become contaminated or exposed, wash the area immediately with clean water and a liquid detergent. If clothing becomes contaminated, remove it immediately. If you splash a concentrate of a pesticide labeled with a “Danger “ or “Warning” signal word, take your contaminated clothing off immediately and dispose of it; do not wash these items!

After each spraying or dusting, bathe and change your clothing; always begin the day with clean clothing. Wash contaminated clothing separately and run an extra rinse cycle afterwards.

Always have someone with you or close by if you are using highly toxic pesticides (those with the signal word **DANGER** plus skull and crossbones).

Apply the Correct Dosage

- To avoid excessive residues on crops for feed and food
- To achieve optimum pest control and minimum danger to non-targeted organisms
- To avoid chemical damage to the crops
- To obtain the most economical control of pests.

Use pesticides for only those crops specified on the label, and use only those that have state and federal registration. Avoid drift to non-targeted areas. Dusts drift more than sprays; airblast sprays drift more than boom sprays. When cleaning or filling application equipment, **do not** contaminate streams, ponds, or other water supplies. Always keep a record of all pesticides used (dates, locations, quantities).

Pesticide Transport

When pesticides are transported in a service vehicle to an application site outside the farm boundaries, the transport vehicle must be clearly marked as a pest control service vehicle in most states and for Category 7 operators in Delaware. Containers must be well secured to prevent breakage or spillage. If pesticide containers are glass, pad and secure them to prevent breakage. When containers are larger than five gallons, tightly brace them to a structural part of the vehicle to prevent accidental spills. Carry a supply of absorbent material to soak up or contain any liquid spills. Keep a shovel and/or broom and pan in the transport vehicle to help quickly contain any spills. Carry a working fire extinguisher (10 - B: C dry chemical, or carbon dioxide) on board as well. While under transport, pesticides must be stored in a separate compartment from the driver such as the bed of a pick-up truck or a van equipped with a partition. All pesticide containers and equipment must be secured to the vehicle so as to prevent removal by unauthorized person(s) when the vehicle is unattended. The door or hatch of any service vehicle tank containing a pesticide must be equipped with a cover that will prevent spillage when the vehicle is moving.

The above requirements do not apply if the pesticide is being transported within the application equipment tank.

For additional information on pesticide transport, contact your state Pesticide Control Program office or the Cooperative Extension pesticide office in your state.

Pesticide Storage

Pesticides should always be stored in their original containers and kept tightly closed. For the protection of others, and especially in case of fire, the storage area should be posted as *Pesticide Storage* and kept securely locked.

Herbicides, especially hormone-like weedkillers such as 2,4-D, should not be stored with other pesticides--primarily insecticides and fungicides--to prevent the accidental substitution of the herbicide for these chemicals.

Store pesticides in a cool, dry, well-ventilated area that is not accessible to children and others who do not know and understand their safe and proper use. Special precautions may be needed in case of a fire in these storage areas.

Any restricted pesticide and empty containers contaminated with their residues **must** be stored in a secure, locked enclosure while unattended. That enclosure **must** bear a warning that pesticides are stored there. If any pesticide must be stored in other than its original container (for example if the original container is leaking), that container must be labeled with the name and concentration of the active ingredient and the signal word and warning statements for the pesticide. Keep an inventory of all pesticides held in storage and locate the inventory list in an accessible place away from the storage site, so it may be referred to in case of an emergency at the storage site.

Keep your local fire department informed of the location of all pesticide storage locations. Fighting a fire that includes smoke from burning pesticides can be extremely hazardous. A fire with smoke from burning pesticides may also endanger the people of the immediate area or community. The people of an area or community may have to be evacuated if the smoke from a pesticide fire drifts in their direction. *In New Jersey*, applicators are required to send an inventory with the <u>exact</u> location of pesticides in storage to their local fire department by May 1st each year. See www.pestmanagement.rutgers.edu/pat/record_forms.htm for templates.

Winter Storage of Pesticides

Plan pesticide purchases so that supplies are used by the end of the growing season. When pesticides are stored for the winter, keep them at temperatures above freezing, under dry conditions, and away from direct sunlight.

The following points should be followed:

1. Always read the label. Special storage recommendations or restrictions will be included.
2. Write the purchase or delivery date of the product on the label with indelible ink. Products may lose their effectiveness over several years. . Check for expiration dates in case they are included on the label.
3. Adequate ventilation is important for storage of pesticides.
4. Store herbicides separately from other pesticides to avoid contamination.
5. Signs of quality deterioration are shown in Table D-1.

Table D-1 Deterioration of Pesticides

Formulation	General Signs of Deterioration
EC	Evidence of separation of components, such as sludge or sediment. Milky appearance does not occur when water is added.
Oils	Milky appearance does not occur when water is added.
WP, SP, WDG	Excessive lumping; powder does not suspend in water.
D, G, WDG	Excessive lumping or caking.

After freezing, place pesticides in warm storage (50°-80°F [10°-26.7°C]) and shake or roll container every few hours to mix product or eliminate layering. If layering persists or if all crystals do not completely dissolve, do not use product. If in doubt, call the manufacturer for guidance.

For a listing of winter storage of pesticides, see Table D-2. Additional information can be obtained from manufacturers' websites.

Disposal of Pesticides

Pesticides should not be disposed of in sanitary landfills or by incineration, unless disposal sites and equipment are especially designed and licensed for this purpose by your state.

The best method to dispose of a pesticide is to use it in accordance with current label registrations. The **triple rinse-and-drain** procedure or the **pressure-rinse** procedure is the recommended method to prepare pesticide containers for safe disposal (see below). This method can save you money as well as protect the environment.

Crush or puncture the container for disposal in a sanitary landfill or deposit in landfills that accept industrial waste, or deliver the intact container to a drum reconditioner or recycling plant. Check with the landfill operator prior to taking empty containers for disposal. For additional information on the disposal of pesticides themselves or unrinsed containers or rinsate, call the state agency responsible for hazardous wastes.

Organic Phosphate Pesticides

The handling and disposal of waste organic phosphates is a specialized job. Many organophosphorous compounds break down by hydrolysis; most of these chemicals decompose much faster in alkaline situations than in acids or neutral solutions.

Carbamate Pesticides

Usually these chemicals decompose rapidly in soil; many break down much faster in an alkaline situation. An example of such carbamate chemicals is carbaryl.

Table D-2. Winter Storage of Chemicals

Chemical	Heated storage required	Heated storage not required	Quality questionable After freezing	Usable after freezing if Put in warm storage	Usable after freezing if put In warm storage and shaken	Quality damaged by high temperatures
acephate						x
Alanap-L					x	
Atrazine 4L		x		x		
Bacillus thuringiensis		x				x
Banvel		x		x		
Basagran	x				x	
Benlate		x				
captan WP		x				
chlorothalonil					x	
Cythion 5E					x	x
Dacthal WP		x				
diazinon		x		x		
dimethoate	x		x			
Dual Magnum		x		x		
Eptam 7E			x		x	
Fusilade DX		x		x		
Goal 2XL	x					
Gramoxone	x				x	
Imidan WP		x				
Lannate	x				x	
Lexone 4L	x		x			
Lorox 4L	x		x			
Lorsban		x			x	
malathion EC		x			x	x
Micro-Tech	x				x	
Monitor 4E		x		x		
Partner	x				x	
Poast 1.5EC	x				x	
Pounce		x			x	
Prefar 4E	x		x			
Prowl EC	x		x			
Pursuit	x			x		
Roundup Ultra Max	x		x			
Sencor 4F		x			x	
Sevin		x			x	

(table continued on next page)

Table D-2. Winter Storage of Chemicals

Chemical	Heated storage required	Heated storage not required	Quality questionable After freezing	Usable after freezing if Put in warm storage	Usable after freezing if put In warm storage and shaken	Quality damaged by high temperatures
Solicam 80DF		x				
Surflan AS		x			x	
Treflan EC	x		x			
2,4-D amine	x		x			
Vydate L	x					

Source: Adapted from "Vegetable Newsletter," by Chris Doll, Illinois County Extension agent; the Cornbelt Chemical Company, McCook, Nebraska; and the "American Cemetery" magazine.

Disposal of Containers

Triple Rinse-and-Drain Method

To empty a pesticide container for disposal, drain the container into the spray tank by holding container in a vertical position for 30 seconds. Add a solvent, capable of removing the pesticide, to the pesticide container, so that it is approximately one-fourth full. Agitate the container thoroughly, and then drain the liquid (rinsate) into the spray tank by holding in a vertical position for 30 seconds. Repeat two more times.

Pressure Rinse Method

An optional method to rinse small pesticide containers is to use a special rinsing device on the end of a standard water hose. The rinsing device has a sharp probe to puncture the container and several orifices to provide multiple spray jets of water. After the container has been drained into the sprayer tank (container is upside down), jab the pointed pressure rinser through the bottom of the inverted container. Rinse for at least 30 seconds. The spray jets of water rinse the inside of the container and the pesticide residue is washed down into the sprayer tank for proper use. Thirty seconds of rinse timeis equivalent to triple rinsing. An added benefit is the container is rendered unusable. In Pennsylvania, this permits the containers to be disposed of as solid waste (not hazardous waste) in an ordinary landfill.

FARM WORKER SAFETY

Identifying Treated Areas for Workers

Farm worker safety regulations impact how workers must be informed about the pesticides with which they may come in contact. The following is a brief overview of some of these regulations.

1. Farm workers who enter treated fields within 30 days of an application of a pesticide must be trained as specified under the Worker Protection Standard (WPS) requirements.
2. No worker can enter a treated field before the end of the label specified restricted-entry interval (REI), unless step 3 below is followed. All WPS-labeled pesticide products are required to have a prescribed REI. These range from 4 to 48 hours or longer. Check your pesticide's label for the reentry time in effect. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other products have different REIs depending on the crop or method of application. When two (or more) pesticides are applied at the same time, and have different REIs, you must follow the longer interval.
3. Workers who enter treated fields before the end of the label specified reentry time must have been properly trained under the WPS regulations, must be provided with the protective equipment specified on the pesticide's label, cannot perform hand labor tasks such as thinning or harvesting, and can only spend up to 1 hour per day in the treated field. The protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label.
4. Farm workers must be verbally informed, in their native language, of all REIs if treated fields are not posted with the prescribed WPS warning sign during the reentry period. If workers are not verbally notified or the label requires it, treated fields must be posted with the prescribed WPS warning sign during the reentry period.
5. For all pesticides, workers must be warned by posting a bulletin board at a point(s) where workers might assemble. This bulletin board should have a listing of the following information:

   a. Location and name of crop treated,
   b. Brand name and common chemical of pesticide applied,
   c. Date of application, and
   d. Date of safe reentry into treated area.

   For New Jersey. The bulletin board should also include a map of the farm which designates the different areas of the farm which might be treated. The required information must also be listed using column headings as defined by New Jersey Department of Environmental Protection (See "Pesticide Application Record" in the back of this publication for an example) and must be in the native language of workers, in addition to English, if they do not read English. This information must be posted either before workers enter treated fields or prior to workers entering fields at the beginning of the next workday, whichever occurs first. Once posted, this information must remain posted for 30 days following the date for safe reentry.
6. Every farm must post the WPS safety poster in a central area at the farm where farm workers are able to view it.
7. Agricultural employers must also provide a decontamination site that includes water, soap, and single use towels for all farm workers who enter treated areas of the farm.

These requirements are being implemented in different ways in each state. For additional information on these and other state farm worker regulations, contact your state Department of Agriculture, Department of Environmental Protection, or local Cooperative Extension office.

Protecting Yourself from Pesticides

Personal Protective Equipment (PPE)

Wearing PPE can greatly reduce the potential for dermal, eye, oral, and inhalation exposure; and thereby significantly reduce the chances of pesticide poisoning or injury. PPE includes such items as coveralls or protective suits, aprons, gloves, footwear, headgear, eyewear, and respirators. When selected correctly, these all reduce the risk of dermal exposure; but they do not eliminate it. All PPE should either be disposable, or easy to clean and sturdy enough for repeated use.

Coveralls

If the pesticide label only lists 'coveralls', it is allowable to wear a coverall made of any fabric, including wovens (like cotton or twill); as well as disposable non-wovens. These do not have to be chemical resistant.

Chemical Resistant PPE

Generally speaking, labels will specify PPE that is "chemical resistant" for protecting the body from moderately toxic (signal word 'Warning') or highly toxic (label signal word 'Danger') pesticides. However, that may not always be the case for specific products; always follow the label.

It is important that all pesticide handlers understand the limitations of PPE. Different types of PPE are not equally resistant to all pesticides and under all conditions. Chemical resistance of a given protective suit, for instance, can vary between different pesticides. Some materials restrict pesticide entry for a long time, while others allow the pesticide to pass through quickly.

There are several criteria for chemical resistance: penetration, degradation, and permeation. Penetration occurs when the chemical leaks through seams, pinholes, and other imperfections in the material. Degradation is a reduction in one or more physical properties of PPE due to contact with a chemical; it essentially starts to break down. Permeation is the process by which a chemical moves through protective material on a molecular level; measured as a volume per area overtime. Breakthrough is what occurs when there is complete passage of a pesticide to the inside of PPE, measured in elapsed time. Once this occurs, your skin is directly exposed to the pesticide.

In some instances, degradation of protective fabric is easy for applicators to recognize. PPE may swell, discolor, shrink, soften, become brittle, or change texture. Be alert for these signs and replace compromised clothing immediately to minimize your exposure to pesticides.

Permeation of a pesticide into a material may begin as soon as it gets on its surface. Once a pesticide is absorbed onto the surface of a garment, it is difficult to detect or decontaminate. In these cases, the pesticide continues to move into and through the PPE. How fast a given pesticide moves through different PPE materials (its permeation rate) can vary widely. Things that can affect the extent of permeation are contact time, concentration, temperature and physical state of the contaminant.

Pesticide breakthrough of PPE can occur without any noticeable signs. If a material is not chemical resistant to a pesticide, complete passage through it can occur very quickly, in just minutes.

Pesticide residues that remain on PPE are likely to continue to permeate through the material once contaminated. If using "reuseable" PPE, pay close attention and be ready to change them whenever the inside surface is contaminated or there are signs of pesticide permeation. Even if you do not see any signs of wear, replace reusable chemical-resistant items regularly — the ability of a chemical-resistant material to resist the pesticide decreases each time an item is worn.

Be sure to clean all reusable PPE items between uses, even if worn for only a brief period of exposure. If you wear that PPE again, pesticide may already be on the inside of the material next to your skin. In addition, PPE worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic.

Disposable PPE is a preferred option to reusable PPE. They are low-cost, and their use minimizes clean-up and spread of contamination.

Selecting chemical resistant PPE

Always follow the pesticide label directions for what is required for you to use under the law. For pesticide handlers, the precautionary statement on the pesticide label indicates if chemical-resistant PPE is required. For workers performing "early entry" tasks, the Agricultural Use Requirements box on the label indicates PPE requirements.

For gloves, labels will often specify materials that are chemical resistant for that product. Older pesticide labels may add another statement that you can consult an EPA chemical resistance category chart for more options. In these cases, the glove type that provides highest protection is listed. Use only those listed.

In some cases, a pesticide label may say "wear chemical-resistant PPE" without specifying the material that protects you. This is more typically the case for suits, aprons, boots, and headgear. In these circumstances, you should consult the PPE manufacturer or their literature (often available online). They can recommend the best garments/gloves to wear with the pesticide that you will be using. Consult the pesticide manufacturer to find out what PPE they recommend to be chemical resistant. You can also contact your state Cooperative Extension pesticide safety office for assistance.

Gloves

The area of the body receiving most exposure from pesticides on their hands and forearms. Research has shown that workers mixing pesticides received 85 percent of the total exposure to the hands and 13 percent to their forearms. The same study showed that wearing chemical-resistant gloves reduced exposure by 99 percent *(Source: The Farm Family Study, John Acquavella).*

Wear the type of chemical-resistant glove specified by the product labeling. Select glove materials according to the label, or by chemical resistance charts, or manufacturer directions. Make sure not to use gloves made of any kind of absorbent material, leather, cloth, cloth-lined, or flocked, unless specified by the label. All of these materials can absorb pesticides, and hold them against your skin. Cotton gloves may be prescribed on the label in very specific uses such as protection for certain fumigants including aluminum phosphide. Always use label-prescribed gloves.

Gloves, non-woven (including coated non-woven) coveralls and hoods, such as Tyvek®, usually are designed to be disposed of after use. Most are intended to be worn for only one work day. For example, you might use disposable gloves, shoe covers, and an apron while pouring pesticide into a hopper or tank, cleaning or adjusting a nozzle, or making minor equipment adjustments. Place disposable PPE in a separate plastic bag or container prior to disposal.

Footwear

Pesticide handlers often get pesticides on their feet. Sturdy shoes and socks may be sufficient to protect your feet during many handling activities. However, some product labels require that you wear waterproof or chemical-resistant footwear.

If the product labeling specifies “chemical-resistant footwear”, you can wear any chemical-resistant shoes; boots; or shoe coverings worn over shoes or boots. Leather or canvas footwear is not chemical resistant; they absorb pesticides and cannot be decontaminated. Do not wear leather boots in these cases.

Eye Protection

Eyes readily absorb pesticides. When a label simply says to “wear protective eyewear”, you may use any of the following: goggles; face shield; safety glasses with shields at front, brow and temple; or a full-face respirator.

Select goggles made of impact-resistant material such as polycarbonate. Goggles that have covered air baffles reduce lens fogging while keeping liquids out.

Under the agricultural Worker Protection Standard, if the label requires goggles for eye protection, then the handler must have immediate access to eyewash container at all times. Regulations require a minimum of a pint per person.

Respiratory Protective Devices for Pesticides

You may be subject to exposure to toxic gases, vapors, and/or particulates when using pesticides. Although your respiratory (breathing) system tolerates a limited exposure, some chemicals can impair or destroy portions of the system. For many pesticides, the respiratory system is the quickest and most direct route into the circulatory system, allowing rapid transport throughout the body. Thus, it is important to follow the pesticide label and employ directions for control of exposure, especially when respiratory protection is specified.

A respirator is a safety device covering at least the mouth and nose that protects the wearer from contaminated air. Respiratory protection varies in design, use, and protective capacity. There are two major **classes** of respirators:

1. Air-purifying respirators that remove contaminants from the air.
2. Atmosphere-supplying respirators that provide clean, breathable air from an uncontaminated source.

Air-purifying respirators may be powered or non-powered. A powered air-purifying respirator uses a blower to pass contaminated air through purifying elements. Non-powered air-purifying respirators may be designed for single use or with replaceable filters, canisters, or cartridges. Air-purifying respirators **DO NOT** supply oxygen and should **never** be used when oxygen may be limited (<19.5 percent oxygen by volume) or when an environment is immediately dangerous to life or health (IDLH).

Purifying elements for air-purifying respirators contain a filter, sorbent, or catalyst (or a combination of these items) to remove specific contaminants from the air passing through the container. When pesticides are used, particulates may be present as solids and/or liquids. When this is the case, a particulate respirator (or filter) is prescribed for use. Pesticide products may be present as gases or vapors. When this is the case, a contaminant-specific chemical cartridge or canister is prescribed. Be sure that the respirator assembly (with component purifying element) is approved for protection against the pesticide you intend to use (see "Selection of Respirator Type" below). Respirators approved only for use against particulates must not be used for gases and vapors.

Air-supplying respirators include supplied-air respirators and self-contained breathing apparatus. These respirators should be used when oxygen is limited. However, the only type of atmosphere-supplying respirators that may be used in an IDLH environment is a **pressure-demand**, self-contained breathing apparatus. The breathing air supply for these respirators should meet or exceed the specification for Grade D breathing air as described in the most current *Compressed Gas Association Specification G-7.1*. See https://www.osha.gov/publications/OSHA3079.pdf

Certification of Respirators

Standards, testing, and certification assure the commercial availability of safe, personal protective devices. The National Institute for Occupational Safety and Health (NIOSH) certify respirators for the contaminant or situation of exposure.

When purchasing a new respirator, the certification numbers per respirator type, are as follows:

TC-13F-XXXX:	self-contained breathing apparatus
TC-14G-XXXX:	gas masks with canisters
TC-19C-XXXX:	supplied air respirators
TC-21C-XXXX:	**powered** particulate respirators **only** (with HE filter only)
TC-23C-XXXX:	chemical cartridge respirators
TC-84A-XXXX:	**non-powered** particulate respirators (with N, P, and R series filters)

There are nine classes of particulate filters based upon filter efficiency and oil degradation resistance. The nine new classes and prescribed use of each are as follows:

N95: Not oil-resistant; moderate filtering efficiency
R95: Oil-resistant; moderate filtering efficiency
P95: Oil-proof; moderate filtering efficiency

N99: Not oil-resistant; high filtering efficiency
R99: Oil-resistant; high filtering efficiency
P99: Oil-proof; high filtering efficiency

N100: Not oil-resistant; highest filtering efficiency (99.97%)
R100: Oil-resistant; highest filtering efficiency (99.97%)
P100:Oil-proof; highest filtering efficiency (99.97%)

Although there are three distinct efficiency levels for filters, most manufacturers are marketing only the 95% to 99.97% efficiency filters as listed above. If you previously used a high efficiency particulate air filter (HEPA), a filtering unit with 99.97% filtering efficiency would be comparable. The appropriate N-, R-, or P-series for the filter will still need to be chosen. If the pesticide label specifies N-, R-, or P-series filtering elements, do not use the N-series when oil is present. The class of the filter will be clearly marked on the filter, filter package, or respirator box. In the case of chemical cartridges that include these filter elements, similar markings will be present.

Selection of Respirator Type

Manufacturers now provide recommendations for appropriate respiratory protection on the pesticide label. These label recommendations are product and task specific. For example, manufacturers may specify organic vapor cartridges or canisters in formulations where the solvent carrier for the pesticide active ingredient is petroleum based. **It is extremely important** to read and follow the product label for respirator requirements since pesticides may have different formulations and use directions.

EPA provides pesticide manufacturers' specific **pesticide label statements for respiratory protection** for five categories of pesticide formulation and application activity.

Service Life of Filters

The **service life of all filters** is limited and all soiled filters should be replaced whenever they are damaged or cause noticeably increased breathing resistance.

The effective service life of a chemical cartridge respirator depends on the conditions of use. Conditions include the type and concentration of contaminant(s), user's breathing rate, and humidity. Cartridges should remain sealed until ready to use. Make sure to use cartridges within the manufacturer's prescribed cartridge shelf life.

Chemical cartridge respirators, when selected appropriately, are essentially 100 percent efficient until the gas or vapor "breaks through." The service life for chemical cartridges can be identified by: warning properties (smell, taste, irrigation); chemical specific end-of-service-life-indicators (ESLI); and predetermined conservative change-out schedules. Reliance on warning properties is problematic due to a wide variation in odor threshold in the general population. The availability of ESLI is limited. Consult pesticide and respirator manufacturers, as well as NIOSH, OSHA, and EPA guidance when establishing a cartridge change-out schedule. Cartridges should be changed immediately whenever break-leakage or filter rupture are detected in the mask. Always dispose of chemical cartridges at the end of a workday. Never reuse a chemical cartridge.

Use and Care of Respirators

With the exception of hooded-powered, air-purifying respirators, no one respirator will fit everyone. The protection provided to a respirator wearer is a function of how well the facepiece (mask) fits. No matter how efficient the purifying element or how clean the supplied air, little protection is provided when there is a leaky face-to-facepiece seal.

The most commonly used facepiece configurations for pesticide use are either half-masks or full-face masks. Half-face masks are typically available as single-use or with cartridges that are replaceable with each use. Full-face masks provide eye protection and a better seal; most full-face masks are sized small, medium, and large affording enhanced fit to the face. Full-facepieces, half-masks, quarter-masks, and even the different brands of the same type respirator have different fit characteristics. A qualitative or quantitative fit test of a given mask type on a user's face should be performed in order to select the best fitting respirator. Kits for qualitative testing are now marketed and easy to use.

Prior to using a respirator, read and understand the manufacturer's instructions that are supplied with the respirator and its component parts. All respirators must be inspected for wear and deterioration of their components before and after each use. Special attention should be given to rubber or plastic parts that can deteriorate. Replacement component parts are available from most manufacturers.

Wearers should perform both positive and negative seal checks every time respirator masks are put on. This will ensure that the respirator is properly sealed on the face and that all inhalation and exhalation ports are functioning properly. Facial hair (i.e., beards and mustaches) prevents the formation of a good seal and may negate any benefit gained by wearing a respirator.

- To perform a <u>positive</u> pressure seal check, cover the exhalation port with the palm of your hand and exhale into the mask. You will feel air escaping at any gaps in your seal. Readjust the mask until there is no leakage.
- To perform a <u>negative</u> pressure seal check, cover or seal off the surface or hose where air is inspired and suck in. A properly sealed mask should collapse on your face with no signs of leakage in the facepiece or hoses. Readjust the mask until there is no leakage.

  After using the respirator, remove and properly dispose of any expendable components such as filters, cartridges, or canisters. Wash the facepiece in a cleaning/sanitizing solution as recommended by the respirator manufacturer. Take care to clean under and around gaskets and valves allowing components to air dry. Store cleaned respirators, as well as replacement purifying elements, in a clean dry place that is not exposed to sunlight or extreme temperatures. Do not store any protective equipment, including respirators, with or near chemicals such as pesticides.

Call your state's Extension office to refer you to pesticide safety education coordinator if you have any questions about pesticide safety equipment.

Pesticide Poisoning

If you have any of the following symptoms during or shortly after using pesticides: headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest, call a physician and the Poison Control Center Center (new national number is 800-222-1222) or agency in your state. See back cover for emergency telephone numbers. Prompt action and treatment may save a life.

In Case of an Accident

- Remove the person from exposure.
- Get away from the treated or contaminated area immediately.
- Remove contaminated clothing.
- Wash with soap and clean water.
- Call a physician and the Poison Control Center or agency in your state. See back cover for emergency telephone numbers.
- Be prepared to give the active ingredient name (common generic name) to responding center/agency.

PROTECT THE ENVIRONMENT

General Guidelines

- Always read the pesticide label and check for environmental concerns and restrictions.
- Do not burn pesticides. The smoke from burning pesticides is toxic and can pollute air.
- Do not dump pesticides in sewage disposal or storm sewers, because this will contaminate water.
- Avoid using excess quantities of pesticides. Calibrate your sprayer to make sure of the output.
- Adjust equipment to keep spray on target. Chemicals off-target pollute and can do harm to fish, wildlife, honeybees, and other desirable organisms.
- Keep pesticides out of ponds, streams, and water supplies, except those intended for such use. A small amount of drift can be hazardous to food crops and to wildlife. Empty and clean sprayers away from water areas.
- Protect bees and other beneficial insects by choosing the proper chemical and time of day for application.
- See additional precautions in section "Protecting Our Groundwater."

Minimize Spray Drift

- Avoid spraying when there is strong wind.
- Use large orifice nozzles at relatively low pressure.
- Use nozzles that do not produce small droplets.
- Adjust boom height as low as practical.
- Do not spray at high travel speeds.
- Spray when soil is coolest and relative humidity is highest.
- Use nonvolatile pesticides.
- Use drift control additives when permitted by the pesticide label.

Notification of Beekeepers

To avoid conflicts and possible lawsuits, it is advisable to always provide notification of insecticide applications to beekeepers within three miles from your site. In New Jersey, this is mandatory, as follows: Beekeepers registered with the New Jersey Department of Environmental Protection (DEP) must be notified before certain pesticides are applied Growers using pesticides on vine crops (June through August), strawberries (April 15 to May 15), or sweet corn (during flowering stage), or in fields where flowering weeds are present that have information on the label indicating the pesticide is toxic to bees must notify beekeepers within three miles of the target site at least 24 hours prior to application. Notification must include approximate date and time of application; location, brand name, and active ingredient of the pesticide to be used; and the name and registration number of the certified pesticide applicator(s). Notification can be made by phone, regular or certified mail as long as it is received 24 hours before the application. A list of registered beekeepers can be obtained by writing to Pesticide Control Program, PO 411, Trenton, NJ 08625. For more detailed information and regulations, consult the Pesticide Control Program www.nj.gov/dep/enforcement/pcp/ or the Rutgers Cooperative Extension Pesticide Office. See inside back cover for telephone numbers.

Protecting Your Groundwater

Groundwater is the water contained below our soils. This water is used by 90 percent of the rural population in the United States as their sole source of drinking water. Contamination of our water supply by pesticides and other pollutants is becoming a serious problem. One source of contamination is agricultural practices. Protection of our groundwater by the agricultural community is essential.

Groundwater collects under our soils in aquifers that are comprised of layers of sand, gravel or fractured bedrock which, by their nature, hold water. This water comes from rainfall, snowfall, etc., that moves down through the soil layers to the aquifer. The depth of the aquifer below the surface depends on many factors. Where it is shallow, we see lakes, ponds and wetlands.

Factors That Affect Movement of Water and Contaminants

The depth of aquifers, in conjunction with soil types, influences how much surface water reaches the aquifer. Their depth also affects how quickly water and contaminants reach an aquifer. Thus, shallow water tables tend to be more vulnerable to contamination than deeper ones.

This tendency, however, depends on the soil type. Soils with high clay or organic matter content may hold water longer and retard its movement to the aquifer. Conversely, sandy soils allow water to move downward at a fast rate. High levels of clay and/or organic content in soils also provide a large surface area for binding contaminants that can slow their movement into groundwater. Soil texture also influences downward water movement. Finer textured soils have fewer spaces between particles than coarser ones, thus decreasing movement of water and contaminants.

Chemistry Plays a Role

The characteristics of an individual pesticide affect its ability to reach groundwater. The most important characteristics are solubility in water, adsorption to soils, and persistence in the environment.

Pesticides that are highly soluble in water have a higher potential for contaminating groundwater than those which are less soluble. The water solubility of a chemical indicates how much chemical will dissolve in water and is measured in parts per million (ppm). Those chemicals with a water solubility greater than 30 ppm may create problems.

A chemical's ability to adhere to soil particles plays an important role. Chemicals with a high affinity for soil adsorption are less likely to reach the aquifer. Adsorption is also affected by the amount of organic matter in the soil. Soils with high organic matter content are less vulnerable than those with low organic matter content.

Finally, how persistent a chemical is in the environment may affect its ability to reach groundwater. Those which persist for a long time may be more likely to cause contamination than materials which breakdown quickly. Persistence is measured by the time it takes half of a given pesticide to degrade (half-life). Chemicals with an overall estimated half-life longer than 3 weeks pose a threat to groundwater.

How to Prevent Contamination of Your Ground Water

1. Examine the chemical properties of the pesticides that you use. If you are using materials which persist for long periods of time, are very water soluble, or are not tightly held by the soil, then you may be contaminating your groundwater. You may wish to select another material that has a shorter persistence, lower water solubility or higher potential for soil adsorption. The following table will assist you with these decisions.

Table D-3 K_d, K_{oc}, Water Solubility and Persistence Values for Selected Pesticides

	Adsorption to[1]		Water	
Pesticide	Soil K_d	OM K_{oc}	Solubility[2] (ppm)	Half Life[3] (Days)
alachlor	4.35	190	242.0	14
atrazine	127.00	160	33.0	60
Dacthal	--	5,000	0.0	30
disulfoton	32.30	2,000	25.0	4
fenamiphos	4.41	171	700.0	20
methomyl	0.03	28	57,900.0	8
metribuzin	0.11	41	1,200.0	30
oxamyl	0.16	1	280,000.0	7
S-metolachlor	--	200	530.0	20
terbacil	0.78	41	710.0	90

[1] OM = organic matter. Chemicals with a lower K_d or K_{oc} number have a greater chance for groundwater contamination.

[2] Chemicals with higher water solubility have a greater chance for groundwater contamination.

[3] Chemicals with longer half-life have a greater chance for groundwater contamination.

2. Determine your local soil and geologic circumstances. If you are in an area with a shallow water table or your soil is low in organic matter or sandy in nature, you have a greater risk of contaminating your groundwater. In these cases, choose a pesticide that has a low water solubility and is not persistent (has a short half-life).
3. Evaluate your management practices. They may be the most important factor in determining your risk of contaminating your groundwater. If you use the same materials year after year, or many times a season, you can increase the potential for contamination due to the amount of pesticide in your soil. The timing of pesticide applications has an effect on groundwater contamination. If you make applications during periods of high rainfall or heavy irrigation, it is more likely that contamination may occur. Also, the water table in the spring may be higher than at other times. Early season applications, therefore, may pose a greater chance for groundwater contamination. Finally, the method of application may have an effect on ground water contamination. Direct injection, incorporation, and chemigation all increase the chance of contamination. If you use these techniques, be sure to follow the procedures listed on the material's label.
4. The location of your wells can be important. If your sprayer loading area or pesticide storage building is too close to your well, the risk of contamination may be greater. Wells used for drinking water or other purposes should be at least 50 feet away from pesticide storage buildings and loading areas. In the event of an accident, this distance should prevent contamination. This minimum distance should also be followed for field irrigation wells. If they are too close to application areas, contamination might occur.
5. Check the condition of any wells in the vicinity of sprayer loading areas, pesticide storage areas or field applications. If they have cracked casings you are inviting trouble. Cracks in a well casing provide a direct point of entry for pesticide-contaminated water in the soil around the well.
6. Incorporate an anti-backflow device in any system used for chemigation or to fill your sprayer with water. In the event of a pump shutoff or other failure, if any back-flow into the water system occurs, these devices will prevent pesticides from entering your well. In many states these devices are now required for sprayers by laws.
7. Care and maintenance of your equipment is also an important consideration. If your equipment does not function properly, you may be applying more than is needed and increasing the chance of groundwater contamination. Prior to the season, inspect all of the working parts of your sprayer or chemigation system. Check the pump to see if it is working properly. For both sprayers and chemigation systems, check the water lines for clogs and leaks. For sprayers, check the nozzles for wear and clogs. Clogged, leaking or worn lines and nozzles can cause pesticides to be delivered excessively or in unwanted areas. Be sure to calibrate your equipment. Uncalibrated equipment can cause over delivery as well. You should calibrate your equipment at the beginning of the season, periodically during the remainder of the season and any time you make changes or adjustment to the equipment.
8. Apply materials only when needed. The use of extraneous pesticides can increase the threat of contamination. Check your irrigation practices as well. Don't irrigate immediately after a pesticide application, unless required by a pesticide's label. The increased water content in the soil might speed up the movement of a pesticide into ground water.

***Remember, you must protect your groundwater*.**

Pesticide Spills

Keep a supply of an absorbent agent on hand to scatter over liquid spills in the area that you store pesticides. Sawdust or janitorial sweeping compound works well in absorbing the liquids in a cleanup. Use a respirator and chemical resistant gloves to clean up spills. Barrier laminate gloves have a broad range of chemical resistance are a good choice to keep in a spill kit. Rubber gloves might break down depending on the pesticide. Let it soak a couple of hours to absorb the spilled pesticide from the floor. This procedure is also recommended for cleaning truck beds that are contaminated.

Specific information concerning pesticide cleanup can be obtained by calling the manufacturer directly or consulting the products' MSDS. The phone numbers for emergencies are listed on every product label. Information can also be obtained by calling CHEMTREC at 800/424-9300, or visiting www.chemtrec.com.

Report pesticide spills to the proper state agency. See back cover for telephone numbers.

Reporting of Pesticide Spills

Pesticide spills may be reported to US EPA Region 3 (800-438-2474) for Delaware, Maryland, Pennsylvania, Virginia, and West Virginia.

In New Jersey, any registered pesticide applicator, or any registered pesticide applicator business, shall immediately inform the DEP of any reportable pesticide spill (1 pound active ingredient or 1 gallon of liquid) occurring under such person's direct supervision and/or direct observation and shall provide the following information:

1. the name of the pesticide applicator,
2. the name of the applicator business, if any,
3. the name of the property owner or operator,
4. the location of the incident,
5. the name and EPA registration number of the pesticide,
6. the estimated amount of pesticide involved, and
7. the corrective action taken.

The report shall be made to the DEP hotline immediately by telephone. Call the Pesticide Control Program at 800-WARNDEP. Submit a written follow-up within 10 days to the Pesticide Control Program, PO Box 411, Trenton, NJ 08625.

TOXICITY OF CHEMICALS

The danger in handling pesticides does not depend exclusively on toxicity values. Hazard is a function of both toxicity and the amount and type of exposure. Some chemicals are very hazardous from dermal (skin) as well as oral (ingestion) exposure. Although inhalation values are not given, this type of exposure is similar to ingestion. A compound may be highly toxic but present little hazard to the applicator if the precautions are followed carefully.

Acute toxicity values are expressed as oral LD_{50} in terms of milligrams of the substance per kilogram (mg/kg) of test animal body weight required to kill 50 percent of the population. The acute dermal LD_{50} is also expressed in mg/kg. These acute values are for a single exposure and not for repeated exposures such as may occur in the field. Rats are used to obtain the oral LD_{50} and the test animals used to obtain the dermal values are usually rabbits.

Table D-4. Acute Categories of Toxicity[1]

Categories	Signal Word	LD_{50} Value (mg/kg) Oral	Dermal
I	Danger-Poison	0-50	0-200
II	Warning	50-500	200-2,000
III	Caution	500-5,000	2,000-5,000
IV	Caution[2]	> 5,000	> 5,000

[1] EPA accepted categories. For examples of each category, see Table D-6 (Toxicity of Chemicals).
[2] No signal word required based on acute toxicity; however, products in this category usually display "Caution."

Read the labels and become familiar with the symptoms of pesticide poisoning. For help in a pesticide emergency, call the appropriate poison information number on the back cover of this book.

Toxicity and LD_{50} Calculations

Weight Conversions

1 ounce (oz)	=	28 grams (gr)
1 pound (lb)	=	454 grams (gr) = 0.45 kg
1 gram (gr)	=	1,000 milligrams (mg)
1,000 mg	=	0.035 oz
1 mg	=	0.000035 oz

Conversions: Body Weight in Pounds (lb) to Body Weight in Kilograms (kg)

(lb)		(kg)
25	=	11.25
50	=	22.5
75	=	33.75
100	=	45
150	=	67.5
200	=	90

To determine an exact weight, multiply known body weight in pounds by 0.45. *Example*: 100 lb x 0.454 = 45.4 kg

Note: All the following calculations use a body weight of 100 pounds. To calculate LD_{50}, first convert body weight to kilograms; to do this multiply weight in lb by 0.454.
Example: 100 x 0.454 = 45.4 kg

Next, multiply given LD_{50} by body weight in kg.
Note: LD_{50} numbers are given by the manufacturer.
Example: LD_{50} of **11mg/kg** x 45.4 kg = 499.4 mg

Next, to convert milligrams (mg) to ounces (oz), multiply mg by 0.000035. *Example*: 499.4 mg x 0.000035 = 0.017 oz.

Table D-5. LD_{50} figures converted to ounces for three commonly used products in the agricultural industry.

	LD_{50}	Body Weight in Pounds 30	60	100	150	200
		-------------------------		Ounces	------------------------	
Insecticide						
methomyl	17	0.008	0.016	0.026	0.039	0.053
Herbicide						
Micro-Tech/ Partner	1,800	0.9	1.7	2.8	4.3	5.7
Fungicide						
chloro- thalonil	10,000	4.9	9.5	15.7	23.8	31.5

Pesticide Formulations

Commercial pesticides may be developed in many different formulations. Some are emulsifiable concentrates, flowables, wettable powders, dusts, and granules. After each pesticide recommendation in this publication, one of these formulations is presumed; however, unless stated to the contrary, equivalent rates of another formulation or concentration of that pesticide can be used.

In most cases, sprays rather than dusts are preferred for the control pests of vegetables. This is because sprays have produced better control and resulted in less drift than dry particulates.

Table D-6 lists type class; use category; acute mammalian toxicity; reentry times; and toxicity to birds, fish, and bees for the pesticides recommended for use in this manual.

Table D-6. Acute Toxicity of Chemicals[1]

Name[2]	Type Class[3]	Use Category[4]	LD_{50} Values Mg/Kg[5] Oral	LD_{50} Values Mg/Kg[5] Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Toxicity[7] Fish	Toxicity[7] Bee
abamectin, Agri-Mek, ABBA, Epi-Mek, Temprano	I-FB	R	300	>1,800	12	N	M	H
ABBA, abamectin	I-FB	R	300	>1,800	12	N	M	H
Abound, azoxystrobin,	F	G	>2,000	>5,000	4	--	H	N
acephate, Orthene	I-OP	G	tech 980	>10,250	24	M	N	H
acetamiprid, Assail, Tristar	I	G	1,064	>2,000	12	N	N	M
acibenzolar-S-methyl, Actigard, Blockade	B,F	G	--	--	12	N	M	N
Acramite, bifenazate	A	G	>5,000	>5,000	12	N	H	N
Actara, thiamethoxam	I-NN	G	>5,000	>2,000	12	N	N	H
Actigard, acibenzolar-S-methyl	B,F	G	--	--	12	N	M	H
Admire Pro, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Agree, *Bacillus thuringiensis aizawai* + *kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
Agri-Fos , phosphite salts,	F	G			4	--	M	N
Agri-Mek, abamectin	I-FB	R	300	>1,800	12	--	M	H
Agri-Mycin-17, streptomycin	B	G	9,000	--	12	--	--	--
Agri-Strep, streptomycin	B	G	9,000	--	12	--	--	--
Agri Tin, triphenyltin hydroxide	F	R	160	500	48	--	H	--
Aim, carfentrazone	H	G	5,143	>5,000	12	N	M	N
alachlor, Micro-Tech, Intrro	H	R-12	1,800	--	12	N	N	N
Alanap L, naptalam	H	G	8,200	--	24	N	N	N
Alcide, sodium chlorite	F	G	--	--	12	N	N	N
Aliette, fosetyl Al	F	G	tech 5,000	>2,000	12,24	N	N	N
Allegiance, metalaxyl	F	G	>2,900	>2,000	24	N	N	N
Altacor, chlorantraniliprole	I	G	>5,000	>5,000	4	--	--	--
Apron, mefenoxam, metalaxyl	F	G	tech 669	>3,100	12	N	N	N
Asana XL, esfenvalerate	I-PY	R-12	458	>2,000	12	N	H	H
Assail, acetamiprid	I	G	1,064	>2,000	12	N	N	M
Assure II, quizalofop-P-ethel	H	G	1,210	--	12	N	N	N
Atrazine, atrazine	H	G	tech 1,780	7,500	12	S	S	N
Authority XL, sulfentrazone,	H	G	1,750	>5,000	12	L	L	--
Avaunt, indoxacarb	I-CA	G	268	--	12	M	M	H
azadirachtin, Aza-Direct, Azatin, Ecozin, Neemix	IGR	G	>5,000	>2,000	12	--	H	N
Aza-Direct, azadirachtin	I	G	>5,000	>2,000	4	--	H	N
Azatin, azadirachtin	IGR	G	>5,000	>2,000	12	--	H	N
azoxystrobin, Abound, Dynasty, Quadris,	F	G	>2,000	>5,000	4	--	H	N
azoxystrobin + chlorothalonil, Quadris opti	F	G	>2,000	>5,000	4	N	H	N
azoxystrobin + propiconazole, Quilt	F	G	1,750	>5,000	12	N	H	N
Aztec, cyfluthrin + tebupirimphos	I	--	--	--	12	--	H	N
Bacillus pumilus GB34, Yield Shield	F-BT	G		NA	NA	NA	NA	NA
Bacillus subtilis GB03, Kodiak	F-BT	G		NA	4	NA	NA	NA
Bacillus thuringiensis, Biobit	I-BT	G	See Footnote 8		4	N	N	N
Banvel, dicamba	H	G	2,629	>2,000	12,24	--	--	N
Basagran, bentazon	H	G	2,063	>6,050	12	S	N	N
Basicop, fixed copper[10]	F	G	472	--	24	--	H	N
Battalion, deltamethrin	I	R	445	>2,000	12	--	H	H
Baythroid XL, beta-cyfluthrin	I	R	647	>2,000	12	--	H	H
Beleaf, flonicamid	I	G	>2,000	>2,000	12	--	N	--
Belt, flubendiamide	I	G	>2,000	>4,000	12	--	--	--
bensulide, Prefar	H	G	tech 271-1,470	--	12	--	H	H
bentazon, Basagran	H	G	2,063	>6,050	12	S	N	N
Besiege, lambda-cyhalothrin + chlorantraniliprole	I	R-12	98.11	>5,000	24	--	H	H

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD_{50} Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
beta-cyfluthrin, Baythroid XL	I	R	647	>2,000	12	--	H	H
beta-cyfluthrin + imidacloprid, Leverage 360	I	R	>1,044	>2,000	12	L	H	H
bifenthrin, Bifenture, Brigade, Capture LFR Fanfare, Sniper, Tundra	I-PY	R	262	>2,000	24	M	H	H
bifenthrin + imidacloprid, Brigadier	I	R	175	>5,000	12	--	H	H
Bifenthrin + zeta cypermethrin, Hero	I-PY	R-10,11	550	--	24	S	H	H
Bifenture, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
bifenazate, Acramite, Floramite	A	G	>5,000	>5,000	12	N	H	N
Biobit, *Bacillus thuringiensis kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
Blackhawk, spinosad	I-ML	G	>5,000	>2,000	4	H	--	--
Blockade, acibenzolar-S-methyl	B,F	G	--	--	12	N	M	N
Blocker, PCNB	F	G	>5,050	>2,020	12	--	H	--
boscalid, Endura	F	G	>2,000	>2,000	12	--	--	--
Botran, dicloran	F	G	tech >5,000	--	12	S	M	N
Bravo, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
*Bravo 720, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
Bravo Ultrex, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
Brigade, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
Brigadier, bifenthrin + imidacloprid	I	R	175	>5,000	12	--	H	H
Brominal, bromoxynil	H	G	tech 260	>2,000	12	H	H	H
bromoxynil, Brominal, Buctril	H	G	tech 260	>2,000	12	H	H	H
Buctril, bromoxynil	H	G	tech 260	>2,000	12	H	H	H
buprofezin, Courier, Talus, Vetica	IGR	G	>5,000	>2,000	12	--	--	--
butylate, Sutan +	H	G	4,500	>4640	2	--	H	--
Cabrio, pyraclostrobin	F	G	>500	>4,000	12	--	H	N
Callisto, mesotrione	H	G	>5,000	>5,000	12	N	N	N
Cannonball, fludioxonil	F	G	>5,000	>2,000	12	L	H	L
Caparol 4L, promethryn	H	G	>5,000	>5,000	24	L	H	--
Captan 400, captan	F	G	9,000	--	96	S	H	N
*captan, Captan 400	F	G	9,000	--	96	S	H	N
Captevate, fenhexamid + captan	F	G	>2,000	>5,000	24	N	H	N
*carbaryl, Sevin	I-CA	G	500	850	12	S	N	H
carfentrazone, Aim	H	G	5,143	>5,000	12	--	M	N
CDAA, Randox	H	G	750	--	12	--	--	--
Champ, fixed copper[10]	F	G	1,000	--	48	--	H	N
Champion, fixed copper[10]	F	G	2,000	--	48	--	H	N
Chateau/Valor, flumioxazin	H	G	>5,000	>2,000	12	N	N	N
chemopodium ambrosioides, Requiem	I,A	G	>5,000	>5,000	4	--	--	--
chlorantraniliprole, Altacor, Coragen,	I	G	>5,000	>5,000	4	--	--	--
chlorantraniliprole + lambda cyhalothrin, Besiege, Voliam Xpress	I	R-12	98	>5,000	24	--	H	H
chlorantraniliprole, thiamethoxam, Durivo, Voliam Flexi	I-NN	G	>5,000	>5,000	12	--	--	H
chlorfonapyr, Pylon	A	G	560	--	12	--	H	H
chlorine, Clorox (bleach)	F	G	--	--	12	N	N	N
chloroneb	F	G	>5,000	>5,000	12	N	--	--
chloropicrin	F,N	R-3,10	250	--	72	--	H	N
*chlorothalonil, Bravo, Bravo 720, Bravo Ultrex, Echo, Equus, Ridomil Gold Bravo	F	G	>10,000	>10,000	12	--	H	L
*chlorpyrifos, Lorsban	I-OP	R	92-276	2,000	12,24	M	H	H
chlorpyrifos + lambda-cyhalothrin Cobalt Advanced	I	R	>50	>3,000	24	M	M	H
clomazone, Command	H	G	1,369	>2,000	12	--	--	--

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD_{50} Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
clopyralid, Spur, Stinger	H	G	>5,000	>2,000	12	--	N	N
Clorox (bleach), chlorine	F	G	--	--	12	N	N	N
Closer, sulfoxaflor	I	G	>5,000	>5,000	12	N	M	H
clothianidin, Poncho, Belay	I-NN	G	>5,000	>2,000	--	N	M	H
Cobalt Advanced, chlorpyrifos + lambda-cyhalothrin	I	R	>50	>3,000	24	M	M	H
Command, clomazone	H	G	tech 2,077	>2,000	12	--	N	N
Concur, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Confirm, tebufenozide	I	G	>5,000	>5,000	4	L	H	M
Coniothyrium minitans, Contans	F	G	--	--	4	--	N	N
Conserve, spinosad	I-ML	G	>5,000	>2,000	4	H	--	--
Contans, *Coniothyrium minitans*	F	G	--	--	4	--	N	N
Copper-Count-N, fixed copper[10]	F	G	--	--	12	--	H	N
copper, fixed[10]	F	G	--	--	24	--	H	N
copper hydroxide, Ridomil Gold Copper, ManKocide	F	G	tech 669	>3,100	48	--	H	N
Coragen, chlorantraniliprole	I	G	>5,000	>5,000	4	--	--	--
Counter, terbufos	I-OP	R-1,2	tech 4.5	1.1	48	--	H	N
Courier, buprofezin	IGR	G	>5,000	>2,000	12	--	--	--
Cruiser, thiamethoxam	I-NN	G	5523	>2,000	12	N	N	H
Crymax, *Bacillus thuringiensis kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
cryolite, Kryocide, Prokil	I-IO	G	>5,000	--	12	N	N	N
Cuprofix Disperss, fixed copper	F	G	>2,000	>4,000	24	--	H	N
Curbit 3E, ethalfluralin	H	G	>10,000	>10,000	12	--	H	N
Curzate, cymoxanil	F	G	433	>5,000	12	N	H	N
Cutlass, *Bacillus thuringiensis kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
cyazofamid, Ranman	F	G	>5,000	>2,000	12	L	L	L
*cycloate, Ro-Neet	H	G	3,160-4,640	--	12	--	M	N
cyfluthrin, Tombstone	I-PY	R	500	>5,000	12	M	H	H
cymoxanil, Curzate,	F	G	433	>5,000	12	N	H	N
cypermethrin, Ammo	I-PY	R	250	2,000	12	N	H	H
cyprodinil + fludioxonil, Switch	F	G	>5,000	>2,000	12	--	H	N
cyromazine, Trigard	IGR	R,G	3,387	>3,100	12	S	H	H
*Dacthal, DCPA	H	G	>10,000	>2,000	24	S	--	N
*dalapon, Dowpon M	H	G	9,330	--	24	S	N	N
Danitol, fenproparthrin	I-PY	R	66	>2,000	24	H	H	H
DCP, dichloropropene	N	R(NJ),G	300	333	72	--	--	--
*DCPA, Dacthal	H	G	>10,000	>2,000	24	S	--	N
Deadline, metaldehyde	I-OT	G	630	--	12,24	H	N	N
deltamethrin, Battalion	I	R	445	>2,000	12	--	H	H
Desicate II, endothall	H	R	233	481	48	H	--	H
Devrinol, napropamide	H	G	>4,640	--	12	--	N	N
diazinon	I-OP	R-11	tech 300-400	3,600	12,24	H	H	H
dicamba, Banvel	H	G	2,629	>2,000	12,24	--	--	N
dichloropropene + chloropicrin, Telone II, Telone C-35	F,N	R-3,10	127	423	72	H	N	--
dicloran, Botran	F	G	tech >5,000	--	12	S	M	N
dicofol, Kelthane, Kelthane MF	A	G	820-960	1,000-1,230	12	M	H	N
difenoconazole+cyprodinil, Inspire Super	F	G	5,000	>5,000	12	--	H	--
diflubenzuron, Dimilin	IGR	G	>10,000	>20,000	12	--	--	--
*Dimate, dimethoate	I-OP	R(NJ),G	tech 235	>400	48	H	H	H

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD_{50} Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
dimethenamid, Frontier, Outlook	H	H	849	>2000	12	--	--	--
*dimethoate, Dimate	I-OP	R(NJ),G	tech 235	>400	48	H	H	H
dimethomorph, Forum	F	G	3,900	>2,000	24	--	H	N
Dimilin, diflubenzuron	IGR	G	>10,000	>20,000	12	--	--	--
dinotefuran, Safari, Venom, Scorpion	I	G	>5,000	>5,000	12	--	--	H
DiPel, *Bacillus thuringiensis kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
diquat	H	G	215-235	400	24	--	--	N
Discipline, bifentrin	I-PY	R	262	>2,000	24	M	H	H
Distance, pyriproxyfen	IGR	G	>5,000	>2,000	12	--	H	N
Dithane, mancozeb	F	G	11,200	15,000	24	--	H	N
diuron, Karmex	H	G	tech >5,000	>5,000	12	--	--	N
dodine, Syllit	F	G	1,000	>6,000	48	--	H	H
Dowpon M, dalapon	H	G	9,330	--	24	S	N	N
Dual Magnum, S-metolachlor	H	G	tech 2,780	>10,000	12	S	M	N
Durivo, chlorantraniliprole + thiamethoxam,	I-NN	G	>5,000	>5,000	12	--	--	H
Dynasty, azoxystrobin	F	G	>2,000	>5,000	4	--	H	N
EBDC, Potato Seed Treater	F	G	4,500	>5,000	24	N	H	N
Echo, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
Ecozin, azadirachtin	IGR	G	>5,000	>2,000	12	--	H	N
Elevate, fenhexamid	F	G	>5,000	>5,000	4	L	M	N
emamectin, Proclaim	I-FB	R	1,516	>2,000	48	N	H	H
endothall, Desicate II	H	R	233	481	48	H	--	H
Endura, boscalid	F	G	>2,000	>2,000	12	--	--	--
Entrust, spinosad	I-ML	G	>5,000	>2,000	4	H	--	--
Epi-Mek, abamectin	I-FB	R	300	>1,800	12	N	M	H
Eptam, EPTC	H	G	tech 1,630	--	12	--	H	H
EPTC, Eptam	H	G	tech 1,630	--	12	--	H	H
Equus, chlorothalonil	F	G	>10,000	>10,000	12	--	H	--
esfenvalerate, Asana XL	I-PY	R-12	458	>2,000	12	--	H	H
ethalfluralin, Curbit 3E	H	G	>10,000	>10,000	12	--	H	N
ethephon, Ethrel	PGR	G	4,229	--	48	--	--	N
ethoprop, Mocap	N	R-2	6.2	2.4	48	H	H	H
Ethrel, ethephon	PGR	G	4,229	--	48	--	--	N
etoxazole, Zeal	A	G	>5,000	>5,000	12	N	H	N
Evolve, thiophanate methyl + mancozeb + cymoxanil	F	G	>5,000	>2,000	24	N	H	N
famoxodone + cymoxanil, Tanos	F	G	960	>2,000	12	--	H	--
Fanfare, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
fenamidone, Reason	F	G	>5,000	>5,000	12	--	--	--
fenamiphos, Nemacur	N	R-2	tech 3	200	48	H	H	N
fenbutatin-oxide, Vendex	A	R	2,631	>2,000	48	M	M	N
fenhexamid, Elevate	F	G	>5,000	>5,000	4	L	M	N
fenhexamid + captan, Captevate	F	G	>2,000	>5,000	24	N	H	N
fenproparthrin, Danitol	I-PY	R	66	>2,000	24	H	--	H
fenproximate, Portal	I,A	G	810		12	--	H	--
fipronil, Regent	I	R	275	841	0	M	H	M
fixed copper[10], Cuprofix Disperss	F	G	--	--	12,24,48	--	H	N
Flint, trifloxystrobin	F	G	>5,000	>2,000	12	M	H	N
flonicamid, Beleaf	I	G	>2,000	>2,000	12	--	N	--
Floramite, bifenazate	A	G	>5,000	>5,000	12	N	H	N
Flouronil, mefenoxam+chlorothalonil	F	G	See Footnote 11	--	48	--	--	--

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD50 Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
*fluazifop-P-butyl, Fusilade DX	H	G	3,328	--	12	--	M	N
fluazinam, Omega	F	G	>5,000	>2,000	48	--	H	N
flubendiamide, Belt	I	G	>2,000	>4,000	12	--	--	--
flubendiamide + buprofezin, Vetica	I	G	>5,000	>5,000	12	L	L	L
fludioxonil, Cannonball, Maxim, Scholar	F	G	>5,000	>2,000	12	L	H	L
fludioxonil + mancozeb, Maxim MZ	F	G	>5,000	>5,000	24	N	H	N
flumioxazin, Chateau/Valor	H	G	>5,000	>2,000	12	N	N	N
fluopicolide, Presidio	F	G	>2,000	>4,000	12	L	H	L
flutolanil + mancozeb, MonCoat MZ	F	G	>5,000	>5,000	24	M	M	N
flutolanil, Moncut	F	G	>5,000	>5,000	12	N	H	N
fluxapyroxad, Priaxor	F	G	>500->2,000	>5,000	12	N	N	N
Folicur, tebuconazole	F	G	3,743	2,011	12	H	H	N
fomesafen, Reflex	H	G	6,950	>1,000	24	N	N	N
Fontelis. penthiopyrad	F	G	12	>5,000	>5,000	H	L	L
Force, tefluthrin	I-PY	R	1,213	>2,000	0	N	H	N
Formula 40, 2,4-D (acid)	H	R(NJ),G	375	--	48	M	N	H
Forum, dimethomorph	F	G	3,900	>2,000	24	--	H	N
fosetyl Al, Aliette	F	G	5,000	>2,000	12,24	N	N	N
Frontier, dimethenamid	H	G	849	>2000	12	--	--	--
Fulfill, pymetrozine	I-OT	G	>5,000	>2,000	12	N	N	N
Fusarex, TCNB	GR	G	--	--	--	--	--	--
*Fusilade DX, fluazifop-P-butyl	H	G	2,712	>2,420	12	--	M	N
gamma-cyhalothrin, Cobalt, Consero, Proaxis,	I-PY	R-12	>2,500	>5,000	24	N	H	H
Gaucho, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Gavel, zoxamide + mancozeb	F	G	--	--	48	--	M	--
Gem, trifloxystrobin	F	G	5,050	>2,000	12	--	H	N
gibberellic acid, GibGro, ProGibb	PGR	G	1,000-25,000	--	4	--	N	N
GibGro, gibberellic acid	PGR	G	1,000-25,000	--	4	--	N	N
glufosinate ammonium, Ignite 280	H	G	>300-<2,000	1,400	12	--	--	--
Glyphomax Plus, glyphosate	H	G	>5,000	>5,000	24	N	N	N
glyphosate, Glyphomax Plus, Roundup Touchdown	H	G	>5,000	>5,000	24	N	N	N
Goal, oxyfluorfen	H	G	tech >5,000	>10,000	24	--	H	N
Goal Tender, oxyfluorfen	H	G	tech >5,000	>10,000	24	--	H	N
Gramoxone Max, paraquat	H	R-1,8	150	--	12,48	M	N	N
Guthion, azinphos-methyl	I-OP	R-1,2,3, 8,10,12	tech 10	200	48	M	H	H
halosulfuron, Sandea	H	G	1,287	>5,000	12	--	N	N
harpin protein, Messenger	F	G	>5,000	>6,000	4	--	N	N
Headline, pyraclostrobin	F	G	>500	>4,000	12	--	H	N
Hero, zeta cypermethrin+bifenthrin	I-PY	R-10,11	550	--	24	S	H	H
hexythiazox, Savey	A	G	>5,000	>5,000	12	--	H	N
Ignite 280, glufosinate ammonium	H	G	>300-<2000	1,400	12	--	--	--
imazamox, Raptor	H	G	>5,000	>4,000	4	N	N	N
imazethapyr, Pursuit	H	G	>5,000	>2,000	12,24	--	N	N
Imidan, phosmet	I-OP	R(NJ),G	tech 147-316	>4,640	24	S	H	H

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD_{50} Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
imidacloprid, Admire, Admire Pro, Concur, Gaucho, Lattitude, Marathon	I-NN	G	tech 450	>5,000	12	M	M	H
imidacloprid, beta-cyfluthrin, Leverage 360	I	R	>1,044	>2,000	12	L	H	H
Impact, topramezone	H	G	>2,000	>2,000	12	N	N	N
Incite, piperonyl butoxide	I-OT	G	>7,500	--	12	N	N	N
indoxacarb, Avaunt	I	G	268	--	12	M	M	H
Inspire Super, difenoconazole+cyprodinil	F	G	5,000	>5,000	12	--	H	--
iron phosphate, Sluggo	M	G	>5,000	>5,000	0	--	--	--
insecticidal soap, M-Pede	I-SO	G	16,900	--	12	N	N	N
Intrepid, methoxyfenozide	I	G	>5,000	>2,000	4	--	N	N
Intrro, alachlor	H	R-12	930-1,350	--	12	S	M	N
*iprodione, Rovral	F	G	>4,400	>2,000	12	--	S	N
Javelin, *Bacillus thuringiensis kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
K-Pam, metam potassium	F	G	630	>1,000	48	H	H	N
Karmex, diuron	H	G	tech >5,000	>5,000	12	N	N	N
Kelthane, Kelthane MF, dicofol	A	G	570-595	>5,000	12	M	H	N
Kerb, pronamide	H	R-5	tech 8,350	>3,160	12	--	N	N
Ketch, *Bacillus thuringiensis aizawai*	I-BT	G	See Footnote 8		4	N	N	N
Knack, pyriproxyfen	IGR	G	>5,000	>2,000	12	--	H	N
Kocide, fixed copper[10]	F	G	1,000	--	12,48	M	H	N
Kodiak, *Bacillus subtilis* GB03	F-BT	G		NA	NA	NA	NA	NA
Kontos, spirotetramat	I	G	>2000	>4000	24	N	N	L
Kryocide, cryolite	I-IO	G	>5,000	--	12	N	N	N
Lambda cyhalothrin, Lambda-Cy, Lambda T, Silencer, Warrior II	I-PY	R	tech 79	632	24	M	H	H
lambda-cyhalothrin, chlorpyrifos, Cobalt Advanced,	I	R	>50	>3,000	24	M	M	H
Lambda-Cy, lambda cyhalothrin	I-PY	R	tech 79	632	24	M	H	H
lambda-cyhalothrin+chlorantraniliprole, Besiege, Voliam Xpress	I	R-12	98.11	>5,000	24	--	H	H
Lambda T, lambda cyhalothrin	I-PY	R	tech 79	632	24	M	H	H
Lannate, methomyl	I-CA	R-8,10	17	5,880	48	H	H	H
Lattitude, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Laudis, tembotrione	H	G	1,750	>5,000	12	--	--	--
Leverage 360, imidacloprid + beta-cyfluthrin,	I	R	>1,044	>2,000	12	L	H	H
Lexone, metribuzin	H	R-14	tech 2,000	20,000	12	--	N	N
lindane	I-CH	R-5	88-125	1,000	12,24	M	M	N
Linex, linuron	H	G	tech 4,000	--	24	--	S	N
linuron, Linex, Lorox	H	G	tech 4,000	--	24	--	S	N
Lorox, linuron	H	G	tech 4,000	--	24	--	S	N
*Lorsban, chlorpyrifos	I-OP	R	92-276	2,000	12,24	M	H	H
malathion	I-OP	G	tech 5,500	>2,000	12	M	H	H
*mancozeb, Acrobat MZ, Curzate, Dithane, Manex II, Manex, ManKocide, Penncozeb, Ridomil Gold MZ	F	G	11,200	15,000	24	--	H	N
mancozeb + copper hydroxide, ManKocide	F	G	See Footnote 11			N	H	N
mandipropamid, Revus	F	G	>5,000	>5,000	12		H	

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD50 Values Mg/Kg[5] Oral	LD50 Values Mg/Kg[5] Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Toxicity[7] Fish	Toxicity[7] Bee
mandipropamid + difenoconazole, Revus Top	F	G	2,958	>5,000	12	L	H	M
maneb, Manex	F	G	tech 7,990	>5,000	24	--	H	N
Manex, maneb	F	G	tech 7,990	>5,000	24	--	H	N
Manex II, mancozeb	F	G	11,200	>15,000	24	--	H	N
ManKocide, mancozeb + copper hydroxide	F	G	See Footnote 11		48			
Marathon, imidacloprid	I-NN	G	Tech 450	>5,000	12	M	M	H
Matrix, rimsulfuron	H	G	>5,000	>2,000	4	N	L	L
Maxim, fludioxonil	F	G	>5,000	>2,000	12	L	H	L
Maxim MZ, fludioxonil + mancozeb	F	G	>5,000	>5,000	24	N	H	N
*MC-2, MC-33, methyl bromide	F,H,N	R-8	See Footnote 9		48	--	--	N
mefenoxam, Apron, Ridomil Gold, Ultra Flourish	F	G	--	--	--	--	H	N
mefenoxam + azoxystrobin, Uniform	F	G	1,459	>5,000	0	--	--	--
mefenoxam + chlorothalonil, Ridomil Gold Bravo, Flouronil	F	G	See Footnote 11					
mefenoxam + copper hydroxide, Ridomil Gold Copper	F	G	See Footnote 11					
mefenoxam + mancozeb, Ridomil Gold MZ	F	G	>5,000	>2,000	48	N	H	N
mefenoxam + PCNB, Ridomil Gold PCNB	F	G	>5,050	>2,020	48	N	H	N
Mertect, thiabendazole	F	G	>5,000	>5,050	12	N	H	N
mesotrione, Callisto	H	G	>5,000	>5,000	12	N	N	N
Messenger, harpin protein	F	G	>5,000	>6,000	4	--	N	N
metalaxyl, Allegiance, Apron, MetaStar	F	G	tech 669	>3,100	12	N	N	N
metaldehyde, Deadline	I-OT		630	--		H	N	N
metam potassium, K-Pam	F	G	630	>1,000	48	H	H	N
metam-sodium, Vapam HL	N	G	1,891	>3,074	48	--	H	N
MetaStar, metalaxyl	F	G	tech 669	>3,100	12	N	N	N
*Metasystox-R, oxydementon methyl	I-OP	R	tech 50	150	48	--	H	H
methomyl, Lannate	I-CA	R-8,10	17	5,880	48	H	H	H
methoxyfenozide, Intrepid	I	G	>5,000	>2,000	4	--	N	N
*methyl bromide, MC-2, MC-33, Terr-O-Gas 67	F,H,N	R-8	See Footnote 9		48	--	--	N
methyl iodide, Midas	F, H, I	--	--	--	--	--	--	--
metiram, Polyram	F	G	>5,000	>2,000	24	N	H	N
metribuzin, Sencor, Lexone	H	R-14	tech 1,100-2,300	>20,000	12	--	M	N
Micro-Tech, alachlor	H	R-12	930-1,350	--	12	S	M	N
Midas, methyl iodide	F, H, I	--	--	--	--	--	--	--
Mocap, ethoprop	N	R-2	61.5	2.4	48	H	H	H
MonCoat MZ, flutolanil+mancozeb	F	G	>5,000	>5,000	24	M	M	N
Moncut, flutolanil	F	G	>5,000	>5,000	12	N	H	N
Movento, spirotetramat	I	G	>2000	>4000	24	N	N	L
M-Pede, insecticidal soap	I-SO	G	16,900	--	12	N	N	N
Mustang Maxx, zeta-cypermethrin	I-PY	R-10,11	310	>5,000	12	--	H	H
myclobutanil, Nova, Rally	F	G	1,600	>5,000	24	--	N	N
napropamide, Devrinol	H	G	>4,640	--	12	--	N	N
naptalam, Alanap L	H	G	1,770	--	24	--	N	N
Neemix, azadirachtin	IGR	G	>5,000	>2,000	12	--	H	N
Nemacur, fenamiphos	N	R-2	tech 3	200	48	H	H	N
neem oil, Trilogy	F,A,I	G	>5 g	--	4	--	H	H
norflurazon, Solicam	H	G	>8,000	>20,000	12	N	M	N
Nova, myclobutanil	F	G	1,600	>5,000	24	--	N	N
Novodor, *Bacillus thuringiensis tenebrionis*	I-BT	G	See Footnote 8		4	N	N	N
novoluron, Rimon	I-IGR	G	3,914	>2,000	12	N	H	N

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD_{50} Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
Noxfire, rotenone	I-BO	G	132-1,500	--	12,48,24	S	H	N
NPV, Spod-X	I	G	--	--	4	--	--	--
NutriPhyte, phosphite salts	F	G			4	--	M	N
Oberon, spiromesifen	IGR	G	>2,000	>4,000	12	--	H	--
Omega, fluazinam	F	G	>5,000	>2,000	48	--	H	N
Orthene, acephate	I-OP	G	tech 980	>10,250	24	M	N	H
oryzalin, Surflan	H	G	>10,000	--	12	--	H	N
Outlook, dimethenamid	H	G	849	>2000	12	--	--	--
oxamyl, Vydate L	I,N-CA	R	37	2,960	48	H	H	H
oxyfluorfen, Goal, Goal Tender	H	G	tech >5,000	>10,000	24	--	H	N
parafinic oil	A	G	22 g	--	4	--	--	--
paraquat, Gramoxone Max	H	R-1,8	150	--	12,48	M	N	N
PBO (piperonyl butoxide)	I-OT	G	>7,500	--	12	N	N	N
PCNB, Terraclor, Blocker	F	G	tech 1,700-5,000	2,000-4,000	12,24	S	H	H
pebulate, Tillam	H	G	tech 921-1,900	>4,640	12	--	M	S
pendimethalin, Prowl	H	G	1,250	>5,000	12,24	--	M	N
Penncozeb, mancozeb	F	G	11,200	>15,000	24	--	H	N
penthiopyrad, Fontelis	F	G	12	>5,000	>5,000	H	L	L
permethrin, Perm-Up	I-PY	R-12	tech >4,000	>4,000	24	N	H	H
Perm-Up, permethrin	I-PY	R-12	tech >4,000	>4,000	24	N	H	H
*phenmedipham, Spin-aid	H	G	>8,000	>4,000	24	--	M	N
*phorate, Thimet	I-OP	R-2,10,11	tech 2-4	20-30	48	H	H	H
phosmet, Imidan	I-OP	R(NJ),G	tech 147-316	>4,640	24	S	H	H
phosphite salts, Phostrol, ProPhyt, Agri-Fos, NutriPhyte, Rampart	F	G	>5,000	>5,000	4	N	H	N
Phostrol, phosphite salts	F	G	>5,000	>5,000	4	N	H	N
Platinum, thiamethoxam	I-NN	G	>5,000	>2,000	12	--	M	N
Poast, sethoxydim	H	G	3,200-3,500	>5,000	12,24	S	M	S
Polyram, metiram	F	G	>5,000	>2,000	24	N	H	N
Poncho, clothianidin	I-NN	G	>5,000	>2,000	--	N	M	H
Portal, fenproximate	I,A	G	810		12	--	H	--
Potato Seed Treater, EBDC	F	G	4,500	>5,000	24	N	H	N
Prefar, bensulide	H	G	tech 271-1,470	--	12	--	H	H
Presidio, fluopicolide	F	G	>2,000	>4,000	12	L	H	L
Previcur Flex, propamocarb hydrochloride	F	G	2,900	>3,000	12	--	N	N
Priaxor, fluxapyroxad	F	G	>500->2,000	>5,000	12	N	H	N
Pristine, pyraclostrobin + boscalid	F	G	>2,000	>2,000	12	--	H	--
Proaxis, gamma-cyhalothrin	I-PY	R-12	>2,500	>5,000	24	N	H	H
Proclaim, emamectin	I-FB	R	1,516	>2,000	48	N	H	H
Procure, triflumizole	F	G	2,230	>2,000	12	--	H	N
ProGibb, gibberellic acid	PGR	G	1,000-25,000	--	4	--	N	N
Pro-Gro, thiram + carboxin	F	G	>2,000	>2,000	--	N	H	N
Prokil, cryolite	I-IO	G	>5,000	--	12	N	N	N
Prolong, *Bacillus thuringiensis kurstaki*	I-BT	G	See Footnote 8		4	N	N	N
pronamide, Kerb	H	R-5	tech 8,350	5,620	12	--	N	N
propamocarb hydrochloride, Previcur Flex	F	G	2,900	>3,000	12	--	N	N
promethryn, Caparol 4L	H	G	>5,000	>5,000	24	L	H	--
ProPhyt, phosphite salts	F	G	>5,000	>5,000	4	N	H	N
*propiconazole, Tilt	F	G	1,517	>4,000	24	--	H	N
Prowl, pendimethalin	H	G	3,956	2,200	12,24	--	M	N
Pursuit, imazethapyr	H	G	>5,000	>2,000	12,24	--	N	N
Pylon, chlorphanapyr	A	G	560	--	12	--	H	H

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD50 Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
pymetrozine, Fulfill	I-OT	G	>5,000	>2,000	12	N	N	N
pyraclostrobin, Cabrio, Headline	F	G	>500	>4,000	12	--	H	N
pyraclostrobin + boscalid, Pristine	F	G	>2,000	>2,000	12	--	H	--
Pyrellin, pyrethrins, rotenone	I	G	1,620	--	12	--	H	--
pyrethrum	I-BO	G	1,500	>1,800	12	N	H	M
pyrimethanil, Scala	F	G	4,505	>5,000	12	--	M	--
pyriproxyfen, Distance, Knack	IGR	G	>5,000	>2,000	12	--	H	N
Quadris, azoxystrobin	F	G	>2,000	>5,000	4	--	H	N
Quadris Opti, azoxystrobin + chlorothalonil	F	G	1,750	>5,000	12	N	H	N
Quilt, azoxystrobin + propiconazole	F	G	1,750	>5,000	12	N	H	N
Quintec, quinoxyfen	F	G	>2,000	>2,000	12	N	H	--
quinoxfen, Quintec	F	G	>2,000	>2,000	12	N	H	--
quizalofop-P-ethel, Assure II	H	G	1,210	--	12	N	N	N
Radiant, spinetoram	I	G	>5,000	>5,000	4	N	H	H
Rally, myclobutanil	F	G	1,600	>5,000	24	--	N	N
Randox, CDAA	H	G	750	--	12	--	--	--
Ranman, cyazofamid	F	G	>5,000	>2,000	12	L	L	L
Rampart, phosphite salts	F	G	--	--	4	--	--	--
Raptor, imazamox	H	G	>5,000	>4,000	4	N	N	N
Raven, *Bacillus thuringiensis tenebrionis*	I-BT	G	See Footnote 8		4	N	N	N
Reason, fenamidone	F	G	>5,000	>5,000	12	--	--	--
Reflex, fomesafen	H	G	6,950	>1,000	24	N	N	N
Regent, fipronil	I	R	275	841	0	M	H	M
Requiem, chemopodium ambrosioides	I,A	G	>5,000	>5,000	4	--	--	--
Revus, mandipropamid	F	G	>5,000	>5,000	12	--	H	--
Revus Top, mandipropamid + difenoconazole	F	G	2,958	>5,000	12	L	H	M
Ridomil Gold, mefenoxam	F	G	1,172	2,020	48	N	N	N
Ridomil Gold Bravo, mefenoxam + chlorothalonil	F	G	See Footnote 11		12			
Ridomil Gold Copper, mefenoxam + copper hydroxide	F	G	See Footnote 11		48			
Ridomil Gold MZ, mefenoxam + mancozeb	F	G	>5,000	>2,000	48	N	H	N
Ridomil Gold PCNB, mefenoxam + PCNB	F	G	>5,050	>2,020	48	N	H	N
Rimon, novoluron	I-IGR	G	3,914	>2,000	12	N	H	N
rimsulfuron, Shadeout	H	G	>5,000	>2,000	4	N	L	L
*Ro-Neet, cycloate	H	G	tech 2,000-4,100	--	12	--	M	N
Rotacide, rotenone	I-BO	G	132-1,500	--	24	S	H	N
*rotenone, Rotenox, Rotacide, Noxfire	I-BO	G	132-1,500	--	12,24,48	S	H	N
Rotenox, rotenone	I-BO	G	132-1,500	--	48	S	H	N
Roundup, glyphosate	H	G	>5,000	>5,000	24	N	N	N
*Rovral, iprodione	F	G	>4,400	>2,000	12	--	S	N
Safari, dinotefuran	I	G	>5,000	>5,000	12	--	--	H
Sandea, halosulfuron	H	G	1,287	>5,000	12	--	N	N
Savey, hexythiazox	A	G	>5,000	>5,000	12	--	H	N
Scala, pyrimethanil	F	G	4,505	>5,000	12	--	M	--
Scholar, fludioxonil	F	G	>5,000	>5,050	PostHarvest	L	H	--
Select, clethodim	H	G	3,610	>5,000	24	L	M	L
*Sencor, metribuzin	H	R-14	tech 2,000	>20,000	12	--	M	N
sethoxydim, Poast	H	G	2,676-3,125	>5,000	12,24	S	M	S
Sevin, carbaryl	I-CA	G	tech 283	>2,000	12	S	N	H
Silencer, lambda cyhalothrin	I-PY	R	tech 79	632	24	M	H	H
*Sinbar, terbacil	H	G	5,000-7,500	--	12	--	N	N

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD50 Values Mg/Kg[5] Oral	LD50 Values Mg/Kg[5] Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Toxicity[7] Fish	Toxicity[7] Bee
Sluggo, iron phosphate	M	G	>5,000	>5,000	0	--	--	--
S-metolachlor, Dual Magnum	H	G	tech 2,780	10,000	12	S	M	N
Sniper, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
sodium chlorite, Alcide	F	G	--	--	12	N	N	N
SoilGard, streptomycetes	F	G	--	--	12	N	N	N
Solicam, norflurazon	H	G	>8,000	>20,000	12	N	M	N
*Spin-aid, phenmedipham	H	G	>8,000	>4,000	24	--	M	N
spinetoram, Radiant	I	G	>5,000	>5,000	4	N	H	H
spinosad, Blackhawk, Consero, Conserve, Entrust,	I-ML	G	>5,000	>2,000	4	H	--	--
spiromesifen, Oberon	IGR	G	>2000	>4,000	12	--	H	--
spirotetramat, Kontos, Movento	I	G	>2000	>4000	24	N	N	L
Stinger, clopyralid	H	G	>5,000	>2,000	12	--	N	N
Spod-X, NPV	I	G	--	--	4	--	--	--
Spur, clopyralid	H	G	>5,000	>2,000	12	--	N	N
Stratego, trifloxystrobin + propiconazole	F	G	4,800	>5050	12	L	H	--
Strategy, ethalfluralin + clomazone	H	G	>5,050	>5,050	24	--	H	N
streptomycetes, SoilGard	F	G	--	--	12	N	N	N
streptomycin, Agri-Mycin-17, Agri-Strep	B	G	9,000	--	12	--	--	--
Sutan +, butylate	H	G	4,500	>4640	2	--	H	--
sulfentrazone, Authority XL	H	G	1,750	>5,000	12	L	L	--
sulfoxaflor, Closer, Transform	I	G,R	>5,000	>5,000	24	S	H	H
sulfur	A,F,I-IO	G	>5,000	>5,000	12,24,48	N	N	N
Super Cu, fixed copper[10]	F	G	--	--	12	--	H	N
Super Tin, triphenyltin hydroxide	F	R	160	500	48	--	H	--
Surflan, oryzalin	H	G	>10,000	--	12	--	H	N
Switch, cyprodinil + fludioxonil	F	G	>5,000	>2,000	12	--	H	N
Syllit, dodine	F	G	1,000	>6,000	48	--	H	H
TCNB, Fusarex	GR	G	--	--	--	--	--	--
Talus, buprofenzin	IGR	G	>5,000	>2,000	12	--	--	--
Tanos, famoxodone + cymoxanil	F	G	960	>2,000	12	--	H	--
tebuconazole, Folicur, Tebuzol	F	G	3,743	2,011	12	H	H	N
tebufenozide, Confirm	I	G	>5,000	>5,000	4	L	H	M
Tebuzol, tebuconazole	F	G	3,743	2,011	12	H	H	N
Tedion, tetradifon	A	G	>10,000	>10,000	12	--	--	--
tefluthrin, Force	I-PY	R	1,213	>2,000	0	N	H	N
Telone II, dichloropropene + chloropicrin	F,N	R-3,10	127	423	72	H	N	--
Telone C-35, dichloropropene + chloropicrin	F,N	R-3,10	127	423	72	H	N	--
tembotrione, Laudis	H	G	1,750	>5,000	12	--	--	--
Temprano, abamectin	I-FB	R	300	>1,800	12	N	M	H
Tenn-Cop, fixed copper[10]	F	G	--	--	24	--	H	N
*terbacil, Sinbar	H	G	5,000-7,500	--	12	--	N	N
terbufos, Counter	I-OP	R-1,2	tech 4.5	1.1	48	--	H	N
Terraclor, PCNB	F	G	tech 1,700-5,000	2,000-4,000	12,24	S	H	N
*Terr-O-Gas 67, methyl bromide	F,H,N	R-8	See Footnote 9		48	--	--	N
tetradifon, Tedion	A	G	>10,000	>10,000	12	--	--	--
*thiabendazole, Mertect	F	G	>5,000	>5,050	12	N	H	N
thiamethoxam, Actara, Cruiser, Durivo Endigo, Platinum, Voliam flexi	I-NN	G	>5,000	>2,000	12	N	N	H
*Thimet, phorate	I-OP	R-2,10,11	tech 2-4	20-30	48	H	H	H
thiophanate-methyl, Topsin M, OLF	F	G	7,500	--	12	--	S	N

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

Name[2]	Type Class[3]	Use Category[4]	LD$_{50}$ Values Mg/Kg[5] Oral	Dermal	Reentry[6] (Hours)	Toxicity[7] Bird	Fish	Bee
thiophanate-methyl + mancozeb, Tops MZ	F	G	>5,050	>2,020	24	N	H	N
thiophanate methyl + mancozeb + cmoxanil, Evolve	F	G	>5,000	>2,000	24	N	H	N
thiram, Thylate, 42-S Thiram	F	G	tech 1,000	>5,000	12	S	H	N
thiram + carboxin, Pro-Gro	F	G	>2,000	>2,000		N	H	N
Thylate, thiram	F	G	tech 1,000	>5,000	12	S	H	N
Tillam, pebulate	H	G	tech 921-1,900	>4,640	12	--	M	S
*Tilt, propiconazole	F	G	1,517	>4,000	24	--	H	N
Tombstone, cyfluthrin	I-PY	R	500	>5,000	12	M	H	H
topramezone, Impact	H	G	>2,000	>2,000	12	N	N	N
Tops MZ, thiophanate-methyl + mancozeb	F	G	>5,050	>2,020	24	N	H	N
Topsin M, thiophanate-methyl	F	G	7,500	--	12	--	S	N
Touchdown, glyphosate	H	G	>5,000	>5,000	24	N	N	N
Transform, sulfoxaflor	I	R	>5,000	>5,000	24	S	H	H
Treflan, trifluralin	H	G	>10,000	--	12,24	N	M	N
Tri-Basic Copper Sulfate, fixed copper[10]	F	G	472	--	24	--	H	N
trifloxystrobin, Gem, Flint	F	G	>5,000	>2,000	12	--	H	N
trifloxystrobin + metalaxyl, Trilex AL	F	G	>5,000	>5,000	24	N	H	N
trifloxystrobin + propiconazole, Stratego	F	G	4,800	>5,050	12	L	H	--
triflumizole, Procure	F	G	2,230	>2,000	12	--	H	N
trifluralin, Treflan, Trilin	H	G	>10,000	--	12,24	N	M	N
Trigard, cyromazine	IGR	R,G	3,387	3,100	12	S	H	H
Trilex AL, trifloxystrobin + metalaxyl	F	G	>5,000	>5,000	24	N	H	N
Trilin, trifluralin	H	G	>10,000	--	12,24	N	M	N
Trilogy, neem oil	F,A,I	G	>5 g	--	4	--	H	H
triphenyltin hydroxide, Super Tin, Agri Tin	F	R	160	500	48	--	H	--
Tristar, acetamiprid	I	G	1,064	>2,000	12	N	N	M
Tundra, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
Ultra Flourish, mefenoxam	F	G	--	--	--	--	--	--
Uniform, mefenoxam + azoxystrobin	F	G	1,459	>5,000	0	--	--	--
Vapam HL, metam-sodium	N	G	1,891	>3,074	48	--	H	N
Vendex, fenbutatin-oxide	A	R	2,631	>2,000	48	M	M	N
Venom, dinotefuran	I	G	>5,000	>5,000	12	--	--	H
Vetica, flubendiamide + buprofezin	I	G	>5,000	>5,000	12	L	L	L
Voliam Flexi, chlorantraniliprole, thiamethoxam	I-NN	G	>5,000	>5,000	12	--	--	H
Voliam Xpress, lambda-cyhalothrin + chlorantraniliprole	I	R-12	98.11	>5,000	24	--	H	H
Vydate L, oxamyl	I,N-CA	R	37	2,960	48	H	H	H
Warrior, lambda cyhalothrin	I-PY	R	tech 79	632	24	M	H	H
XenTari, *Bacillus thuringiensis aizawai*	I-BT	G	See Footnote 8		4	N	N	N
Yield Shield, *Bacillus pumilus* GB34	F-BT	G			NA	NA	NA	NA
Zeal, etoxazole	A	G	>5,000	>5,000	12	N	H	N
zeta cypermethrin, Mustang Maxx	I-PY	R-10,11	310	>5,000	24	S	H	H
zeta cypermethrin + bifenthrin, Hero	I-PY	R-10,11	550	--	24	S	H	H
zoxamide, Gavel	F	G	--	--	48	--	H	H
2,4-D (acid)	H	R(NJ),G	375	--	12,24	M	N	H
42-S Thiram, thiram	F	G	tech 1,000	>5,000	12	S	H	N

(Foot notes continued on next page)

Table D-6. Acute Toxicity of Chemicals[1] *(continued)*

-- = Data not available

* = Material covered under the Superfund Amendments and Reauthorization Act of 1986 (SARA) for storage notification.

[1] The Occupational Safety and Health Administration (OSHA) requires growers to keep on file Safety Data Sheets (SDS) for certain chemicals used during normal spray programs. Safety Data Sheets are replacement of the Material safety Data Sheets. These SDS sheets should be obtained from either your local pesticide dealer or directly from the chemical manufacturer. Some labels carry technical assistance phone numbers that you can call for further information. Call this number to request a SDS sheet from the manufacturer.

[2] Names: Trade names begin with capital letters; common names with small.

[3] Type class: A = acaricide; B = bactericide; F = fungicide; H = herbicide; IGR = insect growth regulator; I = insecticide (followed by the following: BO = botanical, BT = bacterial, CA = carbamate, CH = chlorinated hydrocarbon, EI = insect growth regulator [ecdysone inhibitor], FB = fermentation by-product, IO = inorganic, ML = macrocyclic lactone, NN = neonicotinoid, OP = organic phosphate, OT = other, PY = pyrethroid, SO = soap); N = nematicide; and PGR = plant growth regulator.

[4] Use category: R = restricted use and G = general use. Chemicals designated as general or restricted use as determined by state or federal agencies. Restricted use may not apply to all formulations or all uses of a formulation. Check the label to be sure. The designation (NJ) refers to a compound that is classified as restricted use in New Jersey. The number(s) after the R designation refer to the following reasons for being classified as a federal restricted use product:

1. acute oral toxicity
2. acute dermal toxicity
3. acute inhalation toxicity
4. corrosive to eyes
5. potential to cause tumors
6. potential to cause genetic mutations
7. potential to cause adverse reproductive effects
8. accident history
9. exposure hazard to workers
10. potential effects on wildlife
11. potential effects on birds
12. potential effects on fish and/or other aquatic species
13. potential for groundwater contamination
14. lack of data

[5] LD_{50} = milligrams of substance per kilogram of body weight of the test animal. > = higher than the figure listed. Formulations: LD_{50} values given are for formulated material as you would purchase it; for example, 50WP, 4E, etc., unless otherwise noted. Source: *2001 Farm Chemicals Handbook*; information is listed as supplied by manufacturer.

[6] <u>Reentry: The EPA Worker Protection Standard now requires minimum 12-hour reentry times for all Category III (CAUTION) pesticides, 24-hour minimum reentry times for all Category II (WARNING) pesticides, and 48-hour minimum reentry times for all Category I (DANGER) pesticides. In New Jersey, the NJDEP Pesticide Control Program has designated 48-hour reentry times for some pesticides which EPA has assigned 12- or 24-hour reentry times. Chemicals with multiple designations are based on product and/or formulation differences.</u>

[7] N=nontoxic; L=minimum impact on bees; M=moderately toxic; can be used if dosage, timing and method of application are correct but should **<u>NOT</u>** be applied directly to crop if bees are present; H=highly toxic, severe losses expected.

[8] Toxicity of *Bacillus thuringiensis* is listed as harmless to humans, animals, and useful insects. Please note that some formulations of BT may require safety equipment; follow the label. *Bacillus thuringiensis* materials are marketed as several different subspecies such as *aizawai, kurstaki,* and *tenebrionis*. Different *Bacillus thuringiensis* subspecies may have different insect control properties. Please check labels for pest insects controlled before use.

[9] Acute vapor toxicity, 200 ppm, extremely hazardous by vapor inhalation. Liquid can cause eye and skin burns.

[10] Fixed coppers are listed under several commercially available trade names. Examples are: Basicop, Champ, Champion, Copper-Count-N,Cuprofix Disperss, Kocide, Super Cu, Tenn-Cop, Top Cop with Sulfur, Top Cop Tri-Basic, and Tri-Basic Copper Sulfate.

[11] For toxicity information on fungicide combinations, see toxicity of each component listed by the common chemical name in Table D-6.

NOTES

PEST MANAGEMENT

HOW TO IMPROVE PEST MANAGEMENT

Failure to control an insect, mite, disease, or weed is often blamed on the pesticide when frequently the cause lies elsewhere. Among the more common reasons for failure are the following:

1. Delaying applications until pests become too large or too numerous.
2. Making applications with insufficient gallonage or clogged or poorly arranged nozzles.
3. Selecting the wrong pesticide.

The following points are suggested for more effective pest control:

1. **Inspect field.** Keep abreast of the pest situation and buildup in your fields. Frequent examinations (at least twice per week) help determine the proper timing of the next application. Do not apply controls simply because your neighbor does.

2. **Integrated pest management (IPM).** Guidelines and information about current pest activity in vegetables are published in weekly IPM newsletters and reports. These publications furnish accurate information for the timing of pesticide applications and suggestions for more effective control. To receive these newsletters and reports, contact your state Extension IPM specialist or Extension agent.

   Ongoing programs utilize biological, physical, cultural, and chemical methods in an integrated approach to pest control. Programs involve pest management field scouts visiting fields to collect pest population data. Use this updated information to decide whether insecticide applications or other management actions are needed to avoid economic loss from pest damage. Action thresholds for insect pests are generally expressed as a numerical count of a given life stage or as a damage level based on a recommended sampling procedure. They are intended to reflect the population size that will cause economic damage and, thus, warrant the cost of treatment. Specific thresholds are given in this publication for a number of pests of certain crops. Control decisions also are based on many factors such as:

   a. economic action threshold level (when the cost of control equals or exceeds potential crop losses attributed to real or potential damage)
   b. field history
   c. growth stage and vigor of crop
   d. life stage of the pest
   e. parasite and predator populations
   f. pest populations
   g. resistance to chemicals
   h. time of the year
   i. variety
   j. weather conditions

   To employ an IPM program successfully, basic practices need to be followed. Whether participating in a university or grower-supported IPM program, hiring a private consultant, or performing the work directly, the grower still practices:

   a. frequent and regular examination of fields to determine pest populations and buildup,

   b. applying a control measure only when the economic action threshold level has been reached, and

   c. where possible, using a pesticide that is least harmful to parasites and predators.

3. **Resistance management**. Resistance to pesticides develops because pest organisms change genetically and because intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to reproduce. See the sections on Insect Resistance and Control, and Disease Management for more specific suggestions to reduce the development of pest resistance.

4. **Pest control.** Control guidelines provide a way to decide whether pesticide applications or other management actions are needed to avoid economic loss from pest damage. Guidelines for pests are generally expressed as a numerical count of a given stage or as a crop damage level based on certain sampling techniques. They are intended to reflect the pest population that will cause economic damage and, thus, would warrant the cost of treatment. Guidelines are usually based on the field history, crop development, variety, weather conditions, and other factors. Control recommendations for various pests are presented in this manual.

   a. Insect population sampling techniques include: shake cloth, sweep net, and visual observation.

   Shake cloth (also known as a ground cloth). This sampling procedure consists of using a standard 3-foot by 3-foot shake cloth to assess insect populations. Randomly choose a site without disturbing the plants and carefully unroll the shake cloth between two rows. Bend the plants over the cloth one row at a time and beat the plants vigorously. Plants are pushed back to their original position and gently shaken to dislodge insects held on stems, leaves, and branches. Count only insects that have landed on the shake cloth. The number of sampling sites per field will vary with the crop.

   Sweep net. This sampling procedure uses a standard 15-inch diameter sweep net to assess insect populations. While walking along one row, swing the net from side to side with a pendulum-like motion. The net should be rotated 180 degrees after each sweep and swung through the foliage in the opposite direction. Each pass of the net is counted as one sweep. The number of sweeps per field will vary with the crop.

   Visual observation. Direct counts of any insect stages (eggs, larvae, adults, etc.) are accomplished by examining plants or plant parts (leaves, stems, flowers, etc.). Counts can be taken on single plants or a prescribed length of row which will vary with the crop. Usually, quick moving insects are counted first, followed by those being less mobile.

b. Weed population sampling techniques include: weed identification, growth stage determination, and population.

Weed identification. This first step is too frequently skipped. Perennial weeds and certain serious annual weeds should be controlled before they can spread. Common annual weeds need only be controlled if they represent a threat to yield, quality, or harvestability.

Growth stage determination. The ability of weeds to compete with the crop is related to size of the weed and size of the crop. Control of the weed using herbicides or mechanical methods is also dependant on weed size. A decision to control a weed or not must be carried out before the crop is affected and before the weed is too large to be controlled easily.

Weed population. Weed competition for light, water, nutrients, and space is dependant on population and is usually expressed as weeds per foot of row or weeds per square meter. Control measures are needed when the weed population exceeds the maximum tolerable population of that species.

c. Disease monitoring involves determining the growth stage of the crop, observing symptoms on plants, or the daily collection of weather conditions in the field.

Disease control is primarily obtained by applying protective fungicides on a regular schedule. For many diseases, fungicide application must begin at a certain growth stage and repeated every 7 to 10 days and according to label instructions. When environmental conditions are favorable for disease development, delaying a spray program will result in a lack of control if the disease has progressed too far.

For certain diseases that do not spread rapidly, fields should be scouted regularly. When the first disease symptoms are noticed, a fungicide should be applied and repeated every 7 to 10 days and according to label instructions.

Predictive systems are available for a few diseases. Temperature, rainfall, relative humidity, and duration of leaf wetness period are monitored, and the timing of fungicide application is determined by applying a mathematical model.

Information and guidelines about current pest activity are provided in weekly pest management and newsletter reports. These reports furnish accurate information for the timing of pesticide applications, aiding in more effective control. To receive these reports, contact your local state Extension agent or pest management specialist.

5. **Weather conditions**. These are important to consider before applying a pesticide. Spray only when wind velocity is less than 10 miles per hour. Dust only when it is perfectly calm. Do not spray when sensitive plants are wilted during the heat of the day. *If possible, make applications when ideal weather conditions prevail.*

Certain pesticides, including the biological insecticides and some herbicides, are less ineffective in cool weather. Others do not perform well or may cause crop injury when hot or humid conditions occur. Optimum results can usually be achieved when the temperature is in the 70's during application.

Sprinkler irrigation washes pesticide deposits from foliage. Wait at least 48 hours after insecticide or systemic fungicide application and allow contact fungicides to dry on the leaf surface before irrigating. More frequent fungicide applications may be needed during and after periods of heavy rainfall. Provide a minimum rain-free period of 8 to 12 hours after most post-emergence herbicide applications.

6. **Coverage of plants.** The principal reason aphids, mites, cabbage loopers, and diseases are serious pests is that they occur beneath leaves, where they are protected from pesticide spray deposits or dust particles. Improved control can be achieved by adding and arranging nozzles so that the application is directed toward the plants from the sides as well as from the tops (also see step 10). In some cases, nozzles should be arranged so that the application is directed beneath the leaves. As the season progresses, plant size increases, as does the need for increased spray gallonage to ensure adequate coverage.

Applying insecticide and fungicide sprays with sufficient spray volume and pressure is important to get good coverage. Good coverage is essential for disease control. Sprays from high-volume-high-pressure rigs (airblast) should be applied at rates of 40 to 100 gallons per acre at approximately 400 pounds pressure per square inch. Sprays from low-volume-low-pressure rigs (boom type) should be applied at rates of 50 to 100 gallons per acre at approximately 100 to 300 pounds pressure per square inch. The addition of a spreader- sticker improves coverage and control when wettable powders are applied to smooth-leaved plants, such as crucifers and onions.

Note. High gallonage is important for thorough spray coverage. It is recommended to use a minimum of 40 gallons per acre for effective pest control on vegetable crops.

Use one sprayer for herbicides and a different sprayer for fungicides and insecticides. Herbicide sprays should be applied at between 15 and 50 gallons of spray solution per acre using low pressure (30 to 45 psi). Never apply herbicides with a high-pressure sprayer suitable for insecticide or fungicide application because excessive drift can result in damage to crops and nontarget plants in adjacent fields and areas. On crops that are difficult to wet (asparagus, cole crops, onions, peppers, and spinach), disease control can be improved with the addition of a spray adjuvant. However, DO NOT add oil concentrates, surfactants, spreader-stickers, or any other additive unless specified on the label, or the risk of crop injury may be increased.

7. **Pesticide selection**. Know the pests to be controlled and choose the recommended pesticide and rate of application. When in doubt, consult your Extension agent. The herbicide choice should be based on weed species or cropping systems. The herbicides are listed in alphabetical order under the various crops (see Table E-3).

For certain insects that are extremely difficult to control or are resistant, it may be important to alternate labeled insecticides, especially with different classes of insecticides; for example, alternate a pyrethroid insecticide with either a carbamate or an organophosphate insecticide. Be alert for a possible aphid or mite buildup following the application of certain insecticides such as Sevin. For more assistance, contact your Extension agent.

Caution. Proper application of systemic insecticides is extremely important. The insecticide spray should be directed according to the label instructions (which, in general, indicate away from the seed) or crop injury may occur.

Be sure to properly identify disease(s). Many fungicides control only certain diseases and provide no control of others. For this reason, fungicide combinations are recommended on several crops.

8. **Pesticide compatibility.** To determine if two pesticides are compatible, use the following "jar test" before you tank-mix pesticides or pesticides and fluid fertilizers:

   a. Add 1 pint of water or fertilizer solution to a clean quart jar. Then add the pesticides to the water or fertilizer solution in the same proportion as used in the field.

   b. To a second clean quart jar, add 1 pint of water or fertilizer solution. Then add 1/2 teaspoon of an adjuvant (such as Compex, Sponto 168D, Uni-Mix, or Unite) to keep the mixture emulsified. Finally, add the pesticides to the water-adjuvant or fertilizer-adjuvant in the same proportion as used in the field.

   c. Close both jars tightly and mix thoroughly by inverting 10 times. Inspect the mixtures immediately and after standing for 30 minutes. If a uniform mix cannot be made, the mixture should not be used. If the mix in either jar remains uniform for 30 minutes, the combination can be used. If the mixture with adjuvant stays mixed and the mixture without adjuvant does not, use the adjuvant in the spray tank. If either mixture separates but readily remixes, constant agitation is required. If nondispersible oil, sludge, or clumps of solids form, do not use the mixture.

   Note. For compatibility testing, the pesticide can be added directly or premixed in water first. In actual tank-mixing for field application, unless label directions specify otherwise, add pesticides to the water in the tank in this order: 1) add, wettable granules or powders; 2) then add flowables, emulsifiable concentrates, water solubles, and companion surfactants. If tank-mixed adjuvants are used, these should be added first to the fluid carrier in the tank. Thoroughly mix each product before adding the next product.

9. **Calibration of application equipment.** Periodic calibrations of sprayers, dusters, and granule distributors are necessary to ensure accurate delivery rates of pesticides per acre. Calibrations are made by measuring the total gallons of water applied per acre, in the case of sprayers, and the total pounds of dust or granules applied per acre, in the case of dust and granule distributors. Too little spray or dust applied results in inadequate distribution of toxicant over plant surfaces. Control isusually poor, and additional applications are required. Too much per acre is hazardous for the applicator, is frequently injurious to plants (phytotoxic), and could lead to excessive residues if applied close to harvest.

10. **Selection of sprayer nozzle tips.** The selection of proper sprayer tips for use with various pesticides is very important. Flat fan-spray tips are designed for preemergence and postemergence application of herbicides. These nozzles produce a tapered-edge spray pattern that overlaps for uniform coverage when properly mounted on a boom. Standard flat fan-spray tips are designed to operate at low pressures (30-60 psi) to produce small- to medium-sized droplets that do not have excessive drift. Some flat fan tips (SP) are designed to operate at even lower pressures (15-40 psi) and are generally used for preemergence herbicide applications. Flat fan nozzle tips are available in brass, plastic, ceramic, stainless steel, and hardened stainless steel. Brass nozzles are inexpensive and are satisfactory for spraying liquid pesticide formulations. Brass nozzles are least durable, and hardened stainless steel nozzles are most durable and are recommended for wettable powder formulations which are more abrasive than liquid formulations. When using any wettable powder, it is essential to calibrate the sprayer frequently because, as a nozzle wears, the volume of spray material delivered through the nozzle increases.

    Flood-type nozzle tips are generally used for complete fertilizer, liquid N, etc., and sometimes for spraying herbicides onto the soil surface prior to incorporation. They are less suited for spraying postemergence herbicides or for applying fungicides or insecticides to plant foliage. Coverage of the target is often less uniform and complete when flood-type nozzles are used, compared with the coverage obtained with other types of nozzles. Results with postemergence herbicides applied with flood-type nozzles may be satisfactory if certain steps are taken to improve target coverage. Space flood-type nozzles a maximum of 20 inches apart, rather than the standard 40-inch spacing. This will result in an overlapping spray pattern. Spray at the maximum pressure recommended for the nozzle. These techniques will improve target coverage with flood-type nozzles and result in satisfactory weed control in most cases.

    Full and hollow-cone nozzles deliver circular spray patterns and are used for application of insecticides or fungicides to crops where thorough coverage of the leaf surfaces is extremely important and where spray drift will not cause a problem (see step 6). They are used when higher water volumes and spray pressures are recommended. With cone nozzles, the disk size and the number of holes in the whirl plate affect the output rate. Various combinations of disks and whirl plates can be used to achieve the desired spray coverage.

11. **pH and pesticides.** At times, applicators have commented that a particular pesticide has given unsatisfactory results. Usually, these results can be attributed to poor application, a bad batch of chemical,

pest resistance, weather conditions, etc. Another possible reason for these problems may be the pH of the mixing water.

Some materials carry a label cautioning the user against mixing the pesticide with alkaline materials. The reason for this caution is that some materials (in particular the organophosphate insecticides) undergo a chemical reaction known as "alkaline hydrolysis." This reaction occurs when the pesticide is mixed with alkaline water, that is, water with a pH greater than 7. The more alkaline the water, the greater the breakdown rate.

In addition to lime sulfur, several other materials provide alkaline conditions: caustic soda, caustic potash, soda ash, magnesia or dolomitic limestone, and liquid ammonia. **Water sources in agricultural areas can vary in pH from less than 3 to greater than 10**.

Many manufacturers provide information on the rate at which their products hydrolyze or break down in water solutions. This rate is expressed as "half-life," meaning the time it takes for 50 percent hydrolysis or breakdown to occur. Examples of pesticides that are sensitive to hydrolysis in alkaline water solutions include Counter, malathion, dimethoate, Di-Syston, Furadan, Guthion, Imidan, Lannate, Penncap-M, Sevin, and Thimet.

Check the pH of the water. You can purchase a pH meter or ask your Extension agent to test a sample.

How can you correct the alkaline pH? Nutrient buffer sprays are one method; some brand names include: Buffer-X (Kalo Lab), LI-700 Buffer (Hopkins), Mix-Aid (Agway), Nutrient Buffer Sprays (Ortho), Sorba Spray (Leffingwell), Spray-Aide (Miller), and Unite (Hopkins).

There are some instances when materials should not be acidified, namely, sprays containing fixed copper fungicides, including: Bordeaux mixture, copper oxide, basic copper sulfate, copper hydroxide, etc.

CALIBRATING FIELD SPRAYERS

Width of Boom. The width of boom must be expressed in feet. The boom coverage is equal to the number of nozzles multiplied by the space between two nozzles.

Ground Speed (mph). Careful control of ground speed is very important for accurate spray application. Select a gear and throttle setting to maintain constant speed. A speed of 2 to 3 miles per hour is desirable. From a "running start," mark off the beginning and ending of a 30-second run. The distance traveled in this 30-second period divided by 44 will equal the speed in miles per hour.

Table E-1 Ground Speed Conversion

Tractor Speed	Distance	Travel Time per 500 Feet	
mph	**Ft/Min**	**Min**	**Sec**
1.0	88	5	41
1.5	132	3	47
2.0	176	2	50
2.5	220	2	16
3.0	264	1	53
3.5	308	1	37
4.0	352	1	25
4.5	396	1	16
5.0	440	1	8
6.0	528	0	56
7.0	616	0	49
8.0	704	0	43
9.0	792	0	38
10.0	880	0	34

Example: At a tractor speed of 1 mile per hour, you would travel 88 feet in 1 minute or 500 feet in 5 minutes and 41 seconds.

Sprayer Discharge (gpm). Run the sprayer at a certain pressure, and catch the discharge from each nozzle for a known length of time. Collect all the discharge and measure the total volume. Divide this volume by the time in minutes to determine discharge in gallons per minute. *Catching the discharge from each nozzle checks the performance of the individual nozzle*. When it is not convenient to catch the discharge from each nozzle, a trough may be used to catch the total discharge.

Before Calibrating

1. Thoroughly clean all nozzles, screens, etc., to ensure proper operation.
2. Check to be sure that all nozzles are the same, are made by one manufacturer, and have the same part number.
3. Check the spray patterns of all nozzles for uniformity. Check the volume of delivery by placing similar containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform patterns or do not fill containers at the same rate.
4. Select an operating speed. Note the tachometer reading or mark the throttle setting. When spraying, be sure to use the same speed as used for calibrating.
5. Select an operating pressure. Adjust pressure to desired psi while pump is operating at normal speed and water is actually flowing through the nozzles. This pressure should be the same during calibration and field spraying.

Calibration (Jar Method)

Either a special calibration jar or a homemade one can be used. If you buy one, carefully follow the manufacturer’s instructions.

Make accurate speed and pressure readings and jar measurements. Make several checks. Keep in mind that you are collecting less than a quart of liquid to measure an application rate of several gallons per acre for many acres.

Any 1-quart or larger container, such as a jar or measuring cup, if calibrated in fluid ounces, can easily be used in the following manner:

1. Measure a course on the same type of surface (sod, plowed, etc.) and same type of terrain (hilly, level, etc.) as that to be sprayed, according to nozzle spacing as follows:

Nozzle spacing (in)	16	20	24	28	32	36	40
Course length (ft)	255	204	170	146	127	113	102

2. Time the seconds it takes the sprayer to cover the measured distance at the desired speed. Average several runs.
3. With the sprayer standing still, operate at selected pressure and pump speed. Catch the water from several nozzles for the number of seconds measured in step 2.
4. Determine the average output per nozzle in ounces. The ounces per nozzle equal the gallons per acre applied by one nozzle per spacing.

Calibration (Boom or Airblast Sprayer)

1. Fill sprayer with water.
2. Spray a measured area (width of area covered x distance traveled) at constant speed and pressure selected from manufacturer's information.
3. Measure amount of water necessary to refill tank (gallons used).
4. Multiply gallons used by 43,560 **square feet (SF) per acre (A)**, and divide by the number of square feet in area sprayed. This gives gallons per acre.
5. Add correct amount of spray material to tank to give the recommended rate per acre.

EXAMPLE:

Assume:

10 gal of water used to spray an area 660 ft long and 20 ft wide

Tank size-100 gal

Spray material-2 lb (actual)/A

Calculation:

(Gal used x 43,560 SF/A) ÷ (area sprayed)

= (10 gal x 43,560 SF/A) ÷ (660 ft x 20 ft)

= (435,600 gal x SF)/A ÷ 1,320 SF

=33 gal/A (all other units cancel out)

Tank capacity (gal/A) = 100 gal ÷ 33 gal/A = 3.03 A/tank

If (for some reason) 80% material is used:

$$\frac{6.06}{0.8} = \text{7.57 lb material needed per tank to give 2 lb/A rate}$$

CALIBRATING GRANULAR APPLICATORS

Sales of granular fertilizer, herbicides, insecticides, etc., for application through granular application equipment have been on the increase. Much of the available equipment was not designed for precision application of granular materials; therefore, extra care must be taken to get the results desired. How well the material is applied is no accident. It will take a conscientious operator, effort, knowledge of equipment, and calibration.

The first step to good application is to be sure the equipment is prepared for operation. Be sure all controls are free and work properly. Check and lubricate moving parts as necessary, remove corrosion, and tighten loose nuts and bolts.

Application rates of granular application equipment are affected by several factors: gate openings or settings, ground speed of the applicator, shape and size of granular material, and evenness of the soil surface.

Calibration for Broadcast Applicators (Gravity-Drop or Spinner Applicators)

1. From the label, determine the application rate.
2. From the operators manual, set dial or feed gate to apply desired rate.
3. On a level surface, fill hopper to a given level and mark this level.
4. Measure test area-length of run will depend on size of equipment. It need not be one long run but can be multiple runs at shorter distances.
5. Apply material to measured area, operating at the speed applicator will travel during application.
6. Weigh amount of material required to refill hopper to the marked level.
7. Determine application rate:

$$\text{Area covered (acres)} = \frac{\text{number of runs} \times \text{length of run (ft)} \times \text{width of application (ft)}}{\text{43,560 SF/A}}$$

$$\text{Application rate (lb/A)} = \frac{\text{amount applied (pounds to refill hopper)}}{\text{area covered (acres)}}$$

Note. Width of application is width of the spreader for drop or gravity spreaders. For spinner applicators, it is the working width (distance between runs). Check operator's manual for recommendations, generally one-half to three-fourths of overall width spread.

EXAMPLE:

Assume:
50 lb/A rate
Test run-200 ft
Four runs made
Application width-12 ft
11.5 lb to refill hopper

Area covered:
(4 runs x 200 ft x 12 ft) ÷ 43,560 SF/A
= 9,600 runs x SF ÷ 43,560 SF/A = 0.22A

Application rate:

11.5 lb ÷ 0.22 A = 52.27 lb/A

8. If application rate is not correct, adjust feed gate opening and recheck.

Calibration for Band Applicators

1. From the label, determine application rate.
2. From the operator's manual, determine applicator setting and adjust accordingly.
3. Fill hopper half full.
4. Operate applicator until all units are feeding.
5. Stop applicator; remove feed tubes at hopper.
6. Attach paper or plastic bag over hopper openings.
7. Operate applicator over measured distance at the speed equipment will be operated.
8. Weigh and record amount delivered from each hopper. (Be sure all hoppers and all tubes deliver the same amount.)
9. Calculate application rate:
   Area covered in bands (acres) =

[No. bands x length of run (ft) x band width (ft)] ÷ 43,560 SF = fraction of an acre

10. If not correct, readjust and recheck.

Calibration for Changing from Broadcast to Band Application

[Band width (ft) ÷ row spacing (ft)] x broadcast rate (lbs/A) = Amount needed lbs/acre

SOIL FUMIGATION

In fields that are infested with soilborne plant pathogens, plant parasitic nematodes, or significant weed populations, soil fumigation is one method of reducing pest populations sufficiently to produce high quality and high yielding vegetable crops. Soil fumigants must be applied properly, and an aeration period is necessary between soil fumigant application and planting of the crop. Otherwise, plant injury will occur.

Nearly all soil fumigants have been re-registered since 2009 and label changes and amendments were substantial or a consequence. Labels now include mandatory stipulations on fumigant application including soil tillage, soil temperature, and soil moisture. Labels should be read carefully before deciding whether to use a soil fumigant. Labels have specific requirement for plant-back period that must be adhered to for crop safety. There are also new personal protective equipment mandates as well as site monitoring and management requirements. Your local Cooperative Extension professional may be of assistance for interpretation of these new labels and how they fulfill your specialized needs.

One of the following multipurpose soil fumigants should be used to provide weed, disease, and/or nematode control:

chloropicrin--25-34 gal/A
dichloropropene + chloropicrin (Telone C-17)--
11-17 gal/A
dichloropropene + chloropicrin (Telone C-35)--
13-20.5 gal/A
dichlrorpropene + chloropicrin (Pic-Clor 60)
20-30 gal/A
metam-sodium (Vapam HL)—
37.5-75 gal/A
metam-potassium (K-PAM HL)--
30-60 gal/A
Dimethyl disulfide + chloropicrin (Paladin)
50-60 gal/A

For nematodes only use:
dichloropropene (Telone II)--9-12 gal/A

To determine if it is safe to plant into fumigated soil, collect a soil sample from the treated field (do not go below the treated depth). Place the sample in a glass jar with a screw top lid. Firmly press numerous seeds of a small seeded vegetable crop (lettuce, radish, etc.) on top of the soil and tighten the lid securely. Repeat the process in another jar with nonfumigated soil to serve as a check. Observe the jars within 1 to 2 days. If seeds have germinated, it is safe to plant in the field. If seeds have not germinated in the fumigated sample and have germinated in the nontreated sample, then the field is not safe to plant. Rework the field and repeat the process in a few days.

PESTICIDE DRIFT

When herbicide drift damages your plants, it is an indication that the herbicide has entered the plant. To legally sell the produce, there has to have been an established tolerance for the particular herbicide causing the injury. Some herbicides such as glyphosate (active ingredient in Roundup, Touchdown and others) are used for spot or stale seedbed treatments in a wide range of crops. These herbicides have established tolerances (Table E-2). Other herbicides do not have an established tolerance for most vegetable crops. If the concentration of the herbicide in your vegetable is above the established tolerance or there is no tolerance, then you have a tainted crop that is illegal to sell and is subject to seizure. The website to check for tolerances is: www.epa.gov/pesticides/food/viewtols.htm.

Table E-2. Examples of Tolerances for Some Herbicide Residues in Tomato Fruit.

Herbicide	Tomato Tolerance (ppm)
Dacthal	1.0
Dual	0.1
Poast	24
Sandea	0.05
Select	1.0
Sencor	0.1

Tolerances are not the only factor that should be considered in deciding whether or not to sell or consume produce.

The U.S. EPA tolerance levels are the best scientific information available, but you or your customers may not trust that information completely, and if your customers have heard of the drift problem, selling affected produce may damage your farm's reputation.

Concentrations detected by analyzing selected plant tissues, usually leaves, may have little relationship to the concentrations of herbicide occurring in the harvested portion of the plant, often the fruit. Because there are so many unknowns, it is advisable to not consume the vegetable when visible herbicide injury occurs to the plant. Herbicide drift can kill flowers and damage fruit and leaves. The damage makes the harvested vegetable unsightly and may affect storage life and taste.

If you are interested in harvesting some undamaged vegetables from a field with areas having drift damage, get as much information as possible. What herbicide(s) drifted? Many herbicides that commonly cause drift injury are absorbed by the leaves and translocate to the growing points, fruit, and seed where they concentrate. Some herbicides such as 2,4-D degrade in plants, others such as glyphosate degrade only slightly in plant tissues. Over time the herbicide concentration in the plant may be diluted due to plant growth and herbicide loss in dead shoot and root tissue.

Having the vegetables analyzed for herbicide residue is critical to making an informed decision in herbicide drift situations. Several private laboratories will analyze plant tissues for herbicide residues for a fee; that fee can be several hundred dollars per herbicide per sample. Talk to the applicator who caused the drift problem; they may be willing to pay for the analysis. Some manufacturers will analyze plant tissues for their products. For state Departments of Agriculture to be involved you usually must file a formal written complaint alleging herbicide misapplication. Contact your State Department of Agriculture as soon as possible after discovering herbicide injury. For example, in Pennsylvania, pesticide misuse complaints are filed with the Pennsylvania Department of Agriculture's Bureau of Plant Industry: http://goo.gl/o9zY9.

In addition, samples for residue analysis must be collected correctly and in a timely manner for it to be useful for you in the decision making process. If the harvested part is present, collect that tissue. If fruit are not present, then collect samples of recently formed leaves and the shoot tips. Translocated herbicides will concentrate in those tissues. Ask that fruit samples be collected later to help you in deciding whether or not to sell or consume the fruit. Make sure that samples are collected from the crop plants showing injury and as close as possible to the site of herbicide application.

What does information herbicide residue concentrations tell you? Sometimes it may not tell you much. Obviously the lower the contaminating herbicide concentration, the better, and a concentration below an established tolerance is better than one above, but there are no clear-cut answers. The herbicide may be absent from the parts you wish to harvest and eat, or the herbicide concentration may be below the limits of detection for the equipment or procedure being used. Another possibility is that your sampling procedure was not effective enough to find tissues with residues, or the herbicide may have degraded between the time of the drift and when you sampled (or during sampling, handling, shipping, or storage). Be conservative in how you interpret the residue information.

The scientific literature suggests that for herbicide residues from drift and subsequent absorption into vegetables, acute poisoning effects are very unlikely. Questions about the possible chronic effects (including cancer, the endpoint that is always debated in questions about pesticide safety) from multiple exposures from repeated incidents of herbicide drift along with many other routes of exposure remain the subject of research.

What Should You Do With Fruit and Vegetables After Pesticide Drift? (J. Masiunas, University of Illinois)

A common question after a vegetable field is damaged by pesticide drift is whether or not it is "safe" to harvest and consume the produce. This is a very difficult question to answer. Re-entry time and worker protection information on the pesticide label will provide guidance on when the field can be re-entered, but it provides no information about the residue that might be on or within the produce. To answer conclusively the question about whether or not it is "safe" to harvest and consume the produce requires knowledge of the pesticide involved, the amount of residues within the plant, the health effects of the pesticide, how the harvested part of the plant has changed, and laws regulating pesticides.

WEED CONTROL

Effective weed control requires a program that emphasizes prevention by combining crop rotation with mechanical and chemical control methods.

Postharvest Weed Control

Weed seed populations in the soil should be kept to a minimum by preventing weeds from producing seed in and around vegetable fields. Destroy all weeds immediately after a crop is harvested.

Consider control measures after harvest, but before the first frost, for the following weeds:

1. To suppress or control bitter nightshade, Canada thistle, field bindweed, hemp dogbane, horsenettle, or pokeweed, use a tank-mix of 1 quart Banvel plus 1 quart 2,4-D amine in 10 to 20 gallons of water per acre. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness (**Note.** Delay seeding of winter cover crop 3 weeks for each pint per acre of Banvel used). See herbicide labels for optimum treatment time for each weed.
2. To suppress brambles, horseradish (volunteer), horsenettle, milkweed, poison ivy, or sow thistle, tank-mix 1.5 lb acid equivalent glyphosate, using one of many labeled glyphosate products, plus 1 pint Banvel (see note above) in 10 to 20 gallons of water per acre. Use 1 to 2 quarts surfactant (50 to 100 percent active) per 100 gallons of spray mixture. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness. See

herbicide labels for optimum treatment time for each weed.

3. To control johnsongrass or quackgrass, apply 0.75 to 1.1 lb acid equivalent glyphosate, using one of many labeled glyphosate products, in 5 to 10 gallons of water per acre. Delay tillage until 4 to 7 days after application. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness.

To control Bermudagrass, apply the maximum labeled rate of Poast, Fusilade 2000, or clethodim (Select, Select Max, or Arrow) in late spring after the weed has begun to grow. Work toward planning your crops and crop rotation to be able to treat monthly with one of the above listed products through late summer without conflicting with the Preharvest Interval (PHI) of the crop(s) being grown.

To control yellow nutsedge foliage and suppress nutlet formation, spray with a labeled glyphosate product after flowers (seedheads) appear, but before foliage dies. Use 2.25 lb acid equivalent glyphosate in 10 to 20 gallons of water per acre. Expect only partial control of yellow nutsedge the first year after initiating the program. Plant a crop the following spring with registered herbicides recommended for yellow nutsedge control (see Table E-3). Effective yellow nutsedge control can be achieved by repeating the application for several consecutive years.

NOTES

Table E-3. Herbicide Effectiveness on Major Weeds in Vegetables

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Preplant or Preplant Incorporated																					
Devrinol	G	G	G	G	G	G	N/P	G	N	-	F/P	N	F/G	N	-	F/G	G	P/F	P	N	N
Eptam	G	G	G	G	G	G	G	G	P	G	N	P	F	F	-	G	G	P	P	F/G	F/G
Goal/Goal Tender	P	P	P	P	P	P	N	F/G	-	-	F	-	F	-	G	G	G	F	-	-	-
Prefar	G	G	G	G	F/G	G	N	N	N	N	N	N	F/G	N	P/F	F	F	N	N	N	N
Ro-Neet	G	G	G	G	G	-	N/P	G	N	G	N	N	F	-	G	G	G	N	-	-	F
Treflan	G	G	G	G	G	G	N	G	N	-	N	N	F/G	P/F	N	F	G	N	P/F	P	N
Preemergence or Preplant Incorporated																					
Atrazine	F	P/F	P	F	-	P	P/F	G	F/G	-	G	G	G	G	G	G	G	G	G	G	F
Dual Magnum	G	G	G	G	G	G	F/G	F	N	-	G	N	P	N	-	G	F/G	N	P	G	P
Intrro	G	F/G	G	G	G	G	F	G	N	-	G	P	P/F	N	G	G	G	N	P	G	P
Prowl	G	G	G	G	-	G	N	G	N	-	N	N	F/G	P	N	F/G	F/G	N	F	P	G
Pursuit	P/F	P/F	P/F	P/F	-	N	G	F	-	P	F	G	F	F	G	G	P	G	F	G	
Metribuzin	F	F	F	F	F	-	N	G	F	-	G	F/G	G	F/P	-	F/G	F	G	G	P	G
Preemergence																					
Callisto	N	F	N	P	N	N	P	-	P/F	-	G	F	G	F	G	F/G	-	P	-	P	-
Caparol	F	P/F	P	F	P/F	-	N	G	P	-	G	P/F	G	P	F	F/G	G	F	F	F	P
Chateau	P	P	P	P	P	P	P	G	F	-	G	-	G	F	G	G	G	F	G	G	-
Command	G	G	G	G	G	G	N	N	N/F	-	F	G	G	P	F	N/P	G	P/F	G	-	G
Curbit	F	G	G	-	G	-	N	G	N	-	N	N	P/F	P	-	F	F/G	N	P	P	P
Dacthal	F/G	G	F/G	G	F/G	-	N	P	N	P	N	P	G	N	P	F/G	G	N	N	N	N
Galigan	P	P	P	P	P	P	P	G	P	-	G	F	G	F	G	G	G	F	G	G	F
Goal	P	P	P	P	P	P	P	G	P	-	G	F	G	F	G	G	G	F	G	G	F
Karmex	G	F/G	G	G	F/G	N	N	G	-	-	G	G	G	G	G	G	G	G	G	G	G
Kerb	G	G	G	G	G	-	N	G	N	-	P	N	G	-	-	G	G	P	-	-	P
Lorox	F	P/F	P	F	P/F	-	N	G	P	-	G	P/F	G	P	F	G	G	F	G	G	P
Sandea	N	N	N	N	N	N	F	P	G	-	G	G	F	F	-	G	F	G	F	N	G
Sinbar	F	F	-	F	F	-	P	G	-	G	G	G	G	G	G	P	G	G	G	G	G
Solicam	G	G	G	G	-	F	F	-	-	-	-	F	F	P	-	G	G	G	-	-	F
Spartan Charge	P	P	P	P	P	P	P	-	-	-	-	-	P	P	-	F/G	-	N	P	-	-
Strategy[2]	G	G	G	G	G	G	N	G	N/F	-	F	G	G	P	F	F	G	F	G	P	G

table continued next page

Table E-3. Herbicide Effectiveness on Major Weeds in Vegetables (continued)

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Postemergence																					
2,4-D	N	N	N	N	N	N	P	G	F/G	G	P	F	F/G	G	G	G	G	G	F	G	G
Accent Q	G	P-F	G	G	P	G	P	-	P	-	-	F	P	F	G	G	P-F	P	F-G	N	P
Aim	N	N	N	N	N	N	N	G	P	-	-	P	G	F	-	G	-	F	-	G	G
Assure II/Targa	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Atrazine	F	F	F	F	F	-	G	-	F	-	G	G	G	G	G	G	G	G	G	G	F/G
Banvel	N	N	N	N	N	N	P	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Basagran	N	N	N	N	N	N	F	N	G	-	F	G	F	P	-	F	F/G	G	G	P	G
Buctril	P	P	P	P	P	P	P	G	G	-	G	G	G	G	G	G	F	F	G	G	F
Callisto	N	F	P	P	P	P	F	-	F/G	-	G	G	G	F	F/G	G	-	P	-	F/G	G
Caparol	F	P/F	P	F	P/F	-	N	G	P	-	G	P/F	G	P	F	F/G	G	F	G	G	P
Fusilade DX	G	F/G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
glyphosate products	G	G	G	G	G	G	F	G	G	G	G	G	G	F	G	G	G	F	G	G	G
GoalTender	P	P	P	P	P	P	P	G	P	-	G	F	G	F	G	G	G	F	G	G	F
Gramoxone products [1]	F/G	F/G	F/G	G	F/G	-	G	G	G	-	G	G	F/G	F/G	-	G	F/G	G	P	-	-
Impact	G	G	F/G	G	F	F	-	-	F/G	-	-	G	G	F	-	G	-	G	G	G	G
Laudis	G	F/G	P	G	F	G	-	-	F/G	-	-	G	G	F	-	G	-	F	-	-	-
Lorox	P	P	P	P	P	P	P	G	P/F	-	F/G	P/F	G	-	G	G	G	G	G	P/F	G
Matrix	G	P/F	F/G	G	P	-	F	-	F/G	-		F	F	F	G	G	F/G	P	P/F	P	F
Metribuzin	P	P	P	P	P	-	P	G	-	-	G	G	G	P	G	G	G	G	F	P	P/F
Poast	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pursuit	F/G	F/G	F/G	F/G	P	F/G	-	G	F	-	G	F	G	F	P/F	G	G	P/F	-	-	G
Raptor	P	P	P	P	P	P	P	-	F/G	-	G	-	F	F	G	G	P/F	P/F	G	G	G
Reflex	P	P	P	P	P	P	P	G	F	-	G	G	P	F/G	G	G	-	F	P	F	P
Sandea	N	N	N	N	N	N	G	P	G	-	G	G	N	F	-	G	P	G	F	N	G
Select	G	G	G	G	P	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sinbar	F	F	-	F	F	-	P	G	G	-	G	G	G	G	G	P	G	G	G	G	G
Spin-aid	P	P	P	P	P	P	P	-	P	-	G	G	F	G	G	P/F	G	F/G	-	-	N
Stinger/Spur	N	N	N	N	N	N	N	N	G	P	G	P	P	N	N	N	N	G	P	P	P
Touchdown	G	G	G	G	G	G	F	G	G	G	G	G	G	F	G	G	G	F	G	G	G

[1] Nonselective
[2] Jug-mix of Command and Curbit
G = good F = fair P = poor N = no control
- = insufficient data

Herbicide performance is affected by weather, soil type, herbicide rate, weed pressure and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University of Maryland System, The Pennsylvania State University, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart.

Table E-4 Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals

Herbicide	Asparagus-seeded	Asparagus-established	Beans: lima	Beans: snap	Beets	Broccoli, Cauliflower	Brussels Sprouts	Cabbage	Carrots	Celery	Cucumbers	Garlic	Greens: Collard, Kale, Turnip	Greens: Mustard	Horseradish	Leeks	Lettuce: Head	Lettuce: Leaf
Preplant or Preplant Incorporated																		
Devrinol		R				R[3]		R[3]										
Eptam				R														
Prefar						R	R	R			R		R	R			R	R
Roneet					R													
Treflan			R	R		R	R	R	R				R	R				
Preemergence or Preplant Incorporated																		
Atrazine																		
Dual Magnum	16R[3]		R	R				50R[3]	64R[3]						64R[3]			
Intrro			R															
Metribuzin		R																
Prowl			R	L														
Pursuit			R															
Preplant or Preemergence																		
Gramoxone Products[2]	R	R	R	R		R		R	R		R		R				R	R
Preemergence																		
Callisto																		
Caparol									R	R								
Chateau																		
Command																		
Curbit											R[3]							
Dacthal				R		R	R	R					R	R	R			
Galigan						R[3]		R[3]							R			
Goal						R[4]		R[4]							R			
Karmex		R																
Kerb																	R	R
Lorox										R								
Reflex																		
Sandea		1R	30R	30R							R							
Sinbar		R																
Solicam		14R																
Spartan Charge			R[3]															
Strategy											R							

[1] Nonselective—Do not allow spray or spray drift to contact crop.
[2] Nonselective—Apply before crop emergence or before transplanting.
[3] Labeled and recommended in certain states only (see description under crop).
[4] Transplanted ONLY
[5] Labeled for certain crops, varieties, or herbicide formulations ONLY.
R = Recommended, Blank = Not recommended, L = Labeled (Not recommended), Number = Minimum preharvest interval in days (for postemergence herbicides only)

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Table E-4. Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals (continued)

Herbicide	Muskmelons	Okra	Onions	Parsley	Parsnips	Peas	Peppers-transplanted	Potatoes	Pumpkins	Radishes, Rutabagas, Turnips	Spinach	Strawberries	Summer Squash	Sweet Corn	Sweet Potatoes	Tomatoes-transplanted	Watermelons	Winter Squash
Preplant or Preplant Incorporated																		
Devrinol							R					R				R		
Eptam								R										
Prefar	R		R	R			R		R				R				R	R
Roneet											R							
Treflan		R					R									R		
Preemergence or Preplant Incorporated																		
Atrazine														R				
Dual Magnum							65R[3]	R						R		90R		
Intrro														R				
Metribuzin								R								R		
Prowl						L	70R	R						L		70R		
Pursuit						R												
Preplant or Preemergence																		
Gramoxone Products[2]	R		R			R	R	R	R			R	R	R		R	R	R
Preemergence																		
Callisto														R				
Caparol				R														
Chateau												R						
Command						R	R		R								R	
Curbit		R[3]						R[3]										
Dacthal			R							R		R			R			
Galigan																		
Goal																		
Karmex																		
Kerb																		
Lorox				R	R			R										
Reflex								70R										
Sandea	R								L								57R[3]	L
Sinbar																	70R	
Solicam																		
Spartan Charge																		
Strategy	R								R				R				R	R

[1] Nonselective—Do not allow spray or spray drift to contact crop.
[2] Nonselective—Apply before crop emergence or before transplanting.
[3] Labeled and recommended in certain states only (see description under crop).
[4] Transplanted ONLY
[5] Labeled for certain crops, varieties, or herbicide formulations ONLY.
R = Recommended, Blank = Not recommended, L = Labeled (Not recommended), Number = Minimum preharvest interval in days (for postemergence herbicides only)

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Table E-4. Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals (continued)

Herbicide	Asparagus-seeded	Asparagus-established	Beans: lima	Beans: snap	Beets	Broccoli, Cauliflower	Brussels Sprouts	Cabbage	Carrots	Celery	Cucumbers	Garlic	Greens: Collard, Kale, Turnip	Greens: Mustand	Horseradish	Leeks	Lettuce: Head	Lettuce: Leaf
Postemergence																		
2,4-D		0R																
Accent Q																		
Aim																		
Assure II/Targa			15R															
Atrazine																		
Banvel		1R[3]																
Basagran			30R	30R														
Buctril												112R						
Callisto																		
Caparol									30R	40R								
Fusilade DX	365R	R[3]																
glyphosate products	7R[1]	7R[1]	R[2]	R[2]														
Goal/GoalTender[5]																		
Gramoxone products [1]	6R[2]	6R									0R[1,3]							
Impact																		
Laudis																		
Lorox									0R									
Matrix																		
Metribuzin																		
Poast	1R	365R	15R	15R	60R	30R		30R		30R	14R		30R		60R		30R	15R
Pursuit																		
Raptor		R																
Reflex				30R														
Sandea		1R	30R	30R							30R							
Select Max	1R	1R	21R	21R	30R	30R	30R	30R	30R	30R	14R	45R	14R	14R	30R			14R
Sinbar																		
Spin-aid					60R													
Spur		2R			30R	30R	30R	30R					30R	30R				
Stinger[3]					30R	30R	30R	30R					30R	30R				
Touchdown products	7R[1]	7R[1]	R[2]	R[2]														
Postharvest																		
Gramoxone products [3]			R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]

[1] Nonselective—Do not allow spray or spray drift to contact crop.
[2] Nonselective—Apply before crop emergence or before transplanting.
[3] Labeled and recommended in certain states only (see description under crop).
[4] Transplanted ONLY
[5] Labeled for certain crops, varieties, or herbicide formulations ONLY.
R = Recommended, Blank = Not recommended, L = Labeled (Not recommended), Number = Minimum preharvest interval in days (for postemergence herbicides only)

table continued on next page

Table E-4. Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals (continued)

Herbicide	Muskmelons	Okra	Onions	Parsley	Parsnips	Peas	Peppers-transplanted	Potatoes	Pumpkins	Radishes, Rutabagas, Turnips	Spinach	Strawberries	Summer Squash	Sweet Corn	Sweet Potatoes	Tomatoes-transplanted	Watermelons	Winter Squash
Postemergence																		
2,4-D												R		0R				
Accent Q														R[3]				
Aim									0R				0R	R				0R
Assure II/Targa						30R												
Atrazine														21R				
Banvel																		
Basagran						0R								0R				
Buctril			R															
Callisto														45R				
Caparol				40R														
Fusilade DX			45R												55R			
glyphosate products																		
Goal/GoalTender[5]			60R															
gramoxone products [1]		R[1,2,3]					0R[1]		0R[1,3]			21R[1]	0R[1,3]	0R[1]		0R[1]	R[2]	
Impact														45R				
Laudis														R				
Lorox																		
Matrix								60R								45R		
Metribuzin								60R								7R		
Poast	14R		30R	15R		R	20R	30R	14R		15R	7R	14R		30R	20R	14R	14R
Pursuit						0R												
Raptor																		
Reflex																		
Sandea	57R								30R							30R		30R
Select Max	14R		45R	14R	30R	21R	20R	30R	14R	15R	14R	4R	14R		30R	20R	14R	14R
Sinbar												120R						
Spin-aid											40R							
Spur												NY						
Stinger[3]												30R						
Touchdown products										30R	21R	30R		30R				
Postharvest																		
Gramoxone products [3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]	R[3]

[1] Nonselective—Do not allow spray or spray drift to contact crop.
[2] Nonselective—Apply before crop emergence or before transplanting.
[3] Labeled and recommended in certain states only (see description under crop).
[4] Transplanted ONLY
[5] Labeled for certain crops, varieties, or herbicide formulations ONLY.
R = Recommended, Blank = Not recommended, L = Labeled (Not recommended), Number = Minimum preharvest interval in days (for postemergence herbicides only)

Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1]

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucum-ber	Musk-melon	Onion	Pea
2,4-D	3	3	3	3	3	NR	NR	3	3	3	3
Accent Q	12	4	1[2]	10[2]	10[2]	NR	10[5]	10[2]	10	10[5]	10[2]
Aim	1	12	1	1	1	NR	1	1	1	1	1
Anthem	18	18	18	18	18	0	0	18	18	18	18
Anthem ATZ	18	18	18	18	18	0	0	18	18	18	18
Armezon	9	3	18	18	18	NR	NR	18	18	18	9
Assure II/Targa	4	4	4	NR	4	4	4	4	4	4	NR
Atrazine	SY	SY	SY	SY	SY	NR	NR	SY	SY	SY	SY
Authority Elite	12	4 ½	12	12	2	10	18	12	12	12	12
Authority MTZ	12	4	18	18	18	10	18	18	18	18	18
Authority XL	18	4	36	36	18	18	18	18	36	36	36
Autumn	18	4	18	18	18	1	3	18	18	18	18
Axial	4	0	4	4	1	4	4	4	4	1	4
Axiom	NY	NY	NY	NY	NY	NR	NY	NY	NY	NY	NY
Balance	10	6	18	18	18	NR	6	18	18	18	18
Balance Flex/Pro	10	6	18	18	18	0	6	18	18	18	18
Banvel	AH	1[3]	AH	AH	AH	NR	AH	AH	AH	AH	AH
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis	10	4	18	10	18	NR	10	18	18	18	10
Beacon	8	3	18	8	18	0.5d	8	18	18	18	8
Beyond	3	9	NR	NR	9	8.5	8.5	9	9	9	NR
Boundary	4.5	4.5	12	12	12	8	12	12	12	18	12
Breakfree	NY	NY	NI	NI	NI	0	0	NI	NI	NI	NI
Buctril	1	1	1	1	1	1	1	1	1	1	1
Callisto	10	4	18	18	18	NR	NR	18	18	18	18
Cadet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Canopy	10	4	30	12	18	10	18	18	30	30	12
Canopy EX	12	4	12	12	18	10	18	18	30	18	12
Caparol	12	12	12	12	5	5	5	12	12	8	5
Capreno	18	10	18	18	18	0	10	18	18	18	18
Chateau	12	4	12	4	12	1	4	12	12	12	4
Cimarron Plus	B	10	B	B	B	B	B	B	B	B	B
Clarity	3	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH
Classic[5]	12	3	30	9	18	9	18	18	30	30	9
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Command[5]	16	12	16	9	12	9	9	9	9	16	NR
Corvus	17	9	17	17	17	0	9	17	17	17	17
Curbit	NR	NR	AH	NR	NR	NR	NR	NR	NR	AH	NR
Dacthal	8	8	8	AH	NR	8	8	8	8	NR	8
Define	12	12	12	12	4	NR	NR	12	12	12	12
Degree	SY	SY	SY	SY	SY	NR	NY	SY	SY	SY	SY
Devrinol	12	12	12	12	NR	12	12	12	12	12	12

[1]AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION

[2] 18 Months with a soil pH ≥ 6.5

[3] 20 Days per pint

[4] 30 Days per pint

[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

[6] Transplanted

[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.

[8] See current 2,4-D label

table continued on next page

Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Pepper	Potato	Pumpkin	Rye, winter	Soybean	Sorghum, grain	Squash	Tomato	Water-melon	Wheat, winter
2,4-D	3	3	3	3	.25-1[8]	3	3	3	3	3
Accent Q	10[2]	10[2]	10[2]	4	0.5	10	10	10[2]	10	4
Aim	1	1	1	12	1	1	1	1	1	1
Anthem	18	18	18	18	18	18	18	18	18	18
Anthem ATZ	18	18	18	18	18	18	18	18	18	18
Armezon	18	9	18	3	18	9	18	18	18	3
Assure II/Targa	4	4	4	4	NR	4	4	4	4	4
Atrazine	SY	SY	SY	12	SY	NR	SY	SY	SY	SY
Authority Elite	12	4	12	4 ½	0	10	12	4	12	4 ½
Authority MTZ	18	12	18	18	4	18	18	18	18	4
Authority XL	36	36	18	4	NR	18	36	18	18	4
Autumn	18	18	18	4	3	9	18	18	18	4
Axial	4	4	4	4	4	4	4	4	4	0
Axiom	NY	1	NY	NY	NR	NY	NY	NY	NY	NY
Balance	18	6	18	18	6	6	18	18	18	4
Balance Flex/Pro	18	6	18	18	6	6	18	18	18	4
Banvel	AH	AH	AH	1[3]	1[4]	NR	AH	AH	AH	1[3]
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis	18	NR	18	4	10[7]	10	18	1	18	4
Beacon	18	18	18	3	8	8	18	18	18	3
Beyond	9	9	9	4	NR	9	9	9	9	3
Boundary	12	8	12	12	NR	12	12	12	12	4.5
Breakfree	NI	NY	NI	NY	NY	NY	NI	NI	NI	4
Buctril	1	1	1	1	1	1	1	1	1	1
Cadet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Callisto	18	18	18	4	10	10	18	18	18	4
Canopy	30	30	18	4	NR	12	30	10	18	4
Canopy EX	30	18	18	4	NR	12	30	10	18	4
Caparol	12	12	12	12	12	12	12	12	12	12
Capreno	18	18	18	18	10	10	18	18	18	4
Chateau	12	12	12	4	NR	1	12	12	12	2
Cimarron Plus	B	B	B	B	B	B	B	B	B	1
Clarity	AH	AH	AH	1[3]	1[4]	NR	AH	AH	AH	AH
Classic[5]	30	30	18	3	NR	9	30	9	18	3
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Command[5]	NR	9	NR	12	NR	9	NR	9[6]	9	12
Corvus	17	17	17	17	9	17	17	17	17	4
Curbit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Dacthal	8	8	8	8	8	8	8	8	8	8
Define	4	1	12	12	NR	12	12	12	12	12
Degree	SY	SY	SY	SY	NY	NY	SY	SY	SY	AH
Devrinol	NR	12	12	12	12	12	12	NR	12	12

[1]AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION
[2] 18 Months with a soil pH ≥ 6.5
[3] 20 Days per pint
[4] 30 Days per pint
[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.
[6] Transplanted
[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.
[8] See current 2,4-D label

table continued on next page

Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucum-ber	Musk-melon	Onion	Pea
Distinct	1	1	1	1	1	1	1	1	1	1	1
Dual Magnum	4	4.5	NR	NR	NY	NR	NR	12	12	12	NR
Envive	12	4	18	12	18	10	18	18	18	18	12
Eptam	0	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH
Eradicane	AH	AH	AH	AH	AH	NR	NR	AH	AH	AH	AH
Evik	NY	AH	NY	NY	NY	NY	NY	NY	NY	NY	NY
Extreme	4	9.5	NR	40	40	8.5	18	40	40	40	40
Fierce	18	18	18	18	18	1	18	18	18	12	18
Finesse Grass & Broadleaf	B	B	B	B	B	B	B	B	B	B	B
First Rate	9	30B	30B	30B	30B	9	9	30B	30B	30B	30B
Flexstar	18	4	10	10	18	10	10	18	18	18	10
Flexstar GT	18	4	18	NR	18	10[5]	10[5]	18	18	18	10
Fusilade DX/Fusion	2	2	NR	NR	NR	2	2	NR	NR	NR	NR
Galigan	2	10	2	2	2(NR[6])	10	10	2	2	2	2
glyphosate products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Goal/GoalTender	2	10	2	2	2(NR[6])	10	10	2	2	2	2
Gramoxone products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
GrazonNext HL	24[B]	12	24[B]	24[B]	24[B]	12	12	24[B]	24[B]	24[B]	24[B]
Harmony Extra SG	2	NR	2	2	2	2	2	2	2	2	2
Harmony SG	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Harness	SY	SY	SY	SY	SY	NR	NY	SY	SY	SY	SY
Huskie	4	1	1[B]	9	1[B]	1[B]	1[B]	1[B]	1[B]	1[B]	9
Impact	9	3	18	18	18	0	0	18	18	18	9
Instigate	10	4	18	18	18	0	10	18	18	18	18
Intrro	NY	NY	NI	NI	NI	NY	NY	NI	NI	NI	NI
Karmex	24	24	24	24	24	NY	24	24	24	24	24
Kerb[5]	0	12	5	5	7	5	5	7	7	7	12
Keystone NXT	15	15	18	18	18	0	NY	18	18	18	18
18	10	4	18	10	18	0	0	18	18	18	10
Liberty 280	6	2 1/3	6	6	2 1/3	NR	NR	6	6	2 1/3	6
Lexar EZ	18	NY	18	18	18	0	0	18	18	18	18
Lorox/Linex	4	4	4	4	4	NR	4	4	4	4	4
Lumax EZ	18	4 ½	18	18	18	0	0	18	18	18	18
Marvel	18	4	18	0	18	10	18	18	18	18	10
Matrix	12	12	10	10	12	NR	10	12	12	12	12
Maverick	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]
Metribuzin	4	4	18	18	18	4	18	18	18	18	8
Milestone	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B
Osprey	10	1	10	10	10	12	12	10	10	10	3
Outlook	NY	4	NY	NY	NY	NR	NY	NY	NY	NY	NY
Outrider	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]	3[B]
Overdrive	1	1	1	1	1	1	1	1	1	1	1

[1]AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION

[2] 18 Months with a soil pH ≥ 6.5

[3] 20 Days per pint

[4] 30 Days per pint

[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

[6] Transplanted

[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.

[8] See current 2,4-D label

table continued on next page

Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Pepper	Potato	Pumpkin	Rye, winter	Soybean	Sorghum, grain	Squash	Tomato	Water-melon	Wheat, winter
Distinct	1	1	1	1	1	1	1	1	1	1
Dual Magnum	12	NR	12	4.5	NR	NR	12	6	12	4.5
Envive	18	18	18	4	0	10	18	12	18	4
Eptam	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH
Eradicane	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Evik	NY	NY	NY	AH	NY	NY	NY	NY	NY	AH
Extreme	40	26	40	4	NR	18	40	40	40	4
Fierce	18	4	18	18	0	18	18	18	18	4
Finesse Grass & Broadleaf	B	B	B	B	B	B	B	B	B	4
First Rate	30B	30B	30B	30B	NR	9	30B	30B	30B	3
Flexstar	18	18	18	4	10	18	18	18	18	4
Flexstar GT	18	18	18	4	NR	18[5]	18	18	18	4
Fusilade DX/Fusion	NR	NR	NR	2	NR	2	NR	NR	NR	2
Galigan	2	2	2	10	NR	10	2	2	2	10
glyphosate products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Goal/GoalTender	2	2	2	10	NR	10	2	2	2	10
Gramoxone products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
GrazonNext HL	24[B]	24[B]	24[B]	12	24[B]	24[B]	24[B]	24[B]	24[B]	12
Harmony Extra SG	2	2	2	2	2	2	2	2	2	NR
Harmony SG	1.5	1.5	1.5	1.5	NR	1.5	1.5	1.5	1.5	1.5
Harness	SY	SY	SY	SY	NY	SY	SY	SY	SY	AH
Huskie	1[B]	9	1[B]	1	4	4	1[B]	1[B]	1[B]	1
Impact	18	9	18	3	9	9	18	18	18	3
Instigate	18	10	18	4	10	10	18	18	18	4
Intrro	NI	NI	NI	NI	NY	NY	NI	NI	NI	NY
Karmex	24	24	24	24	24	NY	24	24	24	12
Kerb[5]	12	12	7	12	5	5	7	7	7	12
Keystone NXT	18	15	18	15	NY	NY	18	18	18	15
Laudis	--	10	18	4	8	10	18	10	18	4
Lexar EZ	18	18	18	NY	NY	NY	18	18	18	NY
Liberty 280	6	2 1/3	6	2 1/3	NR	6	6	6	6	2 1/3
Lightning	40B	26	40B	4	9	18	40B	40B	40B	4
Lorox/Linex	4	NR	4	4	NR	4	4	4	4	4
Lumax EZ	18	18	18	4 ½	NY	NY	18	18	18	4 ½
Marvel	18	0	18	4	0	18	18	18	18	4
Matrix	12	NR	12	12	10	12	12	1	12	4
Maverick	3[B]	3[B]	3[B]	3[B]	12[B]	3[B]	3[B]	3[B]	3[B]	NR
Metribuzin	18	12	18	18	4	18	18	4	18	4
Milestone	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B
Osprey	10	10	10	10	3	10	10	10	10	0.25
Outlook	NY	NY	NY	4	NR	NY	NY	NY	NY	4
Outrider	3[B]	3[B]	3[B]	3[B]	12[B]	3[B]	3[B]	3[B]	3[B]	NR
Overdrive	1	1	1	1	1	1	1	1	1	1

[1]AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION

[2] 18 Months with a soil pH ≥ 6.5

[3] 20 Days per pint

[4] 30 Days per pint

[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

[6] Transplanted

[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.

[8] See current 2,4-D label

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Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucumber	Muskmelon	Onion	Pea
Paramount	24B	10	24B	24B	24B	10	10	24B	24B	24B	24B
Paraquat products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PastureGard	1	0	NI	NI	NI	NI	NI	NI	NI	NI	NI
Peak	22	0	22	10	22	1	10	22	22	22	10
Permit	9	2	9	9	15	1	3	9	9	18	9
Permit Plus	9	2	--	1.5	15	1[7]	3	9	9	18	9
Poast	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR	NR
Powerflex HL	9	9	12	12	12	9	9	12	12	12	9
Prefar	4	4	4	4	NR	4	4	NR	NR	NR	4
Prequel	10[5]	18	18	10	18	0	10	18	18	18	18
Princep	SY	SY	SY	SY	SY	NR	NR	SY	SY	SY	SY
Prowl H_2O	NY	4	NR	NR	NY	NY	NY	NY	NY	NY	NY
Pulsar	9	22D	12	12	12	NR	4	12	12	12	9
Pursuit[5]	4	9.5	NR	2	40B	8.5[7]	18	40B	40B	40B	NR
Raptor	3	18	NR	NR	9	8.5[7]	8.5	9	9	9	NR
Reflex	18	4	10	10	18	10	18	18	18	18	10
Realm Q	10	9	18	18	18	NR	10	18	18	18	18
Rely 280	6	2 1/3	6	6	2 1/3	NR	NR	6	6	2 1/3	6
Remedy Ultra	12	12	12	12	12	12	12	12	12	12	12
Resolve	18	9	18	10	18	NR	10	10	18	18	18
Resolve Q	18	18	18	10[5]	18	NR	10[5]	10[5]	18	18	18
Resource	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sandea	9	2	NR	NR	15	1	3	NR	NR	18	9
Select/Select Max	NR	1	1	1	1	1	1	1	1	NR	1
Sharpen 2.85 SC	9	3	9	9	9	NR	9	9	9	9	9
Sierra[5]	24[B]	9	24[B]	24[B]	24[B]	11	24[B]	24[B]	24[B]	24[B]	11
Sinbar	24	24	24	24	24	24	24	24	24	24	24
Solicam	B	B	B	B	B	B	B	B	B	B	B
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sonic/Authority First	12	12	30B	30B	30B	10	18	30B	30B	30B	12
Spartan 4F	12	4	0	12	0	10	18	12	12	12	12
Spartan Advance	12	4	NR	12B	NR[6]	4	12	12B	12B	12B	12B
Spartan Charge	12	4	12B	12B	NR[6]	4	12	12B	12B	12B	12B
Spin-aid	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Spur	10.5	NR	18	18	NR	NR	NR	18	18	10.5	18
Starane Ultra	4	NR	4	4	4	NR	NR	4	4	4	4
Status	1	1	4	4	4	0.25	0.25	4	4	4	4
Steadfast/Steadfast Q	10[5]	4	18	10[5]	18	NR	10[5]	18	18	18	10[5]

[1] AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION
[2] 18 Months with a soil pH ≥ 6.5
[3] 20 Days per pint
[4] 30 Days per pint
[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.
[6] Transplanted
[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.
[8] See current 2,4-D label

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Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Pepper	Potato	Pumpkin	Rye, winter	Soybean	Sorghum, grain	Squash	Tomato	Water-melon	Wheat, winter
Paramount	24B	24B	24B	10	24B	0	24B	24B	24B	0
Paraquat products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PastureGard	NI	NI	NI	NI	NI	NI	NI	NI	NI	0
Peak	--	22	22	0	10	1	22	22	22	0
Permit	10	9	9	2	9	2	9	8	9	2
Permit Plus	10	9	9	2	9[7]	2	9	8	--	2[7]
Poast	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR
Powerflex HL	12	9	12	12	5	9	12	12	12	1
Prefar	NR	4	NR	4	4	4	NR	NR	NR	4
Prequel	18	6	18	18	10	10	18	18	18	4
Princep	SY	SY	SY	SY	SY	SY	SY	SY	SY	SY
Prowl H_2O	NY	NR	NY	NY	NR	NY	NY	NY	NY	4
Pulsar	12	9	12	12	9	4	12	12	12	22D
Pursuit[5]	40B	26	40B	4	NR	18	40B	40B	40B	4[7]
Raptor	9	18	9	4	NR	9	9	9	9	3[7]
Reflex	18	18	18	4	10	18	18	18	18	4
Realm Q	18	10	18	18	10	10	18	18	18	4
Rely 280	6	2 1/3	6	2 1/3	NR	6	6	6	6	2 1/3
Remedy Ultra	12	12	12	12	12	12	12	12	12	12
Resolve	18	NR	18	18	10	18	18	1	18	3
Resolve Q	18	1.5	18	18	10[5]	18	18	1.5	18	3[5]
Resource	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sandea	10	9	NR	2	9	2	NR	NR	NR	2
Select/Select Max	1	1	1	1	1	1	1	NR	1	1
Sharpen 2.85 SC	9	9	9	9	6	1	9	9	9	3
Sierra[5]	24[B]	9	24[B]	24[B]	9	24[B]	24[B]	24[B]	24[B]	NR
Sinbar	24	24	24	24	24	24	24	24	24	24
Solicam	B	B	B	B	B	B	B	B	B	B
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sonic/Authority First	30B	18	30B	12	NR	12	30B	30B	30B	4
Spartan 4F	12	12	12	4	0	18	12	12	12	4
Spartan Advance	12B	4	12B	4	NR	18	12B	12B	12B	4
Spartan Charge	12B	4	12B	4	NR	18	12B	12B	12B	4
Spin-aid	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Spur	18	18	18	NR	10.5	10.5	18	18	18	NR
Starane Ultra	4	4	4	NR	4	NR	4	4	4	NR
Status	4	4	4	1	1	1	4	4	4	1
Steadfast/Steadfast Q	18	10[5]	18	4	0.5	18[5]	18	18	18	4

[1] AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION
[2] 18 Months with a soil pH ≥ 6.5
[3] 20 Days per pint
[4] 30 Days per pint
[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.
[6] Transplanted
[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.
[8] See current 2,4-D label

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Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucum-ber	Musk-melon	Onion	Pea
Stinger	10.5	NR	18	18	NR	NR	NR	18	18	10.5	18
Synchrony XP[5]	12	3	9	9	18	9	18	18	30	30	9
Targa	4	0	0	0	6	4	4	4	4	4	0
Touchdown products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Treflan	NR	NR	NR	NR	NR	5	5	NR	5	5	NR
Ultra Blazer	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Valor	12	4	12	12	12	2	4	12	12	12	12
Valor XLT	12[5]	4	18[5]	12[5]	18[5]	10[5]	18[5]	18[5]	18[5]	18[5]	12[5]
Verdict	NY	4	NY	NY	NY	NR	NY	NY	NY	NY	NY
Vida	1	1	1	1	1	0	1	1	1	1	1
Warrant	9	NY	NI	NI	NI	NI	NY	NI	NI	NI	NI
Yukon	9	2	NI	2	15	1	3	9	9	18	9
Zemax	18	4.5	18	18	18	0	0	18	18	18	18
Zidua	18	18	18	18	18	NR	NR	18	18	18	18

[1]AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION
[2] 18 Months with a soil pH ≥ 6.5
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[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.
[6] Transplanted
[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.
[8] See current 2,4-D label

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Table E-5. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop[1] (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Pepper	Potato	Pumpkin	Rye, winter	Soybean	Sorghum, grain	Squash	Tomato	Water-melon	Wheat, winter
Stinger	18	18	18	NR	10.5	10.5	18	18	18	NR
Synchrony XP[5]	30	30	18	3	NR	9	30	9	18	3
Targa	4	4	4	4	0	4	4	4	4	0
Touchdown products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Treflan	NR[6]	NR	5	NR	NR	5	5	NR[6]	5	NR
Ultra Blazer	AH	18	AH	AH	AH	AH	AH	AH	AH	AH
Valor	12	12	12	4	NR	2	12	12	12	2
Valor XLT	18[5]	18[5]	18[5]	4	0	10[5]	18[5]	12[5]	18[5]	4
Verdict	NY	NY	NY	4	4	NR	NY	NY	NY	4
Vida	1	0	1	1	0	1	1	1	1	0
Warrant	NI	NY	NI	NI	0	NY	NI	NI	NI	4
Yukon	10	9	9	2	9	2	9	2	9	2
Zemax	18	NY	18	4.5	NY	0	18	18	18	4.5
Zidua	18	18	18	18	18	18	18	18	18	18

[1] AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION

[2] 18 Months with a soil pH ≥ 6.5

[3] 20 Days per pint

[4] 30 Days per pint

[5] Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

[6] Transplanted

[7] See label for alternative replant restrictions for certain GMO (genetically modified) varieties.

[8] See current 2,4-D label

Table E-6. Guide to Prepackaged Mixes

Brand Name	Mixture	Formula	Manufacturer
Anthem 2.15SE	Cadet + pyroxsulfone	0.063 +2.09 lb/gal	FMC
Anthem ATZ 4.505 SE	Atrazine + Cadet+ pyroxsulfone	4 + 0.014 + 0.485 lb/gal	FMC
Authority Assist 4L	Authority + Pursuit	3.33 + 0.67 lb/gal	FMC
Authority Elite 7L	Authority + Dual	0.7 + 6.3 lb/gal	FMC
Authority First 70DF	Authority + Firstrate	0.62 + 0.08 lb ai/lb prod.	FMC
Authority Maxx 66DF	Authority + Classic	15.1:1 ratio or 0.62 + 0.041 lb/gal	FMC
Authority MTZ 45 DF	Authority + metribuzin	1:1.5 ratio	FMC
Authority XL 70DF	Authority + Classic	0.62 + 0308 lb ai/lb	FMC
Axial Star	Axial + Starane	0342 + 03.73 lb/gal	Syngenta
Axiom 68DF	Define+metribuzin	4:1 ratio	Bayer
Basis Blend	Harmony SG+ Matrix	1:2 ratio	DuPont
Bicep Lite II Magnum 6L	Dual II Magnum+atrazine	3.33+2.67 lb/gal	Syngenta
Bicep II Magnum 5.5L	Dual II magnum+atrazine	2.4+3.1 lb/gal	Syngenta
Boundary 6.5L	Dual II Magnum+metribuzin	5.25+1.25 lb/gal	Syngenta
Callisto GT 4.18EC	Callisto + Touchdown	0.38 + 3.8 lb/gal	Syngenta
Canopy 75 DG	Lexone+Classic	6:1 ratio	DuPont
Canopy EX 29.5 WDG	Classic+Express	3.33:1 ratio	DuPont
Capreno 3.45SC	Laudis + Thiencarbazone-methyl	2.88 + 0.57 lb/gal	Bayer
Cimarron Plus 63DF	metsulfuron methyl+ Glean	3.2:1 ratio	DuPont
Cinch ATZ 5.5L	Atrazine + Dual	3.1 + 2.4	DuPont
Corvus 2.63SC	Balance Flex + Thiencarbazone-methyl	1.88 + 0.75 lb/gal	Bayer
Crossbow 3.0L	Remedy+2, 4-D	1.0+2.0 lb/gal	Dow AgroScience
Degree Xtra 4EC	Harness+atrazine	2.7+1.34 lb/gal	Monsanto
Distinct 70 DF	Banvel/Clarity+diflufenzopyr	2.5:1 ratio	BASF
Envive 41.3DG	Classic + Valor + Harmony	0.092+0.292+0.029lb ai/lb	DuPont
Extreme 2.17 EC	Pursuit+ glyphosate	0.17 + 2.0 lb/gal	BASF
Fierce 76WDG	Valor + Zidua	1:1.29 ratio	Valent
Finesse 75 DF	Glean + Ally	5:1 ratio	DuPont
ForeFront HL 3.74EC	Milestone + 2,4-D	0.41 + 3.33 lb/gal	Dow AgroScience
Fultime 4 EC	Topnotch + atrazine	2.4 + 1.6 lb/gal	Dow AgroScience
Fusion 2.56 EC	Fusilade + Whip	2.0 + 0.56 lb/gal	Syngenta
Gangster (copack)	Valor + Firstrate	1:1.65 ratio	Valent
Guardsman Max 5L	Outlook + atrazine	3.3 + 1.7 lb/gal	BASF
G-Max Lite	Outlook + atrazine	2.25 + 2.75 lb/gal	BASF
Halex GT 4.38EC	Dual II Magnum + glyphosate + Callisto	2.1 + 2.1 + .21 lb/gal	Syngenta
Harness Xtra 5.6L	Harness + atrazine	3.1 + 2.5 lb/gal	Monsanto
Harmony Extra SG 50 SG	Harmony SG + Express	2:1 ratio	DuPont
Hornet 78.5 WDG	Python + Stinger	1:3.25 ratio	Syngenta+Dow AgroScience
Huskie 2.06 EC	Buctril + pyrasulfotole	1.75 + 0.31 lb/gal	Bayer
Instigate 45.8 WDG	Callisto + Resolve	10:1 ratio	DuPont
Keystone LA NXT 6L	acetochlor + atrazine	4.3 + 1.7 lb/gal	Dow
Keystone NXT 5.6L	acetochlor + atrazine	3.1 + 2.5 lb/gal	Dow
Lexar/Lexar EZ 3.7 SC	atrazine + Dual II Magnum + Callisto	1.74 +1.74 + 0.22 lb/gal	Syngenta
Lumax 3.95 S	atrazine + Dual II Magnum + Callisto	1.0 + 2.68 + 0.268 lb/gal	Syngenta
Marksman3.2 L	Banvel/Clarity + atrazine	1.1 + 2.1 lb/gal	BASF
Northstar 47.4 DG	Beacon + Banvel/Clarity	1:5.9 ratio	Syngenta
Olympus Flex 11.25 WDG	Olympus + Osprey	.068 + .045 lb ai/lb	Bayer
Op-Till 68WG	Saflufenacil + Pursuit	0.178 + 0.502 lb ai/lb	BASF
PastureGard HL 4L	Remedy + Vista	3.0 + 1.0 lb/gal	Dow AgroScience
Permit Plus 74WG	Permit + Harmony SG	0.66 + 0.08 lb ai/lb	Gowan
Prefix 5.29 EC	Dual II Magnum + Reflex	4.34 + 0.95lb/gal	Syngenta
Pulsar	Banvel + Starane + Starane Ultra	0.73 + 0.95 lb ai/lb	Syngenta

Table E-6. Guide to Prepackaged Mixes (continued)

Brand Name	Mixture	Formula	Manufacturer
Require Q	Resolve + Banvel	1:1.75 ratio	DuPont
Resolve Q 22.4 DF	Matrix + Harmony SG	4.6:1 ratio	DuPont
Sequence 5.25 SC	glyphosate + Dual II Magnum	2.25 + 3.0 lb/gal	Syngenta
Sonic 70 DF	Spartan + FirstRate	7.75:1 ratio	Dow AgroScience
Spartan Advance 4.6SC	Spartan + glyphosate	0.56 + 4.04 lb/gal	FMC
Spartan Charge 3.5SE	Spartan + Aim	3.15 + 0.35 lb/gal	FMC
Spirit 57 WDG	Beacon + Peak	3:1 ratio	Syngenta
Status 56 WG	Banvel/Clarity + diflufenzopyr	2.5:1 ratio	BASF
Steadfast ATZ 89 WDG	Accent + Matrix + atrazine	2.1:1:65.6 ratio	DuPont
Steadfast Q 75DF	Accent + Resolve	2:1 ratio	DuPont
Storm 4S	Basagran + Blazer	2.67 + 1.33 lb/gal	UPA
Strategy 2.1 EC	Command + Curbit	1.6 + 0.5 lb/gal	Loveland
SureStart 4.25SE	Harness + Python + Stinger	3.75 + 0.12 + 0.38 lb/gal	Dow
Synchrony XP 28.4 DF	Classic + Harmony SG	3.1:1 ratio	DuPont
TripleFLEX	Harness + Stinger + flumetsulam	3.75 + 0.38 + 0.12 lb/gal	Monsanto
Valor XLT 40 WDG	Valor + Classic	2.9:1 ratio	Valent
Verdict 5.57EC	Saflufenacil + Outlook	0.57 + 5.0 lb/gal	BASF
Yukon 67.5 WDG	Permit + Banvel	1:4.4 ratio	Monsanto
Zemax 3.67L	Callisto + Dual	0.33 + 3.34 lb/gal	Syngenta

Table E-7. Rain Free Requirement After Application of Postemergence Herbicides

Herbicide	Time (hrs)	Herbicide	Time (hrs)
Aim	1	Poast	1
Assure II/Targa	1	Pursuit	1
Atrazine	4	Roundup products	1-6
Banvel	2	Sandea	4
Basagran	8	Select Max	1
Buctril	1	Sencor	--
Fusilade DX	1	Spin-Aid	6
Gramoxone & Paraquat products	0	Touchdown	4
Laudis	1	2,4-D	6-8
Lorox	--		

Table E-8. Herbicide Site of Action for Reducing the Risk of Developing Herbicide-resistant Weeds

Reducing the risk for developing herbicide-resistant weed populations requires incorporating a number of guidelines in managing your fields. These guidelines include:

- Spray only when necessary
- Use alternative methods of control whenever possible such as mechanical cultivation or delayed planting (row crops), mowing (forage crops), and using weed-free crop seeds
- Rotate crops and their accompanying herbicides' site of action
- Limit number of applications of herbicide(s) with same site of action in a given growing season
- Use mixtures or sequential herbicide treatments having different sites of action that will control the weeds of concern
- Scout fields after herbicide application to detect weed escapes or shifts
- Clean equipment before leaving fields infested with or suspected to have resistant weeds

Rotating herbicides with differing sites of action is important for minimizing the risk of developing herbicide-resistant weeds. However, information on herbicide site of action is often not printed on herbicide labels and thus is difficult to obtain. The following tables are designed to assist with herbicide selection based on herbicide site of action.

Below (Table E-7A) is a list of important herbicide groups for agronomic crops grown in the Mid-Atlantic region. To reduce the risk of developing herbicide resistant weeds, avoid repeated use of herbicides with the same site of action. Note that more than one herbicide family may have the same site of action.

A list of common pre-package herbicide mixture and their components is contained in Table E-7B. Be sure to know the site of action for all the herbicides included in the pre-package mixture.

Table E-8A. Important Herbicide Groups for Corn, Soybean, Small Grain, Commercial Vegetable and Forage.

Trade Name	Active Ingredient	HRAC Group[1]	Family	Herbicide Class	Site of Action
2,4-D	2-4-D	4	Phenoxy	Plant growth regulators	IAA-like
Accent Q	nicosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Acclaim Extra	fenoxaprop	1	aryloxyphenoxy propionates	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
Aim	carfentrazone	14	Triazolinone	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Ally	metsulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Arsenal	imazapyr	2	Imidazolinone	Amino acid biosynthesis	ALS-enzyme
Assure II	quizalofop	1	aryloxyphenoxy propionates	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
Atrazine	atrazine	5	Triazines	Photosynthesis inhibitors (mobile 1)	Photosystem II
Authority	sulfentrazone	14	Triazolinone	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Autumn	iodosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Axial XL	pinoxaden	1	Phenylpyrazolin	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
Balan	benefin	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Banvel	dicamba	4	benzoic acid	Plant growth regulators	IAA-like
Barricade	prodiamine	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors

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Table E-8A. Important Herbicide Groups for Corn, Soybean, Small Grain, Commercial Vegetable and Forage. *(cont'd)*

Trade Name	Active Ingredient	HRAC Group[1]	Family	Herbicide Class	Site of Action
Basagran	bentazon	6	Benzothiadiazole	Photosynthesis inhibitors (non-mobile)	Photosystem II
Beacon	primisulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Beyond	imazamox	2	Imidazolinone	Amino acid biosynthesis	ALS-enzyme
Blazer Ultra	acifluorfen	14	diphenyl ethers	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Breakfree	acetochlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Buctril	bromoxynil	6	Nitriles	Photosynthesis inhibitors (non-mobile)	Photosystem II
Butyrac	2,4-DB	4	Phenoxy	Plant growth regulators	IAA-like
Cadet	fluthiacet	14	N-phenyl-phthalimides	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Callisto	mesotrione	27	Triketone	Pigment inhibitors	HPPD (hydroxy-phenyl-pyruvate-dioxygenase)
Chateau	flumioxazin	14	N-phenyl-phthalimides	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Cinch	metolachlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Clarity	dicamba	4	benzoic acid	Plant growth regulators	IAA-like
Classic	chlorimuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Cobra	lactofen	14	diphenyl ethers	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Command	clomazone	13	Isoxazolidinone	Pigment inhibitors	Diterpenes (carotenoid biosynthesis)
Curbit	ethalfluralin	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Dacthal	DCPA	3	None	Seedling growth inhibitors (Root)	Unknown
Degree	acetochlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Devrinol	napropamide	15	Acetamides	Seedling growth inhibitors (Shoot)	Unknown
Dimension	dithiopyr	3	Pyridazines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Distinct	diflufenzopyr	19	Semicarbazone	Auxin transport inhibitor	IAA transport
Dual	metolachlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Eptam	EPTC	8	Thiocarbamates	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
Evik	ametryn	5	Triazines	Photosynthesis inhibitors (mobile 1)	Photosystem II
Express	tribenuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Facet	quinclorac	26	quinoline carboxylic acid	Cell wall biosynthesis inhibitor	Unknown
Finale	glufosinate	10	amino acid derivative	Phosphorylated amino acid (N metabolism disrupter)	Glutamine synthetase
FirstRate	cloransulam	2	triazolopyrimidine (sulfonamides)	Amino acid biosynthesis	ALS-enzyme

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Table E-8A. Important Herbicide Groups for Corn, Soybean, Small Grain, Commercial Vegetable and Forage. *(cont'd)*

Trade Name	Active Ingredient	HRAC Group[1]	Family	Herbicide Class	Site of Action
Flexstar	fomesafen	14	diphenyl ethers	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Formula 40	2-4-D	4	Phenoxy	Plant growth regulators	IAA-like
Fusilade	fluazifop	1	aryloxyphenoxy propionates	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
Gallery	isoxaben	21	Benzamide	Cell wall biosynthesis inhibitor	Cell wall synthesis - site B
Garlon	triclopyr	4	carboxylic acid (pyridines)	Plant growth regulators	IAA-like
Glean	chlorsulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Goal	oxyfluorfen	14	diphenyl ethers	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Goal Tender	oxyfluorfen	14	diphenyl ethers	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Gramoxone	paraquat	22	Bipyridyliums	Cell membrane disrupters	Photosystem I
Harmony SG	thifensulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Harness	acetochlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Impact	topramezone	27	Triketone	Pigment inhibitors	HPPD (hydroxy-phenyl-pyruvate-dioxygenase)
Intrro	alachlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Karmex	diuron	7	Ureas	Photosynthesis inhibitors (mobile 2)	Photosystem II
Kerb	pronamide	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Laudis	tembotrione	27	Triketone	Pigment inhibitors	HPPD (hydroxy-phenyl-pyruvate-dioxygenase)
Liberty	glufosinate	10	amino acid derivative	Phosphorylated amino acid (N metabolism disrupter)	Glutamine synthetase
Lorox	linuron	7	Ureas	Photosynthesis inhibitors (mobile 2)	Photosystem II
Maverick	sulfosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
MCPA	MCPA	4	Phenoxy	Plant growth regulators	IAA-like
Metribuzin	metribuzin	5	Triazinones	Photosynthesis inhibitors (mobile 1)	Photosystem II
Milestone	aminopyralid	4	carboxylic acid (pyridines)	Plant growth regulators	IAA-like
Milo Pro	propazine	5	Triazines	Photosynthesis inhibitors (mobile 1)	Photosystem II
Olympus	propoxycarbazone	2	sulfonylamino-carbonyl-triazolinones	Amino acid biosynthesis	ALS-enzyme
Osprey	mesosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Outlook	dimethenamid	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown

table continued next page

Table E-8A. Important Herbicide Groups for Corn, Soybean, Small Grain, Commercial Vegetable and Forage. *(cont'd)*

Trade Name	Active Ingredient	HRAC Group[1]	Family	Herbicide Class	Site of Action
Peak	prosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Pendulum	pendimethalin	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Permit	halosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Poast	sethoxydim	1	cyclohexanediones	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
PowerFlex	pyroxulam	2	Sulfonamide	Amino acid biosynthesis	ALS-enzyme
Pramitol	prometon	5	Triazines	Photosynthesis inhibitors (mobile 1)	Photosystem II
Prefar	bensulide	8	None	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
Pre-pare	flucarbazone	2	sulfonylamino-carbonyl-triazolinones	Amino acid biosynthesis	ALS-enzyme
Princep	simazine	5	Triazines	Photosynthesis inhibitors (mobile 1)	Photosystem II
Prowl	pendimethalin	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Pursuit	imazethapyr	2	Imidazolinone	Amino acid biosynthesis	ALS-enzyme
Python	flumetsulam	2	triazolopyrimidine (sulfonamides)	Amino acid biosynthesis	ALS-enzyme
Raptor	imazamox	2	Imidazolinone	Amino acid biosynthesis	ALS-enzyme
Reflex	fomesafen	14	diphenyl ethers	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Rely	glufosinate	10	amino acid derivative	Phosphorylated amino acid (N metabolism disrupter)	Glutamine synthetase
Remedy	triclopyr	4	carboxylic acid (pyridines)	Plant growth regulators	IAA-like
Resolve	rimsulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Resource	flumiclorac	14	N-phenyl-phthalimides	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Ro-Neet	cycloate	8	Thiocarbamates	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
Ronstar	oxadiazon	14	Oxadiazole	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Roundup	glyphosate	9	amino acid derivative	Amino acid biosynthesis	EPSP-enzyme
Sandea	halosulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Select	clethodim	1	cyclohexanediones	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
Sierra	flucarbazone	2	Sulfonylamino	Amino acid biosynthesis	ALS-enzyme
Sinbar	terbacil	5	Uracils	Photosynthesis inhibitors (mobile 1)	Photosystem II

table continued next page

Table E-8A. Important Herbicide Groups for Corn, Soybean, Small Grain, Commercial Vegetable and Forage. *(cont'd)*

Trade Name	Active Ingredient	HRAC Group[1]	Family	Herbicide Class	Site of Action
Solicam	norflurazon	12	Pyridazinone	Pigment inhibitors	PDS (carotenoid biosynthesis)
Sonalan	ethalfluralin	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Spartan	sulfentrazone	14	Triazolinone	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Spike	tebuthiuron	7	Ureas	Photosynthesis inhibitors (mobile 2)	Photosystem II
Starane Ultra	fluroxypyr	4	carboxylic acid (pyridines)	Plant growth regulators	IAA-like
Stinger	clopyralid	4	carboxylic acid (pyridines)	Plant growth regulators	IAA-like
Targa	quizalofop	1	aryloxyphenoxy propionates	Fatty acid (Lipid) biosynthesis inhibitors	ACCase
Telar	chlorsulfuron	2	Sulfonylurea	Amino acid biosynthesis	ALS-enzyme
Topnotch	acetochlor	15	Chloroacetamides	Seedling growth inhibitors (Shoot)	Unknown
Tordon	picloram	4	carboxylic acid (pyridines)	Plant growth regulators	IAA-like
Touchdown	glyphosate	9	amino acid derivative	Amino acid biosynthesis	EPSP-enzyme
Treflan	trifluralin	3	Dinitroanilines	Seedling growth inhibitors (Root)	Microtubule inhibitors
Valor	flumioxazin	14	N-phenyl-phthalimides	Cell membrane disrupters	PPO (protoporphyr-ingogen oxidase)
Velpar	hexazinone	5	Triazinones	Photosynthesis inhibitors (mobile 1)	Photosystem II
Vernam	vernolate	8	Thiocarbamates	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
WEEDAR 64	2-4-D	4	Phenoxy	Plant growth regulators	IAA-like
Zidua	pyroxasulfone	15		Seedling shoot inhibitor	Mitosis inhibitor

[1]Herbicide Resistance Action Committee (HRAC) is a system of classifying herbicides developed by the Weed Science Society of America, based on mode and site of actions, to help understand and plan for resistance management. The reference for this table is: E. James Retzinger and Carol Mallory-Smith. 1997. Classification of Herbicides by Site of Action for Weed Resistance Management Strategies. Weed Technology volume 11, pages 384 to 393.

Table E-8B: **Common pre-pack or premix herbicides for crops in the Mid-Atlantic region. The WSSA mode of action (MOA) numbers are the WSSA group numbers (right-hand column of Table A) for herbicide site of action.**

Pre-packaged herbicide	Constituent products	HRAC Group(s)	Pre-packaged herbicide	Constituent products	HRAC Group(s)
Anthem	Cadet + pyroxsulfone	14 +15	Harmony Extra	Harmony SG, Express	2, 2
Anthem ATZ	atrazine + Cadet + pyroxsulfone	5 + 14 + 15	Harness Xtra	Harness, atrazine	15, 5
Authority Assist	Authority, Pursuit	14, 2	Hornet WDG	Python, Stinger	2, 4
Authority Elite	Authority + Dual	14 + 15	Huskie	Buctril + pyrosulfotole	6 + 27
Authority First	Authority, FirstRate	14, 2	Instigate	Callisto + Resolve	27 + 2
Authority Maxx	Authority + Classic	14 + 2	Keystone NXT	Harness, atrazine	15, 5
Authority MTZ	Authority, Sencor	14, 5	Lexar EZ	Dual, Callisto, atrazine	15, 27, 5
Authority XL	Authority + Classic	14, 2	Lumax EZ	Dual, Callisto, atrazine	15, 27, 5
Axial Star	Axial + Starane	1, 4	Marksman	Banvel, atrazine	4, 5
Axiom	Define, Sencor	15, 5	Milestone VM Plus	Milestone, Remedy Ultra	4, 4
Basis Blend	Resolve, Harmony SG	2, 2	NorthStar	Banvel, Beacon	4, 2
Bicep II Magnum	Dual, atrazine	15, 5	Olympus Flex	Olympus, Osprey	2, 2
Boundary	Dual, Sencor	15, 5	Permit Plus	Permit + Harmony SG	2, 2
Breakfree ATZ	Breakfree, atrazine	15, 5	Prefix	Dual, Reflex	15, 14
Callisto GT	Callisto + Touchdown	29 + 9	Pulsar	Banvel+Starene	4, 4
Canopy	Classic, Sencor	2, 5	Require Q	Resolve, Banvel	2, 4
Canopy EX	Classic, Express	2, 2	Resolve Q	Resolve, Harmony SG	2, 2
Capreno	Thiencarbazone, Laudis	2, 27	Sequence	Dual, glyphosate	15, 9
Cimarron Max	metsulfuron, Banvel, 2,4-D	2, 4, 4	Sonic	Authority, FirstRate	14, 2
Cimarron Plus	metsulfuron, Telar	2, 2	Spartan Advance	Spartan+glyphosate	14, 9
Cinch ATZ	atrazine + Dual	5 + 15	Spartan Charge	Aim + Spartan	14 + 14
Corvus	Balance Flexx + thiencarbazone-methyl	27 + 2	Spirit	Peak, Beacon	2, 2
Crossbow	Remedy, 2,4-D	4, 4	Status	Banvel, diflufenzopyr	4, 19
Degree Xtra	Degree, atrazine	15, 5	Steadfast Q	Accent, Resolve	2, 2
Distinct	Banvel, diflufenzopyr	4, 19	Steadfast ATZ	Accent, Resolve, atrazine	2, 2, 5
Envive	Classic, Harmony SG, Valor	2, 2, 14	Storm	Basagran, Blazer	6, 14
Extreme	Pursuit, glyphosate	2, 9	Strategy	Command, Curbit	13, 3
Fierce	Valor + Zidua	14, 15	SureStart	Harness, Python, Stinger	15, 2, 4
Finesse	Glean, Ally	2, 2	Synchrony XP	Classic, Harmony SG	2, 2
Fultime	Topnotch, atrazine	15, 5	TripleFlexx	Harness + Python + Stinger	15 + 2 + 4
Fusion	Fusilade, fenoxaprop	1, 1	Valor XLT	Valor SX, Classic	14, 2
Gangster	Valor SX, FirstRate	14, 2	Verdict	Outlook + Sharpen	14 + 15
Guardsman Max	Outlook, atrazine	15, 5	Yukon	Sandea, Banvel	2, 4
Halex GT	Dual, Callisto, glyphosate	15, 27, 9	Zemax	Callisto + Dual	27 + 15

INSECT MANAGEMENT

Soil Pests-Detection and Control

Wireworms

Wireworms injure vegetable crops by killing seeds or seedlings and tunneling and scarring tubers, roots, bulbs and low-growing vegetable fruit in contact with soil. Fields may be infested with wireworms but severe crop injury may occur only occasionally. Nearly all crops are susceptible.

Detection. Injury to young plants or tubers frequently is sufficient evidence to warrant future control measures. Since there is no effective post-planting rescue treatment, the following methods are useful to detect the presence of wireworms before planting.

Method 1

A technique using baits has been developed for evaluating wireworm potential before planting. The bait stations should be established 2 to 3 weeks before the anticipated planting date. Fields where small grain or grasses have been grown the preceding 2 or 3 years are the best candidates for bait stations.

Since wireworm infestations are often localized within a field, it will be necessary to place the bait stations randomly throughout the field. One bait station per acre is desirable. Place two bait stations at the highest elevation in a field, two on a slope, and two in the lowest area.

Follow this procedure for baiting:

1. Mix 1 cup of untreated wheat or rolled oats and 1 cup of untreated shelled corn at each station
2. Bury the bait about 2 inches deep (if buried too deeply the grain will rot). Cover the ground over each bait station with an 18-inch square of black plastic. The plastic collects solar heat and speeds germination of the corn and wheat, enticing overwintering wireworms to respond.
3. Mark each station with a flag or stake.
4. Dig up the bait stations after 10 to 14 days and count the number of wireworms. For best results wait until the germinating grain has emerged before digging. Look for slender, reddish-brown insects that are ¼ inch to 1 inch long.

Method 2

1. Be sure the soil temperature at the 6-inch depth ranges between 45^{o} and 85^{o}F (7.22^{o} and 29.4^{o}C) and that soil moisture is equivalent to that desired for planting.
2. Collect soil samples from 20 scattered sites per acre. Each sample should represent a soil profile 12 inches deep and 6 inches in diameter. Sample sites should be near plant crowns.
3. Sift soil and count wireworms.

Control. If you find an average of 1 wireworm per bait station (Method 1) or if you find 5 or more wireworms in 20 soil samples (Method 2), a labeled soil insecticide should be used. In some instances, several wireworms may be found in one bait station and none in others. Wireworm infestations tend to concentrate in some locations. It may be possible to limit treatment to areas of the field where the concentration is heaviest. See individual crops for labeled insecticides.

When to apply. Insecticides can be applied either in the spring or fall when the soil temperature at the 6-inch depth is at least 50^{o}F (10^{o}C) and soil moisture is equivalent to that desired for planting. Frequently, the insecticide is applied immediately before planting. When early spring planting is contemplated, the fall treatment is suggested.

Cutworms

A number of cutworm species attack vegetable plants. Some attack the tuber, spear, or fruit by chewing the edible portion, rendering them unmarketable. Others attack the seedlings or transplants, killing them outright or causing them to be unproductive. Cutworms are attracted to lights and can lay eggs into transplants growing in greenhouses that are lighted at night. The cutworm eggs and larvae may be accidentally transferred to the field with the plants.

Most cutworms are night feeders and hide under sod clumps, stones, decaying vegetation, etc., during the day. Weedy or minimum-tillage fields are especially attractive egg-laying sites for cutworm adults (moths). During periods of drought, low-lying areas in fields are more subject to attack than other areas, presumably because of more desirable conditions.

Control. In all cases, consult the label for application details. Where cutworms are suspected, a broadcast incorporation treatment may be necessary, just before planting.

Even if a broadcast treatment is used, fields should be scouted for cutworm damage within a week of planting or plant emergence. If cutworms are actively cutting plants, a postplanting contact treatment may be necessary. The following procedures may help improve control when a contact insecticide treatment is used:

1. Direct sprays at the base of the plants where cutworms are actively feeding.
2. Increase the amount of water used to at least 30 gallons per acre, especially in dry weather.
3. Spray between midnight and 5 A.M., when cutworms are most active.
4. Cultivate after insecticide application to improve contact with cutworms, especially in dry weather.

Garden Centipedes (Symphylans)

Garden centipedes are arthropods that are related to insects. They feed on germinating seed and fibrous roots of many crop and noncrop plants, including practically all vegetable species, and on decaying plant material. They are often associated with moist, fine textured heavier soils and typically establish in spots or field edges. Rotation does not appear to be an effective control. If a spot becomes established, the crops planted into that area have a difficult time growing out of the damage, because the symphylans are continuously grazing on the fibrous roots. Spinach acts as very good host for this pest.

Detection. The first symptom is an area or patch of poorly developing plants, similar to other root problems. Check the soil in these areas so that treatment can be made before planting the next crop, as there is no practical postplanting control. A common practice is to flag off the spot and treat that area with soil insecticides in the following fall or spring. Soil solarization has not been an effective control. It is reasonable to assume that symphylans can be transported in soil on field equipment. Dig up the soil and look for small, slender (less than 0.25 inch) white centipede-like animals that move quickly and try to avoid light. Another method of sampling is to drop the soil into a bucket of water. The symphylans will float to the top.

Symphylans have 12 pairs of legs on 14 body segments. Do not confuse the symphylans with true centipedes--that eat other arthropods and are considered beneficial. Symphylans will have beaded antennae. Centipedes are not expected to be white in color and have large mandibles. Dry or cold (less than 45°F [7.22°C]) soil will reveal few, if any, symphylans. Control is warranted when there is an average of two symphylans per shovelful of soil.

When to treat. If samples are taken in the spring, control is generally warranted if there is an average of over two per shovelful of soil. Samples taken in September or October may average four or five per shovelful to warrant treatment before the next crop. Insecticides are generally applied before spring planting, and fumigant treatments are usually made in the fall. **Note**: Effectiveness of soil-applied insecticides decreases as soil temperature decreases below 55°F (12.8°C).

Grubs

Grubs are the larvae of various beetles and can be serious soil pests in vegetable crops. Most vegetables can be attacked, and serious problems have occurred in potatoes, sweet potatoes, beans, corn, spinach, and strawberries. Grubs cause damage by feeding on the roots and under-ground parts of the plant from one to several inches below the soil surface. The plants may yellow and wilt, which causes a patchy growth in fields where plants are dead or dying. If injured plants are pulled up, the roots will be found to have been eaten off, and usually the curve-bodied grub can be found in the soil.

Adult beetles lay eggs in the soil during June to July. As the soil cools in the fall, the grubs work their way deep into the soil and return to the surface the following spring. Depending on the insect, grubs may take from 1 to 3 years to become adults and may cause problems year after year.

Control. Grub damage is usually associated with grassy or weedy fields. Clean fields may help prevent serious grub damage. Problems may occur in crops planted to fields that were previously sod.

Maggots

Several species of maggots attack either the seed or roots of vegetables during the growing season. The adult of the maggot (a fly) fluctuates in abundance in different areas in different years. Since it is impossible to determine when and where maggots will attack and since nothing can be done once the injury is noted, preventive controls are good insurance before planting if you have previously had maggot problems.

Seed Maggot

Seed attacked by seed maggots usually fails to sprout or, if it does, it is weak or sickly. Newly transplanted plants are also susceptible to maggots that tunnel up through the stem causing the plant to wilt. Injury is most severe in wet, cold springs and on land rich in organic matter.

Control. Control may be achieved using seed treatments containing either chlorpyrifos (Lorsban 50W), clothianidin (Poncho 600), imidacloprid (Concur, Latitude, Gaucho 600), permethrin (Kernel Guard Supreme) or thiamethoxam (Cruiser 5FS). Seed treatments are available as hopper-box treatments or as commercially-treated seed. The level of control will depend on soil type, soil moisture, crop, weather conditions, and other factors.
Note: Not all materials are labeled for all vegetable crops. Refer to each specific crop section of this manual for listing of labeled seed treatments.

IMPORTANT: Do not use treated seed for food or feed

Root Maggot

Plant roots become riddled with maggot tunnels, and underground fleshy parts soon become rotten. Above ground, plants appear off-color, wilt, and seldom reach full growth.

Transplant water treatments, in-furrow treatments, preplant broadcast, and postplant treatments may be recommended depending on the crop. Refer to insecticide labels for labeled materials.

Slugs

Slugs are not insects, but are closely related to snails. All slugs require damp or humid surroundings for development and will avoid the drying effects of sun and wind. During the day, slugs seek shelter under protective debris. This is why weed control is a useful deterrent to any slug problem.

Control. Metaldehyde (Deadline M-Ps and Metaldehyde 3.5% and 7%) is an effective slug-control chemical, and commercial preparations are available at farm supply centers. ***Note: metaldehyde is currently under re-registration and some previously labeled crops are not on the new labels. Refer to current labels for labeled crops and use rates***
Iron phosphate granules (found in Sluggo and many other products) will also provide some control of slugs and snails.

Insect Resistance and Control

Resistance develops because intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to reproduce. Adopting the practices outlined below will help reduce the development of pest resistance.

a. Crop rotation to a nonhost crop reduces the need for pesticide treatment and, thus, reduces the ratio of resistant to susceptible individuals in the breeding population.

b. Spot treatment is an important practice. Early season insects are often concentrated in areas near their over wintering sites. Spot treating these areas, rather than the entire field, will reduce the resistance problem at a reduced cost.

c. Younger insect larvae are more susceptible and less likely to develop resistance, than are older crop pests. Control efforts should be concentrated against the early stages of development.

d. Do not overspray. Attempts to destroy every pest in the field by multiple applications or by using rates higher than labeled rates often eliminate the susceptible but not the resistant pests.The way pesticides are used affects the development of resistance. Insecticides within a specific chemical group usually share a common target site within the pest, and thus share a common Mode of Action (MoA). Resistance often develops based on a genetic modification of this target site. When this happens, the compound usually loses its pesticidal activity. Because all insecticides within the chemical grouping share a common MoA, there is a high risk that this resistance will automatically confer cross-resistance to all the compounds in that group. The MoA classification provides a guide to the selection of insecticides for an insecticide resistance management strategy. The MoA classification scheme below was developed and is endorsed by the Insecticide Resistance Action Committee (IRAC) to insure growers can effectively use insecticide alternations and rotations of insecticides with different modes of action. For more information, see the website www.irac-online.org/. Refer to Table E-10 for a listing of insecticides labeled for vegetables and the MoA group classification.

Table E-9. IRAC Group Numbers and Modes of Action

Group	Mode of Action
	Acetylcholine esterase inhibitors
1	GABA-gated chloride channel antagonists
2	Sodium channel modulators
3	Nicotinic acetylcholine receptor agonists/antagonists
4	Nicotinic acetylcholine receptor agonists
5	Chloride channel activators
6	Juvenile hormone mimics
9	Unknown (selective feeding blockers)
11	Microbial disruptors of midgut membranes
12	Inhibitors of oxidative phosphorylation
15	Chitin inhibitors
17	Moulting disruptors
18	Ecdysone Agonists
20	Mitochondrial inhibitors
22	Voltage dependent sodium channel blockers
23	Inhibitors of lipid synthesis
25	Neuronal inhibitors
26	Aconitase inhibitors
28	Ryanodine receptor modulators

Table E-10. Common Names and Corresponding Trade Names of Vegetable Insecticides.

Active Ingredient	Trade Names	Mode of Action [1]
abamectin	Abba, Agri-Mek, Epi-Mek, Temprano	6
acephate	Orthene	1B
acetamiprid	Assail, TriStar	4A
azadirachtin	Aza-Direct, Ecozin, Neemix	UN
Bacillus thuringiensis aizawai	Agree, Ketch, XenTari	11A
Bacillus thuringiensis israelensis	Gnatrol	11A
Bacillus thuringiensis kurstaki	Baritone, Biobit, Crymax, Dipel, Javelin, Lepinox	11A
Bacillus thuringiensis tenebrinis	Novodor	11A
beta-cyfluthrin	Baythroid XL	3
bifenazate	Acramite, Floramite	UN
bifenthrin	Bifenture, Brigade, Frenzy , Sniper, Capture LFR	3
bifenthrin + imidacloprid	Brigadier, Swagger	3, 4A
bifenthrin + indole butyric acid	Empower[2] (Trade name, not a footnote)	3
buprofezin	Applaud, Courier, Talus	16
carbaryl	Sevin	1A
Chenopodium ambrosioides extract	Requiem	1
chlorantraniliprole (rynaxypyr[R])	Altacor, Coragen	UN
chlorfenapyr	Pylon	13
chlorpyrifos	Lorsban, Warhawk, Yuma	1B
chlorpyrifos + lambda-cyhalothrin	Cobalt Advanced	1B, 3
clothianidin	Belay, Poncho	4A
cryolite	Kryocide, Prokil Cryolite 96	UN
cyfluthrin	Tombstone	3
cypermethrin	Ammo, Cymbush	3
cyromazine	Trigard	17
delta-methrin	Battalion	3
diazinon	Diazinon	1B
dimethoate	Dimate, Dimethoate	1B
dinotefuran	Scorpion, Venom	4A
emamectin benzoate	Denim, Proclaim	6
esfenvalerate	Asana	3
ethoprop	Mocap	1B
etoxazole	Zeal	6
fenbutatin-oxide (hexakis)	Vendex	3
fenpropathrin	Danitol	1
fenproximate	Portal	10B
fipronil	Regent	2B
flonicamid	Beleaf, Carbine	9C
flubendiamide	Belt	2
flubendiamide + buprofezin	Vetica	21A, UN
gamma-cyhalothrin	Proaxis	3
hexakis (fenbutatin-oxide)	Vendex	28
hexythiozox	Savey	28,16
imidacloprid	Admire PRO, Concur, Gaucho, Latitude, Marathon	4A
imidacloprid + beta-cyfluthrin	Leverage 360	4A, 3
indoxacarb	Avaunt	22

table continued next page

Table E-10. Common Names and Corresponding Trade Names of Vegetable Insecticides. ***(continued)***

Active Ingredient	Trade Names	Mode of Action [1]
insecticidal soap	M-Pede	UN
lambda-cyhalothrin	Lambda-Cy, Lambda-T, Mystic, Silencer, Warrior II	3
lambda-cyhalothrin + chlorantraniliprole	Besiege, Voliam Xpress	3,28
lambda-cyhalothrin + thiamethoxam	Endigo	3,4A
malathion	Cythion, Malathion, Malathion 8 Aquamul	1B
methomyl	Lannate	1A
methoxyfenozide	Intrepid	18
neem extract	Trilogy	26
novoluron	Rimon	15
oxamyl	Vydate	1A
permethrin	Arctic, Perm-Up, Kernel Guard Supreme	3
petroleum oils	Suffoil-X	UN
phorate	Thimet	1B
phosmet	Imidan	1B
piperonyl butoxide	Butacide, Incite, Exponet, PBO	UN
propargite	Comite, Omite	12C
pymetrozine	Fulfill	9
pyrethrins	PyGanic	3
pyrethrins + piperonyl butoxide	Pyrethrum TR	3,UN
pyrethrum	Pyrethrum	3
pyriproxyfen	Distance, Esteem, Knack	17
rosemary oil + peppermint oil	Ecotec	UN
spinetoram	Radiant	5
spinosad	Blackhawk, Entrust, GF-120 Naturalyte, Conserve	5
spinosad + gamma-cyhalothrin	Consero	5,3
spiromesifen	Oberon	23
spirotetramat	Movento	23
sulfoxaflor	Closer, Transform	4C
tefluthrin	Force	3
terbufos	Counter	1B
thiamethoxam	Actara, Platinum, Cruiser	4A
thiamethoxam + chlorantraniliprole	Durivo, Voliam Flexi	4A, 28
zeta-cypermethrin	Mustang Maxx	3
zeta-cypermethrin + bifenthrin	Hero	3,3

[1]Mode of Action. Refer to the preceding section for complete explanation

GREENHOUSE INSECT PEST and MITE CONTROL

Adequate ventilation is critical for greenhouse pesticide use. It is especially important to follow the re-entry intervals listed on the labels for worker safety. Always read and fully understand the label before using any pesticide in a greenhouse environment.

Yellow sticky traps are very effective in catching winged aphids, leafminer, thrips, whiteflies, fungus gnats and shore flies. Both blue and yellow traps are effective, and can be hung vertically just above the plant canopy as well as the growing medium surface. It is also helpful to hang traps near doors and side vents, or other areas where insects may enter or exit the greenhouse. It is suggested that at least 1 trap be used per 1,000 sq. ft.

Table E-11. Insecticides and Miticides Labeled for Use on Greenhouse* Vegetables

Product **active ingredient**, product name(s), and (IRAC Classification)	**Target Pests**	**Labeled Crops**	**Days to Harvest** and (REI [hrs])	**Comments**
acequinocyl (Shuttle O) (20B)	Two spotted spider mites	Fruiting vegetables, **except** cucurbits	1 (12)	Use at least 100 gal of water/A 2 applications per year No surfactant or adjuvant use
acetamiprid (TriStar 30SG) (4)	Aphids, leafhoppers, mealybugs, caterpillars, plant bugs, whiteflies, fungus gnat larvae, thrips, beetles, leafminers	Leafy vegetables, fruiting vegetables, cole crops, cucurbits, onions & bulb vegetables	7 (12)	For vegetables grown as transplants only. Treat small area to test for phytotoxicity first.
azadirachtin (Azatin XL, Azatrol EC, Neemix, Ornazin, Azahar, Aza-Direct) (18b)	Immature stages of whiteflies, aphids and other listed insects; fungus gnat larvae (as soil drench)	Most vegetables including fruiting vegetables and cucurbits, herbs/spices and others	0 (4; 12 for Neemix & Ornazin)	Botanical insect growth regulator); some products OMRI-listed. Can be applied via chemigation. Spray water pH should be between 5.5 and 6.5. May be applied via a chemigation system.
Bacillus thuringiensis var ***aizawai*** (XenTari, Agree) (11)	Armyworms, beet armyworm, cabbage looper, tomato fruitworm,	Most vegetables including fruiting vegetables and cucurbits, herbs/spices and others	0 (4)	Lepidopteran larvae only – most effective against early instars.
Bacillus thuringiensis var ***israelensis*** (Gnatrol) (11)	Fungus gnats (larvae only)	All vegetables	0 (4)	Drench. Repeat applications may be needed.
Bacillus thuringiensis var ***kurstaki*** (DiPel, Javelin, Deliver, Biobit) (11)	Armyworms, beet armyworm, cabbage looper, tomato fruitworm,	Most vegetables including fruiting vegetables and cucurbits, herbs/spices and others	0 (4)	Lepidopteran larvae only – most effective against early instars.
Beauveria bassiana strain GHA (Mycotrol O, BotaniGard ES, BotaniGard WP) (NA)	Aphids, thrips, whiteflies, certain other pests	All vegetables, herbs/spices and others	0 (4)	Slow acting, fungus infects insects. Repeat applications at 5-10 day intervals may be needed. Note storage and other restrictions. Mycotrol is OMRI-listed. **Do not use BotaniGard ES on tomatoes.**
bifenazate (Floramite SC) (25)	Spider mites, clover mites	Tomatoes	3 (12)	No more than 2 applications/crop/season for tomatoes that are greater than 1” in diameter at maturity. Maintain spray water pH 5.5 – 6.5. **Do not use an adjuvant.**
buprofezin (Talus 40SC) (16)	Leafhoppers, mealybugs, whiteflies	Tomatoes	1 (12)	Insect growth regulator for immature stages only. Maximum 2 apps/season at least 5 days apart. Will reduce egg viability.

*Applications of insecticides in high tunnels may be considered equivalent to a greenhouse, depending on the state’s definition of “high tunnel”. Check with your state’s pesticide regulatory agency for an interpretation concerning use of pesticides in high tunnels. Always read and fully understand a product label before applying any pesticide.

NA: Not Applicable

table continued next page

Table E-11. Insecticides and Miticides Labeled for Use on Greenhouse* Vegetables *(table continued)*

Product **active ingredient**, product name(s), and (IRAC Classification)	**Target Pests**	**Labeled Crops**	**Days to Harvest** and (REI [hrs])	**Comments**
chlorfenapyr (Pylon) (13)	Caterpillars, spider mites (*Tetranychus* spp.), broad mites, western flower and melon thrips	Tomato, tomatillo, ground cherry, peppers, eggplant, pepinos	0 (12)	**Do not** use on tomato varieties with mature fruit less than 1 inch in diameter. No more than 3 applications per crop.
dinotefuran (Safari 20 SG) (4)	Aphids, leafminers, mealybugs, whiteflies	Cucurbits, fruiting vegetables, head and stem brassicas, leafy vegetables	1 (all but leafy) 7 (leafy) (12)	One application/crop. For vegetable transplants only. May be applied via a chemigation system.
etoxazole (TetraSan 5WDG) (10B)	Spider Mites	Tomatoes only	1 (12)	Do not make more than 2 applications per season. Do not use with an adjuvant.
fenpyroximate (Akari) (21A)	Two spotted spider mites (suppresses whiteflies)	Cucumbers	7 (12)	One application per growing season. Do not use adjuvants.
iron phosphate (Sluggo-AG) (Escar-Go)	Slugs and snails	All vegetables	0 (0)	OMRI-listed. Bait; scatter around plants or perimeter of plantings.
imidacloprid (Marathon) (4)	Aphids, fungus gnat larvae, leafhoppers, whiteflies, others	Cole crops, collards, kale, kohlrabi, lettuce, mustard greens, pepper, tomato, eggplant.	- (12)	**Use on vegetable plants intended for resale only**. May be applied via a chemigation system.
imidacloprid (Admire PRO) (4)	Aphids, whiteflies	Tomato and cucumber only in production greenhouses.	0 (12)	Do not apply to plants growing hydroponically or in rock wool, perlite or other soil-less mix; only for plants growing in field soil, potting media or mixes. May be applied as drench or chemigation system. Label notes possible repellent effect on bumblebees and some beneficials (*Orius* sp.)
malathion (Gowan Malathion 8F) (1)	Japanese beetles, thrips, onion maggots	Succulent beans, cucumbers, eggplant, lettuce, green and bulb onions, sweet corn, tomatoes (crops vary depending on mfg. label)	1-7 (12)	See label for specific crops. May be applied through a chemigation system.

*Applications of insecticides in high tunnels may be considered equivalent to a greenhouse, depending on the state's definition of "high tunnel". Check with your state's pesticide regulatory agency for an interpretation concerning use of pesticides in high tunnels. Always read and fully understand a product label before applying any pesticide.

NA: Not Applicable

table continued next page

Table E-11. Insecticides and Miticides Labeled for Use on Greenhouse* Vegetables *(table continued)*

Product active ingredient, product name(s), and (IRAC Classification)	**Target Pests**	**Labeled Crops**	**Days to Harvest** and (REI [hrs])	**Comments**
potassium salts of fatty acids (insecticidal soap) (M-Pede) (NA)	Aphids; leafminer; spider, broad and russet mites; thrips; whiteflies; plant bugs; leafhopper; powdery mildew (cucumber only)	Many vegetables (see label for specifics), herbs/spices	0 (12)	Works well on whiteflies, mites and aphids if coverage is good but has no residual control. Note label cautions about application frequency, water quality and tank mixing. OMRI-listed
pyrethrins (Pyrenone Crop Spray, Pyronyl Crop Spray, PyGanic, Pyrethrum PT) (3a)	All	All vegetables, herbs/spices	0 (12)	Pyrenone and Pyronyl include PBO synergist; PyGanic is OMRI-listed.
pyriproxyfen (Distance) (7c)	Whiteflies, aphids, fungus gnats, shoreflies	Fruiting vegetables (except non-bell peppers)	1 (12)	Insect growth regulator. **Do not** use on tomato varieties with mature fruit less than 1 inch in diameter. Spray, sprench or drench.
rosemary oil + peppermint oil (Ecotec)	Aphids, beetles, mites, thrips, plant bugs, others	Many vegetables, herbs/spices	0 (0)	OMRI-listed. Can be applied in drip for soil pests.
spirotetramat (Kontos) (23)	Aphids, leafhoppers, mealybugs, psyllids, spider mites, spittlebugs, whiteflies	Vegetable transplants only (see label for list)	- (24)	Apply as drench or via an irrigation system to plants in containers. Not for use in vegetable production.
thiamethoxam (Flagship 25WG) (4a)	Whiteflies, leafhoppers, Colorado potato beetle, stinkbugs	Fruiting vegetables and cucurbits	- (12)	ONLY use for vegetable transplants intended for resale

*Applications of insecticides in high tunnels may be considered equivalent to a greenhouse, depending on the state's definition of "high tunnel". Check with your state's pesticide regulatory agency for an interpretation concerning use of pesticides in high tunnels. Always read and fully understand a product label before applying any pesticide.

NA: Not Applicable

DISEASE MANAGEMENT

Resistance Management

Pathogens can develop resistance to fungicides because of genetic changes in the organism through natural selection or by the intensive use of high-risk fungicides which kill only the susceptible individuals in a given population, leaving resistant populations to reproduce and cause more disease. Use the practices outlined below to help reduce the chances for fungicide resistance development.

a. Proper crop rotations with a non-host crop help reduce the need for certain pesticide treatments and, thus, decrease the chances for resistance to develop to certain fungicide chemistries. This is especially important for controlling soil-borne pathogens.

b. Do not overspray. Attempts to destroy every pest in the field by multiple applications or by using higher than labeled rates often eliminate the susceptible, but not the resistant pathogen population. Do not use less than labeled rates which allow low to moderately resistant populations to survive.

c. Always rotate fungicides with different modes-of-action (MoA) (ie. Fungicide Resistance Action Code (FRAC), see below).

d. Fungicides are organized according to FRAC groups, chemical structure and Mode of Action (MoA). Fungicides within a given FRAC group control fungi in a similar manner and share the same risk for fungicide resistance development. Some fungicides are referred to as high- or at-risk fungicides because of their specific MoA's and therefore have a high-risk for resistance development. See Table E-13 for specific fungicides and fungicide FRAC groups. Groups of fungicides, such as the QoI's (FRAC group 11) or DMI's (FRAC group 3) are prone to resistance development due to very specific MoA's. Fungicides in high- or at-risk groups (in **BOLD** in Table E-13) should be rotated and/or tank-mixed with broad spectrum, protectant fungicides to delay the development of resistant strains of fungi. High- or at-risk fungicides have seasonal application restrictions which should be followed precisely.

e. Do not use high or at-risk fungicides as a rescue treatment for disease control. High-risk fungicides should be used according to the label in full season disease control program or not at all. Applying high- or at-risk fungicides only after a disease is present in a field increases the chances for the development of resistant populations of plant pathogenic fungi.

List of FRAC codes and corresponding chemical groups for commonly-used fungicides in vegetable production:

P1-Salicylic Acid Pathway
M1-inorganic copper
M2-inorganic sulfur
M3-dithiocarbamate
M4-phthalimide
M5-chloronitrile
1-benzimidazole
2-dicarboximide
3-triazole
4-phenylamide
7-carboxamide
9-pyridinamine
11-quinone inside inhibitor (QoI)
12-phenylpyrroles
13-quinolines
14-aromatic hydrocarbons
17-hydroxylanilide
21-quinone outside inhibitor (QiI)
22-benzamides (toluamides)
27-cyanoacetamideoximes
28-carbamate
29-dinitroanilines
30-organotin compounds
33-phosphonates
40-carboxylic acid amides
43-benzamides (acylpicolides)

Seed Treatment

Seed treatment is essential to control seed-borne diseases in many transplanted crops. Failure to treat seed properly could lead to diseases in the plant bed that will reduce plant stands or that are carried into the field at transplanting. Crop failure could result. Seed treatment is especially important for asparagus, broccoli, brussels sprouts, cabbage, cauliflower, collards, eggplant, kale, kohlrabi, pepper, radish and tomato. In the case of peppers and tomatoes, a chlorine seed treatment or hot water seed treatment is essential for prevention of bacterial diseases (bacterial canker, bacterial leaf spot and bacterial speck).

Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments for the elimination of seed-borne pathogens. Heat treatment has the additional benefit of killing pathogens such as the bacterial canker organism of tomatoes that may be found within the seed coat. Heat treatment is particularly useful for tomatoes, peppers, and cole crops that are prone to seed-borne bacterial infections. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled dose water baths. Two baths are required; one for pre-heating, and a second for the effective pathogen killing temperature. The initial pre-heat cycle is for 10 minutes at 100ºF (38ºC) followed by the effective temperature cycle. The following (Table E-12) are effective temperature protocols for several important crop groups: See crop sections for specific seed treatment recommendations.

Table E-12. Effective Seed Treatment Temperature Protocols (2nd Bath) For Pathogen Eradication

Seed	Water temperature		Minutes
	°F	**°C**	
Brussels sprouts, eggplant, spinach, cabbage, tomato	122	50	25
Broccoli, cauliflower, carrot, collard, kale, kohlrabi, rutabaga, turnip	122	50	20
Mustard, cress, radish	122	50	15
Pepper	125	51	30
Lettuce, celery, celeriac	118	48	30

Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper, and may be re-dusted with fungicide if desired. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current season.

Plant Growing Mix

For the best control of all soil-borne diseases, use the plant-growing mix described in Table R-4 or R-5. If this is not possible, use one of the following procedures.

Disease Control in Plant Beds

Preplant

The only practice that ensures complete sterilization of soil is the use of steam. When steam is used, a temperature of 180°F (82.2°C) must be maintained throughout the entire mass of soil for a period of 30 minutes.

Soil fumigation is a method used to provide disease control in plant beds. The following materials are suitable for small lots of soil:

chloropicrin—5 cc/cu ft
metam-sodium (**Vapam HL**)—1 qt in 5 gal of water per 1/2 cu yd of soil

For larger areas, such as plantbeds or seedbeds, the following materials are suitable:

chloropicrin—50 gal/A (3 cc/injection)
methyl bromide (MC-2)—1-2 lb/100 sq ft
metam-sodium (Busan, Nemasol, Vapam HL)—
drench—1 qt/100 sq ft
injection—1 pt/100 sq ft

Potassium N-methyldithiocarbamate (K-Pam HL)—see label, rate varies with method of application

See the "Soil Fumigation" section for proper application techniques.

New restrictions on the use of soil fumigants is pending with the EPA, and their use in some areas of the mid-Atlantic region will become severely limited. Check with local county agricultural agent for updates on pending restrictions

Pre-and Postseeding Soil Treatment in Greenhouse

For Pythium and Phytophthora root rot in pepper, tomato, leaf lettuce, and cucurbits growing in soil and soilless media apply Previcur Flex (see label for rate) at seeding, after emergence or after transplanting. See Table E-14 for a list of selected fungicides for use in the Greenhouse.

Postplant

For damping-off on broccoli, cabbage, cauliflower, cucumbers, melons, squash, lettuce, spinach, onions, and tomatoes in open field beds caused by Pythium and/or Phytophthora, use mefenoxam (Ridomil Gold 4E or Ultra Flourish 2E).

Foliar diseases can be a problem in plant beds. To prevent foliar diseases, it may be necessary to apply fungicide sprays as plants become crowded in plant beds. **Refer to label clearance before use.**

Nematodes

Some 100 species of plant-feeding nematodes can seriously damage various economic plants. Before starting any nematode management procedure, one should determine if the kinds of plant-feeding nematodes and the numbers present in the soil warrant action. Nematode species and numbers are determined from soil and root samples collected in the field.

How to Collect Soil and Root Samples for Nematode Detection

When nematode damage is suspected, both soils and roots should be examined to find out if and to what extent nematodes may be involved. The following procedure is suggested to ensure that samples are collected and handled properly so that the diagnosis made on that sample at a *Nematode Diagnostic Laboratory* is accurate.

Collecting and Handling. Only a single composited sample should be collected in each field. If the field is larger than 2 acres, divide the field into 2 acre blocks and collect a composite sample from each and label each bag accordingly. This will provide a more accurate assessment of the nematode population and enable more targeted management of nematode populations. Do not combine samples from several fields. Collect soil and roots from the edges of the affected area(s) in the field. Take a mixture of roots and soil from at least 10 scattered sites, or preferably, under 10 scattered plants in the affected area. Do not take samples from areas where plants are dead. One can dig plants with a shovel and take a small handful of soil and roots from each, or one can use a soil sampling tube (3/4-inch diameter). Combine the individual samples in a bucket to make a composite sample of at least one quart of soil. Mix the soil in the bucket, then place one pint of the mixed soil in a plastic freezer bag and seal it to prevent drying of the soil. Protect bagged samples from high temperatures and freezing which can kill the nematodes.

Take soil samples while the crop is still growing so that areas that are suspected of being stunted by nematodes can be seen and sampled, because these areas may be missed in random sampling. In general, samples can be taken from June through November. However, to plan your cropping sequence, it is best to take these survey samples after harvest in the fall before any fall tillage and before cold weather arrives. The reason for this recommendation is that nematode populations are generally the highest in the fall, and the chance of detecting damaging levels of plant pathogenic nematodes by soil sampling is also high. This timing is especially important for growers who need to monitor root knot nematode populations. The worst time to sample to detect root knot nematodes is in late spring just before planting.

Survey samples should be taken at a depth of 8 to 10 inches, and several inches from the base of the plants, between plants in the row. Do not take samples if the soil is wet. The moisture level should be less than field capacity and there should not be any free water in the plastic bag after adding the sample. Use a soil sampling tube and take 20 to 25 cores per sample in a random pattern in the field. Mix soil cores in a plastic bucket and immediately place a pint of soil in a plastic bag or a nematode soil sample kit purchased from a nematode testing laboratory.

Submitting Samples for Nematode Analysis. Samples should be sent to a *Nematode Diagnostic Laboratory* as soon as possible after they are collected. However, if there is any delay, the samples should be refrigerated until shipment.

Provide some insulation such as several layers of newspaper, a padded envelope or styrofoam peanuts, around the sample during shipment.

The following information must be included with each sample:

1. Name and address of the grower and of the person submitting the sample
2. Date collected
3. Name of the present crop, the crop to be planted, and history of the affected area
4. Plant and field symptoms
(Check with the laboratory to see if any additional information is required).

Attach the paper with this information to the **OUTSIDE** of the bag of soil. Do **NOT** place the information in the bag with soil. Mark the samples: "For Nematode Analysis." Forward the samples and the information to your Extension agent, or directly to the diagnostic laboratory. There is usually a fee for nematode analysis.

Nematode Management Strategies

Plant-parasitic nematodes are difficult to control after they have become established. The best strategy is to use preventive measures, including nematicides, soil fumigants, and / or cultural practices.

Chemical Management of Nematodes

Fumigants. Soil fumigation can effectively controls plant-feeding nematodes. See the "Soil Fumigation" section for specific fumigants, rates, and application techniques.

Nonfumigant nematicides. Several nonfumigant nematicides are currently available for selected vegetable commodities. These nematicides are listed in the sections dealing with the vegetables on which they are labeled. Some nonfumigant nematicides are not labeled in all states within the mid-Atlantic region, so consult the label carefully before applying a chemical.

These nematicides do not volatilize in the soil as do fumigants. Consequently, these chemicals are effective over a wider range of soil temperature and moisture than are fumigants.

Chemicals which are registered for use on selected vegetables include Counter (20CR), Mocap (10G and 6EC), and Vydate L. The first two are contact nematicides, and the last one acts as both contact and systemic nematicide. Consult the label before applying any of these chemicals.

Factors Affecting the Efficacy of Nematicides. As with any pesticide, the two factors that determine efficacy are concentration and exposure time. If toxic concentrations of a nematicide do not come in contact with the nematode for a sufficient period of time, then acceptable levels of control will not occur. Many factors can dilute the concentration of nematicide available in the soil and/or effectively shorten the time that nematodes are exposed.

Good site preparation is extremely important. The soil should be thoroughly tilled several weeks before application to break up clods and encourage decomposition of plant residues. Nematicides can adsorb to organic matter and thus reduce the amount of compound free in the soil. Soil clods can interfere with nematicide distribution and reduce efficacy.

Fumigant nematicides such as Telone or Vapam volatilize and move through the soil as a gas. The movement of a fumigant through the soil is strongly affected by factors such as temperature, moisture, and soil texture. Fumigants tend to move upwards through the soil and will dissipate quickly unless the surface is sealed after treatment. Follow the label to ensure that you are applying the correct dose for your conditions.

Almost all nonfumigant nematicides such as Vydate are organophosphate or carbamate pesticides, which are potent cholinesterase inhibitors. These compounds are extremely water-soluble, and their redistribution in the soil depends on water movement. Excessive rain or irrigation creates a risk of diluting the nematicide below the level needed to be effective. However, too little water may prevent the nematicide from being distributed effectively in the root zone.

Unlike fumigants, contact nematicides act relatively slowly. Although high concentrations are lethal, the lower concentrations in soil generally kill by behavior modification. The affected nematodes typically are unable to move, find a host, feed, or find a mate. Eventually they die. If exposure to the nematicide is too short or at a low concentration, however, these behavioral modifications can be reversed and the treatment is not effective.

Nonchemical Management of Nematodes

Prevention of spread. Plant-feeding nematodes move only short distances under their own power, a few inches to a few feet. Nematodes are commonly spread by the movement of infested soil and/or infected plants by human activity. Sanitation and good cultural practices are the best preventive measures against nematodes. Obtain nematode-free transplants from reputable sources. Wash soil from machinery and tools before using them at another location. Nematodes may also be spread by wind, water, soil erosion, and animals.

Crop rotation. Rotation of crops is an effective and widely used cultural practice to reduce nematode populations in the soil. To be most effective, crops that are poor hosts or nonhosts of the target nematodes should be included in the rotation sequence.

Cover crops. Some plants commonly used as cover crops are naturally suppressive to certain nematode species, but no single crop is effective against all nematodes. The cover crop plant may be a nonhost and, therefore, the nematodes starve, their population being reduced as with fallow. Nematodes invade the roots of certain other cover crop plants, but they fail to reproduce. Yet, other "antagonistic" plant species exude chemicals from their roots that are toxic to nematodes, such as marigold and asparagus.

Green manures and soil amendments. In general, the incorporation of large amounts of organic matter into the soil reduces populations of plant-feeding nematodes. The decomposition products of some plants kill nematodes. These include butyric acid released during the decomposition of ryegrass and timothy, and isothiocyanates released during the decomposition of rapeseed and other plants in the genus *Brassica*. Maximum benefit of these "natural" nematicides is obtained when the plant material is incorporated into the soil as green manure. Green manure treatments are not equally effective against all plant- parasitic nematodes and therefore it is important to consult with a diagnostic lab or extension agent to make sure the treatment is appropriate for the nematode being controlled. For example, rapeseed is effective against dagger nematodes but not lesion nematodes. Also keep in mind that varieties of the same green manure crop can differ in the amount of toxic chemical components in their cell walls and therefore differ in the amount toxic byproducts released during decomposition.

For dagger nematode control, two years of rapeseed green manure is desirable, but it may be possible to realize the same benefit by growing two crops of rapeseed within one year. The following timetable is suggested for producing two rotations of rapeseed within one year:

- Prepare seedbed and plant rapeseed by late April or early May. (Plant only recommended winter rapeseed varieties.)
- Turn under green rapeseed by early September. Prepare seedbed and plant second crop by mid-September.
- The second crop should be turned under in late spring after soil temperatures reach 45°F or higher.
- Ideal conditions for incorporating the cover crop are similar to those required for obtaining the maximum benefit from fumigation (i.e., the soil should be above 45°F and moist).
- Alternatively, planting dates may be reversed so that the first planting is in the fall followed by a second crop planted in the spring. This would end the rotation cycle in fall of the following year.

Some rapeseed varieties are more effective at suppressing nematode populations than others, and some varieties will not over-winter (i.e. spring types) or they bloom too early in summer to be useful. The winter varieties ‘Dwarf Essex’ and ‘Humus’ work well for both spring and fall planting dates. If planted in the spring, these varieties grow vigorously to crowd out weeds and do not go to seed.

Tips:

- Rapeseed requires a firm, smooth seedbed that is free of weeds, heavy residue, and large clods.
- Seed may be drilled or broadcast. Seed at a depth of 3/8 inch and avoid planting too deep! If seed is broadcast, a cultipacker may be used to cover seed.
- A seeding rate of 7–8 pounds per acre works well.
- Rapeseed is sensitive to broadleaf herbicide carryover.
- Fall-planted rapeseed should have 8–10 true leaves and a 5- to 6-inch tap root with a 3/8-inch diameter root neck before the ground freezes.
- Sulfur is necessary for rapeseed to produce nematicidal compounds. Some soils may be deficient in sulfur. A soil test for sulfur may be beneficial.

Keep in mind that some biofumigant crops like rapeseed and sorghum-sudangrass are hosts for nematodes and it is not until incorporated into the soil as green manure that they will suppress nematode populations.

Plant nutrition and general care of the plant. The harmful effects of nematodes on plants can be reduced by providing plants with adequate nutrition, moisture, and protection from stress. These tactics may sometimes be of limited usefulness, because if susceptible crops are grown continuously, the nematode population may increase to levels that cause serious damage.

Fallow. Fallow is the practice of keeping land free of vegetation for weeks or months by frequent tilling or applying herbicides. In the absence of a host, nematodes gradually die out; however, eggs of some nematodes may survive for years in the soil. Because fallow may be destructive to soil and the land is out of production during that time, extended periods of fallow are not recommended.

Integrated management practices. Each of the practices mentioned above reduces the soil population of plant-feeding nematodes to varying degrees. Each practice has limitations and the degree of nematode control achieved depends on environmental factors, as well as the particular nematode and crop being considered.

Maximum benefit is realized when several of these practices are employed in an integrated crop management program. Because the host range of different nematode varies, the selection of cover crops, rotation crops, and green manures will be determined by the kinds of nematodes present. No single practice is a “cure-all” for all nematode problems.

Table E-13. Commonly Used Fungicides Registered for Vegetables

(The inclusion of a material in this table does not mean it is recommended, check specific crop recommendations to ensure efficacy on selected pests. The table is not all inclusive but focuses on commonly applied fungicides, see crop sections for more recommendations.)

	Actigard (acibenzolar-S-methyl)	**Aliette** (fosetyl A1)	**Botran** (dichloran)	chlorothalonil[a]	**Cabrio** (pyraclostrobin)	**Curzate** (cymoxanil)	**Endura** (boscalid)	Fixed copper[a]	**Flint** (trifloxystrobin)	**Forum** (dimethomorph)	**Gavel** (zoxamide+mancozeb)	**Headline** (pyraclostrobin)	**Inspire Super** (difenoconazole+cyprodonil)	iprodione	mancozeb[a]	**MetaStar** (metalaxyl)	phosphonates[a]	**Presidio** (fluopicolide)	**Previcur Flex** (propamocarb)	**Pristine** (pyraclostrobin + boscalid)	**Procure** (triflumizole)
FRAC Group(s)*	P1	33	**14**	M5	**11**	**27**	**7**	M1	**11**	**40**	**22+** M3	**11**	3+9	2	M3	**4**	33	**43**	28	**11+ 7**	**3**
Crop																					
Asparagus		X110		X190											X	X	X				
Beans, snap			X2	X7			X7	X				X7		X[e]		X					
Beans, lima				X7			X7	X				X7		X[e]		X					
Beets					X			X	X7							X		X7			
Broccoli	X7	X3		X7	X		X			X7			X7	X		X	X	X2			
Carrots				X	X		X	X	X7					X		X				X	
Celery		X3	X7	X7	X			X	X7							X	X	X2			
Chinese cabbage	X7	X3		X7	X		X			X7			X7			X	X	X2			
Cole crops	X7	X3		X7				X					X7			X		X2			
Cucumbers		X	XGH	X	X	X3		X	X	X	X5		X7		X5	X	X	X2	X2	X	X
Eggplants					X		X	X	X3	X						X		X2			
Garlic				X7	X7		X7			X			X7	X		X	X	X2		X7	
Greens, mustard		X3			X		X14	X		X7			X7								
Greens, turnip								X		X7											
Horseradish					X		X		X7							X		X7			
Leeks			X14	X14	X7		X7			X						X	X	X2		X7	
Lettuce		X3	X14		X	X3	X14	X		X				X14		X	X	X2	X2		
Muskmelons		X		X	X	X3		X	X	X	X5		X7		X5	X	X	X2	X2	X	X
Okra																					
Onions, dry		X7	X14	X7	X7		X7	X		X			X7	X7	X7	X	X	X2		X7	
Onions, green		X7	X14	X14	X7		X7	X		X			X14			X		X2		X7	
Parsley		X			X				X7							X	X	X2			
Parsnips				X10	X				X7							X		X7			
Peas							X21	X				X7				X	X				
Peppers					X		X	X	X3	X						X	X	X2	X5		
Potatoes				X7		X14	X10	X		X4	X14[d]	X3		X14	X14[d]	X	X		X14		
Pumpkins/ winter squash		X		X	X	X3		X	X	X			X7		X	X	X	X2	X2	X	X
Radish					X											X		X7			
Spinach	X7	X3			X			X								X	X	X2			
Squash, summer		X		X	X	X3		X	X	X	X5		X7		X5	X	X	X2	X2	X	X
Strawberries		X			X									X[e]						X	X1
Sweet corn				X14								X7			X7						
Sweet potatoes			X[b]				X30					X3				X		X7			
Tomatoes	X14	X14	XGH	X	X	X3	X	X	X3	X4	X5		X		X5	X	X	X2	X5		
Watermelon	X	X		X	X	X3		X	X	X	X5		X7		X5	X	X	X2	X2	X	X

*Numbers and letters indicate fungicide class (FRAC group). Bold numbers in shaded boxes identify those fungicides that have a higher potential for fungicide resistance to develop if the fungicide is used on a continuous basis. These fungicides should be alternated or tank mixed (where recommended) with fungicides from another FRAC group in a spray program. [a]Fixed coppers include: Champ, Kocide, Tenn-Cop, and Cuprofix Disperss. Chlorothalonils includes Applause, Bravo, Echo and Equus; mancozebs include Dithane, Manzate and Penncozeb; phosphonates include Phostrol and Prophyt (check specific labels for labeled crops) [b]Seed treatment or soil use only (not foliar). [c]Not labeled for fresh lima beans, only dry lima beans; [d]X3 for DE, MD, PA and VA; [e]See label for PHI; X = registered, Numbers = days to harvest, No number = 0 days to harvest, GH = greenhouse

Table E-13. Commonly Used Fungicides Registered for Vegetables

(The inclusion of a material in this table does not mean it is recommended, check specific crop recommendations to ensure efficacy on selected pests. The table is not all inclusive but focuses on commonly applied fungicides, see crop sections for more recommendations)

	Quadris, (azoxystrobin)	**Quadris Opti,** (azoxystrobin + chlorothalonil)	Quintec **(quinoxyfen)**	**Rally / Nova** (myclobutanil)	**Ranman** (cyazofamid)	**Reason** (fenamidone)	**Revus** (mandipropamid)	**Revus Top** (mandipropamid + difenoconazole)	**Ridomil Gold, Ultra Flourish** (mefenoxam)	**Ridomil Gold Bravo, Flouronil** (mefenoxam + chlorothalonil)	**Ridomil Gold Copper** (mefenoxam + copper)	**Ridomil Gold MZ** (mefenoxam + mancozeb)	**Ridomil Gold PC** (mefenoxam + PCNB)	**Scala** (pyrimethanil)	**Sulfur** (caution) [c,e]	**Switch** (cyprodinil + fludioxonil)	**Tanos** (famoxadone + cymoxanil)	**tebuconazole**	**Terraclor** (PCNB)	**Tilt** (propiconazole)	**Topsin M** (thiophanate-methyl)
FRAC Group(s)*	**11**	11+ M5	**13**	**3**	**21**	**11**	**40**	**40+ 3**	**4**	**4+** M5	**4**+M1	**4+** M3	**4+ 14**	**9**	M2	**9+ 12**	**11+ 27**	**3**	**14**	**3**	**1**
Crop																					
Asparagus	X100	X100		X180					X									X180			
Beans, snap	X	X14		X					X[b]		X3[d]		X				X	X7	X14		X14
Beans, lima	X	X14							X[b]		X3		X				X	X7	X14		X14
Beets	X								X						X			X7			
Broccoli	X					X2	X1			X7					X	X7		X7	X		
Carrots	X	X				X14			X[b]	X7	X7				X	X7				X14	
Celery	X	X7				X2	X1													X14	X7
Chinese cabbage	X					X2	X1		X[b]	X7						X7		X7	X		
Cole crops	X						X1		X	X7						X7		X7	X		
Cucumbers	X1	X1		X	X	X14	X		X	X	X5	X5			X	X	X3	X7			X
Eggplants	X					X14			X												
Garlic	X						X7		X[a]					X7	X	X7		X7	X		
Greens, mustard	X					X2	X1								X	X7		X7			
Greens, turnip	X					X2	X1		X[b]						X	X7		X7			
Horseradish	X								X[a]												
Leeks	X					X7	X7		X	X21	X7			X7						X	
Lettuce	X		X1			X2	X1		X[a]						X	X	X3				
Muskmelons	X1	X1	X3	X	X	X14	X		X	X	X5	X5				X	X3	X7			X[a]
Okra	X																	X3			
Onions, dry	X					X7	X7		X	X7	X10	X7		X7	X	X7		X7		X14	X[a]
Onions, green	X	X14				X7	X7		X	X21	X7			X7	X	X7		X7		X	X[a]
Parsley	X					X2	X1		X							X					
Parsnips	X								X												
Peas	X								X[b]								X				
Peppers	X		X3			X14	X1		X		X7				X		X3		X		
Potatoes	X14	X14			X7	X14		X14		X14	X14	X14				X7	X				
Pumpkins/ winter squash	X1	X1	X	X	X	X14	X		X	X	X5				X	X	X3	X7			X
Radish	X								X												
Spinach	X					X2	X1		X		X21						X				
Squash, summer	X1	X1		X	X	X14	X		X	X	X5	X5					X3	X7			X
Strawberries	X		X1	X					X					X1		X				X	X
Sweet corn	X																	X7		X14	
Sweet potatoes	X					X14			X					X7					X		
Tomatoes	X1	X1		X	X	X14		X1	X	X14	X14	X5		X1	X		X3		X		
Watermelon	X1	X1	X3	X	X	X14	X		X	X	X5	X5				X	X3	X7			X

*Numbers and letters indicate fungicide class (FRAC group). Bold numbers in shaded boxes identify those fungicides that have a higher potential for fungicide resistance to develop if the fungicide is used on a continuous basis. These fungicides should be alternated or tank mixed (where recommended) with fungicides from another FRAC group in a spray program**.** [a] Seed treatment or soil use only; [b]Ultra Flourish is not labeled on these crops; [c] Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury.[d] Only in DE, PA, MD, and VA. [e] See label for PHI; X=registered, Numbers = days to harvest; No number = 0 days to harvest, GH = greenhouse

Table E-14. Fungicides Registered for Seed Treatment

	42-S Thiram (thiram)	**Allegiance** (metalaxyl)[a]	**Apron** (mefenoxam)[a]	**Captan 400** (captan)	**Dividend Extreme** (difenconazole + mefenoxam)	**Dynasty** (azoxystrobin)	**Evolve** (thiophanate methyl + mancozeb + cymoxanil	**Kodiak** (*Bacillus subtilis* GB03)	**Maxim** (fludioxinil)	**Maxim MZ** (fludioxonil + mancozeb)	**Moncoat MZ** (flutolanil + mancozeb)	**Potato Seed Treater** (EBDC)	**Pro-Gro** (thiram + carboxin)	**Tops MZ** (thiophanate-methyl + mancozeb)	**Trilex AL** (trifloxystrobin + metalaxyl)	**Yield Shield** (*Bacillus pumilus* GB34)
FRAC Group(s)*	M3	**4**	**4**	M3	**3+ 4**	**11**	**1+** M3+ **27**	NC	**12**	**12**+ M3	**7**+ M3	M3	M3	**1**+ M3	**11+ 4**	NC
Crop																
Beans, Snap	X	X	X	X		X		X	X						X	X
Beans, Lima	X	X	X	X		X		X	X						X	X
Beets	X	X	X	X					X							
Broccoli	X		X	X					X							
Carrots	X	X	X						X							
Celery			X						X							
Chinese Cabbage	X		X						X							
Cole Crops	X		X	X					X							
Cucumbers	X	X	X	X					X							
Eggplants	X		X						X							
Garlic			X						X							
Greens, Mustard	X		X	X					X							
Greens, Turnip	X		X	X					X							
Horseradish			X						X							
Leeks			X						X							
Lettuce	X		X						X							
Muskmelons	X		X	X					X							
Okra	X								X							
Onions, Dry	X		X						X				X			
Onions, Green	X		X						X				X			
Parsley			X						X							
Parsnips			X						X							
Peas	X	X	X	X				X	X						X	X
Peppers	X		X	X					X							
Potatoes				X			X		X	X	X	X		X		
Pumpkins/winter squash	X		X	X					X							
Radish	X		X	X					X							
Spinach	X		X	X					X							
Squash, Summer	X		X	X					X							
Sweet Corn	X	X	X	X	X	X		X	X							
Sweet Potatoes			X						X							
Tomatoes	X		X						X							
Watermelon	X		X	X					X							

*Numbers and Letters indicate fungicide FRAC group. Bold numbers in shaded fungicide boxes identify those fungicides (FRAC groups) that have a higher potential for fungicide resistance to develop if the fungicide is used on a continuous basis. These fungicides should be alternated with a labeled fungicide from another FRAC group. **1**-benzimidazole; **4**-acylalanine**; 7**-carboximide**; 11**-QoI inhibitor; **12**-phenylpyrroles; 33-phosphonate; M3-dithiocarbamate; NC-not classified; [a]Mefenoxam and fludioxinil are also ingredients in CruiserMaxx and CruiserMaxx Potato. See labels for instructions, formulations, and for crops that have a label for these materials.

Table E-15. Selected Fungicides and Bactericides Labeled for Greenhouse Use

Fungicide	Target Diseases	Labeled Crops	Comments
BASIC COPPER SULFATE (Cuprofix Disperss; United Phosphorus, Inc.) 24 hr. REI	Many diseases including angular leaf spot, downy mildew. *Alternaria* blight, *Anthracnose*, bacterial blight, etc.	Vegetables including cucumbers, eggplant, peppers, tomatoes, etc.	Crops grown in the greenhouse may be more sensitive to copper injury so the user should determine plant sensitivity.
BACILLUS PUMILUS (Sonata; AgraQuest) 4 hr. REI	Early blight, late blight, downy mildew, powdery mildew	Many vegetables including Brassicas, bulb vegetables, cucurbits, fruiting vegetables, leafy vegetables and root and tuber crops	OMRI approved.
BACILLUS SUBTILLUS (Companion, Growth Products, LTD). 0 hr. REI	Suppression of soilborne and foliar diseases including damping off, root rot and early blight	Many including fruiting and leafy vegetables	May be used in hydroponic and soilless production systems. Most effective used preventatively.
CHLOROTHALONIL plus POTASSIUM PHOSPHITE (Catamaran; Luxembourg – Pamol, Inc.)	Late blight	Tomatoes	
CONIOTHYRIUM MINITANS (Contans, SipcamAdvan) 4 hr. REI	*Sclerotinia sclerotiorum*, *Sclerotinia minor*	Many vegetables including leafy vegetables, brassicas, legumes, fruiting vegetables and bulb vegetables	OMRI approved. Contains a beneficial fungus. Do not allow to stand overnight following mixture. Acts as a preventative.
COPPER HYDROXIDE (Kocide 101, Kocide 2000, Kocide 4.5LF, Kocide DF, DuPont) 24 hr. REI	Leaf spots, *Anthracnose* and bacterial spots	See labels for specific crops	See labels for specific usage instructions.
COPPER SALTS of fatty and rosin acids (Camelot, Whitmire Micro-Gen) 12 hr. REI	*Alternaria* blight, downy mildew, angular leaf spot, powdery mildew, scab, gray mold, bacterial soft rot, bacterial spot, *Cercospora* leaf spot, etc.	Vegetables such as broccoli, cabbage, cucurbits, tomato, etc.	The user should determine if Camelot can be used safely prior to use. Observe for 7 to 10 days for symptoms of injury.
CUPROUS OXIDE (Nordox, Monterey Chemical, Co.) 12 hr. REI	Bacterial spot and speck, Alternaria leaf spot, anthracnose, early and late blight, etc.	Eggplant, pepper and tomato	See label for specific usage instructions.
CYAZOFAMID (Ranman, FMC Corporation) 12 hr. REI	Pythium damping off Basil downy mildew	Tomato greenhouse transplant production and basil	Drench transplant tray with fungicide at planting or up until one week before transplant. See label for additional details.
DICLORAN (Botran, Gowan Company) 12 hr. REI	Pink rot, gray mold, *Sclerotinia* and *Sclerotium* rots, leaf blight and neck rot	Many vegetables including celery, lettuce, onions, garlic and shallots.	May cause leaf bronzing on lettuce. Use adequate volume of water.
FENHEXAMID (Decree, Arysta Life Science) 4 hr. REI	Botrytis	Tomatoes and lettuce	Protectant fungicide with some plant back restrictions. See label for details.
HORTICULTURAL OIL (Ultra-Fine Oil, Whitmire Micro-Gen) 4 hr. REI	Powdery mildew	Cucurbits, melons and squash	Application should be made when disease is first noticed. See label for information on plant safety. Use lower label rates in the greenhouse.
HYDROGEN DIOXIDE (Oxidate, Zerotol, BioSafe Systems LLC) 0 hr. REI	*Anthracnose*, downy mildew, powdery mildew, *Pythium* root rot	Many including cole crops, cucurbit, leafy vegetables, peppers and tomatoes	Strong oxidizing agent. Contact, oxidizing sanitizer . (Active ingredient: hydrogen peroxide)
KAOLIN (Surround WP, Nova Source Tessenderlo Group) 4 hr. REI	Powdery Mildew	Cucurbit vegetables	Product forms a white clay film on leaves and fruit.
MANCOZEB (Dithane F-45, DF, Dow AgroSciences LLC) 24 hr. REI	Leaf spot diseases, seed treatment for damping off, seed rots and seedling blights	Tomatoes and others	Broad-spectrum protectant fungicide.

table continued next page

Table E-15. Selected Fungicides and Bactericides Labeled for Greenhouse Use ***(continued)***

Fungicide	Target Diseases	Labeled Crops	Comments
MANDIPROPAMID (Micora, Syngenta) 4 hr. REI	Downy mildews, blue mold, and late blight, and suppression of Phytophthora blight	Brassicas, peppers, eggplants, leafy vegetables, and tomatoes.	Registered for closed greenhouses with permanent flooring on transplants for re-sale to consumers.
PENTACHLORO-NITROBENZENE PCNB (Terraclor 75 WP, Terraclor Flowable, Terraclor 15G, Chemtura Corp.) 12 hr. REI	Root and stem rot, damping off (*Rhizoctonia solani, Pellicularia filamentosa*)	Vegetable bedding plants. Limited to container-grown beans, broccoli, Brussels sprouts, cabbage, cauliflower, peppers and tomatoes.	Flowable and 75WP: Apply as a soil drench. 15G: Used as growing media mix. See label additional information.
PENTHIOPYRAD (Fontelis, DuPont) 12 hr. REI	Many, including gummy stem blight, Sclerotinia stem rot, leaf spots, powdery mildew and anthracnose	Tomatoes, peppers and edible peel cucurbits	See label for specific usage instructions.
PETROLEUMOIL (Saf-T-Side spray oil, Brandt Consolidated) 12 hr. REI	Powdery Mildew	Cucurbit vegetables	Contact fungicide. Phytotoxicity may occur. See label for details
POTASSIUM BICARBONATE (Armicarb 100, Helena Chemical Company; Milstop, BioWorks, Inc.; Kaligreen, Taogossi Co., LTD) 4 hr. REI	Powdery mildew and others	Many vegetables including cabbage, cucumber, eggplant, broccoli, cauliflower, lettuce, peppers, tomatoes and squash	Works by contact. Potassium bicarbonate disrupts the potassium ion balance in the fungus cell, causing the cell walls to collapse.
POTASSIUM SALTS OF FATTY ACIDS (M-Pede, Dow Agro Sciences) 12 hr. REI	Powdery Mildew	Greenhouse cucumber	Contact fungicide. See label for details.
PROPAMOCARB HYDROCHLORIDE (Previcur Flex, Bayer Crop Science) 12 hr. REI	*Pythium* root rot and damping off	Tomatoes, leaf lettuce, cucurbits and peppers	See label for specific usage instructions.
PYRACLASTROBIN plus BOSCALID (Pageant Intrinsic, BASF Corp) 12 hr. REI	Botrytis grey mold	Tomatoes	Pageant Intrinsic is also labeled for greenhouse use on transplants grown for the home consumer market
PYRIMETHANIL (Scala, Bayer Crop Science) 12 hr. REI	Early blight and gray mold	Tomatoes	Use in well-ventilated houses only and ventilate two hours after application.
STREPTOMYCES GRISEOVIRIDIS strain K 61 (Mycostop, Mycostop Mix, Vedera Oy, Finland) 4 hr. REI	*Fusarium*, *Alternaria*, *Phomopsis*, suppression of *Botrytis*, and root rots of *Pythium*, *Phytophthora*, and *Rhizoctonia*	Many including lettuce, cole crops, cucumbers, melons, peppers, tomatoes and others	Contains a beneficial bacterium. Repeat applications may be needed. Use as a soil spray or drench.
STREPTOMYCES LYDICUS (Actinovate, Natural Industries, Inc.) 1 hr. REI	Damping off and root rot, pathogens Pythium, Rhizoctonia, Phytophthora, Verticillium; and foliar diseases including downy and powdery mildew and Alternaria and Botrytis.	Greenhouse Vegetables and herbs and others.	May be applied to soil or foliage through mist systems or sprayer.
STREPTOMYCIN SULFATE (Agri-mycin 17, Nufarm Americas, Inc.) 12 hr. REI	Bacterial spot	Tomatoes and peppers	Repeated applications can result in resistant bacteria. Do not apply through any irrigation system.
SULFUR (Microthiol Disperss, United Phosphorus, Inc.) 24 hr. REI	Powdery mildew	Crucifers, cucurbits, peppers and tomatoes	Crops grown in greenhouses may be more sensitive to sulfur injury, so the lowest label rate should be tried initially. Do not use within two weeks of an oil spray treatment.
TRICHODERMA HARZIANUM (PlantShield, Rootshield, Bioworks, Inc.) 0 hr. REI	*Pythium*, *Rhizoctonia*, and *Fusarium.* When applied as a foliar spray, suppresses *Botrytis* and powdery mildew.	Greenhouse vegetables	Contains a beneficial fungus. Avoid applications of fungicides at least one week before or after application. Acts as a preventative. Will not cure diseased plants.

table continued next page

Table E-15. Selected Fungicides and Bactericides Labeled for Greenhouse Use *(continued)*

Fungicide	Target Diseases	Labeled Crops	Comments
TRICHODERMA VIRENS GL-21 (formerly known as *Gliocladium virens*) (SoilGard 12G, Certis USA LLC)	Damping off and root rot, pathogens *Pythium* and *Rhizoctonia*	Food crop plants in greenhouse	Acts as a preventative and will protect noninfected plants. Will not cure already diseased plants. Allow treated soil to incubate for one day prior to planting for best results. Do not use other soil fungicides at time of incorporation
TRIFLUMIZOLE (Procure, Chemtura) 12 hr. REI	Powdery mildew	Cucurbint greenhouse transplants, Butterhead varieties of leafy greens	

If any information in these tables is inconsistent with the label, follow the label. Note that some states define pesticide applications in high tunnels as greenhouse applications and other states define them as field applications. Check with your extension educator or state department of agriculture for correct application.

ASPARAGUS

Varieties[1]

Jersey Giant* (RR,FT)	Millennium*
Jersey Knight* (RR,FT)	Purple Passion*
Jersey Supreme* (RR,FT)	

[1]Varieties listed alphabetically
*Indicates hybrid variety
Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Asparagus	**per Acre**	**Pounds P_2O_5 per Acre**				**Pounds K_2O per Acre**				**Nutrient Timing and Method**
Growing crowns	50	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
	50	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
New plantings	75-100	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
Crowns and	50	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
transplants	25-50	0	0	0	0	0	0	0	0	Sidedress 4 weeks after planting.
Cutting beds =	75-100	200	150	100	0[1]	300	225	150	0[1]	Total nutrient recommended.
to maintain	50	200	150	100	0[1]	150	100	75	0[1]	Apply before cutting season.
	25-50	0	0	0	0	150	125	75	0	Sidedress 4 weeks after cutting.

Apply 1.0 to 2.0 pounds of boron (B) per acre every 3 years on most soils. See Table B-10 for more specific boron recommendations.
[1]In Virginia, crop replacement values of 50 lbs. P_2O_5 and 75 lbs. K_2O per acre are recommended on soils testing Very High.

Purity of Seed Lots

Male asparagus hybrid varieties are preferred over standard hybrids and open-pollinated populations because male plants are more vigorous and productive. The varieties listed in the table above are all male hybrids. Some seed lots may contain a significant percentage of female plants. Check with your seed supplier to determine the anticipated proportion of female and/or off-type plants in the lots you procure.

Seed Treatment

Check the tag or contact your seed supplier to determine if seed has been treated. See the Disease Section for more information.

Growing Crowns and Transplants

Crowns can be purchased from suppliers or they can be grown from seed. To grow crowns, sow seed 1½ inches deep at a rate of 6 to 8 pounds per acre (10 to 12 seeds per foot) in rows 24 to 30 inches apart. Field seed in mid-April in warmer, southern areas to mid-May in cooler areas. Crowns must be grown in an area where asparagus has never been grown.

Grow asparagus transplants in 72-100 cell trays containing artificial growing media formulated for pepper transplants. Grow seedlings for 8-10 weeks in the greenhouse, then harden-off in a protected out-door area for two weeks before transplanting. **Timely irrigation, cultivation and application of herbicides are essential** for successful use of seedling transplants. Contact your County Extension Agent for specific herbicide suggestions.

Planting and Spacing

Plant crowns and transplants April 1 to May 20 when soil conditions are favorable. Early plantings produce more vegetative growth and more vigorous crowns than late plantings. Space 1-year-old crowns and transplants 12 inches apart in rows 4½ to 5 feet apart. Make furrows 6 to 8 inches deep, plant crowns 5 to 7 inches deep. Cover crowns with 1 to 2 inches of soil. Cultivate and move soil to seedlings carefully to avoid covering foliage with soil. Gradually fill trenches during the growing season and form a 2-inch ridge over the plants after the fern turns brown in the fall.

Harvest and Postharvest Considerations

Do not harvest asparagus the year of planting. Harvest for two weeks the second year after planting and increase to 6-8 weeks as the planting matures. Stop harvesting by June 15 if fern vigor was good the previous fall. Stop sooner if spear thickness drops. Prolonged cutting increases stress on the plant and can increase root and crown rot. If foliage diseases were severe or fern vigor was low the previous fall, stop harvesting 10 days sooner than normal. Leave soil unridged on young beds for the first 2 to 3 weeks of harvest. On old beds, and in fields where freezing of early emerged spears occurs frequently, begin ridging at start of harvest season. In areas where freeze damage to spears occurs frequently, mulch the beds with straw after herbicide application to delay spear emergence. Remove spears from field promptly after cutting to maintain freshness and a low fiber content. After harvesting, spears should be washed, cooled, trimmed to a uniform length, graded by diameter and bunched. Spears can be stored for up to three weeks at 36°F and 95 percent relative humidity.

Mother Stalk Harvest System for Season Extension

Like many other crop species, asparagus possesses a feedback system for spear/shoot initiation from the underground crown. If few mature shoots ("fern") exist, the crown perceives reduced phytohormone levels and releases additional spears/shoots for elongation. When a threshold number of mature shoots is reached, no more spears/shoots will elongate thereafter from the crown. It is possible to use this system for spear harvest season extension by limiting the number of mature shoots, known as the "mother stalk harvesting system" (MSHS).

The MSHS begins by allowing a fixed number of spears to continue to grow into mature shoots, usually in the range of 2 – 4. After these shoots are established, all spears that subsequently emerge from the crown are harvested. Research has shown that spears will appear more-or-less continuously for several months, as long as the mature shoots continue to prosper and grow. The dynamics of yield are not consistent, however. Following the expected flush of spears in April – June, the rate of new spear emergence drops off during the warmer summer period, then increases once again in the fall as air and soil temperatures drop into a more hospitable range. Yields during the summer period can be extremely low, although spear quality remains acceptable. Spears harvested after the fern canopy is present often appear slightly washed out, since chlorophyll deposition is associated with light levels. Summer yields are often insufficient to justify the cost of harvesting, but must continue since new mature shoots will spell an end to later spear emergence. It is advisable to send a crew through the field to quickly sever any emerging spears on a regular basis, since they grow very quickly into mature shoots during the summer.

Successful MSHS requires more intensive management of the crop than is usually administered in a conventional harvesting system. Spear yields and quality are promoted by regular irrigation and fertilization, and pest and disease management as needed. Staking of the mature foliage prevents crop damage during violent weather events, and renders it easier to harvest young spears. The hope is that favorable market conditions will help to infringe the costs of additional management needs.

There are many variations on specific steps taken in MSHS. For example, research has shown that a period of conventional harvest at the beginning of the season (2 – 3 weeks) followed by the imposition of MSHS has a beneficial impact on cumulative season yield. In southern U.S. locations, the asparagus crop is sometimes mowed during the summer months to promote a fall harvesting season. All of these actions can have a detrimental effect on long-term viability of asparagus crowns, since they require adequate photosynthetic food from the growing months for overwintering and the next year's foliar growth. Therefore, it is not recommended that MSHS is practiced on any single production block for more than one production year. Although research on the long-term effects of MSHS on crown viability is lacking, it is recommended that a minimum of 2 years of conventional harvest separate MSHS on any given asparagus production block.

At present, it is recommended that MSHS be practiced on a small scale by growers participating in direct marketing.

Brush Removal

Burn brush (dead foliage after frost kills the "fern") during the winter to destroy fungi that cause diseases, such as rust and purple spot. (Be sure to obtain a permit in areas where required.) If burning is not done, then mow and disk brush and level ridges in February and March. Avoid damage to spear buds by shallow disking.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Seedbeds, Seeded Fields and Newly Planted Crowns

Preplant or Preemergence

Glyphosate--Apply Glyphomax Plus, Roundup Ultra Max 4SC, or Touchdown prior to crop emergence for control of emerged annual and perennial weeds. Do not apply within a week before the first spears emerge. Rate of application depends upon weed species; see label.

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone SL 2.0. Band or broadcast prior to, during, or after planting but before emergence of crop. Add wetting agent as directed on label. Do not apply paraquat within 6 days before harvest.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 9.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 1 day.

Fluazifop--0.125 to 0.188 lb/A. Apply 0.50 to 0.75 pints per acre Fusilade DX 2E plus oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 365 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Linuron--0.5 to 1.0 lb/A. Apply 1.0 to 2.0 pounds per acre Lorox 50DF when ferns are more than 6 inches tall for residual and postemergence control of many annual broadleaf weeds. Spray emerged weeds when they are less than 4 inches tall. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. A second application can be made 1 to 3 months after the initial application, but observe the following precautions: DO NOT exceed 4.0 pounds of product per acre per year. DO NOT add surfactants, DO NOT tank-mix with other pesticides, and DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur. LABELED FOR USE IN NEW JERSEY ONLY.

Sethoxydim--0.2 to 0.5 lb/A. Apply 1.0 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) to control certain annual or perennial grass weeds. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. Use the lower rate to control seedling annual grasses with less than four leaves and no tillers. Use the higher rate to control established annual grasses with tillers; grasses under stress from heat or drought; or to control perennial grasses including Bermuda grass, quackgrass, or johnsongrass. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, or weed control may be reduced. Observe a minimum preharvest interval of 1 day before harvest. Do not exceed 5.0 pints of Poast per acre in one year.

Cutting Bed

Use a combination of grass and broadleaf weed herbicides to obtain control of a wide spectrum of weeds. Identify the weeds in your field and choose herbicides that control those weeds. Split the herbicide application. Spray part of your grass herbicide before harvest and the remainder after harvest, or switch to another grass herbicide after harvest. Rotate the use of metribuzin with Karmex or Sinbar to avoid repeated use of chemically related products. Choose metribuzin or Sinbar when weeds have emerged, unless another effective postemergence herbicide is used.

Before Spear Emergence and/or after Harvest Season

Mesotrione--0.094 to 0.240 lb/A. Apply 3.0 to 7.7 fluid ounces per acre Callisto 4SC prior to spear emergence in the spring, after final harvest, or both, to control many winter and summer annual broadleaf weeds. Till the field or tank-mix with Gramoxone SL 2.0 to eliminate emerged spears when Callisto is applied after harvest, or crop injury may be observed as white or white streaks in the stems and ferns when treated spears grow. Callisto provides excellent control of horseweed (also called marestail or stickweed), including glyphosate tolerant strains, and common lambsquarters. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Callisto does not control annual grasses. Tank-mix Callisto with a residual annual grass herbicide to control annual grasses. Add oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) if target weeds are emerged at the time of application. DO NOT apply more than 7.7 fluid ounces of Callisto per acre per year, and DO NOT make more than two Callisto applications per year.

Paraquat--0.6 to 1.0 lb/A. Apply 2.4 to 4.0 pints per acre Gramoxone SL 2.0 or OLF prior to crop emergence or immediately after the last cutting to control emerged annual weeds. Add wetting agent as directed on the label. Emerged spears sprayed after the last harvest will be killed but new growth from the crown will not be affected. Tank-mix with residual herbicides for full season control. DO NOT apply within 6 days of harvest.

Diuron--0.75 to 2.0 lb/A. Apply 1.0 to 2.5 pounds per acre Karmex 80DF before spear emergence or after harvest when the soil is disked and free of weeds. Karmex primarily controls broadleaf weeds. Tank-mix with Devrinol to control annual grasses. Use Sinbar or metribuzin after harvest when Karmex is used in early spring before spear emergence.

Linuron--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Lorox 50DF prior to spear emergence or after harvest for residual and postemergence control of many annual broadleaf weeds. Spray emerged weeds when they are less than 4 inches tall. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Additional applications can be made immediately after cutting, or as a post-directed spray at the base of the fern, but observe the following precautions: DO NOT exceed 4 pounds of product per acre per year. DO NOT apply within 1 day of harvest. DO NOT add surfactants, DO NOT tank-mix other pesticides, and DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur. LABELED FOR USE IN NEW JERSEY ONLY.

S-metolachlor--1.26 to 1.90 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in asparagus in Delaware and New Jersey. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 1.33 to 2.00 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied spray prior to spear emergence. Make only one application during the growing season. DO NOT apply within 16 days of harvest.

Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in Delaware and New Jersey ONLY!

Terbacil--1.2 lb/A. Apply 1.5 pounds per acre Sinbar 80W prior to spear emergence or after harvest. Sinbar controls annual grasses and many broadleaf weeds but does not control pigweed sp. and certain other broadleaf weeds. Tank-mix with Karmex for broader spectrum of weed control. This is not recommended for use at time of planting. **Do not use on soils containing less than 1 percent organic matter**.

Metribuzin--1.0 lb/A. Apply 1.33 pounds per acre metribuzin 75DF (or OLF) before spear emergence or after harvest. Metribuzin primarily controls broadleaf weeds. Tank-mix with Devrinol to control annual grasses. Use Sinbar or Karmex after harvest when metribuzin is used in early spring before spear emergence.

Napropamide--4.0 lb/A. Apply 8.0 pounds per acre Devrinol DF-XT per year to established asparagus. Apply before weeds emerge immediately after ridging in the spring. Split the application if ridges are leveled after harvest. Make the second application immediately after leveling the ridge following the harvest season. Incorporation may improve weed control if rainfall does not occur within 24 hours of application. Devrinol controls primarily annual grasses. Combine with Sinbar, metribuzin, or Karmex at the lower labeled rates for better broadleaf weed control.

Norflurazon--2.0 to 4.0 lb/A. Apply 2.5 to 5.0 pounds per acre Solicam 80DF at the end of the cutting season. Spray immediately after the field is cultivated to level the ridges, or use postemergence hebicides to control emerged weeds. Primarily controls grasses and suppresses yellow nutsedge. Use in combination with Karmex or metribuzin to improve the spectrum of weeds controlled. Solicam is a long lasting herbicide in the soil. Do not plant sensitive crops (see label) for 2 years after application.

Sethoxydim--0.2 to 0.5 lb/A. (See the preceding "Sethoxy-dim" paragraph.)

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 1 day.

Clopyralid--0.188-0.25 lb/A. Apply 0.5 to 0.66 pints per acre Spur 3A to control or suppress sensitive annual and perennial broadleaf weeds, including Canada thistle, goldenrod, mugwort, and wild aster species. Spray before, during, or after the cutting season but before ferns develop. Apply when the majority of the weeds' basal leaves have emerged, but before the flower stalk begins to grow. Some crooking or twisting of treated spears may occur. Discard crooked or twisted spears. DO NOT apply if some crooking of emerged spears is not acceptable. Observe a minimum preharvest interval of 48 hours (2 days). Stinger or OLF carryover may affect subsequent crops. Observe all plantback restrictions listed on the label.

Fluazifop--0.125 to 0.188 lb/A. Apply 0.50 to 0.75 pints per acre Fusilade DX 2E plus oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe the minimum preharvest interval and apply no more than 6.0 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application. Labeled in Maryland and New Jersey with a 1-day preharvest interval. Labeled in Delaware and Virginia with a 7-month preharvest interval and in Pennsylvania with a 12-month preharvest interval.

Dicamba--0.25 to 0.50 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Banvel in New Jersey.** Apply 0.5 to 1.0 pint per acre Banvel 4SC to control many annual broadleaf weeds and to suppress or control many perennial broadleaf weeds. Multiple applications can be made during the growing season, provided the total applied in 1 year does not exceed 1 pint per acre. Some crooking or twisting of emerging spears contacted by the spray may occur. Discard crooked or twisted spears. Observe a minimum preharvest interval of 1 day (24 hours).

Warning: Banvel spray *or* vapor drift may injure sensitive crops growing adjacent to treated fields. Do not apply to fields adjacent to sensitive horticultural, fruit, or vegetable crops. Do not apply on days when the temperature is expected to exceed 85 degrees Fahrenheit. Spray residue is difficult to completely remove from sprayers used to apply Banvel. Do not apply Banvel with sprayers which will be used to apply pesticides to sensitive crops.

Glyphosate--Apply Glyphomax Plus, Roundup products or Touchdown products, or OLF (Other Labeled Formulations) as a spot treatment using a directed spray or shielded equipment immediately after the last harvest of the season when all spears have been removed or after ferns have developed. DO **NOT** allow spray to contact emerged spears or ferns, or severe crop injury may result. Rates and optimum application period depend on weed species (see label).

Halosulfuron 0.024 to 0.047 lb/A.--Apply 0.5 to 1.0 dry ounces of Sandea 75DF plus nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence, during or after the cutting season, to control yellow nutsedge and certain annual broadleaf weeds. Emerged common lambsquarters will not be controlled. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Observe a one (1) day preharvest interval (PHI) when applying Sandea during harvest. Application of Sandea to the ferns after harvest may cause temporary yellowing. Use drop nozzles after harvest to direct the spray under the ferns to avoid risk of crop injury and improve coverage of target weeds. Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Linuron--0.5 to 1.0 lb/A. Apply 1.0 to 2.0 pounds per acre Lorox 50DF for residual and postemergence control of many annual broadleaf weeds. Spray emerged weeds when they are less than 4 inches tall before the cutting season, immediately after cutting, or as a directed spray toward the base of the fern. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Additional applications can be made prior to spear emergence or after harvest, but observe the following precautions: DO NOT exceed 4.0 pounds of product per acre per year. DO NOT apply within 1 day of harvest. DO NOT add surfactants, DO NOT tank-mix with other pesticides, and DO NOT use the FLOWABLE (liquid) formulation, or crop injury may occur. LABELED FOR USE IN NEW JERSEY ONLY.

2,4-D--1.0 to 2.0 lb/A. Use 1.0 to 2.0 quarts per acre Formula 40. Apply after a close harvest of asparagus when weeds have considerable foliage. Use no more than two applications spaced 1 month apart. If used after harvest, avoid spraying ferns. Use low pressure; spray on calm days to avoid drift damage to surrounding plants.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Cutworms

Apply one of the following formulations:

carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--2.0 to 4.0 fl oz/A Perm-Up 3.2EC (or OLF)

Note. Early spears are the most heavily damaged because they are the first to appear and grow the slowest. Dig up to ½ inch deep around crowns and use bait if you find 1 cutworm larva or 1 severely damaged spear per 20 plants.

Asparagus Aphid

Watch for tiny (1/16 inch long), bluish green aphids building up on brush. Protection may be important in newly seeded plantings and young cutting beds. Apply one of the following formulations:

malathion--1.5 to 2.0 pts/A Malathion 57EC (or OLF)
pymetrozine--**(apply to ferns after harvest)** 2.75 oz/A Fulfill 50WDG

Asparagus Beetles

Apply one of the following insecticides when needed during cutting season and late summer:

carbaryl--1.0 qt/A Sevin XLR Plus(or OLF)
malathion--1.5 to 2.0 pts/A Malathion 57EC (or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--2.0 to 4.0 fl oz/A Perm-Up 3.2EC (or OLF)
spinetoram **(post-harvest protection of ferns only)**--4.0 to 8.0 fl oz/A Radiant SC
spinosad **(post-harvest protection of ferns only)**--4.0 to 6.0 fl oz/A Entrust SC

Prevent large numbers of beetles from overwintering and laying eggs on spears in spring by spraying ferns in early fall. Daily harvest will minimize exposure to these pests and reduce damage.

Thrips

Apply one of the following formulations:
malathion--1.5 to 2.0 pts/A Malathion 57EC (or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)

NOTE: Use of spinosad or spinetoram for asparagus beetle control will reduce thrips populations.

Asparagus Fern Caterpillar (Beet Armyworm)

Apply one of the following formulations:

chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)

Note: Use of spinosad or spinetoram for asparagus beetle control will reduce beet armyworm population.

Japanese Beetles

Apply to foliage after the cutting season:

permethrin--4.0 fl oz/A Perm-Up 3.2EC (or OLF)

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest[2]
INSECTICIDE			
carbaryl	G	12	1
chlorantraniliprole	G	4	1
malathion	G	12	1
methomyl	R	48	1
permethrin	R	12	1
pymetrozine	G	12	170
spinetoram	G	4	60
spinosad	G	4	60
FUNGICIDE (FRAC code)			
chlorothalonil (Group M5)	G	12	0
Folicur (Group 3)	G	12	180
mancozeb (Group M3)	G	24	120
MetaStar (Group 4)	G	48	AP
Rally (Group 3)	G	24	180
Ridomil Gold (Group 4)	G	48	AP
Quadris (Group 11)	G	4	100
Ultra Flourish (Group 4)	G	48	AP

See Table D-6.
[1]G = general, R = restricted
[2] AP = At planting

Disease Control

Seed Treatment

For New Jersey Only. Dip seed in a solution containing 1 pint of Clorox per gallon of water for 1 to 2 minutes. Provide constant agitation. Use at the rate of 1.0 gallon of the diluted Clorox solution per 2 pounds of seed. Prepare a fresh solution for each batch of seed. Wash seed for 5 minutes in running water and dry thoroughly at room temperature.

Fusarium Root Rot

The pathogen is ubiquitous and may be present in fields where no asparagus has been grown before. Plant varieties with tolerance to Fusarium root rot such as Jersey Giant, Jersey Knight, or Jersey Supreme. Stress caused by overharvesting, low soil pH and/or low fertility, may predispose plantings to infection. Heavy insect damage may also predispose crowns to infection. For crown production, plant treated seed and select a site where asparagus has never been grown before.

For production fields, use tolerant varieties. Plant disease-free crowns, transplants, or seed. Select well-drained fields where asparagus has never been grown. If this is not possible, select fields that have not been in asparagus for at least 8 years.

Phytophthora Crown and Spear Rot

In fields with poor drainage or extensive low areas, use 1.0 pt/A Ridomil Gold 4SL, 2.0 pt Ultra Flourish 2E/A, or 2.0 qt/A MetaStar 2E over the bed as follows:

Cutting fields: Apply 30 to 60 days before the first harvest and make a second application prior to first cutting.

New plantings: Apply after planting seedlings or after covering crowns. This treatment will **not** control Fusarium root and crown rot.

Do not apply Ridomil Gold or MetaStar one day prior to harvest or illegal residues may result.

Purple Spot

Burn brush (dead ferns) in winter to destroy overwintering sources of the fungus. Fungicide applications are not practical during the production season, because new spears emerge daily.

Once fernstalks are full size, scout on a weekly basis and apply one of the following and repeat every 2 to 4 weeks until frost:

Quadris--6.2 to 15.5 oz 2.08F/A
chlorothalonil--2.0 to 4.0 pt 6F/A or OLF

Rotate between fungicides if more than 2 applications are needed.

Asparagus Rust

For long term management of rust, plant resistant varieties such as Jersey Giant, Jersey Knight or Jersey Supreme. Control is especially necessary in 1- or 2-year beds, even with the use of resistant varieties. Scout fields, particularly non-cutting beds, for disease beginning in late June. Traditionally sprays begin in mid-August. Rotate between the following fungicides the first sign of disease:

chlorothalonil--2.0 to 4.0 pt 6F/A or OLF
Folicur--4.0 to 6.0 fl. oz 3.6F/A
mancozeb--2.0 lb 75DF/A or OLF
Rally--5.0 oz 40WSP/A plus an adjuvant (see label for specific details)

Use high rates under severe pressure from rust.

Rally and Folicur are FRAC code 3 fungicides and should not be used consecutively. Misuse of FRAC code 3 fungicides could lead to resistance development.

Leaf blights

Excessive rainfall during the summer months may lead to fungal leaf blights cause by *Alternaria* and *Cercospora* spp. Heavy infections may lead to premature defoliation and poor plant vigor later in the season and the following spring. The most noticeable signs of early leaf blight infection will be sporadic 'hot spots' of brown, dying ferns. Fields should be scouted on a regular basis, especially during periods of prolonged wet weather. Additional fungicide applications may be necessary beyond those for Purple spot and Rust control. Some of the fungicide used to control Purple Spot and Rust, such as chlorothalonil, Folicur, and mancozeb, will be useful for leaf blight control on a 10 to 14 day weather as long weather conditions are favorable for disease development.

BEANS: SNAP, LIMA, AND EDAMAME

Varieties

Snap Bean Variety Selection Guide (Bush)												
						Disease Reactions[4]						
Recommended Variety	**Color[1]**	**Length (in.)**	**Sieve Size[2]**	**Use[3]**	**Days**	**BCMV**	**BCTV**	**Cl**	**Ua**	**Psp**	**Xap**	**Pss**
Green Round Podded Types												
Advantage	DG	6.5	4	F	54	R		R				
Ambition	DG	5.5	4	F	54	R						
Ambra	MG	6.0	4	F	52	R	R					
Boone	MDG	5.5	3-4	F, P	59	R	R		R	I		R
Bowie	MDG	5.5	3-4	F, P	56	R	R					
Brio	MDG	5.2	4	P	55	R	I					
Bronco	DG	5.3	3-4	F	53	R						
Caprice	MDG	5.5	3-4	F, P	56	R		R		R	R	I
Crockett	DG	5.25	2-3	F, P	58	R	R		R	R	R	R
Carlo	MG	5.5	3-4	F	55	R						
Dandy	DG	4.75	3-4	F, P	58	R		R				
Dusky	DG	6.0	4	F	56	R				R		R
Hickok	MDG	5.5	3-4	F	54	R	R		R			
Hystyle	MG	5.1	4-5	P	56	R	R					R
Inspiration	DG	5.8	3-4	F	56	R	I					
Jade II	DG	6.5	4	F	60	R			I			
Maxibel	MG	7.0	2.3	F	60							
Momentum	DG	5.8	3-4	F	56	R						
Nickel	MG	4.25	2-3	F	53					I		
Pike	MDG	5.25	3	F	55	R	R			I	I	I
Prevail	DG	5.5	3-4	F	54	R	I					
Provider	MG	5.5	4-5	F	55							
Secretariat	DG	5.8	4	F	53	R						
Slendrette	MDG	5.0	3-4	P	55	R	R					
Strike	MG	5.5	3-4	F	55	R						
Tema	DG	5.5	3	F	53	R						
Valentino	DG	5.75	3	F	53	R			R			
Green Flat Podded Types												
Furano	MG	5.5		F, P	54	R						
Greencrop	MG	6.5		F	55							
Roma II	MG	5.5		F, P	58	R						
Yellow (Wax) Round Podded Types												
Carson	Y	5.5	4-5	F, P	56	R		R				R
Eureka	Y	5.5	4-5	F	56	R						R
Gold Mine	Y	5.3	4-5	P	56	R				R		
Goldrush	MY	6.0	4	F	55	R						
Rodcor	Y	6.0	4	F	53	R		R		R		
Uranus	DY	5.5	3-4	F	54	R		R	R			

[1]Color: MG = Medium Green, MDG = Medium Dark Green, DG = Dark Green, MY = Medium Yellow, Y = Yellow, DY = Dark Yellow

[2]Sieve Size bean diameter for majority of beans at harvest: 2 = 14.5/64 to 18.5/64 inch, 3 = 18.5/64 to 21.0/64 inch, 4 = 21.0/64 to 24.0/64 inch, 5 = 24.0/64 to 27.0/64 inch

[3]Use: F = fresh market, P = processing Not all processing beans that perform well in the region are listed and processors may use varieties not on this list. Consult with your processor for variety recommendations.

[4]R=resistance; I=intermediate/partial resistance

BCMV=Bean Common Mosaic Virus; BCTV=Beet Curly Top Virus; Ua=rust caused by Uromyces appendiculatus; Cl=anthracnose caused by Colletotrichum lindemuthianum; Psp=halo blight caused by Pseudomonas savastanoi pv. phaseolicola; Xap=common blight caused by Xanthomonas axonopodis pv. phaseoli; Pss=bacterial brown spot caused by Pseudomonas syringae pv. syringae

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Lima Bean	60-90	100	60	20	0[1]	140	100	60	0[1]	Total nutrient recommended.
Single Crop	30-40	100	60	20	0[1]	140	100	60	0[1]	Broadcast and disk-in.
	20	0	0	0	0	0	0	0	0	Band place with planter.
	20	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after emergence.
Lima Bean	30-40	0	0	0	0	0	0	0	0	Total nutrient recommended.
After peas	20	0	0	0	0	0	0	0	0	Band place with planter.
	20	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after emergence.
Snap Bean	40-80	80	60	40	0[1]	80	60	40	0[1]	Total nutrient recommended.
Single Crop	20-40	80	60	40	0[1]	80	60	40	0[1]	Broadcast and disk-in.
	20-40	0	0	0	0	0	0	0	0	Sidedress 4 weeks after planting.
Snap Bean	20-40	80	60	40	0[1]	80	60	40	0[1]	Total nutrient recommended.
After peas	0-20	80	60	40	0[1]	80	60	40	0[1]	Broadcast and disk-in.
	0-20	0	0	0	0	0	0	0	0	Sidedress 4 weeks after planting.

Apply 1.0 to 2.0 pounds of boron (B) per acre every 3 years on most soils. Do not place boron in starter fertilizers due to sensitivity problems. See Table B-10 for more specific boron recommendations.

[1]In Virginia, crop replacement values of 20 lbs. P_2O_5 and 40 lbs. K_2O per acre are recommended on soils testing Very High.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for snap beans.

Critical Snap Bean Tissue Test Values For Most Recently Matured Trifoliate Leaves.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
Before bloom	Deficient	<3.0	0.3	2.0	0.8	0.25	0.2	<25	20	20	15	5	-
	Adequate range	3.0	0.3	2.0	0.8	0.25	0.2	25	20	20	15	5	0.4
		4.0	0.5	3.0	1.5	0.45	0.4	200	100	40	40	10	-
	High	>4.1	0.5	3.1	1.6	0.45	0.4	>200	100	40	40	10	-
	Toxic (>)	-	-	-	-	-	-	-	1000	-	150	-	-
First bloom	Deficient	<3.0	0.3	2.0	0.8	0.25	0.2	<25	20	20	15	5	-
	Adequate range	3.0	0.3	2.0	0.8	0.26	0.2	25	20	20	15	5	-
		4.0	0.5	3.0	1.5	0.45	0.4	200	100	40	40	10	0.4
	High	>4.1	0.5	3.1	1.6	0.45	0.4	>200	100	40	40	10	-
	Toxic (>)	-	-	-	-	-	-	-	1000	-	150	-	-
Full bloom	Deficient	<2.5	0.2	1.5	0.8	0.25	0.2	<25	20	20	15	5	-
	Adequate range	2.5	0.2	1.6	0.8	0.26	0.2	25	20	20	15	5	-
		4.0	0.4	2.5	1.5	0.45	0.4	200	100	40	40	10	0.4
	High	>4.1	0.4	2.5	1.6	0.45	0.4	>200	100	40	40	10	-
	Toxic (>)	-	-	-	-	-	-	-	1000	-	150	-	-

Seed Treatment

Use treated seed to prevent disease. See the Disease Control section in this Chapter for more specific information.

Rough handling of seed greatly reduces germination.

Planting Dates

Planting	*Harvest*
Market snap--Apr. 10-Aug. 10	June 20-Oct. 20
Processing snap--Apr. 20-Aug. 10	July 1-Oct. 20
Fordhook lima--May 15-July 10[1]	Aug. 1-Oct. 20
Baby lima--May 15-July 20	Aug. 1-Oct. 30
Pole lima--May 15-June 15	July 15-Oct. 30

[1] In the southern part of the region, Fordhook types should be planted between June 20-July 10.

In Pennsylvania and normally cooler areas, delay start of planting by 10 days and stop planting 14 days sooner than indicated in the above table. In the southern part of the region, planting dates where pod set is occuring at temperatures abover 90° F (commonly mid July-early August) are at risk of blossom drop, split set, high cull percentage, and reduced yield.

Spacing

Snap Beans. Rows 30 to 36 inches apart, 6 to 10 plants per foot. Plant 50 to 75 pounds seed per acre depending on seed size. Narrow rows increase yields but render late-season tillage difficult. Plant in rows 18 to 24 inches apart with 5 to 7 plants per foot. Plant 75 to 120 pounds of seed per acre, depending on seed size (smaller = lower rate). Calibrate planter according to seed size. Sow 1 to 1½ inches deep in light sandy soil; shallower in heavier soil.

Lima Beans, Fordhook Type. Rows 30 to 36 inches apart, 2 plants per foot. Plant 85 pounds per acre, 1½ inches deep.

Lima Beans, Baby Types. Rows 30 to 36 inches apart, 3 to 4 plants per foot. Plant 50 pounds per acre, 1½ inches deep (deeper if soil is dry). For irrigated fields: Rows 18 to 30 inches apart, 4 to 5 inches between plants; plant 96 pounds per acre at close spacing and 78 pounds per acre at wider spacing.

Lima Beans, Pole Types Large seeded pole lima beans are often started in a cold frame or greenhouse and then transplanted to the field. Higher germination percentages are obtained in this way and earlier crops are obtained. Plant seeds in containers or plug flats at least 1.5 inches in diameter and 2 inches deep. Plant one seed per cell at a depth of one inch. Use a sterile commercial greenhouse media. Bottom heat will improve growth and produce transplants quicker. Transplant to the field once plants have the first true leaves. Do not allow to become completely root bound. Do not disturb roots during the transplanting process or stunting may occur.

Spacing – Pole lima beans are very vigorous and should not be planted too close together or excessive vine growth may reduce yields. Space plants at a distance of 3 to 6 feet in the row (less vigorous types closer, more vigorous types further apart) with a minimum of 5 feet between rows.

Irrigation

Snap beans and lima beans are grown under irrigated and dryland conditions in the region. Bean crops respond to irrigation and highest yields are obtained when soil moisture is not allowed to be depleted by more than 50 percent from the 2 trifoliate leaf stage through pod sizing. Beans are most sensitive to moisture stress during flowering and pod sizing. Water use during this period can be over 0.25 inches per day and water deficit during this period will have the greatest negative impact on yields and pod quality. A balance must be struck however, between maintaining adequate moisture for pod growth while minimizing wetness in the canopy which promotes white mold in all beans and downy mildew and pod blight in lima beans.

Trellising Pole Lima Beans

Sturdy wooden or metal posts should be spaced every 15 to 20 ft in the row. Additional smaller spacer stakes may be needed in between posts. At least 5 ft, preferably 6 ft, of the posts or stakes should be above ground. Tightly stretch a 10 to 12 gauge wire and nail to the tops of the stakes. Stretch a smaller wire or twine and nail to the posts halfway up above the ground. Then tie the twine in a crisscross fashion to the top wire and to the bottom wire (or twine) on which the beans will climb. An individual stake or line should be placed at each plant for initial climbing to the trellis. Bean supports should be put up before the bean plants begin producing "runners" and falling over. A ground wire may also be used and then twine is woven in a V fashion over the top wire and under the bottom wire. An alternative system would use 6 foot plastic netting attached to the posts and a top and bottom wire. It is very important to have a sturdy trellis due to the heavy weight of the lima bean vines.

No-Till / Conservation Tillage

Snap beans have been successfully grown in no-till and conservation tillage systems. In no-till systems, seed are drilled into the stubble/plant residue of a small grain and/or hairy vetch crop. Give consideration to bean variety, date of planting, soil fertility practices, insect control, planting equipment, mulch, residue at harvest, and weed species in the field.

See "Conventional Tillage" section for other preemergence and postemergence weed control recommendations.

Harvest and Post Harvest Considerations

For processing snap beans, harvest is usually started when a graded sample contains about 50% No. 4 sieve size and under. The actual sieve size percentage will vary depending on processor needs and the bean variety. Fresh market snap beans are either hand harvested multiple times at the desired size or machine harvested when the highest percentage of marketable beans can be obtained.

Baby lima beans for mechanical picking are harvested when the highest percentage of full pods can be obtained and when approximately 10 % dry pods are found on the plants. Hand picked lima beans are picked at full green seed stage. Fordhook lima beans should be harvested when the highest percentage of full pods are obtained but before any pods have dried.

Yields of processing snap beans in the 4-6 tons per acre and fresh market snap beans of 150-250 bushels per acre range are expected.

Beans for processing are processed soon after harvest. Transport times should be minimized. Washing and precooling shelled beans is recommended for distance transport.

Snap beans are either hand harvested or machine harvested and then transported to a grading area. They are graded to remove stones, stems, leaves, and other trash; broken, misshapen, or damaged beans; other foreign matter, undermature beans, and overmature beans. Processing beans are further sorted into sieve sizes. Beans for fresh market shipping should mean US No. 1 standards or higher.

A grading line will typically have offloading and conveying belts; a gravity separator to remove soil, rocks, and heavy field trash; an air blast trash remover for leaves, stems, and other light field trash; a rotating drum tumbler to remove pin beans and immature pods through slots; a broken bean eliminator; vibrating tables where good pods are further segregated from field trash; a sizer for processing beans; vibrating washers where pods are rinsed with clean water to remove adhering soil particles and to remove some of the field heat; grading tables where pods are manually inspected to remove overmature, blemished, decayed, or other defective pods; and for fresh market beans, a box filler.

Beans are moved by vibration into wirebound crates or waxed cartons, which are weighed and unloaded onto a box closing machine after which flled containers go to cooling areas (a hydrocooler or forced air cooling room) and then into cold storage. In smaller operations, many of these processes will be done by hand at a sorting table.

Field packing, while possible is practical mainly for direct market and local sales. Beans may also be harvested directly by consumers or local wholesalers as U-pick.

Fresh market snap beans are highly perishable and should be cooled rapidly after harvest, preferably to 40-43 F. They can be effectively vacuum cooled or forced-air cooled, but hydrocooling is preferable not only because cold water cools rapidly but also because the free moisture helps prevent wilting or shriveling. Always use chlorinated water when washing and hydrocooling beans. A free chlorine concentration of about 55 to 70 ppm at pH 6.5-7.0 (neutral) is recommended. Snap beans lose moisture rapidly if not properly protected by packaging or by a relative humidity of 95% or above. When the relative humidity approaches saturation, as in consumer packages, temperatures above 45 F must be avoided or decay is likely to be serious within a few days.

Green beans should be stored at 39 F to 45 F and 95 percent relative humidity. Under these conditions, snap beans will maintain quality for 7 to 10 days. Temperatures of 38 F and lower may cause significant chilling injury to beans. Beans should not be stored or shipped with ethylene generating fruits and vegetables.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in snap beans and lima beans.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preemergence

S-metolachlor--0.63 to 1.91 lb/A. Apply 0.66 to 2.00 pints per acre Dual Magnum 7.62E after seeding and before emergence. Tank-mix with Glyphomax Plus, Roundup Ultra Max 4SC, Touchdown, or Gramoxone SL 2.0 to control emerged weeds. Bentazon, postemergence, may be required for adequate broadleaf weed control. A modified fertility program may be necessary, especially for nitrogen (such as early sidedressing). Do not use on black turtle soup beans. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Clomazone (snap beans only)--0.094 to 0.188 lb/A. (See the following "clomazone "paragraph in conventional tillage).

Glyphosate--0.75 to 1.10 lb acid equivalent/A. Apply 1.6 to 2.4 pints per acre Roundup Ultra Max, 2.0 to 3.0 pints per acre Touchdown, or 2.0 to 3.0 pints per acre Glyphomax Plus after seeding and before emergence. Tank-mix with Dual Magnum 7.62E for residual weed control. Roundup Ultra Max 4SC controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label.

Paraquat--0.6 to 1.0 lb/A. Apply 2.4 to 4.0 pints per acre Gramoxone SL 2.0 a or OLF fter seeding but before emergence, or as a split application before and after seeding to control emerged annual weeds. Do not exceed the maximum total labeled rate when using the split application. Tank-mix with Dual Magnum 7.62E for residual weed control.

Conventional Tillage

Preplant Incorporated

EPTC (snap beans only)--2.5 to 3.0 lb/A. Apply 3.0 to 3.5 pints Eptam 7E or 15 pounds of Eptam 20G. Useful for nutsedge control, annual grasses, and some broadleaf weeds. Incorporate by disking twice into 3 to 4 inches of soil immediately after application. Tank-mix with Treflan to improve control of common lambsquarters. Combining Eptam with Dual Magnum may improve weed control but may increase the risk of crop injury when weather conditions are adverse.

Imazethapyr (lima beans)--0.024 to 0.031 lb/A. Apply 1.5 to 2.0 fluid ounces per acre Pursuit 2SC. Shallow, thorough incorporation improves consistency of performance when dry weather follows application. Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses. Pursuit residues persist in the soil after harvest and may affect following crops. DO NOT exceed 2 fluid ounces per acre of Pursuit 2SC at planting or make more than one application per acre per year. Follow label instructions pertaining to following crops.

S-metolachlor--0.63 to 1.91 lb/A. Apply 0.66 to 2.00 pints per acre Dual Magnum 7.62E. Incorporate 2 to 3 inches deep by disking twice with blades set 4 to 6 inches deep. Primarily controls annual grasses and nutsedge. Do NOT use on black turtle soup beans. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Pendimethalin (lima beans)--0.48 lb/A. Apply 1.0 pint of Prowl H_2O or OLF per acre and incorporate to mix thoroughly with the top 2 to 3 inches of soil. Primarily controls annual grasses and certain broadleaf weeds. Do not use when soils are cold and/or wet soil conditions are anticipated during emergence, or crop injury may result. **Not recommended in New Jersey.**

Trifluralin--0.5 to 0.75 lb/A. Apply 1.0 to 1.5 pints per acre of Treflan 4E or 10 to 15 pounds per acre of Treflan 5G. Incorporate it into 2 to 3 inches of soil within 8 hours after application. Primarily controls annual grasses and a few broadleaf weeds. Treflan may be applied up to 4 weeks prior to planting. Do not use or reduce the rate used when cold, wet soil conditions are expected, or crop injury may result.

Preemergence

Carfentrazone + sulfentrazone (lima beans only)--0.008 to 0.01 + 0.074 to 0.092 lb/A. Apply 3.00 to 3.75 fluid ounces per acre Spartan Charge to control many annual broadleaf weeds, including ALS resistant pigweed species. Combine with another herbicide to control annual grasses. Apply no later than 3 days after seeding, but do NOT apply after cracking. Expect some temporary crop injury after emergence. DO NOT use Spartan Charge if temporary crop injury is not acceptable. **Labeled for use in Delaware ONLY!**

Clomazone (snap beans only)--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Combine with Dual Magnum 7.62E to control yellow nutsedge and pigweed. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in snap beans. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

DCPA (snap bean only)--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse-textured soils low in organic matter and when the application was followed by rainfall or irrigation.

Halosulfuron--0.024 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounces of Sandea 75DF preemergence to control or suppress yellow nutsedge and many annual broadleaf weeds. Results have been most consistent when the application was followed by rainfall or irrigation. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Observe a thirty (30) day preharvest interval (PHI). Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Imazethapyr (lima beans)--0.024 to 0.047 lb/A. Apply 1.5 to 3.0 fluid ounces per acre Pursuit 2SC. Weed control may be inconsistent when dry weather follows application. Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses. Pursuit residues persist in the soil after harvest and may affect following crops. DO NOT apply more than 3.0 fluid ounces of Pursuit 2SC per acre per year. Follow label instructions pertaining to following crops.

S-metolachlor--0.63 to 1.91 lb/A. Apply 0.66 to 2.00 pints per acre Dual Magnum 7.62E. Primarily controls annual grasses and a few broadleaf weeds. Do NOT use on black turtle soup beans. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Sulfentrazone *plus* carfentrazone (jug-mix)--0.082 to 0.103 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Spartan Charge for lima beans in Delaware only.** Apply 3 to 3.75 fl oz per acre of Spartan Charge 3.5 EC as a preemergence application. Spartan Charge will injure emerged lima beans as well as plants that have germinated and are very close to breaking through the soil surface. Use the lower rate on sandy soils with low organic matter. The 24c Label for use of Spartan Charge in lima beans is for control of ALS-resistant pigweed (Group 2 herbicides). At this low rate, Spartan Charge will provide early-season control of pigweed, but do not expect to see significant control of most other species on the label of sulfentrazone products. The level of crop safety is marginal with Spartan Charge and so overlaps will cause injury. Similarly, rinsing tanks in the field can increase the risk of injury as well. Sandy soils or sandy knolls in fields are likely to show injury. Injury can occur if Spartan Charge treated soil is splashed onto emerging and very young seedlings. To reduce this risk, apply Spartan Charge immediately after planting, followed by irrigation to move the herbicide into the soil, rather than allowing it to remain on the soil surface. University of Delaware research shows that most fields will recover from injury and not impact maturity dates or yield.

Postemergence

Bentazon--0.5 to 1.0 lb/A. Apply 1.0 to 2.0 pints per acre Basagran 4SC when beans have fully expanded first trifoliate leaves. Use lower rate to control common cocklebur, mustards, and jimsonweed and the higher rate to control yellow nutsedge, common lambsquarters, common ragweed, and Canada thistle. Temporary, pronounced crop injury may be observed that can result in delayed maturity. The use of oil concentrate may increase the risk and severity of crop injury. To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when weeds are small and soil moisture is adequate. Do not spray when temperatures are over 90°F (32.2°C).

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 21 days.

Fomesafen (snap beans only)--0.125 to 0.188 lb/A. Apply 0.50 to 0.75 pints per acre of Reflex 2SC when snap beans have one to two fully expanded trifoliate leaves. The recommended rate lower than the labeled rate to reduce the risk of crop injury. Use the lower recommended rate when weeds are small or when plentiful soil moisture, high humidity, and warm cloudy weather cause “soft” growing conditions. Add nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray). Tank-mix with bentazon (Basagran) to improve the control of common lambsquarters. Lima beans and most other vegetables are sensitive to fomesafen. Observe labeled plantback restrictions. DO NOT apply to any field more than once every two years.

Halosulfuron--0.024 to 0.031 lb/A. Apply 0.50 to 0.66 dry ounces of Sandea 75DF plus nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) postemergnence to control yellow nutsedge and certain annual broadleaf weeds. Use only the lower rate when treating snap beans. Applications should be sprayed when the crop has 2 to 3 trifoliate leaves and annual weeds are less than 2 inches tall. Treatments applied when beans are younger increases the risk of temporary stunting, and applications after the 3 trifoliate leaf stage increases the risk of a split set. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Observe a thirty (30) day preharvest interval (PHI). Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Imazamox (lima bean only)--0.031 lb/A. Labeled and recommended for use in DE, MD, and VA only. Apply 4.0 fluid ounces of Raptor 1SC per acre to control annual broadleaf weeds when the crop has one to two fully expanded trifoliate leaves. Add nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray). Add 0.5 to 1.0 pint of bentazon (Basagran) to reduce the expression of injury symptoms. Strictly observe all plantback restrictions. Raptor is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. ALS resistant weeds are present in the mid-Atlantic region and will not be controlled.

Quizalofop-P-ethyl (snap beans only)--0.04 to 0.08 lb/A. Apply 6.0 to 12.0 fluid ounces per acre Assure II/Targa 0.88EC postemergence to control most annual and perennial grasses. Add with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with other pesticides unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 14 fluid ounces per acre in one season.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1.0 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within one week before or after Basagran or any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 4 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Maggot

chlorpyrifos--Lorsban ST – **commercially applied seed treatment only**
thiamethoxam--Cruiser 5FS – **commercially applied seed treatment only**

Cutworms (See the "Cutworms" section in Soil Pests--Their Detection and Control.) Apply one of the following formulations:

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC(Sniper, or OLF)
carbaryl--(**snap beans only**) 1.00 to 1.50 qts/A Sevin XLR Plus (or OLF)
diazinon--2.0 to 4.0 qts/A Diazinon AG500 (or OLF)
esfenvalerate **(snap beans only)--**5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Besiege
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin + bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Treatments should be applied if thrips are present from cotyledon stage to when the first true leaves are established and/or when first blossoms form. Apply one of the following formulations:

acetamiprid--4.5 to 5.3 oz/A Assail 30SG (or OLF)
bifenthrin--2.1 to 6.40 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin + imidacloprid--3.8 to 5.5 fl oz/A Brigadier
imidacloprid--**soil** 7.0 to 10.5 fl oz/A Admire Pro (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram--5.0 to 8.0 fl oz/A Radiant SC
spinosad--2.5 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin + bifenthrin--10.3 fl oz/A Hero EC

Mites

Spot-treat areas along edges of fields when white stippling along veins on underside of leaves is first noticed and 20 mites per leaflet are present. Apply one of the following formulations:

bifenthrin--5.12 to 6.40 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenazate – 1.0 to 1.5 lbs/A Acramite 50WS
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
fenpyroximate (**snap beans only**)--2.0 pt/A Portal
zeta-cypermethrin + bifenthrin--10.3 fl oz/A Hero EC

Aphids

Treat only if aphids are well distributed throughout the field (50 percent or more of terminals with five or more aphids), when weather favors population increase, and if beneficial species are lacking. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
bifenthrin + imidacloprid--3.8 to 5.5 fl oz/A Brigadier
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
imidacloprid--**soil** 7.0 to 10.5 fl oz/A, **foliar** 1.2 fl oz/A Admire Pro (or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
sulfoxaflor – 0.75-1.00 oz/A TransformWG

Leafminers

Apply one of the following formulations:

cyromazine--2.66 oz/A Trigard 75WP
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
spinetoram--5.0 to 8.0 fl oz/A Radiant SC
spinosad--2.5 to 3.3 oz/A Blackhawk 36WG

Leafhoppers

Treat only if the number of adults plus nymphs exceeds 100 per 20 sweeps during prebloom, 250 per 20 sweeps during bloom, or 500 per 20 sweeps during pod development. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
bifenthrin--1.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin + imidacloprid--3.8 to 5.5 oz/A Brigadier
carbaryl **(snap beans only**)--1.0 qt/A Sevin XLR Plus (or OLF)
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
esfenvalerate **(snap beans only)--**2.9 to 5.8 fl oz/A Asana XL
imidacloprid--**soil** 7.0 to 10.5 fl oz/A Admire Pro , **foliar** 1.2 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 3.00 pts/A Lannate (or OLF)

thiamethoxam--Cruiser 5ST–**commercially applied seed treatment only**
zeta-cypermethrin--2.72 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Stink bugs, Tarnished Plant Bug (TPB)

Treat only if the number of adults and/or nymphs exceeds 15 per 50 sweeps from the pin pod stage until harvest. Apply one of the following formulations:

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
dimethoate (**TPB only)** --0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl (**TPB only)--**1.50 to 3.00 pts/A Lannate (or OLF)
sulfoxaflor (**TPB only**)--1.50 to 2.25 oz/A Transform WG
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cyperrmethrin+bifenthrin--10.3 fl oz/A Hero EC

Mexican Bean Beetle

Treat if defoliation exceeds 20 percent during prebloom or 10 percent during podding and there is a population potential for further defoliation. These levels of defoliation may result in earlier maturity of the crop. Wait until hatch or adult emergence when eggs and pupae are present. On farms with a succession of bean plantings, the release of the larval parasitoid, *Pediobius foveolatus*, may provide effective biological control. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl (**snap beans only**)--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
esfenvalerate **(snapbeans only)--**2.9 to 5.8 fl oz/A Asana XL
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Besiege
methomyl--0.75 to 3.00 pts/A Lannate LV (or OLF)
zeta-cypermethrin--2.72 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cyperrmethrin + bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Bean Leaf Beetle

Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG
bifenthrin--2.1 to 6.4 fl oz/A Bifenture (Sniper, or OLF)
carbaryl (**snap beans only)**--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
thiamethoxam--Cruiser 5ST – **commercially-applied seed treatment only**
zeta-cypermethrin--2.72 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Beet Armyworm

Apply one of the following formulations:
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
methoxyfenozide--4.0 to16.0 fl oz/A Intrepid 2F
spinetoram--4.0 to 8.0 fl oz/A Radiant SC
spinosad--2.2 to 3.3 oz/A Blackhawk 36WG

Cabbage Looper

Treat if the total number of any worm pests averages 30 per 3 feet of row. Apply one of the following formulations

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
esfenvalerate **(snapbeans only)--**5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 16.0 fl oz/A Intrepid 2F
spinetoram--4.0 to 8.0 fl oz/A Radiant SC
spinosad--2.2 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin +bifenthrin--4.0 to 10.3 fl oz/A Hero EC

European Corn Borer (ECB)--Processing Snap Beans

The most critical times for corn borer treatment are at the bloom and pin stages. Begin treatment when moths are first detected in local blacklight traps. The first application should be applied during the bud-early bloom stage and the second application during the late bloom-early pin stage. After the pin spray, the following thresholds and spray intervals should be used:

Number ECB Moths(BLT)/5 Days	Spray Interval (Days)
Less than 10	No spray
11-25	7
26-50	6
51-75	5
76-250	4
250+	3

European Corn Borer (ECB)--Fresh Market Snap Beans

As a general guideline, treatment should begin when blacklight trap catches average five or more per night. Treatments should be applied on a 7-day schedule from the pin stage until harvest. In general, one to three applications will be needed. Apply one of the following formulations:

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
esfenvalerate **(snap beans only)--**5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram--8 oz/A Radiant SC
spinosad--3.3 oz/A Blackhawk 36WG
zeta-cypermethrin--2.72 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Whiteflies

Apply one of the following formulations:
acetamiprid--4.0 to 5.3 oz/A Assail 30SG
flubendiamide + buprofezin--13.6 to 17.0 fl oz/A Vetica
imidacloprid--**soil** 7.0 to 10.5 fl oz/A Admire Pro, **foliar** 1.2 fl oz/A Admire PRO (or OLF)

Corn Earworm (CEW)

In snap beans, treat every 5 to 7 days if CEW catches in local blacklight traps average 20 or more per night and most corn in the area is mature.

For lima beans, treat when CEW populations exceed one per 6 feet of row.
Apply one of the following formulations:

bifenthrin--2.1 to 6.4 fl oz/A Bifenture (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
esfenvalerate **(snapbeans only)--**5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram--4.0 to 8.0 fl oz/A Radiant SC
spinosad--2.2 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin--2.72 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin + bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
bifenthrin	R	12	3
bifenthrin + imidacloprid	R	12	7
bifenazate	G	12	3
carbaryl(snap beans only)	G	12	3
chlorantraniliprole	G	4	1
cyromazine	G	12	7
INSECTICIDE *(continued)*			
diazinon	R	72	see label
dimethoate	R	48	see label
esfenvalerate	R	12	3
fenpyroximate (snap beans only)	R	12	1
flubendiamide	G	12	1
flubendiamide + buprofezin	G	12	14
imidacloprid (soil/foliar)	G	12	21/7
lambda-cyhalothrin	R	24	7
lambda-cyhalothrin + chlorantraniliprole	R	24	7
methomyl[3]	R	48	see label
methoxyfenozide	G	4	7
spinetoram	G	4	3
spinosad	G	4	3
sulfoxaflor	R	24	7
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
chlorothalonil (snap bean only) (Group M5)	G	12	7
Contans WG (biological)	G	4	0
Cueva (Group M1)	G	4	0
copper, fixed (Group M1)	G	24	0
Endura (Group 7)	G	12	7
Folicur (Group 3) (snap bean)	G	12	7
Fontelis (Group 7)	G	12	0
Forum (Group 40)	G	12	0
Headline (Group 11)	G	12	7
Fontelis (Group 7)	G	12	0
iprodione (Group 2)	G	24	0
K-phite (Group 33)	G	4	1
Omega (Group 29)	G	48	14
Phostrol (Group 33)	G	4	1
Priaxor (Group 7 + 11)	G	12	7
ProPhyt (Group 33)	G	4	0
Quadris (Group 11)	G	4	0
Quilt Xcel (Group 3 +11)	G	12	7
Rally (Group 3) (snap bean)	G	24	0
Rampart (Group 33)	G	4	1
Ridomil Gold (Group 4)	G	48	3
Ridomil Gold Copper (4 + M1)	G	48	5
Switch (Groups 9 + 12)	G	12	7
thiophanate-methyl (Group 1)	G	12	14
Uniform (Groups 4 + 11)	G	0	AP

(table continued next column)

See Table D-6.
1 G = general, R = restricted, AP = At planting
2 Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
3 Days to harvest depends on rate. CONSULT LABEL.

Nematode Control

See Chapter E – Pest Management "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or Mocap 15G at 13-20 lb/A (0.9 to 1.4 pound per 1000 linear feet of row) in a 12 in. band over the row Do not use as an in-furrow treatment.

Snap beans are susceptible, but baby lima beans are resistant to SCN. Growers who rotate snap beans with soybeans should be alert to the possibility of problems in infested fields. Snap beans and lima beans are very susceptible to root knot nematodes.

Soil sampling fields in the fall for SCN and root knot nematode is highly recommended for fields to be planted the following season.

Disease Control

Seed Treatment

Use seed treated with Allegiance or Apron XL LS (0.16 to 0.64 fl oz/100 lb seed) for *Pythium* control plus either Maxim 4FS (0.08 to 0.16 fl oz/100 lb seed) for *Rhizoctonia* and *Fusarium* control or Dynasty (0.15 to 0.76 fl oz/100 lb seed) for *Rhizoctonia* control.

Rough handling of seed greatly reduces germination.

IMPORTANT: Do not use treated seed for food or feed.

Anthracnose and Web Blight *(Rhizoctonia)*

Use western-grown seed and rotate to allow 2 years between bean plantings. When disease appears and/or environmental conditions favors disease development.

Apply one of the following formulations on a 7-14 day schedule and rotate between different modes of action:

Quilt Xcel--10.5-14.0 fl. oz 2.2 SE/A
Quadris--6.2 to 15.5 oz 2.08SC/A
Headline--6.0 to 9.0 fl oz 2.1EC/A
Priaxor--4.0 to 8.0 fl oz 4.17SC/A

Pythium blight (Cottony leak)

Select varieties with good plant architecture that keep the pods off the soil. Narrow row spacing may help keep plants erect and pods from touching the soil. Select fields with good drainage and do not overwater.

Apply one of the following formulations at disease onset and rotate between different modes of action:

Ridomil Gold Copper--5.0 lb 65WP/2.5A
Prophyt--4.0 to 6.0 pts/A
K-Phite--1.0 to 3.0 qt 7LP/A
Phostrol--4.0 to 5.0 pt/A
Rampart--3.0 qt/A

Bacterial Blight

Use western-grown seed.

When incidence is low, apply the following on a 7-10 day schedule:

Fixed copper--1.0 lb a.i/A
Cueva--0.5 to 2.0 gal 9.46L/A

Bacterial Brown Spot

This seed-borne disease occurs primarily on lima beans and is more troublesome in irrigated fields and during wet seasons. Use certified pathogen free seed.

When incidence is low, apply the following on a 7-10 day schedule:

Fixed copper--1.0 lb a.i/A
Cueva--0.5 to 2.0 gal 9.46L/A

Common Bean Rust (*Uromyces appendiculatus*) of Snap Bean

Rust is a problem during late summer/early fall. Plant resistant varieties whenever possible. For susceptible varieties, spray when the disease first appears, and repeat every 7 days.

Apply one of the following formulations ***on a 7-14 day schedule and rotate between different modes of action***:

Quilt Xcel--10.5-14.0 fl. oz 2.2 SE/A
Quadris--6.2 to 15.5 fl oz 2.08F/A
Rally--4.0 to 5.0 oz 40WSP/A
Folicur--4.0 to 6.0 fl oz 3.6F/A
Headline--6.0 to 9.0 fl oz 2.1EC/A
chlorothalonil--2.0 to 4.0 pt 6F/A or OLF
Fontelis--14.0 to 30.0 oz 1.67SC/A

Root Rots

Rotate beans with non-legume crops. Avoid poorly drained soils. Plow under previous crop residue rather than discing. Root rot is caused by a complex of soilborne fungi including *Rhizoctonia*, *Pythium* and *Fusarium*. The primary cause of root rot in the mid-Atlantic region is *Pythium* spp. Pythium causes extensive damage in July and August during periods of warm, humid weather. *Pythium* can also cause extensive pod rot on snap beans. Select varieties that set high in the plant and use a close row spacing to avoid pod contact with the soil to reduce disease incidence.

Apply one of the following at planting:

Ridomil Gold--0.5 to 1.0 pt 4SL/A. Apply in a 7-inch band over the row at seeding. (for *Pythium* only)

<u>To provide control of root rot caused by *Pythium* and *Rhizoctonia*, apply the following:</u>

Uniform--0.34 fl oz 3.66SE/1000 ft row. Apply in a 7 in band after seeding. Avoid direct seed contact, which may cause delayed emergence.

<u>To provide control of root rot caused by *Rhizoctonia*, apply the following in a band up to 7 inches wide:</u>

Quadris--0.4 to 0.8 fl oz 2.08F/1000 ft row

Lima Bean Downy Mildew

Races B, D, E, and F have been found in the mid-Atlantic area during the past 10 years. **Race F has been the only race detected in DE since 2006.** Use resistant varieties where possible. Conditions for disease are favorable when fields receive 1.2 inches or more of rain within 7 days and when the average daily temperature during this period is 78^{o}F (25.6^{o}C) or less. If a period of 90^{o}F (32.2^{o}C) occurs during this period, the cycle is broken, and an additional 7-day period with the above weather conditions is necessary to start infection. Periods of fog or heavy dew can lower the amount of rain necessary for infection to occur. Since environmental conditions vary from field to field and in different locations within a field, use the above information as a guideline. Fields that are not rotated and planted to susceptible varieties should be scouted regularly for disease occurrence.

When weather conditions are favorable for disease apply one of the following:

fixed copper--(Champ DP, 2.0 lb 58DF/A, Kocide 3000) 1.25 lb DF/A or OLF
Forum--6.0 fl oz 4.18SC/A
Headline--6.0 to 9.0 fl oz 2.1 EC/A
ProPhyt--3.0 to 4.0 pts/A
K-Phite--1.0 to3.0 qt/A
Rampart--1.0 to 3.0qt/A
Ridomil Gold Copper--2.0 lb 65WP/A
Phostrol--4.0 pt/A

If lima bean downy mildew is observed in the field, ***apply one of the following:***

Ridomil Gold Copper--2.0 lb 65WP/A
ProPhyt--3.0 to 4.0 pts/A
K-Phite--1.0 to3.0 qt/A
Phostrol--4.0 pt/A

Lima Bean Pod Blight (*Phytophthora capsici*)

Rotate away from other susceptible crops such as peppers, cucurbits or tomatoes. Avoid heavy irrigation and irrigating at night. ***In fields with a history of Phytophthora blight the following may suppress disease when applied for control of downy mildew:***

Ridomil Gold Copper--2.0 lb 65 WP/A
Forum--6.0 fl. oz 4.18SC/A (Endura--8.0 to 11.0 oz 70W/A)

White Mold *(Sclerotinia)* and Gray Mold *(Botrytis)*

Preplant: **For white mold only.** Apply 3 to 4 months prior to disease onset to allow the active agent to reduce levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding beans to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Apply the following:

Contans--2.0 to 4.0 lb 5.3WG/A

Post seeding: Close spacing of snap beans may increase the potential for white mold. Fungicide sprays are needed *only* when the soil has been wet for 6 to 10 days before bloom. For snap beans, a fungicide should be applied at 10-20% bloom. A second spray should be made 7-10 days after the first spray, if the soil remains wet and blossoms are still present. Check labels for details on fungicide timing. For lima beans, later fungicide applications have been beneficial if favorable environmental conditions persist.

Apply one of the following:

Endura--8.0 to 11.0 oz 70W/A
Endura--5.0 oz 70W/A plus thiophanate-methyl (0.7 to 1.05 lb/A 70WP/A active ingredient) (snap beans only)
iprodione--1.5 to 2.0 pts 4F/A or OLF
Omega--8.0 fl oz 500F/A (**also provides good downy mildew control**)
thiophanate-methyl--1.5 to 2.0 lb 70WP/A or OLF
Switch--11.0 to 14.0 oz/A 62.5WG
Switch--6.0 to 11.0 oz/A 62.5WG plus thiophanate-methyl (0.7 to 1.05 lb a.i./A)
Fontelis--16.0 to 30.0 fl. oz 1.67SC/A

Southern Blight (*Sclerotium rolfsii*)

Southern blight can be a serious disease of snap and lima beans in the southernmost areas of the region. The disease is favored by high temperatures as well as wet weather and/or irrigation. Rotations do not eliminate the pathogen, but rotations with corn, sorghum, small grains or grasses reduce disease severity. Moldboard plowing to bury sclerotia can also reduce disease severity. Fungicides can also provide some protection.

Quadris--15.4 fl oz 2.08F/A

BEETS (Garden)

Beets are frost tolerant and produce the best commercial quality when grown during cool temperatures (50^{o} to 65^{o}F [10^{o} to 18.3^{o}C]). Lighter color and wider zoning occur during rapid growth in warm temperatures. Beets will form seedstalks if exposed to 2 or 3 weeks of temperatures below 50^{o}F (10^{o}C) after several true leaves have formed. Beets have a high boron requirement. See Plant Nutrient Recommendations below and Table B-10.

Recommended Beet Varieties

Market	Hybrid	Days	Color	Shape	Use
Boro	Yes	51	Red	Globe	Roots, tops, bunching, baby beets
Cylindra	No	54	Red	Cylindrical	Roots, bunching
Chioggia Guardsman	No	60	Purple & White Zones	Globe	Roots
Eagle	Yes	50	Red	Globe	Roots, bunching
Early Wonder	No	52	Red	Globe	Greens, bunching
Greentop Bunching	No	58	Red	Round	Greens, bunching
Kestrel	Yes	53	Red	Globe	Roots, Bunching
Merlin	Yes	55	Red	Globe	Roots
Pacemaker III	Yes	53	Red	Globe	Roots, bunching
Red Ace	Yes	53	Red	Globe	Roots, bunching
Red Cloud	Yes	53	Red	Round	Roots, bunching
Ruby Queen	No	55	Red	Round	Roots, bunching
Soldier	Yes	30-55	Red	Top shaped	Dark red leaf for greens
Touchstone Gold	No	60	Gold	Round	Roots, bunching
Zeppo	Yes	50	Red	Round	Roots, bunching

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
Beets	Pounds N per Acre	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	75-100	150	100	50	0	150	100	50	0	Total nutrient recommended.
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting.

Apply 1.5 to 3.0 pounds of boron (B) per acre. See Table B-10 for more specific boron recommendations.

Seed Treatment

Use treated seed to prevent disease, see the Disease Section for more information

Seeding and Spacing

The crop is seeded from early April to Mid-August. Optimum germination temperatures range between 50° to 85°F (10° to 29.4°C). Sow seed 1/2 inch deep at the rate of 15 to 18 seeds per foot of row. Space rows 15 to 20 inches apart; thin plants to 3 inches apart. For Fall seeding, rows should be spaced 4-6" apart.

Harvest and Post Harvest Considerations

Market beets are harvested when they reach a size of 1.5-3 inches in diameter. Beet tops for greens may be cut and handled similar to spinach or chard. For bunching beets, roots are undercut and pulled by the tops taking care not to damage them. For larger acreages, beets for roots may be topped and machine dug using a modified potato digger.

Store beets at 32 F and relative humidity of 98 to 100%. Like other root crops, beets are well adapted to storage. Topped beets stored at 32 F can be expected to keep 4 to 6 months. Either cold storage or cool-cellar storage is suitable, provided the humidity is kept sufficiently high to prevent dehydration.

Before beets are stored, they should be topped and sorted to remove all those with disease or mechanical injury. Beets should not be stored in large bulk; and they should be stored in well-ventilated containers, such as ventilated bin boxes or slatted crates, to help dissipate respiratory heat. Increasing the carbon dioxide level in beet storages to 5 to 10 % increased fungal spoilage.

Bunched beets are much more perishable than topped beets, but they can be stored at 32 F for 10 to 14 days. Use of crushed ice is helpful in keeping the bunched beets cold, especially if refrigeration is not available.

Beet greens and other greens are handled like spinach. Because of the perishability of beet greens, they should be held as close to 32 F as possible. At this temperature, they can be held for 10 to 14 days. Relative humidity of at least 95 % is desirable to prevent wilting. Air circulation should be adequate to remove respiration heat but not so rapid that air circulation speeds transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. These leafy greens are commonly shipped with package and top ice to maintain freshness. Research has shown that kale packed in polyethylene-lined crates and protected by crushed ice keeps in excellent condition for 3 weeks at 32 F but only 1 week at 40 F and 3 days at 50 F. Vitamin content and quality are retained better when wilting is prevented.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated

Cycloate--2.5 to 3 lb/A. Apply 1.67 to 2.00 quarts Ro-Neet 6E.

Incorporate into 3 to 4 inches of soil immediately after application. Plant anytime after treatment.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Clopyralid--0.047 to 0.188 lb/A. Apply 2.0 to 8.0 fluid ounces of Stinger 3A or OLF per acre in a single application to control certain annual and perennial broadleaf weeds. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 8.0 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow-crop restrictions, or injury may occur from herbicide carryover.

Phenmedipham--0.5 to 0.67 lb/A. Apply 3.0 to 4.0 pints per acre.

Spin-Aid--1.3EC. For use in Maryland only. See label for application restrictions, mixing instructions, and weather restriction to prevent crop injury or herbicide failure.

Sethoxydim--0.2 to 0.5 lb/A. Apply 1.0 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 60 days and apply no more than 5 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Flea Beetles

Apply one of the following formulations:

bifenthrin--5.12 to 6.40 fl oz/A Bifenture 2EC (Sniper or OLF)

carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)

imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)

thiamethoxam--**soil** 1.70 to 4.01 oz/A Platinum 75SG **foliar** 1.5 to 3.0 oz/A Actara 25WDG

zeta-cypermethrin--1.76 to 4.0 fl oz/A Mustang Maxx (or OLF)

zeta-cypermethrin+bifenthrin--2.6 to 6.1 fl oz/A Hero EC

Aphids

Apply one of the following formulations:

bifenthrin--5.12 to 6.40 fl oz/A Bifenture 2EC (Sniper or OLF)

imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)

sulfoxaflor--0.75 to 1.50 oz TransformWG

thiamethoxam--**soil** 1.70 to 4.01 oz/A Platinum 75SG, **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Leafminers

Apply one of the following formulations:

spinetoram--6.0 to 8.0 fl oz/A Radiant SC

spinosad--2.25 to 3.5 oz/A Blackhawk 36WG

Beet Armyworm

Apply one of the following formulations:

chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC

indoxacarb--3.5 to 6.0 oz Avaunt 30WDG

methoxyfenozide--8.0 to 16.0 fl oz/A Intrepid 2F

spinetoram--6.0 to 8.0 fl oz/A Radiant SC

spinosad--2.25 to 3.5 oz/A Blackhawk 36WG

Garden Webworms

Apply one of the following formulations:

Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel DF (or OLF)

methoxyfenozide--8.0 to 16.0 fl oz/A Intrepid 2F

Disease Control

Seed Treatment

Use seed treated with Apron XL (0.085 to 0.64 fl oz/100 lb) or Allegiance FL (0.75 fl oz/100 lb) for Pythium damping-off protection *plus* Maxim 4FS (0.08 to 0.16 fl oz/100 lb) for *Rhizoctonia* and *Fusarium* protection. Seed treatments are not a substitute for high quality seed.

Damping-Off (*Pythium* or *Phytophthora*).

Apply one of the following preplant incorporated or as a soil-surface spray after planting.

mefenoxam--(Ridomil Gold 1.0 to 2.0 pt 4SL/A or Ultra Flourish 2.0 to 4.0 pt 2E/A)

metalaxyl--(MetaStar--4.0 to 8.0 pt 2E/A) (see label for specific details)

Apply the following as an in-furrow spray only:

Uniform--0.34 fl oz 3.66SE/1000 ft of row (see label for specific details) for *Pythium*

Pocket Rot, Wirestem, Stem Canker and Crown Rot (*Rhizoctonia solani*)

Pocket rot and other diseases caused by *Rhizoctonia* are most prevalent in cool, wet soils and especially in plantings showing poor plant vigor and those fields planted yearly in beets. Rotate between fields each year and scout on a regular basis. Applications of Quadris will also help control foliar diseases of beet such as *Cercospora*, powdery mildew, and *Alternaria*.

Quadris--0.40 to 0.80 fl oz 2.08F/1000 ft row either banded or in-furrow (see label for specific details)

Uniform--0.34 fl oz 3.66SE/1000 ft of row (see label for specific details)

Cercospora Leaf Spot and other foliar diseases.

Allow 2 or 3 years between beet plantings. Thoroughly disc under beet refuse at end of season since leaf spot pathogens can overwinter on plant residues. Warm, wet weather and rainfall favor leaf spot development. Scout plantings on a regular basis, especially if wet weather persists.

Apply one of the following on a preventative basis and/or when weather conditions are favorable for disease development. Repeat every 7 to 10 days.

Rotate one of the following FRAC code 11 fungicides *plus fixed copper at labeled rates***:**

Quadris--6.0 to 15.5 fl oz 2.08F/A (9.0 to 15.5 fl oz F/A for Cercospora)
Cabrio--8.0 to 12.0 oz 20EG/A
Headline--9.0 to 12.0 fl oz 2.09EC/A
Gem--1.9 to 2.9 fl oz 500SC/A
Reason--8.2 fl oz 500SC/A Alternaria suppression only

With one of the following:

tebuconazole--4.0 to 6.0 fl oz 3.6F/A or OLF
Fontelis--16.0 to 30.0 fl oz 1.67SC/A
Tilt--3.0 to 4.0 fl oz 3.6EC/A Cercospora leaf spot only

Do not make more than two sequential applications of Cabrio, Headline, or one application of Quadris, Reason, Gem before alternating to a non-FRAC code 11 fungicide. Tank mix fungicides with fixed copper to help reduce potential fungicide resistance development.

Black Spot

Boron deficiency can cause black spots inside beet roots and large black dry rots on root surfaces. Boron deficiency is most likely to occur in alkaline soils high in calcium and is exacerbated by dry conditions. Apply boron at planting according to soil test results.

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
Bacillus thuringiensis	G	4	0
bifenthrin	R	12	21
carbaryl	G	12	7
chlorantraniliprole	G	4	1
imidacloprid (soil/foliar)	G	12	21/7
indoxacarb	G	12	7
methoxyfenozide	G	4	1
spinetoram	G	4	7
spinosad	G	4	3
sulfoxaflor	R	24	7
thiamethoxam (soil/foliar)	G	12	see label/7
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	21
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
copper, fixed (Group M1)	G	12,24,48	0
Fontelis (Group 7)	G	12	0
Gem (Group 11)	G	12	7
Headline (Group 11)	G	12	7
MetaStar (Group 4)	G	48	14
Quadris (Group 11)	G	4	0
Reason (Group 11)	G	12	14
Ridomil Gold (Group 4)	G	48	0
tebuconazole (Group 3)	G	12	7
Tilt (Group 3)	G	12	14
Ultra Flourish (Group 4)	G	48	0
Uniform (Group 4 + 11)	G	0	AP

See Table 3.
[1] G = general, R = restricted, AP = At planting
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER, COLLARDS, KALE, AND KOHLRABI – COLE CROPS

Varieties[1]

Recommended Broccoli Varieties

Variety	Hybrid	Days[1]	Black Rot	Downy Mildew	Bacterial Head Rot	Cold	Heat[3]
Arcadia	Yes	63	X[2]	X		X	X
Bay Meadows	Yes	60				X	X
Belstar	Yes	66		X		X	
DeCicco	No	48				X	X
Diplomat	Yes	68		X		X	X
Emerald Crown	Yes	63				X	X
Emerald Pride	Yes	74		X			X
Eureka	Yes	76	X	X		X	
Everest	Yes	61		X		X	X
Green Magic	Yes	60					X
Gypsy	Yes	60		X		X	X
Imperial	Yes	72					X
Ironman	Yes	78					
Major	Yes	55		X			X
Marathon	Yes	70				X	
Packman	Yes	50					
Windsor	Yes	68		X	X	X	X

[1]Days from transplant to first harvest
[2]X denotes some degree of resistance or tolerance to disease or environmental conditions

Recommended Brussels Sprouts Varieties[1]

Variety	Days
Dimitri (trial)	105
Jade Cross E	85
Royal Marvel (trial)	85
Churchill (trial)	90
Nelson (trial)	90
Franklin (trial)	100

[1]All varieties are hybrids

Recommended Cabbage Varieties

					Pest or Abiotic Stress Reaction[2]				
Variety	Hybrid	Days	Lbs.	Use[1]	Yellows	Blackrot	Tipburn	Thrips	SplitHead
Green Cabbage									
Artost	Yes	68	3-6	F, P	H		H		H
Bajonet	Yes	80	3-5	F	H				
Benelli	Yes	78	4-10	F-P	H	M	M	M	H
Blue Dynasty	Yes	75	4	F	H	H			H
Blue Lagoon	Yes	68	3-5	F	H	M			
Blue Thunder	Yes	80	4-5	F	H	M			H
Blue Vantage	Yes	72	4	F	H	L	H	H	
Bobcat	Yes	76	4-6	F	H		H	H	H
Bravo	Yes	85	4-10	F, P	H	H			
Bronco	Yes	78	3-5	F	H		M	M	

(table continued next page)

Recommended Cabbage Varieties ***(continued)***

					Pest or Abiotic Stress Reaction[2]				
Variety	**Hybrid**	**Days**	**Lbs.**	**Use[1]**	**Yellows**	**Blackrot**	**Tipburn**	**Thrips**	**SplitHead**
Green Cabbage ***(continued)***									
Caraflex (pointed)	Yes	68	2-3	F	H			H	
Cecile	Yes	80	6	P	H		H		
Charmant	Yes	65	2.5-3	F	H	H		L	H
Cheers	Yes	75	5	F	H	H		H	
Cynamo	Yes	59	2.5-3	F	H				H
Early Thunder	Yes	72	3-4	F	H	M	M	H	
Emblem	Yes	85	3-5	F	H	H	H		H
Grand Vantage	Yes	79	5-6	F	H				
Green Cup	Yes	78	3-4	F	H	H	H	H	
Megaton	Yes	85	10-20	P	H		H		
Padok	Yes	70	5-8	P	H		H		
Platinum Dynasty	Yes	70	4-10	F, P	H	H	H		H
Quick Start	Yes	64	3-4	F	H		H	M	
Ramada	Yes	83	3-6	F	H	H			
Royal Vantage	Yes	79	3-5	F	H	H	H	H	
Solid Blue 780	Yes	79	3-4	F	H	M	H	H	
Stonehead	Yes	67	4	F	H				
Superstar	Yes	85	3-4	F	H	H	H	M	
Thunderhead	Yes	74	3-5	F	H	H	H	H	
Vantage Point	Yes	85	5-6	F	H	H	H	H	
Red Cabbage									
Azurro	Yes	78	3-4	F			H	H	
Cairo	Yes	85	3-6	F	M		H	H	H
Primero	Yes	72	2-3	F			H	H	
Red Dynasty	Yes	75	5-12	F, P			H		H
Red Jewel	Yes	75	3-5	F			H		
Ruby Perfection	Yes	80	3-4	F	M	M	M	H	
Rio Grande Red	Yes	83	4-5	F			M		
Super Red 80	Yes	80	2-5	F		M	H		H
Green Savoy Cabbage									
Alcosa	Yes	62	2-4	F	H		H		
Clarissa	Yes	78	2-3	F	H		H		
Famosa	Yes	75	2-4	F			H		
Melissa	Yes	80	2-4	F	H		H		
Miletta	Yes	88	3-4	F			H		
Savoy Ace	Yes	78	3-4	F	M				
Savoy Blue	Yes	85	3-5	F					
Savoy King	Yes	80	4	F			H		
Red Savoy Cabbage									
Deadon	Yes	105	3-5	F					

[1]Use: F=Fresh market, P=Processing (slaw, kraut)

[2]Pest and abiotic stress reactions: H = High level of resistance or tolerance, M = Moderate or intermediate level of resistance or tolerance.

Recommended Chinese Cabbage and Pak Choi Varieties

Variety	Type	Shape/Color	Hybrid	Days
Apollo	Chinese Cabbage	Napa (barrel)	Yes	65
Blues	Chinese Cabbage	Napa (barrel)	Yes	57
China Gold	Chinese Cabbage	Napa (barrel)	Yes	65
Emiko	Chinese Cabbage	Napa (barrel)	Yes	55
Optiko	Chinese Cabbage	Napa (barrel)	Yes	60
Rubicon	Chinese Cabbage	Napa (barrel)	Yes	52
Yuki	Chinese Cabbage	Napa (barrel)	Yes	67
Greenwich	Chinese Cabbage	Narrow	Yes	69
Green Rocket	Chinese Cabbage	Narrow	Yes	70
Jade Pagoda	Chinese Cabbage	Narrow	Yes	68
Black Summer	Pak Choi	Green petiole	Yes	45
Mei Quing Choi	Pak Choi	Green petiole	Yes	40
Joi Choi	Pak Choi	White petiole	Yes	50
New Nabai	Pak Choi	White petiole	Yes	45
Win Choi	Pak Choi	White petiole	Yes	52

Recommended Cauliflower Varieties

Variety	Hybrid	Color	Days	Self Wrapping	Variety	Hybrid	Color	Days	Self Wrapping
Absolute	Yes	White	70	Yes	Majestic	Yes	White	50	No
Accent	Yes	White	75	Partial	Minuteman	Yes	White	53	No
Amazing	Yes	White	75	Yes	Panther	Yes	Green	70	No
Apex	Yes	White	70	Yes	Snow Crown	Yes	White	55	No
Bishop	Yes	White	65	Partial	Symphony	Yes	White	71	Partial
Candid Charm	Yes	White	68	Partial	Violet Queen	Yes	Purple	65	No
Casper	Yes	White	75	Yes	Vitaverde (trial)	Yes	Green	71	No
Cheddar	Yes	Orange	80	No	Whistler	Yes	White	78	No
Fremont	Yes	White	62	Yes	White Sails	Yes	White	68	Yes
Freedom	Yes	White	67	Yes	26-701 RZ (trial)	Yes	Green	75	No
Graffiti	Yes	Purple	75	No					

Recommended Collard and Kale Varieties

Variety	Type	Hybrid	Color	Comments
Bulldog	Collard	Yes	Dark Green	Lightly waved leaves
Hi-Crop	Collard	Yes	Deep Green	Semi-savoyed leaves
Top Bunch	Collard	Yes	Blue Green	Lighly savoyed leaves
Flash	Collard	Yes	Deep Green	Flat to lightly waved leaves
Blue Max	Collard	Yes	Blue Green	Lightly savoyed leaves
Vates	Collard	No	Deep Green	Flat to lightly waved leaves
Champion	Collard	No	Deep Green	Flat to lightly waved leaves
Dwarf Blue Curled (Vates)	Kale	No	Blue Green	Curled leaf
Dwarf Siberian	Kale	No	Green	Light to medium curl, overwinters
Red Russian	Kale	No	Blue Green-Red	Flat toothed leaf green with red midrib
Winterbor	Kale	Yes	Dark Green	Curled leaf
Blue Knight	Kale	Yes	Blue Green	Curled leaf

(table continued next page)

Recommended Collard and Kale Varieties ***(continued)***

Variety	Type	Hybrid	Color	Comments
Blue Armor	Kale	Yes	Blue Green	Very curled leaf
Blue Ridge	Kale	Yes	Blue Green	Very curled leaf
Redbor	Kale	Yes	Deep Red	Curled leaf
Lacinato	Kale	No	Blue Green	Puckered strap-like leaf
Black Magic	Kale	No	Dark Blue Green	Broader leaved lance leaf type
Starbor	Kale	Yes	Blue Green	Curled leaf

Recommended Kohlrabi Cultivars

Variety	Hybrid	Comments
Azure Star	Yes	Deep Blue-Purple
Grand Duke	Yes	Light Green
Kohlribi	Yes	Deep Purple
Quickstar	Yes	Light Green
Winner	Yes	Light Green

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Broccoli	150-200	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
	50-100	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
	50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting.
	50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting.
Brussels Sprouts,	100-150	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
Cabbage,	50-75	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
Cauliflower	25-50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting.
Kale, Collards	100-200	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
	50-100	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress after each cutting or stripping.
Kohlrabi	25-50	0	0	0	0	0	0	0	0	Total nutrient recommended.
	25-50	0	0	0	0	0	0	0	0	Sidedress if needed according to weather.

Apply 1.5 to 3.0 pounds of boron (B) per acre for broccoli only. Apply 1.5 to 3.0 pounds of B per acre and 0.2 pounds molybdenum (Mo) applied as 0.5 pound sodium molybdate per acre with broadcast fertilizer for Brussels sprouts, cabbage, and cauliflower. See Table B-10 for more specific boron recommendations. Include 25-40 pounds of sulfur per acre in the fertilizer program for cole crops.
[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 25 lbs. K_2O per acre are recommended on soils testing Very High.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for cabbage.

Critical Cabbage Tissue Test Values.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
Most recently matured leaf 5 weeks after transplanting	Deficient	<3.2	0.3	2.8	0.5	0.25	n/a	<30	20	30	20	3	0.3
	Adequate range	3.2	0.3	2.8	1.1	0.25	0.3	30	20	30	20	3	0.3
		6	0.6	5	2	0.6	n/a	60	40	50	40	7	0.6
	High	>6.0	0.6	5	2	0.6	n/a	>100	40	50	40	10	n/a
	Toxic (>)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Most recently matured leaves at 8 weeks after transplanting	Deficient	<3.0	0.3	2	0.5	0.2	n/a	<30	20	30	20	3	0.3
	Adequate range	3	0.3	2	1.5	0.25	0.3	30	20	30	20	3	0.3
		6	0.6	4	2	0.6	n/a	60	40	50	40	7	0.6
	High	>6.0	0.6	4	2	0.6	n/a	>100	40	50	40	10	0.6
	Toxic (>)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wrapper leaf at half head	Deficient	<3.0	0.3	1.7	0.5	0.25	n/a	<20	20	20	30	4	0.3
	Adequate range	3	0.3	2.3	1.5	0.25	0.3	20	20	20	30	4	0.3
		4	0.5	4	2	0.45	n/a	40	40	30	50	8	0.6
	High	>4.0	0.5	4	2	0.45	n/a	>100	40	40	50	10	n/a
	Toxic (>)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Seed Treatment

Check with your seed company to determine if seed is hot water-treated for blackrot. For more information, see the Disease section for treatment to prevent disease.

Planting and Spacing

All cole crops may be direct seeded or transplanted.

Direct Seeding

Precision seeders are recommended for direct seeding Seed should be sown 15 to 20 days in advance of the normal transplant date for the same maturity date.

Transplant Production and Handling for All Cole Crops

Sow in 72 to 128 cell plug trays or sow in transplant production beds at 10 seeds per foot of row in rows 12 to 18 inches apart to be lifted as bare root plants. Early transplant production will require heated greenhouse facilities or frames. Transplants for summer plantings may be produced in field beds. Transplants are ready in 4-6 weeks. Bare root transplants should be planted soon after lifting. If purchasing bare root transplants from nurseries, plant soon upon receipt. Storage of pulled, field-grown cabbage transplants should not exceed 9 days at 32°F (0°C) or 5 days at 66°F (19°C) prior to planting in the field.

Broccoli. Fall Production.

Direct field seeding: Rows 30-36 inches apart; seed: 1/2 to 1 pound per acre so that plants are 12 to 18 inches apart in row; time: Make successive plantings June 20 to July 20 (June 20 to July 5 in Pennsylvania and northern New Jersey).

Transplants: For field transplanting make successive plantings) between July 15 and August 20, depending on location, Set transplants 12 to 18 inches apart in rows 36 inches apart (14,520 plants per acre.

High population planting for bunched broccoli: 2 to 4 rows per bed, rows 18 to 20 inches apart, plants 9 to 10 inches in row (27,000 to 32,000 plants per acre); time: seed June 25 to July 10; transplant July 20 to August 15, depending on location.

For fall plasticulture double cropping, remove previous crop debris and set broccoli transplants 12-21 inches apart in double rows 10-12 inches apart. For larger heads allow greater in-row spacing. Set plants in late July through mid-August, depending on variety maturity and location.

Spring Production.

Spring production of broccoli is successful in cooler areas of the region but is limited by heat in southern areas. Use heat tolerant varieties. For spring production transplant April 1-April 20.

Brussels Sprouts. Brussels sprouts are a long season crop grown for fall production. Transplant rows 3 feet apart; plants 15 inches apart in row. Start planting transplants June 20. Start field seeding June 1.

Cabbage. Cabbage is planted from March through early August depending on location, variety, and intended harvest date. Early varieties require 85 to 90 days from seeding to harvest, and main-season crops require 110 to 115 days.

Crops grown from transplants are 14-21 days earlier. Transplants are set in rows 2 to 3 feet apart and 9 to 15 inches apart in the row for early plantings and 9 to 18 inches apart for late plantings, depending on variety, fertility, and market use.

Cauliflower. Transplants are set in rows 3 to 4 feet apart, and plants are set 18 to 24 inches apart in the row. Make successive plantings in the field between July 15 and August 20, depending on location.

Note. In Pennsylvania and other cool areas, Snow Crown, Snow Grace, and White Cloud can be grown in the spring. Transplant to the field in early April. Spring production in the southern part of the region is not recommended.

Collards. Direct seeded: seed at the rate of 2 pounds per acre Transplanting: Transplants are set in rows 16 to 36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Collards for spring and early summer harvest can be transplanted or seeded starting April 1 in Virginia and warmer, southern areas and April 20 in Pennsylvania and normally cooler areas. Collards can be seeded starting in mid-July through late August for fall harvest. Collards for processing are planted in 4 to 6 row beds, 12-16 inches between rows at a rate of 10-16 seeds per foot of row.

Kale. Direct Seeding: Sow seed at 3-4 pounds per acre in rows spaced 16 to 36 inches apart. Thin to 4 to 5 inches apart in the row. Transplanting: Transplants are set in rows 16 to 36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Kale for spring and early summer harvest can be transplanted or seeded starting April 1 in Virginia and warmer, southern areas and April 20 in Pennsylvania and normally cooler areas. Kale can be seeded or transplanted starting in mid-July through late August for fall harvest. Kale for processing is planted in 4 to 6 row beds, 12-16 inches between rows at a rate of 10-16 seeds per foot of row

Kohlrabi. Transplants may be used for a spring crop. Plant in the field at the same time as broccoli or cabbage. Fall crops can be established by direct-seeding between June 25 and July 15. Seed open-pollinated varieties at the rate of 2 to 3 pounds per acre and thin to 6 to 8 inches between plants in the row. Precision-seed hybrid varieties. Set transplants July 20 to August 15. Space rows 18 to 24 inches apart.

No-Till / Conservation Tillage

Cabbage and broccoli have been successfully grown by transplanting into rolled or herbicide killed cover crops using a no-till transplanter.

Irrigation and Water Use

All cole crops benefit from irrigation to achieve the highest yields and quality. Cole crops require a seasonal total of 10-15 inches of water during the season. Amounts will depend on planting date, seasonal variation, variety, and number of times the field is harvested. For spring crops highest demand is near harvest. For fall crops highest demand is mid season Consistent soil moisture level is especially critical to achieve maximum quality in cauliflower. Any moisture stress, especially when plants reach the 6 to 7-leaf stage may cause cauliflower to button or form heads prematurely..

Harvest and Post Harvest Considerations

Cabbage is harvested when heads are tight and have reached the desired size for the variety and spacing. The head is harvested by bending it to one side and cutting the base with a knife. Harvesting knives should be sharpened frequently. The stalk should be cut flat and as close to the head as possible, yet long enough to retain two to four wrapper leaves. Extra leaves act as cushions during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed. Heads with insect damage and other defects should be discarded. It is important that unharvested immature heads are undamaged because fields will be harvested multiple times. Harvested cabbage can be placed in bags, boxes, wagons, or pallet bins, depending on the harvesting method employed. Holding cabbage too long past harvest maturity will result in head splitting. Store harvested cabbage at 32°F and a relative humidity of 98 to 100%.

Broccoli should be harvested when heads have reached maximum diameter and flower buds (beads) are still tight. Bunched broccoli heads are tied together in groups of 3-4 with a rubber band. Store broccoli and 32°F and relative humidity of 95 to 100 %. Broccoli should be hydrocooled or packed in ice immediately after harvest and kept at 32°F to maintain salable condition. Under these conditions broccoli should keep satisfactorily 10 to 14 days.

For processing, both cabbage and broccoli have the potential to be machine harvested but due to uniformity differences at harvest, hand harvest produces the highest yields and the best quality.

Cauliflower is harvested while the heads are pure white and before the curds become loose and ricey. Most varieties are self blanching. For those that are not, blanching is achieved by tying outer leaves over the heads when heads are 3 to 4 inches in diameter. Blanching takes about 1 week in hot weather and 2 weeks in cooler weather. Store harvested cauliflower at 32 F and a relative humidity of at least 95%. Avoid bruising of heads in harvest, handling and packing.

Kale and collards are harvested by cutting off entire plants near ground level whole plants are then bunched, or lower leaves may be stripped from plants and packed individually. For processing, kale and collards are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles have elongated. Multiple harvests are possible. Because of their perishability, kale and collards should be held as close to 32 F as possible. At this temperature, they can be held for 10 to 14 days. Relative humidity of at least 95 % is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but excessive air circulation will speed transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. These leafy greens are commonly shipped with package and top ice to maintain freshness. Kale packed in polyethylene-lined crates and protected by crushed ice keeps in excellent condition for 3 weeks at 32 F.

The targeted harvest stage for Kohlrabi is when stems are full sized but before they begin to split.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Seeded and Transplanted

Preplant Incorporated

Trifluralin--*Seeded*: 0.50 to 0.75 lb/A. Use 1 to 1.5 pints per acre Treflan 4E. *Transplants*: 0.5 to 1.0 lb/A. Use 1.0 to 2.0 pints per acre Treflan 4E. Incorporate 2 to 3 inches into soil by double-disking within 8 hours after application. **Labeled for broccoli, brussels sprouts, cabbage, cauliflower, collards, and kale only**.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence, followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Transplanted Only

Oxyfluorfen--0.2 to 0.5 lb/A. Apply 0.8 to 2.0 pints per acre Goal 2XL or Galigan 2E, or 0.8 to 1.0 pint per acre GoalTender 4FL before transplanting and transplant through the herbicide on the soil surface to control broadleaf weeds including common lambsquarters, common purslane, common ragweed, pigweed sp., and galinsoga. Use lower rates on coarse-textured soils low in organic matter. Cold, wet conditions in early spring may increase the risk of temporary crop injury which could delay maturity. Annual grasses will not be adequately controlled by Goal. Use Dacthal posttransplant or Poast 1.5EC postemergence to control grasses. Treflan or Dual Magnum may increase the potential for crop injury, especially when conditions are cold and wet, and it is not recommended for use prior to Goal application. Delay cultivation after Goal application, when possible, to reduce deactivation of the Goal by incorporation. **Labeled for broccoli, cabbage, and cauliflower only**.

Preemergence or Post-Transplant

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F. Apply after seeding or transplanting to a clean, weed-free soil. Use good agitation in tank. Dacthal controls annual grasses, common purslane, and lambsquarters, and suppresses or controls certain other annual broadleaf weeds. Preplant incorporate Treflan to improve control of prostrate pigweed, or use in combination with Dual Magnum to control galinsoga.

S-metolachlor--0.48 to 1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in cabbage in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.50 to 1.33 pints per acre Dual Magnum 7.62E before weeds emerge, to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Treat direct-seeded cabbage postemergence, after three to four leaves have developed. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. Treat transplanted cabbage with either a pretransplant, surface- applied application or spray post-transplant within 2 days of planting. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. DO NOT apply to direct-seeded cabbage prior to the three- to four-leaf growth stage or the risk of crop injury may be increased. Certain varieties may be more sensitive to injury. Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for cabbage ONLY!

Postemergence

Clopyralid--0.047 to 0.188 lb/A. Apply 2.0 to 8.0 fluid ounces of Stinger 3A or OLF per acre in one or two applications to control certain annual and perennial broadleaf weeds. Do not exceed 8 fluid ounces in one year. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow-crop restrictions, or injury may occur from herbicide carryover.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Oxyfluorfen--0.125 to 0.188 lb/A. **A Special Local Needs 24C label for broccoli, cabbage, and cauliflower has been approved for the use of GoalTender postemergence in Delaware and New Jersey.** Apply 4.0 to 6.0 fluid ounces per acre of GoalTender 4F to control many seedling annual broadleaf weeds. Treat direct seeded crops when they have more than 4 true leaves, and transplanted crops a minimum of 2 weeks after transplanting and after new growth has replaced foliage present at transplanting. Expect some temporary crop injury after treatment. Crop injury will appear as speckling and/or crinkling of treated foliage. DO NOT tank-mix GoalTender with any other pesticide or use any spray additive, or severe crop injury may result. DO NOT use any oxyfluorfen formulation other than GoalTender 4F, or severe crop injury may result. Two applications of GoalTender may be applied, but DO NOT exceed a total of 8 fluid ounces (0.25 lb/A) per acre. GoalTender will provide residual control in addition to the control of annual broadleaf weeds present at application, but do not cultivate after application, or the herbicide will be deactivated and residual control will be lost. **For use only in broccoli, cabbage and cauliflower. Labeled for use in Delaware and New Jersey ONLY!**

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3.0 pints per acre in one season. **Labeled for broccoli, cabbage, and cauliflower only**.

S-metolachlor--0.48 to 1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in cabbage in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.50 to 1.33 pints per acre Dual Magnum 7.62E before weeds emerge, to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Treat **direct-seeded** cabbage postemergence, after three to four leaves have developed. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. Treat **transplanted** cabbage with either a pretransplant, surface-applied application or spray posttransplant within 2 days of planting. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. DO NOT apply to direct-seeded cabbage prior to the three- to four-leaf growth stage or the risk of crop injury may be increased. Certain varieties may be more sensitive to injury. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for cabbage ONLY!**

Napropamide--1.0 lb/A. Apply 2.0 pounds per acre Devrinol DF-XT preplant incorporated before seeding or transplanting. Primarily controls annual grasses and certain broadleaf weeds. Tank-mix with minimum recommended rate of Treflan 4EC to improve the spectrum of broadleaf weeds controlled. Use only on fine-textured soils such as silt or clay loams with more than 2 percent organic matter. Crop injury has occurred when used on coarse-textured soils low in organic matter. **Labeled for broccoli, Brussels sprouts, cabbage, and cauliflower. Recommended in Pennsylvania ONLY!**

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia**. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Note: Not all pesticides are labeled for each crop in this section. Refer to the Days to Harvest Table at the end of this section and/or the pesticide label to determine which pesticides are labeled on specific crops.

Cabbage Maggot

Note. When yellow-rocket (mustard) first blooms, cabbage maggot adults (flies) begin laying eggs on roots or soil near roots.

bifenthrin--3.4 to 6.8 fl oz/A Capture LFR **(soil appl. only)**
chlorpyrifos--Lorsban Advanced. See specific rates on label

based on method of application and crop. Preplant, at-plant, and post-plant applications are recommended. Do NOT apply as a foliar application.

Diazinon--2.0 to 4.0 qts/A Diazinon AG500 (or OLF) as a preplant broadcast or 4.0 to 8.0 fl oz per 50 gallons of transplant solution.

Cutworms

(Also see the "Cutworms" section in Soil Pests-Their Detection and Control.) Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF) or 3.4 to 6.8 fl oz/A Capture LFR **(soil appl. only)**
chlorpyrifos--Lorsban Advanced. See specific rates on label based on method of application and crop. Preplant, at-plant, and post-plant applications are recommended. Do NOT apply as a foliar application
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
gamma-cyhalothrin--1.92 to 3.20 fl oz/A Proaxis
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--5.0 to 8.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 fl oz/A Endigo ZC
methomyl--1.5 pts/A Lannate LV (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin + bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Field observations indicate that the variety Market Prize may be more attractive to thrips than other varieties. Apply one of the following formulations:

acetamiprid--4.0 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin + imidacloprid--3.8 to 6.1 fl oz/A Brigadier
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
dinotefuran**--soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
gamma-cyhalothrin--2.56 to 3.84 fl oz/A ProAxis
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+thiamethoxam--4.5 fl oz/A Endigo ZC
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 10.0 fl oz/A Entrust SC
thiamethoxam--5.5 oz/A Actara 25WDG
thiamethoxam + clorantraniliprole--10.0 to 13.0 fl oz/A soil Durivo; 4.0 to 7.0 oz/A foliar Voliam Flexi
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin + bifenthrin--10.3 fl oz/A Hero EC

Aphids

Apply one of the following formulations:

acephate **(Brussels sprouts and cauliflower only)--**0.5 to 1.0 lb/A Orthene 97S (or OLF)
acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
bifenthrin+imidacloprid--3.8 to 6.1 fl oz/A Brigadier
Chenopodium extract--2.0 to 4.0 qts/A Requiem
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG (or OLF)
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
pymetrozine--2.75 oz/A Fulfill 50W
spirotetramat--4.0 to 5.0 fl oz/A Movento
sulfoxaflor—1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam+clorantraniliprole--10.0 to 13.0 oz/A soil Durivo; 4.0 to 7.0 oz/A foliar Voliam Flexi

Flea Beetles (FB), Harlequin Bugs

Treat for flea beetles if population reaches 1 beetle per transplant or 5 beetle per 10 plants during cotyledon stage. Apply one of the following formulations:

beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
dinotefuran**--soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
esfenvalerate **(FB only)--**5.8 to 9.6 fl oz/A Asana XL
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
thiamethoxam (**FB only**)--1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam+clorantraniliprole (**FB only)--**10.0 to 13.0 oz/A soil Durivo; 4.0 to 7.0 oz/A foliar Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin +bifenthrin--4.0 to 10.3 fl oz/A HeroEC

Worm Pests

Cole crops may require multiple treatments per season. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance.

Treat cabbage when 20 percent or more of the plants are infested with any species before heading. Once heads are formed, treat when 5 percent of the plants are infested.

Note. Underleaf spray coverage is essential to control newly hatched worms. With boom-type rigs, apply spray with at least 3 nozzles per row--one directed downward and one directed toward each side. Evaluate effectiveness to consider need for further treatment.

Cabbage Looper (CL), Imported Cabbageworm (ICW) and other miscellaneous caterpillar pests

Note: Not all materials are labeled for all crops, insects or application methods. Be sure to read the label for use directions. Apply one of the following formulations:

acephate **(Brussels sprouts and cauliflower only)--**1.0 lb/A Orthene 97S (or OLF)
Bacillus thuringiensi-- 0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF)
bifenthrin+imidacloprid (**ICW only)--**3.8 to 6.1 fl oz/A Brigadier
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
emamectin benzoate--3.2 to 4.8 oz/A Proclaim 5SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC
flubendiamide--2.0 to 2.4 fl oz/A Belt SC
flubendiamide+buprofezin--10.0 to 20.0 fl oz/A Vetica
gamma-cyhalothrin--1.92 to 3.20 fl oz/A Proaxis
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
indoxacarb--2.5 to 3.5 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 fl oz/A Endigo ZC
methomyl **(Fresh-market collards only)--**1.5 to 3.0 pts/A Lannate LV (or OLF)
Note: DO NOT apply to collards when minimum daily temperatures are <50 degrees F or when plants are <10" tall.
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F
novaluron--6.0 to 12.0 fl oz/A Rimon 0.83EC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--10.0 to 13.0 fl oz/A soil/drip Durivo; 4.0 to 7.0 oz/A foliar Voliam Flexi
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin +bifenthrin--4.0 to 10.3 fl oz/A HeroEC

Diamondback Moth (DBM)

Note. Several of these insecticides may no longer be effective in certain areas due to DBM resistance. Consult your local county Extension office for most effective control. Apply one of the following formulations:
acephate **(Brussels sprouts and cauliflower only)--**1.0 lb/A Orthene 97 (or OLF)
Bacillus thuringiensis--0.50 to 1.00 lb/A Dipel (or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--2.0 to 2.4 fl oz/A Belt SC
flubendiamide + buprofezin--10.0 to 20.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
methomyl--(**fresh market collards only)**1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--12.0 to 16.0 fl oz/A Intrepid 2F
novaluron--6.0 to 12.0 fl oz/A Rimon 0.83EC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--1.5 to 4 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--10.0 to 13.0 oz/A soil/drip Durivo; 4.0 to 7.0 oz/A foliar Voliam Flexi

Armyworm

Note: Not all materials are labeled for all insects or application methods. Be sure to read the label for use directions. Apply one of the following formulations:

Bacillus thuringiensis--1.0 to 2.0 lbs/A Dipel (or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--2.0 to 2.4 fl oz/A Belt SC
flubendiamide + buprofezin--10.0 to 20.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
methomyl--(**fresh market collards only)**1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
spinosad--4.0 to 10.0 fl oz/A Entrust SC
tebufenozide--6.0 to 8.0 oz/A Confirm 2F
thiamethoxam+chlorantraniliprole--10.0 to 13.0 fl oz/A soil/drip Durivo; 4.0 to 7.0 oz/A foliar Voliam Flexi

Nematode Control

See Chapter E "Nematodes" section of Soil Pests-Their Detection and Control.

Disease Control

Seed Treatment

Check with your seed company to determine if seed is hot water-treated for blackrot. Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments that only kills pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens that may be found within the seed coat. Heat treatment is particularly useful for cole crops that are prone to seed-borne bacterial infections. Seed heat-treatment follows a strict time and temperature dosage protocol, and is best done with thermostatically controlled water baths (see Section E). Two baths are required; one for pre-heating the seeds, and a second for heat-killing pathogens on and in the seeds. The initial pre-heat cycle is for 10 minutes at 100ºF (36.8ºC) followed by the effective temperature at 122ºF (50ºC). Use a 20 minute soak for broccoli, cauliflower, collards, kale, and Chinese cabbage. Soak brussels sprouts and cabbage for 25 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper. Pelleted seeds are not recommended for heat treatment. Heat treat only seed that will be used immediately.

An alternative to hot water seed treatment is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1 to 2 minutes and rinse for 5 minutes in running water at room temperature.

Following either treatment above, dry the seed, then dust with captan 50WP or thiram 480DP at 1 level teaspoon per pound of seed (3 oz/100 lb).

Damping-Off

Use the following as a banded application after seeding. See label for banded rates based on row spacing. Apply one of the following in a band up to 7 inches wide:

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A)
metalaxyl (MetaStar--See label 2E AG/A)
Quadris--0.4 to 0.8 fl oz 2.08F/1000 row ft
mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A) *plus* Quadris--0.4 to 0.8 fl oz 2.08F/1000 row ft
Uniform--0.34 fl oz 3.66SE/1000 row ft (Collards and Kale only)

Black Rot and Blackleg

Use resistant varieties and hot water seed treatment. Select field not previously planted to crucifers for seedbeds. (See the "Disease Control in Plantbeds" section.) Rotate to allow 2 years between cole crop plantings for black rot control and 4 years between cole crop plantings for blackleg control.

For blackleg control in broccoli only, use iprodione at 2.0 lb/A or OLF immediately after thinning as a directed spray to the base of the plant and adjacent soil surface. A second application may be made up to the day of harvest.

For black rot control, fixed copper sprays (1.0 lb a.i./A) will aid in reducing spread of black rot if treatments are started when disease first becomes evident. Bravo and Blue Gem are cabbage varieties with field resistance to black rot.

Bacterial Head Rot

Bacterial head rot is a problem on broccoli. The only effective control strategy is to use tolerant varieties.

Clubroot

Use of irrigation water containing spores of this fungus is the principal way the disease is spread into new fields. If clubroot occurs, clean and disinfest any equipment to be used in other fields to prevent spread. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve the drainage in the field and grow the crop on raised beds. Use Terraclor 75WP in one of the following ways. Do NOT use the Terraclor 2EC formulation.

1. Use 30.0 lb/A or 37.0 oz/1000 ft of row. Apply in a 12 to 15-inch band and incorporate 4 to 6 inches deep before planting, or
2. Use 40.0 lb/A acre broadcast and incorporate 4 to 6 inches deep before planting, or
3. Use 2.0 lb per 100 gallons of solution and 0.5 pint per plant as a transplant solution.

In addition, Ranman 3.33SC can be used as a transplant soil drench (12.9 to 25.75 fl oz/A) or incorporated into the soil (20.0 fl oz/A), please see label for additional instructions.

Alternaria

Use one of the following at the first sign of disease and continue every 7 to 10 days (Refer to the pesticide table for this section to determine which fungicide is labeled for each specific cole crop. Apply one of the following formulations):

Quadris--6.0 to 15.5 fl oz 2.08F/A
Fontelis--14.0 to 30.0 fl oz 1.67SC/A
Cabrio--12.0 to 16.0 oz 20EG/A
Endura--6.0 to 9.0 oz 70WG/A
chlorothalonil--1.5 pt 6F/A or OLF
Ridomil Gold Bravo--1.5 lb 76.5WP/A (14-day schedule)
Switch--11.0 to 14.0 oz 62.5WG/A
Materials with different modes of action (FRAC code) should be rotated.

Downy Mildew

Presidio--3.0 to 4.0 fl oz 4SC/A
Revus--8.0 fl oz 2.08SC/A
Zampro--14.0 fl oz 4.38SC/A
Actigard--1.0 oz 50WG/A. (Begin applications 7-10 days after thinning and reapply every 7 days for a total of 4 applications per season),
Aliette--3.0 to 5.0 lb 80WDG/A (14-day schedule)
Cabrio--12.0 to 16.0 oz 20EG/A
chlorothalonil--1.5 pt 6F/A or OLF
Quadris--6.0 to 15.5 fl oz 2.08F/A

White Mold

Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.
Contans--2.0 to 4.0 lb 5.3WG/A

Alternatively, during seasons when soils remain wet for extended periods of time apply the following preventatively:
Endura--6.0 to 9.0 oz 70WG/A (Do not make more than two applications per season.)
Fontelis--16.0 to 30.0 fl oz 1.67SC/A

Yellows (*Fusarium*)

Use resistant varieties when possible and practice long crop rotations.

Cole Crop Physiological Disorders

The following are some common physiological disorders that affect these crops and their causes.

Bolting

Bolting in cabbage, collards and kale, and “buttoning” in cauliflower can occur if the early-planted crop is subjected to 10 or more continuous days of temperatures between 35^o to 50^{o}F (1.67^o to 10^{o}C). The degree of the temperature-induced bolting response depends upon variety.

Tipburn of Cauliflower, Cabbage, and Brussels Sprouts

This problem can cause severe economic losses. Tipburn is a breakdown of plant tissue inside the head of cabbage, individual sprouts in Brussels sprouts, and on the inner wrapper leaves of cauliflower. It is associated with an inadequate supply of calcium in the affected leaves, causing a collapse of the tissue and death of the cells. Calcium deficiency may occur where the soil calcium is low or where there is an imbalance of nutrients in the soil along with certain weather conditions (high humidity, low soil moisture, high potash and high nitrogen aggravate calcium availability). Secondary rots caused by bacteria can follow the onset of tipburn and heads of cauliflower can be severely affected. Some cabbage and cauliflower cultivars are relatively free of tipburn problems.

Boron Deficiencies

Cole crops have a high boron requirement. Symptoms of boron deficiency vary with crop type. Most boron deficient cole crops develop cracked and corky stems, petioles and midribs. The stems of broccoli, cabbage and cauliflower can be hollow and are sometimes discolored. Cauliflower curds become brown and leaves may roll and curl, while cabbage heads may be small and yellow.

Hollow Stem in Broccoli and Cauliflower Not Caused by Boron Deficiency

This condition starts with gaps that develop in stem tissues. These gaps gradually enlarge to create a hollow stem. Ordinarily, there is no discoloration of the surface of these openings at harvest but both discoloration and tissue breakdown may develop soon after harvest. Some cultivars of hybrid cauliflower and broccoli may have openings from the stem into the head. Hollow stem increases with wider plant spacings and as the rate of nitrogen increases. The incidence of hollow stem can be greatly reduced by increasing the density of the plant population.

Cabbage Splitting

Cabbage splitting is mainly a problem with early cabbage. A problem can develop when moisture stress is followed by heavy rain. The rapid growth rate associated with rain, high temperatures and high fertility cause the splitting. Proper irrigation and deep cultivation may help prevent splitting. There are significant differences between cultivars in their susceptibility to this problem.

Cauliflower and Broccoli Premature Heading in (Buttoning)

Losses are usually most severe when transplants have gone past the juvenile stage before setting in the field. Stress factors such as low soil nitrogen, low soil moisture, disease, insects, or micronutrient deficiencies can also cause this problem. Some cultivars, particularly early ones, are more susceptible to buttoning than others.

Lack of Heads in Broccoli and Cauliflower

During periods of extremely warm weather (days over 86°F and nights over 77°F) broccoli and cauliflower can remain vegetative due to inadequate cold exposure. This can cause a problem in scheduling the maturation and marketing dates for these crops.

Cauliflower Blanching and Off Colors

Heads exposed to sunlight may develop a yellow and/or red to purple pigment. Certain varieties such as Snow Crown are more predisposed to purple off-colors, especially in hot weather. Self-blanching varieties have been developed to reduce problems with curd yellowing. For open headed varieties, the usual method to exclude light is to tie the outer leaves when the curd is 8 cm in diameter. Leaves may also be broken over the curd to prevent yellowing. In hot weather, blanching may take 3 to 4 days, but in cool weather, 8 to 12 days or more may be required. Cauliflower fields scheduled to mature in cool weather (September and October) that are well supplied with water and planted with “self-blanching” cultivars do not require tying. Newer orange cauliflower and green broccoflower varieties are being planted. They are less susceptible to off-colors but can still turn purple under warm conditions.

Cauliflower Ricing

“Riciness” and “fuzziness” in heads is caused by high temperatures, exposure to direct sun, rapid growth after the head is formed, high humidity, or high nitrogen. “Ricing” is where the flower buds develop, elongate and separate, making the curd unmarketable. Proper cultivar and nutrient management can help minimize this condition.

Development of Curd Bracts in Cauliflower

Curd bracts or small green leaves between the segments of the curd in cauliflower is caused by high temperature or drought. Heat-resistant cultivars and proper water management can help minimize this condition.

Edema on Cole Crop Leaves

Edema is water blistering on cole crop leaves. The most common cause of edema is the presence of abundant, warm soil water and a cool, moist atmosphere. Proper water management can help to minimize this condition.

Black Petiole

Black petiole or black midrib is an internal disorder of cabbage that has been observed in recent years. As heads approach maturity, the under side of the internal leaf petioles or midribs turn dark gray or black at or near the point where the midrib attaches to the main stem. It is believed that this disorder is associated with a potassium (K)-phosphorus (P) imbalance. Proper nutrient management and choice of culivar will help minimize this condition.

Floret (Bead) Yellowing in Broccoli

Yellowing florets may be due to overmaturity at harvest, high storage temperatures after harvest, and/or exposure to ethylene. Any development of yellow beads ends commercial marketability. Bead yellowing due to senescence should not be confused with the yellow to light-green color of areas of florets not exposed to light during growth, sometimes called “marginal yellowing”. Proper postharvest handling and packaging will help to minimize this problem.

Brown Floret (Bead) in Broccoli

This is a disorder in which areas of florets do not develop properly, die and lead to brown discolored areas on the broccoli head. This is thought to be caused by plant nutritional imbalances but also may be due to feeding damage on florets from insects such as harlequin bugs.

			Days to Harvest[1]							
Pesticide	**Use Category[2]**	**Hours to Reentry[3]**	**Broc-coli**	**Brus. Sprt.**	**Cab-bage**	**Cab.[4] (Chin.)**	**Cauli-flower**	**Col-lards**	**Kale**	**Kohl-rabi**
INSECTICIDE										
acephate	G	24	--	14	--	--	14	--	--	--
acetamiprid	G	12	7	7	7	7	7	7	7	7
Bacillus thuringiensis	G	4	0	0	0	0	0	0	0	0
beta-cyfluthrin	R	12	0	0	0	0	0	--	--	0
bifenthrin	R	12	7	7	7	7	7	7	7	7
bifenthrin + imidacloprid	R	12	7	7	7	7	7	7	7	7
bifenthrin + indole butyric acid	R	5	7	7	7	7	7	-	-	7
carbaryl	G	12	3	3	3	--	3	14	14	3
chlorantraniliprole	G	4	3	3	3	3	3	3	3	3
chlorpyrifos (Lorsban 15G)	R(NJ),G	24	AP	AP	AP	AP	AP	AP	AP	AP
(Lorsban Advanced)	R	24/72	30	30	30	30	30	30	30	30
clothianidin (soil/foliar)	G	12	AP/ 21	AP/ 21	AP/ 21	AP/21	AP/ 21	AP / 21	AP/ 21	AP/ 21
cyfluthrin	R	12	0	0	0	0	0	0	0	0
diazinon	R	96	AP	AP	AP	AP	AP	AP	AP	AP
dimethoate	R,G	48	7	--	7	--	7	14	14	--
dinotefuran (soil/foliar)	G	12	21/1	21/1	21/1	21/1	21/1	--	--	21/1
emamectin benzoate	R	12	7	7	7	7	7	14	14	7
esfenvalerate	R	12	3	--	3	3	3	7	--	3
fenpropathrin	R	24	7	7	7	7	7	--	--	7
flonicamid	G	12	0	0	0	0	0	0	0	0
flubendiamide	G	12	8	8	8	8	8	8	8	8
flubendiamide + buprofezin	G	12	1	1	1	1	1	-	-	1
gamma-cyhalothrin	R	24	1	1	1	1	1	--	--	1
imidacloprid (soil/foiliar)	G	12	21/7	21/7	21/7	21/7	21/7	21/7	21/7	21/7
imidacloprid +beta-cyfluthrin	R	12	7	7	7	7	7	7	7	7
indoxacarb	G	12	3	3	3	3	3	--	--	3
lambda-cyhalothrin	R	24	1	1	1	1	1	--	--	1
lambda-cyhalothrin + chlorantraniliprole	R	24	3	3	3	3	3	-	-	3
lambda-cyhalothrin + thiamethoxam	R	24	1	1	1	1	1	1	1	1
methomyl	R	48	3	3	1	10	3	10	10	--
methoxyfenozide	G	4	1	1	1	1	1	1	1	1
novaluron	R	12	7	7	7	7	7	--	--	7
pymetrozine	G	12	7	7	7	7	7	7	7	7
spinetoram	G	4	1	1	1	1	1	1	1	1
spinosad	G	4	1	1	1	1	1	1	1	1
spirotetramat	G	24	1	1	1	--	1	--	--	1
sulfoxaflor	G	12	3	3	3	3	3	3	3	3
tebufenozide	G	4	7	7	7	7	7	7	7	7
thiamethoxam	G	12	0	0	0	0	0	7	7	7
thiamethoxam+ chlorantraniliprole (foliar)	G	12	3	3	3	3	3	7	7	3
thiamethoxam+ chlorantraniliprole (soil)	G	12	30	30	30	30	30	30	30	30
zeta-cypermethrin	R	12	1	1	1	1	1	1	1	1
zeta-cypermethrin+bifenthrin	R	12	7	7	7	7	7	7	7	7
FUNGICIDE (FRAC code)										
Actigard (Group P1)	G	12	7	7	7	7	7	7	7	7
Aliette (Group 33)	G	12,24	3	3	3	3	3	3	3	3
Cabrio (Group 11)	G	12	0	0	0	0	0	3	3	0
chlorothalonil (Group M5)	G	12	7	7	7	7	7	--	--	--
Contans WG (biological)	G	4	0	0	0	0	0	0	0	0
copper, fixed (Group M1)	G	24,48	0	0	0	0	0	0	0	0
Endura (Group 7)	G	12	0,14[5]	0	0	0,14[5]	0	14	14	0
Fontelis (Group 7)	G	12	0	0	0	0	0	0	0	0
MetaStar (Group 4)	G	48	AP	AP	AP	AP	AP	AP	AP	AP
Presidio (Group 43)	G	12	2	2	2	2	2	2	2	2
Quadris (Group 11)	G	4	0	0	0	0	0	0	0	0
Revus (Group 40)	G	4	1	1	1	1	1	1	1	1

(table continued next page)

Pesticide	Use Category[2]	Hours to Reentry[3]	Days to Harvest[1] Broc-coli	Brus. Sprt.	Cab-bage	Cab.[4] (Chin.)	Cauli-flower	Col-lards	Kale	Kohl-rabi
Ridomil Gold (Group 4)	G	48	AP	AP	AP	AP	AP	AP	AP	AP
Ridomil Gold Bravo (Groups 4 + M5)	G	48	7	7	7	7	7	--	--	--
Switch (Groups 9 + 12)	G	12	7	7	7	7	7	7	7	7
Terraclor (Group 14)	G	12	AP	AP	AP	AP	AP	AP	AP	AP
Uniform (Groups 4 + 11)	G	0	AP	AP	AP	AP	AP	AP	AP	AP
Zampro (Groups 40 + 45)	G	12	0	0	0	0	0	0	0	0

[1] AP = At-planting time only [2] G = general, R = restricted [3] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
[4] Tight-heading varieties of Chinese cabbage [5] See label for specific recommendations. Dash (-) in table indicates pesticide is **not** labeled for that crop

CARROTS

Varieties[1]

Processing: Dicing	Market
Achieve*	Achieve*
Danvers 126	Apache*
Danvers Half Long	Bolero*
Envy* (early)	Cellobunch*
Moonraker*	CR 2289*
Royal Chantenay*	Maverick (early)*
Red Cored Chantenay	Mokum (early)*
	Napoli*
Processing: "Coins"	Nelson* (early)
Bolero (early)*	Sugarsnax 54*
Scarlet Nantes	Tendersnax*
YaYa*	Tendersweet

[1]Varieties listed alphabetically *Indicates hybrid variety

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Carrots	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	50-80	150	100	50	0	150	100	50	0	Total nutrient recommended.
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
	25-30	0	0	0	0	0	0	0	0	Sidedress if needed.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seed Treatment

Seeds can be treated to prevent disease. This explanation can be found in the Disease Control Section of this chapter. Seed treatments are not a substitute for high-quality seed.

Seeding Dates

For early harvest (late June to September), sow March 20 to April 30; for late harvest, sow May 1 to July 5 (May 1 to June 15 in Pennsylvania and northern New Jersey). Practice crop rotation, and plant after a small grain crop for highest yields.

Spacing

Processing: Rows 20 to 30 inches apart; "coins," sow for 16 plants per foot; dicing, sow for 6 plants per foot (8 if soil is on the fine-textured side).

Seeding rate: Dicers, 12 to 14 ounces per acre using 2-inch scatter shoe; "coins," sow 2 to 4 pounds per acre using 4-inch scatter shoe. Depth of seeding should be no deeper than one-fourth inch.

Seeding with a precision vacuum seeder produces more uniform carrots. In a row, each vacuum plate meters seed to three separate lines. Lines are generally 1.5 to 2 inches apart and seeds are dropped about 1.5 to 2 inches apart within the line, resulting in 4 to 6 seeds per foot of seed-line for dicers and 6 to 8 plants per foot for slicers. Triple line sets are used increase the distance between seeds in the center row.

Cultivation

Hill with 2 inches of soil to cover shoulders to minimize greening.

Harvest and Post Harvest Considerations

Early fresh market carrots are harvested from July to September. Late market carrots are harvested from September into early winter. Fresh market carrots should be over 5 inches long and between 0.75 and 1.5 inches in diameter. Carrots harvested and handled in hot weather are more prone to rapid decay, and care should be exercised in handling to prevent wilting. Fresh market carrots in small plantings are harvested by loosening soils around the plants with a garden fork and then pulling gently out of the ground by the tops. For larger acreages carrots with intact tops are harvested with a belt pick-up harvester that lifts carrots by their foliage. Belt pick up, coulter pick up, or modified potato harvester types are used for processing carrots.

Carrots are processed immediately after harvest, and not stored. Most are scalped (tops removed) just before digging. A reduction in yield of about 15-20% occurs when carrots are field scalped. Scalped carrots, and those with inadequate, or frozen tops are harvested with a coulter pick-up or a modified potato harvester. Carrots with intact tops are harvested with a belt pick-up harvester that lifts carrots by their foliage then cuts off the tops.

Fresh market carrots are washed, sorted, and packed in one or two-pound plastic bags then the bags are packed into 48 1-lb bags, or 24 2-lb bags per carton; or loose in 50-pound mesh or plastic sacks at a packing house. Store carrots at 32 F and relative humidity of 98 to 100 %. Carrots for processing may be given a pre-storage dip treatment in a 0.1 % solution of sodium o-phenylphenate (SOPP) to reduce storage decay. The solution is not rinsed off after treatment.. Careful handling during and after harvest to avoid bruising, cutting and breakage will help ensure successful storage.

Mature topped carrots can be stored 7 to 9 months at 32° to 34°F with a very high relative humidity, 98 to 100 %. Prompt cooling to 40°F or below after harvest is essential for extended storage. Poorly precooled roots decay more rapidly. Humidity should be kept high to prevent wilting. Carrots stored at 98 to 100 % relative humidity develop less decay, lose less moisture, and remain crisper than those stored at 90 to 95 % relative humidity. A temperature of 32° to 34°F is essential if decay and sprouting are to be minimized.

Pre-storage washing of carrots may be desirable if they are harvested under wet conditions. Many potential decay-causing organisms are removed by washing and better air circulation is fostered. Air circulation between crates of pallet boxes in which carrots are stored is desirable to remove respiratory heat, maintain uniform temperatures, and help prevent condensation. An air velocity of about 14 to 20 ft/min is adequate at low storage temperatures.

Bitterness in carrots, which may develop in storage, is due to ethylene exposure. This gas is given off by apples, pears, and certain other fruits and vegetables and from decaying tissues. Bitterness can be prevented by storing carrots away from such products. Also, ethylene and development of bitterness can be minimized by low-temperature. Surface browning or oxidative discoloration often develops in carrots stored for extended periods.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated

Trifluralin--0.50 to 0.75 lb/A. Apply 1.0 to 1.5 pints per acre Treflan 4EC. Preferably, use two diskings to incorporate treatment into the top 3 inches of soil within 8 hours after application. Plant carrots immediately. Trifluralin is particularly effective on barnyardgrass, foxtail, crabgrass, all panicum, and other annual grasses. It will not control ragweed or jimsonweed.

Preemergence

Linuron--0.5 to 1.5 lb/A. Apply 1.0 to 3.0 pints per acre Lorox 50DF after seeding, but before crop emergence. Sow seed at least one-half inch deep. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. Do NOT exceed a total of 2 pounds of active ingredient linuron per acre per season. Labeled for use in New Jersey ONLY!

Prometryn--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pints per acre Caporol 4L after seeding, but before crop emergence. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed.

S-metolachlor--1.26 to 1.90 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in carrots in New Jersey. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 1.33 to 2.00 pints per acre Dual Magnum 7.62E preemergence to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. **Use ONLY on high organic matter (>20%) muck soils.** Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. Make only one application per crop. Observe a minimum preharvest interval of 64 days after application. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Sethoxydim--0.2 to 0.5 lb/A. Apply 1.0 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5 pints per acre in one season.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Fluazifop--0.125 to 0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 6.0 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Linuron--0.75 to 1.5 lb/A. Apply 1.5 to 3.0 pounds per acre Lorox 50DF or 1.5 to 3.0 pints per acre Lorox 4L. Apply when carrots are approximately 3 to 6 inches tall. Avoid postemergence applications when daily temperatures are 90°F (32.2°C) or above or during a period of cloudy weather or just after rain or irrigation. Linuron is effective on most weeds including ragweed. Do not plant treated area to crops not on the label within a 4-month period after treatment.

Metribuzin--0.25 lb/A. Apply 0.33 pound per acre Sencor 75DF postemergence to carrots with a minimum of six true leaves to control many broadleaf weeds, including tropic croton, spotted spurge, and horseweed. Do not use to control triazine-resistant weeds. Do not apply within 3 days after periods of cool, wet, cloudy weather. Do not tank-mix with any other pesticide or apply within 3 days, or excessive crop injury may result. Do not apply to carrots with less than six true leaves or excessive crop injury may result. Varietal differences exist in carrot tolerance to Sencor. Use caution when treating new varieties.

Prometryn--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pints per acre Caporol 4L after the crop has 3 true leaves, through the 6 true leaf stage of growth. Primarily controls many seedling annual broadleaf weeds less than 2 inches tall. Annual grasses may only be suppressed. Follow with overhead irrigation if rainfall does not occur. Use lower rate when the crop and weeds are small, or when cloudy, humid growing conditions prevail and the higher rate when the crop and weeds are more mature and hot dry growing conditions prevail. Add nonionic surfactant to be 0.5% of the spray solution (2.0 quarts per 100 gallons) or oil concentrate to be 1% of the spray solution (1.0 gallon per 100 gallons). One preemergence treatment of up to 4 pints per acre plus two postemergence treatments of 2.0 pints per acre may be applied, but do not exceed 8 pints per acre per crop cycle. Observe a minimum preharvest interval of 30 days.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF or postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Leafhoppers (LH), Aphids

Begin spraying when true leaves first appear. Repeat every 14 days or as needed.

Leafhoppers transmit aster yellows. Seedling protection from leafhoppers is important. Apply one of the following formulations:

beta-cyfluthrin (**LH only**)--1.6 to 2.8 fl oz/A Baythroid XL
cyfluthrin **(LH only)--**1.6 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate **(LH only)--**5.8 to 9.6 fl oz/A Asana XL

flonicamid **(Aphids only)**--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360
malathion--2.0 pts/A Malathion 57EC (or OLF)
methomyl (**LH only**)--1.5 to 3.0 pts/A Lannate LV (or OLF)
sulfloxafor--1.5 to 2.75 oz/ATransform WG
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG

Cutworms

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid + beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360
methomyl--0.75 to 1.50 pts/A Lannate LV (or OLF)

Carrot Weevil

Begin treatment when weevils become active. Apply one of the following formulations:

beta-cyfluthrin--2.8 fl oz/A Baythroid XL
cyfluthrin--2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--9.6 fl oz/A Asana XL
imidacloprid + beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360
oxamyl--2.0 to 4.0 pts/A Vydate L

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
beta-cyfluthrin	R	12	0
cyfluthrin	R	12	0
esfenvalerate	R	12	7
flonicamid	G	12	3
imidacloprid(soil/foliar)	G	12	21/7
imidacloprid + beta-cyfluthrin	R	12	7
malathion	G	24	7
methomyl	R	48	1
oxamyl	R	48	14
sulfloxafor	R	24	7
thiamethoxam	G	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
Contans WG (biological)	G	4	0
Endura (Group 7)	G	12	0
fixed copper (Group M1)	G	24	2
Fontelis (Group 7)	G	12	0
iprodione (Group 2)	G	24	0
Mertect (Group 1)	G	12	--
Pristine (Groups 11 + 7)	G	12	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	0
Switch (Groups 9 + 12)	G	12	7
Ultra Flourish (Group 4)	G	48	0

See Table D-6. [1] G = general, R = restricted

Nematode Control

Nematode control is essential for successful production. See Chapter E "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or use Vydate L. Heavy rainfall following application and prior to emergence can result in less effective control with Vydate L. Consult label before use.

Disease Control

Seed Treatment

Use seed treated with Maxim 4FS (0.08 to 0.16 fl oz/100 lb seed) for *Rhizoctonia* and *Fusarium* control and Apron XL or (0.32 to 0.64 fl oz/100 lb seed or Allegiance FL (0.75 fl oz/100 lb seed) for Pythium damping-off protection. Seed treatments are not a substitute for high-quality seed.

Damping-Off (*Pythium* and *Phytophthora*)

Use seed treatments as instructed above. Apply the following preplant incorporated or as a soil-surface spray after planting however, if the seed treatment contains mefenoxam or metalaxyl do not use soil application.

mefenoxam--Ridomil Gold 0.5 to 1.3 pt 4SL/A or Ultra Flourish--2.0 to 4.0 pt 2E/A

Aster Yellows

Use insecticides to control leafhoppers, and control weed populations (including carrot volunteers) on periphery of fields early in the season to prevent transmission by leafhoppers from the weeds into the crop. The severity of aster yellows and damage to the crop will depend on the age of the crop when the infection occurs. The earlier the infection occurs, the more severe and widespread the symptoms later in the season. See leafhopper management under “Insect Control”.

Leaf Blights (*Alternaria* and *Cercospora*)

Several varieties such as Bolero, Calgary, Carson, Cheyenne, and Choctaw exhibit tolerance to leaf blight and should be grown where adapted. For susceptible varieties, begin applications when disease threatens or early July, and continue every 7 to 10 days until frost. For processing crops or situations when the crop is not being marketed with its foliage, a 25% disease incidence threshold may be used to time the first fungicide application. Scout carrot fields by variety. While walking across the field in a ‘V’ or ‘W’ shaped transect for each variety, evaluate disease incidence on five leaves from five adjacent plants in a minimum of ten locations. A leaf is infected if one or more fungal leaf blight lesions are observed. When twelve of the fifty leaves scouted show symptoms (~25%) then apply the first fungicide spray. Subsequent sprays can be based on the label recommended spray interval or on increased disease severity. Under severe defoliation, add urea (10.0 lb/A) to encourage new leaf growth.

Tank mix and/or alternate one of the following fungicides *with* chlorothalonil--1.5 to 2.0 pt 6F/A or OLF:
Quadris--6.0 to 15.5 fl oz 2.08F/A (9.0 to 15.5 fl oz F/A for Cercospora)
Cabrio--8.0 to 12.0 oz 20EG/A
Pristine--8.0 to 10.5 oz 38WG/A
Fontelis--16.0 to 30.0 fl oz 1.67SC/A

For Alternaria leaf blight only, tank mix and alternate one of the following fungicides *with* chlorothalonil--1.5 to 2.0 pt 6F/A or OLF**:**
Endura--4.5 oz 70W/A
Switch--11.0 to 14.0 oz 62.5WG/A
iprodione--1.0 to 2.0 pt 50WP/A or OLF (check label for rotational restrictions)

Powdery Mildew

For powdery mildew, if symptoms are observed early in the season, initiate a fungicide spray program to protect foliage. Do not make more than one sequential application of Cabrio and/or Pristine before alternating with chlorothalonil. Disease development mid to late season rarely results in reduced yield at harvest. Under severe defoliation, add urea (10.0 lb/A) to encourage new leaf growth.

Tank mix and alternate one of the following FRAC code 11 fungicides *with* chlorothalonil--1.5 to 2.0 pt 6F/A**:**
Cabrio--8.0 to 12.0 oz 20EG/A
Pristine--8.0 to 10.5 oz 38WG/A

Bacterial Blight (*Xanthomonas*)

Initiate a fixed copper-based bactericide program as soon as symptoms are first observed. Not all copper-based products are created equal and vary by copper content as well as active ingredient(s) (see Table E-13 for a list of available fixed-copper products and check label for rates). Avoid walking and working in fields when the foliage is wet to reduce bacterial spread.

White Mold (*Sclerotinia sclerotiorum*)

Few products are available for the management of white mold. Avoid planting in shaded or poorly drained areas and areas with a history of severe white mold, and rotate infested fields to a non-host crop for at least 2 to 3 years. Maximize air movement through the plant canopy by using wider plant spacing. Remove and destroy infected plant material in the field. Apply Contans WG 3 to 4 months prior to planting to allow the active agent to reduce levels of sclerotia inoculum in the soil. Following application, incorporate to a depth of 1 to 2 inches. **Do not plow** before seeding carrots to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer. Most effective when used as part of an integrated pest management program.

Contans--2.0 to 4.0 lb 5.3WG/A

Storage Rots (*Botrytis* and *Sclerotinia*)

Remove roots from field, separate and discard damaged roots before placing them in storage at 32°F (0°C) and 90 to 95 percent relative humidity immediately after digging. As carrots are placed into storage, dip into the following fungicide solution for 5 to 10 seconds.
Mertect 340F--41.0 fl oz/100 gal water

CELERY

Varieties[1]

PennCrisp (PA only)	These varieties are recommended strains for PA and other areas where
Utah 52-70	climatic conditions are favorable for celery production.

[1] Varieties listed by maturity, earliest first.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Celery	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	150-175	250	150	100	0	250	150	100	0	Total nutrient recommended.
	50-75	250	150	100	0	250	150	100	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting.
	25-50	0	0	0	0	0	0	0	0	Sidedress 6-8 weeks after planting.

Apply 1.5 to 3.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

A physiological disorder called "brown check," is characterized by russeting and cracking on the inner side of the petiole. There is evidence that brown check may be caused by excessive amounts of potassium in the soil, although boron nutrition may also be involved. Plant resistant varieties, particularly Utah 52-70. Brown check may appear if varieties other than Utah 52-70 or related lines are planted on soils with high potassium levels and if a heavy rate of potassium fertilizer is used.

Seed Treatment

Freshly harvested seed may exhibit dormancy leading to poor germination. Therefore seeds should either be stored at <40° (4.44 °C) for six or more months or treated with phytohormones. For seed treatments pertaining to the eradication of pathogens see the Disease section.

Transplant Production

Because of the long growing season required, celery is usually treated as a transplant crop. Sow seed in the greenhouse 10 to 12 weeks before field planting. About 35,000 plants can be produced from 2½ ounces of seed. Temperatures between 70° to 75°F (21.1° to 23.9°C) should be maintained until the plants emerge, then 65° to 70°F (18.3° to 21.1°C) for steady growth. To reduce the production of "seeders," night temperatures should not drop below 55°F (12.8°C). Plants for the early crop should not be set in the field until danger of a prolonged cold period or actual freeze is over.

If plants become too tall or spindly before field setting, they can be clipped back to a 5- or 6-inch height. Plants can be hardened by withholding water 7 to 10 days after setting in field. Never harden celery plants by lowering temperatures.

Planting

Celery is a cool-season crop that grows most rapidly, yields best, and develops top quality at moderately cool temperatures (55° to 75°F [12.8° to 23.9°C]), good soil moisture, and relatively high humidity. It will withstand light freezes, but both young and old plants are damaged by moderate freezes. Celery, a biennial, initiates seed stalk (bolts) after being exposed to temperatures below 55°F (12.8°C) for a number of days.

Satisfactory crops can be produced on fertile, medium-textured mineral soils with irrigation. Since celery is expensive to grow, experience in both production and marketing is desirable before large-scale operations are attempted.

The usual planting period is May 1 to June 30. Transplants are grown in greenhouses or imported from Florida. Under satisfactory growing conditions, celery reaches usable size 85 to 100 days from transplanting. Special blanching practices can improve color and eating quality. High plant populations can promote blanching. For non self-blanching cultivars, blanching can be accomplished by trenching or other mechanical means.

Field Spacing

Rows: 16 to 32 inches apart; *plants*: 8 inches apart in row. Set from 30,000 to 45,000 plants per acre.

Harvest and Postharvest Considerations

Harvest when stalks are of sufficient size but before any pithiness has developed in the petioles. Celery should be cooled quickly to temperatures below 45°F (7.2°C) by hydrocooling, vacuum-cooling, icing, or other means of refrigeration. Stalks can be held for 5 to 7 weeks if storage is near 32°F (0°C) with 98 percent relative humidity.

Celery Disorders

Blackheart

Internal leaves develop a brown discoloration which eventually becomes deep black. The cause is similar to tip-burn of lettuce or blossom-end rot of tomato. Although many predisposing factors may be involved, water-stress results in a calcium deficiency disorder causing cell death. Symptom development is much more severe as plants approach maturity. Environmental conditions that favor rapid growth such as heavy rain or irrigation before drought favor blackheart development. High nitrogen, potassium, and sodium levels may also play a role. Blackheart is prevented by ensuring steady plant growth and avoiding wide fluctuations in moisture and nutrients. Drench applications of soluble calcium can lessen or prevent the development of blackheart. Drip irrigation, which provides more even moisture levels can help reduce risk.

Brown Check

A physiological disorder called "brown check," is characterized by russeting and cracking on the inner side of the petiole. There is evidence that brown check may be caused by excessive amounts of potassium in the soil, although boron nutrition may also be involved. Plant resistant varieties, particularly Utah 52-70. Brown check may appear if varieties other than Utah 52-70 or related lines are planted on soils with high potassium levels and if a heavy rate of potassium fertilizer is used (see earlier celery nutrition table).

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Preemergence

Prometryn--1.2 to 1.6 lb/A. Apply 2.4 to 3.3 pints per acre Caporol 4L after seeding, but before crop emergence. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. Do NOT use on sand or loamy sand soils, or crop injury may occur.

Postemergence

Linuron--0.75 to 1.50 lb/A. Apply 1.5 to 3.0 pounds per acre Lorox 50DF. Make a single application after celery trans-plants are established, but before celery is 8 inches tall to control most broadleaf weeds. Spray before target weeds reach 6 inches in height. DO NOT exceed 40 psi or apply when temperatures exceed 85°F. DO NOT add surfactants, oil concentrate, or liquid fertilizer. Use only the Lorox 50DF formulation of linuron. **For use on celery grown on muck soils only!**

Prometryn--1.6 to 3.2 lb/A. Apply 2.4 to 3.2 pints per acre Caporol 4L after the crop has 3-5 true leaves. Primarily controls many seedling annual broadleaf weeds less than 2 inches tall. Annual grasses may only be suppressed. Use lower rate when the crop and weeds are small, or when cloudy, humid growing conditions prevail and the higher rate when the crop and weeds are more mature and hot dry growing conditions prevail. Do NOT use on sand or loamy sand soils, or crop injury may occur. Do NOT tank-mix Caporol with any other pesticide. DO NOT use spray additives such as nonionic surfactant or oil concentrate. Do NOT apply within two weeks of any herbicidal oil such as "carrot oil" or Stoddard Solvent. Make either one preemergence application or one postemergence application, but not both. Observe a minimum preharvest interval of 40 days.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97 EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids

Apply one of the following formulations:
acephate (**green peach aphid only**)--0.5 to 1.0 lb/A Orthene 97S (or OLF)
acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil only** 4.4 to 10.5 fl oz/A Admire Pro (or OLF)
malathion--1.5 pts/A Malathion 57EC (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WDG
spirotetromat--4.0 to 5.0 fl oz/A Movento
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG

Leafhopper

Apply one of the following formulations:
beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
buprofezin--9.0 to 13.6 fl oz/A Courier 3.6SC
carbaryl--(aster leafhopper) 1.0 to 2.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 5.0 to 6.0 oz/A, **foliar** 1.0 to 3.0 oz/A Venom 70SG (or OLF), or **soil** 9.0 to 10.5 fl oz/A, foliar 2.0 to5.25 fl oz/A Scorpion 35SL (or OLF)
imidacloprid--**soil only** 4.4 to 10.5 fl oz/A , Admire PRO (or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG

Tarnished Plant Bug (*Lygus*)

Look for bugs on leaves shortly after transplanting and when nearby alfalfa or grain is cut. Apply one of the following formulations:
beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF)
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG

Mites

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz Agri-Mek 0.7SC

Leafminer

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
chlorantraniliprole--5.0 to 7.5 fl oz/A Coragen 1.67SC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyromazine--2.66 oz/A Trigard 75WSP
dinotefuran--**soil** 5.0 to 6.0 oz/A, **foliar** 1.0 to 3.0 oz/A Venom 70SG (or OLF), or **soil** 9.0 to 10.5 fl oz/A, **foliar** 2.0 to 5.25 fl oz/A Scorpion 35SL (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 10.0 fl oz/A Entrust SC

Cutworms

Apply one of the following formulations:
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL

cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
methomyl--1.5 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)

Cabbage Looper

Apply one of the following formulations:
acephate--1.0 lb/A Orthene 97S, (Acephate 97UP, or OLF)
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel DF (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
emamectin benzoate--3.2 to 4.8 oz/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG
methomyl--3.0 pts/A Lannate LV (or OLF)
permethrin--2.0 to 8.0 oz/A Perm-Up 3.2 EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC

Beet Armyworm (BAW), Fall Armyworm (FAW)

Apply one of the following formulations:
acephate (**FAW only)--**1.0 lb/A Orthene 97S (Acephate 97UP, or OLF)
chlorantraniliprole (**BAW only)--**3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofenzin--12.0 to 17.0 fl oz/A Vetica
indoxacarb (**BAW only**)--3.5 oz/A Avaunt 30WDG
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl 0 oz/A Entrust SC

Disease Control

Seed Treatment

Use seed that is at least 2 years old. Soak newer seed in hot water at 118°F (47.8°C) for 30 minutes. Use seed treated with Maxim 4F (0.08 to 0.16 fl oz/100 lb) for *Rhizoctonia* and *Fusarium* management and Apron XL (0.085 to 0.64 fl oz/100 lb seed) for *Pythium* damping-off protection.

Damping-Off (*Pythium*)

Damping off is favored by excessive soil moisture. Avoid over-saturation of seedbeds and do not transplant diseased plants in the field. Apply one of the following:

Ridomil Gold--1.0 to 2.0 pt 4SL/A preplant incorporated broadcast or in a 7-inch band (not for use in a greenhouse)
Uniform--0.34 fl oz 3.66SE/1000 ft of row in-furrow (see label for specific details) for *Pythium* and/or *Rhizoctonia*

Crater and Petiole Rot or Basal Stalk Rot (*Rhizoctonia*)

Rotate out of celery for at least 3 years to insure crop residue is thoroughly decomposed. Avoid planting transplants too deep and in poorly drained soils. Where problems occur regularly apply fungicides.

Quadris--0.40 to 0.80 fl oz 2.08F/1000 row feet applied in a 7-in band in–furrow or shortly after emergence directed at the stem.

Pink Rot (*Sclerotinia)*

Few products are available for pink rot control. Avoid planting in shaded or poorly drained areas and areas with a history of pink rot. Rotate fields for at least 2 or 3 years. Maximize air movement through the plant canopy. Apply 3 to 4 months prior to the onset of disease to allow the mycoparasite to reduce sclerotial inoculum levels in the soil. Following application, incorporate to a depth of 1 to 2 inches; however, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer, **do not plow** between treatment and planting times.

Contans--2.0 to 4.0 lb 5.3WG/A

During the season apply:
chlorothalonil--3.0 pt 6F/A or OLF, shortly after plants emerge and repeat on a 7-day schedule (suppression only).
Cannonball--7.0 oz 50WP/A

Leaf Blights (*Cercospora* and *Septoria*)

Use certified, disease-free seed or treat seed with hot water or fungicides. Practice careful sanitation in transplant production or rotate ground seedbeds. Use 3 or 4 year crop rotations. Apply one of the following formulations:

Alternate:
Quadris--9.0 to 15.5 fl oz 2.08F/A
Quadris Opti--2.4 to 3.7 pt 5.5SC /A

With one of the following:
chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
copper, fixed--at labeled rates
Fontelis--14.0 to 24.0 fl oz 1.67 EC/A
Tilt--4.0 fl oz 3.6EC/A

Fusarium Yellows

Do not obtain plants from areas of known infestation. There are no means of chemical control. Avoid seeding or transplanting into infested soil or use resistant varieties.

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
abamectin	R	12	7
acephate	G	24	21
acetamiprid	G	12	7
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
buprofezin	R	12	7
carbaryl	G	12	14
chlorantraniliprole	G	4	1
clothianidin	G	12	21
cyfluthrin	R	12	0
cyromazine	G	12	7
dinotefuran (soil/foliar)	G	12	21/7
emamectin benzoate	R	12	7
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide + buprofezin	G	12	7
imidacloprid (soil only)	G	12	45
indoxacarb	G	12	3
malathion	G	24	7
methomyl	R	48	7
permethrin	R	12	1
pymetrozine	G	12	7
spinetoram	G	4	1
spinosad	G	4	1
spirotetromat	G	24	3
sulfloxafor	G	12	3
thiamethoxam	G	12	7

(table continued next page)

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
FUNGICIDE (FRAC code)			
chlorothalonil (Group M5)	G	12	7
Contans WG (biological)	G	4	0
Cannonball (Group 12)	G	12	0
copper, fixed (Group M1)	G	24	0
Fontelis (Group 7)	G	12	3
Quadris (Group 11)	G	4	0
Quadris Opti (Groups 11+M5)	G	12	7
Ridomil Gold (Group 4)	G	48	0
Tilt (Group 3)	G	12	14
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.

1 G = general, R = restricted, AP = At planting

CUCUMBERS

For earlier cucumber production and higher, more concentrated yields, use gynoecious varieties. A gynoecious plant produces a high percentage of female flowers (the ones that produce fruits). To produce pollen, 1 to 15 percent of pollinator must be planted; seedsmen add this seed to the gynoecious variety. Both pickling and slicing gynoecious varieties are available. Parthenocarpic cucumbers that produce fruits without pollination are also available for protected culture and field production.

Recommended Cucumber Varieties

Variety	Days	F1[1]	Type[2]	Use[3]	Disease Reactions[4]								
					Scab (Ccu)	PM (Px)	AN (Co)	DM[5] (Pcu)	ALS (Psl)	Cmv	Wmv	Zmv	Prsv
Standard Slicing Varieties													
Cobra	60	Yes	Gyn	F	X	X	X		X	X	X	X	X
Cortez	59	Yes	Gyn	F	X	X	X		X	X	X	X	X
Darlington	62	Yes	Gyn	F	X	X	X		X	X	X	X	X
Dasher II	58	Yes	Gyn	F	X	X	X		X	X			
Dominator	55	Yes	Gyn	F	X	X	X		X	X			
General Lee	66	Yes	Gyn	F	X	X				X			
Indy	59	Yes	Gyn	F	X	X	X		X	X	X	X	X
Intimidator	53	Yes	Gyn	F	X	X	X		X	X			
Marketmore76	68	No	Mon	F	X	X				X			
Mongoose	55	Yes	Gyn	F	X	X	X		X	X	X	X	X
Speedway	56	Yes	Gyn	F	X	X	X		X	X			
Stonewall	53	Yes	Gyn	F	X	X	X		X	X			
SV3462CS	56	Yes	Gyn	F	X	X	X	X	X			X	
SV4719CS	56	Yes	Gyn	F	X	X	X	X	X			X	
Talladaga	61	Yes	Gyn	F	X	X	X		X		X		
Thunder	58	Yes	Gyn	F	X	X	X		X	X		X	
Thunderbird	60	Yes	Gyn	F	X	X	X		X	X	X	X	X
Turbo	67	Yes	Gyn	F	X	X	X		X	X			
Slicers – Long types													
Suyo Long	61	No	Mon	F		X							
Tasty Green	52	Yes	Mon	F		X							
Pickles													
Calypso	51	Yes	Gyn	HF	X	X	X		X	X			
Eureka	57	Yes	Mon	HF	X	X	X		X	X	X		X
Expedition	50	Yes	Gyn	MP	X	X	X		X	X			
Fanci Pak	53	Yes	Gyn	HF	X	X	X		X	X			
Feisty	57	Yes	Gyn	MP	X	X	X		X	X			
Jackson Supreme	52	Yes	Gyn	HMFP	X	X	X		X	X			
H19 Little Leaf	57	No	Parth	HF	X	X	X		X	X			
Lafayette	52	Yes	Gyn	MP	X	X	X		X	X			

(table continued next page)

Recommended Cucumber Varieties *(continued)*

Variety	Days	F1[1]	Type[2]	Use[3]	Disease Reactions[4]								
					Scab (Ccu)	PM (Px)	AN (Co)	DM[5] (Pcu)	ALS (Psl)	Cmv	Wmv	Zmv	Prsv
Pickles *(continued)*													
Logan	51	Yes	Gyn	MP	X	X	X		X	X			
Puccini	50	Yes	Parth	HMFP	X		X		X	X			
Sassy	57	Yes	Gyn	MP	X	X	X		X	X			
Treasure	51	Yes	Gyn	MP	X	X	X		X				
Vlaspik	51	Yes	Gyn	MP	X	X	X		X	X			
Protected Culture/High Tunnels													
Corinto	48	Yes	Parth	F	X					X			
Lisboa	60	Yes	Parth	F									
Rocky	46	Yes	Parth	F		X							
Socrates	52	Yes	Parth	F	X	X							

[1]F1 hybrid (yes/no)
[2]Type: Gyn = Gynoecious or mostly female flowers – a small amount of a monoecious pollinizer (5-15%) variety will be added as a pollen source; Mon = monoecious type with both female and male flowers; Parth = Parthenocarpic type that sets fruit without pollination
[3]Use: F= Fresh Market, P=Processing (pickling), H= Hand harvest multiple times, M=Machine harvest once over
[4]Disease reactions. X denotes high or intermediate level of resistance to Scab, Powdery Mildew (PM), Anthracnose (AN), Downy Mildew (DM), Angular Leaf Spot (ALS), Cucumber mosaic virus (Cmv) Watermelon Mosaic Virus (Wmv), Zucchini yellows mosaic virus (Zmv), or Papaya ring spot virus (Prsv)
[5]Only those varieties with some resistance to the current strain of downy mildew are noted with an X.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Cucumbers	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	80-150	150	100	50	0[1]	200	150	100	0[1]	Total nutrient recommended.
	25-50	125	75	25	0[1]	175	125	75	0[1]	Broadcast and disk-in.
	25	25	25	25	0	25	25	25	0	Band place with planter.
	25-75	0	0	0	0	0	0	0	0	Sidedress when vines begin to run.

For plasticulture production, fertilization rates are based on a standard row spacing of 6-feet.
[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Suggested Fertigation Schedule for Fine-Textured Soils - Cucumber

Days After Planting	By Days After Planting Period		Cumulative Amount Applied	
	Nitrogen (N)[1]	Potash (K_2O)[1,2]	N[1]	K_2O[1,2]
	lb/acre			
Preplant[3]	-	-	45	70
0-7 (7 days)	2	2	47	72
8-21 (13 days)	5	5	52	77
22-63 (41 days)	20	20	72	97
64-70 (6 days)	3	3	75	100

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot bed centers. Adjust proportionally for other widths. See Fertigation in section C-Irrigation Management for more information.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season, to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for cucumbers.

Critical cucumber tissue test values for most recently matured leaves.

Timing	Value	N %	P %	K %	Ca %	Mg %	S %	Fe ppm	Mn ppm	Zn ppm	B ppm	Cu ppm	Mo ppm
Before Flowering	Deficient	<3.5	0.3	1.6	2	0.58	0.3	<40	30	20	20	5	0.2
	Adequate range	3.5	0.3	1.6	2	0.58	0.3	40	30	20	20	5	0.3
		6	0.6	3	4	0.7	0.8	100	100	50	60	20	1
	High	>6.0	0.6	3	4	0.7	0.8	>100	100	50	60	20	2
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-	-
Early Bloom	Deficient	<2.5	0.3	1.6	1.3	0.3	0.3	<40	30	20	20	5	0.2
	Adequate range	2.5	0.3	1.6	1.3	0.3	0.3	40	30	20	20	5	0.3
		5	0.6	3	3.5	0.6	0.8	100	100	50	60	20	1
	High	>5.0	0.6	3	3.5	0.6	0.8	>100	100	50	60	20	2
	Toxic (>)	-	-	-	-	-	-	-	900	950	150	-	-

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. See the Disease Section for more information on treatment to prevent disease.

Planting Dates

Start seeding in mid-April in warmer, southern areas and May 10 in Pennsylvania and other cool areas. Successive plantings can be made through early August.

Container-grown plug plants are planted through the plastic when daily mean temperatures have reached 60°F (15.6°C). Planting dates vary from April 20 in southern regions to June 20 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers or rye windbreaks.

Spacing

Slicers: Space rows 3 to 4 feet apart with plants 9 to 12 inches apart. Seeding rate: 1.5 pounds per acre. *Machine Harvest Pickles*: Research and field experience has shown that 55,000 to 65,000 plants per acre is the optimum population for yield and quality. To accommodate a harvester width of 84 inches, three rows 26 to 28 inches apart should be planted on each bed. Plants should be 4 to 5 inches apart in the row. If the harvester has a 90-inch head, space rows 30 inches apart and space plants 3 to 4 inches apart in the row. For machine harvest of pickles, high plant populations concentrate pickle maturity. Parthenocarpic pickles are being trialed in the region. These are planted to achieve 22,000 to 28,000 plants per acre.

Hand Harvest Pickles: Space rows 3 to 4 feet apart with plants 6 to 8 inches apart. Seeding rate: 1.5 to 2 pounds per acre.

Mulching

Plastic mulch laid before field planting conserves moisture, increases soil temperature, and increases early and total yield. Fumigated soil aids in the control of weeds and soil-borne diseases. Several fumigants can be used on cucumber depending on what the predominant pests are. See the Chapter E “Soil Fumigation” and "Nematodes" sections under “Soil Pests--Their Detection and Control”. Fumigant and mulch should be applied to well-prepared planting beds 30 days before field planting. Various widths of plastic mulch are available depending on individual production systems and available equipment. Plasic should be laid immediately over the fumigated soil. The soil must be moist when laying the plastic. Fumigation alone may not provide satisfactory weed control under plastic. Black plastic or paper can be used without a herbicide to provide control of most weeds. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate (NO_3-) form. Trickle (drip) irrigation is recommended for plastic mulch systems and tape is laid at the same time as mulch.

Foil and highly reflective mulches can be used to repel aphids that transmit viruses in fall-planted (after July 1) cucurbits. Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil mulches. Also, a herbicide is not necessary. Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Cucumbers also have been successfully grown in no-till systems on cover crop mulch.

Season Extension

Cucumbers for early production may be successfully grown in high tunnels, in low tunnels with perforated clear plastic row covers, or using floating row covers. Use plastic mulch and trickle irrigation as discussed above in “mulching”. This field system similar to that used for early sweet corn is also successful: A modified bedshaper is used to form a ridge on each side of the plant row, leaving a suitable area for planting. A 36-inch-wide piece of embossed clear plastic is then used to cover the plant row, leaving a 5 to 6 inch-high space between the planted row and the plastic cover. It is estimated that temperatures may be increased 10-20 F depending on time of planting and sunlight availability and intensity.

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper cucumber pollination and fruit set. In high tunnels bumblebees are particularly effective. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See the section on "Pollination" in Section A, the General Production Recommendations, and/or Table D-6 for relative toxicity of various pesticides for hazards to bees.

Trellising

Fresh market slicer cucumbers and pickles may be produced on trellises. This is the preferred system in high tunnels. Yields are 2 to 3 times greater than the average from

non-trellised fields. In high tunnels and greenhouses, parthenocarpic types can be used (requiring no pollinizers).
Benefits of Trellising:

1. Improved fruit quality, particularly with respect to color and shape. Trellised cucumbers have no yellow "ground spot."
2. More effective control of many diseases and insects.
3. Less damage to vines resulting in a longer harvest season.
4. More consistent and thorough harvesting resulting in fewer jumbos and culls.
5. Harvesting trellised cucumbers is easier than harvesting ground grown cucumbers since fruit hang where visible and easily reached.

Production of cucumbers on trellises, however, involves a greater investment than when grown on the ground due to the cost of erecting trellises.

Erect the trellis so that there is one 6 ft high with a top (No. 8) and bottom (No. 12) wire and plastic twine or netting tied between the two wires at each plant. Posts or poles should be no more than 15 ft apart and the top wire should be very taut. A additional brace between posts may be required in the season when the fruit load becomes heavy. In high tunnels wires are stretched at the height desired and plastic twine is used to train plants, cucumber plants will not climb the trellises satisfactorily by themselves. Training the main stem is required until it reaches and extends over the top wire. Pruning lateral runners near the base of the plant will result in higher yields. The first 4 to 6 lateral runners that appear should be removed. Other runners above this point should be allowed to run. Single stem systems are often used in high tunnels.

Irrigation

Cucumbers require irrigation for best yields and quality. Cucmbers are most sensitive to moisture stress during flowering and fruiting. Water use during this period can be over 0.25 inches per day and water deficit during this period will have the greatest negative impact on yields and fruit quality. A balance must be struck, however, between maintaining adequate moisture for fruiting while minimizing wetness in the canopy and on the soil surface which promotes fruit rots and downy mildew.

Harvest and Storage

Cucumbers should be harvested when they have reached full size for the variety but while seeds are still soft. For slicers and manually-harvested pickles, multiple harvests at 2-3 day intervals, will be necessary. Machine-harvested pickles are harvested once when a small percentage (less than 5%) have become oversized. This produces the highest bushel yields. Size requirements of processors will also dictate harvest schedules for machine and hand harvest pickles.

Cucumbers can be held 10 to 14 days at 50° to 55°F with a relative humidity 90-95%. They are subject to chilling injury if held longer than about 2 days at temperatures below 50°F. At temperatures of 50° F and above, they ripen rather rapidly, the green color changing to yellow. This color change starts in about 10 days at 50° F and is accelerated if the cucumbers are stored in the same room with apples, tomatoes, or other ethylene-producing crops. Cucumbers for fresh market are usually waxed to reduce moisture loss.

Greenhouse Production

Varieties specifically developed for greenhouses are, most commonly, parthenocarpic varieties bred specifically for the lower light conditions of fall, winter, and early spring. European “English” or “Dutch” types and Asian types are available. Hydroponic nutrient solutions systems are commonly used for production in greenhouses and cucumbers are trellised with single or double stem trained onto twine. Links to greenhouse production information can be found in Section A, General Production Recommendations of this publication.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in cucumbers.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee’s (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay seeding or transplanting the crop for 7 days after the application of Sandea under plastic mulch. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for cucumbers to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2). Recalibrate and reduce herbicide rates for banded applications.

Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME preemergence to direct-seeded cucumbers to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 1.12 lb/A. Apply 1.0 to 3.0 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2.0	0.4	0.125
3.0	0.6	0.188
4.0	0.8	0.250
5.0	1.0	0.312
6.0	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season before the vines begin to run. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047** pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.

Postemergence

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 as or OLF a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, 0wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3.0 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated

Bensulide *plus* naptalam--4.0 to 6.0 lb/A *plus* 2.0 lb/A. Apply 1.0 to 1.5 gallons of Prefar 4EC *plus* 1.0 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment before seeding or transplanting. Tank mix is approved.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 0.94 lb/A. Apply 1.0 to 2.5 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For soil strips between rows of plastic mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Postemergence

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.50 to 0.66 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.**

Paraquat--0.6 lb/A. A Special Local-Needs 24(c) label has been approved for the use **Gramoxone SL 2.0 or OLF postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 **or OLF** as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of SelectMax 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select 2EC will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of

the mulch. See the label for additional information and warnings.
Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.
NOTE: Copies of specific insecticide product labels can be downloaded by visiting www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via Google or other web search engines.

Seed Corn Maggot

See Chapter E "Maggots" section in "Soil Pests--Their Detection and Control".)

chlorpyrifos (seed treatment-Lorsban 50W or OLF)

Note: The use of imidacloprid at planting may reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles can transmit bacterial wilt; however, losses from this disease vary greatly from field to field and among different varieties. Pickling cucumbers grown in high-density rows for once-over harvesting can compensate for at least 10 percent stand losses. On farms with a history of bacterial wilt infections and where susceptible varieties are used, insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run (usually about 3 weeks after plant emergence). Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--2.4 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5 to 6 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1 to 4 oz Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.0 fl oz/A Danitol 2.4EC (or OLF)
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Cutworms

(Also see Chapter E "Cutworms" section in "Soil Pests--Their Detection and Control")
Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pickleworm, Melonworm

When using foliar materials, make one treatment prior to fruit set, and then treat weekly. If using soil or drip applications, follow instructions on the label.

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
chlorantraniliprole--melonworm **drip** 2.0 to 3.5 fl oz/A, **foliar** 2.0 to 5.0 fl oz/A; pickleworm **drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate (pickleworm only)--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Stink bug

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)

dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Apply one of the following formulations:
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetroram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 8.0 fl oz/A Entrust SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG (or OLF)
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo

Aphids

Note. Aphids transmit multiple viruses. For chemical control of aphids, apply one of the following formulations:

acetamidprid--2.5 to 4.0 oz/A Assail 30G (or OLF)
Chenopodium ambrosioides extract--2.0 to 3.0 qt/A Requiem 25EC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin+thiamethoxam--4.5 fl oz/A Endigo ZC
methomyl **(**melon aphid only)--1.5 to 3.0 pts/A Lannate LV (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WP
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG (or OLF); **foliar** 1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi)

Leafminers

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
cyromazine--2.66 oz/A Trigard 75WSP
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
spinosad--6.0 to 8.0 fl oz/A Entrust SC
spinetroram--6.0 to 10.0 fl oz/A Radiant SC

Cabbage Looper

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--soil/drip/foliar 3.5 to 5.0 fl oz/A Coragen
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant EC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot-treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season. Apply one of the following formulations:

Note. Continuous use of carbaryl, or a pyrethroid may result in mite outbreaks.

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
bifenazate--0.75 to 1.00 lb/A Acramite 50WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
fenpyroximate--2.0 pts/A Portal
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC

Nematode Control

See Chapter E, "Nematodes" section of “Soil Pests-Their Detection and Control”. Use fumigants listed in the "Soil Fumigation" section.

Vydate L--1.0 to 2.0 gal 2L/A. Incorporate into top 2 to 4 inches of soil or 2.0 to 4.0 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480 DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

Damping-Off

Apply the following in a 7-inch band after seeding. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold, Ultra Flourish or MetaStar needed per acre

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A or Ultra Flourish--2.0 to 4.0 pt 2E/A)
metalaxyl--(MetaStar--4.0 to 8.0 pt 2E/A)
Uniform--0.34 fl oz 3.66SE/1000 ft row

Viruses (WMV2, PRSV, ZYMV and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV, and CMV. Use varieties with multiple virus resistance when possible. Plant fields far away from existing cucurbit plantings to help reduce aphid transmission of viruses from existing fields into new fields.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be neccessary.

Angular Leaf Spot

At first sign of disease, apply the labeled rates of fixed copper *plus* mancozeb. Repeat every 7 days. To minimize the spread of disease, avoid working in field while foliage is wet.

Powdery Mildew

Excellent resistance is available in all recommended cucumber varieties. The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides has been reported in the Eastern US. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failure.

Powdery mildew generally occurs from mid-July until the end of the season. Observe fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves, begin the following fungicide program:

Alternate one of the following tank mixes:
Torino--3.4 fl oz 0.85SC/A
Procure--4.0 to 8.0 fl oz 480SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Rally--5.0 oz 40WSP/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
tebuconazole--4.0 to 6.0 fl oz 3.6 F/A or OLF *plus* chlorothalonil--2.0 to 3.0 pt 6F/A
Inspire Super--16.0 to 20.0 fl oz 2.8F/A plus chlorothalonil 2.0 to 3.0 pt 6F/A

With:
Fontelis--12.0 to 16.0 fl oz 1.67SC /A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A,
Pristine--12.5 to 18.5 oz 38WG/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Downy Mildew

Downy mildew pathogen strains present in the mid-Atlantic have changed in recent years. Newly developed cultivars with resistance or tolerance to downy mildew should be planted where available. Even when using resistant cultivars, it is important to maintain a good fungicide program. The downy mildew pathogen does not overwinter in the mid-Atlantic. However introduction to the region has occurred very early in recent years. Scout fields for disease incidence beginning at plant emergence. Begin sprays when vines run or earlier if disease occurrence is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (http://cdm.ipmpipe.org) for current status of the disease. Once the disease has become established in an area, new plantings should receive an application of Ranman, or Previcur Flex at the 1-3 leaf stage. Spray programs that include fungicides with several modes of action [for example, Ranman (Group 21) plus Gavel (Groups 22 + M3) alt. with Previcur Flex (Group 28) plus chlorothalonil (Group M5)] are more effective than programs with few modes of action. Follow all label precautions for preventing development of resistance to these fungicides. Preventative applications are much more effective than applications made after disease is detected.

The following are the most effective materials (always tank-mix these products with a protectant such as chlorothalonil--1.5 to 3.0 pt 6F/A or OLF, or mancozeb--3.0 lb 75DF/A or Gavel--1.5 to 2.0 lb 75DF/A):

Ranman--2.10 to 2.75 fl. oz. 400SC/A see label for additional precautions
Previcur Flex--1.2 pt 6F/A

Other materials for use in rotation as tank mix partners with a protectant:
Presidio--3.0 to 4.0 fl oz 4SC/A (caution, pathogen is less sensitive to Presidio than in the past)
Tanos--8.0 oz 50DF/A
Forum--6.0 fl oz 4.17SC/A
Zampro--14.0 fl oz 525SC/A
Curzate--3.2 oz 60DF/A

Materials with different modes of action (FRAC codes) should always be alternated.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Anthracnose

Excellent resistance is available in some varieties and should be used when possible. Begin fungicide applications when vines begin to run, or earlier if symptoms are detected. Alternate chlorothalonil or mancozeb with other effective fungicides every 7 days. Fungicides with a high risk for resistance development such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris), should be tank-mixed with a protectant fungicide. When tank-mixing, use at least the minimum labeled rate of each fungicide in the tank-mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not apply them. Use fungicides from a different FRAC code.

Alternate:
chlorothalonil--1.5 to 3.0 pt 6F/A or OLF (use low rate early in season)
mancozeb--2.0 to 3.0 lb 75DF/A or OLF

To improve the performance of chlorothalonil, combine it with:

thiophanate-methyl--0.5 lb 70WP/A or OLF

***With one of the following formulations*:**

a tank-mix containing chlorothalonil or mancozeb *plus*
Pristine--18.5 oz 38WG/A
Tanos--8.0 oz 50DF/A
Inspire Super 16.0 to 20.0 fl oz 2.8 F/A
Quadris Top 12.0 to 14.0 fl oz 2.7 F/A
Quadris--11.0 to 15.5 fl oz 2.08F/A
Cabrio--12.0 to 16.0 oz 20EG/A

Gummy Stem Blight

Gummy stem blight occurs primarily in the late summer. Fungicides with a high-risk for resistance development such as Pristine (a FRAC code 11 fungicide) should be tank-mixed with a protectant fungicide to reduce the chances for resistance development (see Table E-13). When tank-mixing, use at least the minimum labeled rate of each fungicide in the tank mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not use. Apply fungicides from a different FRAC code.

Begin sprays when vines begin to run.

Alternate one of the following formulations:

chlorothalonil--2.0 pt 6F/A
mancozeb--2.0 to 3.0 lb 75DF/A or OLF

***With*:**

a tank-mix containing either chlorothalonil or mancozeb plus one of the following fungicides:

tebuconazole--8.0 fl oz 3.6 F/A or OLF
Inspire Super--16.0 to 20.0 fl oz 2.8F/A
Switch--11.0 to 14.0 oz 62.5 WG/A
Fontelis--12.0 to 16.0 fl oz 1.67SC/A

or a tank-mix containing either chlorothalonil or mancozeb plus one of the following FRAC code 11 fungicides:
Pristine--12.5 to 18.5 oz 38WG/A
Quadris--11.0 to 15.5 fl oz 2.08F/A (not recommended in Maryland, Delaware and Virginia due to resistance)
Cabrio--12.0 to 16.0 oz 20EG/A (not recommended in Maryland, Delaware and Virginia due to resistance)

Belly Rot

Apply the following at the 1- to 3-leaf stage. Make a second application 10 to 14 days later or just prior to vine tip–over or whichever occurs first.

Quadris--11.0 to 15.5 fl oz 2.08F/A

Scab

Scab typically occurs during cool periods. Excellent resistance is available in some varieties and should be used when possible. Apply one of the following as true leaves form and repeat every 5 to 7 days.

chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
mancozeb--2.0 to 3.0 lb 75DF/A or OLF

Cottony Leak (*Pythium*)

At planting apply:
mefenoxam--1.0 to 2.0 pt Ridomil Gold 4SL/A or 2.0 to 4.0 pt Ultra Flourish 2E/A. Apply in a 7-inch band after seeding. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as cucurbits, peppers, lima and snap beans, eggplants, and tomatoes) for as long as possible and improve drainage in the field, apply preplant fumigants to suppress disease. When conditions favor disease development fungicides should be applied under excellent resistance management practices. Apply one of the following fungicides which provide suppression only. Rotate with fungicides in different FRAC groups and tank mix with a fixed copper.

Revus--8.0 fl oz 2.08 F/A
Ranman--2.75 fl oz 400SC/A
Presidio--3.0 to 4.0 fl oz 4SC/A
Forum--6.0 fl oz 4.17SC/A
Gavel--1.5 to 2.0 lb 75DF/A
Tanos--8.0 to 10.0 oz 50DF/A
Zampro--14.0 fl oz 525SC/A

Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	0
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin	R	12	3
bifenazate	G	12	3
carbaryl	G	12	3
Chenopodium extract	G	4	0
chlorantraniliprole	G	4	1
clothianidin (soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	0
dinotefuran (soil/foliar)	G	12	21/1
esfenvalerate	R	12	3
etoxazole	G	12	7
fenpropathrin	R	24	7
fenpyroximate	G	12	1
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide + buprofezin	G	12	1
imidacloprid (soil)	G	12	21
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	1

(table continued next page)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE ***(continued)***			
lambda-cyhalothrin + chlorantraniliprole	R	24	1
lambda-cyhalothrin + thiamethoxam	R	24	1
methomyl	R	48	3
methoxyfenozide	G	4	3
oxamyl	R	48	1
permethrin	R	12	0
pymetrozine	G	12	0
spinetoram	G	4	1
spinosad	G	4	1
spiromesifen	G	12	7
sulfloxafor	G	12	1
thiamethoxam			
soil/drip	G	12	30
foliar	G	12	0
thiamethoxam+chlorantraniliprole			
soil/drip	G	12	30
foliar	G	12	1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Folicur (Group 3)	G	12	7
Fontelis (Group 7)	G	12	1
Forum (Group 40)	G	12	0
Gavel (Groups 22+ M3)	G	48	5
Inspire Super (Groups 3 + 9)	G	12	7
mancozeb (Group M3)	G	24	5
MetaStar (Group 4)	G	48	AP
Presidio (Group 43)	G	12	2
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quadris Top (Groups 11 + 3)	G	12	1
Rally (Group 3)	G	24	0
Ranman (Group 21)	G	12	0
Revus (Group 40)	G	4	0
Ridomil Gold (Group 4)	G	48	5
Switch (Groups 9 + 12)	G	12	1
Tanos (Groups 11 + 27)	G	12	3
thiophanate-methyl (Group 1)	G	24	1
Torino (Group U6)	G	4	0
Ultra Flourish (Group 4)	G	48	5
Uniform (Groups 4 + 11)	G	0	AP
Zampro (Groups 45 + 40)	G	12	0

See Table 3.

[1] G = general, R = restricted

[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

[3] AP=at planting

EGGPLANT

Recommended Varieties

Standard Market Dark Purple-Skinned Oval Types
Epic* (TMV)
Galine*
Black Bell II* (TMV)
Traviata* (mostly organic)
Nadia*
Night Shadow*
Classic*
Santana*

Specialty Types
Barbarella (Round dark purple)
Beatrice* (Round purple)
Birgah (Round purple)
Gretel* (White mini)

Specialty Types *(continued)*
Kermit (Round green/white mini)
Mangan* (Japanese purple)
Megal* (Italian type)
Ichiban* (Asian)
Calliope* (Small; purple variegated)
Machiaw* (Asian)
Nubia (purple variegated)
Oriental Charm* (Asian; spineless violet)
Orient Express* (Asian type)
Millionaire* (Long Japanese)
Zebra* (Purple variegated)
Fairy Tale (Purple variegated)
White Star* (White)
Turkish Orange (Orange; small oval; heirloom)

Varieties listed earliest (55 days) to latest (85 days) according to vendors
*Indicates F_1 hybrid varieties
Disease resistance/tolerance (according to vendor) and/or specialty descriptions in parentheses ( )

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Eggplant	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	125-150[1]	250	150	100	0	250	150	100	0	Total nutrient recommended.
	50-100	250	150	100	0	250	150	100	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks after planting.
	25-50	0	0	0	0	0	0	0	0	Sidedress 6-8 weeks after planting.

For plasticulture production, fertilization rates are based on a standard row spacing of 6-feet. Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-1 for more specific boron recommendations.

[1]If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 225 pounds of nitrogen (N) per acre with recommended P_2O_5 and K_2O and disk-in or incorporate prior to laying mulch.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for eggplant.

Critical eggplant tissue test values.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
Most recently matured leaves at early fruit set	Deficient	<4.2	0.3	3.5	0.8	0.25	0.4	<50	50	20	20	5	0.5
	Adequate range	4.2	0.3	3.5	0.8	0.25	0.4	50	50	20	20	5	0.5
		6	0.6	5	1.5	0.6	0.6	100	100	40	40	10	0.8
	High	>6.0	0.6	5	1.5	0.6	0.6	>100	100	40	40	10	0.8
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-	

Seed Treatment

Seed should be treated to prevent disease. See the Disease section for more information.

Transplant Production

Sow seed in the greenhouse 8 to 10 weeks before field planting. Three to 4 ounces of seed are necessary to produce plants for 1 acre. Optimum temperatures for germination and growth are 70^{o} to 75^{o}F (21.1^{o} to 23.9^{o}C). Seedlings should be transplanted to 2-inch or larger pots or containers anytime after the first true leaves appear, or seed can be sown directly into the pots and thinned to a single plant per pot. Control aphids on seedlings in greenhouse with an aerosol–bomb before transplanting to field.

Transplanting Dates

Harden plants for a few days at 60^{o} to 65^{o}F (15.6^{o} to 18.3^{o}C) and set in field after danger of frost and when average daily temperatures have reached 65^{o} to 70^{o}F (18.3^{o} to 21.1^{o}C). Usual transplanting dates are May 15 to June 5.

Eggplant is a warm-season crop that makes its best growth at temperatures between 70^{o} to 85^{o}F (21.1^{o} to 29.4^{o}C). Temperatures below 65^{o}F (18.3^{o}C) result in poor growth and fruit set.

Spacing

Rows: 4 to 5 feet apart; *plants*: 2 to 3 feet apart in the row. Space plants 18 to 30 inches apart in Pennsylvania and for late plantings in other areas.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 60.0 pounds per acre of N, P_2O_5 and K_2O. Then thoroughly incorporate into the soil. If soil tests medium or less in soil potassium, apply a fertilizer with a ratio of 1-1-2 or 1-1-3 carrying 60 pounds of nitrogen per acre.

After mulching and installing the trickle irrigation system, apply completely soluble fertilizers to supply 40 pounds (10.0 to 20.0 pounds in Pennsylvania) of N, P_2O_5 and K_2O per fertilized-mulched acre during each application (a description of a fertilized-mulched acre may be found in the "Irrigation" section of this publication). On soils testing low and low to medium in boron and that have not received any preplant boron fertilizer, include 0.25 pound of actual boron per fertilized-mulched acre in each soluble fertilizer application. For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting the eggplants. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of six to seven applications. In

Pennsylvania, do not exceed 120 pounds of nitrogen per acre per season.

Mulching

Producing eggplant on plastic mulch can increase yields and earliness. Several fumigants can be used on eggplant depending on what the predominant pests are. Various widths of plastic mulch are available depending on individual production systems and available equipment. Fumigation alone may not provide satisfactory weed control under plastic. At least 50 percent of the nitrogen (N) should be in nitrate form NO_3^{-1} when planting in fumigated soil under plastic mulch.

Staking

High intensity eggplant production benefit from staking. Consider the costs and economic returns. Use a staking system similar to that described in the “Tomatoes” section of this manual. Eggplants require a stake at each plant to support the plant and fruit load.

Harvest and Post Harvest Considerations

Fruits should be harvested when the outside is still a glossy color and the seed and pulp are white. Soft fruit and dark seed indicate overmaturity. Fruits must be harvested as they reach maturity to ensure continued fruit set.

Eggplant fruit should be moved from the field to a protected area as soon as possible after harvest. If left in direct sunlight the fruit will sunburn. Cool eggplants in a cold room, forced-air or forced-air and evaporative cooling. Fruit are sensitive to temperature below 50°F, but can be stored for 1-2 weeks at 50-54°F and 90-95% relative humidity.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee’s (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use lower rate on coarse -textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preemergence

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Postemergence

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F as a banded directed shielded spray 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray broadcast when eggplants are grown without plastic mulch, or band between the rows when plastic mulch is used. Controls late season annual grasses, common purslane, and certain other broadleaf weeds.

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG **as a banded directed shielded spray to the soil strips between rows of plastic mulch ONLY,** to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied in one year.**

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone SL 2.0 **or OLF as a banded directed shielded spray between the rows ONLY,** to control emerged grass and broadleaf weed seedlings. DO NOT allow the spray to contact plants as injury or residues may result. Use shields to prevent spray contact with crop plants. DO NOT exceed a spray pressure of 30 psi. Add a wetting agent as per label.

Clethodim--0.094 to 0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

For Transplanting Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **planting into soil without plastic mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).

2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Preplant Incorporated

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or activate with one-half inch of sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Trifluralin--0.5 to 1.0 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Trilin in Maryland.** Apply 1.0 to 2.0 pints per acre Trilin prior to transplanting. Incorporate to a depth of 3 inches. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Avoid planting during periods of cold, wet weather to reduce the risk of temporary stunting.

Postemergence

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Broadcast spray when eggplants are grown without plastic mulch, or band between the rows when plastic mulch is used. Controls late season annual grasses, common purslane, and certain other broadleaf weed.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids

Apply one of the following formulations:
acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
bifenthrin + imidacloprid--3.80 to 9.85 fl oz/A Brigadier
Chenopodium extract--2.0 to 3.0 qts/A Requiem EC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50 SG
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
malathion--1.0 to 1.5 pts/A Malathion 57EC (or OLF)
methomyl (**green peach aphid only**)--0.75 to 3.00 pts/A Lannate LV (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate 2L
pymetrozine--2.75 oz/A Fulfill 50WDG
spirotetramat--4.0 to 5.0 fl oz/A Movento
sulfoxaflor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Colorado Potato Beetle (CPB)

CPB has the ability to rapidly develop resistance to insecticides; thus, see the section on "How to Improve Pest Control" for information on resistance management practices. The use of the egg parasitoid, *Edovum puttleri*, has been shown to control CPB effectively in eggplant, or apply one of the following insecticides:

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
acetamiprid--1.5 to 2.5 oz/A Assail 30SG (or OLF)
Bacillus thuringiensis tenebrionis (**small CPB larvae only**) (Novodor, Raven)
Note. Larval reduction may not be noticeable for 48 to 72 hours after application.
Make first application when eggs begin to hatch and repeat applications at 5- to 7-day intervals if small larvae are present. NOT effective against medium larvae and adults. If rainfall occurs within 24 hours post-treatment, reapplication may be necessary.
bifenthrin+imidacloprid--5.10 to 9.85 fl oz/A Brigadier
chlorantraniliprole--drip/foliar 3.5 to 5.0 fl oz/A Coragen 1.67SC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cryolite--8.0 to 16.0 lbs/A Kryocide 96WP (or Prokil cryolite 96)

dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi)

Flea Beetles (FB)
Apply one of the following formulations:
beta-cyfluthrin--2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture EC (or OLF)
bifenthrin + imidacloprid--5.10 to 9.85 fl oz/A Brigadier
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cryolite--8.0 to 16.0 lbs/A Kryocide 96WP (or Prokil cryolite 96)
cyfluthrin--2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF)
imidacloprid + beta-cyfluthrin--4.1 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; foliar 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Leafminers (LM), Eggplant Lacebug (ELB)
Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
bifenthrin + imidacloprid (**LM only)--**5.10 to 9.85 fl oz/A Brigadier
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
malathion (**ELB only**)--2.5 pts/A Malathion 57EC (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram (**LM only**)--6.0 to 10.0 fl oz/A Radiant SC
spinosad (**LM only**)--6.0 to 10.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole (**LM only)--**soil 10.0 to 13.0 fl oz/A Durivo

Mites
Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
bifenazate--0.75 to1.00 lb/A Acramite 50WS
etoxazole--2.0 to 3.0 fl oz/A Zeal Miticide [1]
fenpyroximate--2.0 pts/A Portal
hexakis--2.0 to 3.0 lbs/A Vendex 50WP (or OLF)
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC

Thrips
beta-cyfluthrin--2.1 to 2.8 fl oz/A Baythroid XL
bifenthrin+imidacloprid--5.10 to 9.85 fl oz/A Brigadier
clothianidin--**soil** 9.0 to12.0 fl oz/A Belay 2.13SC
cyfluthrin--2.1 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
zeta-cypermethrin + bifenthrin--10.3 fl oz/A Hero EC

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	7
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	7
bifenthrin	R	12	7
bifenthrin + imidacloprid	R	12	7
bifenazate	G	12	12
chlorantraniliprole	G	4	1
clothianidin (soil/foliar)	G	12	AP/21
cryolite	G	12	0
cyfluthrin	R	12	7
dinotefuran (soil/foliar)	G	12	21/1
etoxazole	G	12	7
fenpropathrin	R	24	3
fenpyroximate	R	12	1
flonicamid	G	12	0
gamma-cyhalothrin	R	24	5
hexakis	R	48	3
imidacloprid (soil/foliar)	G	12	21/7
imidacloprid + cyfluthrin	R	12	7
lambda-cyhalothrin	R	24	5
lambda-cyhalothrin + chlorantraniliprole	R	24	5
malathion	G	12	3
methomyl	R	48	5
oxamyl (soil/foliar)	R	48	7/1
pymetrozine	G	12	0
pyriproxyfen	G	12	14
spinetoram	G	4	1
spinosad	G	4	1
spiromesifen	G	12	7
spirotetramat	G	24	1
sulfoxaflor	G	12	1
thiamethoxam (soil/foliar)	G	12	30/0
thiamethoxam + chlorantraniliprole (soil/foliar)	G	12	30/1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil	G	12	3
copper, fixed (Group M1)	G	24	0
Flint (Group 11)	G	12	0
Forum (Group 40)	G	12	0

(table continued)

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
FUNGICIDE (FRAC code) *(continued)*			
Presidio(Group 43)	G	12	2
Quadris (Group 11)	G	4	0
Quadris Top (Groups 11+3)	G	12	0
Ranman (Group 21)	G	12	0
Ridomil Gold (Group 4)	G	12	7
Ultra Flourish (Group 4)	G	12	7

See Table D-6.

1 G = general, R = restricted

Nematode Control

See Chapter E, "Nematodes" section of "Soil Pests-Their Detection and Control". Use fumigants listed in the "Soil Fumigation" section.

Disease Control

Seed Treatment

Soak seed in hot water at 122°F (50°C) for 25 minutes. Dry seed then slurry or dust with thiram 480DP at the rate of 2/3 teaspoon /lb seed (4 oz/100 lb).

Damping-Off

Control is obtained by using the seed treatment and seeding into a sterile mix. Consideration should be given to using soilless mixes containing microorganisms that suppress damping-off fungi.

SoilGard 12G--1.0 to 1.5 lb/cu yd of soilless mix.

SoilGard is a naturally occurring soil fungus which is an antagonist to plant pathogenic fungi. Uniformly add SoilGard 12G when soilless mixes are being blended by mechanical devices. After one day of incubation, seed or transplants can be added to the treated mix.

Verticillium Wilt

Best control can be accomplished by a 4- to 5-year rotation with crops other than tomato, potato, pepper, strawberry, or any of the brambles. Varieties which appear to maintain yield in infested fields include Classic, Epic, Vernal, and Viserba.

Soil fumigation will provide some control by delaying symptom expression. Refer to the "Soil Fumigation" section for details on application. Use metam-sodium (Vapam HL at 56 to 75 gallons per acre) with a plastic seal. Broadcast treatments are superior to row treatments.

Grafting Verticillium resistant tomato rootstocks to susceptible eggplant varieties is a viable strategy to reduce the impact of disease.

Before grafting: 1) expose the scion and rootstock to sunshine for two to three days, 2) withhold water from the plants to avoid spindly growth and 3) make sure that the scions and rootstock have stems of a similar diameter. Grafted plants are usually healed and acclimated in a plastic tunnel. The healing and acclimatization are very important for grafted plants to survive. The tunnel is covered with materials that provide shade and maintain a high relative humidity inside the tunnel.

Leaf Spots and Fruit Rot

Scout on a regular basis and begin preventative sprays when weather conditions favor disease development or when symptoms of disease first appears and repeat every 7 to 10 days.

Tank mix chlorothalonil--1.5 pt 6F/A or fixed copper at labeled rates with one of the following FRAC code 11 fungicides:

Quadris--6.0 to 15.5 fl oz 2.08F/A
Cabrio--8.0 to 12.0 oz 20EG/A (leaf spots only)
Flint--2.0 to 4.0 oz 50WDG/A
Quadris Top--8.0 to 14.0 fl oz 2.72SC/A

and rotate with one of the following:

chlorothalonil--1.5 pt 6F/A or OLF
fixed copper at labeled rate

Do not make more than 4 total applications of fungicides from the FRAC code 11 group in a single year. Tank mix FRAC code 11 fungicides with a protectant fungicide such as copper or chlorothalonil to help reduce resistance development.

Tomato Spotted Wilt Virus (TSWV)

TSWV is spread by thrips from flowering ornamental plants to eggplant. Do not grow any ornamental bedding plants in the same greenhouse as eggplant transplants. Monitor and scout greenhouses for thrips and begin an insecticide control program once observed.

Phytophthora Blight (*Phytophthora capsici*)

The pathogen causes collar rot, fruit rot, and stem cankers. To minimize the occurrence of the disease, rotate fields away from susceptible crops (such as cucurbits, peppers, eggplants, and tomatoes) for as many years as possible. For control of collar rot, plant onto raised beds apply the following via drip application:

mefenoxam---Apply 1.0 pt (Ridomil Gold) 4SL/A or 1.0 qt (Ultra Flourish) 2E/A at transplanting and 30 days later

Apply drip applications of 3.0 to 4.0 fl. oz Presidio 4SC/A between mefenoxam applications when conditions favor disease development

mefenoxam---broadcast prior to planting or in a 12 to 16-inch band over the row before or after transplanting. Make two supplemental post-directed applications at 1.0 pt/A Ridomil Gold or 1.0 qt/A Ultra Flourish to 6 to 10 inches of soil on either side of the plants at 30-day intervals. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre when band applications are made.

For suppression of the aerial stem and fruit rot phase of Phytophthora blight, apply the following on a 7 to 10 day schedule when environmental conditions are conducive for disease development.

Presidio--3.0 to 4.0 fl. oz 4SC/A *plus* fixed copper at labeled rates
Ranman--2.75 fl. oz 400SC/A plus a non-ionic surfactant or an organosilicone (see label for specifics; do not apply with copper)
Forum--6.0 fl oz 4.18SC/A *plus* fixed copper at labeled rates

Fruit Disorders

Liver Spot and Pitting

'Liver spot' and 'pitting' are late season physiological disorders that appears on fruit at post-harvest as a result of chilling injury. Light-tan to coppery colored spots appear on fruit after washing often with the appearance of scratching on the fruit surface. The scratching of fruit is most likely cause by rough handling or where fruit were in contact with the ground. Small slightly sunken brown pits can also develop on fruit. Liver spot and/or pitting are thought to occur because of a thinner waxy fruit cuticle as a result of cooler temperatures. Temperatures at or below 50^{o}F are often associated with both disorders.

Internal Seed Cavity Browning (ISCB)
Symptoms of ISCB includes the discoloration, or browning of the fruit tissue directly surrounding the seed cavities of the fruit. Internal seed cavity browning can be caused by low temperatures, as well as, brusing and compression injury during harvest and post harvest handling.

GARLIC

Varieties

Obtain the best strains of Italian or German (late or pink-skinned type) "Rocambole" garlic, Polish softneck (no hard seed stalk) types that will braid, or elephant types from a local grower who has had success with fall-planted garlic or reputable agriculture products vendor. Unlike many strains sold commercially, such a strain will be hardy and, therefore, will overwinter very well. Avoid the Creole types (also called Early, Louisiana, White Mexican, etc.), since they are not very winter-hardy and do not keep well. Both the Italian and Creole types have a white outer skin covering the bulb, but the Italian type has a pink skin around each clove. Elephant garlic (*Allium ampeloprasum* - is a type of leek that produces bulbils; it is milder than regular garlic and up to four times larger) may not yield very well when fall-planted in areas with severe cold or extensive freezing and thawing cycles, which cause heaving. The Italian and Elephant types take about 220 days to mature.

Many of the most productive Italian garlic strains will produce seed stalks prior to harvest. Snap these seed stalks just as they begin to coil for best yields. "Rocambole" types have coiled seedstalks that are perfectly normal and not the result of any poor cultural practice or herbicide contamination.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N per Acre	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Garlic		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	125	150	150	150	0	150	150	150	0	Total nutrient recommended.
	75	150	150	150	0	150	150	150	0	Broadcast and disk-in.
	25	0	0	0	0	0	0	0	0	Topdress when 6-in. tall (March 15).
	25[1]	0	0	0	0	0	0	0	0	Topdress 6-weeks after first split (May 1).

Apply all topdressing at mid-day when plants are dry to reduce the chance of burn.
[1]Use ammonium sulfate for the second topdressing to help with pungency.

Planting

Garlic cloves should be planted between about September 15 and October 25 in Central Pennsylvania. They could be planted up to 10 days earlier in the cool, short-season areas and up to 3 weeks later in the warm, long-season areas. Fall-planted garlic establishes an excellent root system and receives a natural cold treatment that produces the highest possible garlic yields. Cloves must be exposed to temperatures between 32^{o} and 50^{o}F (0^{o} and 10^{o}C) for about 2 months prior to the long day-length periods that induce bulbing. Therefore, spring-planted garlic (e.g., Elephant type) may be fairly successful where it can be planted by early March.

Garlic yields tend to increase as the size of the mother bulb increases. The long, slender cloves in the center of the bulb, cloves weighing less than 1 gram, and bulbs with side growths and very poor skin covering of cloves should not be used for planting.

Spacing

Garlic should be planted 4 by 4 inches apart in triple rows or multiple beds 16 to 18 inches apart. Between-row spacing depends on the equipment available. Clove tops should be covered with 1 to 1½ inches of soil. The cloves must not be so deep that the soil will interfere with the swelling of the bulbs, nor so shallow that rain, heaving from alternate freezing and thawing, and birds will dislodge them. Physical placement of cloves with the root end oriented downward gives optimum results. Cloves dropped into furrows are likely to lie in all positions and may produce plants with crooked necks.

Harvest and Post Harvest Considerations

Fall-planted garlic is ready to harvest about the second week in July. When a few tops fall over, push all of them down and pull a sample. There are only about 10 days to 2 weeks for optimum garlic harvest. Before then, the garlic is unsegmented like an onion; much after that period, the cloves can separate so widely that the outer sheath often splits and exposes part of the naked clove. Harvested at the proper time, each clove should be fully segmented and yet fully covered by a tight outer skin.

Run a cutter bar under the bulbs to cut the extensive root system and partially lift them. The bulbs are usually pulled and gathered into windrows. Tops are placed uppermost in the windrow to protect bulbs from the sun, and the garlic is left in the field for a week or more to dry or cure thoroughly. Curing can also be accomplished in a well-ventilated shed or barn. Use this option when rain is forecasted during the curing phase. The bulbs must be thoroughly dried before being shipped or stored.

After curing garlic, discard diseased and damaged bulbs. Clean the remaining bulbs to remove the outer loose portions of the sheath, and trim the roots close to the bulb. Braid or bunch together by the tops of the bulbs, or cut off the tops and roots and bag the bulbs like dry onions.

When properly cured, garlic keeps well under a wide range of temperatures. Temporary storage in open-mesh sacks in a dry, well-ventilated storage room at 60^{o} to 90^{o}F is acceptable. However, garlic is best stored under temperature and humidity conditions required for onions (32^{o} to 35^{o}F and 65 percent relative humidity). Garlic cloves sprout quickly after bulbs have been stored at temperatures near 40^{o}F, so avoid prolonged storage at this temperature. Garlic stored at above 70 percent relative humidity at any temperature not only molds but also begins to develop roots.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crops and weeds are within recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Postemergence

Bromoxynil--0.125 to 0.250 lb/A. Apply 4.0 to 6.0 fluid ounces per acre Buctril 4E when weeds are 1 to 2 inches tall and the garlic is less than 12 inches tall. Use the lower rate on small weeds and the higher rate on larger weeds or when they are under stress. Use 40 to 100 gallons of spray solution per acre. Concentrated spray solutions increase the risk of crop injury. Good coverage of the weeds is essential for good control. Do not apply within 112 days of harvest when garlic is grown on mineral soil. Do not apply within 60 days of harvest when garlic is grown on muck soil.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 32 fluid ounces per acre in one season.

Fluazifop--0.125 to 0.188 lb/A. Apply 0.50 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware,**

New Jersey and Virginia. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Beet Armyworm (BAW)

Apply one of the following formulations:

methomyl--1.5 pts/A Lannate LV (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0-6.0 fl oz/A Entrust SC

Thrips

During hot, dry weather, the population of thrips increases following harvest of adjacent alfalfa or grain. Thrips could, therefore, present the most serious insect problem on garlic. (See "Insect Control" section under Onions. Read and follow specific label directions for use on garlic; if not listed, do not use.) Apply one of the following formulations:

acetamiprid--5.0 to 8.0 oz/A Assail 30SG (or OLF)
dinotefuran--5.25 to7 fl oz/A; **foliar** Scorpion 35SL or 3.0 to 4.0 fl oz/A foliar Venom 70 SG or 8.75 to10.50 fl oz/A; **soil** Scorpion 35SL or 5.0 to 6.0 fl oz/A; **soil** Venom 70SG
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
malathion--1.5 to 2.0 pts/A Malathion 57EC (or OLF)
permethrin--6.0 to 8.0 fl oz/A Perm-UP 3.2 EC (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
zeta-cypermethrin--2.88 to 4.00 fl oz/A Mustang Maxx (or OLF)

Note: Use of spinosad or methomyl for beet armyworm control will suppress thrips population.

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
dinotefuran	G	12	1
gamma-cyhalothrin	R	24	14
lambda-cyhalothrin	R	24	14
malathion	G	24	3
methomyl	R	48	7
permethrin	R	12,24	1
spinetoram	G	4	1
spinosad	G	4	1
zeta-cypermethrin	R	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	7
Cannonball (Group 12)	G	12	7
chlorothalonil (Group M5)	G	12	7
Endura (Group 7)	G	12	7
Forum (Group 40)	G	12	0
Inspire Super (Groups 3 + 9)	G	12	7
Metastar (Group 4)	G	48	AP
Pristine (Groups 11 + 7)	G	12	7
Quadris (Group 11)	G	4	0
Quilt (Group 3 + 11)	G	12	14
Quilt Xcel (Group 3 + 11)	G	12	14
Ridomil Gold (Group 4)	G	12	7
tebuconazole (Group 3)	G	12	7
Uniform (Groups 4 + 11)	G	0	AP

(table continued next column)

See Table 3.

[1] G = general, R = restricted

[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-off (*Pythium* and *Rhizoctonia*)

Use clean pathogen-free seed that has been treated with a fungicide seed treatment. Apply one of the following before planting to assist with managing damping-off pathogens.

mefenoxam--(Ridomil Gold--0.5 to 1.0 pt 4SL/A or Ultra Flourish--1.0 to 2.0 pt 2EC/A) (*Pythium* only)
metalaxyl (MetaStar)--2.0 to 4.0 pt 2EC/A (*Pythium* only)
Quadris--0.40 to 0.80 fl oz 2.08F/1000 row ft (*Rhizoctonia* only)
Uniform--0.34 fl oz 3.66SE/1000 row ft in-furrow (see label for specific details) for *Pythium* and/or *Rhizoctonia*

White Rot (*Sclerotium cepivorum*)

Disease development is favored by cool, moist soil conditions. Soil temperatures for infection range from 50° to 75°F, with optimum being 60° to 65°F. At soil temperatures above 78°F, the disease is greatly inhibited. Sclerotia can survive for over 20 years, even in the absence of a host plant. Soil moisture conditions that are favorable for onion and garlic growth are also ideal for white rot development. Rotate between crops for as many years as possible.

At planting, apply an in-furrow treatment of one of the following:

iprodione at 4.0 pt in 20 gallons of water minimum based on a 38 to 40-inch row spacing; spray both the cloves and the covering soil used to fill the furrow (1 application per year allowed).
Cannonball--0.5 oz 50 WP/1000 ft row in-furrow prior to seed placement
tebuconazole--20.5 oz 3.6F/A or OLF in a 4 to 6 inch band over the top or in-furrow at seeding. Tebuconazole also can be applied via drip irrigation. For best results apply immediately after seeding.
Two additional foliar tebuconazole applications at 4.0 to 6.0 fl oz 3.6F/A or OLF may also be applied.

In treated fields, do not grow crops other than garlic and leafy vegetables during the harvest year, and do not grow garlic, leafy vegetables, tomatoes, root crops, cereal grains, or soybeans during the following year.

Botrytis Leaf Blight (Blast)

Scout fields on a regular basis. Cool summer temperatures (55-75 °F) and long periods of leaf wetness provide optimum environmental conditions for rapid leaf blighting. Leaves of older plants are more susceptible to blast infection than are the younger plants. Apply the following preventatively when weather conditions favor disease development and repeat at 7 to 10 day intervals.

Tank mix and/or alternate chlorothalonil--1.5 to 3.0 pt 6F/A or OLF with one of the following formulations:
Endura--6.8 oz 70WG/A
Pristine--14.5 to 18.5 oz 38WG/A
Inspire Super--16.0 to 20.0 fl oz 2.82SC/A (also for purple blotch)
Quilt Xcel--17.5 to 26.0 fl oz 2.2SE/A (also for downy mildew)

Do not make more than 2 consecutive applications of Endura or Pristine before switching to a fungicide with a different mode of action.

Thoroughly disc or plow under plant debris after harvest.

Purple Blotch (*Alternaria porri*)

Scout fields on a regular basis. Purple blotch development increases with high humidity, rain and persistent dews with an optimum temperature range of 71 to 85°F. Apply one of the following preventatively when weather conditions favor disease development and repeat at 7 to 10 day intervals.

Tank mix chlorothalonil--1.0 to 3.0 pt 6F/A or OLF with one of the following fungicides:

Endura--6.8 oz 70WG/A
Inspire Super--16.0 to 20.0 fl oz 2.82SC/A (also Botrytis leaf blight)
Quadris--6.0 to 12.0 fl oz 2.08F/A
Quilt--14.0 to 27.5 fl oz 1.66F/A
Quilt Xcel--14.0 to 21.0 fl oz 2.2SE/A
tebuconazole--4.0 to 6.0 fl oz 3.6F/A or OLF

Do not make more than 2 consecutive applications of Cabrio, Pristine or Quadris (FRAC code 11 fungicides) or, Endura (FRAC code 7) before switching to a fungicide with a different mode of action (i.e. FRAC code).

Thoroughly disc or plow under plant debris after harvest.

Downy Mildew (*Peronospora destructor*)

Tank mix chlorothalonil--1.0 to 3.0 pt 6F/A or OLF with one of the following fungicides:
Forum--6.0 fl oz 4.18SC/A
Cabrio--8.0 to 12.0 oz 20EG/A (suppression only),
Pristine--18.5 oz 38WG/A (suppression only),
Quadris--9.0 to 15.5 fl oz 2.08F/A
Quilt Xcel--17.5 to 26.0 fl oz 2.2SE /A

Fusarium Basal Rot (*Fusarium* spp.)

The fungus infects and causes decay of the stem plate. During the growing season, leaves can turn yellow and then brown. This disease is favored by very warm soil temperatures so symptoms are most frequently observed in mid to late summer. A 4-year crop rotation with non-hosts is the most effective management strategy.

Bloat Nematode (*Ditylenchus dipsaci*)

Infected garlic appears bloated and twisted, with swollen leaves and distorted and cracked bulbs. Secondary infection by *Fusarium* sp.is common. Plant only clean seed. Avoid planting bulbs that are split, have damaged basal plates or are desiccated. Currently there are no certification programs for garlic so check with your supplier about what production process they have in place to ensure clean seed cloves. Plant garlic in a location that has not been cropped to garlic or another *Allium* crop for at least four years. Following harvest plant biofumigant cover crops may help reduce nematode levels. Keep soils moist since the bloat nematode cannot survive long periods in high moisture. Implement good sanitation practices and avoid dumping culls and other infested debris in the field.

Marketing

New growers should develop a local retail market (road-side stands, night markets, gourmet restaurants), wholesale shipper, or processing market before planting. The demand for garlic is increasing due to recent reports about the health and medical benefits of garlic.

GREENS (MUSTARD, TURNIP)

Recommended Varieties

Mustard Greens	Turnip Greens[1]
Tendergreen (Fall only)	All Top (Fall fresh and processing)
Savanna* (Spring and Fall)	Alamo* (Spring, Fall, fresh and processing)
Florida Broadleaf (Fall only)	Top Star* (Fall)
Green Wave (Fall only)	Shogin* (Fall only)(DMR,MR) (tops and roots)
Southern Giant Curled (Fall only)	Topper* (Fall)
	Sevin Top (Fall)

Asian Mustards

A number of asian mustard species and varieties are adapted to the region. See the earlier cabbage section for chinese cabbage and Pak Choi recommendations. Also See the Specialty Vegetable Section.

For Kale and Collard Greens, see the cole crop section.

[1] Many root types can also be used for greens or as bunched turnips with greens. See Turnip section for variety recommendations for root types.
* Indicates hybrid variety
Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Greens	**per Acre**	**Pounds P_2O_5 per Acre**				**Pounds K_2O per Acre**				**Nutrient Timing and Method**
	50-110	150	100	50	0	150	100	50	0	Total nutrient recommended.
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
	25-60	0	0	0	0	0	0	0	0	Topdress after each cutting.

Seeding

Seed in early- to mid-August for fall harvest. Mustards and turnip greens planted in the spring are susceptible to bolting if exposed prolonged to cold temperatures. Savanna mustard and Alamo turnip have been successfully grown when seeded March 15 to April 20. Later spring plantings have lower risk of bolting. For all plantings, sow 3 to 4 pounds of seed per acre in rows 12 to 24 inches apart.

A wide variety of mustards are available for incorporating into salad mixes for microgreens or baby salad mixes. These are sown in beds or trays as a broadcast or in narrow rows. They can be seeded from late winter through late fall in high tunnels for successive harvests.

Harvest

Greens may be harvested by cutting off entire plant near ground level and then bunching (once over harvest) or by cutting 2-6 inches above the ground to allow for regrowth. For processing, greens are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles and midribs have become too large. Multiple harvests may be possible. Greens for baby salad mix are cut at the ground level for once over harvest or 1-2 inches above ground level for multiple cuts. Greens for processing should be transported as quickly as possible to the processing plant .

Greens for fresh market, because of their perishability, should be held as close to 32°F as possible. At this temperature, they can be held for 10 to 14 days. Relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but rapid air circulation will speed transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling.

Greens are commonly shipped with package and top ice to maintain freshness. Research has shown that greens packed in polyethylene-lined crates and protected by crushed ice keeps in excellent condition if kept near 32°F but deteriorates rapidly at higher temperatures.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil types and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated

Trifluralin--0.5 to 0.75 lb/A (processing turnip greens only and all mustard greens). Apply and incorporate Treflan 4EC before planting at a broadcast rate of 1.0 pint per acre on coarse and medium soils and 1.5 pints per acre on fine soils. Incorporate within 8 hours into top 2 to 3 inches of soil.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre of Dacthal 6F as a preemergence treatment at seeding.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Clopyralid--0.047 to 0.188 lb/A. Apply 2.0 to 8.0 fluid ounces of Stinger 3A or OLF per acre in one (turnip greens) or two (mustard greens) applications to control certain annual and perennial broadleaf weeds. Do not exceed 8.0 fluid ounces in one year. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 8.0 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3.0 pints per acre in one season. **Labeled for use in mustard greens only! Do not use for weed control in turnip greens.**

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

NOTE – not all materials listed are labeled on all types of greens. Please refer to labels for crops and insects labeled as well as use directions.

Aphids

Apply one of the following formulations:

acetamiprid**--(mustard greens only)** 2.0 to 4.0 oz/A Assail 30SG (or OLF)

bifenthrin + imidacloprid (**mustard greens only**)--3.8 to 6.1 fl oz/A Brigadier (or OLF)

Chenopodium extract--2.0 to 4.0 qts/A Requiem

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC

dimethoate--0.5 pt/A Dimethoate 400 4EC (or OLF)

flonicamid--2.0 to 2.8 oz/A Beleaf 50SG

imidacloprid--(**mustard greens only**) **soil** 4.4 to10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)

imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360

sulfloxafor--(**mustard greens only**) 1.5 to 2.0 fl oz/A Closer SC

thiamethoxam--(**mustard greens only**) **soil** 1.66 to 3.67 Platinum 75SG; f**oliar** 1.5 to 3.0 oz/A Actara 25WDG

Leafhoppers

Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL

bifenthrin + imidacloprid (**mustard greens only**)--3.8 or 6.1 fl oz/A Brigadier (or OLF)

carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus; aster leafhopper - 1.0 to 2.0 qt/A Sevin XLR Plus (or OLF)

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC

cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)

dimethoate--0.5 pt/A Dimethoate 400 4EC (or OLF)

imidacloprid--(**mustard greens only**) **soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)

imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360

Thrips

Apply one of the following formulations:

imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360

spinetoram--(**mustard greens only**) 6.0 to 10.0 fl oz/A Radiant SC

spinosad--**(mustard greens only)** 4.0 to 10.0 fl oz Entrust SC

thiamethoxam (**mustard greens only**)--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 3.0 to 5.5 oz/A Actara 25WDG

Leafminers

Apply one of the following formulations:

cyromazine--2.66 oz/A Trigard or OLF (**mustard greens, turnip greens - tops only**)

dimethoate--0.5 pt/A Dimethoate 400 4EC (or OLF)

spinetoram--(**mustard greens only**) 6.0 to 10.0 fl oz/A Radiant SC

spinosad--(**mustard greens only**) 4.0 to 10 fl oz Entrust SC

Flea Beetles

Apply one of the following formulations:

beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL

carbaryl--0.5 to 1.0 qts/A Sevin XLR Plus (or OLF)

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC

cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)

imidacloprid-(**mustard greens only**) **soil--**4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar--**1.3 fl oz/A Admire PRO (or OLF)

imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360

thiamethoxam--(**mustard greens only**) **soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Beet Armyworm

Apply one of the following formulations:

chlorantraniliprole (**mustard greens only**) **soil, drip, foliar--** 3.5 to 5.0 oz/A Coragen
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG (**mustard greens, turnip greens - tops only)**
flubendiamide--2.0 to 2.4 fl oz/A Belt SC
flubendiamide + buprofezin--10.0 to 20.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 25WDG (**mustard greens, turnip greens - tops only)**
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 8.0 fl oz/A (**early season**) 8.0 to 10.0 fl oz/A (l**ate season**) Intrepid 2F
spinetoram--(**mustard greens only**) 5.0 to 10.0 fl oz/A Radiant SC
spinosad--**(mustard greens only)** 4.0 to 10.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--(**mustard greens only**) **soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Cabbage Looper (CL), Imported Cabbageworm (ICW)

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin + imidacloprid--(**mustard greens only**) 3.8 to 6.1 fl oz/A Brigadier (or OLF)
chlorantraniliprole--(**mustard greens only**) **soil/drip/foliar** 3.5 to 5.0 oz/A Coragen
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
emamectin benzoate--2.4 to 4.8 oz Proclaim 5SG (**turnip green - tops only**)
flubendiamide--2.0 to 2.4 fl oz/A Belt SC
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
indoxacarb--2.5 to 3.5 oz/A Avaunt 25WDG (**mustard greens, turnip greens - tops only**)
methoxyfenozide--4.0 to 8.0 fl oz/A (**early season)** ,8.0 to 10.0 fl oz/A (l**ate season**) Intrepid 2F
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram**--**(**mustard greens only**)5.0 to 10.0 fl oz/A Radiant SC
spinosad**--**(**mustard greens only**) 3.0 to 6.0 fl oz Entrust SC
thiamethoxam + chlorantraniliprole--(**mustard greens only**) **soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Diamondback Moth Caterpillar

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel DF (or OLF)
chlorantraniliprole**--(mustard greens only**) **soil, drip, foliar**3.5 to 5.0 oz/A Coragen
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG (**turnip greens - tops only**)
flubendiamide--(**mustard greens only**) 2.0 to 2.4 oz/A Belt SC
indoxacarb--(**mustard greens, turnip greens - tops only)** 3.5 oz/A Avaunt 25WDG (or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram**--**(**mustard greens only**) 5.0 to 10.0 fl oz/A Radiant SC
spinosad--**(mustard greens only)** 1.5 to 4.0 fl oz Entrust SC
thiamethoxam + chlorantraniliprole--(**mustard greens only**) **soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Hawaiian Beet Webworm

chlorantraniliprole**--(mustard greens only**) **soil, drip, foliar** 3.5 to 5.0 oz/A Coragen
spinetoram--**(mustard greens only)** 7.0 to 10.0 fl oz/A Radiant SC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin + imidacloprid	R	12	7
carbaryl	G	12	14
Chenopodium extract	G	4	0
chlorantraniliprole (soil/drip/foliar)	G	4	3
clothianidin (soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	7
dimethoate	R	48	14
emamectin benzoate (tops only)	R	12	14
flonicamid	G	12	0
flubendiamide	G	12	8
imidacloprid (soil/foliar)	G	12	21/7
imidacloprid + beta-cyfluthrin	R	12	7
indoxacarb (tops only)	G	12	3
methomyl	R	48	10
methoxyfenozide	G	4	1
spinetoram	G	4	1
spinosad	G	4	1
sulfloxafor	G	12	3
thiamethoxam (soil/foliar)	G	12	30/7
thiamethoxam + chlorantraniliprole (soil/foliar)	G	12	30/7
FUNGICIDE (FRAC code)			
Aliette (Group 33)	G	12,24	3
Cabrio (Group 11)	G	12	0
copper, fixed (Group M1)	G	24	0
Folicur (Group 3)	G	12	7
Fontelis (Group 7)	G	12	0
Forum (Group 40)	G	12	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	0
Switch (Groups 9 + 12)	G	12	7
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.
[1] G = general, R = restricted, AP = At planting
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off (caused by *Pythium*, *Rhizoctonia* or *Phytophthora* spp.).

Apply one of the following preplant incorporated or as a soil-surface spray after planting:

Ridomil Gold--1.0 to 2.0 pt 4SL/A (turnip greens only)
Quadris--0.40 to 0.80 floz 2.08F/1000 row ft
Uniform--0.34 fl oz 3.66SE/1000 row ft

Downy Mildew

Apply the following during periods of high moisture and moderate temperatures (for disease suppression) and continue every 14 days.

Forum--6.0 fl oz 4.18SC/A *plus* fixed copper
Aliette--3.0 lb 80WDG/A (for mustard greens only)
Quadris--6.0 to 15.5 oz 2.08F/A
Cabrio--8.0 to 16.0 oz 20EG/A

Leaf Spot

Practice good crop rotation with crops other than crucifers. When conditions favor disease development, alternate one of the following every 7 to 10 days:

Quadris--6.0 to 15.5 oz 2.08F/A
Cabrio--8.0 to 16.0 oz 20EG/A

With one of the following formulations:

Folicur--3.0 to 4.0 fl oz 3.6F/A or OLF
Fontelis--14.0 to 30.0 fl oz 1.67SC/A
Switch--11.0 to 14.0 oz 62.5WG/A
copper, fixed--0.75 to 1.5 lb 53.8DF/A or OLF

HORSERADISH

Horseradish belongs to the Mustard family and is grown for its roots. The fleshy, white roots resemble parsnip in shape. Horseradish is a hardy perennial grown in annual production systems. Roots left in the ground two or more growing seasons become stringy and woody. Because of its perennial nature, if roots are not harvested or killed, horseradish can become a weed.

Three general types of horseradish exist: “common”, “Bohemian” and “Big Top Western”. "Common" types have broad crinkled leaves and are considered to have high quality, large, smooth roots. They are susceptible to virus and white rust. "Bohemian" types have medium-sized narrow smooth leaves and somewhat lower quality. They are susceptible to virus, but have some white rust tolerance. “Big Top Western” types have smooth, large upright leaves with large good quality roots; however, the roots are rough or corky on the surface. They have resistance to virus and white rust. Use local selected strains that are adapted to the area.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state’s soil test report recommendations and/or your farm’s nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Horseradish	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	150-200	200	150	100	0	200	150	100	0	Total nutrient recommended.
	50	200	150	100	0	200	150	100	0	Broadcast and disk-in.
	50-100	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after planting.
	50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting if needed.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Sets for Planting

Sets are selected roots from the previous crop. They should be 10 to 12 inches long and 1/4 to 5/8 inch in diameter. Do not allow them to dry out before planting. To ensure proper orientation of roots at planting, make a square cut at the end of the root nearest the main root, and at the other end make a slanting cut. Plant the slanting cut end downward.

Planting and Spacing

Plant in late April to early May. Place sets at an angle in a furrow so the top end will be 1 inch deep and the bottom 2 inches deep. Or, use a dribble to make a slanted planting hole. Or, plant sets leaving several inches above the soil surface and cover by forming ridges in the row. Sets should point in the same direction that the cultivator will go, e.g., for two-row cultivator, two rows in one direction and the next two rows in the opposite direction. Space rows 34 to 36 inches apart with 18 inches between sets in the row.

Harvesting and Storage

Dig roots as needed. In an annual system, the set will become the main root which is the largest and most valuable for market. For maximum growth, harvest once tops have died due to frost. Alternatively, tops can be cut off as close to the soil surface as possible. Then wait several days before harvesting. Roots overwinter; however, soil conditions may prevent winter harvesting. Store horseradish in the dark with temperatures between 32 and 40° F4° F (0 - 4° C) and 98 percent relative humidity. Roots exposed to light become green. Roots can be stored for 8-9 months. If storage and temperature conditions cannot be met, consider harvesting the following spring by digging the roots as soon as new growth starts to appear. Select the top performing lateral roots for the next crop.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil types and percent organic matter in each field.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preemergence

DCPA--6.0 to10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F immediately after planting to control annual grasses and some broadleaf weeds.

Oxyfluorfen--0.5 lb/A. Apply 2.0 pints per acre Goal 2XL or 1 pint of GoalTender 4F immediately after planting to control certain broadleaf weeds. Emerged plants which receive direct or indirect (drift) spray contact will be injured. It may be desirable to cultivate immediately prior to application to remove germinated weeds. Delay cultivation after Goal application, when possible, to reduce deactivation of Goal by incorporation. Do not use Goal herbicide on horseradish plantings which are weak or under stress due to temperature, disease, fertilizer, nematodes, insects, pesticides, drought, or excessive moisture.

S-metolachlor--0.95 to 1.90 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E in New Jersey. The use of this product is legal ONLY if a waiver of liability provided by the local growers' association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E after planting, but before weeds or crop emerge to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse textured soils low in organic matter, and the higher rate on fine textured soils and soils high in organic matter. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. Make only one application per crop. Observe a minimum preharvest interval of 64 days after application. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2 to 0.5 lb/A. Apply 1.0 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 60 days and apply no more than 5.0 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids

Apply one of the following formulations:
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF),
foliar 1.2 fl oz/A Admire PRO (or OLF)
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
malathion--1.0 to 2.0 pts/A Malathion 57EC (or OLF)
methomyl--1.5 pts/A Lannate LV (or OLF)
sulfoxaflor--0.75 to 1.50 oz/A Transform WG
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG

Cutworms

Apply one of the following formulations:
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)

Flea Beetles (FB), Harlequin Bugs

Apply one of the following formulations:
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
cyfluthrin (**FB only**)--1.6 to 2.8 fl oz/A Tombstone (or OLF)
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF),
foliar 1.2 fl oz/A Admire PRO (or OLF)
spinosad--**(FB only)** 1.7 to 3.3 oz/A Blackhawk 36WG
thiamethoxam (**FB only)--**1.5 to 3.0 oz/A Actara 25WDG

Imported Cabbageworm

Apply one of the following formulations:
Bacillus thuringiensis--0.12 to 1.5 lb/A Javelin (or OLF)
chlorantraniliprole **(AW only)--**3.5 to 5.0 fl oz/A Coragen
malathion--1.0 to 2.0 pt/A Malathion 57EC (or OLF)
spinosad--1.7 to 3.3 oz/A Blackhawk 36WG

Leafhoppers **(Note: Some species of leafhopper can transmit brittleroot disease of horseradish).**

Apply one of the following formulations:
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF),
foliar 1.2 fl oz/A Admire PRO (or OLF)
sulfoxaflor--1.50 to 2.75 oz/A Transform WG
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG

Thrips

Apply one of the following formulations:
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF)
methomyl--1.5 pts/A Lannate LV (or OLF)
spinetoram--6.0 to 8.0 fl oz/A Radiant SC
spinosad--1.7 to 3.3 oz Blackhawk 36WG

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
Bacillus thuringiensis	G	4	0
carbaryl	G	12	**7**
chlorantraniliprole	G	4	1
cyfluthrin	R	12	0
flonicamid	G	12	3
imidacloprid (soil/foliar)	G	12	21/7
malathion	G	24	7
methomyl	R	48	65
spinetoram	G	4	3
spinosad	G	4	3
sulfoxaflor	R	24	7
thiamethoxam	G	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	14
Endura (Group 7)	G	12	0
Fontelis (Group 7)	G	12	0
Presidio (Group 43)	G	12	7
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	0
Uniform (Groups 4 + 11)	G	0	AP
Vapam HL	R	48	0

See Table D-6.

[1] G = general, R = restricted, AP = At planting

Disease Control

Damping-Off (caused by *Pythium* and *Phytophthora*)

Apply one of the following in a 7-inch wide band at planting:

Ridomil Gold--1.0 to 2.0 pt 4SL/A
Ultra Flourish--2.0 to 4.0 pt 2E/A
MetaStar--4.0 to 8.0 pt 2EAG/A
Presidio--3.0 to 4.0 fl oz 4SC/A
Quadris--0.4 to 0.8 fl oz 2.08F/1000 row ft
Uniform--0.34 fl oz 3.66SE/1000 ft row

Bacterial Leaf Spot

Rotate away from cruciferous crops for at least 2 years if the field has a history of disease. Avoid excessive irrigation and maintain proper drainage. Avoid cultivation or other activity when foliage is wet to minimize spread of the disease.

Alterneria Leafspot and Cercospora Leafspot

Utilize resistant varieties where available. A 3-year rotation to non-cruciferous crops may be required if the field has a history of disease.

When conditions favor disease development, apply one of the following and rotate between fungicides of different modes of different FRAC groups on a 7-14 day schedule:

Quadris--6.2 to 15.5 fl oz 2.08F/A
Cabrio--8.0 to 16.0 oz 20EG/A
Endura--4.5 fl. oz 0.7DF/A (Alternaria only)
Fontelis--16.0 to 30.0 fl. oz SC /A

Ramularia Leafspot

When conditions favor disease development apply the following on a 7-10 day schedule:

chlorothalonil--3.0 pts 6F/A

White Rust

Utilize certified, disease-free seed. A rotation to non-cruciferous crops may be required if the field has a history of disease. Manage weeds and volunteer hosts.

When conditions favor disease development, apply one of the following on a 7-14 day schedule:.

Quadris--6.2 to 15.5 fl oz 2.08F/A
Cabrio--8.0 to 16.0 oz 20EG/A

Verticillium wilt

Apply through irrigation system 0.6-1.0 inches of water in the fall once.

Metam-sodium (Vapam HL)--50.0 gal/A

LEEKS

Varieties[1]

Arkansas (Overwinter)	Lancelot (Overwinter)
Megaton* (Summer/Fall)	Lexton* (Overwinter)
Bandit (Overwinter)	Pandora (Summer/Fall)
Belton* (Summer/Fall)	Tadorna (Overwinter)
King Richard (Summer)	

* Indicates F1 hybrid varieties

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Leeks	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	100-125	200	150	100	0	200	150	100	0	Total nutrient recommended.
	50-75	200	150	100	0	200	150	100	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks after planting if needed.

Apply 3.0 to 4.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Transplants

Southern transplants are used for early spring plantings. For summer planting, sow in seedbeds from early March to mid-May. About 2.0 pounds of seed are required to provide enough plants to set an acre. Seed should be planted 1/3 to 1/2 inch deep 12 to 16 weeks before field setting. Plants will be ready to set in early August.

Field Spacing

Rows: 20 to 30 inches apart; *plants*: 4 to 6 inches apart in the row. Set plants in trenches 3 to 4 inches deep using celery-type planter.

Culture

Leeks grow slowly for the first 2 or 3 months. To develop a long white stem, start to gradually fill in trenches and then hill soil around stems to 3 or 4 inches.

Harvest and Post Harvest Considerations

Spring-transplanted leeks are ready for harvest in July. August-planted leeks are ready for harvest by November or can be overwintered. Half-mature leeks of the hardy varieties will stand winter freezing with some protection such as salt hay or straw if planted in very cold areas. In mild winter areas no protection is required. They will be ready early in the spring. Undercut the leeks with a bar on a tractor or for smaller plantings dig with a spading fork.

After digging, leeks can be left in the field to dry for a short period. Leeks are bunched with three to four leeks per bunch. If soil sticks to the leeks, power wash the bunches before packing. If necessary, leeks can be cooled by icing in the box, hydrocooling or vacuum cooling with a water spray. Store leeks at 32-36F with 95-100% relative humidity for up to two months, but more typical storage is 7 to 21 days.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Postemergence

S-metolachlor--0.64 to 1.27 lb/A. A **Special Local-Needs 24(c) label has been approved for the use of Dual Magnum in leeks in New Jersey. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.67 to 1.33 pints per acre after the leeks have reached the two true leaf stage of growth. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual grass and certain broadleaf weeds, including galinsoga preemergence. Use other methods to control emerged weeds prior to application. Observe a 21-day preharvest interval. Make only one application per crop per season. Do NOT use on coarse textured soils with less than 1% organic matter. **Other**

generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia**. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Onion Maggot

Apply the following formulation:

malathion (**adults only**)--1.5 to 2.0 pts/A Malathion 57EC (or OLF)
zeta-cypermethrin (**adults only**)--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

Thrips, Aphids

Apply one of the following formulations:
acetamprid--5.0 to 8.0 oz./A Assail 30SG (or OLF) **(thrips only)**
malathion--1.5 to 2.0 pts/A Malathion 57EC (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC **(thrips only)**
zeta-cypermethrin--2.24 to 4.00 oz/A **(aphids only)**; 2.88 to 4.00 fl oz/A **(thrips only)** Mustang Maxx (or OLF)

Armyworms (AW), Cutworms (CW), Cabbage Loopers (CL)

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A (**CW and CL);** 1.0 to 2.0 lbs/A **(AW only)** Dipel DF (or OLF)
spinosad (**AW and CL only**)--3.0 to 6.0 fl oz/A Entrust SC
spinetoram (**AW and CL only**)--5.0 to 10.0 fl oz/A Radiant SC
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
Bacillus thuringiensis	G	4	0
malathion	G	24	3
spinetoram	G	4	1
spinosad	G	4	1
zeta-cypermethrin	R	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	7
chlorothalonil (Group M5)	G	12	14
Endura (Group 7)	G	12	7
Folicur (Group 3)	G	12	7
Forum (Group 40)	G	12	0
Inspire Super (Groups 3 + 9)	G	12	7
Pristine (Groups 11 + 7)	G	12	7
Quadris (Group 11)	G	4	0
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6. [1] G = general, R = restricted, AP = At planting
[2]Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off and Other Seedling Diseases

mefenoxam + azoxystrobin (Uniform--0.34 fl. oz 3.66SC/1000 ft. row). See label for restrictions

Purple Blotch and Downy Mildew

Begin preventative applications in fall as soon as transplants are set out especially in fields where purple blotch had been a problem in the past. Rotate the following at 10-day intervals as long as night temperatures remain warm and there are extended periods of leaf wetness.

Alternate:
Forum--6.0 fl oz 4.18SC/A (for downy mildew only; must be tank mixed with another fungicide effective for downy mildew)

chlorothalonil--1.5 to 3.0 pt 6F/A or OLF; (do not apply chlorothalonil more than three times per season)

With one of the following FRAC code 11 fungicides:

Quadris--6.0 to 12.0 fl oz 2.08F/A for purple blotch, or Quadris--9.0 to 15.5 fl oz 2.08F/A for downy mildew
Cabrio--8.0 to 12.0 oz 20EG/A (use 12.0 oz/A for downy mildew)
Pristine--10.5 to 18.5 oz 38WP/A (for purple blotch) or 18.5 oz 38WP/A for downy mildew suppression,
FRAC code 3 fungicides
Folicur--4.0 to 6.0 fl oz 480SC/A
Inspire Super--16.0 to 20.0 fl oz. 2.82 SC/A (Purple blotch only)
Endura--6.8 oz 70WG/A (for purple blotch only)

Materials with different modes of action (FRAC code) should always be alternated.

White Rot (*Sclerotium*)

This disease is severe only on overwintered leeks. Disease development is favored by cool, moist soil conditions. The soil temperature range for infection to occur ranges from 50° to 75°F, with optimum being 60° to 65°F. At soil temperatures above 78°F, the disease is greatly inhibited. Sclerotia can survive for over 20 years, even in the absence of a host plant. Soil moisture conditions that are favorable for leek, garlic and onion growth are also ideal for white rot development.

Apply Folicur--4.0 to 6.0 fl oz 480SC/A (10–14 day interval) (suppression only)

In treated fields, do not grow crops other than leek and leafy vegetables during the harvest year, and do not grow leeks, garlic, leafy vegetables, tomatoes, root crops, cereal grains, or soybeans during the following year.

LETTUCE, ENDIVE AND ESCAROLE

Varieties

Lettuce: Bibb, Boston and Butterhead Types
Ermosa (DMR,LMV,TBR)
Buttercrunch
Esmeralda
Optima
Bennett
Harmony (DMR,TBR)
Forlina RZ (heat tolerant)
Hungarina RZ (heat tolerant)
Skyphos (red)
Rex

Lettuce: Bibb, Boston and Butterhead Types
Dancine
Nancy

Lettuce: Iceberg Types
Summer Time
Ithaca (fall or spring)
Keeper (spring)

Lettuce: Green Leaf Types
Grand Rapids (TBR)
Salad Bowl (Direct Market)
Waldmann's Green
Tropicana
Two Star
Royal Oakleaf
Starfighter (heat tolerant)
Bergams Green

Lettuce: Red Leaf Types
New Red Fire
Red Sails (Direct Market)
Crissy
Red Express

Lettuce: Romaine (Cos) Types
Ideal Cos (spring,fall)(TBR)
Green Forest (CRR,TBR)
Coastal Star (CRR)
Rouge de Hiver (red)(fall)
Rubicon
Dov (heat tolerant)
Musena
Cuore (light green)
Helvius
Monte Carlo

Lettuce: Batavia/Summer Crisp Types
Magenta (red)
Nevada
Sierra

Endive
Green Curled
Salad King

Escarole
Florida Deep Heart
Full Heart Batavian

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N per Acre	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Leaf lettuce,	100-125	200	150	100	0	200	150	100	0	Total nutrient recommended.
Endive,	50-75	200	150	100	0	200	150	100	0	Broadcast and disk-in.
Escarole	25-50	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after planting.
Iceberg lettuce	60-80	200	150	100	0	200	150	100	0	Total nutrient receommended.
	25-50	200	150	100	0	200	150	100	0	Broadcast and disk-in.
	25-30	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after planting.

Lettuces for Salad Mixes

Salad mixes, baby lettuce mixes, and mesclun mixes are blends of fresh, tender greens combined for their variety of textures, flavors and colors that are grown, harvested, and marketed together. Leaves are harvested by cutting and plants are allowed to regrow. Ingredients vary, consisting of looseleaf, red leaf, oakleaf, romaine and other lettuces mixed with other greens such as: arugula, chicory, corn salad, chard, dandelion, endive, escarole, mizuna, mustard radicchio, sorrel, spinach, tango, tat-soi, kale, mache, beet leaf, purslane and certain herbs. Mixed plantings of salad greens can be mechanically harvested.

Growing Conditions

Lettuce and endive are cool-season crops. Properly hardened lettuce transplants can tolerate temperatures as low as 20° to 25°F (-6.67° to -3.89°C). Temperatures above 85°F (29.4°C) for several days will cause seedstalk formation and bolting in lettuce. Temperatures below 70°F (21.1°C) during the seedling stage promote premature seedstalk formation in endive and escarole.

Seed Treatment

Treat seeds to prevent disease. See the Disease section for more information.

Seeding and Transplanting

Spring crop. The early endive and escarole crop is usually grown from transplants shipped into the region. Lettuce transplants are started in frames or greenhouses. Seed for the lettuce crop is sown in frames in November, in unheated greenhouses in December, and in heated greenhouses in January and February at the rate of 4 to 6 ounces of seed for 1 acre of plants. Plants are ready for field planting early in March.

Direct-seeded lettuce is sown in prepared beds as early in the spring as the ground can be worked. Seeds require light to germinate so should be sown at shallow depth. Some of the seeds should actually be uncovered and visible. Pelleted seed should be watered at night during high-temperature periods (soil temperatures above 80^{o}F [26.7^{o}C]) until germination occurs. The spring lettuce crop can be field-seeded or transplanted through May. In the southern part of the region, planting after April results in seed stalk formation. Only leaf lettuce should be seeded as late as May. Successive plantings of endive can be made through the middle of August.

Seed Priming. Lettuce seeds are induced to enter physiological dormancy by tenperatures in excess of 85^{o}F. This can make it difficult to establish a fall crop. Priming lettuce seeds in 1% potassium phosphate (K_3PO_4) for 20 hours at 75^{o}F prior to sowing will prevent thermodormancy from occurring. Many vendors currently offer primed lettuce seeds as a product for fall production.

Fall lettuce crop. Seed in the field July 25 to August 10 in Pennsylvania and other cool areas, and August 5 to 20 in warmer areas. When transplants are used, planting dates can be delayed 2-3 weeks.

Spacing

Lettuce. Head and Romaine lettuce is planted in rows 2 feet apart with plants 12 to 15 inches apart in the row. Leaf and Boston type lettuce are planted 3 to 4 rows per bed with beds spaced 66 to 72 inches on centers. Space plants 9 to 12 inches apart in the row. Lettuce for baby greens or salad mixes is direct seeded in close rows (3-6 inches apart) or broadcast across beds.

Coated seed is recommended for precision seeding of heading types. Plant a single coated seed every 2 to 3 inches, or two seeds spaced 1 inch apart every 12 inches. Direct-seeded plants should be thinned when two or three true leaves have formed.

Endive and Escarole. Plant three to four rows per bed and space beds 66 to 72 inches on centers. Space plants 9 to 15 inches apart in the row.

Irrigation

Lettuce requires frequent irrigation with total seasonal water requirements of 10-12 inches.

Harvest and Post Harvest Considerations

Lettuce is extremely perishable and needs to be handled delicately, and marketed rapidly.

Head lettuce is hand cut and trimmed,and placed in cartons or containers in the field. It is then vacuum cooled or hydrocooled. Specialty leaf lettuces and other greens for bag mixes are hand harvested or mechanically harvested.

A strong bitter taste and toughness develops if harvest is delayed or if crop is over-mature, and then the product becomes unmarketable.

Head lettuce is harvested when the heads are of good size (about 2 lbs), well formed and solid. Leave three undamaged wrapper leaves on each head. Put heads in containers in the field and avoid bruising. Leaf, butterhead and cos/romaine types are cut, trimmed and bundled before placing in cartons.

Lettuce should be precooled to 34F soon after harvest and stored at 32F and 98 to 100% relative humidity for retention of quality and shelf life. At 32 F, head lettuce can be held in good condition for 2 to 3 weeks, Leaf, cos/romaine, and butterhead lettuce has a shorter shelf life. Lettuce is easily damaged by freezing, so all parts of the storage room must be kept above the highest freezing point of lettuce (31.6F).

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Pronamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Kerb 50W to seeded or transplanted head lettuce, endive, and escarole. Irrigation (1 to 2 inches) should follow application. Primarily controls annual grasses and certain broadleaf weeds. Unlabeled crops should not be planted for 3 to 12 months, depending on herbicide rate used and crop. See label. Labeled crops include heading lettuce varieties, endive, and escarole.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days (head types) or 15 days (leaf types) and apply no more than 3 pints per acre in one season. Labeled for head and leaf-type lettuces.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

NOTE: NOT ALL PESTICIDES ARE LABELED FOR EACH CROP IN THIS SECTION. REFER TO THE LABELS TO DETERMINE WHICH CROPS ARE LABELED FOR EACH PESTICIDE.

Aphid

On fall crop, seedling protection from aphids is important. Spray if the aphid population reaches 1 aphid/plant during the seedling stage of plant development, or >4 aphids/plant beyond the seedling stage. Apply one of the following formulations:

acephate--0.5 to 1.0 lb/A Orthene 97S (Acephate 97UP, or OLF)
acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
dimethoate--0.5 pt/A Dimethoate 400 4EC (**not for head lettuce**) (or OLF)
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin+thiamethoxam--**(head and leaf lettuce only)** 4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WP
spirotetremat--4.0 to 5.0 fl oz/A Movento
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Leafhopper

Control of leafhoppers will prevent spread of lettuce yellows. In the spring, spray when plants are one-half inch tall; repeat as needed. In the fall, spray seedlings four to five times at 5-day intervals. Apply one of the following formulations:

acephate--0.5 to 1.0 lb/A Orthene 97S (Acephate 97UP, or OLF)
beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture EC (Sniper or OLF)
buprofezin--9.0 to 13.6 fl oz/A Courier SC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
dimethoate--0.5 pt/A Dimethoate 400 4EC (**not for head lettuce**) (or OLF)
dinotefuron--**soil** 5.0 to 6.0 oz/A, **foliar** 1.0 to 3.0 oz/A Venom 70SG; or **soil** 9.0 to 10.5 fl oz/A, **foliar** 2.00 to 5.25 fl oz/A Scorpion 35SL (or OLF)
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro, **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--**(head and leaf lettuce only)** 1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--2.0 to 8.0 oz/A Perm-Up 3.2 (or OLF)
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--**(head lettuce only)** 4.0 to 10.3 fl oz/A Hero EC

Tarnished Plant Bug

This insect can cause serious damage to the fall crop; it is usually numerous where weeds abound. Apply one of the following formulations:

beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
bifenthrin--5.12 to 6.4 fl oz/A Bifenture EC (Sniper or OLF)
carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF)
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + thiamethoxam--**(head and leaf lettuce only)** 4.0 to 4.5 fl oz/A Endigo ZC
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--**(head lettuce only)** 10.3 fl oz/A Hero EC

Thrips

Some species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed. Do not produce vegetable transplants with bedding plants in the same greenhouse. Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 10.0 fl oz/A Entrust SC
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin (**head lettuce, onion thrips only**)--10.3 fl oz/A Hero EC

Leafminer

Apply one of the following formulations:
abamectin--1.75 to 3.50 fl oz/A Agri-Mek 0.7SC (or OLF)
chlorantraniliprole--**(larvae only) soil/drip/foliar** 5.0 to 7.5 fl oz/A Coragen 1.67SC
cyromazine--2.66 oz/A Trigard 75WSP
dimethoate--0.5 pt/A Dimethoate 400 4EC (**not for head lettuce**) (or OLF)
dinotefuron--**soil** 5.0 to 6.0 oz/A, **foliar** 1.0 to 3.0 oz/A Venom 70SG; or **soil** 9.0 to 10.5 fl oz/A, **foliar** 2.00 to 5.25 fl oz/A Scorpion 35SL (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 10.0 fl oz/A Entrust SC

Cutworms

(Also see Chapter E the "Cutworms" section in “Soil Pests--Their Detection and Control”.)

Apply one of the following formulations:
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture EC (Sniper, or OLF)
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--**(head and leaf lettuce only)** 0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin +chlorantraniliprole--**(head and leaf lettuce only)** 6.0 to 9.0 fl oz/A Voliam Xpress
methomyl--1.5 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--**(head lettuce only)** 4.0 to 10.3 fl oz/A Hero EC

Cabbage Looper

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1 lb/A Dipel DF (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture EC (Sniper or OLF)
chlorantraniliprole **soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
emamectin benzoate--3.2 to 4.8/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
indoxacarb--2.5 to 3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin--**(head and leaf lettuce only)** 0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--**(head and leaf lettuce only)** 5.0 to 8.0 fl oz/A Voliam Xpress
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F (early season); 8.0 to 10.0 fl oz/A Intrepid 2F (mid to late season)
permethrin--2.0 to 8.0 fl oz/A Perm-Up 3.2 (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--**(head lettuce only)** 4.0 to 10.3 fl oz/A Hero EC

Beet Armyworm

Apply one of the following formulations:
chlorantraniliprole**--soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 to 6.0 oz/A Avaunt 30WDG
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F (early season); 8.0 to 10.0 fl oz (mid to late season)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC

Corn Earworm (CEW)

Note. Head lettuce seedlings, in the 7- to 18-leaf stage, are vulnerable to CEW attack in August to September. Control must be achieved before center leaves start to form a head (15- to 18-leaf stage). Apply Lannate every 2 to 5 days or permethrin every 5 to 10 days according to CEW moth populations and pest management alerts. Apply one of the following formulations:

beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture EC (Sniper or OLF)
chlorantraniliprole **soil/drip/foliar--**3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubenidamide+buprofezin--12.0 to 17.0 fl oz/A Vetica

imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--**(head and leaf lettuce only)** 1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--**(head and leaf lettuce only)** 5.0 to 8.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--**(head and leaf lettuce only)** 4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
zeta-cypermethrin+bifenthrin--**(head lettuce only)** 4.0 to 10.3 fl oz/A Hero EC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest Head Let.	Leaf Let.	En-dive	Esca-role
INSECTICIDE						
abamectin(Agri-mek)	R	12	7	7	7	7
acephate	G	24	21	-	-	-
acetamiprid	G	12	7	7	7	-
Bacillus thuringiensis	G	4	0	0	0	0
beta-cyfluthrin	R	12	0	0	0	0
bifenthrin	R	12	7	-	-	-
buprofezin	R	12	7	7	7	7
carbaryl	G	12	14	14	14	14
chlorantraniliprole	G	4	1	1	1	1
clothianidin	G	12	21	21	21	21
cyfluthrin	R	12	0	0	0	0
cyromazine	G	12	7	7	7	7
dimethoate	R	48	--	14	14	14
dinotefuran (soil)	G	12	21	21	21	21
(foliar)	G	12	7	7	7	7
emamectin benzoate	R	12	7	7	7	7
flonicamid	G	12	0	0	0	0
flubendiamide	G	12	1	1	1	1
flubendiamide + buprofezin	R	12	7	7	7	7
imidacloprid (soil)	G	12	21	21	21	21
imidacloprid (foliar)	G	12	7	7	7	7
imidacloprid + beta-cyfluthrin	R	12	7	7	7	7
indoxacarb	G	12	3	3	3	3
lambda-cyhalothrin	R	24	1	1	-	-
lambda-cyhalothrin + chlorantraniliprole	R	24	1	1	-	-
lambda-cyhalothrin + thiamethoxam	R	24	7	7	-	-
methomyl (<1.5 pt)	R	48	7	7	10	10
methomyl (>1.5 pt)	R	48	10	10	10	10
methoxyfenozide	G	4	1	1	1	1
permethrin	R	12	1	1	1	1
pymetrozine	G	12	7	7	7	7
spinetoram	G	4	1	1	1	1
spinosad	G	4	1	1	1	1
spirotetramat	G	24	3	3	3	3
sulfloxafor	G	12	3	3	3	3
thiamethoxam(foliar)	G	12	7	7	7	-
zeta-cypermethrin	R	12	1	1	1	1
zeta-cypermethrin+ bifenthrin	R	12	7	-	-	-

(table continued next column)

(continued)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest Head Let.	Leaf Let.	En-dive	Esca-role
FUNGICIDE (FRAC code)						
Botran (Group 14)	G	12	14	14	14	14
Cannonball (Group 12)	G	12	0	0	0	0
Contans WG (biological)	G	4	0	0	0	0
Endura (Group 7)	G	12	14	14	--	--
Fontelis (Group 7)	G	12	3	3	3	3
Forum (Group 40)	G	12	0	0	0	--
iprodione (Group 2)	G	12	14	14	14	14
MetaStar (Group 4)	G	48	At plant application only			
Previcur Flex (Group 28)	G	12	2	2	2	2
Quadris (Group 11)	G	4	0	0	0	0
Reason (Group 11)	G	12	2	2	-	-
Revus (Group 40)	G	4	1	1	1	--
Ridomil Gold (Group 4)	G	12	At plant application only			
Ultra Flourish (Group 4)	G	48	At plant application only			
Uniform (Group 4 + 11)	G	0	At plant application only			
Zampro (Groups 45 + 40)	G	12	0	0	0	0

See Table D-6.
[1] G = general, R = restricted
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
Dash (-) in table indicates pesticide is **NOT** labeled for that crop.

Disease Control

Seed Treatment

Dust seed with thiram 480DP at the rate of 1 level teaspoon per pound of seed (3.0 oz/100 lb). See Table E-14 for additional seed treatment options.

Damping-Off and Other Seedling Diseases

(See the "Disease Control in Plantbeds" section in this publication.) Apply one of the following in a 7-inch band after seeding or transplanting. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre:

mefenoxam--(Ridomil Gold--1.0 to 2.0 pt 4SL/A or 2.0 to 4.0 pt Ultra Flourish 2E/A)
metalaxyl (MetaStar)--4.0 to 8.0 pt 2EAG
Uniform--0.34 fl. oz 3.66SE/1000 row. See label for restrictions. Uniform applied at planting will also help control Rhizoctonia and Downy mildew

At planting, application of mefenoxam or metalaxyl will also help suppress Downy mildew development.

Big-Vein

The disease is favored by cool temperatures (<60°F) and high soil moisture conditions. Produce the crop on raised beds and avoid planting in fields with low-lying areas. Soil fumigation is helpful. Refer to the “Soil Fumigation” section for details on application.

Corky Root

Development of the disease is favored by continual cropping and by high soil moisture conditions. Cultural practices that reduce soil compaction, such as the use of a rye cover crop and use of high beds should be considered. Limiting irrigation between transplanting or thinning should be adopted to reduce disease incidence.

Downy Mildew

An application of mefenoxam (Ridomil Gold 4SL or Ultra Flourish 2E), or metalaxyl (MetaStar 2E) for damping-off will assist in the control of early-season downy mildew. See "Damping-Off and Other Seedling Diseases" above for use pattern. Use one of the following during periods of high moisture and moderate temperatures.

Alternate one of the following fungicides:
Revus--8.0fl. oz 2.08SC/A,
Zampro--14.0 fl oz 525SC/A
Reason--5.5 to 8.2 fl. oz 500SC/A
Forum--6.0 fl oz 4.18SC/A
Previcur Flex--1.33 pt 6F/A

Leaf Spots (Septoria, Anthracnose and Cerospora)

When conditions favor disease development, alternate the following and repeat every 7 to 14 days:

Quadris--6.0 to 15.5 fl oz 2.08F/A
Fontelis--14.0 to 24.0 fl oz 1.67SC/A

Bottom Rot (*Rhizoctonia*)

A midsummer application of a soil fumigant will be beneficial for the fall crop (Refer to “Soil Fumigation” section for details on materials and application techniques). For the spring and fall crops, all fields should receive one of the following fungicide applications one week after transplanting or thinning and at 10 and/or 20 days later if conditions warrant and/or cultivation has been done.

Endura--8.0 to 11.0 oz 70W/A (suppression only) (2 applications per season allowed)
iprodione--1.5 to 2.0 lb 50WP/A or OLF (3 applications per season allowed)

Do not cultivate directly after applying either of the above (see labels for details)

Uniform--0.34 fl oz 3.66SE/1000 ft row in-furrow applied at transplanting or seeding will also help control Downy mildew

Lettuce Drop (*Sclerotinia*)

Apply one of the following at transplanting and/or thinning (see labels for restrictions). Rotate fungicides if more than one application is needed:

Cannonball--7.0 oz 50WP/A
iprodione--1.5 to 2.0 lb 50WP/A or OLF (2 applications per season allowed)
Endura--8.0 to 11.0 oz 70W/A (suppression only) (2 applications per season allowed)
Quadris--0.40 to 0.80 fl. oz/1000 row ft. 2.08F

Do not cultivate directly after application (see labels for details)

Preplant: Apply 3 to 4 months prior to the anticipated onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but do not plow before seeding or transplanting lettuce to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2.0 to 4.0 lb 5.3WG/A

Gray Mold (*Botrytis*)

Gray mold is most troublesome in transplant greenhouses where air movement is poor and relative humidity remains high. Avoid overcrowding plants and water early in the day to help reduce leaf wetness overnight. If possible vent to reduce relative humidity.

Apply one of the following as a foliar spray:

Cannonball--7.0 oz 50WP/A
Endura--8.0 to 11.0 oz 70W/A (2 applications per season allowed)
Botran--3.0 tbsp 75WP/gal (greenhouse use) or 2.0 to 5.3 lb 75WP/A in field application (1 application allowed at high rate, see label for details, may cause temporary bronzing of leaves)

Yellows

Control leafhopper vectors with insecticides. Refer to the preceding "Leafhopper" section under Insect Control.

Viruses

LMV (lettuce mosaic virus): Use virus-free or MT lettuce seed.
TuMV (turnip mosaic virus): Troublesome in late summer and early fall plantings. Control weed hosts around irrigation risers and areas bordering fields.

Tomato Spotted Wilt Virus (TSWV)

TSWV is spread from flowering ornamental plants (flowers) to lettuce by thrips. Do not grow any ornamental bedding plants in the same greenhouse as lettuce transplants. Scout and monitor for greenhouse thrips regularly and begin an insecticide control program once observed.

MUSKMELONS and Mixed Melons

Recommended Varieties

Muskmelons/Cantaloupes

Round Netted Types – No Sutures
Caribbean Gold* (PMR 2, FR 0,1,2)[1] (trial)
Sarah's Choice* (PMR; FR 0,1,2)

Lightly Sutured Types
Aphrodite* (PMR1,2; FR 0,1,2)
Athena* (PMR 1,2; FR 0,1,2)
Atlantis* (PMR 1,2; FR 0,1,2)
Goddess* (PMR 1,2; FR 0,1,2) (Early)
Grand Slam* (PMR 1,2; FR 0,1,2)
Minerva* (PMR1,2; FR 0,1,2)
Strike* (PMR 2; FR 0,1,2)

Distinct Sutured Types
Halona* (PMR, FR 3) (early)
Majus* (PMR 1,2,5; FR 0,1,2) (trial)
Orange Sherbet* (PMR 2; FR 1,2)
Tirreno* (PMR 1,2,5; FR 0,1,2) (trial)

Specialty Melons

CanaryTypes
Amy*
Castile*
Sunbeam* (PMR 1,2; FR 0,1,2)

Galia Types
Visa* (PMR)
Arava* (PMR)
Courier* (PMR, FR 0,1,2)
Diplomat (PMR)

Honeydew Types
Earli-Dew*
SummerDew* (PMR, 1,2; FR 0, 2)
Dewlightful* (PMR)
Angelina* (PMR 1,2; FR 0,2)

Other Types
Sugar Cube*(PMR 1,2; FR 0,1,2; ZYMV, PRSV, WMV)
(mini round netted orange flesh melon)
Sprite* (mini asian type, white flesh)
French Orange*(FR 0,1,2)(charentais/cantaloupe cross, orange flesh)
Lambkin* (Chrismas type, green flesh)

[1] .Disease reactions: PMR = Powdery Mildew resistance with races; FR = Fusarium wilt resistance and races, ZYMV = Zucchini yellows mosaic virus resistance, PRSV = Papaya ringspot virus resistance, WMV = watermelon mosaic virus resistance
* Indicates hybrid varieties.
Letters in parentheses indicate disease resistance possessed by varieties. See the Abbreviations" section in front portion of this publication.

Melon Descriptions

ANANAS MELONS (Middle Eastern melons) are oval shaped with medium-fine netting over pale green to orange rind. Very sweet, aromatic white flesh or orange-pink flesh. Average weight is three to four pounds.

CANARY MELONS have bright yellow rinds and an oblong shape. Inside, the pale, cream-colored flesh is juicy, and the flavor is very mild.

CASABA MELONS have an oval shape with a pointy end and wrinkled yellow skin, weighing four to seven pounds. The pale, almost white flesh is extremely sweet.

CRENSHAW MELONS are a Casaba cross with a slightly more oblong shape, weighing at least 5 pounds. The slightly wrinkled green rind ripens to yellow. Inside, the flesh is pale peachy orange. It has a strong, spicy aroma.

CHARENTAIS MELONS are French melons identifiable by their smooth, gray, or gray-blue rinds with sutures and orange flesh and are small in size.

CHRISTMAS MELONS have a football shape and weighing upwards of 5 to 8 pounds. They have green mottled rinds and pale orange to light green flesh depending upon the variety. Sweet flesh.

GALIA MELONS are Israeli melons that have netted rinds similar to cantaloupes but paler in color. The sweet pale green to almost white flesh has the consistency of a honeydew with what has been described as a spicy-sweet or banana-like aroma. When ripe, they slip from the vine.

HONEYDEWS have smooth, white to greenish-white rinds (some may be yellow) and sweet flesh that may be green, white, or orange. Its texture is similar to a cantaloupe, but the flavor more subtle and sweet.

MUSKMELONS are the familiar American cantaloupes with orange flesh and netted skin.This includes deep sutured round to oval "Superstar" types, Eastern "Athena" types that are oval with slight sutures, and Western shipping types without sutures.

ORIENTAL MELONS are small (weighing a little more than a pound), elongated yellow melons with white sutures, and sweet, pale peach to white flesh. Because the seeds are so small and the rind is so thin, the entire melon can be eaten.

PERSIAN MELONS bigger than cantaloupes, have a dark green rind with light brown netting. As it ripens, the rind turns to light green. Bright pink-orange flesh has a delicate flavor. Unlike most melons in the Reticulatus group, Persian melons do not slip from the vine when mature.

CROSSES are also available. There are a number of crosses between types such as muskmelon x galia and charentais x muskmelon that produce excellent melons.

OTHER SPECIALTY MELONS that do not fit into the above catagories are also available including those catagorized as “Gourmet”.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state’s soil test report recommendations and/or your farm’s nutrient management plan supercede recommendations found below.

Muskmelons	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	75-150	150	100	50	0[1]	200	150	100	0[1]	Total nutrient recommended.
	25-50	150	100	50	0[1]	200	150	100	0[1]	Broadcast and disk-in or follow fertigation schedule.
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines begin to run or follow fertigation schedule.
	25-50	0	0	0	0	0	0	0	0	Sidedress prior to first harvest or follow fertigation schedule.

For plasticulture production, fertilization rates are based on a standard row spacing of 6-feet. Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Suggested Fertigation Schedule for Coarse-Textured Soils – Muskmelon

Days After Planting	Daily Nitrogen[1]	Daily Potash[1,2]	Cumulative Nitrogen[1]	Cumulative Potash[1,2]
	----------------------lbs/A---------------------			
Preplant[3]	---	---	25	50
0-28	0.9	0.9	50.2	75.2
29-49	1.3	1.3	77.5	102.5
50-77	1.5	1.5	119.5	144.5
78-91	0.7	0.7	129.3	154.5

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot bed centers. Adjust proportionally for other widths. See Fertigation in section C-Irrigation Management for more information.

Suggested Fertigation Schedule for Fine-Textured Soils – Muskmelon

Days After Planting	By Days After Planting Period		Cumulative Amount Applied	
	Nitrogen (N)[1]	Potash (K_2O)[1,2]	N[1]	K_2O[1,2]
	lb/acre			
Preplant[3]	-	-	57	62
0-28 (28 days)	9	9	66	71
29-49 (20 days)	10	10	76	81
50-77 (27 days)	15	15	91	96
78-91 (13 days)	3.5	3.5	94.5	99.5

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot bed centers. Adjust proportionally for other widths. See Fertigation in section C-Irrigation Management for more information.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for muskmelons.

Critical muskmelon tissue test values.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
Most recently matured leaves at 12” vine stage	Deficient	<4.0	0.4	5	3	0.35	-	<40	20	20	20	5	0.6
	Adequate range	4	0.4	5	3	0.35	0.2	40	20	20	20	5	0.6
		5	0.7	7	5	0.45	-	100	100	60	80	10	1
	High	>5.0	0.7	7	5	0.45	-	>100	100	60	80	10	1
	Toxic (>)	-	-	-	-	-	-	-	900	-	150	-	-
Most recently matured leaves at early fruit set	Deficient	<3.5	0.3	1.8	1.8	0.3	-	<40	20	20	20	5	0.6
	Adequate range	3.5	0.3	1.8	1.8	0.3	0.2	40	20	20	20	5	0.6
		4.5	0.4	4	5	0.4	-	100	100	60	80	10	1
	High	>4.5	0.4	4	5	0.4	-	>100	100	60	80	10	1
	Toxic (>)	-	-	-	-	-	-	-	900	-	150	-	-

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. Seed should be treated to prevent disease, for more information go to the Disease Section.

Plant Production

Transplants should be grown in pots or cells that provide a space of *at least* 2 inches by 2 inches for each plant. Smaller pots or cells will restrict root growth and provide less protection to the newly set transplant. If the seed is of good quality with a high germination test, one seed per pot is sufficient. One ounce of muskmelon seed contains 950 to 1,250 seeds.

Planting and Spacing

Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (15.6°C). Temperatures below 45°F can stunt plant growth. Planting dates vary from May 1 in southern regions to June 5 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers, or rye strips.

The recommended spacing for muskmelons is 5 to 6 feet between rows and 2 to 3 feet between plants in the row.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5, apply enough farm-grade fertilizer to supply 25-50% of N and K_2O requirements and thoroughly incorporate into the soil. Apply all P_2O_5 pre-plant and incorporate into the soil. Apply the balance of N and K_20 through the drip irrigation system throughout the season. The first fertigation application should be within a week after field transplanting or direct seeding.

Mulching

Fumigated soil aids in the control of weeds and soil-borne diseases. Plastic mulch laid before field plantings conserves moisture, increases soil temperature, and increases early and total yields. Several fumigants can be used on muskmelon depending what the predominant pests are. Plastic and fumigant should be applied to well-prepared planting soil 30 days before field planting. Various widths of plastic mulch are available depending on individual production systems and available equipment. The soil must be moist when laying the plastic. Fumigation alone may not provide satisfactory weed control under plastic. Black plastic or paper can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate NO_3^{-1} form.

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on "Pollination" in the General Production Recommendations and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Harvest and Post Harvest Considerations

Muskmelons should be harvested no sooner than half-slip and preferably at full-slip for optimum fruit quality. Canary melons and Galia melons also slip, but Honeydews do not. Pick honeydew melons when the stem end becomes slightly springy and the skin takes on a creamy yellow appearance. Harvest daily in hot weather. Cooling to remove field heat is desired. Precooling can be done with cold water, cold air, or ice. Hydrocooling is the most efficient method, but room cooling and forced air cooling are also suitable for melons. After precooling, muskmelons should be stored at 36-41 F and 95% relative humidity. A full-slip melon can be kept about 15 days at this temperature. Honeydews and other non-slip melons should not be stored below 40 F, as chilling injury will result. They will retain adequate quality for 2-3 weeks at 45-50 F.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in melons.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious under clear plastic. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Halosulfuron--0.023 to 0.047 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 1.0 dry ounce Sandea 75WG under plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay transplanting for seven days after application. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1.0 dry ounce of Sandea, applied under plastic mulch.**

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.

Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME as a banded directed shielded spray preemergence to the weeds to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use, or use Strategy, the jug-mix that contains clomozone (Command) and ethalfluralin (Curbit).

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 1.12 lb/A. Apply 1.0 to 3.0 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC as a banded directed shielded spray preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a jug-mix of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2.0	0.4	0.125
3.0	0.6	0.188
4.0	0.8	0.250
5.0	1.0	0.312
6.0	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023 to 0.047 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 1.0 dry ounces of Sandea 75WG to suppress or control broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally slight stunting may be observed following Sandea use early in the season, before the vines begin to run. When observed, recovery is rapid, with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with his mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 lb/A, equal to 1.0 dry ounce of Sandea, applied preemergence DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 lb/A, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Pendimethalin--1.0 lb/A. Apply 2.1 pints per acre Prowl H_2O as a banded directed shielded spray before transplanting, or before seeded crop has emerged. Activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. A second treatment at the same rate may be applied as a banded directed shielded spray postemergence a minimum of 21 days after the first application, but before the vines begin to run. **DO NOT apply “over the top” of the crop, or severe injury may occur. Observe a 35 day PHI (PreHarvest Interval).**

Postemergence

Halosulfuron--0.023 to 0.031 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.50 to 0.66 dry ounce Sandea 75WG as a banded directed shielded spray to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a banded directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Pendimethalin--1.0 lb/A. Apply 2.1 pints per acre Prowl H_2O as a banded directed shielded spray before transplanting, or before seeded crop has emerged. Activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds emerging from seed (preemerngence). Tank-mix with Gramonone plus a nonionic surfactant or another recommended postemergence herbicide to control emerged weeds. **DO NOT apply "over the top" of the crop, or severe injury may occur. Observe a 35 day PHI (PreHarvest Interval).**

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applicatons)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated

Bensulide *plus* naptalam--4.0 to 6.0 lb/A *plus* 2.0 lb/A. Apply 1.0 to 1.5 gallons of Prefar 4EC ***plus*** 1.0 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment before seeding or transplanting. Tank-mix is approved.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 0.94 lb/A. Apply 1.0 to 2.5 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023 to 0.047 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Postemergence

Halosulfuron--0.023 to 0.031 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.50 to 0.66 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT**

exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 **or OLF** as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled ,as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3.0 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Corn Maggot

To prevent maggot damage to transplants, a banded application of a soil-incorporated insecticide may be needed. Also see Chapter E – Pest Management under the heading of "Soil Pests--Their Detection and Control" Maggots. **Note:** The use of imidacloprid at planting may help to reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles transmit bacterial wilt, and most varieties of muskmelons are highly susceptible to this disease. Also, adult beetles can cause direct feeding injury to young plants. Insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--2.4 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin**--soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran**--soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.0 fl oz/A Danitol 2.4EC
imidacloprid**--soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC

methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Squash Vine Borer

When vines begin to run, apply one of the following formulations to bases of plants four times at 7-day intervals:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Cutworms (Also see "Cutworms" section in Soil Pests--Their Detection and Control.)

Apply one of the following formulations:
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pickleworm (PW), Melonworm (MW)

When using foliar materials, make one treatment prior to fruit set, and then treat weekly. If using soil or drip applications, follow instructions on the label.

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.0 qt/A Sevin XLR (or OLF)
chlorantraniliprole--melonworm **drip** 2.0 to 3.5 fl oz/A, **foliar** 2.0 to 5.0 fl oz/A Coragen 1.67SC pickleworm **drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Aphids

Note. Aphids transmit multiple viruses. For chemical control of aphids, apply one of the following formulations:

acetamiprid--2.5 to 4.0 oz/A Assail 30G (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin+thiamethoxam--4.5 fl oz/A Endigo ZC
methomyl--(melon aphid only) 1.5 to 3.0 pts/A Lannate LV (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WP
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil/drip** 1.66 to 3.67 oz/A Platinum 75SG (or OLF); **foliar** 1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Squash Bug

Begin treatments if greater than one egg mass per plant is present. Sprays should target nymphal stages. Treat every 7-10 days, or as needed with one of the following formulations:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2 13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Leafhoppers

High levels of leafhoppers cause leaf yellowing (chlorosis) known as hopper burn which will result in yield loss. Apply one of the following formulations:

acetamiprid--2.5 to 4.0 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
dimethoate--1.0 pt/A Dimethoate 400 4EC (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid**--soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
thiamethoxam--**soil/drip** only1.66 to 3.67 oz/A Platinum 75SG (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Leafminers

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
chlorantraniliprole--**soil/drip** 5.0 to 7.5 fl oz/A Coragen 1.67SC; **foliar** 5.0 to 7.0 fl oz/A Coragen 1.67SC
dimethoate--1.0 pt/A Dimethoate 400 (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70S G (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
oxamyl--2.0 to 4.0 pts/A Vydate L
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (Pounce 3.2 EC, or OLF)
spinosad--6.0 to 8.0 fl oz/A Entrust SC
thiamethoxam--**soil/drip only** 1.66 to 3.67 oz/A Platinum 75SG (or OLF)

Rindworms (Cucumber beetle larvae)

Damage to the rinds may result from any one or a complex of insects including cucumber beetle, wireworms, and a number of “worm species”, including but not limited to beet armyworm. Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle and beet armyworm sections for labeled products.

Beet Armyworm

Apply one of the following formulations:
chlorantraniliprole--**soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 to 6.0 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin + chlorantraniliprole--6 .0 to 9.0 fl oz/A Voliam Xpress
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi

Cabbage Looper

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--**soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Stink bug

Apply one of the following formulations:

beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture EC (Sniper, or OLF)
cyfluthrin--2.4 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF)**; foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Mites

Mite infestations generally begin around field margins and grassy areas. **CAUTION: DO NOT** mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season. Apply one of the following formulations:

Note: Continuous use of carbaryl or pyrethroids may result in mite outbreaks.

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
bifenazate--0.75 to 1.00 lb/A Acramite 50WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
fenpyroximate--2.0 pts/A Portal
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC

Thrips

Apply one of the following formulations:
Chenopodium extract--2.0 to 3.0 qts/A Requiem 25EC
dimethoate--1.0 pt/A Dimethoate 400 (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 8.0 fl oz/A Entrust SC
thiamethoxam--**soil/drip only** 1.66 to 3.67 oz/A Platinum 75SG (or OLF)
thiamethoxam + chlorantraniliprole--**soil/drip only** 10.0 to 13.0 fl oz/A Durivo

Whiteflies

Apply one of the following formulations:

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
fenpyroximate--2.0 pts/A Portal
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
pyriproxyfen--8.0 to 10.0 fl oz/A Knack
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC
sulfloxafor--4.25 to 4.5 fl oz/A Closer SC
thiamethoxam-- **soil/drip** 1.66 to 3.67 oz/A Platinum 75SG (or OLF); **foliar** 3.0 to 5.5 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	0
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin	R	12	3
bifenazate	G	12	3
carbaryl	G	12	3
Chenopodium extract	G	4	0
chlorantraniliprole	G	4	1
clothianidin(soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
dimethoate	R	48	3
dinotefuran (soil/foliar)	G	12	21/1
esfenvalerate	R	12	3
etoxazole	G	12	7
fenpropathrin	R	24	7
fenpyroximate	G	12	3
flonicamid	G	12	0
flubendiamide	G	12	1
INSECTICIDE *(cont'd)*			
flubendiamide+buprofezin	G	12	1
imidacloprid (soil only)	G	12	21
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	1
lambda-cyhalothrin + chlorantraniliprole	R	24	1
lambda-cyhalothrin + thiamethoxam	R	24	1
methomyl	R	48	3
methoxyfenozide	G	4	3
oxamyl	R	48	1
permethrin	R	12	0
pymetrozine	G	12	0
pyriproxyfen	G	12	7
spinetoram	G	4	3
spinosad	G	4	3
spiromesifen	G	12	7
sulfloxafor	G	12	1
thiamethoxam (soil/drip)	G	12	30
(foliar)	G	12	0
thiamethoxam+chlorantraniliprole			
(soil/drip)	G	12	30
(foliar)	G	12	1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Folicur (Group 3)	G	12	7
Fontelis (Group 7)	G	12	1
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
Inspire Super (Groups 3 + 9)	G	12	7
mancozeb (Group M3)	G	24	5
MetaStar (Group 4)	G	48	AP
Presidio (Group 43)	G	12	2
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quadris Top (Groups 11+3)	G	12	1
Quintec (Group 13)	G	12	3
Rally (Group 3)	G	24	0
Ranman (Group 21)	G	12	0
Reason (Group 11)	G	12	14
Revus (Group 40)	G	4	0
Ridomil Gold (Group 4)	G	48	5
Switch (Groups 9 +12)	G	12	1
Tanos (Groups 11 + 27)	G	12	3
Torino (Group U6)	G	4	0
Ultra Flourish (Group 4)	G	48	5
Uniform (Groups 4 + 11)	G	0	AP
Zampro (Groups 45 + 40)	G	12	0

(table continued next column

See Table D-6.

[1] G = general, R = restricted, AP = At planting

[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL [3]AP = At plant

Nematode Control

See Chapter E – Pest Management the Nematodes section under Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section of the same chapter, or Vydate L--1.0-2.0 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2.0 to 4.0 pts 2L/A applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480DP (4.5 fl oz/100 lb) and an approved commercially available insecticide.

Damping-Off and Pythium Crown Rot

Apply the following in a 7-inch band after seeding. Use formula given in the "Calibration for Changing from Broadcast to Band Application" of Section E for calibrating Granular Application Equipment to determine amount of Ridomil Gold, Ultra Flourish or MetaStar needed per acre. Apply one of the following:

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A or Ultra Flourish--2.0 to 4.0 pt 2E/A)
metalaxyl (MetaStar--4.0 to 8.0 pt 2E/A)
Uniform--0.34 fl oz 3.66SE/1000 ft row

Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV, and CMV. Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See the preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be necessary.

Fusarium Wilt

Rotate to allow 5 years between muskmelon plantings in any given location. Use resistant cultivars when possible. The cultivars ‘Athena’, ‘Minerva’, and ‘Aphrodite’ have resistance to Race 0, 1, and 2 (predominant races present in the area). Cultivars ‘Eclipse’ and ‘Superstar’ have resistance to Race 2 only.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Muskmelons should be grown on raised beds and fields should be adequately drained to ensure water does not accumulate around the base of the plants. Rotate away from susceptible crops (cucurbits, peppers, lima beans and snap beans, eggplants, and tomatoes) for as long as possible. Apply preplant fumigants to suppress disease. Apply one of the following when conditions are favorable for disease development and always tank-mix with a fixed copper:

The following materials provide suppression only:
Revus--8.0 fl oz 2.08 F/A
Ranman--2.75 fl oz 400 SC/A
Presidio--3.0 to 4.0 fl oz 4SC/A
Forum--6.0 fl oz 4.17SC/A
Gavel--1.5 to 2.0 lb 75DF/A (**Note: some muskmelon cultivars are sensitive to Gavel**)
Tanos--8.0 to 10.0 oz 50DF/A
Zampro--14 fl oz 525SC/A

Materials with different modes of action (FRAC codes) should always be alternated.

Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

Powdery Mildew

Excellent host resistance is available in most recommended muskmelon varieties. The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern US. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failure. Materials with different FRAC codes should always be alternated. Powdery mildew generally occurs from mid-July until the end of the season. Scout fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves, begin the following fungicide program:

Alternate:

Quintec--6.0 fl oz 2.08SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Torino--3.4 fl oz 0.85SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

With one of the following FRAC code 3 fungicides:

Procure--4.0 to 8.0 fl oz 480SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Rally--5.0 oz 40 WSP/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
tebuconazole--4.0 to 6.0 fl oz 3.6 F/A or OLF plus chlorothalonil--2.0 to 3.0 pt 6F/A
Inspire Super 16.0 to 20.0 fl oz 2.8F/A *plus* chlorothalonil 2.0 to 3.0 pt 6F/A or OLF

with:
Fontelis--12.0 to 16.0 fl oz 1.67SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Pristine--12.5 to 18.5 oz 38WG/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Downy Mildew

Scout fields for disease incidence beginning in early summer. Begin sprays when vines run or if disease is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (http://cdm.ipmpipe.org) for current status of the disease. Preventative applications are much more effective than applications made after downy mildew is detected. The following are the most effective materials (tank-mix these products with a protectant such as chlorothalonil (1.5 to 2.0 pt 6F/A or OLF) or mancozeb (3.0 lb 75 DF/A) and rotate between different FRAC codes. **Note:** some cultivars are sensitive to mancozeb. Apply one of the following formulations:

Ranman--2.10 to 2.75 fl. oz. 400SC/A
Previcur Flex--1.2 pt 6F/A

Zampro--14.0 fl oz 525SC/A

Other materials for use in rotation as tank mix partners with a protectant:
Presidio--3.0 to 4.0 fl oz 4SC/A
Tanos--8.0 oz 50WDG/A
Curzate--3.2 oz 60DF/A
Forum 6.0 fl oz 4.17SC/A
Gavel--1.5 to 2.0 lb 75DF/A (Gavel contains mancozeb, which is a protectant fungicide and therefore does not need a tank-mix partner.)
Note: Some muskmelon varieties are sensitive to Gavel.

Materials with different modes of action (FRAC codes) should always be alternated.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if the label allows.

Alternaria Leaf Blight

Rotate muskmelons with unrelated crops. Begin sprays when vines begin to run, or earlier if symptoms are detected.

Alternate one of the following:
chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
mancozeb--2.0 to 3.0 lb 75DF/A or OLF (Muskmelon varieties, 'Harvest Queen', 'Gold Star', 'Super Star', 'Sweet and Early', and 'Saticoy' are sensitive to mancozeb.)

With:
Pristine--12.5 to 18.5 oz 38WG/A

a tank-mix containing chlorothalonil *plus* one of the following every 14 days:

Reason--5.5 fl oz 500SC/A
Inspire Super--16.0 to 20.0 fl oz 2.8F/A
Quadris Top--12.0 to 14.0 fl oz 2.7F/A
Quadris--11.0 to 15.5 fl oz 2.08F/A (Do not apply near apples, see label for details)
Cabrio--12.0 to 16.0 oz 20EG/A

Materials with different modes of action (FRAC codes) should always be alternated.

Scab

Disease occurs during cool periods. Begin sprays as true leaves form. Repeat every 5 to 7 days.

chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Gummy Stem Blight

Fungicides solo products within the FRAC code 11 (Cabrio, Quadris and Flint) are not recommended in the mid-Atlantic region. Pristine, which contains both FRAC code 11 and 7 components should always be tank-mixed with a protectant fungicide to reduce the possibility of resistance development (See Table E-13). When tank-mixing, use the minimum labeled rate of each fungicide in the tank-mix. Do not apply FRAC code 11 fungicides more than 4 times total per season.

Begin sprays when vines begin to run, apply the following:

Under low disease pressure:
Apply chlorothalonil every 7 days at 2.0 to 3.0 pt/A or OLF

Under high disease pressure:
Alternate:
chlorothalonil--2.0 to 3.0 pt 6F/A or OLF (Use low rate early in season)

With:
A tank-mix containing a protectant fungicide (such as chlorothalonil) *plus one of the following:*
Pristine--12.5 to 18.5 oz 38WG/A
Switch--11.0 to 14.0 oz 62.5 WG/A
tebuconazole--8.0 fl oz 3.6 F/A, or OLF
Inspire Super--16.0 to 20.0 fl. Oz 2.8F/A

Manganese Toxicity

This disorder occurs in acid soils (pH less than 5.8). Maintain soil pH at 6.5 to avoid toxicity.

OKRA

Okra is a tropical annual with a wide range of adaptation. It is, however, very sensitive to frost and cold temperatures and should not be planted until soil has warmed in the spring.

Varieties[1]

Annie Oakley II*
Clemson Spineless 80
Cajun Delight*
Jambolaya
North and South*

[1]Varieties listed alphabetically * Indicates hybrid varieties.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Okra	**per Acre**	**Pounds P_2O_5 per Acre**				**Pounds K_2O per Acre**				**Nutrient Timing and Method**
	125-150[1]	250	150	100	0	250	150	100	0	Total nutrient recommended.
	50-100	250	150	100	0	250	150	100	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks after planting.
	25-50	0	0	0	0	0	0	0	0	Sidedress 6-8 weeks after planting.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.
[1]If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 225 pounds of nitrogen (N) per acre with recommended phosphorus and potassium and disk-in prior to laying mulch. For drip/trickle fertilization, see Chapter C under drip/trickle fertigatoin section.

Seed Treatment

See the Disease section for seed treatment to prevent disease.

Seeding and Spacing

Usual field seeding date is May 20 to June 1. Generally only one planting is made. For Pennsylvania, seed in the greenhouse in cells on May 5 and transplant to the field on June 5 to 10 through black plastic mulch on raised beds with drip irrigation. Okra also responds to the application of trellises and row covers or high tunnels.

For dwarf varieties, space the rows about 3½ feet apart; for medium and tall varieties, 4 to 4½ feet apart. Drill seeds ¼ to ½ inch deep, 3 or 4 per foot of row (5 to 7 pounds per acre). Thin the plants when they are 5 inches high. Dwarf varieties should be about 12 to 15 inches apart in the row; plants of tall varieties should be 18 to 24 inches apart.

Harvest and Post Harvest Considerations

An okra pod usually reaches harvesting maturity 4 to 6 days after the flower opens. The pods are 3 to 3½ inches long at this stage and are tender and free of fiber. Pick pods at least every second day. Large and undesirable pods should be removed to permit the plant to continue to bear over a long period. Allergies to okra are common, so protective gloves are recommended. Harvested okra should be kept at temperatures between 50° to 55°F (10° to 12.8°C) and relative humidity of 85 to 90 percent. Okra pods are subject to chilling injury below 50°F (10°C).

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

There has been no research on this crop in this area. The following are suggestions taken from company labels:

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated

Trifluralin--0.5 to 1 lb/A. Apply 1.0 to 2.0 pints per acre Treflan 4E. Incorporate 2 to 3 inches deep within 8 hours of application by disking twice with blades set 4 to 6 inches deep.

Shielded & Directed Between Rows of Plastic Mulch

Mesotrione--0.094 to 0.188 lb/A. Apply 3.0 to 6.0 fluid ounces of Callisto 4SC per acre. Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morninglory species. Apply Treflan 4E between the rows of mulch to control annual grasses. Crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. **See the Callisto label for additional use precautions.**

Postemergence - Directed

Mesotrione--0.094 lb/A. Apply 3.0 fluid ounces of Callisto 4SC per acre. Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morninglory species. Preplant incorporate Treflan 4E to control annual grasses. Temporary injury, appearing as whitening of the foliage after application, may occur. Varieties may differ in sensitivity to mesotrione. Crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. **See the Callisto label for additional use precautions.**

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids
Apply one of the following formulations:

Chenopodium extract--2.0 to 3.0 qts/A Requiem
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar--**1.3 to 2.2 fl oz/A Admire PRO (or OLF)
malathion--1.5 pts/A Malathion 57EC (or OLF)
sulfoxaflor--1.5 to 2.0 fl oz/A Closer SC

Corn Earworm
Apply one of the following formulations:
Bacillus thuringiensis--1.0 lb/A Dipel DF (or OLF)
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
zeta-cypermthrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Japanese Beetle
Apply one of the following formulations:
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
malathion--1.5 pts/A Malathion 57EC (or OLF)

Stink bugs
Apply one of the following formulations:
bifenthrin--2.1 to 6.4 fl oz/A Bifenture EC (Sniper, or OLF)
carbaryl--1.0 to 1.5 qts/A Sevin XLR Plus (or OLF)
zeta-cypermthrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Whiteflies
Apply one of the following formulations:
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
pyriproxyfen--8.0 to 10.0 fl oz/A Knack
sulfoxaflor--4.25 to 4.5 fl oz/A Closer SC

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
Bacillus thuringiensis	G	4	0
bifenthrin	R	12	7
carbaryl	G	12	3
chlorantraniliprole	G	4	1
flubendiamide	G	12	1
flubendiamide + buprofezin	G	12	1
imidacloprid (soil/foliar)	G	12	21/0
indoxacarb	G	12	3
malathion	G	12	1
pyriproxyfen	G	12	14
spinetoram	G	4	1
spinosad	G	4	1
sulfoxaflor	G	12	1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	7
FUNGICIDE (FRAC code) *(cont'd)*			
chlorothalonil (Group M5)	G	12	3
Folicur (Group 3)	G	12	7
Quadris (Group 11)	G	4	0

(table continued next column)

See Table D-6.

[1] G = general

Nematode Control
Nematode control is very important in the production of this commodity. See Chapter E, "Nematodes" section of "Soil Pests--Their Detection and Control". Use fumigants listed in the "Soil Fumigation" section.

Disease Control
Seed Treatment
Use thiram 480DP at 3.0 to 4.0 oz/100 at 3.0 to 4.0 oz/100 lb of seed (2/3 tsp/lb) *plus* Apron XL LS (0.32 to 0.64 fl oz /100 lb of seed) for improved germination and stand.

Damping-Off
Use seed treated with thiram *plus* Apron XL LS (0.32 to 0.64 fl oz/ 100 lb of seed).

Seedling Root Rot and Basal Stem Rot (*Rhizoctonia*)

Apply Quadris--0.40 to 0.80 fl oz 2.08F/1000 row ft

Fusarium and Verticillium Wilts
Avoid planting in fields where either disease is present. Rotate with non-solanaceous crops or cotton.

Fruit Rot
Choanephora is a soil-borne fungal disease which attacks senescent blossoms and fruit. There are no fungicides labeled for Choanephora control. Improving air circulation is the only effective means of reducing the chances for Choanephora development. In extreme cases, some growers remove the lower juvenile leaves to improve air circulation.

Leaf Spots
Apply one of the following formulations:

chlorothalonil--1.5 pt 6F/A or OLF
Folicur--4.0 to 6.0 floz 3.6F/A or OLF
Quadris--6.0 to 15.5 floz 2.08F/A
fixed coppers--0.75 to 1.75 lb/A (check label for specific rate ranges)

ONIONS

Recommended Bulbing Onion Varieties

Variety	Hybrid	Type[1]	Days	Description[2]	Color	Storage	Method[3]	Size
Ebenezer	No	Long Day	120	Storage LD	Yellow	Long	Sets	Med-Large
Sedona	Yes	Long Day	120	Storage LDSP	Yellow	Long	DS, TP	Large
Southport Red Globe	No	Long Day	120	Storage LD	Red	Long	DS, TP	Large
Bradley	Yes	Long Day	118	Storage LDSP	Yellow	Long	DS, TP	Large
Delgado	Yes	Long Day	118	Storage LDSP	Yellow	Long	DS, TP	Med-Large
Red Wing	Yes	Long Day	118	Storage LD	Red	Long	DS, TP	Large
Talon	Yes	Long Day	110	Storage LDSP	Yellow	Long	DS, TP	Large
Fortress	Yes	Long Day	110	Storage LDN	Yellow	Long	DS, TP	Medium
Red Sky	Yes	Long Day	110	Storage LDSP	Red	Long	DS, TP	Med-Large
Braddock	Yes	Long Day	107	Storage LDN	Yellow	Long	DS, TP	Large
Safrane	Yes	Long Day	106	Storage LDN	Yellow	Long	DS, TP	Medium
Prince	Yes	Long Day	105	Storage LDN	Yellow	Long	DS, TP	Large
Tequila	Yes	Long Day	120	Spanish	Yellow	Medium	DS, TP	Very Large
Mesquite	Yes	Long Day	120	Spanish	Yellow	Medium	DS, TP	Very Large
Spanish Medallion	Yes	Interm. Day	110	Sweet Spanish	Yellow	Medium	DS, TP	Very Large
Expression	Yes	Interm. Day	98	Sweet Spanish	Yellow	Short	TP	Large
Super Star	Yes	Interm. Day	100	Sweet Spanish	White	Short	TP	Large
Candy	Yes	Interm. Day	95	Sweet Spanish	Yellow	Very Short	TP	Very Large
Exacta	Yes	Interm. Day	94	Sweet Spanish	Yellow	Very Short	TP	Large
Bridger	Yes	Overwinter	n/a	Storage	Yellow	Long	DS	Large
Hi-keeper	Yes	Overwinter	n/a	Storage	Yellow	Long	DS	Med-Large
T-420	Yes	Overwinter	n/a	Storage	Yellow	Long	DS	Med-Large
Toughball	Yes	Overwinter	n/a	Storage	Yellow	Long	DS	Medium

[1]Long day onions direct seeded or transplanted in early spring; Intermediate day onions normally early spring transplanted; and Overwintering onions direct seeded in later summer.
[2]Onion descriptions: Storage = long keeping types; LD = Long Day; SP or Spanish = Spanish type; N = Northern type; Sweet Spanish = short keeping softer scale sweet types.
[3]Method of establishment: DS = Direct Seeded, TP = Transplanted

Recommended Green or Bunching Onions (Scallions)

Variety	Comments
Evergreen Long White Bunching	Overwinter
Kincho	Summer
Ishikura Improved	Summer
Southport White Globe	Overwinter
Feast	Summer
Parade	Summer
Tokyo Long White Bunching	Summer
White Gem	Summer-Fall
White Sweet Spanish	Spring-summer

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Bulb onions	75-100	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
	50-75	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting.
Green onions	150-200	200	100	50	0[1]	200	100	50	0[1]	Total nutrient recommended.
	50-75	200	100	50	0[1]	200	100	50	0[1]	Broadcast and disk-in.
	50	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting.
	50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks before harvest.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.
[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 25 lbs. K_2O per acre are recommended on soils testing Very High.

Seed Treatment

Buy commercial fungicide treated seed, if available. See the Disease section for more information.

Transplant Production

Produce onion transplants in cell trays. The maximum cell size recommended for Sweet Spanish transplants is 338 cells per tray. Grow transplants 10-12 weeks and maintain a plant height of 4 inches.

Planting and Seeding Dates

For dry bulb onions, sets or seeds can be planted as soon as soil conditions are favorable in the spring. Transplants for bulb onions can be planted March 20 to April 1.

Seed for bunching onions can be planted as soon as soil conditions are favorable in the spring. Successive plantings can be made through the summer.

Growing for the Simply Sweet Onion™ branding program is an option for Pennsylvania growers. Information on cultivars, production methods and licensing can be obtained by contacting the Pennsylvania Vegetable Growers Association at 717-694-3596 or pvga@pvga.org

Spacing

For dry bulb onions, space rows 24 inches apart. Space eight to nine sets per foot (24 bushels per acre). For large Spanish onions, space sets 4 to 5 inches apart and seeds ½ to 2 inches in row (2 pounds per acre using split shoe). For bunching onions, space rows 12 to 16 inches apart; space seed ½ to 1½ inches apart (7 to 10 pounds per acre). Plant seed ½ to 3/4 inch deep except on muck. On muck soils plant seed ½ to 1 inch deep. Place sets 1 to 1½ inches deep.

Plasticulture

The use of plasticulture for sweet Spanish onion production has resulted in consistent high quality, large bulb sized onions. Raised beds (6 to 8 inches high) are generally placed on 72 to 78 inch centers; however, if equipment is adjustable and soil is friable, beds can be made on 66 inch centers. Transplants are spaced on a 6 inch X 6 inch spacing with 4 rows planted across a 28 inch to 30 inch wide raised bed. In addition, 2 drip irrigation lines are placed in the bed between each of the outer two rows of onion transplants to maintain adequate soil moisture for sizing onion bulbs and producing a sweet onion taste.

For plasticulture systems, broadcast two-thirds of nitrogen prior to making raised beds and laying plastic in the field and one-third through the drip irrigation tape. Apply phosphorus and potassium as well as any magnesium or calcium based on soil test results prior to making the raised beds with plastic mulch and drip tape. If top growth appears chlorotic (yellow) or stunted, a tissue test analysis is recommended in order to make corrective measures before onion initiate bulb enlargement. Avoid using sulfur containing fertilizers. While some sulfate is required for optimum plant growth, soil sulfur levels should be less than 20 ppm; since high soil sulfur increase the pungency of onion bulbs by increasing pyruvic acid levels.

Onions are shallow-rooted, and unless moisture supply is constant, they bulb early and produce small bulbs. Light, frequent irrigations should be used when onions are small to minimize leaching of nitrogen from the root zone. It is recommended that at least 1.5 to 2.0 inches of water be applied in 3 to 5 applications every week by drip irrigation. Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application. Irrigation should thoroughly wet the soil to a depth of 18 inches. Stop watering after bulbs have reached full size, and tops have begun to fall.

Cultivation

For bunching onions, hill 1 to 2 inches to ensure white base.

Harvest and Postharvest Considerations

Bulb Onions

Start harvesting when at least 50% of onion tops have fallen. The tops of some sweet Spanish cultivars may not fall at maturity and should be harvested once the desired bulb size is reached. Pull bulbs by hand or undercut them (such as with a potato digger) without damaging their base. In plasticulture systems, pull bulbs through existing holes in the plastic mulch. Lay bulbs on the soil or mulch surface for 3 days if no rain is predicted. If rain is predicted, cut tops from onion bulbs (leaving 1.5 inch necks; shorter necks increase the likelihood of disease) and place bulbs in potato burlap bags or bulk bins and bring into shelter. If bulbs are packed in burlap bags, they can be placed in a greenhouse or high tunnel for 5 to 7 days to dry. Place sheets of row cover material over burlap bags of onions to reduce/eliminate sunburn. If using bulk bins for drying onions, place in room with high air flow and a controlled heat source (the drying temperature for onions should never exceed 90°F). Keep in dryer with moderate heat and high air flow for at least 48 hours. Before removing bulk bins from dryer, randomly check onion necks to ensure the surface is paper dry. If storing sweet onion bulbs for a short period of time (up to 2 months), maintain cool temperature (38°F to 45°F) and low relative humidity (75-85%) with active air movement.

For harvesting storage-type onions, rows are undercut, lifted and windrowed for field curing. Rod-weeder diggers and knife undercutters are most common. After an appropriate interval, the undercut onions are lifted and windrowed. This may be done with tops onto prevent sun-scald or tops may be removed in the windrowing operation. Topping may be done by hand or by machine. With good air movement and proper placement of onions in storage, onions have been found to store best with tops on; however, this may complicate removal of onions from bulk storage and necessitates extra handling at packing time. Onions should be adequately cured in the field, in open sheds, or by forced air before storage. Adequate curing in the field or in open sheds may require 2 to 4 weeks, depending on the weather. The best skin color develops at 75° to 90° F. and 60-75% relative humidity.

The most common method of curing is by forced ventilation in the storage by blowing heated air at 75° to 85°F through the onions at 2 cf./m. air flow per cubic foot of onions. Onions are considered cured when the neck is tight and the outer scales are dry and brittle. This condition is reached when onions have lost 3 to 5% of their weight. If not adequately cured, onions are likely to decay in storage. Refrigerated storage is often used for onions to be marketed late in the spring. Onions to be held in cold storage should be placed there immediately after curing. A temperature of 32° F will keep onions dormant and reasonably free from decay, provided the onions are sound and well cured when stored. Air circulation should be sufficient to prevent heating and to remove moisture from within bins or sacks. Storage onions can be held for 6 to 8 months at 32° F.

Green Onions and Scallions

Harvest should begin when green onions are 1/4 to 1/2 inch in diameter at the base. Semi-bulbing types will be slightly enlarged at the base (up to 1 inch). Onions are hand pulled and bunched with 6-9 onions, or 1/4 lb, held together with rubber bands, Pulling is usually done without undercutting and bunching is usually done in the field. Field boxes are moved to packing areas within two to three hours of being harvested. It is recommended that bunched green onions are run through a washer/cooler machine that washes them in a 33 to 35 F water. Green tops are usually trimmed to 12 inches. In some cases harvested onions are bunched in the packing shed. Chilling the wash water removes field and ambient heat from the onions. They are then immediately packed in waxed boxes. Hold green onions at 32° F and 95 to 100 % relative humidity. Green onions are normally marketed promptly. They can be stored 3 to 4 weeks at 32° F if moisture loss is prevented. Crushed ice spread over the onions aids in supplying moisture. Packaging green onions in perforated polyethylene film also will aid in preventing moisture loss.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preemergence

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F at time of seeding or immediately after planting sets. A second application may be needed for longer season seed onions.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 32 fluid ounces per acre in one season. Labeled for dry bulb onions only.

Fluazifop--0.125 to 0.188 lb/A. Apply 0.50 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0. 25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application. Labeled for dry bulb onions only.

S-metolachlor--0.64 to 1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in dry bulb onions in New Jersey, Pennsylvania, and Virginia, and in green onions in New Jersey. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.67 to 1.33 pints per acre after the onions have reached the two true leaf stage of growth. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. On soils with an organic matter content greater than 5 percent, one additional treatment may be applied 3 to 4 weeks after the first treatment. Primarily controls annual grass and certain broadleaf weeds, including galinsoga preemergence. Use other methods to control emerged weeds prior to application. Observe a 60-day preharvest interval. DO NOT exceed a total of 2.65 pints per acre per season. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.** For use on dry bulb onions only.

Oxyfluorfen--0.025 to 0.060 lb/A. Apply 1.6 to 3.2 fluid ounces per acre Goal 2XL or 1.0 to 2.0 fluid ounces of GoalTender 4F postemergence when onions have a minimum of three true leaves to control seedling broadleaf weeds with four true leaves or less. Repeat the application but do not exceed a total of 0.5 pound per acre (32 fluid ounces per acre of Goal 2XL or 16.0 fluid ounces of GoalTender) and do not apply within 60 days of harvest.

Goal may cause injury to onion foliage. The injury will appear as necrotic spots on leaves and/or twisted leaves. Heed the following precautions to avoid or minimize injury: Use flat fan nozzles, 20 to 40 psi and 20.0 to 40.0 gallons of water per acre. DO NOT tank-mix with any other pesticide. DO NOT use surfactant, oil concentrates, or any other additive. DO NOT apply during extended periods of cool, wet, cloudy weather. DO NOT exceed 0.05 pound per acre (3.2 fluid ounces) per application. DO NOT apply to onions with less than three true leaves (do not count the flag leaf).

Bromoxynil--0.125 to 0.188 lb/A. Apply 4.0 to 6.0 fluid ounces Buctril 4EC to dry bulb onions with a minimum of 3 true leaves (do not count the flag leaf) to suppress or control many seedling broadleaf weeds with 4 true leaves or less in 50.0 to 70.0 gallons of water per acre. Water volume is important. Concentrated spray solutions kill onions. Repeat applications can be made, but do not apply more than 12.0 fluid ounces in a single growing season. Buctril may cause injury to onions. The injury will appear as necrotic spots on the leaves. To minimize the risk of injury, heed the following warnings. DO NOT tank-mix with any other pesticides or apply within 3 days of any other pesticide. DO NOT add surfactants, oil concentrates, or other additives. DO NOT treat onions injured by sand, insects, or disease. DO NOT treat onions growing during periods of cloudy weather with high humidity or other low light intensity conditions that could result in "soft" foliage with a thinner-than-normal waxy layer on the leaf surface. DO NOT treat onions with less than 3 true leaves. DO NOT count the flag leaf.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3.0 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Onion Maggot

Continuous planting of onions on the same ground will increase onion maggot problems. Flies migrate up to one-half mile. Rotation is extremely important to reduce onion maggot damage. Avoid mechanical injury to bulbs in the field or during harvesting. Damaged plants encourage maggot infestation. Bury cull piles.

Seed Treatment

Onion seed commercially-treated with cyromazine (Trigard ST) is available (pelleted). Growers must purchase seed treated by seed company.

Preplant
diazinon--2.0 to 4.0 qts/A Diazinon AG 500 (or OLF) preplant or in-furrow broadcast just before planting and mix into the top 3-4 inches of soil

Postplant Soil Drench
chlorpyrifos **(dry bulb only)--**1.0 qt/A Lorsban Advanced (or OLF)

Postplanting Spray Treatment
First-brood adult flies first appear in early to mid-May. Second brood occurs in July, and third brood occurs in August to September. The fall maggots are most important, because maggots may end up in stored onions, causing onion rot.

Crushed onions or culls attract onion maggot flies. Rotate fields if possible and eliminate culls. Foliar applications of insecticides are not likely to control maggot flies. Flies spend most of their time outside onion fields and must be contacted with the insecticide during application for control to occur. If a spray is applied, apply directly over the row. Soak soil around base of seedlings. Apply one of the following formulations:

Note: Permethrin also has a repellent effect.

gamma-cyhalothrin **(bulb only)--**1.92 to 3.20 fl oz/A Proaxis
malathion--2.5 pts/A Malathion 57EC (or OLF)
permethrin--4.0 to 12.0 fl oz/A Perm UP 3.2EC (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

Cutworms

(Also see "Cutworms" section in Soil Pests--Their Detection and Control.)

Apply one of the following formulations:
gamma-cyhalothrin **(bulb only)--**1.92 to 3.20 fl oz/A Proaxis
lambda-cyhalothrin **(bulb only)--**0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
methomyl--3.0 pts/A Lannate LV (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

Leafminers

Apply one of the following formulations:

cyromazine--2.66 oz/A Trigard 75WP
dinotefuran--5.25 to 7.00 fl oz/A **foliar** Scorpion 35SL or 3.0 to 4.0 fl oz/A **foliar** Venom 70 SG or 8.75 to 10.50 fl oz/A **soil** Scorpion 35SL or 5.0 to 6.0 fl oz/A **soil** Venom 70SG
spinosad--3.0-6.0 fl oz/A Entrust SC
spinetoram--6.0 to 10.0 fl oz/A Radiant SC

Thrips

Frequently, thrips populations increase following adjacent alfalfa or grain harvest. Apply one of the following formulations:

abamectin--1.75 to 3.5 fl oz/A Agri-Mek SC (or OLF)
dinotefuran--5.25 to 7.00 fl oz/A **foliar** Scorpion 35SL or 3.0 to 4.0 fl oz/A **foliar** Venom 70 SG or 8.75-10.50 fl oz/A **soil** Scorpion 35SL or 5.0 to 6.0 fl oz/A **soil** Venom 70SG
lambda-cyhalothrin **(bulb only)--**1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
methomyl--3.0 pts/A Lannate LV (or OLF)
permethrin--6.0 to 12.0 oz/A Perm-UP 3.2 EC (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
zeta-cypermethrin--2.88 to 4.00 fl oz/A Mustang Maxx (or OLF)

Note: use of spinosad for leafminer control will suppress thrips population.

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE			
abamectin	R	12	30
acetamiprid	G	12	7
chlorpyrifos	R	24	AP
cyromazine	G	12	60(AP) 7(foliar)
diazinon	R	72	60(AP)
dinotefuran	G	12	1
gamma-cyhalothrin	R	24	14
lambda-cyhalothrin	R	24	14
malathion	G	12	3
methomyl	R	48	7
permethrin	R	12	1
spinetoram	G	4	1
spinosad	G	4	1
zeta-cypermethrin	R	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	7
chlorothalonil, dry onions (Group M5)	G	12	7
copper, fixed (group M1)	G	24	0
Endura (Group 7)	G	12	7
iprodione (Group 2)	G	24	7
Inspire Super (Groups 3+9)	G	12	7
mancozeb (Group M3)	G	24	7
Omega (Group 29)	G	48	7
Pristine (Groups 11 + 7)	G	12	7
Quadris (Group 11)	G	4	0
Quadris Opti (Groups 11 + M5) (dry bulb)	G	12	7
Quilt (Group 3 + 11)	G	12	14
Quilt Xcel (Group 3 + 11)	G	12	14
Reason (Group 11)	G	12	7
Ridomil Gold (Group 4)	G	48	7
Scala (Group 9)	G	12	7
Switch (Groups 9 + 12)	G	12	7
tebuconazole (Group 3)	G	12	7
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.

1 G = general, R = restricted, AP = At planting

2 Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

3 AP = At planting

Disease Control

Seed Treatment

Buy commercial fungicide treated seed, if available. Multiple fungicides are often needed to manage the diversity of soilborne fungi that cause seed decay. Check with your seed company to determine what seed treatment technology is available.

Damping-Off

mefenoxam--Ridomil Gold at 0.5 to 1.0 pt 4SL/A applied as a broadcast or banded immediately after seeding the field

Uniform--0.34 fl oz 3.66SE/1000 ft of row in-furrow (see label for specific details) or apply 4.5 fl oz/A to the bed during shaping for transplanted onions for *Pythium* and/or *Rhizoctonia*.

Downy Mildew (*Peronospora destuctor*)

The pathogen can survive as oospores in the soil, or on bulbs, sets and seed. Downy mildew development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field. Apply one of the following fungicides accordingly and rotate between different FRAC codes:

mancozeb--3.0 lb 75DF/A or OLF, applied at 7-day intervals, or alternate with the following products if downy mildew has been observed in the field or region:

Quadris--9.0 to 15.5 fl oz 2.08F/A
Quadris Opti--2.4 to 3.6 pt 5.5SC/A, (dry bulb)
Cabrio--12.0 oz 20EG/A
Pristine--18.5 oz 38WG/A (suppression only)
Reason--5.5 fl oz 500 SC/A
Quilt Xcel--14.0 to 21.0 fl oz 2.2SE/A

Purple Blotch (*Alternaria porri*)

The pathogen overwinters in plant residue from onion-related plants. Purple blotch development is promoted by warm, moist conditions. Grow onions in well drained soil and rotate with non-related crops. Sweet Spanish types are especially susceptible to purple blotch.

Several of the most effective fungicides are listed below. Applications may be needed every 7 days for proper control. Rotate fungicides in different FRAC codes to slow the development of fungicide resistance (**NOTE:** iprodione applied at the high rate, and Pristine are labeled for use at 14-day intervals) Apply one of the following formulations:

Pristine--10.5 to 18.5 oz 38W/A at 14-day intervals (also will provide suppression of downy mildew)
Quadris--6.0 to 12.0 fl oz 2.08F/A
Quadris Opti--1.6 to 3.2 pt 5.5SC/A
Omega--1.0 pt 500F/A
iprodione (Rovral)--1.5 pt 4F/A or OLF
chlorothalonil--1.0 to 3.0 pt 6F/A or OLF
mancozeb--3.0 lb 75DF/A or OLF
Endura--6.8 oz 70WG/A
Reason--5.5 fl oz 500SC/A
Quilt--14.0 to 27.5 fl oz 1.66F/A
Quilt Xcel--14.0 to 21.0 fl oz 2.2SE/A

Botrytis Leaf Blight

The pathogen overwinters in cull piles, on onion debris in the soil, and as sclerotia where related crops were recently grown. Botrytis leaf blight is promoted by moist, cool to mild conditions. Eliminate sources of inoculum and rotate 2 or 3 years between onion-related crops. Fungicide applications can be delayed until there is an average of 1 lesion on 10 leaves.

Apply and alternate between one of the following:

iprodione (Rovral)--1.5 pt 4F/A or OLF at 14-day intervals (for dry bulb onions only)
Switch--11.0 to 14.0 oz 62.5WG/A
chlorothalonil--1.0 to 3.0 pt 6F/A or OLF
Quadris--9.0 to 15.5 fl oz 2.08F/A
Quadris Opti--1.6 to 3.2 pt 5.5SC/A,
Inspire Super--16.0 to 20.0 fl oz 2.82EC/A
Endura--6.8 oz 70WG/A
Pristine--14.5 to 18.5 oz 38WG/A
Scala--9.0 oz SC/A + mancozeb--3.0 lb/A + chlorothalonil--1.5 pt/A (also effective against purple blotch).
Quilt Xcel--14.0 to 21.0 fl oz 2.2SE/A

Always alternate between materials from different FRAC codes to reduce chances for fungicide resistance development.

Stemphylium Leaf Blight

Apply one of the following formulations:

Pristine--10.5 to 18.5 oz 38WG/A (will offer suppression to downy mildew at the higher rate),
Cabrio--8.0 to 12.0 oz 20EG/A (will offer suppression to botrytis leaf blight at the higher rate),
Switch--11.0 to 14.0 oz 62.5 WG/A,
iprodione (Rovral)--1.5 pt 4F/A or OLF

White Rot (*Sclerotium cepivorum*)

White rot is most limiting in cool, moist soils and most severe on overwintered onions. The sclerotia can be long lived (over 20 years) in the soil in the absence of an Allium host. White rot development is very dependant on soil temperatures with the optimum temperatures being between 60° and 65°F. Apply one of the following formulations:

Apply tebuconazole--20.5 oz 3.6F/A or OLF in a 4 to 6 inch band over or into the furrow at planting or may also be applied by chemigation. Two additional foliar applications 4.0-6.0 fl oz/A may also be applied (dry bulb onion only).

Bacterial diseases (Soft rot, Slippery Skin, Sour Skin and Center Rot)

Plant seed and transplants that are pathogen free. Rotate to a non-host for 2 or more years and eliminate volunteer onions and weeds. Avoid overhead irrigation especially with water that may be contaminated with pathogen(s). Minimize injury to maturing or harvested bulbs. Dry mature bulbs as soon as possible after harvest.

Initiate a preventative fixed copper tank mixed with mancozeb program when conditions become favorable for bacterial diseases, typically warm and wet weather. Not all copper-based products are created equal and vary by copper content as well as active ingredient(s) (see Table E-13 for a list of available fixed-copper products and check label for rates).

Botrytis Neck Rot

Infection is favored by cool, wet conditions and poor drying and curing of onions at harvest and often develops on injured bulbs in storage. Minimize nitrogen late in the season to promote drying of the necks at harvest. Windrow plants to ensure dry tops before topping operation.

iprodione (Rovral)--1.5 pt 4F/A or OLF at 14-day intervals (for dry bulb onions only)

Black Mold (*Aspergillus niger*)

This fungus is common in the soil and crop residue and affects a large number of vegetables. Manage by promptly and adequately drying bulbs after harvest. Heated air favors disease development. Storing bulbs at low temperature and humidity with help manage black mold if cured properly when harvested.

PARSLEY

Varieties

Flat Leaf	Curly Leaf
Giant of Italy	Banquet (Overwintering)
Italian Flat Leaf	Champion Moss
Italian Plain Leaf	Darki
	Forest Green (Semi-curled)
	Krausa
	Lisette
	Moss Curled II
	Titan

Varieties listed alphabetically. All varieties are open pollinated

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Parsley	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	150-175	200	150	100	0	200	150	100	0	Total nutrient recommended.
	50-75	200	150	100	0	200	150	100	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress after first cutting.
	25-50	0	0	0	0	0	0	0	0	Sidedress after each additional cutting.

Seeding and Spacing

Seed is sown 1/3 inch deep in a well-prepared seedbed beginning April 5. Later plantings can be seeded through July 10. Spacing between rows is 15 to 18 inches. Usual seeding rate is 20 to 40 pounds per acre. with plants spaced 4 to 8 inches apart in each row. Seed is slow to germinate. If seed is more than 1 year old, have germination checked and adjust seeding rate accordingly.

Harvest and Post Harvest Considerations

Parsley may be harvested by cutting a few leaves at a time from each plant, or the entire bunch of leaves may be removed for sale. Although parsley leaves are used most commonly in the fresh green condition, their characteristic flavor and green color can be retained if the leaves are dehydrated for dried herb markets. Store fresh parsley at 32°F and 95 to 100% relative humidity. Parsley should keep 2 to 2.5 months at 32°F. High humidity is essential to prevent desiccation. Packaging in perforated polyethylene bags and using top ice are often beneficial. A controlled atmosphere of 10 % oxygen and 11 % carbon dioxide can help retain green color and salability.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in parsley.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Preemergence

Linuron--0.5 to 1.0 lb/A. Apply 1.0 to 2.0 pounds per acre Lorox 50DF or 1.0 to 2.0 pints Lorox 4L immediately after seeding. Follow with irrigation if rainfall does not occur. Primarily controls broadleaf weeds. Annual grasses may only be suppressed

Prometryn--0.5 lb/A. Apply 1.0 pint per acre Caporol 4L after seeding, but before crop emergence. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. Additional postermergence and postharvest treatments may be applied, but DO NOT exceed 3 pints per acre per crop cycle. DO NOT use on sand or loamy sand soils, or crop injury may occur.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Prometryn--0.5 lb/A. Apply 1 pint per acre Caporol 4L after the crop has developed 3 true leaves. Primarily controls seedling annual broadleaf weeds less than two inches tall. Annual grasses may only be suppressed. An additional treatment can be applied to regrowth after the first harvest, but do NOT exceed 3 pints per acre per crop cycle. Do NOT use on sand or loamy sand soils, or crop injury may occur. Do NOT tank-mix Caporol with any other pesticide. Do NOT use spray additives such as nonionic surfactant or oil concentrate. Do NOT apply within two weeks of any herbicidal oil such as “carrot oil” or Stoddard Solvent. Observe a minimum preharvest interval of 40 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more **than 3.0 pints per acre in one season.** Labeled for use in Parsley and Cilantro.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids

Apply one of the following formulations:
acetamiprid--2.0 to 4.0 oz/A Assail 30G (or OLF)
azadirachtin--1.0 to 2.0 pts/A Aza-Direct (Azatin or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
malathion--1.0 to 2.0 pts/A Malathion 57EC (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WP
spirotetramat--4.0 to 5.0 fl oz/A Movento
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Armyworms

Apply one of the following formulations:
Bacillus thuringiensis--1.0 to 2.0 lbs/A Dipel DF (or OLF)
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
imidacloprid + beta-cyfluthrin--3.0 fl oz/A Leverage 360
indoxacarb--3.5 to 6.0 oz/A Avaunt 30WDG
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F (early season); 8.0 to 10.0 fl oz/A Intrepid 2F (mid to late season)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)

Flea Beetles, Leafhoppers, Tarnished Plant Bugs

Apply one of the following formulations:

beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
carbaryl--**(FB,LH)** 0.5 to 1.0 qt/A, **(TPB)** 1 to 2 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
dinotefuran--**(FB, LH) soil** 5.0 to 6.0 oz/A, **foliar** 1.0 to 3.0 oz/A Venom 70SG, or, **soil** 9.0 to 10.5 fl oz/A, **foliar** 2.0 to 5.25 fl oz/A Scorpion 35SL (or OLF)
flonicamid--**(TPB only)** 2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil (LH only)** 4.4 to 10.5 fl oz/A Admire Pro (or OLF); **foliar (FB, LH only)--**1.3 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin—**(FB, LH)** 3.0 fl oz/A Leverage 360
permethrin--**(LH only)** 2.0 to 8.0 fl oz/A Perm-Up 3.2 (or OLF)
thiamethoxam--**(FB, LH) soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

zeta-cypermethrin--**(FB, LH)** 2.4 to 4.0 fl oz, **(TPB)** 3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
azadirachtin	G	4	0
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
carbaryl	G	12	14
clothianidin	G	12	21
cyfluthrin	R	12	0
dinotefuran (soil/foliar)	G	12	21/7
emamectin benzoate	R	12	7
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide+buprofezin	G	12	7
imidacloprid (soil/foliar)	G	12	21/7
imidacloprid + beta-cyfluthin	R	12	7
indoxacarb	G	12	3
malathion	G	24	7
methoxyfenozide	G	4	1
permethrin	R	12	1
pymetrozine	G	12	7
spinetoram	G	4	1
spinosad	G	4	1
spirotetromat	G	24	3
sulfloxafor	G	12	3
thiamethoxam (drip/foliar)	G	12	7
zeta-cypermethrin	R	24	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
copper, fixed (Group M1)	G	24	0
Fontelis (Group 7)	G	12	3
MetaStar (Group 4)	G	48	45
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	21
Tilt (Group3)	G	12	14
Ultra Flourish (Group 4)	G	48	--
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.

[1] G = general, R - restricted

Nematode Control

Nematode control is essential for satisfactory parsley production. See Chapter E "Nematodes" section of Soil Pests-Their Detection and Control. Before planting, soil should be fumigated with metam-sodium (Busan or Vapam HL) according to directions in the "Soil Fumigation" section.

Disease Control

Seed Treatment

See Table E-14 for seed treatment options.

Damping-off

Apply one of the following as a soil surface spray immediately after seeding:

mefenoxam (Ridomil Gold 4SL/A--1.0 to 2.0 pt or 2.0 to 4.0 pt Ultra Flourish 2E/A)

metalaxyl (MetaStar)--4.0 to 8.0 pt 2E/A

Uniform--0.34 fl. oz 3.66SE/1000 row. See label for restrictions

Bacterial leaf blight and Septoria leaf spot

To help reduce disease pressure from bacterial and fungal diseases, do not plant parsley continually in the same field. Rotate with non-related crops for at least 2 years. Space successive plantings in the same year as far apart as possible. Heavy winds and rain may damage leaves and predispose leaves to bacterial infections.

Bacterial leaf blight: Prevention is key to reducing spread of the pathogen. Avoid working in the fields while the foliage is wet to help reduce spread. Scout fields on a regular basis for early symptoms, apply the following and repeat every 7 days:

fixed copper at labeled rates.

Tank-mixing a fixed copper with Quadris will also help control Septoria leaf spot.

Septoria leaf spot: The disease has caused serious problems in past years. Severe losses will occur if not controlled properly, especially if field or farm has a history of the disease. Grow parsley in areas of farm without history of disease. Plant blocks as far part as possible. **Early detection and prevention is key to controlling septoria leaf spot.** Scout daily, and apply fungicides preventatively, (before first leaf spots appear), tank-mix or rotate the following every 7 days. Early season infections (i.e., prior to first cutting) will severely reduce subsequent harvests.

Rotate the following every 7 days prior to the onset of the disease

Tilt--3.0 to 4.0 fl oz 3.6F/A plus fixed copper at labeled rates (do not apply Tilt within 14 days of harvest)

Fontelis--14.0 to 24.0 fl oz 1.67SC/A

with one of the following FRAC code 11 fungicides:

Quadris--6.0 to 15.5 fl oz 2.08F/A *plus* fixed copper at labeled rates

Cabrio--12.0 to 16.0 oz 20WG/A fixed copper at labeled rates

Note: Do not make more than 2 applications of Tilt, Cabrio, or Quadris per growing season. Applications of Tilt, Cabrio and/or Quadris will also help control other leaf spots.

Tank-mixing Tilt, Cabrio, Fontelis, or Quadris with a fixed copper may also help reduce bacterial infections.

PARSNIPS

Varieties[1]

All America
Harris Model
Javelin*

Varieties listed alphabetically. * Denotes hybrid variety

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Parsnips	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	50-75	150	100	50	0	150	100	50	0	Total nutrient recommended.
	25-50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seeding and Spacing

Seed in March and April. The seeds germinate slowly. Never use seed that is more than 1 year old.

Seed 3 to 5 pounds per acre at a depth of 1/4 to 3/8 inch in rows 18 to 30 inches apart. Adjust seeder to give 8 to 10 plants per foot of row. Thin seedlings to 2 to 4 inches in the row.

Harvest and Postharvest Considerations

Parsnips may be dug, topped, and stored at 32°F and 90 to 95 percent relative humidity. They can be stored for up to 6 months. Storage conditions for parsnips are similar to those for carrots. Good market quality is the result of starch changing to sugar which occurs after 2 to 3 weeks in storage below 35°F. It is not necessary to leave parsnips out over winter or to freeze them to achieve acceptable quality. Because parsnips are susceptible to wilting, storage humidity must be kept high. Ventilated plastic crate liners help to prevent moisture loss. Parsnips left in the ground over winter should be removed before growth starts in the spring and flower stalk formation begins.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preemergence

Linuron--0.75 to 1.5 lb/A. Apply 1.5 to 3.0 pounds per acre Lorox 50DF or 1.5 to 3.0 pints per acre of Lorox 4L right after seeding. Plant seed at least ½ inch deep.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2..0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids

Apply one of the following formulations:

azadirachtin--15.0 to 30.0 oz/A Ecozin Plus (or OLF)
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)
malathion--1.0 to 2.0 pts/A Malathion 57EC (or OLF)
sulfoxaflor--0.75 to 1.50 oz/A Transform WG
thiamethoxam--**soil** 1.7 to 4.0 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Leafhoppers

Apply one of the following formulations:
carbaryl--0.5 to 1.0 qt/A Sevin Plus XLR (or OLF)
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)
sulfoxaflor--1.50 to 2.75 oz/A Transform WG
thiamethoxam--**soil** 1.7 to 4.0 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Pesticide	Use **Category**[1]	Hours to **Reentry**[2]	Days to **Harvest**
INSECTICIDE			
azadirachtin	G	4	0
carbaryl	G	12	7
imidacloprid (soil/foliar)	G	12	21/7
malathion	G	24	7
sulfoxaflor	R	24	7
thiamethoxam (drip/foliar)	G	12	7
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	10
Quadris (Group 11)	G	12	0
Ridomil Gold (Group 4)	G	48	0

See Table D-6.
[1] G = general, R = restricted
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off (*Pythium* and *Phytophthora*)

Apply the following preplant incorporated or as a soil-surface spray after planting:

Ridomil Gold--1.0 to 2.0 pt 4SL/A

Leaf Spots, (*Alternaria* and *Cercospora*), Rhizoctonia Stem Canker and Powdery Mildew

Rotate fields to allow at least 2 years between parsnip plantings. Always plant in well-drained soils with a pH of 7.0. Ridge soil over shoulders to prevent pathogen infection. Begin sprays at the first sign of disease and repeat no more than three times at 10-day intervals.

Rotate or tank-mix:
chlorothalonil--1.5 to 2.0 pt 6F/A or OLF

With one of the following FRAC code 11 fungicides:
Quadris--9.0 to 15.5 fl oz 2.08F/A, or
Cabrio--8.0 to 12.0 oz 20EG/A

Do not make more than one consecutive application of Quadris or Cabrio.

PEAS

Peas thrive in cool weather and tolerate frost. Planting for processing is based on the heat-unit theory. First plantings can be made as soon as soil can be tilled in the spring. Do not attempt plantings after April 30. Inoculation of seed enhances early nodule formation.

Varieties

Processing*	**Edible Pod: Flat**
Icebreaker	Dwarf Gray Sugar (FR)
Icepack	Oregon Sugar Pod #2
Cabree	
Early Freezer 680	**Edible Pod: Round**
Bolero	Sugar Ann
Ashton	Sugar Snap (trellis type)(FR)
	Super Sugar Snap (trellis type)
Market	
Progress No. 9	
Knight	
Bolera	
Lincoln	
Green Arrow	
Mr. Big	

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

***Use varieties recommended by processors. Local adaptation and quality needs of processors must be considered. Consult the Delaware Extension Program website for results from recent processing pea variety trials: ag.udel.edu/extension/vegprogram/index.htm**

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Peas	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	40-80	120	80	40	0[1]	120	80	40	0[1]	Total nutrient recommended.
	40-80	120	80	40	0[1]	120	80	40	0[1]	Broadcast and disk-in.

[1]In Virginia, crop replacement values of 20 lbs. P_2O_5 and 20 lbs. K_2O per acre are recommended on soils testing Very High.

Seed Treatment

Use seed already treated with an approved seed treatment, or treat seed with a slurry or dust that contains an approved commercial fungicide-insecticide mixture. See the Disease Control section for more information.

Seeding and Spacing

Peas can be planted between February 25 and April 30 when soil conditions are favorable. For processing peas, drill 250 to 275 pounds of seed per acre in rows 6 to 8 inches apart. For market peas, seed 80 to 120 pounds per acre in 30-inch rows. Seed at a depth of no more than 1 inch unless soil is dry. Use press wheel drill or seeder to firm seed into soil.

Harvest and Post Harvest Considerations

Processing peas are mature starting from between May 20 and through July 5. Pick shelling types while they are firm, but still succulent. Harvest snow peas before seed swelling becomes too pronounced. Crisp fleshy snap types should be picked when they are round and firm, but still succulent. Peas in pod, shelled peas, and edible pod peas lose part of their sugar content, on which much of their flavor depends, unless they are promptly cooled to near 32°F and maintained at a relative humidity of 90-95%, after picking. Forced air cooling, using 32°F air at 90-95% humidity, is the preferred method of cooling since it does not result in surface moisture, and minimizes the risk of decay. After precooling, the peas should be packed with crushed ice (top ice) to maintain freshness and turgidity. Top ice provides the required high humidity (≥95%) to prevent wilting.or shriveling. The ideal storage temperature at 32°F and temperatures must not be allowed to go over 34°F when any surface moisture is present on the peas or rapid decay and deterioration will occur. Edible pod peas, peas in pod, and shelled peas cannot be expected to be salable for more than 1 to 2 weeks even at 32°F unless packed in crushed ice. With top ice, the storage period may be extended a week.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated or Preemergence

Imazethapyr--0.024 to 0.032 lb/A. Apply 1.5 to 2.0 fluid ounces per acre Pursuit 2SC. Shallow, thorough incorporation improves consistency of performance when dry weather follows application. Primarily controls broadleaf weeds. Use in combination with another herbicide to control annual grasses. Pursuit residues persist in the soil after harvest and may affect following crops. Incorporation may increase the persistence of soil residues. Do not make more than one application of Pursuit per acre per year. Follow label instructions pertaining to following crops.

Preemergence

Clomazone--0.188 to 0.380 lb/A**.** Apply 8.0 to 16.0 fluid ounces Command 3ME preemergence to control annual grasses and many annual broadleaf weeds, except pigweed sp. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. DO NOT apply when wind or weather conditions favor spray drift. Avoid preemergence applications when fields are adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from off-site Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in peas. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command has been used for weed control in peas.

S-metolachlor--0.48 to 0.96 lb/A. Apply 0.5 to 1.0 pints per acre Dual Magnum 7.64E (or OLF). Primarily controls annual grasses, suppresses yellow nutsedge, and suppresses or controls certain annual broadleaf weeds including pigweed species and nightshade species. Common lambsquarters and common ragweed will NOT be controlled. Recommended rates may be lower than the labeled rate to reduce the risk of crop injury. The use of less than 1 pint of Dual Magnum may reduce the duration or level of control of some weeds.

Cold wet weather after application increases the risk of crop injury, which may delay maturity. Use the minimum recommended rate, or choose another herbicide when cold wet weather is anticipated after planting. DO NOT use Dual Magnum on peas in Nassau County or Suffolk County, New York. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Bentazon--0.75 to 1.0 lb/A. Apply 1.5 to 2.0 pints per acre Basagran 4SC after peas have more than three pairs of leaves. Do not add oil concentrate. Ground application in a minimum of 20 gallons per acre is preferred. For broadleaf weed control only. See label for weed size for effective control.

Clethodim--0.094 to 0.125 lb/A. Apply 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 21 days.

Quizalofop-P-ethyl--0.04 to 0.08 lb/A. Apply 6.0 to 12.0 fluid ounces Assure II/Targa 0.88EC per acre postemergence to control most annual and perennial grasses. Add with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with other pesticides unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 14 fluid ounces per acre in one season.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within one week before or after Basagran or any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 4 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Maggots

Seed Applied Treatments:

chlorpyrifos Lorsban ST ***commercially applied seed treatment only***

thiamethoxam (Cruiser 5FS) ***commercially applied seed treatment only***

Cutworms

See the Chapter E "Cutworms" section in Soil Pests--Their Detection and Control.

Apply one of the following formulations:

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF)

diazinon--2.0 to 4 .0 qts/A Diazinon AG500 (or OLF)

NOTE: Must be broadcast just before planting and immediately incorporated into the soil

esfenvalerate--5.8 to 9.6 fl oz/A Asana XL

flubendiamide--2.0-3.0 fl oz/A Belt SC

lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)

lambda-cyhalothrin + chlorantraniliprole--5.0 to 8.0 fl oz/A Besiege

zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)

zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pea Aphid

Treat when there are 5 to 10 aphids per plant or 50 or more aphids per sweep in a 15-inch sweep net. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)

dimethoate--0.32 pt/A Dimethoate 400 4EC (or OLF) **Not for Use On Field Peas**

esfenvalerate--2.9 to 5.8 fl oz/A Asana XL

imidacloprid--**soil** 7.0 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)

methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)

Armyworms and Other Caterpillars

Apply one of the following formulations:

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF)

chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 2SC
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin + chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
spinetoram--4.0 to 8.0 fl oz/A Radiant SC
spinosad--2.2 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin--2.72 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
bifenthrin	R	12	3
chlorantraniliprole	G	4	1
diazinon	R	72	see label
dimethoate	R	48	see label
esfenvalerate	R	12	3
flubendiamide	G	12	1
imidacloprid (soil/foliar)	G	12	21/7
lambda-cyhalothrin	R	24	7
lambda-cyhalothrin+ chlorantraniliprole	R	24	7
methomyl	R	48	see label
spinetoram	G	4	3
spinosad	G	4	3
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
Contans WG (biological)	G	4	0
Endura (Group 7)	G	12	7
Headline (Group 11)	G	12	7
MetaStar	G	48	--
Quadris (Group 11)	G	4	0
sulfur (Group M2)	G	24	--
Ridomil Gold (Group 4)	G	48	--
Ultra Flourish (Group 4)	G	48	--
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.
[1] G = general, R = restricted, AP = At planting

Disease Control

Seed Treatment

Use seed already treated with an approved seed treatment, or treat seed with a slurry or dust that contains an approved commercial fungicide-insecticide mixture. For disease control, use seed treated with Maxim 4FS (0.08 to 0.16 fl oz/100 lb seed) for *Rhizoctonia* and *Fusarium* control and Apron XL LS (0.16 to 0.64 fl oz/100 lb seed) or Allegiance (0.75 fl oz/100 lb) for Pythium control.

Damping-Off and Root Rot

Rotate and allow 4 to 5 years between pea plantings. Do not double crop with legume of any type. For damping-off and root rot caused by *Pythium*, apply the following as a broadcast treatment at seeding:

Ridomil Gold--0.5 to 1.0 pt 4SL/A (*Pythium* only)
MetaStar--2.0 to 4.0 pt 2E/A (*Pythium* only)
Ultra Flourish--1.0 to 2.0 pt 4E/A (*Pythium* only)
Quadris--0.40 to 0.80 fl oz 2.08F/1000 ft row (*Rhizoctonia*)
Uniform--0.34 fl oz 3.66SE/1000 ft of row in-furrow (see label for specific details) for *Pythium* and/or *Rhizoctonia*

Downy Mildew (*Peronospora viciae*)

Plant resistant varieties. Avoid planting next to the previous year's pea fields because the disease can overwinter on old debris. Downy mildew is seed-borne and using seed treatments that are effective for downy mildew such as Allegiance FL or Apron XL can prevent primary systemic infections. Downy mildew development is favored by prolonged cool, wet weather conditions. Control strategies include crop rotations of 3 years or more.

White Mold

Preplant. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding peas to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer:

Contans--2.0 to 4.0 lb 5.3WG/A

At the beginning of flowering or prior to onset of disease apply:

Endura--8.0 to 11.0 oz 70W/A (7 to 10 day interval, no more than 2 applications per growing season).

Fusarium Wilt

Use resistant varieties if available. Plant as early possible minimize crop growth when soil temperatures are ideal for Fusarium wilt development (68 to 72°F).

Viruses

Use resistant varieties when possible and control aphids.

Bacterial Blight

Plant bacteria-free seed. Avoid walking through fields when vines are wet.

Ascochyta Blight

Ascochyta blight is favored by long periods of leaf wetness and heavy growth of vines that creates a moist chamber effect under the pea vine canopy. Plant fungicide treated seed. Deeply incorporate crop debris immediately after harvest before the fungus can be dispersed by wind or rain. Scout on a regular basis because pathogen can develop and spread rapidly. In fields with a history of blight apply one of the following fungicides preventatively:

Quadris--6.0 to 15.5 fl oz 2.08F/A
Headline--6.0 to 9.0 fl oz 2.1EC/A
Endura--8.0 to 11.0 oz 70W/A

Powdery Mildew

Powdery mildew is favored by warm, dry days and cool nights that lead to dew formation. Disease severity is usually highest in late summer therefore fall plantings are most susceptible. If available, plant resistant or less susceptible cultivars. At first appearance of disease, apply:

sulfur--3.0 to 10.0 lb/A

PEPPERS

Varieties[1]

Bell Types	Sweet Frying Types
Redstart*	Key Largo*
Red Knight* (BLSR 1,2,3, PVY)	Aruba* (PT)
Aristotle*(PT,BLSR 1,2,3, TMV, PVY)	X3R Key West* (BLSR 1,2,3)
Early Excursion*(TMV, PVY, BLSR 1,2,3)	Biscayne*
Karisma* (BLSR, 1-3, TMV,PMV, PVY)	Cubanelle
Paladin* (PR, TMV)	
Red Bull* (BLSR 1,2,3)	**Hot Types**
Revolution* (PT, BLSR,1,2,3,5, CMV)	NuMex Joe E. Parker
PS0994-1819* (PT, BLSR 1,2,3,4,5)	Hungarian Wax (yellow)
Tomcat* (BLSR 1-5, TMV)	Super Chili*
Intruder*(BLSR 1,2,3, PT, TEV, TMV)	Cayenne Long Slim
Delerio* (orange color, TSWV)	Mesilla*
Mecate* (Yellow color, BLSR 1,2,3, TMV, PMV)	Cheyenne*
Declaration* (BLSR 1,2,3,5, PT, CMV, TSWV)	Mitla*
Archimedes* (BLSR 1,2,3, PT, TMV)	Ixtapa*
Summer Sweet #209 (TMV, PVY, BLSR 1,2,3)	El Jefe* (BLSR 1,2,3 , PVY)
Cherry Types	**Cheese and Pimento Types**
Cherry Bomb*(hot)	Lipstick
Large Red Cherry	

1 Varieties listed by maturity within each type, earliest first.

* Indicates hybrid variety.

Letters in parentheses indicate disease resistance possessed by varieties. . BLSR 1-5 = bacterial leaf spot resistant to races 1, 2, 3, 4 and/ 5; PT = *Phytophthora* tolerant; PR = *Phytophthora* resistant; PVY = potato virus Y; TEV = tobacco etch virus; TMV = tobacco mosaic virus; TSWV = tomato spotted wilt virus

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Peppers	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	100-180[1]	200	150	100	0[2]	200	150	100	0[2]	Total nutrient recommended.
	50	200	150	100	0[2]	200	150	100	0[2]	Broadcast and disk-in or follow fertigation schedule.
	50	0	0	0	0	0	0	0	0	Sidedress after first fruit set or follow fertigation schedule.
	25-30	0	0	0	0	0	0	0	0	Sidedress later in season if needed or follow fertigation schedule

Apply 1.0 pound of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

[1]If crop is mulched with plastic but not drip/trickle fertilized, broadcast 150 pounds of nitrogen (N) per acre with phosphorus and potassium fertilizer.

[2]In Virginia, crop replacement values of 50 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Suggested Fertigation Schedule for Coarse-Textured Soils - Pepper

Days After Planting	Daily Nitrogen[1]	Daily Potash[1,2]	Cumulative Nitrogen[1]	Cumulative Potash[1,2]
	----------------------lbs/A		---------------------	
Preplant[3]	---	---	50	100
0-14	0.5	0.5	57.0	107
15-28	0.7	0.7	66.8	116.8
29-42	1.0	1.0	80.8	130.8
43-56	1.5	1.5	101.8	151.8
57-98	1.8	1.8	177.4	227.4

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot centers. Adjust proportionally for other widths. See Fertigation in C-Irrigation Management for more information.

Suggested Fertigation Schedule for Fine-Textured Soils - Pepper

Days After Planting	By Days After Planting Period		Cumulative Amount Applied	
	Nitrogen (N)[1]	Potash (K_2O)[1,2]	N[1]	K_2O[1,2]
	lb/acre			
Preplant	-	-	72	52
0-14 (14 days)	2.5	2.5	74.5	54.5
15-28 (13 days)	4	4	78.5	58.5
29-42 (13 days)	5.5	5.5	84	64
43-56 (13 days)	8	8	92	72
57-98 (41 days)	28.5	28.5	120.5	100.5

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot centers. Adjust proportionally for other widths. See Fertigation in C-Irrigation Management for more information.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for peppers.

Critical peppertissue test values.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
Most recently matured leaves prior to blossom	**Deficient**	<4.0	0.3	5	0.9	0.35	0.3	<30	30	25	20	5
	Adequate range	4	0.3	5	0.9	0.35	0.3	30	30	25	20	5
		5	0.5	6	1.5	0.6	0.6	150	100	80	50	10
	High	>5.0	0.5	6	1.5	0.6	0.6	>150	100	80	50	10
	Toxic (>)	-	-	-	-	-	-	-	-	-	350	-
Most recently matured leaves at first flower	**Deficient**	<3.0	0.3	2.5	0.9	0.3	0.3	<30	30	25	20	5
	Adequate range	3	0.3	2.5	0.9	0.3	0.3	30	30	25	20	5
		5	0.5	5	1.5	0.5	0.6	150	100	80	50	10
	High	>5.0	0.5	5	1.5	0.5	0.6	>150	100	80	50	10
	Toxic (>)	-	-	-	-	-	-	-	1000	-	350	-
Most recently matured leaves at early fruit set	**Deficient**	<2.9	0.3	2.5	1	0.3	0.3	<30	30	25	20	5
	Adequate range	2.9	0.3	2.5	1	0.3	0.3	30	30	25	20	5
		4	0.4	4	1.5	0.4	0.4	150	100	80	50	10
	High	>4.0	0.4	4	1.5	0.4	0.4	>150	100	80	50	10
	Toxic (>)	-	-	-	-	-	-	-	-	-	350	-

Seed Treatment

Check with your seed company to determine if seed is hot water-treated. Purchase hot water treated seed if possible or request hot water seed treatment. See the Disease Section for more information to prevent disease.

Planting and Spacing

Pepper is a warm-season cop that grows best at temperatures of 70° to 75F (21.1° to 23.9°C). Peppers are sensitive to temperature extremes. Poor fruit set and blossom drop can be expected when night temperatures drop below 60°F (15.6°C) or day temperatures rise above 85°F (29.4°C). Transplant into the field May 1 to May 30 for summer harvest. In Virginia and warm areas, transplant July 25 to August 1 for fall harvest.Space rows 4 to 5 feet apart. Set plants 12 to 18 inches apart in the row. Select fields with good drainage. Plant on raised, beds to aid in disease management. To minimize sunscald when growing peppers on sandy soils and on plastic mulch without drip irrigation, plant varieties that have excellent fruit cover from foliage .

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 25-50% of N and K_2O requirements and thoroughly incorporate into the soil. Apply all P_2O_5 pre-plant and incorporate into the soil. Apply the balance of N and K_20 through the drip irrigation system throughout the season. In Pennsylvania, do not exceed 80 to 90 pounds of N per acre per season. On soils testing low and low to medium in boron, also include 0.25 pound of actual boron per fertilized- mulched acre in each soluble fertilizer application. **For convenience, rates of fertilizer an be converted from a mulched acre to linear foot basis. See Table C-8.**

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting peppers. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of 6 applications through the trickle irrigation system. The soluble fertilizer may be delivered in 12 equally timed applications through the growing season, provided the soluble nutrients are applied at half the above suggested rates per application so that the total seasonal rates of N, P_2O_5, and K_2O and B are the same. The number of fertilizer applications can be reduced for late plantings and in areas where the growing season is short. These rates were developed on sandy loam soils with a cation exchange capacity (CEC) of 3 to 5. If your soil has a lower CEC, you may wish to increase the total seasonal soluble fertilizer nutrient rates by at least one-third. On very coarse, very low CEC soils, it may be profitable to increase the total seasonal soluble fertilizer nutrient rates two-thirds over the first suggestion. On the heavier textured soils with higher CEC, you may wish to decrease the total seasonal soluble fertilizer nutrients by one-half.

Mulching

The use of black plastic mulch with drip irrigation and double rows can greatly increase yields and percentage of No. 1 sized (large) peppers. Use opaque, white plastic when planting in the summer for fall harvest. Plant on raised beds to aid in disease management. Plant double rows 12 to 15 inches apart with plants staggered 12 to 18 inches apart in each of the double rows. Use 5-foot wide plastic for double rows and 4-foot wide plastic for single row peppers. Do not use plastic mulch without trickle irrigation on sandy soils.

Staking

Staking peppers helps protect fruit from sunburn by holding the plants in an upright position. Use 2- to 2½-foot long by 1¼ x 1½-inch Honduran pine stakes (half length tomato stakes). Drive stakes 6 to 8 inches into the soil every 4 to 5 feet in the plant row. Tie plants with polyethylene string that is used for staked tomatoes. Tie the first string 7 to 9 inches above the soil when plants are 10 to 12 inches tall or at first fruit set. For single row peppers, run the string on one side of the row, looping and tightening string around each stake for about 100 feet. Then run the string back on the opposite side of the plant row using the same procedure. Allow 3- to 4-foot untied breaks every 100 feet to make harvesting easier. For double rows of peppers, use one row of stakes in each row of peppers. Tie each row separately as described above for single row peppers.

A second tie should be made at 6 to 8 inches above the first string and before peppers enlarge and fall over the first string. Use the same procedure described above. An alternate method for applying the second string in single and double rows is to run a single string in the center of the plant canopy of each row, allowing the branches to grow up through the string and be caught and supported by the string.

Consider the cost of staking versus reduction in losses and increases in quality and price received when making a decision about staking peppers. The higher price offered for red peppers increases the potential for profit when staking for the red compared to the green market.

Harvest and Post Harvest Considerations

Harvest green fruit once they have reached full size and the walls are firm. Harvest every 7 to 14 days to achieve maximum yields. Harvest colored peppers after they turn color. Colored (red, yellow, orange) pepper production requires two to four weeks of additional growing time. Increased attention to insects and diseases is required to produce mature, colored fruit. Harvest hot peppers after they reach full size and the walls are firm for green fruit and after they have turned color for colored fruit.

Peppers are picked by hand using a twisting, pulling motion with part of the stem (peduncle) and fruit cap (calyx) adhering to the fruit; branches of the plant are usually brittle and can break easily if pulled too hard. Hot peppers generally detach from the plant much more easily than sweet peppers and plants are less brittle.

Keep harvested peppers out of direct sunlight to avoid water loss, sun scald, and heat damage. Peppers can be brushed or washed after harvest. If peppers are washed in a dump tank, wash water temperature should be 0°-10°F warmer than the peppers. Cold water creates a partial vacuum that draws some water (and potentially bacteria) into the fruit, leading to premature breakdown. Chlorinated water or another labeled surface disinfectant should be used. Peppers can be cooled with room cooling, forced air cooling, forced air with evaporative cooling and vacuum cooling.

Optimal conditions for storing peppers are 45° - 50°F with relative humidity 85 - 90%. Chilling injury occurs at temperatures below 45°F, and damage may occur even below 50°F depending on variety and other factors. Bell peppers may be stored 2 to 3 weeks if handled properly. Dried hot peppers are stored at 32° to 38°F.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Transplants

S-metolachlor--0.63 to 0.95 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in peppers in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.67 to 1.00 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga,and certain other broadleaf weeds. Use as a surface-applied pretransplant spray before laying the plastic mulch, or as a directed basal spray after establishment. DO NOT preplant incorporate Dual Magnum. Make only one application during the growing season. DO NOT apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in transplanted bell peppers only in DE, NJ, and PA! Labeled for use in bell, chili, Cubanelle, and tabasco peppers in Delaware, Maryland, and New Jersey.**

Seeded and Transplants

Clomazone--0.25 to 0.50 lb/A. Apply 0.66 to 1.33 pints per acre Command 3ME pretransplant before laying plastic mulch. Use the lower rate on fields with coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops or a winter crop. Use higher rates on fields with fine-textured soils and those with high organic matter, or to improve control of certain weeds, including common cocklebur. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Combine with Devrinol or Dual Magnum (transplants only) to improve the control of carpetweed and pigweed sp. Labeled for use on all varieties including bell, hot, pimento, and sweet (except banana).

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used preplant incorporated for weed control in peppers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control in peppers.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds**. DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant (surface applied)

Transplants

Pendimethalin--0.48 to 1.42 lb/A. Apply 1.0 to 3.0 pints per acre Prowl H_2O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. **DO NOT apply "over the top" of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval). Labeled for use on bell pepper, chili pepper, cooking pepper, pimiento, and sweet pepper.**

S-metolachlor--0.63 to 0.95 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in peppers in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.67 to 1.00 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied banded directed shielded spray, preemergence to the weeds. Posttransplant banded directed shielded sprays should be applied to weed-free soil. Dual Magnum will not control emerged weeds. Control emerged weeds with Graomoxone added to the shielded and directed banded herbicide spray. Make only one application during the growing season. DO NOT apply within 65 days of harvest**. Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in transplanted bell peppers only in DE, NJ, and PA! Labeled for use in bell, chili, Cubanelle, and tabasco peppers in Delaware, Maryland, and New Jersey.**

Seeded and Transplants

Clomazone--0.25 to 0.75 lb/A. Apply 0.66 to 2.00 pints per acre Command 3ME pretransplant as a banded directed shielded spray. Use the lower rate on fields with coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops or a winter crop. Use higher rates on fields with fine-textured soils and those with high organic matter, or to improve control of certain weeds, including common cocklebur. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Combine with Devrinol or Treflan (transplants only) to improve the control of carpetweed and pigweed sp. Labeled for use on all varieties including bell, hot, pimento, and sweet (except banana). See WARNING below.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used preplant incorporated for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control in peppers.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. May reduce stand of and yield of fall grains. Mold board plowing will reduce the risk of injury.

Postemergence

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray broadcast when crop is grown without plastic mulch or band between the rows when plastic mulch is used. Controls late season annual grasses, common purslane, and other broadleaf weeds.

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray to the soil strips of peppers grown on plastic mulch ONLY to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application**. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied in one year.**

Pendimethalin--0.48 to 1.42 lb/A. Apply 1.0 to 3.0 pints per acre Prowl H_2O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds preemergence. Tank-mix with paraquat to control emerged weeds. Use the lower rate on coarse-textured or sandy soils. **Do NOT apply "over the top" of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval). Labeled for use on bell pepper, chili pepper, cooking pepper, pimiento, and sweet pepper.**

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a banded, directed, and shielded spray between the rows ONLY, to control emerged grass and broadleaf weed seedlings. Do not allow spray to contact plants as injury or residues may result. Use shields to prevent spray contact with crop plants. Do not exceed a spray pressure of 30 psi. Add wetting agent as per label.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

For Transplanting Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Planting into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note: All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated

Transplants

Trifluralin--0.5 to 1.0 lb/A. Apply 1.0 to 2.0 pints per acre Treflan 4E. Incorporate into 2 to 3 inches of soil within 8 hours after application. Slight stunting may result if weather is cool and damp.

Seeded and Transplants

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators to control most annual grasses and certain broadleaf weeds. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Trifluralin--0.5 to 1.0 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Trilin in Maryland.** Apply 1.0 to 2.0 pints per acre Trilin prior to transplanting. Incorporate to a depth of 3 inches. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Avoid planting during periods of cold, wet weather to reduce the risk of temporary stunting.

Preplant (soil surface applied)

Transplants

S-metolachlor--0.63 to 0.95 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in peppers in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.67 to 1.00 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied pretransplant spray, or as a directed basal spray after establishment. DO NOT preplant incorporate Dual Magnum. Posttransplant directed sprays should be applied to weed-free soil. Dual Magnum will not control emerged weeds. Cultivate and/or hoe to control emerged weeds before treatment. Make only one application during the growing season. DO NOT apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in transplanted bell peppers only in DE, NJ, and PA! Labeled for use in bell, chili, Cubanelle, and tabasco peppers in Delaware, Maryland, and New Jersey.**

Seeded and Transplants

Clomazone--0.25 to 0.75 lb/A. Apply 0.66 to 2.0 pints per acre Command 3ME pretransplant. Use the lower rate on fields with coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops or a winter crop. Use higher rates on fields with fine-textured soils and those with high organic matter, or to improve control of certain weeds, including common cocklebur. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Combine with Devrinol or Treflan (transplants only) to improve the control of carpetweed and pigweed sp. Labeled for use on all varieties including bell, hot, pimento, and sweet (except banana).

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used preplant incorporated for weed control in peppers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control in peppers.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT prior to transplanting or seedingIncorporate with one-half inch of sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. May reduce stand of and yield of fall grains. Mold board plowing will reduce the risk of injury.

Postemergence

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Controls late season annual grasses, common purslane, and other broadleaf weeds.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last

harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.
Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Cutworms

(Also see Section E in "Soil Pests--Their Detection and Control".)

Preplant
bifenthrin-- 12.75 to 25.5 fl oz/A Capture LFR

Postplanting Treatment
Apply one of the following formulations:
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II **or** 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin +chlorantraniliprole--5.0 to 8.0 fl oz/A Voliam Xpress
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Flea Beetle

Apply one of the following formulations:
beta-cyfluthrin--2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF)
imidacloprid + beta-cyfluthrin--4.1 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II **or** 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin +chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
permethrin **(sweet, bell-type only)--**4.0 to 8.0 oz/A Perm-Up 3.2EC (or OLF)
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil, drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Green Peach Aphid

Note. For best green peach aphid control during periods of drought, apply insecticide 2 to 3 days after irrigation. Thorough spray coverage beneath leaves is important when foliar sprays are used. Apply one of the following formulations:

acephate (**bell pepper only)**--0.5 to 1.0 lb/A Orthene 97S (or OLF)
acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
Chenopodium extract--2.0 to 3.0 qts/A Requiem
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid-- **soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
imidacloprid + beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WDG
spirotetramat--4.0 to 5.0 fl oz/A Movento
sulfoxaflor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--**soil, drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi)

Pepper Maggot

Pepper maggot flies are active from June 1 to mid-August. Apply one of the following formulations:

dimethoate--0.50 to 0.60 pt/A Dimethoate 400 4EC (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Note: Use of acephate for corn borer control in bell peppers will reduce pepper maggot infestations.

Pepper Weevil (PW)

PW is a pest occasionally imported on older transplants or transplants with flowers or fruit. Apply one of the following formulations:

acetamiprid--2.5 to 4.0 oz/A Assail 30SG (or OLF)
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
clothianidin**--foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cryolite--8.0 to 12.0 lbs/A Kryocide 96W (or Prokill Cryolite 96)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid--**foliar only** 2.2 fl oz/A Admire PRO (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
permethrin **(sweet, bell pepper only)--**4.0 to 8.0 oz/A Perm-Up 3.2 EC (or OLF)
thiamethoxam--**foliar only** 3.0 to 5.5 oz/A Actara 25WDG
thiamethoxam + chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

European Corn Borer (ECB)

Note. Begin treatments when fruit are ¼ to ½ inch in diameter or larger and ECB moths are being caught in either local pheromone or blacklight traps. Consult your county Extension agent or integrated pest management reports for additional information about trap catches, phenology predictions, and proper timing of sprays for ECB. Apply one of the following formulations:

acephate **(bell pepper only)**--0.75 to 1.00 lb/A Orthene 97S (or OLF)
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
imidacloprid + beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
indoxacarb **(bell pepper only)**--3.5 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II **or** 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin +chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--3.0 pts/A Lannate LV (or OLF)
methoxyfenozide (**early season)--**4.0 to 8.0 fl oz/A Intrepid 2F; (**late season**)--8.0 to 16.0 fl oz/A Intrepid 2F
permethrin **(sweet, bell-type only)--**8.0 oz/A Perm-Up 3.2 EC or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Leafminers

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
chlorantraniliprole--5.0 to 7.5 fl oz/A Coragen 1.67SC
cyromazine--2.66 oz/A Trigard 75WSP
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 10.0 fl oz/A Entrust SC

Tomato Fruitworm also called Corn Earworm (CEW), Hornworms (HW)

Control CEW and HW beginning in mid-July

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
emamectin benzoate **(HW only)**--2.4 to 4.8 oz/A Proclaim 5SG
esfenvalerate (**CEW only**)--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
imidacloprid + beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
indoxacarb **(bell pepper only)**--3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II **or** 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin +chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--**soil, drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Beet Armyworm

Apply one of the following formulations:
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5 SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide + buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
methoxyfenozide (**early season**)--4.0 to 8.0 fl oz/A Intrepid 2F; (**late season)--**8.0 to 16.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam + chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4 .0 to 7.0 oz/A Voliam Flexi)

Fall Armyworm

Apply one of the following formulations:
Bacillus thuringiensis--1.0 to 2.0 lbs/A Dipel (or OLF)
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide +buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin(**small larvae only)**--1.28 to 1.92 fl oz/A Warrior II **or** 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin +chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide (**early season)--**4.0 to 8.0 fl oz/A Intrepid 2F; (**late season**)--8.0 to 16.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Cabbage Looper

Apply one of the following formulations:
acephate **(bell-pepper only)**--0.5 to 1.0 lb/A Orthene 97S (or OLF)
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
beta-cyfluthrin--2.1 to 2.8 fl oz/A Baythroid XL
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--2.1 to 2.8 fl oz/A Tombstone (or OLF)

emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5 SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
indoxacarb--2.5 to 3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II **or** 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide (**early season**)--4.0 to 8.0 fl oz/A Intrepid 2F; (**late season**)--8.0 to 16.0 fl oz/A Intrepid 2F
permethrin **(sweet, bell-type only)--**4.0 to 8.0 oz/A Perm-Up 3.2 EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Diseased plants should be rogued out. After spraying for thrips, place diseased plants in a plastic bag and remove from the field. Several species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed. Do not produce vegetable transplants with bedding plants in the same greenhouse. Apply one of the following formulations:

acetamiprid--4.0 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--2.1 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC(Sniper, or OLF)
cyfluthrin--2.1 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid**--soil only** 7.0 to 14.0 fl oz/A Admire Pro (or OLF)
imidacloprid +beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam--**soil only** 1.66 to 3.67 oz/A Platinum 75SG
zeta-cypermethrin+bifenthrin--10.3 fl oz/A Hero EC

Stink bugs

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
clothianidin**--foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
fenpropathrin **green stinkbug only**--10.67 fl oz/A Danitol 2.4 EC
imidacloprid +beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II **or** 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
thiamethoxam--**foliar** 3.0 to 5.5 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Mites

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
bifenazate--0.75 to 1.00 lb/A Acramite 50WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
fenpyroximate--2.0 pts/A Portal
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2S

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest[2]
INSECTICIDE			
abamectin	R	12	7
acephate (bell pepper only)	G	24	7
acetamiprid	G	12	7
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	7
bifenthrin	R	12	7
bifenazate	G	12	3
chlorantraniliprole (soil/drip/foliar)	G	4	1
clothianidin(soil/foliar)	G	12	AP/21
cryolite	G	12	14
cyfluthrin	R	12	7
cyromazine	G	12	0
dimethoate	R	48	see label
dinotefuran(soil/foliar)	G	12	21/1
emamectin benzoate	R	12	7
esfenvalerate	R	12	7
etoxazole	G	12	7
fenpropathrin	R	24	3
fenpyroximate	R	12	1
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide+buprofezin	G	12	1
imidacloprid (soil/foliar)	G	12	21/0
imidacloprid+beta-cyfluthrin	R	12	7
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	5
lambda-cyhalothrin+ chlorantraniliprole	R	24	5
lambda-cyhalothrin+ thiamethoxam	R	24	5
methomyl	R	48	3
methoxyfenozide	G	4	1
oxamyl	R	48	7
permethrin (**bell pepper only**)	R	12	3
pymetrozine	G	12	0
spinetoram	G	4	1
spinosad	G	4	1
spriomesifen	G	12	1
spirotetramat	G	24	1

(table continued next column)

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest[2]
INSECTICIDE *(cont'd)*			
sulfoxaflor	G	12	1
thiamethoxam (soil/foliar)	G	12	30/0
thiamethoxam+chlorantraniliprole **(soil/foliar)**	G	12	30/1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	7
FUNGICIDE (FRAC code)			
Agri-Mycin/Agri-Strep (Group 25)	G	12	AP
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	3
copper, fixed (Group M1)	G	24	0
Flint (Group 11)	G	12	3
Forum (Group 40)	G	12	4
Manzate Pro-Stick (Group M3)	G	24	7
MetaStar (Group 4)	G	48	7
Presidio (Group 43)	G	12	2
Priaxor (Groups 7 + 11)	G	17	7
Quadris (Group 11)	G	4	0
Ranman (Group 21)	G	12	0
Revus (Group 40)	G	12	1
Ridomil Gold (Group 4)	G	12	7
Ridomil Gold Copper (Groups 4 + M1)	G	48	7
Tanos (Groups 11 +27)	G	12	3
Terraclor (Group 14)	G	12	--
Ultra Flourish (Group 4)	G	12	7
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.
[1] G = general, R = restricted;
[2] AP=At Plant

Nematode Control

See Chapter E "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or use oxamyl (Vydate L) for control. Consult label before use.

Disease Control

Seed Treatment

Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens that may be found within the seed coat. Heat treatment is particularly useful for crops, such as pepper and tomato, that are prone to seed-borne bacterial infections. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heat cycle is for 10 minutes at 100ºF (37ºC) followed by the effective temperature. Soak pepper seed at 125ºF (51º) for 30 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current production season.

Following either treatment above, dry the seed, then dust with Captan 50WP or Thiram 480DP at 1 level teaspoon per pound of seed (3 oz/ 100 lb). See Table E-14 for additional seed treatment options.

Damping-Off

Use the disease-free planting mix described in Tables A-2 and A-3. Consideration should be given to using soilless mixes containing microorganisms that suppress damping-off fungi.

Quadris--0.40 to 0.80 fl oz 2.08F/A per 1000 ft/row at transplanting will help suppress Rhizoctonia root rot

Transplants that have been sitting in flats for extended periods prior to transplanting and/or slow to establish after setting are prone to Rhizoctonia root rot.

A Section 2ee has been granted for the use of Previcur Flex—1.2 pt 4F/A at transplanting and will help suppress Pythium root rot. Can be applied via drip or tank mixed with Admire Pro when setting transplants (see Section 2ee).

Bacterial Leaf Spot

The best method for limiting loss due to bacterial leaf spot is to plant BLS resistant cultivars. Along with races 1, 2 and 3 there is evidence that races 4 and 6 are present in the region. There are a number of cultivars that have resistance to three races or more races of the pathogen (see Table above). In fields with a history of bacterial leaf spot, only plant cultivars that have bacterial leaf spot resistance. When producing transplants, be sure to use the Clorox or heat seed treatment described under the preceding "Seed Treatment" section. Purchase heat-treated seed or disease-free transplants. In some years, there can be a high risk of developing bacterial leaf spot when using southern-produced transplants. Be sure to purchase only certified transplants. Prior to transplanting, apply streptomycin (Agri-Mycin 17, Agri-Strep) sprays (1.0 lbs per 100 gallons, 1¼ teaspoons per gallon) when first true leaves appear and continue every 4 to 5 days until transplanting. Streptomycin cannot be used on transplants after they are transplanted in field.

Loss from bacterial spot may be reduced by maintaining a high level of fertility. Maintaining high fertility levels will stimulate additional leaf formation to replace those lost from bacterial spot infections. However, sufficient restraint must be used to ensure that plants do not become overly vegetative, or fruit set may be severely reduced. Where disease is present or anticipated, do not work in fields when plant surfaces are wet. Disk field as soon as possible after the growing season. This will hasten breakdown of the crop debris that is harboring the bacteria and minimize overwintering of the bacteria in the field.

Field sprays to help reduce spread: If growing susceptible varieties or varieties showing symptoms of the disease, applying fixed copper at labeled rates. If necessary, begin preventative fungicide applications shortly after transplanting and repeat every 7 to 10 days, especially if symptoms of bacterial leaf spot are present during transplant production and/or on transplants. A "Section 2ee" for the use of Quintec at 6.0 fl oz 2.08F/A for the suppression of bacterial leaf spot in pepper has been granted for all states in mid-Atlantic region, except PA.

Anthracnose Fruit Rot

Anthracnose fruit rot is increasing in the mid-Atlantic region. Disease 'hot spots' typically develop in areas of field with prior history of anthracnose, especially in fields where peppers or tomatoes have been grown in the past. Heavy winds and rain help spread spores of pathogen to healthy areas of field. Excessive fertility programs may also help create thick, dense canopies which reduce chemical control and create microclimates conducive for fruit infection. Scout on a regular basis as fruit begin to develop. Use adequate water volume to insure good penetration into canopy. Apply preventative applications starting at bloom before the onset of fruit infections, especially in fields with history of the disease. Removing infected fruit from heavily infested areas of field has been shown to help reduce inoculum loads and reduce spread of the disease if done early and often enough.

***Beginning at flowering apply on a 7 day schedule*:**

Alternate:

chlorothalonil--1.5 pt/A 6F or OLF
Manzate Pro-Stick--1.6 to 3.2 lb 75DF/A

With a tank mix containing chlorothalonil at 1.5 pt/A or Manzate Pro-Stick at 1.6 lb/A and one of the following FRAC code 11 fungicides:

Quadris--6.2 to 15.5 fl oz 2.08F/A
Cabrio--8.0 to 12.0 oz 20EG/A
Priaxor--4.0 to 8.0 fl oz 4.17SC/A

Do not make more than two consecutive applications of any FRAC code 11 fungicide.

Bacterial Soft Rot

During periods of humid weather, the stem ends of harvested peppers may turn brown due to bacterial soft rot. If necessary, pack peppers dry without washing to minimize soft rot losses. If peppers must be washed, maintain 25 ppm of chlorine (1 tablespoon of Clorox per 8 gallons of water) in the wash water. Avoid washing peppers with water more than 10°F (6°C) cooler than the fruit temperature to prevent movement of bacteria into the stem end of the fruit.

Phytophthora Blight

Plant loss can be severe in all pepper types. Phytophthora blight typicially develops in low-lying areas of fields after rain and can spread quickly throughout the entire field. Planting on a ridge or raised, dome-shaped bed will help provide better soil drainage. Use a minimum 3-year crop rotation with crops other than peppers, cucurbits, lima and snap beans, eggplants, or tomatoes. In fields with low-lying or wet areas, plant only Phytophthora-tolerant cultivars such as ‘Paladin’, ‘Aristotle’, or ‘Revolution’. See Table above. In heavily-infested fields with a known history of Phytophthora blight, plant only resistant or tolerant cultivars to help reduce plant losses. If mefenoxam-insensitivity is known to exist in a field/farm, plant only tolerant cultivars. Do not apply mefenoxam or metalaxyl in fields where insensitivity is known to exist.

For control of the crown rot phase of Phytophthora blight, apply one of the following:

mefenoxam--1.0 pt Ridomil Gold 4SL/A or 1.0 qt Ultra Flourish 2E/A ormetalaxyl (MetaStar)--4.0 to 8.0 pt 2E/A at transplanting and 30 days later
Presidio--3.0 to 4.0 fl. oz 4SC/A
Ranman--2.75 fl. oz 400SC/A (may be applied via transplant water (see label for restrictions)

When using polyethylene mulch, apply Ridomil Gold , Ultra Flourish, Ranman, or Presidio at the above rates and timing by injection through the drip irrigation system. Dilute prior to injecting to prevent damage to injector pump. Only apply Ridomil Gold 4SL at transplanting and 30 days later. Apply Presidio or Ranman via drip between Ridomil applications.

For prevention of the aerial stem and fruit rot phase of blight:

The following materials are labeled for suppression of the aerial phase of phytophthora blight on pepper fruit. For best results tank mix one of the following with a copper containing fungicide and rotate on a 7 day schedule with 2.5 lb Ridomil Gold Copper 65WP/A.

Alternate one of the following:

Presidio--3.0 to 4.0 fl oz 4SC/A *plus* fixed copper at labeled rates
Revus--8.0 fl oz 2.08SC/A *plus* fixed copper at labeled rates
Ranman--2.75 fl oz 400SC/A *plus* a non-ionic surfactant
Forum--6.0 fl oz 4.18SC/A *plus* fixed copper at labeled rates

With:

Ridomil Gold Copper--2.5 lb 65WP/A.

Blossom End Rot

This physiological disorder is caused by reduced calcium uptake and calcium movement into the fruit when soil moisture is low. To control blossom end rot, maintain proper soil calcium and nutrient balance. Avoid root pruning and damage. The most effective control is to maintain uniform, favorable soil moisture. This is especially important when cropping in raised beds for Phytophthora control, because soil in raised beds will dry more quickly than in flat bed culture.

Sunscald

To reduce sunscald, select varieties with good foliage cover. Maintain vigorous vegetative growth by following recommended fertilizer (especially nitrogen) program and timely irrigation. Harvest carefully to avoid damaging stems, branches and foliage.

Southern Blight (*Sclerotium*)

High soil moisture and temperature favor disease development. Long crop rotations with corn and small grains help reduce disease incidence. Additionally, use the following in the transplant water:

Terraclor--3.0 lb 75WP/100 gal of water or OLF and apply 0.5 pint per plant.

Verticillium Wilt

The soil-borne fungus can infect a number of crops including eggplant, tomato, pepper, potato, and strawberries and can survive in the soil for many years. Therefore, a long, proper crop rotation is necessary to reduce losses due to verticillium wilt. DO NOT grow tomato, potato, strawberries, or eggplant in rotation or consecutively in the same field and never plant other solanaceous crops, such as eggplants or tomatoes, between pepper plantings.

Viruses

Early season cold injury can often result in virus-like mosaic and distortion symptoms in actively growing young plants in the spring following cooler than normal temperatures. In past instances, entire fields or blocks look symptomatic. Early-season transplants will grow out of problem over time.

Tobacco mosaic virus (TMV): TMV is transmitted mechanically. Use resistant varieties to control TMV.

Aphid-transmitted viruses (PVX, CMV, TEV, PVY, and AMV): CMV has caused problems in peppers in the mid-Atlantic region the past few growing seasons. Infected fruit may develop small, irregular brown spots that run parallel on fruit. Young developing leaves may develop mosaic symptoms. The positive identification of pepper viruses with laboratory tests can be difficult. Importantly, these viruses of pepper cannot adequately be controlled with insecticide applications, but symptom expression can be delayed through their use. Since aphids transmit the virus, growers may wish to use yellow trap pans containing water to determine when mass flights of winged aphids occur. Repeated applications of a contact aphicide at those times are most beneficial.

Thrips-transmitted virus (Tomato Spotted Wilt Virus, TSWV, and Impatiens Necrotic Spot Virus, INSV): Resistant varieties should be used, especially in Virginia. TSWV can be severe on peppers during both greenhouse transplant and field production of the crop. INSV causes similar symptoms on peppers as TSWV; however, the virus is not as severe and does not limit production to the same extent as TSWV. Both viruses are transmitted by a number of thrips (Western flower thrips most notably) in a persistent manner (ie. thrips can transmit the virus during their entire life cycle). During transplant production, thrips can transmit the virus from infected ornamental plants (flowers). DO NOT GROW any ornamental bedding plants in the same greenhouse as pepper transplants. **Monitor greenhouses and scout fields regularly for thrips populations.** Begin an insecticide program once thrips are observed. When thrips are observed in the field, treat with an insecticide and rogue out any plant showing TSWV symptoms.

Skin separation or "silvering" of bell pepper fruit

Skin separation or 'silvering' in bell pepper fruit reduces aesthetic fruit quality. Research in New Jersey has shown that phytophthora-tolerant bell pepper cultivars (such as 'Paladin' and 'Aristotle') are more prone to the development of skin separation or 'silvering' in fruit compared to phytophthora-susceptible varieties such as 'Alliance' or 'Camelot'.

POTATOES

Varieties

Varieties[1]	Table Stock	Chipping	Yield	Spacing
Early				
Andover	+++	+++	+	9-10
Envol	+++	No	++	8-10
Michigan Purple (purple skin)	++	No	++	8-10
Dark Red Norland D	++	No	+	8-10
Superior (SR,VS)	+++	+	++	8-12
Vivaldi (yellow flesh)	+++	No	++	8-10
Midseason				
Atlantic[2]	No	+++	+++	7- 9
Chieftain (red skin)	++	No	++	7- 9
Eva	++	++	++	8-10
Dakota Crisp	++	+++	+++	8-10
Harley Blackwell	++	+++	++	9-12
King Harry (for organic production)	++	--	++	8-10
Kueka Gold (pale yellow flesh)	++	+	+++	9-10
NorDonna (red skin)	++	No	++	9-12
Norkotah Russet	++	No	+	9-12
Peter Wilcox (purple skin/yellow flesh)	++	No	++	8-10
Reba[3]	+++	++	++	7- 9
Yukon Gold[3] (yellow flesh)	+++	No	++	8-10
Purple Majesty (purple skin/purple flesh)	++	++	++	9-12
Late				
Gold Rush	+++	No	++	8-10
Katahdin (LR)	++	No	+++	8-10
Kennebec (VS,LBT)(not for eastern Virginia)	++	No	+++	7-10
Lehigh (yellow flesh)	+++	++	+++	8-10
Marcy	++	+++	+++	7- 9
Snowden (for chips only)	No	+++	++	8-10

+ = fair   ++ = good   +++ = excellent

1 Varieties are listed alphabetically within maturity group.
2 Tubers of the chipping variety "Atlantic" are extremely susceptible to internal necrosis and hollow heart.
3 Tubers of "Reba" and "Yukon Gold" are susceptible to hollow heart during cool growing seasons. Apply one-third of the nitrogen at planting and sidedress the remainder when plants are 4 to 6 inches high to help reduce hollow heart.
Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

White Potatoes	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	150-180[1]	200	150	100	0[2]	300	200	100	0[2]	Total nutrient recommended.
	50	200	150	100	0[2]	300	200	100	0[2]	Broadcast and disk-in.
	100	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting.
	0-30[1]	0	0	0	0	0	0	0	0	Adjust rate based on petiole nitrate testing at flowering.

Apply 1.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.
[1]For high yielding potato crop systems (>250 cwt. per acre), an extra split N application at flowering may be useful. Consult *Nitrogen management for white potato production* for more information (http://pubs.ext.vt.edu/438/438-012/438-012.html).
[2]In Virginia, crop replacement values of 50 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for potatoes.

Critical potato tissue test values for most recently matured leaves.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
Row Closure	Deficient	<3.0	0.2	3.5	0.6	0.3	0.3	<40	30	30	20	5	0.1
	Adequate range	3	0.2	3.5	0.6	0.3	0.3	40	30	30	20	5	0.1
		6	0.8	6	2	0.6	0.5	150	60	60	60	10	0.2
	High	>6.0	0.8	6	2	0.6	0.5	>150	60	60	30	10	-
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-	-
First blossom	Deficient	<3.0	0.2	3	0.6	0.25	0.2	<40	30	30	20	5	0.1
	Adequate range	3	0.2	3	0.6	0.25	0.2	40	30	30	20	5	0.1
		4	0.5	5	2	0.6	0.5	150	100	60	30	10	0.2
	High	>4.0	0.5	5	2	0.6	0.5	>150	100	60	30	10	-
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-	-
Tubers half size	Deficient	<2.0	0.2	2.5	0.6	0.25	0.2	<40	20	30	20	5	0.1
	Adequate range	2	0.2	2.5	0.6	0.25	0.2	40	20	30	20	5	0.1
		4	0.4	4	2	0.6	0.5	150	100	60	30	10	0.2
	High	>4.0	0.4	4	2	0.6	0.5	>150	100	60	30	10	-
	Toxic (>)	<3.0	0.2	3.5	0.6	0.3	0.3	-	-	-	-	-	-

Planting and Spacing

The recommended planting dates for potatoes are March 10 to April 5 in Maryland and Virginia, March 20 to April 15 in Delaware, and March 20 to April 25 in New Jersey. In Pennsylvania, the recommended planting dates are March 25 to June 5.

Space seed 7 to 12 inches apart in 34- or 36-inch rows. Use close spacing for large, cut seed pieces and wider spacing for whole (B-size) seed. Use close spacing for to be potatoes marketed in 5.0 and 10-pound consumer packs and for 'Katahdin' and 'Kennebec', which tend to set few tubers and produce oversize tubers.

Seed-Piece Treatment

Use certified seed. See the Disease section for more information on seed-piece treatment to prevent disease.

Harvest and Storage Considerations

Vine killing is done before harvest using herbicides or mechanical methods (rolling, mowing). See the vine kill section for recommended herbicides. **Vines of potatoes going into storage should be completely dead at least 14 to 21 days before harvest**. Healing of cuts and bruises is most rapid at a tuber temperature of 50^{o} to 60^{o}F (10^{o} to 15.6^{o}C) and a relative humidity of 90 to 95% with no free water. This temperature should be maintained for 2 to 3 weeks at the beginning of the storage period. The temperature should then be lowered to 40°F (4.44°C) for table stock or seed potatoes. Potatoes for processing are stored at 45°-50°F when a rot-producing agent such as field frost, late blight, or soft rot is present, the curing period should be eliminated, and the temperatures lowered to 45°F (7.22°C) as soon as possible with increased air flow. Monitor the storage daily and, if the rot continues, the crop should be sold immediately.

Vine Killing

Potato vines are frequently killed prior to harvest. Vine desiccation facilitates ease at harvest by reducing excessive potato foliage or weed growth. In early harvests, vine desiccation can hasten or improve skin set on relatively immature potatoes, thus reducing tuber damage during grading, packing and shipping. Proper skin set of the potato improves shelf life, promotes retention of potato quality during transport, and improves eye appeal. Also, market demand for smaller (B-size) potatoes of some varieties may be greater for mid-size tubers than for large tubers. Tubers stop growing soon after vine dessication. Decisions as to when to apply vine desiccants are based on intended market, demand for a given size and the need for high quality, non-skinned tubers.

Diquat--0.25 to 0.5 lb/A. Apply 1.0 to 2.0 pts/A of Reglone for preharvest vine desiccation in a minimum of 20 gallons of water per acre by ground application. Add a non-ionic surfactant (NIS) containing 75% or greater surface active agent at 0.25 to .05% v/v (1.0 to 2.0 qts/100 gals) of the finished spray volume. Rainfall 30 minutes following application will not affect the activity of Reglone. Do not apply to drought stressed potatoes. A second application may be made if necessary in dense vine growth. Do not exceed a total of 4.0 pts/A of Reglone. If two applications are made, allow at least 5 days between applications.

Glufosinate-ammonium--0.38lb/A. Apply 29.0 fl oz/A Rely 200 at the beginning of natural vine senescence in a single application. Potatoes with heavy or dense vines may require an application of another desiccant (diquat) to complete vine desiccation. Thorough coverage of vines is essential for satisfactory results. Do not harvest potatoes within 9 days of Rely application nor apply to potatoes grown for seed. Do not plant treated areas to wheat, barley, buckwheat, millet, oats, rye, sorghum or triticale until 30 or more days after Rely 200 application.

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Sprout Inhibitors

Apply the following directly to tubers:

Chloropropham--1% Solution. Apply Sprout Nip 3EC as a 1% solution (1.0 gallon of Sprout Nip per 35.0 gallons of water) after potatoes have been washed. The spray nozzles should be adjusted to applythe growth regulator spray evenly The spray solution should be applied at the rate of 1 quart of the 1% solution per 2000 pounds (20 cwt bags) of potatoes. Conveyer rollers will distribute the spray solution and assure complete coverage of each potato. **Note: Other formulations of Sprout Nip are available,** such as maleic hydrazide (MH-30 SG). Apply to crop 2-3 weeks after full bloom or when harvestable tubers are at least 1.5" in diameter. Do not apply when the temperature is expected to exceed 80°F (26.6°C) that day. Read the label carefully and follow the labeled rate.

Potato Physiological Disorders

There are a number of disorders of potatoes that are not caused by disease organisms. These disorders are commonly associated with adverse environmental conditions or cultural practices. The following table lists common potato disorders.

Disorder	**Primary Cause**	**Occurrence**	**Market Effect**
Brown Center	rapid growth	early to	quality
Hollow Heart	after stress	mid bulking	poor processing
Blackheart	low oxygen, wet soil	bulking and storage	Quality poor processing
Heat Necrosis	heat,acid soil (low Ca)	harvest	Quality poor processing
Vascular Discoloration	fast vine death, low moisture	harvest	poor processing
Jelly End Glassy End	fast vine death, low moisture	harvest	poor processing
Heat Sprouting	hot soil	Late bulking	quality, yield poor processing
Internal Sprouting	piling, sprout inhibition	storage	Quality poor seed
Chilling Freezing	Low temperature	harvest and storage	Quality yield prone to rots
Deformation	heat*	bulking	quality
Growth Crack	wet/dry soil*	bulking	quality
Chaining	hot soil	mid-bulking	yield (size)
Hair Sprout	hot soil	late-bulking	quality and yield
Swollen Lenticel	wet soil	bulking-harvest	storage rots
Greening	light	bulking-storage	quality

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Before Planting

Glyphosate--1.5 to 3.75 lb acid equivalent/A. Apply 3.2 to 8.1 pints per acre Roundup Ultra Max 4SC, 4 to 10 pints per acre Touchdown or 4.0 to 10.0 pints per acre Glyphomax Plus in the fall after harvest to control perennial grasses and broadleaf weeds, including quackgrass, field bindweed, Canada thistle, and others. Delay application after harvest to allow for adequate weed regrowth to intercept the spray. Apply before frost to weeds with cold-sensitive foliage. Do not till or mow for 1 week after application. Consult the label for additional details and the rate to use for each weed species.

Preemergence/Drag-Off

EPTC--3.0 to 4.5 lb/A. Apply 3.4 to 5.1 pints per acre Eptam 7E or 30.0 to 45.0 pounds per acre of Eptam 10G at one of the times listed below.

1. Just before planting and disking. This treatment is best for early season control of nutsedge and other weeds, but on plantings before April 1, it may reduce early vigor and yields slightly.
2. Just after "dragging off." Incorporate into soil in one or two cultivations with a spiketooth harrow or similar piece of equipment.
3. Just before first or second cultivation. This treatment is best for late-season control of nutsedge and other weeds. Do not apply within 45 days of harvest.

Primarily controls annual grasses, yellow nutsedge, and a few broadleaf weeds. Use linuron or metribuzin according to recommendations after planting to increase the spectrum of broadleaf weeds controlled.

Fomesafen--0.188 to 0.25 lb/A. Apply 0.75 to 1.0 pint per acre Reflex) after planting or before potatoes emerge, but after final drag-off. Primarily controls broadleaf weeds. Tank-mix with Dual Magnum or Prowl, or use in addition to Eptam for preemergence annual grass control, and with Metribuzin and/or Matrix to control additional broadleaf weeds. Potato varieties may vary in their response to Reflex, so determine crop tolerance before using. DO NOT preplant incorporate or crop injury may occur. DO NOT apply to emerged potato plants or severe crop injury will occur. Observe a preharvest interval of 70 days. Apply fomesafen only one time in alternate years (once every two years).

Linuron--0.4 to 1.0 lb/A. Apply 0.8 to 2.0 pounds per acre Lorox 50DF (or OLF) after planting or before potatoes emerge, but after final drag-off and before grasses are 2 inches tall and broadleaf weeds are 6 inches tall. Primarily controls broadleaf weeds. Tank-mix with Dual Magnum or Prowl, or use in addition to Eptam for preemergence annual grass control. Use lower rates if tank-mixed. Do not plant to crops not on the label for 4 months after treatment.

S-metolachlor--0.96 to 1.91 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E or Dual II Magnum 7.64E before potatoes emerge, but after final drag-off. Dual Magnum will primarily control annual grasses. Nutsedge (nutgrass, coffeegrass) control may be adequate if weed pressure is light. Tank-mix Dual Magnum with linuron or metribuzin for broadleaf weed control. A jug-mix of Dual Magnum and Metribuzin that is labeled for use in white potatoes is sold under the trade name Boundary. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Metribuzin--0.38 to 0.5 lb/A. Apply 0.5 to 0.66 pound per acre Metribuzin 75DF (or OLF) (use comparable rates of liquid) just prior to emergence. If drag-off is practiced, then the application should be made after drag-off. Primarily controls broadleaf weeds. Tank-mix with Dual Magnum or Prowl, or use in addition to Eptam for preemergence annual grass control. Read label for rotation crop restrictions. A jug-mix of Dual Magnum and Sencor that is labeled for use in white potatoes is sold under the trade name Boundary. Do not apply within 60 days of harvest.

Note. Preemergence application to ‘Atlantic’ and ‘Norland’ or to any early maturing, smooth, white- or red-skinned potato varieties, may cause crop injury, especially under adverse weather conditions and when higher labeled rates are used.

Pendimethalin--0.48 to 1.42 lb/A. Apply 1.0 to 3.0 pints per acre Prowl H_2O before potatoes emerge. Prowl primarily controls certain broadleaf weeds, including velvetleaf and early-season annual grasses, but does not control yellow nutsedge. Combine with Lorox to improve velvetleaf control, or with linuron or metribuzin to improve the control of most other broadleaf weeds.

Postemergence

Rimsulfuron--0.0156 lb/A. Apply 1.0 ounce per acre Matrix 25DF early postemergence to control many weeds including foxtail species, pigweed species, wild mustard, and wild radish. Common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge may only be suppressed. Tank-mix with reduced rates of metribuzin, following label instructions, to increase the spectrum of weeds controlled. Repeat the application 2 to 4 weeks after the initial spray to improve the suppression or control of common purslane and perennial weeds, such as field and hedge bindweed. Results may be most effective when used following a preemergence residual weed control program. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) to improve weed control. DO NOT exceed 2.0 ounces of Matrix 25DF per acre per year.

Rimsulfuron (Matrix 25DF) is an ALS inhibitor. Herbicides in this class have a single site of action in susceptible plants. Always use in combination with other herbicides with a different site of action in the plant to prevent the development of resistant weed populations. Read and follow label cautions and resistance management recommendations.

S-metolachlor--1.6 lb/A. Apply 1.67 pints Dual Magnum 7.62E as a directed spray after hilling/at lay-by to provide preemergence control of sensitive weeds for the remainder of the growing season. Emerged weeds will not be controlled. This treatment may be applied in addition to a previous (drag-off) application of Dual Magnum or Dual II Magnum, but do not apply more than 3.6 pints Dual Magnum per acre in one season. Maintain a 40-day preharvest interval between the after hilling/at lay-by application of Dual Magnum and harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Metribuzin--0.25 to 0.50 lb/A. Apply 0.33 to 0.66 pound per acre Metribuzin 75DF (or OLF) before weeds are 1 inch tall. Primarily controls broadleaf weeds. Apply only if there have been at least three successive sunny days prior to application. Do not use on red-skinned or early maturing, smooth, white-skinned varieties. Treatment may cause some yellowing or minor burn. Read label for soil texture, crop rotation, and varietal restrictions.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2 to 0.4 lb/A. Apply 1.0 to 2.0 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Wireworms (Also see Chapter E "Wireworms" section in Soil Pests--Their Detection and Control.)

Apply one of the following formulations:
Preplant Application: Broadcast and incorporate just before planting.
ethoprop--2/3 to 1.0 gal/A Mocap 6EC (or OLF).
bifenthrin--12.75 to 25.5 fl oz/A Capture LFR (or OLF)

Planting Application
bifenthrin--19.2 fl oz/A Bifenture 2EC (Sniper, or OLF) or 12.75 to 25.50 fl oz/A Capture LFR
bifenthrin+imidacloprid--16 to 25.6 fl oz/A Brigadier
ethoprop--2/3 to 1.0 gal/A Mocap 6EC (or OLF)
fipronil--2.9 to 3.2 fl oz/A Regent 4SC (specific rate depends on row spacing; see label.)
phorate--**at planting and post-emergence light or sandy soils** 8.5 to 11.3 oz Thimet 20G/1,000ft, **heavy or clay soils** 13.0 to 17.3 oz Thimet 20G/1,000 ft **do not use post-emergence in heavy soils**

Lay-by Application
bifenthrin--3.2 to 9.6 fl oz/A Bifenture 2EC (Sniper, or OLF) or 12.75 to 25.50 fl oz/A Capture LFR

Cutworms (Also see Chapter E,"Cutworms" section in Soil Pests--Their Detection and Control.)

Cutworms are present during July and August. They are especially troublesome to tubers where soil cracking occurs. Variegated cutworms feed on lower leaves and petioles, and protective sprays should be applied if numbers exceed six worms per plant or foliar loss is more than 10 percent. Black cutworms are largely underground feeders, but will occasionally feed on leaves. No materials are effective if larvae do not feed above ground (foliar and systemic insecticides are ineffective). Several spray applications may be required for control. Apply one of the following insecticides:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--3.2 to 9.6 fl oz/A Bifenture 2EC (Sniper, or OLF) or 12.75 to 25.50 fl oz/A Capture LFR **(soil appl. only)**
carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF)
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Besiege
lambda-cyhalothrin+thiamethoxam--3.5 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 pts/A Lannate LV (or OLF) **(variegated cutworm only)**
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--2.6 to 6.1 fl oz/A Hero EC

Colorado Potato Beetle (CPB)

Pesticide Resistance Management

Do not rely exclusively on the neonicotinoid class of insecticides (Class 4: Actara, Assail, Cruiser, Gaucho, imidacloprid, Leverage 360, Platinum, Scorpion, or Venom) for CPB control. It is important to use all available effective pest management strategies, including crop rotation, pest scouting, treatment thresholds, and alternative (different class) insecticides, such as abamectin (Agri-Mek), Avaunt plus PBO, Blackhawk, Coragen, cryolite, Entrust, Radiant, Rimon, Voliam Xpress, or Vydate.

For rotated fields adjacent to CBP overwintering sites or to previous year's potato fields, most of the colonizing adults can be killed by treating only a strip of rows along the field edge where the invasion front is expected. Fields should still be monitored for beetles and other insect pests throughout the season.

Note: DO NOT use foliar applications of any neonicotinoid insecticide (clothianidin, imidacloprid, thiamethoxam, dinotefuron, acetamiprid) in fields previoiusly treated with seed-treatment or at-planting neonicotinoids

Apply one of the following formulations:

Preplant or Planting Application

clothianidin--**in-furrow-**9.0 **to** 12.0 fl oz/A, **foliar** 2.0 **to** 3.0 fl oz/A Belay
imidacloprid--s**oil** 5.7 to 8.7 fl oz/A Admire Pro (or 13.0 to 20.0 fl oz/A imidacloprid 2F, or OLF)
dinotefuran--**soil** 11.0 to 13.0 fl oz/A Scorpion 35SL; or 6.5 to 7.5 oz/A Venom 70SG
thiamethoxam--**soil** 1.66 **to** 2.67 oz/A Platinum 75SG (or OLF)

Postemergence Application

Rotation to nonsolanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems. Avoid the application of late-season sprays to prevent the buildup of insecticide-resistant beetles.

Beginning at plant emergence, sample fields weekly for CPB to determine the need to spray. Select at least 10 sites per field along a V- or W-shaped path throughout the field. At each site, select one stem from each of five adjacent plants and count and record all adults, large larvae (more than half-grown), and small larvae (less than half-grown). As a general guideline, if more than 50 adults or 75 large larvae or 200 small larvae are counted per 50 stems, a treatment is recommended. The amount of yield loss as a result of CPB feeding depends on the age of the potato plant. 'Superior' variety (short season) cannot compensate for early season defoliation by overwintered beetles, but during the last 30 days of the season, 'Superior' can withstand up to 50 percent defoliation without yield loss.

Note: Several of these insecticides may no longer be effective in certain areas due to CPB resistance. Check with your county Extension agent for most effective control.

Apply one of the following formulations:

abamectin--1.75 to 3.5 fl oz/A Agri-mek 0.7SC (or OLF)
acetamiprid--1.5 to 4.0 oz/A Assail 30SG (or OLF)
azadirachtin--up to 21.0 fl oz/A Azatin XL (AzaDirect, Ecozin, Neemix or OLF)
bifenthrin+imidacloprid--4.80 to 6.14 fl oz/A Brigadier
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen
clothianidin--**foliar** 2.0 **to** 3.0 fl oz/A
cryolite--10.0 to 12.0 lbs/A Kryocide 96WP (or Prokill Cryolite 96)
cyromazine--2.66 oz/A Trigard
dinotefuran--**foliar** 2.0 to 2.75 fl oz/A Scorpion 35SL or 1.0 to 1.5 oz/A Venom 70SG
imidacloprid--**foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
indoxacarb--3.5 to 6.0 oz/A Avaunt 30WDG **(larvae only**). The addition of the synergist piperonyl butoxide (PBO) is necessary when using indoxacarb.
lambda-cyhalothrin+thiamethoxam--3.5 to 4.5 fl oz/ A Endigo ZC
novoluron--6.0 to 12.0 fl oz/A Rimon 0.83EC
oxamyl--1.0 to 4.0 pt/A Vydate L
phosmet--1 1/3 lbs/A Imidan 70W
spinetoram--4.5 to 8.0 fl oz/A Radiant SC
spinosad--1.7 to 3.3 fl oz/A Blackhawk
thiamethoxam--**foliar** 1.5 to 3.0 fl oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--4.0 oz/A Voliam Flexi

Flea Beetles

Apply one of the following formulations:
acetamiprid--1.5 to 2.5 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin **lay-by--**3.2 to 9.6 fl oz/A, **foliar** 2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin+imidacloprid--4.8 to 6.14 fl oz/A Brigadier
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 2.0 to 3.0 fl oz/A Belay 2.13SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 11.0 to 13.0 fl oz/A Scorpion 35SL or 6.5 to 7.5 oz/A Venom 70SG; **foliar** 2.0 to 2.75 fl oz/A Scorpion 35SL or 1.0 to 1.5 oz/A Venom 70SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid--**soil** 5.7 to 8.7 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
lambda-cyhalothrin–1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Besiege
lambda-cyhalothrin+thiamethoxam--3.5-4.5 fl oz/A Endigo ZC
methomyl--1.5 pts/A Lannate LV (or OLF)
oxamyl--2.0 to 4.0 pt/A Vydate L
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
phosmet--1 1/3 lbs/A Imidan 70W
thiamethoxam--**soil** 1.66 to 2.67 oz/A Platinum 75SG or **foliar** 1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--4.0 oz/A Voliam Flexi
zeta-cypermethrin--1.76 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta–cypermethrin+bifenthrin--2.6 to 6.1 fl oz/A Hero EC

Potato Leafhoppers

Monitor fields for the buildup of leafhoppers from early June until early August. Treatment is suggested if leafhopper counts exceed 1 adult per sweep or 1 nymph per 10 leaves. Apply one of the following formulations:

acetamiprid--1.5 to 4.0 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin+imidacloprid--3.8 to 6.14 fl oz/A Brigadier
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 2.0 to 3.0 fl oz/A Belay 2.13SC
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)

dinotefuran--**soil** 11.0 to 13.0 fl oz/A Scorpion 35SL; or 6.5 to 7.5 oz/A Venom 70SG; **foliar** 2.0 to 2.75 fl oz/A Scorpion 35SL or 1.0 to 1.5 oz/A Venom 70SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid--**soil** 5.7 to 8.7 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Besiege
lambda-cyhalothrin+thiamethoxam--3.5 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
oxamyl--2.0 to 4.0 pt/A Vydate L
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
phosmet--1 1/3 lbs/A Imidan 70W
sulfoxaflor--1.5 to 2.25 oz/A Transform WG
thiamethoxam--**soil** 1.66 to 2.67 oz/A Platinum 75SG or **foliar** 1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--4.0 oz/A Voliam Flexi
zeta-cypermethrin--1.76 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta–cypermethrin+bifentrhin--4.0 to 10.3 fl oz/A Hero EC

European Corn Borer (ECB)

Proper timing of ECB sprays is critical. Apply first spray when 10% of the stems have entry holes in fresh market varieties or 25% in processing varieties. Make two to three applications on a 5- to 10-day schedule. Consult your county Extension agent and/or area pest management newsletter. **Apply one of the following formulations:**

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
indoxacarb--3.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Besiege
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
novaluron--6.0 to 12.0 fl oz/A Rimon 0.83EC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
spinetoram--6.0 to 8.0 fl oz/A Radiant SC
spinosad--1.7 to 3.3 fl oz/A Blackhawk
thiamethoxam+chlorantraniliprole--4.0 oz/A Voliam Flexi
zeta-cypermethrin--1.76 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Aphids

Insecticide treatments are recommended when aphid counts exceed 2 per leaf prior to bloom, 4 aphids per leaf during bloom, and 10 aphids per leaf within 2 weeks of vine kill. Apply one of the following formulations:

acetamiprid--2.5 to 4.0 oz/A Assail 30SG (or OLF)
bifenthrin+imidacloprid--3.80 to 6.14 fl oz/A Brigadier
Chenopodium extract--2.0 to 3.0 qts/A Requiem
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 2.0 to 3.0 fl oz/A Belay 2.13SC
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil** 5.7 to 8.7 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
pymetrozine--2.75 to 5.50 oz/A Fulfill 50WDG
spirotetramat--4.0 to 5.0 fl oz/A Movento
thiamethoxam--**foliar** 3.0 oz/A Actara 25WDG or **soil** 1.66 to 2.67 oz/A Platinum 75SG
sulfoxaflor--0.75 to 1.5 oz/A Transform WG
thiamethoxam+chlorantraniliprole--4.0 oz/A Voliam Flexi
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Potato Tuberworm

Note: Treat when foliage injury is first noted. Four to five applications at 7- to 14-day intervals may be needed. Tuberworms are primarily a problem on the fall crop.

Because moths are actively flying at dusk, sprays are most effective when applied early evening. Apply one of the following formulations:

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--2.9 to 9.6 fl oz/A Asana XL
imidacloprid+beta-cyfluthrin--2.8 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Besiege
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
novaluron--6.0 to 12.0 fl oz/A Rimon 0.83EC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3,4,5]
INSECTICIDE			
abamectin	R	12	14
acetamiprid	G	12	7
azadirachtin	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin	R	12	21
bifenthrin + imidacloprid	R	12	21
carbaryl	G	12	7
Chenopodium extract	G	4	0
chlorantraniliprole (any method)	G	4	14
chlothianidin (soil/foliar)	G	12	AP/14
cryolite	G	12	0
cyfluthrin	R	12	0
cyromazine	G	12	7
dimethoate	R(NJ),G	48	7
dinotefuran (soil)	G	12	PP[5]
(foliar)			7
esfenvalerate	R	12	7
ethoprop	R	48	AP[4]
fipronil	R	0	90
flonicamid	G	12	7
imidacloprid (seed treatment)	G	12	AP[4]
(soil/foliar)	G	12	AP/7
imidacloprid +cyfluthrin	R	12	7
indoxacarb	G	12	7
lambda-cyhalothrin	R	24	7

(table continuednext page)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3,4,5]
INSECTICIDE			
lambda-cyhalothrin + chlorantraniliprole	R	24	14
lambda-cyhalothrin + thiamethoxam	R	24	14
methamidaphos	R	48	14
methomyl	R	48	6
novaluron	G	12	14
oxamyl	R	48	7
permethrin	R	12	14
phorate	R	48	90
phosmet	G	24	7
pymetrozine	G	12	14
spinetoram	G	4	7
spinosad	G	4	7
spirotetremat	G	24	7
sulfoxaflor	R	24	7
thiamethoxam (seed treatment)	G	12	AP[4]
thiamethoxam (soil/foliar)	G	12	30/14
thiamethoxam+chlorantraniliprole	G	12	14
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	21
FUNGICIDE (FRAC code)			
Blocker (Group 14)	G	12	AP[4]
chlorothalonil (Group M5)	G	12	0
Curzate (Group 27)	G	12	14
Endura (Group 7)	G	12	30
Forum (Group 40)	G	12	4
Gavel (Groups 22 + M3)	G	48	14/3[3]
Gem (Group 11)	G	12	7
Headline (Group 11)	G	12	3
iprodione (Group 2)	G	12	14
Luna Tranquility (Groups 7+9)	G	12	7
mancozeb (Group M3)	G	12,24	14/3[3]
Moncut (Group 7)	G	12	AP[4]
Omega (Group 29)	G	48	14
Polyram (Group M3)	G	24	14/3[3]
Presidio (Group 43)	G	12	7
Previcur Flex (Group 28)	G	12	14
Priaxor (Groups 7 + 11)	G	12	7
Quadris (Group 11)	G	4	14
Quadris Opti (Groups 11 + M5)	G	12	14
Quadris Top (Groups 3 + 11)	G	12	14
Quash (Group 3)	G	12	1
Ranman (Group 21)	G	12	7
Reason (Group 11)	G	12	14
Revus (Group 40)	G	12	14
Revus Top (Groups 40 + 3)	G	12	14
Ridomil Gold Bravo (Groups 4 + M5)	G	48	7
Ridomil Gold Copper (Groups 4 + M1)	G	48	7
Ridomil Gold MZ (Groups 4 + M3)	G	24	14/3[3]
Super Tin (Group 30)	R	48	7
Tanos (Groups 11 + 27)	G	12	14
thiophanate-methyl (Group 1)	G	12	14
Ultra Flourish (Group 4)	G	48	0

See Table D-6.
[1] G = general, R = restricted
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
[3] 14 days = NJ, MD, VA; 3 days = DE, PA
[4] AP = At Plant
[5] PP = Preplant

Nematode Control

See Chapter E, "Nematodes" section in Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section, or use one of the following:

Vydate--1.0 to 2.0 gal 2L/A applied in at least 20 gal/A preplant in-furrow treatment. Foliar applications at 2.0 to 4.0 pt 2L/A can be utilized to offer further suppression of nematodes. See labels for more details.
Mocap--4.4 fl oz per 1,000 row ft 6F or OLF. Apply in a 12-inch band over the row at planting (avoid contact with seed piece), or 1.0 to 1.5 gal/A broadcast.

Certain mustard green cover crops planted in the fall and incorporated prior to planting may offer nematode suppression. (see Disease Management sub-section Non-chemical management of nematodes in E section)

Disease Control

Seed-Piece Treatment

Use certified seed. Give seed potatoes a warming-up (65° to 70°F [18.3° to 21.1°C]) period of 2 to 3 weeks before planting to encourage rapid emergence. Plant seed pieces immediately after cutting or store under conditions suitable for rapid healing of the cut surfaces (60° to 70°F [15.6° to 21.1°C] plus high humidity). Dust seed pieces with fungicides immediately after cutting. Some fungicide seed-piece treatments are formulated with fir or alder bark. Bark formulations have been effective treatments. Use one of the following:

For *Fusarium spp.*:
Captan--1.0 lb 7.5D/cwt or OLF
mancozeb*--1.0 lb 8D/cwt or OLF
Polyram--1.0 lb 7D/cwt or OLF

For *Fusarium* spp. *and Rhizoctonia* spp.:

Maxim--0.5 lb 0.5D/cwt
Maxim MZ*--0.5 lb/cwt
MonCoat MZ*--0.75 to 1.00 lb 7.5D/cwt
Tops--1.0 lb 2.5D/cwt
Tops MZ*--0.75 to 1.00 lb 8.5 D/cwt
Evolve* (thiophante-methyl, mancozeb and cymoxanil)--0.75 lb/cwt

Additionally for aphid, Colorado potato beetle, flea beetle and potato leafhopper control, apply one of the following:

Cruiser 5FS--see label for application directions and rates,
Belay 2.13SC--see label for application directions and rate
Tops MZ Gaucho--12.0 oz/cwt

*Seed-piece fungicides that contain EBDC fungicides or cymoxanil also provide protection against seedborne late blight infections.

Air Pollution

Symptoms appear as tiny spots of brown tissue on the upper surface of leaves and a bronzing of the lower surfaces. Some varieties such as Kanona, Red Norland, and Snowden are particularly sensitive.

Early Blight

Begin preventative sprays and continue every 7 to 10 days according to a disease forecasting system where available. If late blight is a threat, then begin sprays when plants are 8 inches tall.

Alternate or tank-mix one of the following preventative fungicides:

chlorothalonil--1.0 to 1.5 pt 6F/A or OLF

mancozeb--1.5 to 2.0 lb 75DF/A or OLF (**Note: DO NOT apply more than a combined total of 15.0 pounds of mancozeb or Polyram per acre per crop**)

Polyram--2.0 lb 80DF/A or OLF (**Note: DO NOT apply more than a combined total of 15.0 pounds of mancozeb or Polyram per acre per crop**)

Super Tin--3.0 to 6.0 fl oz 4L/A or OLF *plus* mancozeb--2.0 lb 75DF/A or OLF

With one of the following pre-mix fungicides:

Luna Tranquility--8.0 to 11.2 fl oz 4.16SC/A (only use 11.2 fl oz/A rate in Delaware)

Priaxor--4.0 to 8.0 fl oz 4.17SC/A

Quadris Opti--1.6 pt 5.5 SC/A

Quadris Top--8.0 to 14.0 fl oz 2.72SC/A

Revus Top--5.5 to 7.0 fl oz 4.16 SC/A

Tanos--6.0 oz 50W/A *plus* a protectant fungicide (i.e., chlorothalonil or mancozeb)

Or with one of the following single-active ingredient fungicides:

Endura--2.5 to 4.5 oz 70WG/A

Quash--2.5 to 4.0 oz 50WDG/A (do not use an adjuvant with Quash on potato)

Quadris--6.0 to 15.5 fl oz 2.08F/A

Gem--6.0 to 8.0 oz 25WDG/A

Headline--6.0 to 9.0 fl oz 2.1F/A

Reason--5.5 to 8.2 fl oz 500SC/A

Late Blight

Begin fungicide applications when plants are 6 inches tall and repeat every 7 days or apply fungicides according to a disease forecasting system such as BLITECAST or WISDOM. One of the following protective fungicides should be applied early in the season prior to the occurrence of any disease in the region:

chlorothalonil--1.0 to 1.5 pt 6F/A or OLF,

mancozeb--1.5 to 2.0 lb 75DF/A or OLF. (**Note. DO NOT apply more than a total of 15.0 pounds per acre per crop**),

Polyram--2.0 lb 80DF/A or OLF. (**Note. DO NOT apply more than a total of 15.0 pounds per acre per crop**).

Monitor for movement of the disease by contacting your local extension professional or visiting the following website to receive updates on where the disease is currently located (www.usablight.org). Once late blight is detected in your area, tank mix one of the following translaminar fungicides which can move into and through leaves with a protectant fungicide:

Curzate--3.33 oz 60DF/A plus a protectant fungicide (ie, chlorothalonil or mancozeb),

Forum--4.0 to 6.0 fl oz 4.18SC/A plus a protectant fungicide,

Gavel--1.5 to 2.0 lb 75DF/A

Omega--5.5 fl oz. 500F/A

Presidio--4.0 fl. oz 4SC/A

Previcur Flex--1.2 pt 6F/A plus a protectant fungicide (ie, chlorothalonil or mancozeb)

Ranman--1.40 to 2.75 fl oz 400SC/A

Revus--5.5 to 8.0 fl oz 2.08SC/A

Revus Top--5.5 to 7.0 fl oz 4.16SC/A

Super Tin--3.0 to 6.0 fl oz 4L/A or OLF *plus* mancozeb--2.0 lb 75DF/A or OLF,

Tanos--6.0 to 8.0 oz 50W/A *plus* a protectant fungicide (ie, chlorothalonil or mancozeb)

When a field contains new late blight infections and harvest is near, vines should be destroyed immediately to help prevent tuber infection.

Rhizoctonia stem canker and black scurf

Apply one of the following as an in-furrow spray at planting:

Quadris--0.4 to 0.6 fl oz 2.08F/1000 row ft

Moncut--0.79 to 1.18 oz 70DF/1000 row ft

Verticillium Wilt

Select fields with a low incidence of wilt. Use resistant varieties where possible. Do not use tomato, eggplant, or pepper in rotation with potato. The use of sudangrass in rotation with potato may reduce nematode levels. The use of Mocap (see "Nematode Control" section) will reduce lesion nematode levels in the soil, resulting in less Verticillium wilt.

Apply one of the following through center pivot irrigation in the fall to fallow fields for suppression of Verticillium and lesion nematode:

K-Pam HL--30.0 to 60.0 gal/A,

metam-sodium (Vapam HL)--37.5 to 70.0 gal/A

White Mold

Apply one of the following immediately prior to row closing and repeat 28 days later:

Endura--5.5 to 10.0 oz 70WG/A

Omega--5.5 to 8.0 fl oz 500F/A

iprodione--2.0 pt 4F/A or OLF

thiophanate-methyl--1.0 to 1.5 lb 70WP/A

Common Scab

Potato scab is caused by a soil-inhabiting fungus (*Streptomyces scabies*). The disease is suppressed in acid soils (pH <5.2), so increase of soil pH with lime favors development of scab. When lime is needed, therefore, it is best to apply after potato harvest and before subsequent crops grown in rotation. The optimum soil pH for growing scab susceptible potato varieties is about 5.0 to 5.2. Scab resistant potato varieties may be grown at pH 5.5 to 6.2. Plant scab-free seed potatoes. Use resistant varieties and rotate with small grains, corn, or alfalfa. Avoid rotations using red clover. Maintain adequate soil moisture during and after tuber set. Avoid heavy application of manures.

Bacterial Soft Rot

Prevent wounding and make certain tubers are dry before packing. Free chlorine wash maintained at 25 ppm chlorine or use of a fresh chlorine rinse maintained at 50 ppm chlorine may help reduce soft rot.

Leak (*Pythium*) and Pink Rot (*Phytophthora*)

Leak is a disease that usually enters the tubers through bruises occurring in conjunction with the harvesting of immature tubers during hot weather. Pink rot generally occurs in poorly drained areas. Be sure to rotate out of potatoes for at least 2 years. Apply one of the following fungicides in a 6- to 8-inch band directly over the seed-piece prior to row closure:

Platinum Ridomil Gold--2.2 fl oz 1.6E/1000 ft of row
Presidio--4.0 fl oz 4SC/A (**Pink rot only**), followed by a side-dressing application between hilling and tuber initation (see label for more information)
Ridomil Gold--0.42 fl oz 4SL/1000 ft of row
Ultra Flourish--0.84 fl oz 2E/1000 ft of row
Ranman--0.42 fl. oz/1000 ft row.

An alternative application technique is to apply one of the following fungicides with as much gallonage as possible for ground applications and a minimum of 5 gal/A for aerial applications. Make the first application at flowering and the second 14 days later. If the field has a history of pink rot or leak a third application might be warranted 14 days after the second application. Be sure to get some coverage of the soil surrounding plants for root uptake to occur.

Ridomil Gold Bravo--2.0 lb 76WP/A
Ridomil Gold Copper--2.0 lb 65WP/A
Ridomil Gold MZ--2.5 lb 68WP/A

Virus Diseases

Numerous seed borne viruses can occur in potato including potato leafroll, potato virus S (PVS), potato virus M (PVM), and several strains of potato virus Y PVY). There has been an increase in occurrence of PVYN strain in the region. Control these seed borne viruses by obtaining virus-free certified or foundation seed.

PUMPKINS AND WINTER SQUASH

Varieties[1]

Pumpkins (less than 1 pound)
Apprentice* (FR,PR)
Munchkin
Wee-B-Little*
Baby Boo

Pumpkins (1 to 3 pounds)
Baby Pam
Baby Bear*
Touch of Autumn* (PMT)
Rockafellow* (PMT)

Pumpkins (2 to 6 pounds)
Prankster* (PMT)
Cannonball* (hard shell)
Iron Man * (FR, PR, PMT) (hard shell)
Field Trip*(PMT)
Orange Smoothie* (hard shell)
Hybrid Pam*
Fall Splendor*(PMT)
Mystic Plus* (PMT)
(5-6 pounds, plant at closer spacing to reduce size)
Small Sugar (BRT)
Kakai (edible seeds)

Pumpkins (10 to 20 pounds)
Magic Lantern* (PMT)
Apollo* (PMT)
Sorcerer*
Charisma* (PMR)
Capt. Jack
Magician* (PMR, ZYMV)

Pumpkins (more than 20 pounds)
Pro Gold 510*
Howden Biggie
Gladiator* (PMT)
Aladdin (PMT)
Gold Medal*
Apogee*
Solid Gold*

Exhibition Pumpkins (more than 50 pounds)
Atlantic Giant
Prize Winner

Ornamental Pumpkins
Knuckle Head*
Rascal* (PMR; PR; WMV)

Winter Squash (Acorn Type)
Table Ace*
Taybelle* (semi bush, PMT)
Table Gold
Table Queen
Table Star * (PMT)
Autumn Delight * (PMT)
Royal Ace (bush PMT)

Winter Squash (Butternut Type)
Butterboy* (restricted vine)
Puritan Butternut
Metro* (restricted vine, PMR)
Quantum *
Waltham Butternut

Winter Squash (Buttercup Type)
Sunshine*
Buttercup
Sweet Mama
Bon Bon (green)

Winter Squash (Delicious Type)
Golden Delicious

Winter Squash (Hubbard Type)
Hubbard Types
Boston Marrow

Spaghetti Squash
Tivoli*
Stripetti*
Vegetable Spaghetti

Processing
Golden Delicious
Neck Pumpkin Types
Atlas* & Other Butternut Types

[1] Varieties are listed by maturity within each type, earliest first.
* Indicates hybrid varieties
Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N per Acre	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Pumpkins and	50-100	150	100	50	0[1]	200	150	100	0[1]	Total nutrient recommended.
Winter Squash	25-50	150	100	50	0[1]	200	150	100	0[1]	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run.

For crops grown on plastic mulch, fertilization rates are based on a standard row spacing of 6 feet.
[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. See the Disease section for more information in treating seed to prevent disease.

Seeding and Spacing

Seed in the field between June 15 and July 5 in cooler areas, and between June 15 and July 15 in warmer, southern areas.

Base plant spacing on vine habit and average fruit size of the variety. **Note.** Fruit size may be decreased at closer spacings.

Large vine with fruit over 30 pounds: Rows 10 to 12 feet apart with 5 to 6 feet between plants in the row.

Large vine with fruit 12 to 25 pounds: Rows 7.5 to 9 feet apart with 4 feet between plants in the row.

Large/medium vine with fruit 8 to 15 pounds: Rows 6 to 7.5 feet apart with 3 to 4 feet between plants in the row.

Small vine/bush with fruit less than 8 pounds: Rows 5 to 6 feet apart with 2 feet between plants in the row.

Conservation Tillage (No-Till) Pumpkins

Seed or transplanted no-till pumpkins planted into small grain cover crop or stubble, hairy vetch, or fallow ground has produced commercially acceptable yields. A cover crop on the soil surface will reduce dirty pumpkins at harvest, provide some weed suppression, and minimize fruit rot by creating a barrier between pumpkins and the soil. Since cultivation is not an option in a no-till planting system and few post-emergence herbicides are available to control escaped weeds, choose fields carefully for no-till production. The performance of residual preemergence herbicides depends on rainfall or overhead irrigation for activation. Moisture for activation is more critical in no-till fields consisting of a trash or straw layer. Inadequate activating moisture for residual preemergence herbicides can lead to weed control failures. Control grasses postemergence with Poast or Select, and use Sandea to control yellow nutsedge and certain annual broadleaf weeds postemergence. Sandea is an ALS inhibitor (group 2), and is at high risk for weed resistance development. ALS resistant weed biotypes have been identified for common ragweed, common cocklebur, Palmer amaranth, and other pigweed species in the mid Atlantic region. Sandea will NOT control certain pigweed species, common lambsquarter, annual moringlory, Eastern black nighshade, or any ALS resistant weed. Suggested cultural procedures are outlined below. **Not recommended in New Jersey due to the high risk of weed resistance development and the lack of postemergence control options for certain pigweed species, common lambsquarter, annual moringlory, Eastern black nighshade, or any ALS resistant weed.**

Cover Crop Establishment

Small grain stubble provides an ideal crop-mulch for pumpkins. Be sure the combine distributes straw uniformly. No other manipulation of the crop residue is required before planting pumpkins. An alternative crop-mulch is hairyvetch. Seed hairy vetch in the fall 3 to 4 weeks before the average frost date at the rate of 20 to 25 pounds per acre with a grain drill or broadcast spreader. On sloping ground, mix a winter-killed variety of spring oats (0.5 bushel per acre) with the vetch to decrease the time required for ground cover to reduce soil erosion. Adjust soil pH before the vetch is seeded because tillage will not be performed before pumpkin planting. Application of phosphorus and potassium before seeding vetch is optional, depending on soil test results.

Cover Crop and Weed Management

Soil Moisture. Soil moisture prior to planting is a critical factor for successful establishment of pumpkins. The living, hairy vetch cover crop may remove soil moisture and prevent pumpkin germination and growth. If irrigation is not available, kill the vetch 10 to 14 days prior to planting in order for rainfall to provide adequate soil moisture for seeding or transplanting. If rainfall is excessive, hairy vetch may remove water to facilitate timely planting. Irrigation will eliminate the concerns about soil moisture for pumpkin seeding and germination.

Contact Herbicides. To kill hairy vetch, apply Gramoxone SL 2.0 (2.4 pints 2SC per acre) 10 to 14 days before planting, followed by a second application after seeding but before seedlings emerge or before transplanting. For sequential applications of Gramoxone SL 2.0 or OLF, the rates may be reduced slightly. Two applications, each at 1.1 pound of glyphosate acid equivalent per acre (3.0 pints per acre of Roundup Ultra, Glyphomax Plus, or Touchdown IQ, or 2.4 pints per acre of Roundup Ultra Max), are required for effective hairy vetch control. Glyphosate is required for control of some weeds such as horseweed and smartweed. **Caution:** glyphosate-resistant horseweed has been identified and become widespread in numerous fields in the mid Atlantic region. This weed will not be adequately controlled by any glyphosate product. Glyphosate has the potential to remain on foliage of weeds until washed off by rainfall or irrigation which could cause injury to germinating pumpkin seedlings or transplants. Allow at least 3 days between application and planting. A glyphosate product or Gramoxone SL 2.0 or OLF may be applied singularly, sequentially, or alternately to control specific weeds and cover crops.

To kill standing small grains or weeds in small grain stubble, make one application of glyphosate. Glyphosate is preferred for the control of grasses. Gramoxone SL 2.0 or OLF is acceptable for small grasses and for morningglory control. (See glyphosate caution above.)

Residual Herbicides for Pumpkins. Prefar (bensulide), may be applied alone or in combination with the first application of either Gramoxone or glyphosate to control germinating weeds as the mulch cover dies. Curbit **(not labeled in all states; see Pumpkin Weed Control Sections above for details)** should not be applied until after seeding and it should not be used for transplanted pumpkins. Prefar can be applied to the soil surface before transplanting pumpkins.

Strategy (clomozone *plus* ethalfluralin) or Curbit (ethalfluralin), may be used alone or in combinations with Prefar (bensulide). **Curbit is not labeled in all states (see Pumpkin Weed Control "clomozone" and "ethalfluralin" sections above for details).** Strategy, Curbit and Prefar may allow late season grass escapes which can be controlled by Select (clethodim) or Poast (sethoxydim) postemergence. Certain broadleaf weeds and yellow nutsedge can be controlled with a postemergence application of Sandea (halosulfuron). Broadleaf weed escapes not controlled by preemergence or postemergence herbicides should be hand weeded before the canopy closes to reduce the weed seed load for following crops.

Pumpkin Planting

See the herbicide recommendations for pumpkins for further discussion.

Use "no-till" corn planters equipped with coulters to cut through straw or cover crop stems killed by contact herbicides. Planters with finger pickup or air/vacuum units function well for seeding pumpkins. Plate planters may damage seed and should be evaluated carefully before use. Cole plate planters are satisfactory. A disk coulter on the seeding unit is essential to cut through the vetch or straw stems. Mount a 3-inch wide waffle coulter ahead of pot-transplanters to provide for effective penetration of the cover crop and plant placement.

Fertility

Hairy vetch will normally supply all the nitrogen requirements for pumpkins. However, if nitrogen deficiency symptoms appear before fruit production, topdress with 20 to 30 pounds nitrogen per acre. Phosphorus and potassium amendments can be applied (based on soil tests) to the soil surface before planting cover crop or before planting pumpkins. When planting pumpkins into non-legume cover crops for grain stubble, apply the recommended phosphorus, potassium, lime, and other nutrients based on soil tests before planting. Nitrogen rate recommendations may need to be increased based on fertilizer source, fertilizer application method, crop residue amount, and amount of time in a conservation tillage (no-till) production system. See Conservation Tillage Crop Production in section A.

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper set and pollination. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on "Pollination" in the General Production Recommendations and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Harvesting and Post Harvest Considerations

Disease-free fruit following a regular fungicide program during crop production will minimize postharvest fruit rots. Harvest when fruits are mature and prior to frost. Use care in handling fruit to prevent wounds. Wounding can negate benefits from a season-long fungicide program. Cure fruit after harvest at temperatures between 80° to 85°F (26.7° to 29.40°C) with a relative humidity of 75 to 80 percent for approximately 10 days. Temperatures below 50°F (10°C) cause chilling injury. The hard-shelled squashes, such as Butternut, Delicious, Spaghetti, and the Hubbard strains, can be stored. Store at 55°F (12.8°C) and 50 - 70 percent relative humidity. Acorn squash will store for 5-8 weeks; pumpkins for 2-3 months and other hard-shelled squashes will store for 3 months except hubbard that may hold for 5-6 months. Remove squash from the field before they have chilling injury and do not allow fruits to be exposed to extended periods below 50°F. Handle fruits carefully to eliminate bruising or damage and remove stems from squash like butternuts that can damage adjacent fruit. Store winter squash in a cool, dry, well-ventilated area. The longer keeping winter squash types can be kept in saleable condition through late winter, into spring (3-6 months). Research has not documented any benefit to post-harvest fruit fungicide dips.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s) registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Ethalfluralin--0.38 to1.12 lb/A. Apply 1.0 to 3.0 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC as a banded directed shielded spray preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2.0	0.4	0.125
3.0	0.6	0.188
4.0	0.8	0.250
5.0	1.0	0.312
6.0	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

S-metolachlor--0.95 to 1.27 lb/A. Apply 1.00 to 1.33 pints of Dual Magnum 7.62E per acre as a directed and shielded spray between the rows of plastic mulch in pumpkins to suppress or control annual grasses, yellow nutsedge, and certain annual broadleaf weeds including nightshade species. Leave 1 foot (12 inches) of untreated area between the spray and any emerged pumpkin foliage. Do NOT apply Dual Magnum under the plastic or spray the plastic mulch. Tank-mix with other herbicides to improve the number of annual broadleaf weeds controlled. Dual Magnum will not control emerged weeds. Tank-mix with Gramoxone SL 2.0 and apply as a directed shielded spray if weeds have emerged. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium-and fine-textured soils and sites that have been heavily manured. **Dual magnum is labeled for use ONLY in pumpkins. Dual Magnum is NOT Labeled and should NOT be used on winter squash.**

Postemergence

Carfentrazone--0.008 to 0.031 lb/A. Apply 0.5 to 2.0 fluid ounces of Aim 2EC or Aim 1.9EW as a banded directed shielded spray between the rows of plastic mulch to suppress or control broadleaf weeds including morninglory species, pigweed species, common lambsquarters, and nightshade species when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Aim, applied postemergence, will not control annual or perennial grasses. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution), or oil concentrate or methylated seed oil to be 1-2% percent of the spray solution (1.0 to 2.0 gallons per 100 gallons of spray solution). **The shielded (hooded) sprayer must be designed to prevent spray or drift from contacting the stems, leaves, flowers or fruit of the crop, or severe injury may occur.**

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.50 to 0.66 dry ounce Sandea 75WG as a banded directed shielded spray between the rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **Do NOT exceed total of 0.047 pounds per acre, equal to 1.0 dry ounce of Sandea, applied postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied to multiple crops in one year.**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of or Gramoxone SL 2.0 or OLF postemergence as a banded directed shielded spray between the rows of plastic mulch in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a banded directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3.0 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applicatons)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation

of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated

Clomazone--0.25 to 0.50 lb/A. **For pumpkins ONLY**, apply 0.5 to 1.0 pint per acre Command 4EC preplant. Incorporate immediately after application. For best results, use equipment that will provide shallow, thorough incorporation. Poor incorporation technique may result in excessive crop injury in streaks throughout the field. Use lower rates on fields with coarse-textured soils that are low in organic matter and when planting short-season varieties. Use higher rates when planting full-season varieties in fine-textured soils and those with high organic matter. Expect some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, that becomes apparent after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control.

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.25 to 0.50 lb/A. **For winter squash ONLY,** apply 0.66 to 1.30 pints per acre Command 3ME preemergence to control annual grasses and many annual broadleaf weeds, except pigweed sp., carpetweed, annual morningglory sp., and yellow nutsedge. Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor spray drift. Preemergence applications are restricted to after June 15 in Maryland to reduce the risk of drift injury to rapidly growing sensitive spring foliage. Avoid preemergence applications when fields are adjacent to horticultural fruit, vegetable, or other sensitive crops (see label). Drift injury from off-site Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations. Follow all label restrictions that require buffer zones between treated fields and sensitive crops.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command has been used.

Ethalfluralin--0.56 to 0.94 lb/A. **A Special Local Needs Label 24(c) has been approved for the use of Curbit 3E on winter squash and pumpkins in Delaware, Maryland, Pennsylvania, and Virginia.** Apply 1.5 to 2.5 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others, may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use on transplanted pumpkin or winter squash. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the 2 pint rate on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips Between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

S-metolachlor--0.95 to 1.27 lb/A. Apply 1.00 to 1.33 pints of Dual Magnum 7.62E per acre as an inter-row or inter-hill spray in pumpkins to suppress or control annual grasses, yellow nutsedge, and certain annual broadleaf weeds including nightshade species. **Do NOT apply Dual Magnum over the pumpkin row or hill!** Leave 1 foot (12 inches) of untreated area over the row or hill (six inches on each side) and between the spray and any emerged pumpkin foliage. Dual Magnum application over the row may result in moderate to severe injury when seeding and application is followed by rainfall or irrigation before crop emergence. Dual Magnum injury appears as dark green healthy looking foliage on emerged seedlings that are stunted and recover only slowly. Injury may result in reduced yield and/or delayed maturity. Tank-mix with other herbicides to improve the number of annual broadleaf weeds controlled. Dual Magnum will not control emerged weeds. Tank-mix with Gamoxone Inteon and apply as a directed shielded spray if weeds have emerged. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. **Dual Magnum is labeled for use ONLY in pumpkins. Dual Magnum is NOT Labeled and should not be used on winter squash.**

Postemergence

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.50 to 0.66 dry ounces of Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves, but has not yet begun to “run” or bloom. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution). Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant, and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated, but may require 2 to 3 weeks to become evident, and up to a month for the weed to die. Occasionally slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid, with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed total of 0.047 pounds per acre, equal to 1.0 dry ounce of Sandea, applied postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied to multiple crops in one year.**

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Corn Maggot

See Section E, "Maggots" section in Soil Pests--Their Detection and Control.

chlorpyrifos--Lorsban 50W (**commercial applied seed treatment only**) - pumpkin only

Note: Use of imidacloprid at planting may reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles commonly carry bacterial wilt bacteria on their mandibles, Therefore, when plants are young, they need to be protected from cucumber beetle feeding to manage bacterial wilt. Cucumber beetles also cause direct damage to pumpkin and winter squash rinds. Fall treatments with foliar insecticides to prevent feeding damage may also reduce the incidence of black rot. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--2.4 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Squash Vine Borer

When vines begin to run, apply to bases of plants four times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. Apply one of the following formulations:

Note: Use of spinosad or spinetoram for looper control will reduce squash vine borer populations.

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole---6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Cutworms

(Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Apply one of the following formulations:
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin+indole butyric acid--3.5 to 8.7 lbs/A Empower[2]
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pickleworm, Melonworm

Make one treatment prior to fruit set, and then treat weekly. Apply one of the following formulations:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
chlorantraniliprole--melonworm **drip** 2.0 to 3.5 fl oz/A, **foliar** 2.0 to 5.0 fl oz/A Coragen 1.67SC; pickleworm **drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate (pickleworm only)--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Aphids

Apply one of the following formulations:

Note. Aphids transmit mosaic virus. Thorough spray coverage beneath leaves is important. Treat seedlings every 5 to 7 days or as needed. Also, mosaic-resistant winter squash cultivars are available.

acetamiprid--2.5 to 4.0 oz/A Assail 30G (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin+thiamethoxam--4.5 fl oz/A Endigo ZC
pymetrozine--2.75 oz/A Fulfill 50WDG
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG (or OLF); **foliar** 1.5 to 3.0 oz/A Actara 25WDG (or OLF)
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi

Stink bug

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Apply one of the following formulations:
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 8.0 fl oz/A Entrust SC

Squash Bug

Begin treatments if greater than one egg mass per plant is present. Sprays should target nymphal stages. For best squash bug control, under leaf spray coverage is essential. Apply one of the following formulations:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
azadirachtin--7.0 to 16.0 fl oz/A Neemix Apply when pests first appear and are in their early nymphal stages.
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 fl oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz Hero EC

Leafminers

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
cyromazine--2.66 oz/A Trigard 75WSP
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinosad--6.0 to 8.0 fl oz/A Entrust SC
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SC (or OLF)

Rindworms

Damage to the rinds may result from a complex of insect pests including cucumber beetle, wireworms, and a number of "worm" species, (beet army worm, etc). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle section for labeled products.
For Lepidopteran rindworms, use one of the following formulations:

flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC

Cabbage Looper

Apply one of the following formulations:

Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.0 fl oz/A Danitol 2.4EC
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi

zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Mites

Mite infestations generally begin around field margins and grassy areas. **CAUTION:** DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot-treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season. Apply one of the following formulations:

Note. Continuous use of carbaryl, or the pyrethroids may result in mite outbreaks.

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
bifenazate--0.75 to 1.00 lb/A Acramite 50 WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC
zeta-cypermethrin+bifenthrin--10.3 fl oz/A Hero EC

Note. The addition of crop oils or organosilicon spray additives will increase miticide effectiveness.

Whiteflies

Apply one of the following formulations:
clothianidin--**soil** 9 .0 to 12.0 fl oz/A Belay 2.13SC
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin+thiamethoxam--4.5 fl oz/A Endigo ZC
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC
sulfloxafor--4.25 to 4.5 fl oz/A Closer SC
thiamethoxam--**foliar** 3.0 to 5.5 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	0
azadirachtin	G	4	0
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin	R	12	3
bifenazate	G	12	3
carbaryl	G	12	3
chlorantraniliprole	G	4	1
clothianidin	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	0
dinotefuran (soil/foliar)	G	12	21/1
esfenvalerate	R	12	3
etoxazole	G	12	7
fenpropathrin	R	24	7
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide+buprofezin	G	12	7
imidacloprid (soil)	G	12	21
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	1
lambda-cyhalothrin + chlorantraniliprole	R	24	1
INSECTICIDE *(cont'd)*			
lambda-cyhalothrin + thiamethoxam	R	24	1
methomyl	R	48	3
methoxyfenozide	G	4	3
oxamyl	R	48	1
permethrin	R	12	0
pymetrozine	G	12	0
spinetoram	G	4	3
spinosad	G	4	3
spiromesifen	G	12	7
sulfloxafor	G	12	1
thiamethoxam (soil/foliar)	G	12	30/0
thiamethoxam+chlorantraniliprole	G	12	1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Flint (Group 11)	G	12	0
Folicur (Group 3)	G	12	7
Fontelis (Group 7)	G	12	1
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
Inspire Super (Groups 3 + 9)	G	12	7
Mancozeb (Group M3)	G	24	5
MetaStar (Group 4)	G	48	AP
Presidio (Group 43)	G	12	2
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quadris Top (Groups 11 + 3)	G	12	1
Quintec (Group 13)	G	12	3
Rally (Group 3)	G	24	0
Ranman (Group 21)	G	12	0
Revus (Group 40)	G	4	0
Ridomil Gold (Group 4)	G	48	5
Sulfur Micronized Wettable (Group M2)	G	24	-
Switch (Groups 9 + 12)	G	12	1
Tanos (Groups 11 + 27)	G	12	3
Torino (Group U6)	G	4	0
Ultra Flourish (Group 4)	G	48	5
Uniform (Groups 4 + 11)	G	0	AP
Zampro (Groups 45 + 40)	G	12	0

(table continued next column)

See Table D-6.
[1] G = general, R = restricted
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
[3] AP=At Plant

Nematode Control

See Chapter E – Pest Management the Nematodes Section under Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section of the same section or:

Vydate L--1.0 to 2.0 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2.0 to 4.0 pints 2L/**A** applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480DP 4.5fl oz/100 lb and an approved commercially available insecticide.

Damping-Off

Apply one of the following in a 7-inch band after seeding. Use formula in the “Calibration for Changing from Broadcast to Band Application" of Section E of Calibrating Granular Application Equipment to determine the amount of Ridomil Gold or Ultra Flourish or MetaStar needed per acre.

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A or 2.0 to 4.0 pt Ultra Flourish 2.0 to 4.0 pt 2E/A)
metalaxyl (MetaStar--4.0 to 8.0 pt 2E/A)
Uniform--0.34 fl oz 3.66SE/1000 ft row

Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV, and CMV. Use varieties with multiple virus resistance when possible. Plant fields as far away from existing cucurbit plantings as possible to help reduce aphid transmission of viruses from existing fields to new fields.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at planting may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be neccessary.

Angular Leaf Spot/Bacterial Leaf Spot

Both diseases can produce foliar symptoms that are often over-looked. Early detection is important, since control of the foliar phase can reduce infections in developing fruit. Infected fruit will become unmarketable. Both diseases are seedborne and can survive on infested debris for at least one year or until the debris decomposes. Rotate away from fields with history of bacterial problems. Incorporate the following into a standard disease management program when leaf spot is first detected, and repeat every 7 to 10 days:

copper, fixed--at labeled rates plus mancozeb

Choanophora fruit rot

This disease occurs during warm wet weather and develops predominantly on flowers or fruit near the ground. Management is difficult because disease development is rapid, and weather dependant. Fungicide sprays are not effective because flowers, which open daily, must be protected immediately. Practices that reduce soil moisture or reduce soil contact, such as raised beds and plastic mulch, may be beneficial.

Powdery Mildew

Some available varieties have resistance or tolerance to powdery mildew and should be used if possible (see variety tables). The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern US. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures.

Powdery mildew generally occurs from mid-July until the end of the season. Powdery mildew development on tolerant varieties will vary from year to year. Planting tolerant varieties will help delay the development of powdery mildew and improve performance of fungicide applications. If Powdery mildew has become well established in the mid- to late part of the season, only apply protectant fungicides such as chlorothalonil or sulfur. Make first application when powdery mildew is observed in the area or is detected by scouting (one lesion on the underside of 45 old leaves).

Alternate:

Quintec--6.0 fl oz 2.08 SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6 F/A or OLF
Torino--3.4 fl oz 0.85SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

With one of the following:

Fontelis--12.0 to 16.0 fl oz 1.67SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A
Procure--4.0 to 8.0 fl oz 480SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Rally--5.0 oz 40WSP/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
tebuconazole-4.0 to 6.0 fl oz 3.6F/A or OLF *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Inspire Super--16.0 to fl oz 2.8 F/A *plus* chlorothalonil 2.0 to 3.0 pt 6 F/A or OLF
Pristine--12.5 to 18.5 oz 38WG/A *plus* chlorothalonil--2.0 to 3.0 pts 6F/A or OLF

Or with:

Micronized Wettable Sulfur--4.0 lb 80W/A. Sulfur may injure plants, especially at high temperatures. Certain varieties can be more sensitive. Consult label for precautions.

Downy Mildew

Scout fields for disease incidence early in the growing season. Begin sprays when vines run or if downy mildew is predicted for the region. For current status of the disease, refer to the Cucurbit Downy Mildew forecasting website http:cdm.ipmpipe.org/. **Preventative applications are much more effective than applications made after disease is detected**. The following are the most effective materials: Tank-mix one of the following products with a protectant such as chlorothalonil--1.5 to 3.0 pt 6F/A or Gavel--1.5 to 2.0 lb 75DF/A and alternate between different modes of action (FRAC codes):

Presidio--3.0 to 4.0 fl oz 4SC/A
Ranman--2.10 to 2.75 fl. oz 400 SC/A
Revus--8.0 fl oz 2.08SC/A
Zampro--14.0 fl oz 525SC/A

Other materials for use in tank mix or alternation:
Previcur Flex--1.2 pt 6F/A
Tanos--8.0 oz 50DF/A
Forum--6.0 fl oz 4.17SC/A
Curzate--3.2 oz 60DF/A

Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Plectosporium Blight (Microdochium blight)

Research studies have shown that no-till pumpkin production may reduce disease development. Rotate with crops other than cucurbits. It is important to achieve maximum foliage coverage with each fungicide application. Scout fields on a regular basis. Once symptoms appear on petioles or as fruit begins to form, apply one of the following and repeat every 7-10 days:

chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Quadris Top--12.0 to 14.0 fl oz 2.7 F/A

A spray schedule that alternates Cabrio or Flint with chlorothalonil will also provide control.

Scab

Use resistant varieties when possible. Scab develops during cool periods. Begin sprays as true leaves form and repeat every 5 to 7 days.

chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Gummy Stem Blight (Black Rot) and Anthracnose

Rotate crops to allow at least 2 years between cucurbit plantings. Pumpkin cv. 'Small Sugar' appears to be the least affected by Black rot. Fungicides with a high-risk for resistance development, such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris), should be tank-mixed with a protectant fungicide. When tank-mixing, use at least the minimum labeled rate of each fungicide in the tank-mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not apply them. Use fungicides from a different FRAC code.

Begin the following fungicide program when fruit start to form:

Alternate:
chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
(use low rate early in season)

With one of the following:
Pristine--12.5 to 18.5 oz 38WG/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Switch--11.0 to 14.0 oz 62.5 WG/A
tebuconazole--8.0 fl oz 3.6 F/A or OLF
Inspire Super--16.0 to 20.0 fl oz 2.8 F/A

Maintain fungicide schedule until harvest. See the "Harvesting and Storage" section. Fungicide application for black rot control will help maintain "handles" on the fruit. Harvest carefully because wounding can negate benefits from a season-long fungicide program.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits) for as long as possible. Preplant fumigants will also suppress disease. Fields should be adequately drained to ensure that water does not accumulate around the base of the plant. Mefenoxam (Ridomil Gold or Ultra Flourish) should be applied pre-plant for early season control. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. When conditions favor disease development, tank mix one of the following with fixed copper at labeled rates (for suppression only):

Revus--8.0 fl oz 2.08F/A
Ranman--2.75 fl oz 400 SC/A
Presidio--3.0 to 4.0 fl oz 4SC/A
Forum--6.0 fl oz 4.17SC/A
Tanos--8.0 to 10.0 oz 50DF/A

Materials with different modes of action (i.e. FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Fusarium Fruit Rot

This disease is especially destructive in fields where pumpkins are grown on an annual basis. Once the pathogen is established in a field losses can be significant. Fruit rot is caused by several Fusarium spp., and fungicide applications are not effective. Hard rind cultivars are less susceptible to Fusarium fruit rot than other cultivars. Production of pumpkin on a no-till cover crop mulch layer such as winter rye plus hairy vetch has been shown to help reduce disease incidence. Greater disease reductions will occur when the mulch layer is thicker.

RADISHES, RUTABAGAS, AND TURNIPS

Radishes. Radishes are a quick-growing, cool-season crop developing its best quality and root shape when grown at temperatures of 50° to 65°F (10° to 18.3°C) in moderate to short day lengths. Crop must be grown rapidly (23 to 28 days) and with an adequate moisture supply. When growth is checked, the radish becomes hot, tough, and pithy. Long days (15 hours) and warm temperatures induce seedstalk formation. Under medium to short day lengths, roots are generally well shaped and tops are small.

Rutabagas. A cool-season crop developing best at temperatures of 60° to 65°F (15.6° to 18.3°C). Usually considered a fall crop; it can be grown in the spring.

Varieties

Radish (Red globe; white interior)	**Rutabaga**
Saxa	American Purple Top (and Improved Strain)
Rover*	Helenor
Cherriette*	Laurentian
Perfecto	
Rudolf (Crack tolerant)	**Turnip White**
Cherry Belle	Tokyo Cross*
Pink Beauty (organic)	White Lady*
Champion	Hakeuri*
Crimson Giant (large globe)	Shogoin
	Just Right*
Daikon/Specialty Radish	White Ball*
Watermelon (White flesh, red interior, globe)	
Shumkyo Semi Long (Red flesh, white interior, elongated)	**Turnip Purple**
White icicle (White flesh, white interior, elongated)	Purple Prince*
Minowase (Daikon)	Purple Top White Globe (MR)
Mihashige (Daikon)	Royal Crown*
China Rose (Red flesh, white interior, elongated)	
Chinese Winter (Daikon)	
Discovery* (Daikon)	
Round Black Spanish (Heirloom, Dark flesh, white interior, large globe)	
April Cross* (Daikon)	
Sakurajima Mammoth (White flesh, white interior, large globe)	

Varieties listed earliest to latest according to vendors: radish 18 – 45 days; Daikon/Specialty 24 – 80 days; Rutabaga 90 – 100 days; Turnip 35 – 75 days.
*Indicates F_1 hybrid variety Disease resistance/tolerance (according to vendor) and/or specialty descriptors in parentheses ( )

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N per Acre	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Radishes,	50	150	100	50	0	150	100	50	0	Total nutrient recommended.
Rutabagas, and Turnips	50	150	100	50	0	150	100	50	0	Broadcast and disk-in.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seed Treatment

Check with your seed company to determine if seed is hot water-treated. Purchase hot water treated seed if possible or request hot water seed treatment. See the Disease section for more information to prevent disease.

Spacing and Seeding

Radishes. Seed as early in the spring as soil can be worked, then at 8 to 10 day intervals through September. Seed 10 to 15 pounds per acre. Space rows 8 to 15 inches apart with 12 to 15 plants per foot in the row.

Rutabagas. Seed in early spring for the early summer crop and at least 90 days before the early freeze date in the fall. Sow 1½ to 2 pounds of seed per acre at a depth of ¼ inch in rows 30 to 36 inches apart. Thin to 4 to 8 inches in the row when plants are 2 to 3 inches tall.

Turnips. Seed as early in the spring as soil can be worked or at least 70 days before the early freeze date in the fall. Seed in rows 1 to 2 pounds per acre, 1/8 to 1/4 inch deep, in rows 14 to 18 inches apart. Plants should be 2 to 3 inches apart in the row. Seed can also be broadcast at the rate of 2.5 pounds per acre.

Harvesting and Post Harvest Considerations

Radishes. Bunch or wrapped/bagged are the two ways radishes are sold. Typically, in this region they are bunched with the tops on. Plants are pulled and bunched with rubber bands or twist ties. Shelf life for bunched radishes is 10-14 days. Store at a temperature of 32^{o}F (0^{o}C) and at a relative humidity of 95-100%.

Rutabagas. Pull and trim tops in field. Bruised, dam-aged, or diseased rutabagas will not store well. Wash rutabagas in clean water, spray-rinse with clean water, then dry as rapidly as possible before waxing or shipping. Rutabagas can be stored 2 to 4 months at 32^{o}F (0^{o}C) and at a relative humidity of 90 to 95 percent.

Turnips. The crop is dug mechanically and either bunched or topped. Turnips can be stored over winter at 32^{o} to 35^{o}F (0^{o} to 1.67^{o}C) and at a relative humidity of 90 to 95 percent.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Use shallow cultivation as necessary to control seedling weeds.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee’s (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide esistance development by weeds in your fields.

Preemergence

Turnips. DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F immediately after seeding.

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days for radish and 30 days for rutabagas and turnips.

Clopyralid--0.047 to 0.188 lb/A. Turnips ONLY! (roots and tops) Apply 2.0 to 8.0 fluid ounces of Stinger 3A or OLF per acre in a single application to control certain annual and perennial broadleaf weeds. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 8.0 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days for turnip roots and 15 days for turnip tops. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow-crop restrictions, or injury may occur from herbicide carryover.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Cabbage Maggot

Note. When yellow-rocket (mustard family) first blooms, cabbage maggot adults (flies) begin laying eggs on roots or soil near roots.

chlorpyrifos--Lorsban Advanced. See specific rates on label based on method of application and crop. Preplant, at-plant, and post-plant applications are recommended. Do NOT apply as a foliar application.

diazinon--2.0 to 4.0 qts/A Diazinon AG500 (or OLF) as a preplant broadcast or 4 to 8 fl oz per 50 gallons of transplant solution.

Cutworms

Apply one of the following formulations:

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL

carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF)

cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)

imidacloprid+beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360

Flea Beetles

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
carbaryl--0.5 to 1.0 qts/A Sevin XLR (or OLF)
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360
spinosad--1.7 to 3.3 oz/A Blackhawk
thiamethoxam--**soil** 1.7 to 2.17 oz/ A Platinum 75SG or OLF; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Aphids

Apply one of the following formulations:
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.2 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--2.4-2.8 fl oz/A Leverage 360
malathion--1.0 to 2.0 pts/A Malathion 57EC (or OLF)
sulfoxaflor--0.75 to 1.5 oz/A Transform WG
thiamethoxam--**soil** 1.70 to 2.17 oz/ A Platinum 75SG or OLF; **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Leafminers

Apply one of the following formulations:
spinetoram--6.0 to 8.0 fl oz/A Radiant SC
spinosad--1.7 to 3.3 fl oz/A Blackhawk

Armyworm, Cabbage Looper (CL), Imported Cabbageworm(ICW), Diamondback Moth Larvae

Note: For best worm control, underleaf spray coverage is essential.

Apply one of the following formulations:

Bacillus thuringiensis--0.5 to 2.0 lb/A Dipel DF (or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC **(AW only)**
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL (**ICW only**) **(turnips only)**
methoxyfenozide (**CL and DL only**)--4.0 to 8.0 fl oz/A; 8.0 to 10.0 fl oz/A **(ICW only)** Intrepid
spinetoram **(CL only**)--6.0 to 8.0 fl oz/A Radiant SC
spinosad (**CL only**)--1.7 to 3.3 fl oz/A Blackhawk

The following chart gives minimum days wait between last application of pesticide and harvest of root crucifers.

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest[2] Radish	Rutabagas	Turnip
INSECTICIDE					
Bacillus thuringiensis	G	4	0	0	0
beta-cyfluthrin	R	12	0	0	0
carbaryl	G	12	7	7	7
chlorantraniliprole	G	4	1	1	1
chlorpyrifos	R	24	30	30	30
cyfluthrin	R	12	0	0	0
diazinon	R	96	AP	AP	-
esfenvalerate	R	12	7	-	7
imidacloprid (soil/foliar)	G	12	21/7	21/7	21/7
imidacloprid + cyfluthrin	R	12	7	7	-
malathion	G	12	7	3	7
methoxyfenozide	G	4	-	-	1
spinetoram	G	4	3	3	3
spinosad	G	4	3	3	3
sulfoxaflor	R	24	7	7	7
thiamethoxam (soil/foliar)	G	12	21/7	21/7	21/7
FUNGICIDE (FRAC code)					
Cabrio (Group 11)	G	12	0	0	0
copper, fixed (Group M1)	G	24	0	-	0
Presidio (Group 43)	G	12	7	7	7
Quadris (Group 11)	G	4	0	0	0
Ridomil Gold (Group 4)	G	48	AP	AP	AP
Ridomil Gold Copper (Groups 4 + M1)	G	48	7	-	-
Ultra Flourish (Group 4)	G	48	AP	AP	AP
Uniform (Groups 4 + 11)	G	0	AP	AP	AP

(table continued next column)

See Table D-6.
Dash (-) in table indicates pesticide is **not** labeled for that crop.
[1] G=general, R=restricted
[2] AP=At planting application

Disease Control

Seed Treatment

Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens that may be found within the seed coat. Heat treatment is particularly useful for crops that are prone to seed-borne bacterial infections. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heat cycle is for 10 minutes at 100ºF (37ºC) followed by the effective (pathogen killing) temperature. Soak radish seed at 122°F (50°) for 15 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current production season.

An alternative to hot water seed treatment is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1 to 2 minutes with constant agitation and rinse for 5 minutes in running water.

Following either treatment above, dry the seed, then dust with Captan 50WP or Thiram 480DP at 1 level teaspoon per pound of seed (3 oz/100 lb).

Damping-off (caused by *Pythium Phytophthora, and Rhizoctonia*)

Apply one of the following as a pre-plant incorporated or as a soil surface spray after planting:

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A or Ultra Flourish--2.0 to 4.0 pt 2E/A)
Presidio--3.0 to 4.0 fl. oz 4SC/A (for root rots caused by *Pythium*)

Uniform--0.34 fl. oz 3.66SE/1000 ft row.See label for restrictions. Uniform applied at seeding will also help control Rhizoctonia and Downy mildew.

Black Rot, Blackleg, Alternaria

Black rot, Black leg and Alternaria can survive on infested debris and on infested seed. Purchase certified or treated seed. Use hot water seed treatment to help reduce seed-borne infections. See the proceeding "Seed Treatment" section. Thoroughly disc or plow under all plant debris after harvest. Eliminate cruciferous weeds from field which can act as hosts and rotate with non-cruciferous crops.

Clubroot

Radishes are susceptible to clubroot, whereas turnips are resistant. Use of irrigation water containing spores of the fungus is the principal way that the pathogen is spread to new fields. If clubroot occurs, take time to clean and disinfest any equipment to be used in other fields to its prevent spread. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve drainage in the field as much as possible and grow using raised beds.

Downy Mildew

Apply the following when weather conditions favor disease development and/or disease is first noticed:

copper, fixed--at labeled rates every 7 to 10 days

Applications of mefenoxam, Presidio, or Uniform applied at planting for root rot control will also help reduce chances for downy mildew development.

Leaf Spots (caused by *Cercospora* or *Alternaria*)

Long periods of wet weather and driving rains which promote soil splashing are conducive for development. Thoroughly disc or plow under all plant debris after harvest. Eliminate cruciferous weeds from field which can act as hosts and rotate with non-cruciferous crops.

Apply the following preventatively and/or when conditions favor development:

Alternate one of the following FRAC code 11 fungicides:
Quadris--6.0 to 15.5 oz 2.08SC/A
Cabrio--8.0 to 12.0 oz 20WG/A

With:

copper, fixed--at labeled rates every 7 to 10 days.

Scab

This disease is more severe under dry soil conditions, high soil pH, and low level of magnesium. Heavy irrigation in the first 2 weeks after emergence and the application of sulfur to reduce soil pH will assist in disease control.

White Rust

When weather conditions favor disease development or at the first sign of disease in field:

Alternate one of the following FRAC code 11 fungicides:

Quadris--6.0 to 15.5 fl oz 2.08F/A
Cabrio--8.0 to 16.0 oz 20WG/A

With one of the following:

Presidio--3.0 to 4.0 fl. oz 4SC/A
Ridomil Gold Copper--2.0 lb 65WP/A every 7 days.

SPECIALTY VEGETABLES & HERBS

Marketing Specialty Vegetables

The term ‘specialty vegetables’ refers to the large group of crops that fit into several niche markets. They are sometimes called ‘exotic’ as they represent a class of vegetables unlike standard tomatoes, peppers, beans, peas and sweet corn, etc.; ‘alternative’ because they represent new enterprises that traditional vegetable growers might try; or ‘designer veggies’ that allow the consumer to be creative with their presentation. Specialty vegetables can be described as the new and unusual in the manner they are produced (organic, hydroponic); in the color, shape or flavor of the varieties grown (red and oakleaf lettuces, pear tomatoes, hierloom varieties and unusual greens like radicchio); in their size (baby and miniature); or in their ethnic origins and demand (Asian crucifers and cucurbits, Hispanic peppers).

As with any new enterprise, developing a marketing plan for specialty vegetables is essential. There are several important points to consider:

- Before you plant, make sure you know where you will be selling your crop when it is ready to harvest.
- Be sure you fully understand all the quality, grading and packaging requirements, and costs for various market outlets. Apparently similar ethnic groups may want very different varieties of the same crop.
- Be sure to determine if they will want it when you can produce it.
- Assess the costs of production, especially the time and labor required. On-farm trials will help determine varieties and production systems, and small plantings will help work out problems that can be resolved easily (Maynard, 1995). Keep accurate records of the small scale productions to be able to estimate costs and returns for larger commercial plantings.
- Increase production as demand grows, but be constantly aware of the number of growers entering the enterprise. Here your prospective buyers may be the most revealing source of competition, though state and federal crop reporting agencies, and your local Extension workers are good sources of information.
- Project the effects on price that various levels of competitive supply will have to determine if returns will pay for any required capital costs over a specified period of time.

If you know where you will sell, how to produce, and that there will be enough income to cover expenses, make sure you will enjoy working in that enterprise. It will be tough to make an enterprise successful if a producer does not like working with a crop. Likewise, keep in mind that a specialty enterprise may not be limited to a single vegetable, but may include a group of complimentary crops that fill a diverse market niche. Each crop may be a required part of the mix in order to gain a foothold in the market that a single crop will not allow.

Understanding marketing for specialty crops is the first step toward making profitable production decisions. The following sections describe the production practices for specialty vegetables grouped by the general market outlets for the specific crops to direct the producer's attention to that critical part of the decision process.

Specialty Vegetable Markets

Organic & Hydroponic Specialties

Production practices which, in and of themselves, create niche-market 'specialty vegetables' are not the focus of this manual. Most, if not all, of the crops described in this manual can be grown by 'organic' practices, that is without the use of synthetic chemicals. Likewise, using 'hydroponic' techniques to grow crops in a nutrient solution, normally in a controlled environment structure such as a greenhouse, is also suitable for many vegetable crops if there is sufficient market demand to justify the capital investment for this type of system.

Both of these production systems require marketing to specific niche markets where demand is greatest for them. The combination of organically grown exotic vegetables may compound the demand.

Fresh-Cut Processing

A new market has emerged in the last ten years that coincides with the growth of two worker families with high disposable incomes and little time for meal preparation. The rapid growth of the convenience foods industry to service these types of consumers has encompassed fresh vegetables with the advent of fresh-cut processing, ie. prepackaged, ready-to-eat salads and uncooked, ready-to-stir fry vegetables. The major ingredients used by the fresh-cut industry are mainstay vegetables like iceburg lettuce, cabbage, carrots and spinach, but as discussed in the next section, many specialty crops naturally compliment those standards with color, texture and taste in both salads and stir-fry mixes. Some are their own pre-mixed salads by definition.

Fresh-cut processing grew out of the need for convenience, but was allowed by advances in packaging and post-harvest technologies. The shelf-life of fresh vegetables, once cut, is inherently very short, especially leafy vegetables such as lettuces. Oxidative browning and decay follow rapidly. Development of breathable plastic films which create a miniature controlled atmosphere within the package reduce the levels of oxygen and ethylene while increasing the carbon dioxide levels. These conditions slow the chemical browning process and reduce the growth of decay organisms. Sanitizing the produce before and during the processing greatly reduces the number of decay organisms entering the package (see HAACP box). The combination of handling practices and packaging materials has increased the shelf-life of fresh-cut products from a few days to several weeks.

Baby & Miniature Vegetables

Variety Selection

Though the publicity is perhaps not as great as during the late 1980's when they were faddish, there is demand for smaller vegetables among gourmet and specialty food outlets. Many types of vegetables can be harvested at an immature stage and sold as baby vegetables. There are other cultivars of vegetables which mature smaller than standard types of the same vegetable. These are referred to as miniatures. Most of the companies offering specialty vegetable seeds also recommend certain varieties for immature harvest in addition to listing miniature varieties.

Culture

Baby and miniature vegetables are planted and grown much the same as standard varieties. Plant spacing is one major exception, because miniatures are physically smaller and baby leaf and root crops are often harvested at the stage a standard variety would be thinned. Higher plant densities are desirable to maximize production. Baby leaf and some root crops can be grown in a solid bed created by broadcast seeding since they will be harvested before crowding becomes a factor. Spacing of miniature varieties will depend on the final size of the dwarfed plant. On the other hand, vegetables grown for their fruit (seeds or pods) such as beans, corn and squash should be grown at standard plant spacings to maximize output per plant. Crowding can affect the production of fruit reducing yields even if those fruit are to be harvested immature.

Field fertility is another production factor that may be modified depending on the crop and harvest stage. Immature, baby vegetables are harvested before they begin drawing significant amounts of nutrients from the soil. Most will perform with little additional fertilizer beyond the reserves left from previous crops.

Postharvest Handling

Baby vegetables are immature crops at harvest-time and as such, both fruit and leafy crops tend to have higher respiration rates and are more tender than when they reach maturity. Proper post-harvest handling procedures are critical to maximize shelf-life. Gentle handling and special packaging from harvest on are required to reduce bruising and dehydration . Rapid post-harvest cooling for removal of field heat is critical for extending the shelf-life. This may be combined with multiple washings to remove soil and field debris followed by spin-drying as a method of adding value for buyers.

Plastic-lined cardboard boxes, clear plastic food-service containers and inflated, resealable, plastic bags are some of the innovative packages tried in early tests. The industry has settled on 3-pound plastic-lined, or wax treated, cardboard boxes for the wholesale trade. larger bulk boxes may be suitable to send these products to fresh-cut processors who eventually repackage their finished products in the consumer-oriented plastic bags or clamshell boxes. These products allow both modified atmosphere treatment to reduce decay, and support throughout the bulk package to reduce bruising/injury caused by the weight of the product itself. The grower will need to determine the appropriate package for the intended market.

Pest Control

Pest control on baby vegetables is not quite the same as for the same crops grown to maturity. The early harvest of baby crops is a great factor in pest control decisions since it may eliminate the possibility of using many compounds which have a long Pre-Harvest Interval. Therefore, it is critical to begin with a well-drained, weed free soil. Alternative controls such as insect barriers (floating row covers), mulches for weed control and pre-plant fumigation play a greater role in growing healthy baby crops.

Familiarity with the life-cycles of insect pests may also allow production and harvest to be completed before a pest becomes a problem. The shorter cropping cycle does not, however, reduce the need for careful monitoring and control of pests which attack at the early stages of crop growth. The multiple plantings for continuous harvest may also compound pest problems as disease innoculum may build up and insect pests may migrate from earlier plantings into later ones.

Table F1 . Baby and Miniature Vegetable Varieties and Harvest Stage

Vegetable Type	Harvest Stage 1	Varieties for Baby Harvest	Miniature Varieties
Beans	IF	Aiguillon (LSI), Cristal, Fine de Bagnols, Blue Lake	
Beets	IR	Burpee Golden (LSI), Boldet (LSI), Dwergina (JSS/SW)	Baby Beet Spinel (NHRS) Crosby's Egyption (SB) Little Ball (NK)
Carrot	IR	Minicor (LSI/JSS), Round Paris Market (LSI), A&C Brand Nantes (A&C), Nantes (SB), Scarlet Nantes S. T. (HMS), Chantenay Red Core #5 (HMS), Amsterdam A. B. K. (SW), Caramba (SGS/NK)	Carrot Sucrum (NHRS/SB) Baby Long Carrot (NHRS) AMCA (A&C) Planet (SGS/NK) Little Finger (NK) Amstel (PS)
Corn	IF	Any sweet corn variety harvested within 3 days of silk emergence - supersweet varieties with tendencies to produce multiple ears/plant will increase yields	Golden Midget (NHRS/PS) Baby Asian Corn (LSI/SGS)
Greens	G	Most greens, including mustards, cabbages (European & Oriental), chicories, etc. can be harvested at the 4" to 6" stage. A mixture of baby greens and lettuces can be sold as "Mesclun" salad mix.	
Lettuce	G	Green Oak Leaf (General), Red Oak Leaf (LSI), Merveille de Quatra Saisons (LSI), Sucrine (LSI), Lollo Rosso (LSI), Lollo Biondo (LSI), Red Grenobloise (LSI), Diana (LSI), Kagraner Sommer (LSI), Craquante D'Avignon (LSI), Red Salad Bowl (LSI)	Tom Thumb (General) Baby Oak (JSS) Perella Red (LSI) Perella Green (LSI) Rougette de Midi (LSI) Morgana (JSS) Summer Baby Bibb (SGS) Little Gem Mini Romaine (SGS) Rubens Dwarf Romaine (SGS)
Radish	IR	Flamboyant (LSI/SGS), Flambo (LSI), Sezanne (LSI), Italian Oliva (LSI), French Breakfast (SW)	
Squash	IF	zucchini & yellow curved or straightneck, white & golden scallop, Jersey Golden Acorn, and Sweet Dumpling all can be harvested just before or after blossom drop.	
Turnip	IR	Milan Early Red Top (LSI), De Milan (SGS), Tokyo Cross (general), White Lady (A&C/PS)	Market Express (JSS)

[1]Codes for Baby Harvest Stage: IF = immature fruit, IR = immature roots (usually ½" – 1" diameter), G = greens (usually 4" – 6 " and before head formation).

Table F2: Potherbs & Salad Greens - "Designer Veggies"

Leafy greens can be described simply as any plant grown for consumption of its fleshy leaves, petioles and/or stems, either raw or cooked. The list is long.

Types of Greens	
Lettuces:	Iceberg, Romaine, Crisphead/Batavia, Leaf, Bibb, Boston
Other Composites:	Endive, Escarole, Radicchio, Dandelion
Mustards:	Arugula, Cress, Mustard, Turnip tops
Cabbages:	Red, Green & Savoy, Chinese Napa
Spinach:	Flat leaf & Savoy
Oriental Mustards	Mibuna, Misuna, Mizuna, Pak Choy; Flowering Broccoli
Other Oriental Greens	Tricolor Amaranth, Shungiku Chrysanthemum
Miscellaneous:	Belgian Endive, Mache/Corn Salad, Orach, Claytonia/Miner's Lettuce, Sorrel, Purslane

Culture

Several factors affect how leafy greens will be produced. The market you are growing for determines the type of crop (heading or non-heading) and harvest stage (baby or mature), which in turn establish plant spacing, length of time from planting to harvest, pest control practices, and post-harvest handling practices.

Plant Spacing

Maximizing production of leafy greens means covering as much of the ground as possible. A 54-66" wide by 4" high bed, enough to fit between tractor wheels set at 5-6' spacing, is standard in the Vineland area. Three to six rows, determined by the size of the crop, are spaced evenly across the bed.

Three rows are used for the largest heading cabbages which require 20-24" between plants in the row. Leaf, romaine and iceberg lettuces, and endives which are spaced 14-18" in the row. Precision seeding allows even spacing of two to three plants for each intended plant to harvest. Extra plants are hand thinned to proper spacing two to four weeks after emergence. Seedlings started earlier in greenhouses are transplanted at proper spacing in the row to achieve the earliest harvest.

Spinach, mustards, and lettuces grown for baby greens, use four or five rows on a bed, depending on the machinery setup of the farmer. Plant spacing in the row is 3-4" for spinach, up to 6-8" for mustards, and as little as 1" for baby greens. To push even more production from a given area, spreader shoes on the seeder creates a wide band of seeds. Effective herbicides are critical for establishing crops in this type of system as hand howing is not possible, and cultivation is more difficult.

Six- or eight-row beds are normally only used for radishes, but growers are experimenting with as many rows and spreader shoes for baby lettuce production, effectively creating a solid bed of seedlings by harvest time.

Time From Planting to Harvest

Baby greens are just that. If they are more than 6" tall, then they are too old for the market. That means arrugula and other mustards will barely be in the ground 2-3 weeks. Lettuces will take slightly longer to be ready, but by 6 weeks, most leafy greens are beyond the baby stage.

However, just as quickly as the baby stage passes, most leafy greens are fast crops. The majority of mustards, including the leafy oriental types, will be ready for harvest in 40-45 days. Leaf lettuces are ready 45-55 days from planting.

Heading type plants take longer. Romaine and iceberg lettuce are 60 to 80 day crops, while cabbages can take as little as 85-90 days for early types to as much as 110-115 days for main season crops. To get a jump on the season, most heading types of greens, and some leaf lettuces, are usually started in greenhouses growing 4-6 week old plants to be ready for transplanting between mid-March through April.

Pest Control

Weeds

Removing unwanted plants may be the most difficult aspect of leafy green production. Because they are in the ground such a short time, and are often followed by other crops, residues are not tolerable. The list of herbicides from which to select is, therefore, rather limited. In general, labels for mainstream crops will also apply to specialty leafy greens. Consult the weed management sections of this publication to select alternatives that fit these new crop alternatives. Consult the state Commercial Production Guidelines for specific chemical pest control recommendations.

With those limitations, the hoe and cultivator then become the required tool for weed control. Small sweep cultivators are used for narrow row spacings and older crops. The rolling basket cultivator is the implement of choice for young crops in three and four rows per bed arrangements.

Insects

Careful crop monitoring is required to produce insect-free greens. Timing production and physical insect barriers such as floating row covers can effectively control insects on many of the shortest season crops, longer season crops usually require insecticides of some type to protect them from an array of root maggots, lepidopteran worms, aphids, thrips, flea beetles, and more. Effective IPM scouting can identify pest population changes and alert the grower when a pest control application may be required.

Diseases

The same can be said about disease control on most leafy greens. Sanitation in the greenhouse and plant beds are essential for the control of damping-off diseases. Some root and stem diseases require hot water seed treatment, and for crucifer growers, careful monitoring of soil pH to keep it at or above 7.0, is essential if clubroot becomes a problem on your farm. Leaf diseases can also be avoided in short season crops, and monitored carefully to time protective fungicide sprays on longer season crops.

Mesclun

California is the center of mesclun production and they've been growing under hoop houses for years. I'm not sure if anyone is using _heated_ raised beds, but it should work. You'll just need to be on top of water management since the heated beds will dry out faster, and baby veg. don't take water stress too well.

The major pests I would expect to encounter in greens grown at high density in high humidity would be slugs, white flies, and botrytus. Slugs can be trapped (the old stale beer in a pan trick) and there are parasites for white flies now. Botrytus needs plenty of air movement and ventilation. You also need to be careful not to drop cut leaves if you will be making multiple harvests because botrytus gets started on injured tissue (bacterial soft rot does also).

Mesclun is still in high demand in many metropolitan areas.

SPINACH

Varieties[1]

Fall (summer planted)	Summer (spring planted)
Renegade* (Semi-savoy; DM races 1 – 7)	Donkey* (Semi-savoy; DM races 1 – 11)
Carmel* (Semi-savoy; DM races 1 – 11, 13)	Renegade* (Semi-savoy; DM races 1 – 7)
Racoon* (DM races 1 – 10, 12)	Carmel* (Semi-savoy; DM races 1 – 11, 13)
Interceptor* (DM races 1 – 7, 9, 11)	Regiment* (Semi-savoy; DM races 1 – 7)
Python* (DM races 1 – 7, 9, 11)	Tyee (Semi-savoy; DM races 1 – 3)
Tyee (Semi-savoy; DM races 1 – 3)	Corvair* (DM races 1 – 11)
Emu* (Slow bolting; DM races 1 – 10)	Olympia* (DM races 1 – 3)
Melody* (Savoy; DM races 1 – 2, CMV)	
Regal* (Semi-savoy; DM races 1 – 7, WRR)	**"Baby" leaf type**
Space* (Semi-savoy; DM races 1 – 3)	Carmel* (Semi-savoy; DM races 1 – 11, 13)
Sardinia (Semi-savoy; DM races 1 – 7)	Baby's Leaf*
Samish* (Semi-savoy; DM races 1 – 4)	Scarlet* (Red vein; DM races 1 – 3)
Unipack 12* (Slow bolting; DM races 1 – 4)	Swan* (DM races 1 – 10)
Unipack 151 (Semi-savoy; frost/heat tolerant; DM races 1 – 4)	
Salad Fresh (Frost tolerant)	

Disease resistance/tolerances (according to vendors) and specialty characters in parentheses ( )
Varieties listed according to days to maturity according to vendors (25 to 55 days)
*F_1 hybrid variety

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Spinach	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Spring or Fall	100-195	200	150	100	0[1]	200	150	100	0[1]	Total nutrient recommended.
	50-75	200	150	100	0[1]	200	150	100	0[1]	Broadcast and disk-in.
	25-40	0	0	0	0	0	0	0	0	Sidedress or topdress.
	25-40	0	0	0	0	0	0	0	0	Topdress after each cutting.
Overwinter	100-150	200	150	100	0[1]	200	150	100	0[1]	Total nutrient recommended.
	20-30	200	150	100	0[1]	200	150	100	0[1]	Broadcast and disk-in at Fall planting.
	50-80	0	0	0	0	0	0	0	0	Topdress in late February when crop begins to grow.
	30-40	0	0	0	0	0	0	0	0	Topdress in March.

[1]In Virginia, crop replacement values of 50 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Seed Treatment

Use seed that has been treated. For more information see the Disease section to prevent disease.

Seeding

Seeding Dates. *Spring*: March 12 to April 20 (harvest May 20 to June 7). *Fall*: August 10 to August 31 (harvest September 25 to October 10). *Overwinter*: October 1 to 15 (harvest in the spring).

Seeding Rates. *Not clipped*: 10.0 to 14.0 pounds per acre. *Clipped*: 18 to 25 pounds per acre.

Spacing. *Processing*: rows on 12-inch centers. *Market*: rows on 12-inch centers. Planted on 6- and 8-row beds.

Preharvest

FOR FALL HARVEST ONLY. Apply 6.0 to 8.0 grams (active ingredient) gibberellic acid per acre to improve harvesting efficiency of semi-upright varieties and to increase yield of spinach under cool growing conditions. For best response, apply when daytime temperatures are 40^{o} to 70^{o}F (4.4^{o} to 21.1^{o}C) and when early morning dew is present on the crop. Make one application in 20 to 50 gallons of water per acre by ground equipment 12 to 18 days before each harvest. When applying gibberellic acid to promote growth of a second or third cutting, wait until some regrowth has occurred before making application.

Harvest and Post Harvest Considerations

For processing, harvest before plants are too large (or begin to bolt in spring plantins), usually when 16" to 17" tall. A second cut is made often in summer planted for fall harvest after suitable regrowth has developed. At harvest, the first cut is made 6-7 inches above the ground to eliminate as much stem and petiole and older leaves as possible for the whole leaf pack. Prior to the second cutting, small disks can be used to cut away yellow or old leaves and to remove some soil away from the crown to facilitate harvest. Depending on temperature, and plant density, 3-4 weeks are needed between the first and second cutting to obtain adequate regrowth.

For fresh market harvests, plants prior to harvest should be dry to prevent petiole breakage. When harvesting by hand, cut leaves above the crown or soil line and bunch. Care should be taken to exclude leaves that are dirty with soil or are yellow. Bunched spinach must be handled very carefully to reduce breakage of plants or bunches during bunching, washing and packaging. Spinach for bag mixes are usually hand harvested, but mechanical harvesters for this purpose are now available. Walk-behind harvesters are also available for smaller acreage growers.

Special guidances for handing cut spinach, particularly for the bagged salad market, have been developed due to elevated food safety concerns. See this website for more information: http://www.caleafygreens.ca.gov/food-safety-practices

Store spinach at 32 F and 95 to 100% relative humidity. Spinach is very perishable; hence, it can be stored for only 10 to 14 days. The storage temperature should be as close to 32 F as possible. Crushed ice should be used for rapid cooling and for removing the heat of respiration. Top ice is also beneficial. Hydro-cooling and vacuum cooling are other satisfactory cooling methods for spinach.

Most spinach for fresh market is prepackaged in perforated plastic bags to reduce moisture loss and physical injury. Controlled atmospheres with 10 to 40 percent carbon dioxide and 10% oxygen have been found to be beneficial in retarding yellowing and extending shelf life.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in spinach.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Preplant Incorporated

Cycloate--2.5 to 3.0 lb/A. Apply 3.0 to 4.0 pints per acre Ro-Neet. Apply before seeding and incorporate into soil 2 to 4 inches with disk. Delay of planting for 7 to 10 days may help reduce potential injury.

Preemergence

S-metolachlor--0.32 to 0.63 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in spinach in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions. A**pply 0.33 to 0.67 pints per acre Dual Magnum 7.62E to control annual grasses, galinsoga, and certain other broadleaf weeds. Use as a surface-applied preemergence spray. DO NOT preplant-incorporate Dual Magnum into the soil. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Apply Dual Magnum to spinach accurately with a well calibrated sprayer. The margin of crop safety for Dual Magnum on spinach is narrow; rates higher than recommended for the soil type may result in crop injury. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Observe a minimum preharvest interval of 50 days.**

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Clopyralid--0.047 to 0.188 lb/A. Apply 2.0 to 8.0 fluid ounces of Stinger 3A or OLF per acre in a single application to control certain annual and perennial broadleaf weeds. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 8.0 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Application of higher recommended rates, 0.094 to 0.188 lb/A (4.0 to 8.0 fluid ounces), may cause a crop response that appears as a more upright leaf development. Yield and maturity are not affected. Observe a minimum preharvest interval (PHI) of 21 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow-crop restrictions, or injury may occur from herbicide carryover.

Phenmedipham--0.33 to 0.67 lb/A. Apply 2.0 to 4.0 pints per acre Spin-aid 1.3E. For use on spinach for processing only. Controls seedling broadleaf weeds. Only chickweed less than three inches long or tall can be controlled consistently. Scout fields regularly and reapply if weeds germinate after the initial application, but do NOT exceed 6.0 pints per acre per year and maintain a 40-day preharvest interval. Apply only during the fall months to spinach with a minimum of four to six true leaves. Apply in a spray volume of 10.0 to 18.0 gallons of water per acre. The use of an 8002 flat fan nozzle or a comparable nozzle is suggested. See label for application restrictions, mixing instructions, and weather restrictions to prevent crop injury or herbicide failure.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. Choose Poast 1.5EC to control large crabgrass. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Annual blue-grass, yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Cutworms (Also see Chapter E "Cutworms" section in "Soil Pests--Their Detection and Control".)

Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

Flea Beetle

Apply one of the following formulations:
beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL **foliar** 2.00 to 5.25 fl.oz/A Scorpion 35SL, or 1.0 to 3.0 oz/A Venom 70SG
imidacloprid--**foliar only** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

Aphids

Apply one of the following formulations:
acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC

flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro (or OLF), **foliar** 1.3 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
pymetrozine--2.75 oz/A Fulfill 50WDG
spirotetramat--4.0 to 5.0 fl oz/A Movento SC
sulfoxaflor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Leafminers

Apply one of the following formulations:
abamectin--1.7 to 3.5 fl oz/A Agri-Mek 0.70 SC (or OLF)
chlorantraniliprole--**soil/foliar** 5.0 to 7.5 fl oz/A Coragen 1.67SC
cyromazine--2.66 oz/A Trigard 75WSP
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.00 to 5.25 fl oz/A Scorpion 35SL, or 1.0 to 3.0 oz/A Venom 70SG
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 10.0 fl oz/A Entrust SC

Cabbage Looper (CL), Beet Armyworm (BAW)

Apply one of the following formulations:
Bacillus thuringiensis **(CL only)**--0.5 to 1.0 lb/A Dipel DF (or OLF)
beta-cyfluthrin (**CL only)**--1.6 to 2.4 fl oz/A Baythroid XL
chlorantraniliprole--**soil/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin **(CL only)**--1.6 to 2.4 fl oz/A Tombstone (or OLF)
emamectin benzoate--3.2 to 4.8 oz/A Proclaim 5SG
flubendiamide (**BAW only**)--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)

Note: Continuous use of methomyl may result in leafminer outbreaks. DO NOT apply methomyl when minimum daily temperature is 32°F (0°C) or lower. DO NOT apply to spinach seedlings less than 3 inches in diameter.

methoxyfenozide (**early season**)--4.0 to 8.0 fl oz/A Intrepid 2F; (**late season**)--8.0 to 10.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Grasshoppers

Apply one of the following formulations:
beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
carbaryl--0.5 to 1.5 qt/A Sevin XLR Plus (or OLF)
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone (or OLF)
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360

Webworms

Apply one of the following formulations:

Note: Sprays must be applied before webbing occurs.

Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
chlorantraniliprole (**Hawaiian beet webworm only**) **drip, foliar**--3.5 to 5.0 fl oz/A Coragen 1.67SC
methoxyfenozide (**Garden webworm only) (early season)**-4.0 to 8.0 fl oz/A Intrepid 2F; (**late season**)--8.0 to 10.0 fl oz/A Intrepid 2F

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	7
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
carbaryl	G	12	14
chlorantraniliprole (soil/foliar)	G	4	1
clothianidin (soil/foliar)	G	12	see label/21
cyfluthrin	R	12	0
cyromazine	G	12	7
dinotefuran (soil/foliar)	G	12	21/7
emamectin benzoate	R	12	7
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide+buprofezin	G	12	7
imidacloprid (soil/foliar)	G	12	21/7
imidacloprid + beta-cyfluthrin	R	12	7
indoxacarb	G	12	3
methomyl	R	48	7
methoxyfenozide	G	4	1
pymetrozine	G	12	7
spinetoram	G	4	1
spinosad	G	4	1
sulfoxaflor	G	12	3
spirotetramat	G	24	3
thiamethoxam (soil/foliar)	G	12	30/7
thiamethoxam + chlorantraniliprole (soil/foliar)	G	12	30/7
zeta-cypermethrin	R	12	1
FUNGICIDE (FRAC code)			
Actigard (Group P)	G	12	7
Aliette (Group 33)	G	12	3
Cabrio (Group 11)	G	12	0
coppers, fixed (Group M1)	G	24	0
Fontelis (Group 7)	G	12	3
MetaStar (Group 4)	G	48	21
Presidio (Group 43)	G	12	2
Quadris (Group 11)	G	4	0
Ranman (Group 21)	G	12	0
Reason (Group 11)	G	12	2
Revus (Group 40)	G	4	1
Ridomil Gold (Group 4)	G	48	21
Ridomil Gold Copper (Groups 4 + M1)	G	48	21
Tanos (Groups 11 + 27)	G	12	1
Ultra Flourish (Group 4)	G	48	21
Uniform (Groups 4 + 11)	G	0	AP

See Table D-6.
[1] G = general, R = restricted,
[2] AP -At plant

Disease Control

Seed Treatment

Use seed treated with Maxim 4FS (0.08 to 0.16 fl oz/100 lb seed) for *Rhizoctonia* and *Fusarium* control and Apron XL LS (0.16 to 0.64 fl oz./100 lb seed) for *Pythium* control.

Damping-Off

Apply one of the following preplant incorporated or as a soil surface spray after planting:

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A or 2.0 to 4.0 pt Ultra Flourish 2E/A)
metalaxyl (MetaStar)--4.0 to 8.0 pt 2E
Uniform (mefenoxam + azoxystrobin)--0.34 fl oz 3.66SE/1000 ft row

At planting application of mefenoxam or metalaxyl will also help control early-season white rust infections in spinach.

Downy Mildew (Blue Mold) and White Rust

Rotate away from spinach for at least 2 years. Use resistant varieties where possible. Do not plant spring crop near overwintered fields. The use of mefenoxam or metalaxyl at planting for damping-off control will provide early season control. Fungicides containing copper may cause phyto-toxicity.

Foliage Application: Beginning 2 to 3 weeks after emergence (or prior to symptom development), apply one of the following FRAC code 11 fungicides (do not apply if temperature is 90^{o}F [32.2^{o}C] or above):

Cabrio--12.0 to 16.0 oz 20EG/A (white rust only use 8.0 to 12.0 oz.)
Quadris--12.0 to 15.5 fl oz 2.08SC/A (white rust only use 6.0 to 15.5 fl oz/A)
Reason--5.5 to 8.2 fl oz 500SC/A
Tanos--8.0 to 10.0 oz 50W/A

and alternate on a 7 to 10-day schedule with one of the following fungicides:

Ranman--2.75 fl oz 400F/A (plus an organosilicone or nonionic surfactant, see label for details, do not apply with copper)
Presidio--4.0 fl oz 4SC/A
Revus--8.0 fl oz 2.08F/A
Aliette--3.0 lb 80WDG/A
Actigard--0.5 to 0.75 oz 50WG/A
Ridomil Gold Copper--2.5 lb 65WP/A (14-day schedule)
Fixed copper (see labels for rates and details)

FRAC code 11 fungicides, such as Quadris, Cabrio, Reason and Tanos should not be applied more than twice before switching to a fungicide with a different mode of action. **Shanked application:** mefenoxan--0.25 pt Ridomil Gold 4SL/A, 0.5 pt Ultra Flourish 2E/A or 1.0 pt MetaStar 2E/A may be shanked in 21 days after planting or after first cutting. A second shanked application may be made 21 days later or after the second cutting.

Leaf Spots and Anthracnose

These diseases can be prevalent in overwintered spinach and during periods between second and third cuttings. Apply one of the following as soon as symptoms appear in the spring or shortly after cutting and repeat every 7 to 10 days. If more than 2 applications are needed, apply a copper fungicide prior to making a third application of either FRAC code 11 fungicide:

Quadris--6.0 to 15.5 fl oz 2.08SC/A
Cabrio--12.0 to 16.0 oz 20EG/A
Fontelis--14.0-24.0 fl oz 1.67SC/A

FRAC code 11 fungicides, such as Quadris and Cabrio should not be applied more than twice before switching to a fungicide with a different mode of action

Cucumber Mosaic Virus

Use resistant (MR and MMR) varieties. See table.

STRAWBERRIES

"**The Mid-Atlantic Commercial Berry Guide for Commercial Growers",** a cooperative publication for Pennsylvania, Maryland, New Jersey, Delaware, West Virginia, and Virginia, contains additional information and can be found on the website pubs.cas.psu.edu/freepubs/MAberryGuide.htm.

Annual Production System on Plastic Mulch

This system is recommended for Delaware, Maryland, New Jersey, Virginia, southeastern Pennsylvania, and for trial in other areas of Pennsylvania.

Varieties

Early	**Late**
Sweet Charlie[1]	Ovation
Midseason	**Everbearer**
Chandler	Albion
Camarosa[2] (shipping only)	Seascape
Allstar	
Darselect	

[1] Matures 7 to 10 days earlier than Chandler; recommended for trial in southern regions of Maryland. Plant only in areas with low risk of frost. May require overhead sprinkler for additional frost protection during bloom.
[2] Must be fully red-ripe for flavor development.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Annual System Strawberries	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	90-120	100	70	40	0	165	115	65	0	Total nutrient recommended.
	60-75	100	70	40	0	165	115	65	0	Broadcast and disk-in.
	15-25	0	0	0	0	0	0	0	0	Inject through drip at first flowering in Spring.
	15-25	0	0	0	0	0	0	0	0	Inject through drip at fruit enlargement, about 2-weeks after first flowering.

For crops grown on plastic mulch, fertility rates are based on a standard row spacing of 5 feet. Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Background

The annual strawberry production system has potential for increased profitability over conventional matted-row plantings. Establishment costs are higher, but production is earlier (when crop value is highest) and of higher quality. Start with small acreage and increase as knowledge and experience is gained with the system. This is an integrated system and all of the components are important for maximum production and efficiency. Omission of one or more of the following components could lead to failure.

Site Selection

Plan the field location of strawberries grown on plastic and matted rows carefully if you intend to harvest by Pick-Your-Own. Pick-Your-Own customers have a strong preference for berries grown on plastic and may not pick matted row strawberries located in adjacent fields. The annual system has given highest yields at locations with a long growing season. Select fields with good surface and internal drainage, a southern exposure, and protection from westerly winds.

Field Preparation

Have the soil tested to determine specific nutritional needs. Apply 50 to 75 pounds actual nitrogen plus P_2O_5 and K_2O at the rates recommended from the soil test, plus 1.0 to 2.0 pounds of boron unless soil test results indicate above-normal levels, and work into beds. Base additional phosphorus, potassium, and boron application rates on soil test results. It is particularly important to adjust the soil pH to the 6.0 to 6.5, according to methods described in Section B. Prepare raised beds (30 to 40 inches wide and 6 to 8 inches high) on 5- to 5½-foot row centers. Beds should be center-crowned and firm. Depending on soil type, plant vigor, and plant tissue test results, inject an additional 30 to 40 pounds of nitrogen per fertilized-mulched acre through the drip system in the spring. **For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.**

Weed Control.

Fumigation is essential to control weeds because labeled residual herbicides cannot be used over the top of the plastic to provide adequate weed control around the plant hole. Several weed control options are listed below to control troublesome winter annuals and other weeds that grow around plant holes.

Prepare soil, apply fertilizer, then apply fumigant. See the Chapter E "Soil Fumigation" and "Nematodes" sections under "Soil Pests--Their Detection and Control" for materials, rates, and precautions. Wait 20 days to allow the fumigant to act and disperse. Then prepare raised beds as described above and apply 4.0 to 6.0 pounds per acre of Devrinol DF-XT to the surface of the bed and the area between beds. Lay drip irrigation and plastic mulch.

OR

Apply fertilizer, prepare raised beds, and inject metam-sodium (Vapam HL) at 56.0 to 75.0 gallons per acre or 37.0 gallons per mulched acre. Immediately reshape beds (if necessary to form a firm, crowned bed) and apply 4.0 to 6.0 pounds per acre of Devrinol DF-XT to the surface of the bed and the area between beds, and lay drip irrigation and plastic mulch. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

OR

Apply fertilizer and prepare raised beds as described above. Apply 4.0 to 6.0 pounds per acre of Devrinol DF-XT to the surface of the bed. Apply drip irrigation and plastic mulch. Inject metam-sodium (Vapam HL) through the drip system at 37 gallons per mulched acre. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

Weeds between the mulched beds can be controlled with standard strawberry weed control herbicides recommended for matted-row culture. Band the treatment between the strips of plastic. Grasses between the rows and around plant holes can be controlled by postemergence applications of Poast 1.5EC. See recommendations for Poast 1.5EC in the "Weed Control" section of Matted Row Culture.

Plants and Planting

The best current option is the use of transplant "plugs" propagated from actively growing runner tips. Plugs can be purchased directly or one can purchase tips and produce the plugs. To produce plugs, use a well-drained artificial mix containing 50% peatmoss and 50% horticultural vermiculite or 50% pearlite. A poorly drained growing medium promotes root diseases. A list of nurseries that supply plugs and runner tips, and/or directions for propagating from tips, is available through your local county Extension office.

Plugs are easy to plant mechanically with a waterwheel-type planter. Be sure to place the crown of the transplant at the soil level when planting. Deep planting can promote decay of the plant and shallow planting allows the plant to dessicate. Space plants 12 inches apart in each of the double rows in a staggered pattern. Space double rows 12 to 18 inches apart on the bed. The 18-inch between-row spacing has produced high yields and requires a 36- to 40-inch wide bed.

Plant in late August to early September for highest first-year yields in southern New Jersey, Delaware, Maryland, and Virginia. In Pennsylvania and northern New Jersey plant in mid to late August. Mid-September is the latest recommended planting date.

Renovation

Strawberries grown on plasticulture can be renovated in July. For varieties (Sweet Charlie) and plantings with moderate vigor, mow tops with a rotary mower, leaving several leaves on the plant. For very vigorous varieties (Chandler) and plantings, cutting away a portion of the crown with an asparagus knife leaving 3 crowns or a combination of mowing followed by crown thinning, may be the most effective renovation technique. After renovation, maintain adequate soil moisture and good insect and disease control. In early September, apply 60 pounds of N, P_2O_5, and K_2O per mulched acre via drip irrigation and manage the renovated planting using the same cultural practices as for a new planting.

Renovation has improved berry size, however, size is usually smaller than in the first harvest season. Marketable yields of renovated strawberries have been equal to yields in the first harvest season with careful management. Renovation is especially useful if the planting will be harvested as a Pick-Your-Own.

Row Covers

Floating row covers (FRC) are an essential part of the system to reduce the desiccating effects of winter winds, for frost and freeze protection, and early fruiting. Ultraviolet light resistant covers with a weight of 1.0 to 1.4 ounces per square yard and 60 to 70 percent light transmission have been effective. Apply FRC between October 15 and November 15, depending on location and planting date, for maximum fall growth and yields. FRC can be applied in early December for overwinter protection. Remove the FRC at the first signs of flower bud emergence. Leaving the covers on too long may reduce fruit size. Leave the covers at the edge of the field so plants can be quickly covered if there is a frost warning.

Irrigation

Overhead irrigation at planting is essential to cool plants and plastic in warm weather and improve establishment. Provide for irrigation in the fall to promote good plant growth before row covers are applied. Large fruit size is important for high crop value, and adequate moisture is critical for maintaining good fruit size. Drip irrigation is effective in increasing fruit size without wetting the fruit and causing increased fruit rots. Be prepared to irrigate frequently to maintain favorable soil moisture in the spring. Overhead mist irrigation may be required in the spring for frost and freeze protection.

Pest Control.

Use an effective disease control program. To control Phytophthora crown rot caused by *Phytophthora cactorum* on newly set transplants apply Ridomil Gold 4SL--1.0 pt/A through the trickle irrigation system after transplanting. Apply a fungicide to control leaf spots after plants are established and just before covering plants with the floating row in the fall. Insecticides and miticides should be applied during late summer and fall to prevent aphids and mites from reaching damaging levels in the spring. Maintain a good pest control program after covers are removed in the spring.

Bloom sprays are important for control of Botrytis gray mold. See "Disease Control" and "Insect Control" sections for materials and rates.

Harvesting

The Chandler variety grown with the annual system ripens about 1 week earlier than standard varieties grown in matted rows. The duration of harvest is about 3 weeks. For local markets, harvest when tips have red color.

Matted Row Culture

Varieties[1]

Early	Late
Earliglow (RSR)	Ovation
Annapolis (RSR)	Jewel
Midseason	
Darselect	
Allstar (VR,RSR)	
Honeoye	

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

New Plantings

Matted Row Strawberries	Pounds N per Acre	Soil Phosphorus Level Low	Med	High (Opt.)	Very High	Soil Potassium Level Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	110-150	100	70	40		165	115	65	0	Total amount of nutrients recommended
	30	100	70	40		165	115	65	0	Broadcast and disk-in deep
	20-30	0	0	0		0	0	0	0	Sidedress 2 weeks after planting
	20-30	0	0	0		0	0	0	0	Sidedress when first runners start
	30-40	0	0	0		0	0	0	0	Topdress in mid-August
	10-20	0	0	0		0	0	0	0	Topdress in February or March

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Established Plantings

Matted Row Strawberries	Pounds N per Acre	Soil Phosphorus Level Low	Med	High (Opt.)	Very High	Soil Potassium Level Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
	30	100	70	40		165	115	65	0	Topdress at renovation
	20-30	100	70	40		165	115	65	0	Topdress in Mid-August
	20-30	0	0	0		0	0	0	0	Topdress in February or March at greenup

Plants

Use certified dormant plants packed dry in polyliners.

Spacing

Plant virus-free plants as early in the spring as possible. Plant in rows approximately 4' apart with plants 18 to 30 inches apart in row. Distance will depend on variety and soil type. The approximate number of plants needed at these spacings per acre is between 4,400 and 7,300.

Renovation

Strawberry beds must be renovated annually (immediately after harvest) to thin the plants, retain vigor, and maintain berry size in subsequent years. Follow the steps below when renovating strawberry plantings:

1. Apply 2,4-D herbicide for broadleaf weed control. Wait 7 to 8 days for weeds to absorb the herbicide.
2. Mow off the leaves as close to the ground as possible without damaging the crowns.
3. Narrow row widths to 12 inches using a cultivator or rototiller. Allow ½ to 1 inch of soil to cover crown.
4. Apply topdressing with N as indicated in tables above, andP, and K preferably as based on soil test results, or as indicated in recommendations above.
5. Apply preemergent herbicides.
6. Irrigate to incorporate fertilizer and herbicide.

Pollination

Honeybees and wild bees are important for proper pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Do not apply insecticides during bloom. If an insecticide must be applied during bloom, see section on "Pollination" in the General Production Recommendations and/or Table D-6 for relative toxicity of various pesticides for hazards to bees and observe precautions for use.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

New Planting-Posttransplant

DCPA--6.0 to 9.0 lb/A. Apply 8.0 to 12.0 pints per acre Dacthal 6F. Apply preplant incorporated with shallow cultivation before transplanting, or apply anytime after transplanting to weed-free soil. Primarily controls annual grasses and certain small-seeded broadleaf weeds.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT to weed-free soil immediately after trans-planting. Activate with one-half inch sprinkler irrigation within 24 hours after application. Napropamide left on the soil surface is broken down by sunlight. Irrigation moves the herbicide into the soil and prevents breakdown by the sun. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds.

Terbacil--0.10 to 0.15 lb/A. Apply 2.0 to 3.0 dry ounces of Sinbar 80WDG per acre after transplanting but before new runner plants start to root. Controls many annual broadleaf weeds, but may be weak on pigweed species. Do NOT add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar 80WDG label. If strawberry transplants are allowed to develop new foliage prior to applicaton, the spray must be followed immediately by 0.5 to 1.0 inches of irrigation or rainfall to wash the Sinbar 80WDG off the strawberry foliage, or unacceptable crop injury may result. University data has shown that more consistent weed control and less crop injury occurs when 0.05 lb/A, 1.0 dry ounce, of Sinbar 80WDG is applied at 3 week intervals. Begin applications 3 to 6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height.

Certain varieties differ in their sensitivity to Sinbar 80WDG. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80WDG to soils with less than 0.5% organic matter. Do NOT use more than 8.0 ounces of Sinbar 80WDG per acre per year unless otherwise directed on the label.

New Planting-Postemeergence (summer)

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 4 days.

Sethoxydim--0.2 to 0.4 lb/A. Apply 1.0 to 2.0 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 7 days and apply no more than 2.5 pints per acre in one season.

Terbacil--0.1 to 0.3 lb/A. Apply 2.0 to 6.0 dry ounces of Sinbar 80WDG per acre in late summer or early fall to control winter annual broadleaf weeds. Use lower rates on coarse-textured sandy soils low in organic matter, and higher rates on fine-textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar 80WDG label. If the crop is not dormant at the time of application, the spray must be followed immediately by 0.5 to 1.0 inches of irrigation or rainfall to wash the Sinbar 80WDG off the foliage, or unacceptable crop injury may result.

University data has shown that more consistent weed control and less crop injury occurs when 0.05 lb/A, 1.0 dry Ounce, of Sinbar 80WDG is applied at 3 week intervals. Begin applications 3 to 6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height.

Certain varieties differ in their sensitivity to Sinbar 80WDG. Determine varietal tolerance before spraying field. DO NOT apply Sinbar 80WDG to soils with less than 0.5% organic matter. DO NOT use more than 8 ounces of Sinbar 80WDG per acre per year unless otherwise directed on the label.

New Planting-Late Fall Dormant

DCPA--6.0 to 9.0 lb/A. Apply 8.0 to 12.0 pints per acre Dacthal 6F. Apply to weed-free soil in the fall and repeat in earlyspring, but do not apply after bloom. Primarily controls annual grasses and certain broadleaf weeds.

Napropamide--2.0 to 3.0 lb/A. Apply 4.0 to 6.0 pounds per acre of Devrinol DF-XT (or OLF). Apply in late fall through early winter (not on frozen ground) or in early spring. Do not apply from bloom through harvest. Rainfall or irrigation will increase effectiveness. Primarily controls annual grasses and certain broadleaf weeds, including chickweed spp.

Clethodim--0.094 to 0.125 lb/A. (See the preceding “Clethodim” paragraph.)

Sethoxydim--0.2 to 0.4 lb/A. (See the preceding "Sethoxy-dim" paragraph.)

Terbacil--0.1 to 0.2 lb/A. Apply 2.0 to 4.0 dry ounces of Sinbar 80WDG per acre just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds, but may be weak on pigweed species. Use lower rates on coarse textured sandy soils low in organic matter, and higher rates on fine textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive. Do NOT apply within 110 days of harvest.

Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. DO NOT apply Sinbar 80WDG to soils with less than 0.5% organic matter. DO NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

Bearing Year-Late Winter or Early Spring

Clopyralid--0.047 to 0.250 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Stinger 3A or OLF to control weeds in strawberries in New Jersey, Maryland, Pennsylvania, and Virginia. The legal use of this product may require a waiver of Liability that has been signed by the grower, and returned to Dow AgroSciences.** Apply 2.0 to 10.5 fluid ounces of Stinger 3A or OLF per acre in one or two applications during the spring to control certain annual and perennial broadleaf weeds. Observe a minimum preharvest interval (PHI) of 30 days.

When two applications are used to control succeptible hard-to-kill perennial weeds, spray the first application in the spring at least 30 days before harvest and second application at renovation, after harvest. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds, but do not exceed 10.5 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. Do NOT tank-mix Stinger or OLF with other herbicides registered for use in strawberries. A generic formulation of clopyralid, called Spur, is labeled in all states, but only allows one application per year after harvest. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe crop restrictions or injury may occur from herbicide carryover.

DCPA--6.0 to 9.0 lb/A. Apply 8.0 to 12.0 pints per acre Dacthal 6F. Apply anytime to weed-free soil in the early spring. Do not apply after bloom. Primarily controls annual grasses and certain broadleaf weeds.

Flumioxazin--0.096 lb/A. Apply 3.0 dry ounces of Chateau 51WDG to established stands of matted row strawberries in late winter or early spring when strawberries are dormant, or as a hooded or shielded spray between the rows of strawberries on plastic mulch before fruit set. Controls many annual broadleaf weeds, and suppresses or controls wild pansy. Tank-mix with 2,4-D to improve the spectrum of weeds controlled when treating dormant matted row strawberries, or tank-mix with Gramoxone when aplying a hooded or shielded spray between the rows of strawberries grown on plastic mulch. Oil concentrate at 1% of the spray solution (1.0 gallon per 100 gallons of spray solution) or nonionic surfactant at 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) may be added to improve the control of emerged weeds, but may also increase the risk of crop injury.

Napropamide--2.0 to 3.0 lb/A. Apply 4.0 to 6.0 pounds per acre Devrinol DF-XT (or OLF). Apply in late fall through early winter (not on frozen ground) OR in early spring. Do not apply from bloom through harvest. Rainfall or irrigation will increase effectiveness. Primarily controls annual grasses and certain broadleaf weeds.

Clethodim--0.094 to 0.125 lb/A. (See the preceding “Clethodim” paragraph.)

Sethoxydim--0.2 to 0.4 lb/A. (See the preceding "Sethoxy-dim" paragraph.)

2,4-D--1.0 to 1.5 lb/A. Apply 1.0 to 1.5 quarts per acre amine form of 2,4-D (Formula 40) to established stands in late winter or early spring when the strawberries are dormant. Controls many broadleaf weeds. Do not apply unless possible injury to the crop is acceptable. Do not apply 2,4-D between mid-August and winter dormancy, as it may affect flower bud formation, resulting in distorted berries.

Bearing Year Renovation-Summer

Clopyralid--0.047 to 0.250 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Stinger 3A or OLF to control weeds in strawberries in New Jersey, Maryland, Pennsylvania, and Virginia. The legal use of this product may require a waiver of Liability that has been signed by the grower, and returned to Dow AgroSciences.** Apply 2.0 to 10.5 fluid ounces of Stinger 3A or OLF per acre in one or two applications to control certain annual and perennial broadleaf weeds. When two applications are used to control succeptible hard-to-kill perennial weeds, spray the first application in the spring at least 30 days before harvest and second application at renovation, after harvest. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds, but do not exceed 10.5 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. DO NOT tank-mix Stinger or OLF with other herbicides registered for use in strawberries. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

DCPA--6.0 to 9.0 lb/A. Apply 8.0 to 12.0 pints per acre Dacthal 6F. Apply anytime after harvest to weed-free soil. Primarily controls annual grasses and certain broadleaf weeds.

Paraquat--0.5 lb/A. Apply 2.0 pints per acre of Gramoxone SL 2.0 or OLF as a directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution). Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. Do not apply more than 3 times per season. See the label for additional information and warnings.

Terbacil--0.2 to 0.4 lb/A. Apply 4.0 to 8.0 ounces per acre Sinbar 80WDG at postharvest renovation after old leaves have been removed but before new growth begins. Primarily controls broadleaf weeds but does NOT control pigweed species. Use Devrinol, Dacthal, or Poast 1.5 EC to control annual grasses. Use lower rates on coarse-textured sandy soils low in organic matter, and higher rates on fine-textured silt and clay soils high in organic matter. DO NOT add surfactant, oil concentrate, or any other spray additive. Certain varieties differ in their sensitivity to Sinbar 80WDG. Determine varietal tolerance before spraying field. DO NOT apply Sinbar 80WDG to soils with less than 0.5% organic matter. DO NOT use more than 8.0 ounces of Sinbar 80WDG per acre per year unless otherwise directed on the label.

Clethodim--0.094 to 0.125 lb/A. (See the preceding “Clethodim” paragraph.)

Sethoxydim--0.2 to 0.4 lb/A. (See the preceding "Sethoxy-dim" paragraph).

2,4-D--1.0 to 1.5 lb/A. Apply 1.0 to 1.5 quarts per acre amine form of 2,4-D (Formula 40) to established stands immediately after the last picking. Controls many broadleaf weeds. Do not apply 2,4-D between mid-August and winter dormancy, as it may affect flower bud formation, resulting in distorted berries.

Established Planting-Late Fall Dormant

DCPA--6.0 to 9.0 lb/A. Apply 8.0 to 12.0 pints per acre Dacthal 6F. Apply to weed-free soil in the fall and repeat in early spring, but do not apply after bloom. Primarily controls annual grasses and certain broadleaf weeds.

Napropamide--2.0 to 3.0 lb/A. Apply 4.0 to 6.0 pounds per acre Devrinol DF-XT (or OLF). Apply in late fall through early winter (not on frozen ground) **OR** in early spring. Do not apply from bloom through harvest. Rainfall or irrigation will increase effectiveness. Primarily controls annual grasses and certain broadleaf weeds, including chickweed spp.

Clethodim--0.094 to 0.125 lb/A. (See the preceding “Clethodim” paragraph.)

Sethoxydim--0.2 to 0.4 lb/A. (See the preceding "Sethoxy-dim" paragraph.)

Terbacil--0.2 to 0.4 lb/A. Apply 4.0 to 8.0 dry ounces of Sinbar 80WDG per acre just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds, but may be weak on pigweed species. Use lower rates on coarse-textured sandy soils low in organic matter, and higher rates on fine-textured silt and clay soils high in organic matter. DO NOT add surfactant, oil concentrate, or any other spray additive. DO NOT apply within 110 days of harvest.

Certain varieties differ in their sensitivity to Sinbar 80WDG. Determine varietal tolerance before spraying field. DO NOT apply Sinbar 80WDG to soils with less than 0.5% organic matter. DO NOT use more than 8 ounces of Sinbar 80WDG per acre per year unless otherwise directed on the label.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Aphids, Spittlebug

Apply one of the following formulations 10 days after new growth begins:

acetamiprid--1.9 to 4.0 oz/A Assail 30SG (or OLF)
azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
bifenthrin--6.4 to 32 oz/A Brigade WSB (or OLF)
diazinon (**aphids only**)--1.0 pt/A Diazinon AG500 (or OLF)
fenpropathrin (**spittlebugs only**)--10.67 oz/A Danitol 2.4EC
imidacloprid **foliar**--1.3 fl oz/A Admire Pro (or OLF)
neem extract (**aphids only**)--0.5 to 1.0% of Trilogy solution
rosemary oil+peppermint oil--1.0 to 4.0 pt/A Ecotec
thiamethoxam--**soil** 1.70 to 4.01 oz/A Platinum 75SG; **foliar** 1.5 to 3.0 oz/A Actara 25WDG (**aphids only**)
thiamethoxam+chlorantraniliprole--**foliar** 2.0 to 4.0 oz/A Voliam Flexi (**aphids only**)

Leafroller

Apply one spray 10 days after full bloom:

acetamiprid--4.0 to 6.9 oz/A Assail 30SG (or OLF) **Oblique banded leafroller only**
azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
bifenthrin--6.4 to 32.0 oz/A Brigade WSB (or OLF)
carbaryl--1.0 to 2.0 qt/A Sevin XLR Plus (or OLF)
diazinon--1.0 pt/A Diazinon AG500 (or OLF)
pyrethrins--4.5 to 18.0 fl oz/A PyGanic EC 5.0 II
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 6.0 fl oz/A Entrust SC

Potato Leafhopper

Apply one of the following formulations:
acetamiprid--1.9 to 4.0 oz/A Assail 30SG (or OLF)
azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
malathion--1.5 to 3.0 pt/A Malathion 57 EC (or OLF)
pyrethrins--4.5 to 18.0 fl oz/A PyGanic EC 5.0 II
thiamethoxam--**soil** 1.70 to 4.01 oz/A Platinum 75SG, **foliar** 3.0 to 4.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**foliar** 2.0 to 4.0 oz/A Voliam Flexi

Root Weevils

Note: Foliar sprays target adults. Soil applications target larvae. Apply one of the following formulations:
Entomopathic nematodes (use *Heterorhabdtitis bacterio-phora*). Apply 1-2 billion per acre during evening or early morning when soil temperatures are 60°F (15.6°C) or greater, then irrigate them into the soil.
malathion--1.5 to 3.0 pt/A Malathion 57EC (or OLF)
thiamethoxam--**soil** 1.70 to 4.01 oz/A Platinum 75SG; **foliar** 4.0 oz/A Actara 25WDG
bifenthrin--8.0 to 32.0 oz/A Brigade WSB (or OLF)

Sap Beetles

Sap beetles are attracted to ripe, decaying fruit and bore into berries. They are a nuisance, especially in Pick-Your-Own fields where rotting, over-ripe berries abound. Preventing the accumulation of decaying fruit on or between beds is one way of avoiding beetle buildup. Apply one of the following formulations:

acetamiprid--4.0 to 6.9 oz/A Assail 30SG (or OLF)
azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
bifenthrin--6.4 to 32.0 oz/A Brigade WSB (or OLF)
fenpropathrin--16.0 to 21.3 fl oz/A Danitol 2.4 EC
novaluron—12.0 fl oz/A Rimon 0.83EC

Slugs

Slugs prefer a cool, wet, dark environment. Mulch, weeds, and other plant trash in beds during a wet spring provide the perfect setting for their development. Mulch removal and adequate weed control are two ways to reduce the slug population. Apply one of the following formulations:
metaldehyde--see labels for rates.
iron phosphate--20.0 to 44.0 lb/A Sluggo (or OLF)

Strawberry Rootworm

Use of broad-spectrum insecticides for other pests will aid in controlling strawberry rootworm.

Spotted Wing Drosophila

Spotted wing drosophila has been problematic on day-neutral strawberries during late summer and fall, but not on strawberries earlier in the season. Apply one of the following formulations:

fenpropathrin--16.0 to 21.3 fl oz/A Danitol 2.4EC
spinetoram--6.0 to 10.0 fl oz/A Radiant SC

Strawberry Weevil (Strawberry Clipper)

Apply one of the following formulations after new growth starts and before fruit buds are visible. Repeat 10 days later:

azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
chlorpyrifos--1.0 qt/A Lorsban 4E (or OLF). Apply when buds first appear and again 10-14 days later. DO NOT apply after blossoms are open.
bifenthrin--6.4 to 32.0 oz/A Brigade WSB (or OLF)
fenpropathrin--16.0 to 21.3 fl oz/A Danitol 2.4 EC

Tarnished Plant Bug

Apply one of the following formulations:
acetamiprid--4.0 to 6.9 oz/A Assail 30SG (or OLF)
azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
bifenthrin--6.4 to 32.0 oz/A Brigade WSB (or OLF)
fenpropathrin--10.67 fl oz/A Danitol 2.4EC
pyrethrins--4.5 to 18.0 fl oz/A PyGanic EC 5.0 II
rosemary oil+peppermint oil--1.0 to 4.0 pt/A Ecotec

Thrips

Apply one of the following formulations:
acetamiprid--4.0 to 6.9 oz/A Assail 30SG (or OLF)
azadirachtin--15.0 to 30.0 oz/A Ecozin Plus 1.2% ME (or OLF)
neem extract--0.5 to 1.0% of Trilogy solution
pyrethrins--4.5 to 18.0 fl oz/A PyGanic EC 5.0 II
rosemary oil+peppermint oil--1.0 to 4.0 pt/A Ecotec
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 6.0 fl oz/A Entrust SC

Two-Spotted Spider Mite (TSSM)

For best results, control TSSM early in the spring before eggs are laid. Thorough underleaf spray coverage is necessary. Alternate materials with different modes of action. Apply one of the following formulations:

abamectin--16.0 fl oz/A Epi-mek 0.15 EC (Temprano, or OLF)
acequinocyl--21.0 to 31.0 fl oz/A Kanemite 15SC
bifenazate--0.75 to 1.00 lb/A Acramite 50WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
fenbutatin-oxide--1.5 to 2.0 lb/A Vendex 50WP (or OLF)
fenpyroximate--2.0 pt/A Portal
hexythiazox--6.0 oz/A Savey 50DF (or OLF)
neem extract--0.5 to 2.0% of Trilogy solution
rosemary oil+peppermint oil--1.0 to 4.0 pt/A Ecotec
spiromesifen--12.0 to 16.0 fl oz/A Oberon 2SC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
abamectin	R	12	3
acequinocyl	G	12	1
acetamiprid	G	12	1
azadirachtin	G	4	see label
bifenazate	G	12	1
bifenthrin	R	12	0
bifenthin + avermectin B1	R	12	3
buprofezin	G	12	3
carbaryl (foliar)	G	12	7
chlorantraniliprole	G	4	1
chlorpyrifos	R	24	Prebloom
diazinon	R	72	5
etoxazole	G	12	1
fenbutatin-oxide	R	48	1
fenpropathrin	R	24	2
fenpyroximate	G	12	1
flubendiamide	G	12	1
hexythiazox	G	12	3
imidacloprid (soil/foliar)	G	12	14/7
iron phosphate	G	0	0
malathion	G	12	3
metaldehyde[3]	G	12	see labels
methoxyfenozide	G	4	3
neem extract	G	4	0
novaluron	G	12	1
pyrethrins	G	12	0
pyriproxyfen	G	12	2
rosemary + peppermint oil	G	4	0
spinetoram	G	4	1
spinosad	G	4	1
spiromesifen	G	12	3
thiamethoxam(soil/foliar)	G	12	50/3
thiamethoxam+ chlorantraniliprole	G	12	3
FUNGICIDE (FRAC code)			
Abound (Group 11)	G	4	0
Aliette (Group 33)	G	12	0.5
Cabrio (Group 11)	G	12	0
Captan (Group M4)	G	24	0
Captec (Group M4)	G	24	0
Captevate (Groups 17 + M4)	G	24	0
copper, fixed (Group M1)	G	24	0
Elevate (Group 17)	G	12	0
Fontelis (Group 7)	G	12	0
Inspire Super (Groups 3 + 9)	G	12	0
K-Phite (Group 33)	G	4	0
Mettle (Group 3)	G	12	0
Phostrol (Group 33)	G	4	0
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	1
Prophyte (Group 33)	G	4	0
Quintec (Group 13)	G	12	1
Rally (Group 3)	G	24	0
Rampart (Group 33)	G	4	0
Ridomil Gold (Group 4)	G	48	0
Rovral (Group 2)	G	24	prebloom
Scala (Group 9)	G	12	1
Sulfur (Group M2)	G	24	1
Switch (Groups 9 +12)	G	12	0

(table continued next page)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
FUNGICIDE (FRAC code) *(cont'd)*			
Thiram (Group M3)	G	24	3
Topsin M (Group 1)	G	24	1
Torino (Group U6)	G	4	0
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

[1] G = general, R = restricted

[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL

[3] Depends on product formulations. CONSULT LABEL

Nematode Control

See Chapter E - "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Disease Control

Dip Treatments for Freshly Dug (Bare Root) Transplants

Use 5.0 to 8.0 fl oz/ of Abound or Switch per 100 gal. of water for plants with a known anthracnose problem. Dip entire plant for 2 to 5 minutes, then plant as quickly as possible. Phosphite fungicide can be used to suppress *Pythium* or *Phytophthora*. See labels for specific details. Iprodione (2.0 lb 50WP/ 100 gal water) can be used as a preplant dip for gray mold control.

Angular Leaf Spot

This disease may cause caps to turn brown or black resulting in unmarketable fruit. Planting disease-free plants is critical. If symptoms appear after plants are established, applying fixed copper products can help, but not if weather is highly favorable to the disease. Overhead irrigation/frost protection will make this disease worse. Discontinue fixed copper applications if plant injury occurs, usually after 4 to 5 sprays.

Anthracnose Fruit Rot

Begin sprays no later than 10% bloom or prior to disease development and continue on a 7 to 10 day interval. Use the higher rate and shorter intervals when disease pressure is high. Do not make more than two (2) consecutive applications of fungicides other than captan or thiram before switching to a fungicide in a different chemical class. Maintain continuous coverage of captan and/or a FRAC Group 11 (strobilurin) fungicide, by applying the following combinations:

Application #1:

Captan--3.7 lb 80WDG/A or Thiram 4.4 lb 75WDG/A
tank-mixed with
Pristine--18.5 to 23.0 oz 38 WG/A or Cabrio--12.0 to 14.0 oz 20EG/A

Application #2, apply one of the following:

Captevate--3.5 to 5.25 lb 68WDG/A
Captan--3.7 lb 80WDG/A or OLF

Application #3:

Captan--3.7 lb 80WDG/A or OLF or Thiram 4.4 lb/A 480DP/A

tank-mixed with

Pristine--18.5 to 23.0 oz 38WG/A or Cabrio--12.0 to 14.0 oz 20EG/A

For subsequent applications<u>, rotate among the following fungicides or fungicide combinations</u>:

Captan--1.9 to 3.7 lb 80WDG/A or OLF
Elevate--1.1 to 1.5 lb 50WDG/A *plus* Cabrio--12.0 to 14.0 oz 20EG/A
Pristine--18.5 to 23.0 oz 38WG/A
Switch--11.0 to 14.0 oz. 62.5WG/A *plus* Cabrio--12.0 to 14.0 oz 20EG/A
When wet weather persists or during bloom, include Elevate or Switch to improve Botrytis control.

Gray Mold (Botrytis Fruit Rot)

Start sprays when plants begin to bloom, because 90% of fruit infections occur through the flower, and repeat every 7-10 days. Increase spray intervals during persistent dry periods, but decrease intervals to 5-7 days during very wet periods. Four weekly sprays starting at 5-10% bloom are usually sufficient for season-long control. Tank-mix and rotate fungicides from different FRAC codes to reduce the chances for fungicide resistance development.

Application #1, apply one of the following:

Captan--3.7 lb 80WDG/A or OLF
Thiram--4.4 lb 480DP/A
Switch--11.0 to 14.0 oz. 62.5WG/A

Application #2, apply one of the following:

If resistance is unlikely on your farm:
Elevate--1.1 to 1.5 lb 50WDG/A
Fontelis--16.0 to 24.0 fl oz 1.67SC/A (except Jewel, L'Amour, and Clancy varieties)
If testing, observation or frequent prior use of the above materials indicates high resistance risk:
Captevate--3.5 to 5.25 lb 68WDG/A
Captan--3.7 lb 80WDG/A or OLF
Thiram--4.4 lb 480DP/A

Application #3:

same as Application #1

<u>For subsequent applications, rotate between two or more of the following fungicides</u>:

Captan--3.7 lb 80WDG/A
Captevate--3.5 to 5.25 lb 68WDG/A
Elevate 1.1 to 1.5 lb 50WDG/A
Switch--11.0 to 14.0 oz. 62.5WG/A
Fontelis--16.0 to 24.0 fl oz 1.67SC/A (except Jewel, L'Amour, and Clancy varieties)

Fungal Leaf Blight, Leaf Scorch and Leaf Spot

Leaf diseases are not usually problematic in strawberries, particularly in the fall or early spring. Incidence may be associated with plant source, but prolonged warm, wet weather favors increased disease. In such cases, don't make more than 2 consecutive applications of FRAC Group 11 fungicides (Cabrio & Pristine) before switching to another product to reduce chances of fungicide resistance development. A**pply one of the following:**

Captan--3.8 lb 80WDG/A or OLF
Captec--3.0 qt/A 4L/A
Captan--2.5 lb 80WDG/A or OLF *plus* Topsin-M--1.0 lb 70WP/A
Cabrio--12.0 to 14.0 oz. 20EG/A
Pristine--18.5 to 23.0 oz 38WG/A
Rally--2.5 to 5.0 oz 40WSP/A

Rovral--1.5 to 2.0 pt 4FL/A (prebloom only)

Powdery Mildew

Unless symptoms are severe, crop losses are rare in the fall and the disease may not reappear in the spring. Check both sides of leaves in the spring for disease pressure. Severe disease during spring may justify fungicide application on a 14 to 21 day interval. To reduce chances of fungicide resistance developing, don't make more than 2 consecutive applications of FRAC Group 11 fungicides (Cabrio and Pristine). Apply one of the following:

Cabrio--12.0 to14.0 oz 20EG/A
Rally--2.5 to 5.0 oz 40WSP/A
Pristine--18.5 to 23.0 oz 38WG/A
Procure--4.0 to 8.0 oz 50WSP/A
Quintec--4.0 to 6.0 fl oz 2.08SC/A
Torino--3.4 oz 0.85SC/A
Mettle--3.0 to 5.0 fl oz 125ME/A
Inspire Super--16.0 to 20.0 fl oz 2.8F/A

Virus Diseases

Use certified, virus-free plants.

Red Stele and Phytophthora Crown Rot

Where possible, prevent spread of the red stele pathogen via cultivation equipment and/or surface runoff water. Selecting fields with well-drained soils and planting on high, raised beds will help reduce disease. Crop rotation may be of little value, as the red stele pathogen persists in soil for many years, and persistence of the crown rot pathogen is unknown. However, disease is very unlikely when clean plants are introduced to soil with no history of strawberry production. If red stele is present, use resistant varieties such as 'Allstar', 'Earliglow', 'Guardian' and 'Latestar', which have resistance to several races. No resistant cultivars are available for crown rot. The following fungicides can be applied as preplant dips (for "freshly dug" or "bare root" transplants), foliar sprays, or by drip irrigation for additional control. See section on preplant dips for further information on this method. For other application methods:

New Plantings

Foliar sprays of phosphite products should begin 14 to 21 days after planting and continue on a 30 to 60 day interval as long as favorable disease conditions occur. These products include:

Aliette--2.5 to 5.0 lb 80WDG/A
K-Phite--1.0 to 3.0 qt/A
ProPhyt--2.0 to 4.0pt/A
Phostrol--2.5 to 5.0 pt/A
Rampart--1.0 to 3.0 qt/A

Fungicides containing mefenoxam or metalaxyl can be applied as sprays or through drip irrigation. These fungicides include:

Ridomil Gold--1.0 pt 4SL/*treated* A
Ultra Flourish--2.0 pt 2F/*treated* A
Metastar 2E--2.0 qt 2F/*treated* A

Calculate the correct rate for drip applications as for a banded spray:

Width of Bed (in inches) X Broadcast rate of fungicide = Fungicide rate for Drip Application
Bed Spacing (in inches)

For example, for strawberries planted in beds on 5 ft (60 inch) centers:

30 inch-wide bed/60 inches between beds X 1 pt/A = 0.5 pt 4SL/A of strawberry.

Established Plantings

Spring applications should begin when plants start active growth and before 1st bloom. Foliar sprays of phosphite products should be repeated every 30 to 60 days as long as weather conditions favor disease development. These products include:

Aliette--2.5 to 5.0 lb 80WDG/A
K-Phite--1.0 to 3.0 qt/A
ProPhyt--2.0 to 4.0 pt/A
Phostrol--2.5 to 5.0 pt/A
Rampart--1.0 to 3.0 qt/A

Fungicides containing mefenoxam or metalaxyl can be applied as sprays or through drip irrigation. The first spring application should be made when plants start active growth before 1st bloom. A second spring application may be made at fruit set when Ridomil Gold is used, but not Meta Star or Ultra Flourish. All 3 products may be applied to perennial plantings in the fall after harvest has been completed. These fungicides include (apply one of the following):

Ridomil Gold--1.0 pt 4SL/*treated* A
Ultra Flourish--2.0 pt 2E/*treated* A

Calculate the correct rate for drip applications as for a banded spray:

Width of Bed (in inches) X Broadcast rate of fungicide = Fungicide rate for Drip Application
Bed Spacing (in inches)

For example, for strawberries planted in beds on 5 ft (60 inch) centers:

30 inch-wide bed/60 inches between beds X 1 pt/A = 0.5 pt 4SL/A of strawberry

Black Root Rot

This is a disease complex caused by cultural stresses coupled with many different fungi and by nematode feeding injury, and is the main reason for preplant fumigation of strawberry. The most prevalent fungi associated with the disease are *Rhizoctonia* and *Pythium*. Crop rotation of 4 to 5 years will reduce the incidence of black root rot. In fields with a high water table, the use of raised beds will provide some control.

SUMMER SQUASH

Varieties[1]

Scallop Types
Flying Saucer (yellow and green)
Garden Sun (yellow)
Peter Pan (light green)
Starship (dark green)
Sunburst (yellow/golden)
Sunny Delight (yellow)

Specialty Types
Comela (light green Middle Eastern)
Eight Ball (round green)
Magda (light green Middle Eastern)

Yellow Straightneck Types
Conqueror (GMO) GS (CMV,WMV2,ZYMV)
Fortune PY
Goldprize GS (WMV2, ZYMV)
Lemondrop L GS
Liberator (GMO), PY (CMV,WMV2,ZYMV)
Lioness GS (CMV,WMV2,ZYMV)
Multipik PY
Patriot II (GMO) PY (WMV2,ZYMV)
Seneca Prolific GS
Superpik PY
XPT 1832 III (GMO) (CMV,WMV2,ZYMV)

Yellow Crookneck Types
Gentry (tolerant to high temperatures)
Gold Star (CMV)
Prelude II (GMO) GS (CMV,WMV2, ZYMV,PM)
Superset PY (CMV, WMV)

Zucchini Green
Cashflow (ZYMV)
Dividend (CMV,WMV2, ZYMV)
Elite
Equinox (WMV2,ZYMV,PM)
Judgement III (GMO) (CMV, WMV2,ZYMV, PM)
Justice III (GMO) (CMV, WMV2, ZYMV)
Independence II (GMO) ((WMV2,ZYMV)
Paycheck (CMV,WMV2,ZYMV,PM)
Payroll (WMV2,ZYMV,PM)
Revenue (CMV,WMV2,ZYMV)
Reward (PMT, ZYMV, WMV2 CMV)
Spineless Beauty
Spineless Perfection (PM, ZYMV,WMV)
Tigress (WMV2,ZYMV)

Zucchini Yellow
Golden Delight (WMV2,ZYMV)
Golden Glory (WMV2,ZYMV,PM)
Goldenrod (CMV,WMV2)
Gold Rush

Listed alphabetically; consult seed vendor for maturity information
Viral Resistance genes: CMV=Cucumber Mosaic Virus, WMV2=Watermelon Mosaic Virus 2, and ZYMV=Zucchini Yellow Mosaic Virus
[1]ALL SUMMER SQUASH VARIETIES ARE HYBRIDS. Varieties listed by maturity within each type, earliest first and are recommended for DE, D, NJ, PA, VA and WV
[2]**GMO**, where denoted variety transformed with viral coat protein antisense for strong virus resistance. Varieties not denoted **GMO** have conventionally-bred resistance as indicated.
[3]In yellow-fruited summer squash the precocious yellow gene, (PY) confers tolerance to CMV and WMV2 as compared to the green stem (GS) counterpart.
[4]PM where denoted indicates varieties with intermediate resistance to powdery mildew.
Varieties with multiple resistance are available (see above table). Varieties expressing the precocious yellowing gene (PY) such as 'Multipik' will mask the greening of fruit caused by WMV and CMV, but will become bumpy and/or distorted when infected with either PRSV or ZYMV. **All 4 viruses may be detected at some level in squash fields in our region in any given year, therefore it is best to plant varieties with resistance to more than one virus, especially in later plantings when virus transmission by aphids increases. Virus resistance and PWR recommended for Fall/late planting.**

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Summer Squash	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	75-100	150	100	50	0[1]	200	150	100	0[1]	Total nutrient recommended.
	25-50	150	100	50	0[1]	200	150	100	0[1]	Broadcast and disk-in.
	50	0	0	0	0	0	0	0	0	Sidedress and fertigate when vines start to run.
	25-30	0	0	0	0	0	0	0	0	Apply through irrigation system.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.
[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. See the Disease section for more information to treat seed to prevent disease.

Seeding, Transplanting, and Spacing

Seed April 15 through August 15 in warmer, southern regions and May 10 to August 1 in Pennsylvania and other cool areas. Use 4 to 6 pounds of seed per acre.

Container-grown plants are planted through the plastic when daily mean temperatures have reached 60^{o}F (15.6^{o}C). Planting dates vary from April 15 in southern regions to June 1 in northern areas. Early plantings should be protected from winds with hot caps, tents, or row covers.

Space rows 5 to 6 feet apart with plants 2 to 3 feet apart in the row.

Mulching

Fumigated soil aids in the control of weeds and soil-borne diseases. Plastic mulch laid before field plantings conserves moisture, increases soil temperature, and increases early and total yields. Several fumigants can be used on summer squash depending what the predominant pests are. Plastic and fumigant should be applied to well-prepared planting soil 30 days before field planting. Various widths of plastic mulch are available depending on individual production systems and available equipment. The soil must be moist when laying the plastic. Fumigation alone may not provide satisfactory weed control under plastic. Black plastic or paper can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate (NO_3^{-1}) form.

Foil mulches can be used to repel aphids that transmit mosaic in fall-planted (after July 1) squash. Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil or other repellent mulches. Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Growers may wish to consider trickle irrigation. See the section on "Irrigation" in this publication.

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on "Pollination" in the General Production Recommendations and/or Table D-6 for relative toxicity of various pesticides for hazards to bees.

Harvest and Post Harvest Considerations

Zucchini and summer squash are harvested after fruits reach the desired size but before they forms hard seeds or rinds. Crook-neck, straight-neck and zucchini should be 1.25 to 2 inches in diameter and zucchini and straight-neck squash 7 to 8 inches long. Scallop squash should be 3 to 4 inches in diameter. Summer squash and zucchini are delicate and are easily prone to bruising and scratching. Handle with care when harvesting, grading and packing. Squash should be stored at 41^{o} to 50^{o}F and 95% relative humidity. The typical shelf life is 7 to 14 days. Summer squash is highly sensitive to freezing injury. Do not store or transport together with ethylene producing crops.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See the "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.

Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME as a banded directed shielded spray preemergence to the weeds to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use, or use Strategy, the jug-mix that contains clomozone (Command) and ethalfluralin (Curbit).

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 1.12 lb/A. Apply 1.0 to 3.0 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use on transplanted summer squash. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2.0	0.4	0.125
3.0	0.6	0.188
4.0	0.8	0.250
5.0	1.0	0.312
6.0	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command)

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray between rows of plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1.0 dry ounce of Sandea, applied preemergence. Do NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094**

pound per acre, equal to 2.0 dry ounces of Sandea, in a year.

Postemergence

Carfentrazone--0.008 to 0.031 lb/A. Apply 0.5 to 2.0 fluid ounces of Aim 2EC or Aim 1.9EW as a banded directed shielded spray between the rows of plastic mulch to suppress or control broadleaf weeds including morningglory species, pigweed species, common lambsquarters, and nightshade species when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Aim applied postemergence will not control annual or perennial grasses. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution), or oil concentrate or methylated seed oil to be 1 to 2% percent of the spray solution (1.0 to 2.0 gallons per 100 gallons of spray solution). **The shielded (hooded) sprayer must be designed to prevent spray or drift from contacting the stems, leaves, flowers or fruit of the crop, or severe injury may occur.**

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.5 to 0.66 dry ounce Sandea 75WG as a banded directed shielded spray between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, in a year.**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately

after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 0.94 lb/A. Apply 1.0 to 2.5 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips Between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Corn Maggot

(See Chapter E "Maggots" section in "Soil Pests--Their Detection and Control".) **Note.** The use of imidacloprid at planting will reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles can transmit bacterial wilt and cause stand losses by direct feeding injury. If adult beetles are abundant and there is a history of disease problems, insecticides should be applied before beetles feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence, and repeat applications at weekly intervals if new beetles continue to invade fields. Apply one of the following formulations:

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--2.4 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.0 fl oz/A Danitol 2.4EC
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Squash Vine Borer

When vines begin to run, apply one of the following formulations:to bases of plants four times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins.

Note: Use of spinosad for looper control will reduce squash vine borer populations.

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz /A Endigo ZC
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Cutworms

(Also see Chapter E the "Cutworms" section in "Soil Pests--Their Detection and Control".)

Apply one of the following formulations:
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz /A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pickleworm, Melonworm

Make one treatment prior to fruit set, and then treat weekly with one of the following formulations:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
chlorantraniliprole--melonworm **drip** 2.0 to 3.5 fl oz/A, **foliar** 2.0 to 5.0 fl oz/A Coragen 1.67SC; pickleworm **drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress

lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinosad--4.0 to 8.0 fl oz/A Entrust SC
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Aphids

Note. Aphids transmit multiple viruses. Cultivars that are resistant to multiple aphid-transmitted viruses are available. For chemical control of aphids, apply one of the following formulations:

acetamiprid--2.5 to 4.0 oz/A Assail 30G (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50SG
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
pymetrozine--2.75 oz/A Fulfill 50WDG
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG (or OLF); **foliar** 1.5 to 3.0 oz/A Actara 25WDG)
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi

Stink bug

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Apply one of the following formulations:
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC

Squash Bug

Begin treatments if greater than one egg mass per plant is present. Sprays should target nymphal stages. For best squash bug control, under leaf spray coverage is essential. Apply one of the following formulations:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
azadirachtin--7.0 to 16.0 fl oz/A Neemix Apply when pests first appear and are in their early nymphal stages.
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
permethrin--8.0 fl oz/A Perm-Up 3.2EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz Hero EC

Leafminers

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
cyromazine--2.66 oz/A Trigard 75WSP
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2 EC (or OLF)
spinosad--6.0 to 8.0 fl oz/A Entrust SC
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SC (or OLF)

Rindworms (cucumber beetle larvae)

Damage to the rinds may result from a complex of insect pests including cucumber beetle, wireworms, and a number of "worm" species, (beet army worm, etc). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle section for labeled products.

For Lepidopteran rindworms, use one of the following formulations:

flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress

Cabbage Looper

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.0 fl oz/A Danitol 2.4EC
flubendiamide--1.5 fl oz/A Belt SC

flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 oz/A Hero EC

Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season. Apply one of the following formulations:

Note. Continuous use of carbaryl, or pyrethroids may result in mite outbreaks.

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
bifenazate--0.75 to 1.00 lb/A Acramite 50 WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	0
azadirachtin	G	4	0
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin	R	12	3
bifenazate	G	12	3
carbaryl	G	12	3
chlorantraniliprole	G	4	1
clothianidin(soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	0
dinotefuran (soil/foliar)	G	12	21/1
esfenvalerate	R	12	3
etoxazole	G	12	7
fenpropathrin	R	24	7
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide+buprofezin	G	12	1
imidacloprid (soil)	G	12	21
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	1
lambda-cyhalothrin+ chlorantraniliprole	R	24	1
lambda-cyhalothrin+ thiamethoxam	R	24	1
methomyl	R	48	3
methoxyfenozide	G	4	3
oxamyl	R	48	1
permethrin	R	12	0
pymetrozine	G	12	0

(table continued on next page)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE *(continued)*			
spinetoram	G	4	3
spinosad	G	4	3
spiromesifen	G	12	7
sulfloxafor	G	12	1
thiamethoxam			
soil/drip	G	12	30
foliar	G	12	0
thiamethoxam+ chlorantraniliprole			
soil/drip	G	12	30
foliar	G	12	1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Flint (Group 11)	G	12	0
Folicur (Group 3)	G	12	7
Fontelis (Group 7)	G	12	1
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
Inspire Super (Groups 3 + 9)	G	12	7
Mancozeb (Group M3)	G	24	5
MetaStar (Group 4)	G	48	AP
Presidio (Group 43)	G	12	2
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quadris Top (Groups 11 + 3)	G	12	1
Rally (Group 3)	G	24	0
Ranman (Group 21)	G	12	0
Revus (Group 40)	G	4	0
Ridomil Gold (Group 4)	G	48	5
Tanos (Groups 11 + 27)	G	12	3
Torino (Group U6)	G	4	0
Ultra Flourish (Group 4)	G	48	5
Uniform (Groups 4 + 11)	G	0	AP
Zampro (Groups 45 + 40)	G	12	0

See Table D-6.
1 G = general, R = restricted, AP = At planting
2 Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
3 AP -At plant

Nematode Control

See Chapter E - "Nematodes" part of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section of the same chapter, or

Vydate L--1.0 to 2.0 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2.0 to 4.0 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480DP (4.5 fl oz/100 lb) and an approved commercially available insecticide.

Damping-Off

Apply one of the following in a 7-inch band after seeding.

Use formula in the "Calibration for Changing from Broadcast to Band Application" of Section E Calibrating Granular Application Equipment to determine amount of Ridomil Gold, Ultra Flourish or MetaStar needed per acre:

mefenoxam (Ridomil Gold--1.0 **to** 2.0 pt 4SL/A or 2.0 **to** 4.0 pt Ultra Flourish 2E/A)
metalaxyl (MetaStar--4.0 **to** 8.0 2E/A)
Uniform--0.34 fl oz 3.66SE/1000 ft row

Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV, and CMV.

Varieties with multiple resistance packages are available (see variety table). Varieties expressing the precocious yellowing gene such as "Multipik" will mask the greening of fruit caused by WMV2 and CMV but will become distorted when infected with either PRSV or ZYMV. **All 4 viruses may be detected at some level in squash fields in the region in any given year, therefore plant varieties with resistance to more than one virus.** The following control measures should also be used.

Plant fields as far apart as possible from existing cucurbit plantings to reduce the chances for aphid transmission. Using reflective mulch may help to prevent aphid transmission of viruses. (See preceding "Mulching" section.)

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be neccessary.

Choanophora Fruit Rot

This disease occurs during warm wet weather and develops predominantly on flowers or fruit near the ground. Management is difficult because disease development is rapid, and weather dependant. Fungicide sprays are not effective because flowers, which open daily, must be protected immediately. Practices that reduce soil moisture or reduce soil contact, such as raised beds and plastic mulch, may be beneficial.

Powdery Mildew

Some available varieties have intermediate resistance to powdery mildew and should be used if possible. The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures.

Powdery mildew generally occurs from mid-July until the end of the season. Make the first fungicide application when powdery mildew is observed in the area or is detected by scouting (one lesion on the underside of 45 old leaves), begin the following fungicide program:

Alternate one of the following tank mixes:
Torino--3.4 fl oz *plus* chlorothalonil--2.0 to 3.0 pt 6F/A
Procure--4.0 to 8.0 fl oz 480SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Rally--5.0 oz 40WSP/A *plus* chlorothalonil-2.0 to 3.0 pt 6F/A
tebuconazole--4.0 to 6.0 fl oz 3.6 F/A or OLF *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Inspire Super 16.0 to 20.0 fl oz 2.8 F/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Fontelis--12.0 to 16.0 fl oz 1.67SC/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF
Pristine--12.5 to 18.5 oz 38WG/A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Downy Mildew

Scout fields for disease incidence early in the growing season. Begin sprays when plants meet in the row or if disease occurrence is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (http://cdm.ipmpipe.org) for current status of the disease. **Preventative applications are much more effective than applications made after downy mildew is detected.** The following are the most effective materials. Tank-mix one of these products with a protectant such as chlorothalonil--1.5 to 2.0 pt 6F/A or OLF:

Ranman--2.10 to 2.75 fl. oz. 400 SC/A
Previcur Flex--1.2 pt 6F/A
Zampro--14.0 fl oz 525SC/A

Other materials for use in rotation as tank mix partners with a protectant:
Tanos--8.0 oz 50DF/A
Forum--6.0 fl oz 4.17SC/A
Gavel--1.5 to 2.0 lb 75 DF/A (Gavel contains the protectant mancozeb, and does not need a tank-mix partner)
Curzate--3.2 oz 60DF/A
Presidio--3.0 to 4.0 fl oz 4SC/A

Materials with different modes of action (FRAC codes) should be alternated to reduce the chances for fungicide resistance development.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Plectosporium Blight (Microdochium blight)

A three year rotation with crops other than cucurbits is advised. It is important to achieve maximum foliage coverage with the fungicide application. Once symptoms appear on petioles or after fruit form, apply one of the following and repeat every 7 to 10 days:

chlorothalonil--2.0 to 3.0 pt 6F/A, or OLF
mancozeb--2.0 to 3.0 lb 75DF/A or OLF
Quadris Top--12.0 to 14.0 fl oz 2.7 F/A

A spray schedule that rotates Cabrio or Flint with chlorothalonil will also provide control.

Scab

Use resistant varieties when possible. Scab develops during cool periods. Begin sprays as true leaves form and repeat every 5 to 7 days:

chlorothalonil--2.0 to 3.0 pt 6F/A or OLF

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate Rotate away from susceptible crops (such as peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits) for as long as possible. Preplant fumigants will also suppress disease. Fields should be adequately drained to ensure that water does not accumulate around the base of the plant. Mefenoxam (Ridomil Gold or Ultra Flourish) or metalaxyl (MetaStar) should be applied pre-plant for early season control. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. When conditions favor disease development, apply one of the the following with fixed copper at labeled rates (for suppression only):

Revus--8.0 fl oz 2.08F/A
Ranman--2.75 fl. oz. 400 SC/A
Presidio--3.0 to 4.0 fl oz 4SC/A
Forum--6.0 oz 4.17SC/A
Gavel--1.5 to 2.0 lb 75DF/A
Tanos--8.0 to 10.0 oz. 50DF/A

Materials with different modes of action (i.e. FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Presidio may also be applied through the drip irrigation (see label for details). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

SWEET CORN

Varieties

Fresh Market Sweet Corn Variety Selection Guide

Variety	Relative Maturity	Kernel Type[1]	Disease Reactions[2] Et	Pst	Ps	MDMV	Bm	Bt Insect Resistance[3]
Bicolor Varieties								
Xtra-Tender 272A	72	Aug		I			I	
Temptation	72	SE						
Temptation II (GMO)	72	SE						Performance
Mirai 366BC	73	Mirai						
Sweet Rhythm	73	Syn	I	I				
Awesome	74	Syn		I				
Xtra-Tender 2074	74	Aug		I	R			
Marquette	76	SS	I					
BSS0977(GMO)	78	SS	I	I	R			Attribute
Summer Sweet HiGlow 7932MR	78	SS	I	I	R		I	
Xtra-Tender 278A	78	Aug	I	I			I	
Montauk	79	Syn	I	I				
Obsession	79	Aug	I	I	R			
Obsession II (GMO)	79	Aug	I	I	R			Performance
Summer Sweet 7902R	79	SS	R	I	R		I	
Sensor	80	SE	I		I			
BC0805 (GMO)	82	Syn			I		I	Attribute
Providence	82	Syn			R		I	
Serendipity	82	Syn					I	
Delectable	84	SE	I	I	R	R		
Journey	84	Syn	I	I	I	I		
White Varieties								
Mirai 421W	71	Mirai	I	I	I			
Xtra-Tender 372A	72	Aug		I			I	
Frosty	73	SE	I	I				
Sugar Pearl	73	SE	I	I	I			
Sweet Ice	74	Syn		I				
Whiteout	74	SE	I	I				
Edelweiss	76	SE						
Ice Queen	77	SS	I	I	I	I		
Xtra-Tender 378A	78	Aug		I			I	
Munition	78	SS	I	I	R	I		
Mattapoisett	80	Syn	I	I	I			
WSS0987 (GMO)	81	SS	I		R			Attribute
Avalon	82	Syn	I	I			I	

(table continued next page)

Varieties *(continued)*

Fresh Market Sweet Corn Variety Selection Guide

			Disease Reactions[2]					
Variety	Relative Maturity	Kernel Type[1]	Et	Pst	Ps	MDMV	Bm	Bt Insect Resistance[3]
White Varieties								
Devotion	82	Aug		I				
Silver King	82	SE	I	I	I		I	
Argent	83	SE	I	R	I			
Celestial	84	Syn	I	R	I			
Yellow Varieties								
Vision	73	Aug		I			I	
GSS0966 (GMO)	78	SS	I	I	R			Attribute
Summer Sweet 7210R	78	SS	R	R	R		R	
Incredible	82	SE		I	R	R		

[1]Kernel Type: SE = Sugary Enhanced, SS = Supersweet, Syn = Synergistic, Aug = Augmented Shrunken. See Table "Sweet Corn Genetics and Isolation Requirements" table for additional details. (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
[2]R=resistance; I=intermediate/partial resistance
Et = Northern corn leaf blight caused by *Exserohilum turcicum*; Pst = Stewart's wilt caused by *Pantoea stewartii*; Ps = Common rust caused by *Puccinia sorghi*; MDMV = Maize dwarf mosaic virus; Bm = Southern corn leaf blight caused by *Bipolaris maydis*. (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
[3]Insect resistance from *Bacillus thuringiensis* transgenes is available in some varieties. Attribute varieties have the Cry1Ab gene for corn earworm and European corn borer (ECB) resistance. Performance Series varieties have the Cry1A.105 and Cry2AB genes for corn earworm, ECB and fall armyworm resistance. Performance Series varieties also have transgenes conferring glyphosate resistance. (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)

Processing[1] Sweet Corn Variety Selection Guide

				Disease Reactions[3]				
Variety	**Color**	**Relative Maturity**	**Kernel Type[2]**	**Et**	**Pst**	**Ps**	**MD MV**	**Bm**
Protégé	yellow	77	SS	R	I	R		R
SS Jubilee Plus	yellow	83	SS			R		I
Overland	yellow	84	SS	R	R	R		I
GSS 2259P	yellow	84	SS	I	I	R	R	
GSS 1453	yellow	84	SS	R		R		
GH 6462	yellow	83	SU	I	I	R	I	I
GH 9597	yellow	83	SU	I	R	R	R	

[1]Use varieties recommended by processors. Local adaptation and quality needs of processors must be considered. Consult the Delaware Extension Vegetable Program website for results from recent processing sweet corn variety trials: http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/ (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
[2]Kernel Type: SU = Sugary/Normal, SS = Supersweet. See Table "Sweet Corn Genetics and Isolation Requirements" table for additional details. (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
[3]R=resistance; I=intermediate/partial resistance(Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
Et = Northern corn leaf blight caused by *Exserohilum turcicum*; Pst = Stewart's wilt caused by *Pantoea stewartii*; Ps = Common rust caused by *Puccinia sorghi*; MDMV = Maize dwarf mosaic virus; Bm = Southern corn leaf blight caused by *Bipolaris maydis*. (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Sweet Corn	**per Acre**	**Pounds P_2O_5 per Acre**				**Pounds K_2O per Acre**				**Nutrient Timing and Method**
Fresh Market	125-150	160	120	80	0[1,2]	160	120	80	0[1,2]	Total nutrient recommended.
	40-60[3]	120	100	60	0[1]	120	100	60	0[1]	Broadcast and disk-in.
	20	40	20	20	0[1,2]	40	20	20	0[1,2]	Band-place with planter.
	50-75[3]	0	0	0	0	0	0	0	0	Sidedress when corn is 12-18 inches tall.
Processing	125-175	120	80	60	0[2,4]	120	80	60	0[2,4]	Total nutrient recommended.
	55-80	80	60	40	0	80	60	40	0	Broadcast and disk-in.
	20	40	20	20	0[2,4]	40	20	20	0[2,4]	Band-place with planter.
	50-75	0	0	0	0	0	0	0	0	Sidedress 2 weeks after emergence.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

[1]In Virginia, crop replacement values of 40 lbs. P_2O_5 and 40 lbs. K_2O per acre are recommended on soils testing Very High.

[2]For early planting when soil temperatures are low, band 20 lbs. P_2O_5 and 20 lbs. K_2O per acre when soil tests are Very High to facilitate early growth.

[3]On very sandy soils, reduce the amount of nitrogen (N) applied via broadcast application and disked-in. Instead, split N applications to include an additional split when corn is 6-inches tall of 40 lbs. N per acre. So, N is applied with the broadcast fertilizer, at-planting in a band, when corn is 6 inches tall, and again when corn is 12-18 inches tall. In New Jersey, consult your Extension Agent for more information on the approved pre-sidedress nitrate test.

[4]In Virginia, crop replacement values of 20 lbs. P_2O_5 and 20 lbs. K_2O per acre are recommended on soils testing Very High.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for sweet corn.

Critical sweet corn tissue test values.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
Whole plants at the 6 inch stage	**Deficient**	<3.0	0.3	2.5	0.5	0.25	0.4	<50	40	30	10	5	0.1
	Adequate range	3	0.3	2.5	0.5	0.25	0.4	50	40	30	10	5	0.1
		4	0.5	4	0.8	0.5	0.6	100	100	40	30	10	0.2
	High	>4.0	0.5	4	0.8	0.5	0.6	>100	100	40	30	10	0.2
	Toxic (>)	-	-	-	-	-	-	-	-	-	100	-	-
Most recently matured leaves at the 30 inch stage	**Deficient**	<2.5	0.2	2.5	0.5	0.2	0.2	<40	40	25	10	4	0.1
	Adequate range	2.5	0.2	2.5	0.5	0.2	0.2	40	40	25	10	4	0.1
		4	0.4	4	0.8	0.4	0.4	100	100	40	30	10	0.2
	High	>4.0	0.4	4	0.8	0.4	0.4	>100	100	40	30	10	0.2
	Toxic (>)	-	-	-	-	-	-	-	-	-	100	-	-
Most recently matured leaves just prior to tassel	**Deficient**	<2.5	0.2	2	0.3	0.15	0.2	<30	30	20	10	4	0.1
	Adequate range	2.5	0.2	2	0.3	0.15	0.2	30	30	20	10	4	0.1
		4	0.4	3.5	0.6	0.4	0.4	100	100	40	20	10	0.2
	High	>4.0	0.4	3.5	0.6	0.4	0.4	>100	100	40	20	10	0.2
	Toxic (>)	-	-	-	-	-	-	-	-	-	100	-	-

Pre-sidedress Soil Nitrogen Test (PSNT)

A soil test (PSNT) to determine the need for sidedress nitrogen on sweet corn has been developed. The test is effective for sweet corn grown on soils with loamy-textured, high organic matter or where manure has been applied. Sandy soils with low organic matter are known to have low nitrogen availability without using the PSNT. Contact your local county Extension agent for information on sampling and using the PSNT (NJ only).

Sweet Corn Genetics and Isolation Requirements

Variety Class	Genes Present	Variety Examples	Kernel Properties	Grow apart from class(es)[1]
Normal	*su*	*Silver Queen *Stowells Evergreen	100% normal	*Supersweet *Augmented Shrunken
Sugary Enhanced (heterozygous)	*su, se (1 copy)*	*Silverado *Argent	75% normal 25% sugary enhanced	*Supersweet *Augmented Shrunken
Sugary Enhanced (homozygous)	*su, se (2 copies)*	*Table Sweet™ varietes *Silver King, Sugar Snow II *Imaculata, *Brilliance	100% sugary enhanced	*Supersweet *Augmented Shrunken
Supersweet	sh_2	*Snow White *Boreal *Millenium	100% supersweet	*Normal *Sugary Enhanced (all) *Synergistic (all)
Synergistic (Heterozygous se with sh_2)	*su, se (1 copy),* sh_2 *(1 copy)*	*Sweet Breed™ varieties	56% normal 19% sugary enhanced 25% supersweet	*Supersweet *Augmented Shrunken
Synergistic (Homozygous se with sh_2)	*su, se (2 copies),* sh_2 *(1 copy)*	*TripleSweet™ varieties *Cinderella	75% sugary enhanced 25% tender supersweet	*Supersweet *Augmented Shrunken
Synergistic (Homozygous se with bt_2)	*su, se (2 copies),* bt_2 *(1 copy)*	*Misquamicut *Avalon	75% sugary enhanced 25% tender supersweet	*Supersweet *Augmented Shrunken
Augmented Shrunken	*se (2 copies),* sh_2 *(2 copies)*	*Gourmet Sweet™ varieties *Multisweet™ varieties *Xtra-Tender™ varieties	100% tender supersweet	*Normal *Sugary Enhanced (all) *Synergistic (all)
Mirai™	*su, se (2 copies),* sh_2 *(2 copies)*	*Mirai 002	100% tender supersweet	None necessary

[1]To avoid starchy kernels, isolate by ≥ 500 feet or ≥ 12 days in silking.
All sweet corn must be isolated from field and popcorn varieties by a distance of at least 500 feet.

The sweetness of the corn kernel is determined by both the tassel and silk parent, while the tenderness is determined entirely by the silk parent. Therefore, any pollen from varieties other than the one planted in the field may interfere with sweetness, for example field and popcorn. Certain sweet corn varieties must also be isolated from other sweet corn by greater than 500 feet or 12 days difference in silking date. The table above may be used to determine which corn varieties must be isolated from each other during pollination. Super sweet (sh_2) varieties are more difficult to establish than other types of sweet corn. Handle seed gently and use plateless planters to prevent damage to seed. Soil temperature and soil moisture should be optimum to reduce seed decay and obtain good stands.

Seed Treatment

Request that seed be treated with fungicides, see the disease control section for more information. See insect control section for seed treatments available for seed corn maggot and wireworm control.

Seeding and Spacing

Seed is sown as early as the last week in March on the light, sandy soils. Use a cold-tolerant variety for early plantings. Successive plantings can be made into early July. Corn is drilled in the field at the rate of 12.0 to 15.0 pounds per acre at about 1 inch deep. The smaller eared early varieties are planted in rows 36 inches apart and about 8 to 10 inches between plants in the row. The two-eared varieties and the later large-eared varieties are planted 36 inches between rows and 10 to 12 inches apart in the row. Recommended planting rates are between 14,500 and 19,000 plants per acre.

Mulching

The use of clear plastic mulch will improve stands, conserve moisture, and produce earlier maturity. Corn is seeded in the usual manner except 10 to 20 days earlier in double rows 14 inches apart and on 5- to 6-foot centers. Apply herbicide and then cover with clear, plastic. Using ridges between double rows or wire hoops to allow space for corn seedlings to grow vertically. Allow plastic to remain over plants for 30 days after emergence, then cut and remove plastic from field. Plants can then be grown out in the usual manner. Before using this system, it is recommended that a test be run to determine if nematodes are present. If nematodes are present in the soil, control measures are necessary before the above procedure can be used. Use a cold-tolerant variety to avoid uneven stand and uneven vigor. Sweet corn can also be grown by planting through black plastic or IRT mulch in early plantings using plastic mulch planters.

Harvest and Handling

Fresh Market Sweet Corn

Fresh market sweet corn is best harvested early in the morning when there is reduced field heat.

Harvesting sweet corn at the proper stage is critical to maintain sweetness and tenderness. During the summer, sweet corn will remain in prime condition for only 1-2 days. As the ear reaches prime condition the silks begin to dry down, the husk fills out with plump kernels, and the kernel exudes a milky liquid when punctured with the thumbnail. Ear tips should be filled. Sweet corn will approach maturity 18-22 days after silking and should be picked daily. As the kernel passes prime harvest time, sugars convert to starch and the hull will become tough. Supersweet varieties will maintain sweetness longer than other varieties and extra tender varieties maintain eating quality for a longer period.

Sweet corn may be harvested by hand or mechanically. Mechanical harvesters are more efficient; however, they pick the entire crop at one time. When you handpick corn, grasp the ear near the base and sharply twist it downward while rotating your wrist. Corn is normally piled on a wagon in the field or is put in baskets or bins and then graded/packed at a nearby packing area. At the packing area, sweet corn should be trimmed uniformly to eliminate flag leaves and long shanks. If left on the ear, they will cause packaging problems and induce further moisture loss. Objectionable kernel denting may occur from a moisture loss of 2 percent or less. Only first-quality sweet corn devoid of defects and of uniform maturity, color, shape, and size should be selected and packed. Any ears exhibiting signs of disease or mechanical or insect damage should be discarded along with any ears that lack adequate shuck coverage. Sweet corn for shipping is most commonly packaged in wire bound crates or perforated wax boxes. Burlap bags are also used for local shipment. Pallet or bin boxes are sometimes used; however, corn packed in this manner will be hard to cool completely and ears will heat up in the center of the bin from respiration. Sweet corn for shipping is most commonly packaged in wire bound crates or perforated wax boxes. Burlap bags are also used for local shipment. Pallet or bin boxes are sometimes used; however, corn will Sweet corn quality, sweetness, and tenderness will deteriorate rapidly after harvest. Sweet corn should be cooled immediately after harvest and kept near 32°F to retain optimum freshness. Corn for local markets is often picked daily and sold the same day. Those shipping corn over any distance must first remove all field heat. Recommended cooling methods are hydrocooling and package icing.

Hydrocooling is the most efficient and effective method of cooling corn. Corn is immersed in ice cold water, which quickly removes all field heat. Corn being shipped long distances should be hydrocooled. For smaller growers and short distance shippers, ice can be added to the crate during packing. The addition of 1 pound of ice per 5 lbs. of sweet corn is normally sufficient. Ice can also be blown on top of the crates when placed in a cooler or refrigerated truck.

Corn placed in cold storage before being pre-cooled will not retain freshness for nearly as long as hydrocooled or iced corn.

Processing Sweet Corn

For processing sweet corn, harvest of standard sugary (su) and sugary-extender (se) varieties begins when kernels reach 70-75% moisture. Supersweet (sh2) varieties have a much higher sugar content than su or se varieties and maintain their sugar content longer after harvest. They are usually harvested at 77-78% moisture. Harvest timing will be determined by the processing companies.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

No-Till / Conservation Tillage

Consider production goals, sweet corn variety, date of planting, soil fertility practices, insect control, planting equipment, mulch, and weed species in the field when considering a conservation tillage program. Consult state Cooperative Extension and agricultural specialists for advice.

Paraquat *plus* S-metolachlor *plus* atrazine--0.3 to 0.6 lb/A *plus* 0.96 to 1.91 lb/A *plus* 1.0 to 2.0 lb/A. Apply 1.2 to 2.4 pints per acre Gramoxone SL 2.0 *plus* 1.0 to 2.0 pints per acre Dual II Magnum 7.64E *plus* 1.1 to 2.2 pounds per acre atrazine 90DF (or other atrazine formulations). Add surfactant as indicated on the Gramoxone SL 2.0 or OLF label. Use this combination when existing vegetation includes small annual grasses and/or broadleaf weeds. Gramoxone SL 2.0 or OLF will control existing vegetation, Dual II Magnum will provide residual annual grass control, and atrazine will provide residual annual broadleaf weed control. (See atrazine restrictions under the "Early Emergence" section).

Glyphosate *plus* S-metolachlor *plus* atrazine--0.75 to 1.50 lb glyphosate equivalent/A *plus* 0.96 to 1.91 lb/A S-metolachlor *plus* 1.0 to 2.0 lb/A atrazine. Apply the appropriate acid equivalent rate of Glyphomax Plus, Roundup products or Touchdown products, or OLF (Other Labeled Formulations) *plus* 1.0 to 2.0 pints per acre Dual II Magnum 7.64E *plus* 1.1 to 2.2 pounds per acre atrazine 90DF (or other atrazine formulations). Use this combination when existing vegetation includes dense, well-established annual weeds and/or perennial weeds. Roundup Ultra Max will control existing vegetation in 1 to 3 weeks. Perennial weeds must be treated at the proper growth stage to obtain effective control. (See label for application time and rate.) Dual II Magnum will provide residual annual grass control, and atrazine will provide residual annual broadleaf control. (See atrazine restrictions under the "Early Emergence" section.)

See "Conventional Tillage" section for useful early emergence and postemergence weed control recommendations.

Conventional Tillage

Preplant Incorporated or Preemergence

Alachlor--1.5 to 3.0 lb/A. Apply 1.5 to 3.0 quarts Micro-Tech or Intrro. Primarily controls annual grasses and certain broadleaf weeds, including pigweed, nightshade, and galinsoga, and suppresses yellow nutsedge when preplant incorporated. Combine with atrazine to improve control of other broadleaf weeds. Also available as a jug-mix with atrazine sold as Bullet.

S-metolachlor--0.96 to 1.91 lb/A. Apply 1.0 to 2.0 pints per acre Dual II Magnum 7.64E (or OLF). Primarily controls annual grasses, controls or suppresses yellow nutsedge, and suppresses certain broadleaf weeds. Use preplant incorporated to improve yellow nutsedge control. Combine with atrazine or Extrazine to improve control of most broadleaf weeds. Also available as jug-mixes with atrazine sold as Bicep II Magnum and Bicep II Magnum Lite. **Other**

generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop and may or may not include the safener for corn.

Atrazine--1.0 to 1.5 lb/A. Apply 1.0 to 1.5 quarts atrazine 4FL (or OLF). Primarily controls broadleaf weeds. Combine with Micro-Tech, Partner, or Dual II Magnum to improve control of annual grasses. Use the lowest recommended rate when combined with an annual grass herbicide or to reduce the risk of herbicide residues which may affect certain crops planted the following year. Also sold as jug-mixes, with alachlor sold as Bullet, and with s-metolachlor sold as Bicep II Magnum and Bicep II Magnum Lite.

RESTRICTIONS: Do not double-crop the season atrazine or any atrazine-containing products are used. Grass cover crops can be established after corn harvest provided the recommended rate of atrazine was not exceeded. Moldboard plowing before planting a crop sensitive to atrazine will minimize the risk of injury from atrazine residue. **See label for specific crop rotation restrictions.**

Preemergence

Mesotrione--0.094 lb/A. Apply 3.0 fluid ounces of Callisto 4SC per acre. Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species. Combine with Micro-Tech, Partner, or Dual II Magnum to control annual grasses. Temporary injury, appearing as whitening of the foliage after emergence, may occur. Rainfall or irrigation after planting and treatment, but before emergence, increases the likelihood of crop injury. Cold weather that slows corn growth will also retard recovery from injury following preemergence treatments. Sweet corn varieties differ in sensitivity to mesotrione. The majority of varieties exhibit slight injury symptoms when weather conditions after application are favorable. Certain varieties are tolerant, while others exhibit more noticable injury. Although no variety was severely injured by the recommended rate, postemergence application is preferred when weather conditions that favor injury occur at planting. Severe crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. Lexar and Lumax are labeled jug-mixes that contain mesotrione or s-metolachlor and atrazine. Camix is a labeled jug-mix that contains mesotrione and s-metolachlor. The mesotrione rate applied when the jug-mixes are used may be higher than the recommended rate, which may increase the risk of crop injury and herbicide carryover. **See the sweet corn section of the Callisto label for additional use precautions.**

Early Emergence

Atrazine--1.0 to 2.0 lb/A. Apply 1.0 to 2.0 quarts per acre Atrazine 4L (or OLF). Primarily controls broadleaf weeds. Apply postemergence when weeds and corn are up to 2 inches tall. Add oil concentrate to be 1% of the spray solution. Do Not exceed the maximum rate per acre per year listed on the label for your soil's erodibility class. Also available as a jug-mix with bentazon, sold as Laddok S-12.

RESTRICTIONS: When this and other atrazine treatments are used, do not double-crop during this season. Cover crops after corn are satisfactory providing the recommended rate of atrazine is not exceeded. Mold-board plowing before planting grain or vegetables the following spring will minimize the risk of atrazine residue injury.

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.5 to 0.66 dry ounces Sandea 75WG to control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and velvetleaf. Spray before corn reaches 8 inches in height, or use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage and into the whorl. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade, and will only suppress morningglory species. Always add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant, and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated, but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Corn varieties may vary in sensitivity to Sandea. Use caution when treating new varieties. DO NOT apply to "Jubilee". Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT use if organophosphate (OP) insecticides have been applied to the crop, or the risk of crop injury may increase.**

Carfentrazone--0.008 lb/A. Apply 0.5 fluid ounces per acre Aim 2EC or Aim 1.9EW before corn reaches 8 inches in height to control seedling broadleaf weeds including pigweed species, common lambsquarters, morningglory species, eastern black nightshade, and velvetleaf. Aim will not control ragweed species. Tank-mix with atrazine at reduced rates or another broadleaf weed herbicide to increase the spectrum of weeds controlled. Always add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). Expect to see speckling on the crop foliage after application. Initially the injury may appear to be substantial, but it is not systemic and corn outgrows the injury rapidly. Variety sensitivity to Aim may vary. Use caution when treating new varieties. Weather conditions may affect the degree of injury observed. Injury may be more severe during periods of warm, cloudy weather with high humidity and plentiful soil moisture when corn growth is rapid and "soft." To reduce the risk of crop injury, use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage and into the whorl.

Tembotrione--0.082 lb/A. Apply 3.0 fluid ounces of Laudis per acre postemergence to control many annual broadleaf weeds, including common lambsquarters and triazine-resistant broadleaf weed biotypes, and many annual grasses. Add methylated seed oil (MSO) or concentrate (COC) to be 1% of the spray solution (1.0 gallon per 100 gallons of spray solution). In addition, the label requires the addition of nitrogen liquid fertilizer (1.5 quarts per acre) or AMS (1.5 pounds per acre). Tank mix with 0.25 to 1.0 lbs ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. Do not apply tank-mixes of Laudis and atrazine to corn greater than 12 inches tall. Do not use postemergence if Callisto, Lumax or Lexar was used preemergence. Do not tank-mix with Callisto. Laudis will control/suppress most annual grass species, but may not control certain grass species or grasses larger than the maximum recommended size when treated. Fall panicum is not controlled by Laudis. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before 2 inches in height. Laudis has up to an 18 month replant restriction for many vegetables.

Topramezone--0.016 to 0.022 lb/A. Apply 0.75 to 1.0 fluid ounces of Impact/Armezon 2.8SC per acre postemergence to control many annual broadleaf weeds, including common lambsquarters and triazine-resistant broadleaf weed biotypes, and annual grasses. Add oil concentrate (COC) to be 1% of the spray solution (1 gallon per 100 gallons of spray solution). In addition, the label requires nitrogen fertilizer (liquid or AMS). Tank-mix with 0.25 to 1.0 lbs ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. DO NOT apply tank-mixes of Impact/Armezon and atrazine to corn greater than 12 inches tall. DO NOT use postemergence if Callisto, Lumax or Lexar was used preemergence. DO NOT tank-mix with Callisto. Impact/Armezon will control/suppress crabgrass and most other annual grass species, but may not control certain grass species or grasses larger than the maximum recommended size when treated. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before 2 inches in height. Use the higher recommended rate to suppress or control panicum species or in rescue applications where the target weeds have grown beyond the size indicated on the label. Impact/Armezon has an 18 month replant restriction for most vegetables.

Postemergence

(Annual grass control will be minimal.)

Atrazine--1.0 to 2.0 lb/A. Apply 1.0 to 2.0 quarts per acre Atrazine 4L (or OLF). See atrazine **in Early Postemergence** section.

Bentazon--0.75-1.0 lb/A. Apply 1.5 to 2.0 pints per acre Basagran 4SC. See label for susceptible broadleaf weeds; results are better when weeds are young. Will provide partial control of yellow nutsedge. Grasses will NOT be controlled. Cultivation within 10 to 14 days will increase control. Also available as a jug-mix with atrazine sold as Laddok S-12.

2,4-D Amine--0.25 to 0.5 lb/A. Use 0.5 to 1.0 pint 4EC. Apply after corn and weeds emerge. Use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage or into the whorl of the corn. Warm, wet weather at application may increase the possibility of crop injury. Use the lower recommended rate when these conditions prevail. Delay cultivation for 8 to 10 days after treatment to avoid damaging corn due to temporary brittleness sometimes caused by 2,4-D. Sweet corn varieties differ in 2,4-D tolerance. Super sweet varieties may be more sensitive than other varieties. Injury will be less when the minimum recommended rate is used. Use with caution on new varieties. DO NOT apply from tasseling to dough stage. At high rates, 2,4-D may cause temporary injury to corn. Do not use a sprayer to apply 2,4-D that will be used to spray sensitive crops postemergence.

Ester formulations, although labeled, are more subject to volatilization and movement to sensitive crops and, therefore, are not recommended.

Clopyralid--0.047 to 0.25 lb/A. Apply 2.0 to 10.5 fluid ounces of Stinger 3A or OLF per acre in one or two applications to control certain annual and perennial broadleaf weeds when sweet corn is less than 18 inches tall. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds. Do not exceed 10.5 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow-crop restrictions, or injury may occur from herbicide carryover.

Mesotrione--0.094 lb/A. Apply 3.0 fluid ounces of Callisto 4SC per acre. Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species. Always add nonionic surfactant to be 0.25% of the spray solution (1 quart oer 100 gallons of spray solution), but DO NOT add oil concentrate, liquid fertilizer, or AMS, or tank-mix Callisto and bentazon (Basagran), or severe crop injury may be observed. Temporary minor injury, appearing as whitening of the new foliage, may occur. The crop will quickly outgrow minor injury with no affect on yield or earliness. Sweet corn varieties differ in sensitivity to mesotrione. The majority of varieties may exhibit slight injury symptoms. Certain varieties are tolerant while others exhibit more noticable injury. No variety was severely injured by the recommended rates applied with nonionic surfactant. DO NOT tank-mix Callisto with organophosphate or carbamate insecticides, or apply if the crop was treated with Counter or Lorsban, or severe crop injury may occur**.** Lexar and Lumax are labeled jug-mixes that contain mesotrione or s-metolachlor and atrazine. Camix is a labeled jug-mix that contains mesotrione and s-metolachlor. The mesotrione rate applied when the jug-mixes are used may be higher than the recommended rate, which may increase the risk of crop injury and herbicide carryover. **See the sweet corn section of the Callisto label for additional use precautions.**

Nicosulfuron--0.031 lb/A. Apply 0.9 dry ounces of Accent Q per acre as a broadcast or with drop nozzles as a directed spray as an early postemergence rescue treatment to control emerged annual grasses. Treat sweet corn with a broadcast spray or with drop nozzles as a directed spray up to 12 inches tall or up to and including 5 leaf collars, or as a directed spray with drop nozzles only to sweet corn up to 18 inches tall. Do not treat sweet corn more than 18 inches tall to contol many annual grasses and certain annual broadleaf weeds. Tank-mix with atrazine to increase the spectrum of weeds controlled. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution). Accent is safe to apply to certain varieties, injures others, and kills certain sweet corn varieties. Contact your DuPont Crop Protection Sales Representitive for information on local sweet corn varieties that have been evaluated for tolerance to Accent. Crop injury may be apparent within 1 to 2 weeks of application as yellowing and death of sweet corn foliage, beginning with the youngest leaves first, or the injury may not be observed until harvest. Injury at harvest is seen as a constriction at the top, middle, or bottom of the ear, depending on the time of application. Late postemergence applications are more likely to result in ear injury than early postemergence applications. Accent is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT use if organophosphate (OP) insecticides have been applied to the crop, or the risk of crop injury may increase.**

Postemergence

"Poast Protected" Sweet Corn ONLY!

Sethoxydim--0.15 to 0.3 lb/A. Use ONLY on sweet corn hybrids designated as "Poast Protected" ONLY! Other **sweet corn varieties will be severely injured or killed.** Apply 0.75 to 1.5 pint per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. Applications of Poast to "Poast Protected" sweet corn may be made until the onset of pollen shed. Do NOT apply Poast after pollination has occurred. A second application of Poast may be made 10 days after the first application. For best results, treat annual grasses when they are actively growing and before tillers are present. The rate of 0.75 pints/A should only be used when annual grasses are less than 3 inches tall and temperatures and moisture are favorable for rapid growth. Use a minimum of 1.0 pint/A when weeds are 3 inches tall or larger, or when growing conditions are not optimum. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with Aim due to the potential for severe leaf burn. Volunteer "Poast Protected" sweet corn can be controlled with clethodim (Select, Select Max, or Arrow). Other postemergence grass herbicides such as Fusilade, Assure II, and Targa will NOT control volunteer "Poast Protected" sweet corn. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

"Roundup Ready" Sweet Corn ONLY!

Glyphosate --0.75 to 1.0 lb glyphosate equivalent/A. Apply the appropriate acid equivalent rate of a labeled Roundup product or OLF (Other Labeled Formulations) before weeds exceed two inches in height or 4 true leaves. Larger weeds can be killed but yield may be reduced before the weeds are killed. Treat 3 to 4 weeks after planting when growing conditions are favorable. Perennial weeds must be treated at the proper growth stage to obtain effective control. (See label for application time and rate.) Tank-mix glyphosate with Dual II Magnum for residual annual grass control, and atrazine for residual annual broadleaf control. Observe all rate restrictions and Preharvest Intervals for all products applied.

Nuisance Bird Management and Repellency

Preharvest Treatment

Noise-producing devices are useful to scare away injurious birds. A permit is required to use an exploding device in New Jersey. Permits may be obtained from New Jersey Division of Fish and Wildlife, Clinton WMA, 7 Van Syckels Road, Hampton, NJ 08827, 908/735-8793.

Avitrol is labeled for use in sweet corn, but each state has different regulations and permit processes. Read the label carefully before use. Consult your local county Extension office for current restrictions.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Corn Maggot (SCM), Wireworms (WW)

Early season control of seed corn maggot and wireworm can be achieved with planter-box seed treatments, commercially-treated seed, or in-furrow treatments. Rescue treatments applied post-planting are not effective.

Seed Treatment

1. **Commercially-Applied Seed Treatments (SCM and WW only)**
   abamectin+thiamethoxam (Avicta DUO)
   chlorpyrifos (**SCM only**) (Lorsban 50WSPor OLF)
   clothianidin (Poncho 600)
   clothianidin + Bacillus firmus (Poncho/Votivo)
   imidacloprid (Gaucho 600)
   thiamethoxam (Cruiser 5FS)
2. **Hopper Box Treatments**
   imidacloprid (Latitude ST or OLF)

At-planting Soil-Applied Treatment

chlorpyrifos--8 oz/1000 row ft Lorsban 15G (or OLF)
tefluthrin--4.0 to 5.0 oz/1000 row ft Force 3G
terbufos--6.0 to 8.0 oz/1000 row ft Counter 15G–SmartBox® system only

White Grubs

At-planting Soil-Applied Treatment

chlorpyrifos--8 oz/1000 row ft Lorsban 15G (or OLF)
tefluthrin--4.0 to 5.0 oz/1000 row ft Force 3G (or OLF)
terbufos--6.0 to 8.0 oz/1000 row ft Counter 15G--SmartBox® system only

Cutworms (Also see the "Cutworms" section of Soil Pests--Their Detection and Control.)

At-planting Soil Applied Treatment

tefluthrin--4.0 to 5.0 oz/1000 row ft Force 3G

Foliar Treatment

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorpyrifos--1.0 to 2.0 pts/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--11.0 to 26.0 fl oz/A Cobalt Advanced
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone 2EC (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
permethrin--4.0 to 8.0 fl oz/A Perm-UP 3.2EC (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Corn Rootworms Larvae

Crop rotation is the most effective control. Avoid planting corn after corn, cucumbers, pumpkins, or squash. Rotation distance of even 3 feet is effective. Soil insecticides applied at planting aim to protect the root zone for about 6 to 8 weeks after application. To be effective, corn rootworm egg hatch must occur during that time. When allowed on the label, T-band tends to be more effective than in-furrow application. Apply one of the following formulations:

At Planting Treatment:

chlorpyrifos--8.0 oz/1000 row ft Lorsban 15G (or OLF)
tefluthrin--4.0 to 5.0 oz/1000 row ft Force 3G (or OLF)
terbufos--6.0 to 8.0 oz/1000 row ft Counter 15G-SmartBox® system only

At Cultivation:

chlorpyrifos--2.0 pts/A Lorsban Advanced (or OLF)
tefluthrin--4.0 to 5.0 oz/1000 row ft Force 3G (or OLF)

Corn Rootworm Adults

Most insecticides used for worm control at silk will control corn rootworm adults. Apply one of the following formulations:

Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will **NOT** control corn rootworm adults.

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC(Sniper, or OLF)
chlorpyrifos--1.0 to 2.0 pts/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--11.0 to 26.0 fl oz/A Cobalt Advanced
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone 2EC (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.50 pts/A Lannate LV
permethrin--4.0 to 8.0 fl oz/A Perm-UP 3.2EC (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Corn Flea Beetle

Flea beetles transmit bacterial wilt disease (also known as Stewart's wilt) and are numerous after mild winters. Use varieties resistant to bacterial wilt disease or those listed in the Sweet Corn varieties table. Treat susceptible varieties at spike stage when 5% of the plants are infested.

Note: Commercially-applied seed treatments (Cruiser, Gaucho, or Poncho) provide early-season protection from corn flea beetle injury.

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF) – ***Use prohibited on hand harvested corn***
chlorpyrifos--1.0 to 2.0 pts/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--11.0 to 26.0 fl oz/A Cobalt Advanced
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone 2EC (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.50 pts/A Lannate LV
permethrin--4.0 to 8.0 fl oz/A Perm-UP 3.2EC (or OLF)
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Corn Leaf Aphid

Apply one of the following formulations:
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorpyrifos+lambda-cyhalothrin--11.0 to 26.0 fl oz/A Cobalt Advanced
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
methomyl--0.75 to 1.5 pts Lannate LV
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Mites

Apply one of the following formulations:
bifenthrin--5.12 to 6.40 fl oz/A Bifenture 2EC (Sniper, or OLF)
spiromesifen--5.7 to 16.0 fl.oz/A Oberon 2SC
zeta-cypermethrin+bifenthrin--10.3 fl oz/A Hero EC

Sap Beetle (SB) Adults

Loose-husked varieties and ears damaged by other insects are more susceptible to sap beetle attack. Varieties with long, tight silk tubes can reduce SB damage by 50%.

Begin sampling at pollen shed and treat when 5 percent of the ears have adults and/or eggs. Apply one of the following formulations:

Note: Insecticides used for worm control at silk may not control sap beetle infestations. Sweet corn varieties with the *Bacillus thuringiensis* genes will **NOT** control sap beetles.

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF) - ***Use prohibited on hand harvested corn***
chlorpyrifos+lambda-cyhalothrin--16.0 to 38.0 fl oz/A Cobalt Advanced
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)

lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.50 pts Lannate LV
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Japanese Beetle (JB)

Note: Insecticides used for worm control at silk may not control Japanese beetle infestations. Sweet corn varieties with the *Bacillus thuringiensis* genes will **NOT** control Japanese beetles.

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 to 2.0 qts/A Sevin XLR Plus (or OLF) - ***Use prohibited on hand harvested corn***
chlorpyrifos+lambda-cyhalothrin--32.0 to 42.0 fl oz/A Cobalt Advanced
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone 2EC (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Grasshoppers

Apply one of the following formulations:
beta-cyfluthrin--2.0 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.5 qts/A Sevin XLR Plus (or OLF) - ***Use prohibited on hand harvested corn-***
chlorpyrifos--0.5 to 1.0 pt/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--6.0 to 13.0 fl oz/A Cobalt Advanced
cyfluthrin--2.0 to 2.8 fl oz/A Tombstone 2EC(or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Stink Bugs

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorpyrifos+lambda-cyhalothrin--16.0 to 38.0 fl oz/A Cobalt Advanced
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 10.0 fl oz/A Besiege
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Caterpillar Pests (Also see "Insect Control-Decision Making" in the following section.)

Bacillus thuringiensis (Bt) sweet corn hybrids are available that express single or stacked insecticidal proteins for protection against lepidopteran pests. Attribute® hybrids (Syngenta Seeds) expressing the cry1Ab protein (YieldGard trait) have been available since 1996, and growers can purchase 80K or 25k seed units of white, yellow and bicolor SE and Sh_2 hybrids for local, shipping and processing markets. Performance Series™ hybrids (Seminis Seeds) expressing two new Bt proteins are also available in 80K or 25k seed units and these stacked traits provide additional protection, particularly for corn earworm and fall armyworm, and these hybrids also are Roundup Ready. In addition, a few Attribute® II hybrids (Syngenta Seeds) expressing the YieldGard and Viptera traits will be available in 2013, and this stacked Bt technology provides nearly 100% control of all lepidopteran pests.

All Bt sweet corn hybrids that express the cry1AB protein provide 100% protection against European corn borers, thus no insecticides are needed during the whorl or tasseling stages, or even during silking if this pest is the only concern. However, corn earworm and fall armyworm are more tolerant to the cry1Abb proteins, and unsprayed corn is also exposed to sap beetles, stink bugs, and silk feeding by corn rootworm adults which can reduce pollination, thus insecticide sprays may be needed to ensure fresh market quality when these pests are active. In recent years, the control efficacy of Attribute hybrids with the YieldGard trait has declined in some geographic regions, and there is growing evidence that corn earworm has developed some degree of resistance to the cry1Ab protein. Thus, fields planted in Bt hybrids will need insecticide applications, depending on their planting date and the earworm or fall armyworm moth pressure during silking and ear development. Under moderate to high moth activity (mid August-early September), many eggs are laid later in ear development after the expressed proteins have degraded in wilted/brown silk tissue. This loss of Bt activity is also accelerated by hot, dry conditions which cause rapid desiccation of the silk tissue, and there may be less silk-feeding on wilted/brown silk. As a result, earworms and fall armyworms have a greater chance of surviving and invading the ear. Under these conditions, up to 50% or more of the Attribute® ears can become infested with larvae, which pose a quality problem. Spray regimes of three or four applications starting at the onset of silking and repeated 3-4 days apart may be required when moth activity and temperature is high. The stacked Bt hybrids (Performance Series™, Attribute® II) are significantly more effective than the single protein Attribute® hybrids and should require much fewer applications, if any, depending on the market outlet and ear quality requirements.

Corn rootworm adults, Japanese beetles, other silk-feeders, stink bugs, and sap beetles also can cause ear quality problems in Bt corn, because none of the expressed proteins are active on these insects. High rates of silk feeding prevent adequate pollination. Supplemental silk sprays applied to the Attribute® corn should effectively control these secondary pests. For the newer stacked Bt hybrids, sap beetle infestations have been much reduced due to the relative lack of stalk and ear damage caused by lepidopteran pests. Nevertheless, on farms with a known history of sap beetle problems, an insecticide spray should be applied when 50 to 75% of the ears have wilted silks (the time when sap beetle larvae begin to hatch on silks).

Multiple sprays may be needed depending on population pressure. When more than 50% of ears have fresh silks cut back by rootworm adults and the plants are still pollinating, an insecticide spray also is recommended.

NOTE: Loose husked varieties and ears with short or no silk tubes are more susceptible to worm damage.

European Corn Borer (ECB)

Thorough spray coverage in whorls and on plants is essential. Select an insecticide that has low toxicity to bees (refer to Table D-6). Apply one of the following formulations:

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
chlorpyrifos--1.0 to 2.0 pts/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--16.0 to 38.0 fl oz/A Cobalt Advanced
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone 2EC (or OLF)
esfenvalerate--5.8 **to** 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
indoxacarb (**through tassel push only**)--2.5 to 3.5 oz/A Avaunt 30WDG
methoxyfenozide (**early-season whorl treatment**)--4.0 to 16.0 fl oz/A Intrepid 2F
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.50 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-UP 3.2EC (or OLF)
spinetoram--3.0 to 6.0 fl oz/A Radiant SC
spinosad--1.67 to 3.30 oz/A Blackhawk 36WG
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Corn Earworm (CEW)

Many insecticides are highly toxic to bees. For more information concerning toxicity of insecticides to bees, refer to Table D-6. Apply one of the following formulations:

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
chlorpyrifos+lambda-cyhalothrin--16.0 to 38.0 fl oz/A Cobalt Advanced
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone 2EC (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.50 pts/A Lannate LV
permethrin--4.0 to 8.0 fl oz/A Perm-UP 3.2EC (or OLF)
spinetoram--3.0 to 6.0 fl oz/A Radiant SC
spinosad--2.2 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Fall Armyworm (FAW)

For whorl applications, direct spray over the plants so that it penetrates leaf whorls when FAW first appears and repeat application, if necessary. For foliar spray applications, high-spray gallonage (50 to 75 gallons per acre) is necessary for effective FAW control. Apply one of the following formulations:

beta-cyfluthrin (**first and second instar only**)--2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF)
chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC
chlorpyrifos--1.0 to 2.0 pts/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--11.0 to 26.0 fl oz/A Cobalt Advanced
cyfluthrin (**first and second instar only**)--2.8 fl oz/A Tombstone 2EC (or OLF)-
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
indoxacarb (**through tassel push only**)--2.5 to 3.5 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.50 pts/A Lannate LV (or OLF)
spinetoram--3.0 to 6.0 fl oz/A Radiant SC
spinosad--1.67 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

True Armyworm

Apply one of the following formulations:
beta-cyfluthrin (**first and second instar only)**--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorpyrifos--1.0 to 2.0 pts/A Lorsban Advanced (or OLF)
chlorpyrifos+lambda-cyhalothrin--11.0 to 26.0 fl oz/A Cobalt Advanced
cyfluthrin--**(first and second instar only)**1.6 **to** 2.8 fl oz/A Tombstone 2EC (or OLF)
esfenvalerate--5.8 **to** 9.6 fl oz/A Asana XL
flubendiamide--2.0 to 3.0 fl oz/A Belt SC
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 10.0 fl oz/A Besiege
methomyl--0.75 to 1.5 pts/A Lannate LV (or OLF)
methoxyfenozide (**early-season whorl treatment**)--4.0 to 16.0 fl oz/A Intrepid 2F
spinetoram--3.0 to 6.0 fl oz/A Radiant SC
spinosad--1.67 to 3.3 oz/A Blackhawk 36WG
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3,4]
INSECTICIDE			
beta-cyfluthrin	R	12	0
bifenthrin	R	12	1
carbaryl (**hand harvest prohibited**)	G	see label	2
chlorantraniliprole	G	4	1
chlorpyrifos (soil/foliar)	G	24	35/21
chlorpyrifos+ lambda-cyhalothrin	R	24	21
cyfluthrin	R	12	0
esfenvalerate	R	12	1
flubendiamide	G	12	1
imidacloprid (seed treatment)	G	12	see label
indoxacarb (mech./hand harvest)	G	12/14 days	3
lambda-cyhalothrin	R	24	1
lambda-cyhalothrin+ chlorantraniliprole	R	24	1
methomyl	R	48	0
methoxyfenozide	G	4	3
permethrin	R	12	1
spinetoram	G	4	1
spinosad	G	4	1
spiromesifen	G	12	see label
tefluthrin	R	0	see label
terbufos	R	48 - 72	see label
thiamethoxam (seed treatment)	G	1	see label
zeta-cypermethrin	R	12	3
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
Aproach (Group 11)	G	12	7
chlorothalonil (Group M5)	G	12	14
Headline (Group 11)	G	12	7
Headline AMP (Groups 3+11)	G	12	20
mancozeb (Group M3)	G	12,24	7
Priaxor (Group 7+11)	G	12	7
Prosaro (Group 3+3)	G	12	7
Quadris (Group 11)	G	4	7
Quilt (Groups 11 + 3)	G	12	14
Quilt Xcel (Groups 11+3)	G	12	14
Stratego (Groups 11 + 3)	G	12	14
Stratego YLD (Groups 11+3)	G	12	0
Tilt (Group 3)	G	12	14

See Table D-6.
1 G = general, R = restricted
2 Chemicals with multiple designations are based on product and/or formulation differences. **CONSULT LABEL**
3 See label for days to harvest for feed, forage and/or stover. Days to harvest as listed in table are for grain/ears only.
4 AP=At Plant

Insect Control--Decision Making Fresh Market

Whorl/Tassel Infestation

In general, insect larval feeding (ECB and FAW) during the whorl stage of sweet corn development has a greater impact on early planted, short-season varieties. For ECB on early plantings, apply first spray when 15 percent of the plants show fresh feeding signs. Additional applications may be necessary if infestation remains above 15 percent. An early tassel treatment is usually more effective than a whorl treatment because larvae are more exposed to the chemicals. The impact of infestation on mid- and late-season plantings depends on the stage of the plants when the infestation occurs. Treat for FAW during the early whorl stage when more than 15 percent of the plants are infested. During mid- to late-whorl stages, treatment for both FAW and ECB may be necessary if more than 30 percent of the plants are infested. Treat fields in early tassel stage if more than 15 percent of the emerging tassels are infested with ECB, FAW, or young CEW larvae.

Ear Infestation

Direct sampling for CEW, FAW, and ECB during silking is not practical because of the low thresholds of ear damage. Begin treatment when 10 percent of the ears show silk. If CEW populations are heavy, it may be necessary to begin treatments when the very first silks appear. Silk sprays should continue on a schedule based on area blacklight and pheromone trap counts, geographical location, and time of year. Early in the season, silk sprays may be required on a 3- to 6-day schedule. When CEW populations are heavy, it may be necessary to treat on a 1- to 3-day schedule.

Applications during the low populations can be terminated up to 5 days before last harvest. During heavy populations and high temperatures, treatments will need to be made according to the legal "days to harvest" of the chemical. For best control during heavy infestations, maximize the gallonage of water per acre, use a wetting agent, and make applications during the early morning. If irrigation or rains wash off the spray within 24 hours after an application, repeat treatment as soon as the foliage dries.

For more precise timing of silk sprays, use blacklight and pheromone traps to determine the actual moth activity on your farm. **Monitoring data from pheromone and blacklight traps are available on the websites:** www.pestwatch.psu.edu. and www.mdipm.umd.edu. Contact your county Extension agent or consult your state pest management newsletter for more information on these techniques.

Processing

Whorl/Tassel Infestation

The ECB is the major whorl pest in early planted corn. Larvae that hatch prior to tassel emergence feed on the whorl leaves and cause yield losses. Decisions to treat whorl infestations are based on the percentage of "infested" plants with light (LD), moderate (MD), or heavy (HD) feeding damage.

"Infested" plants are classified as: light damage (LD less than 10 percent of the leaf area is affected), moderate damage (MD = 10 to 50 percent of the leaf area is affected), and heavy damage (HD = all leaves are damaged).Treat if the market value of the expected yield loss exceeds twice the cost of a whorl application. Expected yield loss is calculated as 0.08 x LD + 0.24 x MD + 0.44 x HD. Count only damaged plants with live larvae.

Ear Infestation

The four insects that normally infest the ears of corn grown for processing are the ECB, CEW, SB, and FAW. Decisions to treat are based on the percentage of ears that are potentially damaged by a combination of these pests that occur during the silking period. A primary ear on a plant is potentially damaged if: (1) the plant has one or more ECB or FAW egg masses on it, (2) there are one or more CEW or SB eggs in the silk of the primary ear, or (3) young larvae of any of the four species are feeding in the silk of the ear.

When 50 percent of the corn in a field is silking, treat if 5 percent of the plants in silk meet one or more of the above criteria. At 100 percent silking (about 16 to 18 days before harvest), treat if 10 percent of the plants fall into one or more of the above categories. At 100 percent brown silking (10 to 12 days from harvest), treat if 20 percent of the ears have larvae feeding on the silks or in the silk tube.

When overall moth activity is high, fixed-treatment schedules according to blacklight trap catches should be used. Moth units are calculated by multiplying the average number of CEW moths in a region over 5 days times 5 and adding the value of the average number of corn borer moths in a region over 5 days. If moth units fall between 75 and 150 per 5 days, fixed schedules of 1 to 2 insecticide treatments are recommended. Fixed schedules of 2 to 5 insecticide treatments applied 3 or 4 days apart are recommended if the average number of moth units for a region exceeds 150 per 5 days. Consult your pest management specialist for more detailed information.

Nematode Control

Nematode control is very important to the production of this crop. See Chapter E "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or use Counter 15G or Mocap 15G. Consult labels for use directions. See seed treatment section below.

Disease Control

Seed Treatment

Request that seed be treated with one or more of the following fungicides for seedling diseases and damping-off: Allegiance, Apron XL, Dynasty, or Maxim XL. Seed treatment with these fungicides is especially important for early seedings of Super Sweet (sh) varieties. There are several new insecticide/nematicide seed treatments for sweet corn that may be beneficial where soil insects and nematodes may be yield limiting. Request seed treated with Avicta DUO or Poncho/VOTiVO. These seed treatments may improve establishment but will not protect plants from nematode damage later in the growing season.

Stewart's Bacterial Wilt

Use varieties resistant to Stewart's wilt listed in the sweet corn varieties table at the front of this section in areas with a history of bacterial wilt. More variety information relative to Stewart's Bacterial Wilt is available at: www.sweetcorn.uiuc.edu/index.html. Control of flea beetles is essential for effective disease management. Flea beetles transmit Stewart's wilt and are prevalent after mild winters. Use insecticide-treated seed or a recommended insecticide at seedling emergence. Treat susceptible varieties at spike stage when 5% of the plants are infested. See Insect Control Section for flea beetle control recommendations.

Maize Dwarf Mosaic Virus (MDMV)

MDMV is most likely to occur on corn planted after July 1. The virus is transmitted by aphids to sweet corn from infected weeds, especially Johnsongrass. Less frequently, the disease may be transmitted in/on seed. For control, manage weeds and aphids and plant resistant varieties for fall harvest.

Smut

There is no true genetic resistance to smut in sweet corn. Later maturing, larger varieties tend to be more tolerant to smut than early, smaller varieties. Since damaged tissue is more prone to infection, control corn borers, stink bugs, and other problematic insect pests as first tassel appears.

Leaf Spots and Blights (Gray leaf spot, Northern corn leaf spot; Southern, Northern and Anthracnose leaf blights)

For optimal control begin sprays before symptoms appear. In recent years, leaf blights in sweet corn have increased. Regular scouting and protectant fungicides late in the season may be necessary.

Apply the following protectant fungicides:

chlorothalonil (Do not apply to corn to be processed.)--0.75 to 2.0 pt 6F/A (7 day schedule) or OLF
mancozeb--1.5 lb 75DF/A (5 to 7 day schedule)

and rotate on a 7-14 day schedule with one of the following:

Headline AMP--10.0 to 14.4 fl oz 1.68SC/A
Priaxor--4.0 to 8.0 fl oz 4.17SC/A
Quilt--7.0 to 14.0 fl oz 1.67 SC/A
Quilt Xcel--10.5 to 14 fl oz. 2.2SC/A
Stratego--10.0 fl oz. 2.08 EC/A
Stratego YLD--4.0 to 5.0 fl. oz. 4.18 EC/A (5-14 day schedule)
Prosaro--6.5 fl. oz 421 SC / A (5-14 day schedule)
Headline--9.0 to 12.0 fl oz 2.1EC/AQuadris--9.2 to 15.5 fl oz 2.08SC/A
Aproach--6.0 to 12.0 fl. oz 2.08 SC/A
Tilt and generics--2.0 to 4.0 fl oz 3.6 EC/A

Do not make more than 2 consecutive applications of one of the above fungicides before rotating to another fungicide from a different FRAC code.

Rust

Rust can occasionally become troublesome on susceptible hybrids. In most years chemical control measures are not warranted. However, corn warrants spraying if infection occurs prior to the whorl stage. Observe fields on a regular basis.

If pustules are observed prior to the whorl stage, apply one of the followingon a 7-14 day schedule

Headline AMP--10.0 to 14.4 fl oz 1.68SC/A
Priaxor--4.0 to 8.0 fl oz 4.17SC/A
Quilt--7.0 to 14.0 fl oz 1.67 SC/A
Quilt Xcel--10.5 to 14 fl oz. 2.2SC/A (7-14 day schedule)
Prosaro--6.5 fl. oz 421 SC / A (5-14 day schedule)
Stratego--10.0 fl oz. 2.08 EC/A (7 to 14 day schedule)
Stratego YLD--4-5 fl. oz. 4.18 EC/A (5-14 day schedule)
Headline--9.0 to 12.0 fl oz 2.1EC/A (7 to 14 day schedule)
Quadris--9.2 to 15.5 fl oz 2.08F/A
Aproach--6.0 to 12.0 fl. oz 2.08 SC/A
Tilt--2.0 to 4.0 fl oz 3.6 EC/A (7 to 14 day schedule)
chlorothalonil (Do not apply to corn to be processed.)--0.75 to 2.0 pt 6F/A (7 day schedule) or OLF
mancozeb--1.5 lb 75DF/A (5 to 7-day schedule) or OLF

SWEET POTATOES

Varieties[1]

Beauregard[2] (FR)(rosy skin)	Hernandez
Covington	O' Henry (white flesh)
Evangeline (root-knot resistant)	Hayman (white flesh)

[1] Varieties listed alphabetically.
[2] Beauregard sizes rapidly. Plant late and sample fields beginning in early September.
Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Sweet Potatoes	per Acre	Pounds P_2O_5 per Acre				Pounds K_2O per Acre				Nutrient Timing and Method
	50-75	200	100	50	0[1]	300	200	100	0[1]	Total nutrient recommended.
	25	200	100	50	0[1]	300	200	100	0[1]	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run.

[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Plant Production

For hard-to-sprout varieties, a presprout procedure started 3 to 4 weeks before normal bedding time is recommended. To presprout, store seed roots at 85°F (29.4°C) and 90 percent relative humidity until the sprouts that appear are 1 to 1½ inches long (20 to 28 days). Seed roots can then be bedded normally.

Bed seed stock about April 1 to 10 in new, clean sand and cover with 2 to 3 inches of clean sand. Fertilize with 5.0 ounces per square yard 10-10-10 or its equivalent. **A Special Local-Needs label 24(c) has been approved for the use of Devrinol DF-XT on sweet potato plant beds in Virginia. See the Weed Control section for details.** Cover beds with floating row cover or clear plastic. Floating row cover may be left on the bed until danger of frost has passed. Clear plastic should be ventilated after 7 days with one, ½-inch hole every 4 linear feet of bed to prevent accumulation of carbon dioxide. Clear or white plastic may also be used over greenhouse hoops with thermostatically controlled fans and vents. Keep beds moist and temperature between 75° to 85°F (23.9° to 29.4°C). About 1,000 sprouts can be produced from 1 bushel of seed stock at a single cutting. One bushel of seed stock requires 11 to 15 square feet of bed area. When sprouts are ready to be transplanted, they should be cut from the beds by snipping at the soil line. This minimizes the transfer of diseased sweet potato tissue. See the "Disease Control" section.

Field Planting

Plant in the field between May 5 and June 15 in warmer, southern areas and between May 20 and June 5 in cooler areas. Well-rooted, 6- to 8-inch long sprouts can be set with the transplanter on ridges 8 to 10 inches high. Row spacing is 30 to 36 inches; distance between plants in the row is 12 to 18 inches. Use a high-phosphate starter solution (15-30-15 or equivalent at the rate of 3.0 pounds in 50 gallons of water) at transplant time.

Research has shown that the variety "Beauregard" yields a more uniform crop if no nitrogen is applied before or at transplanting. For maximum production, apply the recommended nitrogen as a sidedressing 3 to 4 weeks after transplanting.

Harvest and Post Harvest Considerations

A 3- to 5-month growing season is required for mature root development depending on the variety.The sweet potatoes root is covered by a thin, delicate skin that is very easily broken. Striking the roots with harvesting equipment or dropping them into containers injures the skin. Bruises and abrasions must be kept at a minimum.

Various methods can be used to harvest sweet potatoes. Growers with a small area may harvest by hand using a garden fork. Growers with a few acres can use a one row modified mold board plow or middle buster with a notched coulter adjusted just left of the main stems. After the sweet potatoes are plowed out, they are removed from the vines and place into smooth baskets. Mechanical diggers patterned after a low flat-bed type potato digger or digger-windrower are often used. These are one or two row machines that incorporate a short separating chain behind a wide blade that elevates both soil and potatoes onto the chain. Soil is taken off as the potatoes move up with the chain and the sweet potatoes drop off to the ground in the back or to the side of the digger. Care must be taken to bring enough soil up with the chain so that potatoes are not bruised or scraped. Potatoes are picked up by hand and placed in smooth sided baskets. .After the roots are dug, they should be cured in the storage house at 80° to 85°F (26.7° to 29.4°C) and 90 percent relative humidity for 6 to 8 days. After curing, temperature should be lowered to 55°F (12.8°C), but relative humidity should be maintained at 85 percent. A detailed description of post-harvest handling of sweet potatoes can be found in this extension publication: http://www.bae.ncsu.edu/people/faculty/boyette/pubs/sweetpotatoes postharvest-1.pdf.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in sweet potatoes.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

Plant Beds

Napropamide--1.0 to 1.5 lb/A. **A Special Local-Needs label 24(c) has been approved for the use of Devrinol DF-XT on sweet potato plant beds in Virginia.** Apply 2.0 to 3.0 pounds per acre Devrinol DF-XT to the plant beds immediately after planting and irrigate to ensure herbicide "activation." The field rate of 2.0 to 3.0 pounds per acre of Devrinol DF-XT is equal to 0.7 to 1.1 ounces of product per 1,000 square feet of plant bed. Annual grasses and certain broadleaf weeds will be controlled.

Pretransplant

Flumioxazin--0.078 lb/A. Apply 2.5 dry ounces of Valor 51WDG after all tillage has been completed, but 2 to 5 days before planting the crop, to control annual broadleaf weeds. Tillage or cultivation after Valor application reduces or eliminates weed control. DO NOT till or cultivate after applying Valor unless weeds emerge. Use in combination with other recommended herbicides to control annual grasses. Valor can be difficult to clean out of a spray tank. Follow tank cleaning recommendations on the label to avoid injury to other crops after spraying Valor. DO NOT use prior to planting greenhouse-grown transplants. DO NOT use on any variety other than 'Beauregard' unless the user has tested Valor on the variety and has found crop tolerance to be acceptable.

Preemergence after Transplanting

Clomazone--0.5 to 1.0 lb/A. Apply 1.33 to 2.66 pints per acre Command 3ME before weeds emerge. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Cultivate or irrigate after application to reduce the risk of vapor drift. Command 3ME is an excellent herbicide for the control annual grasses and many annual broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. DO NOT apply when wind or weather conditions favor spray drift. Avoid preemergence applications when fields are adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from off-site Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations. Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command has been used.

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F at time of transplanting or 10 to 14 days after planting to weed-free, freshly cultivated soil. Cultivation after application may reduce weed control. Moisture following application is essential. Primarily controls annual grasses and certain broadleaf weeds including carpetweed, common purslane, and common lambsquarters.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT after transplanting, but before weed emergence to control annual grasses and certain annual broadleaf weeds. Irrigate or cultivate within 24 hours of application to incorporate the herbicide. Use the lower rate on coarse-textured sandy soils low in organic matter. Use may reduce the stand and yield of fall planted small grains. Moldboard plowing will reduce the injury to small grain cover crops.

Postemergence

Fluazifop--0.125 to 0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 55 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2 to 0.5 lb/A. Apply 1.0 to 2.5 pint per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot, humid, cloudy conditions prevail. To reduce the risk of crop injury, omit the additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of the grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5.0 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware and Virginia.** Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Soil Insects (Wireworm, Flea Beetle Larvae, White Grubs, and Rootworms)

Before Planting

ethoprop--5.1 to 6.9 fl oz/1000 row ft Mocap 6EC (or OLF) Apply in a 12 to 15-inch band on the row 2 to 3 weeks before planting and incorporate 2-4 inches deep during or immediately following treatment (**wireworm, white grubs and flea beetles only).**

chlorpyrifos--4.0 pt/A Lorsban Advanced (or OLF) (wireworm and flea beetle larvae only)

At - Planting Application

bifenthrin--19.2 fl oz/A Bifenture 2EC (Sniper or OLF) **,** or 12.75 to 25.5 fl oz/A Capture LFR **(wireworm , white grubs and rootworms only)**

Lay-by Application

bifenthrin--3.2 to 9.5 fl oz/A Bifenture 2EC(Sniper, or OLF), or 12.75 to 25.5 fl oz/A Capture LFR **(wireworm, white grub and rootworms only)**

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL

cyfluthrin--0.8 to 1.6 fl oz/A Tombstone (or OLF)

imidacloprid +beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360

lambda-cyhalothrin--0.96 to 1.6 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)

lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Besiege

lambda-cyhalothrin+thiramethoxam--3.5 to 4.5 fl oz/A Endigo ZC

zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)

zeta-cypermethrin+bifenthrin--2.6 to 6.1 fl oz/A Hero EC

Click Beetles (Adult Stage of Wireworm)

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF)

Flea Beetle Adults

acetamiprid--1.5 to 2.5 fl oz/A Assail 30SG (or OLF)

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)

bifenthrin+imidacloprid--5.1 to 7.7 fl oz/A Brigadier

carbaryl--1.0 to 2.0 qt/A Sevin XLR Plus (or OLF)

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 2.0 to 3.0 fl oz/A Belay 2.13SC

cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)

imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro(or OLF); **foliar**-1.2 fl oz/A Admire PRO (or OLF)-

imidacloprid+beta-cyfluthrin--2.4 to 2.8 fl oz/A Leverage 360

lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)

lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Besiege

lambda-cyhalothrin+thiamethoxam--3.5 to 4.5 fl oz/A Endigo ZC

thiamethoxam--**soil** 1.66 to 2.67 oz/A Platinum 75SG; f**oliar** 1.5 to 3.0 oz/A Actara 25WDG

zeta-cypermethrin--1.76 to 4.00 fl oz/A Mustang Maxx (or OLF)

zeta-cypermethrin+bifenthrin--2.6 to 6.1 fl oz/A Hero EC

Tortoise Beetles, Cucumber Beetles Adults (CB)

acetamiprid--1.5 to 4.0 fl oz/A Assail 30SG (or OLF) (**CB only)**

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL(**CB only)**

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF) (**CB only**)

bifenthrin+imidacloprid--5.1 to 7.7 fl oz/A Brigadier (**CB only**)

carbaryl--1.0 to 2.0 qt/A Sevin XLR Plus (or OLF)

lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)

lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Besiege

lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC

zeta-cypermethrin--1.76 to 4.00 fl oz/A Mustang Maxx (or OLF) (**CB only**)

zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC (**CB only**)

Pesticide	Use Category[1]	Hours to Reentry	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
beta-cyfluthrin	R	12	0
bifenthrin	R	12	see label
bifenthrin + imidacloprid	R	12	21
carbaryl	G	12	7
chlorpyrifos	R	24	125
clothianidin (foliar/soil)	G	12	14/see label
cyfluthrin	R	12	0
ethoprop	R	48/72	see label
imidacloprid+cyfluthrin	R	12	7
imidacloprid (soil/foliar)	G	12	125/7
lambda-cyhalothrin	R	24	7
lambda-cyhalothrin+ chlorantraniliprole	R	24	14
lambda-cyhalothrin+ thiamethoxam	R	24	14
thiamethoxam (foliar/soil)	G	12	14/see label
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	21
FUNGICIDE (FRAC code)			
Botran (Group 14)	G	12	0
Mertect (Group 1)	G	12	0
Scholar (Group 12)	G	12	0
Uniform (Groups 4 + 11)	G	12	AP

See Table D-6.

1 G = general, R = restricted, AP = At planting

Nematode Control

See Chapter E "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or Mocap (60.0 to 80.0 pounds per acre of 10G or 1.0 to 1.5 gallons of 6EC) or Vydate L. Use as recommended on the label.

Disease Control

Seedling Disease Control (*Rhizoctonia* sp. and *Pythium* sp.)

Uniform--0.34 fl oz 3.66SE/1000 row ft.

Black Rot and Scurf

Seedbed soil should be new or sterilized sand, and a bed temperature of 80° to 85°F (26.7° to 29.4°C) should be maintained. Use a 2-year rotation to reduce potential for disease development in the fields. Avoid applying fertilizer after July 1.

Use seed potatoes that are free of scurf scales for sprout production. During bedding, dip "seed roots" for 1-2 minutes in a suspension containing 8.0 fluid ounces of Mertect 340F per 7.5 gallons of water and plant immediately.

Use sprouts that are cut above the soil line whenever possible to reduce incidence of scurf.

Avoid bruising roots during harvest. Maintain a temperature of 80° to 85°F (26.71° to 29.4°C) during the curing period, and DO NOT allow temperature during storage to drop below 55°F (12.8°C). Maintain a relative humidity of 85 to 90 percent during curing and storage.

Soft Rot (*Rhizopus*)

Use a resistant variety (eg. Beauregard)

***During bedding*:** Just before bedding, use a 10 to 15 second root dip. Use Botran 75WP (1.0 lb/10 gal water).

***At harvest*:** Dip or spray harvested table or seed-stock roots after cleaning and before packaging. Use 1.0 lb of Botran 75WP in 100 gallons of treating solution. Scholar 1.9SC at 16.0 to 32.0 fl oz/100 gal of dip is also an option.

Pox (Soil Rot)

Maintain a pH between 4.8 and 5.2 to assist in control. Use crop rotation, clean seed, and lean beds. Fumigation prior to planting may also help.

Fusarium Wilt

Use resistant varieties.

Surface Rot

Minimize injury during harvest. Cure as soon as possible under proper storage conditions. Use clean seed for bedding.

TOMATOES

Recommended Market Tomatoes

Variety	Hybrid	Type	Season	Culture[1]	Use[2]	Disease Reactions[3]	Habit
Applause	Yes	Globe, Red	Early	Field	DM, LW	V,F	Determinate
Primo Red	Yes	Globe, Red	Early	Field	DM, LW, S	V,F,Tomv	Determinate
Sunshine	Yes	Globe, Red	Early	Field	DM, LW, S	V,F,Gls	Determinate
Sunstart	Yes	Globe, Red	Early	Field, HT	DM, LW, S	V,F,Gls	Determinate
Amelia	Yes	Globe, Red	Mid	Field	LW, S	V,F,Tswv	Determinate
BHN 1009	Yes	Globe, Red	Mid	Field	LW, S	V,F	Determinate
BHN 589	Yes	Globe, Red	Mid	Field, HT	DM, LW	V,F,Tomv	Determinate
BHN 961	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,Tomv	Determinate
BHN 964	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,Tomv,Eb	Determinate
Brandy Boy	Yes	Globe, Red	Mid	Field, HT	DM, LW		Determinate
Charger	Yes	Globe, Red	Mid	Field, HT	DM, LW, S	V,F,Gls,Asc,Tylc	Determinate
Crista	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,V,Tswv	Determinate
Defiant	Yes	Globe, Red	Mid	Field	DM, LW	V,F,Lb	Determinate
Floralina	Yes	Globe, Red	Mid	Field	DM, LW	V,F,Asc,Gls	Determinate
Florida 47R	Yes	Globe, Red	Mid	Field	LW, S	V,F,Asc,Gls	Determinate
Mountain Glory	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,Gls,Tswv	Determinate
Mountain Spring	Yes	Globe, Red	Mid	Field	DM, LW	V,F	Determinate
Mt. Merit	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,N,Tswv, Lb,	Determinate
Red Deuce	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,Tomv,Gls,Asc	Determinate
Red Defender	Yes	Globe, Red	Mid	Field	DM, LW, S	V,F,N,Tswv	Determinate
Rocky Top	Yes	Globe, Red	Mid	Field, HT	DM, LW, S	V,F,Gls	Determinate
Scarlet Red	Yes	Globe, Red	Mid	Field, HT	DM, LW, S	V,F	Determinate
Sunbrite	Yes	Globe, Red	Mid	Field, HT	DM, LW, S	V,F	Determinate
SunGuard	Yes	Globe, Red	Mid	Field, HT	DM. LW	V,F,Gls,Asc	Determinate
BHN 871	Yes	Globe, Yellow	Mid	Field, HT	DM, LW	V,F,Tomv	Determinate
Carolina Gold	Yes	Globe, Yellow	Mid	Field	DM, LW	V,F	Determinate
Lemon Boy	Yes	Globe, Yellow	Mid	Field, HT	DM, LW	V,F,N	Indeterminate
BHN602	Yes	Globe, Red	Mid, Late	Field	DM, LW, S	V,F,Tswv	Determinate
Florida 91	Yes	Globe, Red	Mid, Late	Field	DM, LW, S	V,F,Asc,Gls	Determinate
Mt. Fresh Plus	Yes	Globe, Red	Mid, Late	Field	DM, LW, S	V,F,N	Determinate
Phoenix	Yes	Globe, Red	Mid, Late	Field	LW, S	V,F,Asc,Gls	Determinate
Red Bounty	Yes	Globe, Red	Mid, Late	Field, HT	DM, LW	V,F,N,Gls,Tswv	Determinate

[1]Culture: Field = For field growing, HT = for growing in a High Tunnel (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
[2]Use: DM = direct market (roadside, farmer's market); LW = Local wholesale; S = Shipping (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
[3] Resistances or tolerances: V = Verticillium wilt; F = Fusarium wilt; N = Root knot nematode, Asc = Alternaria stem canker; Gls = Gray leaf spot; Tomv = Tomato mosaic virus; Tswv = Tomato spotted wilt virus; Lb = Late blight; Eb = Early blight.
For information on resistance to specific disease races or species contact your seed supplier. (Abbreviations applicable to this table; not nessarily elsewhere in this guide.)

Recommended Plum, Cluster, Cherry, and Grape Tomatoes

Variety	Type	Color	Hybrid	Disease Reactions[1]	Form
Plum Crimson	Plum	Red	Yes	V,F	Determinate
Plum Dandy	Plum	Red	Yes	V,F	Determinate
Plum Regal	Plum	Red	Yes	V,F,Lb,Tswv,	Determinate
Picus	Plum	Red	Yes	V,F,Asc,Gls,Tswv	Determinate
Pony Express	Plum	Red	Yes	V,F,N,Tomv,Bs	Determinate
Mariana	Plum	Red	Yes	V,F,N,Asc	Determinate
Victoria Supreme	Plum	Red	Yes	V,F,N,Asc,Gls	Determinate
Health Kick	Plum	Red	Yes	V,F,Asc,Tswv,Bs	Determinate
Mt. Magic	Small cluster	Red	Yes	V,F,Lb	Indeterminate
BHN 762	Cherry	Red	Yes	V,F	Determinate
Sun Sugar	Cherry	Orange	Yes	F, Tmv	Indeterminate
Mountain Bell	Cherry	Red	Yes	V,F	Indeterminate

(table continued next page)

Recommended Plum, Cluster, Cherry, and Grape Tomatoes *(continued)*

Variety	Type	Color	Hybrid	Disease Reactions[1]	Form
Sweet Chelsea	Cherry	Red	Yes	V,F,N,Tomv	Indeterminate
Sun Gold	Cherry	Orange	Yes	F, Tomv	Indeterminate
Sweet Treats	Cherry	Pink	Yes	F,Tomv,Gls	Indeterminate
BHN 785	Grape	Red	Yes	F	Determinate
Mini Charm	Grape	Red	Yes	V,F,Tomv	Indeterminate
Smarty	Grape	Red	Yes	V, F	Indeterminate
Jolly Elf	Grape	Red	Yes	V,F	Determinate
Jolly Girl	Grape	Red	Yes	V, F	Determinate
Cupid	Grape	Red	Yes	F, Asc	Indeterminate
Juliet	Large Grape	Red	Yes		Indeterminate

[1] Resistances or tolerances: V = Verticillium wilt; F = Fusarium wilt; N = Root knot nematode, Asc = Alternaria stem canker; .
(Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
Gls = Gray leaf spot; Tomv = Tomato mosaic virus; Tswv = Tomato spotted wilt virus; Lb = Late blight; Eb = Early blight. .
(Abbreviations applicable to this table; not nessarily elsewhere in this guide.)
Tmv = Tobacco mosaic virus. For information on resistance to specific disease races or species contact your seed supplier. .
(Abbreviations applicable to this table; not nessarily elsewhere in this guide.)

Recommended Heirloom Tomatoes

Variety	Maturity	Size	Shape	Color	Plant Form
Mortgage Lifter	Late	Large	Beefsteak	Pink skin, Pink flesh	Indeterminate
Hawaiian Pineapple	Late	Large	Beefsteak	Orange bicolor	Indeterminate
Prudens Purple	Mid	Large	Globe	Deep pink skin and flesh	Indeterminate, potato leaf
Mister Stripy	Late	Large	Round	Bicolor red and yellow	Indeterminate
Brandywine Red	Late	Large	Beefsteak	Red skin, red flesh	Indeterminate, potato leaf
Box Car Willie	Late	Med-large	Globe	Red skin, red flesh	Indeterminate
Eva Purple Ball	Mid	Medium	Round	Deep pink skin and flesh	Indeterminate
Arkansas Traveler	Late	Medium	Round	Red skin, red flesh	Indeterminate
Costoluto Genovese	Late	Medium	Ribbed flat globe	Red skin and flesh	Indeterminate
Snow White	Late	Small	Round cherry	Yellow skin and flesh	Indeterminate
Yellow Pear	Late	Small	Small pear	Yellow skin and flesh	Indeterminate

Recommended Processing Tomatoes

Variety	Season	Hybrid	Disease reactions[1]
TSH4	Early	Yes	V,F,Bs
H-3402	Mid	Yes	V,F,N,Bs
H-9704	Mid	Yes	V,F,Asc
H-9997	Early	Yes	V,F,N,Asc,Bs

[1]Disease resistance or tolerance: V = F = Fusarium wilt, Asc = Alternaria stem canker,
N = Root knot nematode, Bs = Bacterial speck

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

Tomatoes	Pounds N per Acre	Soil Phosphorus Level: Low	Med	High (Opt.)	Very High	Soil Potassium Level: Low	Med	High (Opt.)	Very High	Nutrient Timing and Method
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre				
Bare-Ground	80-90	200	150	100	0[1]	300	200	100	0[1]	Total nutrient recommended.
Fresh Market	40-45	200	150	100	0[1]	300	200	100	0[1]	Broadcast and disk-in.
	40-45	0	0	0	0	0	0	0	0	Sidedress when first fruits are set.
Processing	50-75	200	150	100	0[1]	250	150	100	0[1]	Total nutrient recommended.
Marchine Harvest	25	200	150	100	0[1]	250	150	100	0[1]	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress at first cultivation.
Polyethylene	150-210	200	150	100	0[1]	300	200	100	0[1]	Total nutrient recommended.
Mulched	0	200	150	100	0[1]	150	100	50	0	Broadcast and disk-in.
Fresh Market	50-85	0	0	0	0	0	0	0	0	Incorporate into the plant bed before laying polyethylene mulch.
	90-125	0	0	0	0	150	100	50	0[1]	Fertigate 0.5 to 2.5 pounds per day. See chart and Drip/Trickle Fertilization section.

Apply 1.0 to 2.0 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.
[1]In Virginia, crop replacement values of 50 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Suggested Fertigation Schedule for Coarse-Textured Soils – Fresh Market Tomatoes

Days After Planting	Daily Nitrogen[1]	Daily Potash[1,2]	Cumulative Nitrogen[1]	Cumulative Potash[1,2]
	lbs/A			
Preplant[3]	---	---	50	125
0-14	0.5	0.5	57	132
15-28	0.7	0.7	67	142
29-42	1.0	1.0	81	156
43-56	1.5	1.5	102	177
57-77	2.2	2.2	148	223
78-98	2.5	2.5	201	276

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot bed centers. Adjust proportionally for other widths. See Fertigation in C-Irrigation Management for more information.

Suggested Fertigation Schedule for Fine-Textured Soils - Fresh Market Tomatoes

Days After Planting	By Days After Planting Period		Cumulative Amount Applied	
	Nitrogen (N)[1]	Potash (K_2O)[1,2]	Nitrogen (N)[1]	Potash (K_2O)[1,2]
	lb/acre			
Preplant[3]	-	-	72	52
0-14 (14 days)	2.5	2.5	74.5	54.5
15-28 (13 days)	3.5	3.5	78	58
29-42 (13 days)	4.5	4.5	82.5	62.5
43-56 (13 days)	6.5	6.5	89	69
57-77 (20 days)	15	15	104	84
78-98 (20 days)	17	17	121	101

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are for 6 foot bed centers. Adjust proportionally for other widths. See Fertigation in C-Irrigation Management for more information.

Plant Tissue Testing and Petiole Sap Testing

Plant tissue testing and petiole sap testing are valuable tools to assess crop nutrient status during the growing season, to aid with in-season fertility programs, or to evaluate potential deficiencies or toxicities. The following are critical petiole sap and tissue test values for tomatoes.

Tomato Developmental Stage	**Fresh Petiole Sap Concentration (ppm)**	
	NO_3-N	**K**
First buds	1000-1200	3500-4000
First open flowers	600-800	3500-4000
Fruits one-inch diameter	400-600	3000-3500
Fruits two-inch diameter	400-600	3000-3500
First harvest	300-400	2500-3000
Second harvest	200-400	2000-2500

Critical tomato tissue test values.

Timing	**Value**	**N**	**P**	**K**	**Ca**	**Mg**	**S**	**Fe**	**Mn**	**Zn**	**B**	**Cu**	**Mo**
		%	**%**	**%**	**%**	**%**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Most recently matured leaves prior to blossom	**Deficient**	<3.0	0.3	3	1	0.3	0.3	<40	30	25	20	5	0.3
	Adequate range	3	0.3	3	1	0.3	0.3	40	30	25	20	5	0.2
		5	0.6	5	2	0.5	0.8	100	100	40	40	15	0.6
	High	>5.0	0.6	5	2	0.5	0.8	>100	100	40	40	15	0.6
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-	-
Most recently matured leaves at first flower	**Deficient**	<2.8	0.2	2.5	1	0.3	0.3	<40	30	25	20	5	0.2
	Adequate range	2.8	0.2	2.5	1	0.3	0.3	40	30	25	20	5	0.2
		4	0.4	4	2	0.5	0.8	100	100	40	40	15	0.6
	High	>4.0	0.4	4	2	0.5	0.8	>100	100	40	40	15	0.2
	Toxic (>)	-	-	-	-	-	-	-	1500	300	250	-	-
Most recently matured leaves at early fruit set	**Deficient**	<2.5	0.2	2.5	1	0.25	0.3	<40	30	20	20	5	0.2
	Adequate range	2.5	0.2	2.5	1	0.25	0.3	40	30	20	20	5	0.2
		4	0.4	4	2	0.5	0.6	100	100	40	40	10	0.6
	High	>4.0	0.4	4	2	0.5	0.6	>100	100	40	40	10	0.6
	Toxic (>)	-	-	-	-	-	-	-	-	-	250	-	-

Seed Treatment

Hot water treatment is administered to eradicate bacterial pathogens from seeds. Check with your seed company to determine if seed is hot water treated. Purchase hot water treated seed if possible or request hot water seed treatment. For more information to prevent disease see Disease Management in Section E.

Hardening Transplants

It is usually desirable to harden tender tomato seedlings before planting them in the field. Recent research has shown that hardening tomato plants by exposure to cool temperatures 60^{o} to 65^{o}F (15.6^{o} to 18.3^{o}C) day and 50^{o} to 60^{o}F (10^{o} to 15.6^{o}C) night for one week or more causes catfacing. Harden plants by withholding nitrogen and reducing water. Allow plants to wilt slightly between light waterings.

Drip/Trickle Fertilization

For any nutrient management program, begin by obtaining an accurate soil test from a certified laboratory. Choose a nutrient program as necessary to meet your individual production system requirements based on soil and production history.

Before laying plastic mulch, adjust soil pH to 6.5 and apply enough farm-grade fertilizer to supply 50 to 85 pounds per acre of N, depending on soil and yield potential. You should also apply the balance of your needed K_2O that you do not plan to apply via fertigation as a modified broadcast application that treats only the mulched area. Nitrogen fertilizer should be incorporated into the bed or split between incorporated and a surface band bed treatment immediately before laying plastic mulch.

After laying plastic mulch and installing the trickle irrigation system, apply completely soluble fertilizer through the drip system to supply additional nitrogen and potash throughout the season, depending on soil texture and yield potential (see table for suggested schedule). Nitrogen and potassium fertigation should be increased over the growing season as plants mature (see table for example). Adjust rates as necessary based on soil and tissue tests.

Fresh Market

Yield, fruit size, and fruit quality of market tomatoes is increased by the use of black plastic mulch in combination with trickle irrigation. Form raised, dome-shaped beds to aid in disease control. Lay 4-foot wide black plastic mulch tightly over the beds.

For early summer harvest of market tomatoes, start transplanting April 10 to 20 in southern or normally warmer areas, and May 10 to 25 in cooler, northern areas.

See the "Trickle Irrigation" section of General Production Recommendations for detailed recommendations on fertilizing tomatoes grown with plastic mulch and trickle irrigation.

Ground Culture

Space *determinate* vined varieties in rows 4 to 5 feet apart with plants 15 to 24 inches apart in the row. For *indeterminate* varieties, space rows 5 to 6 feet apart with plants 24 to 36 inches apart in the row.

Stake Culture

Staking tomatoes is a highly specialized production system. Recommendations below are for the short-stake cultural system using determinate cultivars that grow 3 to 4 feet in height. Row widths of 5 to 6 feet with in-row spacings from 18 to 24 inches between plants are recommended.

Pruning. Pruning is practiced to establish a desired balance between vine growth and fruit growth. Little to no pruning results in a plant with a heavy load of smaller fruit. Moderate pruning results in fewer fruits that are larger and easier to harvest. Pruning can result in earlier maturity of the crown fruit and improve spray coverage and pest control.

Removing all suckers up to the one immediately below the first flower cluster is adequate for most determinate cultivars. Removing the sucker immediately below the first flower cluster or pruning above the first flower cluster can result in severe leaf curling and stunting of the plant and should be avoided. Prune when the suckers are 2 to 4 inches long. A second pruning may be required to remove suckers that are too small to be easily removed during the first pruning and to remove ground suckers that may develop. Pruning when suckers are too large requires more time and can damage the plants, delay maturity, and increase disease incidence. Do not prune plants when they are wet to avoid spread of bacterial diseases. Pruning should be done before the first stringing because the string can slow down the pruning process. Pruning is variety and fertility dependent. Less vigorous determinate cultivars generally require less pruning. Growers should experiment with several degrees of pruning on a small scale to determine pruning requirements for specific cultivars and cultural practices.

Staking. Staking improves fruit quality by keeping plants and fruit off the ground and providing better spray coverage. Staked tomatoes are easier to harvest than ground tomatoes.

Staking tomatoes consists of a series of wooden stakes with twine woven around the stakes to train the plants to grow vertically off the ground. Stakes 4- to 4½-feet long by 1-inch square are driven approximately 12 inches into the soil between the plants.

Vigorous cultivars may require larger and longer stakes. A stake placed between every other plant is adequate to support most determinate varieties. Placing an additional stake at an angle and tied to the end stake of each section will strengthen the trellis system. Stakes can be driven by hand with a homemade driving tool or with a commercially available, power-driven stake driving tool. Drive stakes to a consistent depth so that spray booms can be operated in the field without damaging the trellis system Select "tomato twine" that is resistant to weathering and stretching and that binds well to the wooden stakes. Tomato twine is available in 3- to 4-pound boxes, and approximately 30 pounds per acre are required. To make tying convenient, use a homemade stringing tool. This tool can be made from a length of metal conduit, PVC pipe, broom handle, or wooden dowel. With conduit or PVC pipe, the string is fed through the pipe. With a broom handle or wooden dowel, two small parallel holes, each approximately ½ to 1 inch from the end, must be drilled to feed the string through one hole along the length of the tool and through the other hole. The tool serves as an extension of the worker's arm (the length cut to the worker's preference) and helps to keep the string tight.

Proper stringing consists of tying the twine to an end stake passing the string along one side of the plants, looping the twine around each stake until you reach the end of a row or section (100-foot sections with alleys may be helpful for harvesting). The same process is continued on the other side of the row. The string tension must be tight enough to hold the plants upright but harvest can be difficult and strings can scar fruit if they are too tight.

The first string should be strung 8 to 10 inches above the ground when plants are 12 to 15 inches tall and before they fall over. Run the next string 6 to 8 inches above the preceding string before plants start to fall over. Three to 4 stringings are required for most determinate varieties. Stringing should be done when the foliage is dry to prevent the spread of bacterial diseases.

Conservation Tillage (No-Till) with Hairy Vetch

(For use in Delaware, Maryland, and Pennsylvania) **not** recommended for use in New Jersey, Virginia, or West Virginia)

Transplanting tomatoes into a hairy vetch cover crop can produce yields equivalent to or greater than those achieved with black plastic mulch and eliminates the expenses for installation and disposal of plastic mulch. Tomatoes grown in hairy vetch remain vigorous and produce fruit over a longer period of time compared to conventional production systems. Other benefits of using a no-till system include erosion control, moisture conservation during the summer, increased soil organic matter, improved soil fertility and structure, and weed suppression. **Cautions**: The no-till system is not adapted to heavy, poorly drained soils with high weed populations. Tomatoes will mature at least one week later on hairy vetch mulch than on black plastic due to decreased soil warming in all soil types. The living cover crop can remove soil moisture during the spring. This may increase the difficulty of transplanting tomatoes and require irrigation immediately after transplanting.

Cover Crop Establishment. Form beds before planting the cover crop. Inoculate hairy vetch seed for maximum nitrogen fixation and plant with a forage/grass seeder or grain drill with a grass seed hopper. Seed hairy vetch over the top of the beds at 25 to 40 pounds per acre between August 15 and September 15 in cool areas and September 1 and October 1 on the Delmarva Peninsula and southern New Jersey. For erosion control and greater mulch bio-mass, seed rye or "spring" oats at up to 40 pounds per acre in addition to 25 to 40 pounds per acre of vetch. The "spring" oats will not overwinter, leaving an almost pure stand of hairy vetch in the spring. (Note. Little winter kill may occur in mild winters on the Delmarva Peninsula and normally warm areas.) Rye will overwinter and form a support for the vetch during the spring. For trial: Plant crimson clover at 10 to 20 pounds per acre with the vetch and rye to increase the biomass of mulch and increase nitrogen fixation. However, this may increase the difficulty of transplanting tomatoes.

Cover Crop and Weed Management. Timing: Allow vetch to grow until the flower bud stage (early to late May) or several weeks longer to obtain adequate mulch biomass and nitrogen fixation. Be sure to kill the vetch before it produces mature seed. Seeds are immature when they are easily crushed between your fingers. **Caution**: Delay in killing vetch until mature seed formation may result in vetch weeds in succeeding crops.

Mowing: Flail mowing can desiccate hairy vetch without herbicides. If mowing is delayed until hairy vetch begins flowering and oats and rye are heading, minimal regrowth will occur. If hairy vetch is mowed while vegetative, regrowth may require a postemergence herbicide application. Vetch regrowth often occurs approximately 3 to 4 weeks after transplanting when the first flush of weeds emerge through the mulch. A directed application of metribuzin (0.33 lb/A Sencor/Lexone 75DF) has successfully controlled vetch regrowth and provided weed control when applied at this time. A second directed application of metribuzin may be required for full-season weed control. Grass weeds emerging after this time can be controlled with sethoxydim. **Caution**: Hairy vetch decomposes rapidly and emerging weeds will eventually require control. The use of the vetch mulch system eliminates the possibility for mechanical cultivation. Organic growers will need alternative weed control strategies (mowing, hand weeding, etc.) to control winter annuals, perennials, and escaped annual weeds.

Herbicides: An alternative method of killing hairy vetch is with an application of paraquat (Gramoxone SL 2.0 2.4 pints per acre). Sethoxydim (1.0 to 2.0 pints per acre of Poast 1.5EC) or clethodim (3 fluid ounces per acre of Select 2EC) with oil concentrate can be used to control oat or rye cover crops that escaped control by mowing or paraquat application. Prior to planting tomatoes, apply napropamide (2.0 to 4.0 pounds per acre Devrinol DF-XT) to control grasses. Rainfall or sprinkler irrigation is required to incorporate residual herbicides. Use recommended postemergence herbicides to control weeds that escape this preplant herbicide application.

Tomato Management. Planting: Tomato plants should be transplanted with minimal disturbance to the cover crop mulch. Mechanical transplanters with spades that insert plants through the mulch into the soil are available. Mount coulters ahead of the spades to aid in loosening the soil. Care should be taken to avoid catching the viny vetch mulch on axles or protrusions that would disturb the uniform layer. After transplanting, lay drip irrigation tubing over the top of the mulch 2-3 inches from the tomato plants, with emitter pores up. Staking will improve fruit quality.

Fertility: Apply phosphorus, potassium, and other nutrients (at rates determined by soil test) when forming beds in the fall or broadcast over the beds after cover crop is killed or mowed. Hairy vetch will supply a significant portion of the nitrogen requirement for tomatoes and good yields can be achieved with no additional nitrogen applications. Maximum yields can be obtained using one-half the fertilizer nitrogen applied to tomatoes grown on plastic mulch.

Apply a high phosphorus starter solution at planting. Within 1 week after transplanting, apply a complete soluble fertilizer to supply 10 to 40 pounds (5 to 15 pounds on heavy soils) of N, P_2O_5, and K_2O per fertilized-mulched acre through the drip irrigation system. The same rate of soluble N-P_2O_5-K_2O fertilizer should be applied when first fruit are 1 inch in diameter and again when the fruit begin to ripen. On soils testing low or low to medium in boron, include 0.5 pound of actual boron per fertilized-mulched acre in each fertilizer application.

Processing Tomatoes

Transplanting

Processing tomatoes can be transplanted starting April 15 to 20 in warmer, southern areas to May 5 to 10 in Pennsylvania and normally cooler areas. Successive plantings can be made through early June.

Space transplants 9 to 12 inches apart in single rows 5 feet apart or to accommodate machine harvesters. Small, determinate varieties may be grown in double rows. Space double rows 12 inches apart and space plants 12 to 18 inches apart in each of the double rows. Plant spacing appears to affect fruit size and yield, but research is not yet complete.

Fruit Ripening

Ethephon is labeled for use on processing tomatoes. Proper application increases earliness and yield and decreases sorting of green fruit in machine-harvested tomatoes. Rate and time of application are critical for successful use of ethephon. See state fact sheets or product label for details on rates, time of application, and temperature effects on the successful use of ethephon.

Harvest and Post Harvest Considerations

Tomatoes may be harvested at the mature green stage (when and after which the fruit cavity is filled by gel), breaker stage (just showing pink at the bottom of the fruit), semi-ripe (with different amounts of red pigmentation) or fully ripe, depending or marketing requirement. Tomato fruits are very perishable and subject to surface and internal damage, and must be handled with care. If tomatoes are to be harvested at breaker, partially ripe, or vine-ripe stages, fields should be harvested often and thoroughly to hasten the ripening of later fruits and reduce the overall the range of ripeness. Harvesting every day may be desirable during the peak of the season. Remove all diseased, misshapen, and otherwise cull tomatoes from the vines as soon as they are discovered. Remove discarded tomatoes from the field to avoid the spread and buildup of diseases and insect pests. . For standard slicing tomatoes, cherry tomatoes, and plum tomatoes, remove the stem during picking. Cluster tomatoes are harvested with the whole truss attached to fruits.

Tomatoes should be washed sufficiently to remove dust and foreign material by hand with clean cloths or mechanically by spraying them with a small amount of chlorinated water as they move over a set of soft brush rolls. The small amount of retained water may be removed by absorbent rollers alone or in combination with an overhead air-blast drier. The wash water should be several degrees warmer than the pulp temperature of the tomatoes to avoid drawing water and disease organisms into the fruit. The water should be chlorinated at the rate of 125 ppm. The chlorine level and pH (6.0 – 7.0) of the wash water should be checked at least hourly during the day with test papers or a meter.

Tomatoes are then sized and separated by color and grade and carefully packed into 25 lb. boxes.

Size Classification of Tomatoes

Size Designation	Diameter (inches) Minimum*	Maximum**
Extra small	1-28/32	2-4/32
Small	2-4/32	2-9/32
Medium	2-9/32	2-17/32
Large	2-17/32	2-28/32
Extra large	2-28/32	3-15/32

Color Classification of Tomatoes

Tomatoes may be graded into the following color classes (some classes may be combined):

Green - The surface of the tomato is completely green. The shade of green may vary from light to dark. Mature green fruits are typically ripened at the terminal market or by the repacker with ethylene gas.

Breakers - There is a definite break in the color from green to tannish yellow with pink or red skin covering not more than 10 percent of the surface.

Turning - More than 10 percent but not more than 30 percent of the surface, shows a definite change in color from green to tannish yellow, pink, red, or a combination of those colors.

Pink - More than 30 percent but not more than 60 percent of the surface, shows pinkish red or red color.

Light Red - More than 60 percent but not more than 90 percent, shows pinkish red or red color.

Red - More than 90 percent of the surface, shows red color.

For long distance shipping, mature green harvest is the common practice. For local wholesale, harvest is usually at the breaker stage. For direct market, harvest is at the ripe stage Store mature-green tomatoes at 55 to 70°F; breakers, partially ripe, and ripe fruit at 50°F and a relative humidity of 90 to 95%. Exposing tomatoes to temperatures below 50 F results in loss of color, shelf life, and firmness.

Tomato Disorders

Catfacing

Fruits are malformed and scarred, usually at the blossom end. Catfacing is caused by one week of exposure of seedlings to day temperatures in the range 60° to 65°F (15.6° to 18.3°C) and night temperatures at 50° to 60°F (10° to 15.6°C) approximately 4 weeks before pollination. The first flower cluster is susceptible to low temperature-induced catfacing when seedlings have 4 to 5 true leaves. Fruits on later clusters will show catfacing if exposed to low temperatures in the field. Avoid hardening seedlings by exposure to low temperatures. Varieties differ in their susceptibility to the disorder.

Internal Browning (IB), Graywall (GW), and Blotchy Ripening (BR)

These problems are a complex of physiological disorders and pathological diseases. Green fruit with IB have brown necrotic areas in the walls and internal tissues. Areas around necrotic tissue ripen slowly and unevenly, resulting in a mottled, greenish-yellow and red fruit color. IB can be caused by tobacco mosaic virus (TMV).

Irregular, grayish-brown blotchy areas (GW) can occur on the upper half of fruit free of TMV. On ripening, fruit with GW or BR have blotchy areas of green and yellow tissue surrounded by areas of normal red tissue. Greenish-white and white tissue are usually present in the fruit walls, and brown necrotic areas may be located around the vascular system of the fruit. Yellow-eye, a ring of yellow tissue surrounding the stem scar, often occurs in fruit with BR and internal white tissue.

GW and BR symptoms often appear on shaded fruit growing in the interior of dense, vegetative plants. Cloudy, moist, cool weather; high soil moisture; high nitrogen; soil compaction; and low potassium increase the incidence and severity of GW and BR.

Yellow Shoulders

Yellowing may occur on the shoulders of the fruit exposed to the sun, especially on varieties having darker green shoulders when immature (those lacking the uniform ripening gene). The tissue beneath the yellow shoulder is usually corky and may vary from greenish white to pale yellow. This disorder can be overcome by selection of varieties with the uniform ripening gene. Provide good fruit cover as described below.

Sunburn and Sunscald

Sunburn and sunscald result from exposure to direct sunlight. Mild sunburn appears as yellowish or yellow-red color of fruit on the side exposed to the sun. Severe symptoms appear as whitish, water-soaked, scalded, or blistered areas. Sunscald is more severe on fruit growing in shaded conditions, followed by exposure to direct sunlight due to defoliation or exposure during harvesting. Under dry conditions, the white areas can become dry and leathery. Secondary infection can produce a dark, dry rot. Under moist conditions, scalded areas can decay from secondary infections. To control sunburn and sunscald, select varieties with good fruit cover and supply sufficient water and nutrients to provide good vegetative growth. Train workers to avoid turning vines during harvesting or to reposition vines to shade fruit.

Blossom-End Rot (BER)

This physiological disorder is caused by inadequate movement of calcium into the fruit. BER occurs when soil moisture is low and is more severe when plants have small, shallow root systems. Plastic mulch can restrict the movement of water to the root zone and increase BER. Hot, windy conditions increase water loss from the plant and increase the incidence of BER.

Be sure soil calcium is sufficient and in balance with other essential plant nutrients. Test the soil and apply lime and fertilizer according to recommendations, then lay plastic mulch when soil moisture is optimum for planting. Apply irrigation to wet the root zone and encourage deep root development.

Fruit Cracking and Russeting

Fruit cracking is due to rapid uptake of water by the fruit, resulting in enlargement of cells and separation of the epidermis of the fruit. Water can be taken up by the fruit through the roots and vascular system or through the fruit tissue around the stem scar.

The type of cracking (*concentric* cracks around the stem, *radial* cracks radiating out from the stem, or *diagonal* or *transverse* cracks across the fruit) is determined primarily by fruit structure and variety. More than one type of cracking may be present in a variety or an individual fruit.

The severity of cracking is determined by rainfall and irrigation amounts, variety and stage of maturity. As the fruit ripens, the strength of bonding between cells progressively decreases, resulting in more severe cracking. Severity of cracking is increased by high rainfall and irrigation, or frequent low to moderate rainfall, especially following a period of low soil moisture.

To minimize cracking, select a crack-resistant variety. Maintain a high level of calcium in the soil. Keep fruit growing at a uniform rate by maintaining uniform soil moisture levels. Maintain good fruit cover by proper fertilization and fungicide applications. Harvest fruit at the earliest stage of maturity that is acceptable by your market.

Russeting or weather checking of the surface of the fruit is caused by the presence of water on the fruit surface for extended periods of time when there are frequent light rainfalls, mist, fog, and dew. Wide fluctuations in temperature of exposed fruit also contribute to russeting. Russeting can cause fruit to be unmarketable. Maintain good fruit cover by proper fertilization and fungicide applications. Use varieties that feature a dense canopy and resistance to foliar diseases.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide.rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Note: All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Pretransplant Incorporated or Pretransplant

Metribuzin--0.25 lb/A. Apply 0.33 pounds per acre metribuzin (or OLF) in a band under the plastic, immediately before laying the mulch. Mechanically incorporate before laying the mulch, or apply to the soil surface and incorporate with the condensation that forms on the underside of the mulch. Primarily controls broadleaf weeds. Tank-mix with Devrinol control annual grasses.

Pretransplant

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG in a band under plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay transplanting for seven days after application. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1.0 dry ounce of Sandea, applied pretransplant under platic mulch.**

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Combine with metribuzin to improve the spectrum of broadleaf weeds controlled. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above and below), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds**. DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Pretransplant/ Preemergence to the Weeds

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray to the soil strips between rows of plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a 1 year (12 month) period.**

S-metolachlor--0.95 to 1.9 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E as a banded directed shielded spray to control annual grasses, yellow nutsedge, nightshade species, galinsoga, and certain other broadleaf weeds. Use as a surface-applied banded spray, preemergence to the weeds. Posttransplant banded directed shielded sprays should be applied to weed-free soil. Dual Magnum will not control emerged weeds. Control emerged weeds with Graomoxone added to the shielded and directed banded herbicide spray. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Apply only when the soil surface is dry to avoid risk of vapor drift injury to the crop. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Make only one application during the growing season. DO NOT apply within 30 days of harvest if 1.33 pints per acre or less is used, or within 90 days of harvest if more than 1.33 pints per acre is used except in VA, where a 60 day PHI must be observed when 1.67 pints or less Dual Magnum is used per year. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Metribuzin--0.25 lb/A. Apply 0.33 pounds per acre metribuzin (or OLF) as a banded directed shielded spray. Primarily controls broadleaf weeds. Tank-mix with Devrinol, or Treflan to control annual grasses at planting, or use a postemergence herbicide. An additional postemergence application of metribuzin may be necessary to control broadleaf weeds.

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. May reduce stand of and yield of fall grains. Moldboard plowing will reduce the risk of injury.

Pendimethalin--0.48 to 1.42 lb/A. Apply 1.0 to 3.0 pints per acre Prowl H_2O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. **DO NOT apply "over the top" of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval).**

Postemergence

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F as a banded directed shielded spray 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray as a band directed between the rows of plastic mulch. Controls late season annual grasses, common purslane, and other broadleaf weeds.

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray to the soil strips between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied in a 1 year (12 month) period**

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF **as a banded directed shielded spray between the rows ONLY,** to control emerged grass and broadleaf weed seedlings. Do not allow spray to contact plants as injury or residues may result. Use shields to prevent spray contact with crop plants. Do not exceed a spray pressure of 30 psi.

Add wetting agent as per label.

Pendimethalin--0.48 to 1.42 lb/A. Apply 1.0 to 3.0 pints per acre Prowl H_2O as a banded directed shielded spray andactivate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds preemergence. Use the lower rate on coarse-textured or sandy soils. Tank-mix with paraquat to control emerged weeds. **Do NOT apply "over the top" of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval).**

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

For Transplanting Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **planting into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated-Transplants

Napropamide--1.0 to 2.0 lb/A. Apply 2.0 to 4.0 pounds per acre Devrinol DF-XT prior to transplanting. Incorporate thoroughly to a depth of 2 to 3 inches the same day as application. Use lower rate on coarse-textured or sandy soils. Primarily controls annual grasses and certain broadleaf weeds. Use in combination with metribuzin to improve the spectrum of broadleaf weeds controlled. May reduce stand and yield of fall grains if fields are only disked. Moldboard plowing will reduce the risk of injury.

Trifluralin--0.5 to 1.0 lb/A. Apply 1.0 to 2.0 pints per acre Treflan4EC (or OLF). Incorporate with double-disking into 2 to 3 inches of soil within 8 hours after application. Mount the boom on the front of disk. Primarily controls annual grasses and certain broadleaf weeds. Use in combination with metribuzin to improve the spectrum of broadleaf weeds controlled. Stunting may result if weather is cool and damp. Will not control ragweed, jimsonweed, or morningglory.

Metribuzin--0.25 lb/A. Apply 0.33 pounds per acre metribuzin (or OLF) and incorporate before transplanting tomto plants with a minimum of 5 true leaves. Transplants with less than 5 true leaves are at greater risk of herbicide injury. Primarily controls broadleaf weeds. Tank-mix with Devrinol, or Treflan to control annual grasses at planting, or use Poast 1.5EC to control grasses postemergence. An additional postemergence application of metribuzin may be necessary to control broadleaf weeds.

Pretransplant Incorporated or Pretransplant

S-metolachlor--0.95 to 1.9 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E as a pretransplant incorporated or pretransplant surface applied spray to control annual grasses, yellow nutsedge, nightshade species, galinsoga, and certain other broadleaf weeds. Apply Dual Magnum before weeds germinate. Dual Magnum will not control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Make only one application during the growing season. DO NOT apply within 30 days of harvest if 1.33 pints per acre or less is used, or within 90 days of harvest if more than 1.33 pints per acre is used except in VA, where a 60 day PHI must be observed when 1.67 pints or less Dual Magnum is used per year. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Pretransplant

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the developmentof resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **. DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied pretransplant. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a 1**year (12 month) period.

Postemergence-Transplanted

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

DCPA--4.5 to 10.5 lb/A. Apply 6.0 to 14.0 pints per acre Dacthal 6F to weed-free soil 4 to 6 weeks after transplanting or after direct-seeded plants are a minimum of 6 inches tall. The crop should be well established and growing under conditions that are favorable for good growth. Dacthal will provide residual control of annual grasses and certain broadleaf weeds, including common purslane, but will not control emerged weeds. Applications can be made over the top of the crop when grown without plastic mulch but must be banded between the rows when plastic mulch is used.

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga after the crop has been transplanted at least 14 days. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1.0 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea applied preemergence and postemergence to multiple crops in a 1 year (12 month) period.**

Metribuzin--0.25 lb/A. Use 0.33 pound per acre Metribuzin 75DF on tomato plants with a minimum of 5 true leaves. Transplants with less than 5 true leaves are at greater risk of herbicide injury. Primarily controls broadleaf weeds, but does NOT control nightshades. Use Devrinol, or Treflan preplant incorporated or apply Poast 1.5EC postemergence to control annual grasses. Applications should be delayed until transplants have a minimum of 5 true leaves, have recovered from transplant shock and new growth is evident, or at least 2 weeks. Do not treat tomato plants with less than 5 true leaves. Transplants with less than 5 true leaves are at greater risk of herbicide injury. Do not apply within 3 days after periods of cool, wet, or cloudy weather or crop injury will occur. Do not apply within 24 hours of treatment with other pesticides. Treatment with Sencor may be repeated in 14 days if necessary. Repeat application to suppress or control yellow nutsedge. Do not apply within 7 days of harvest.

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a directed spray between the rows. Do not allow spray to contact plants, as injury or residues may result. Use shields to prevent spray contact with crop plants. Do not exceed a spray pressure of 30 psi. Add wetting agent as per label.

Rimsulfuron--0.0156 to 0.031 lb/A. Apply 1.0 to 2.0 dry ounces per acre of Matrix 25DF early postemergence to control many annual weeds. Optimum results are obtained when the weeds are very small, less than one inch in height, but not before the crop has at least two full-sized true leaves. Common lambsquarters, common ragweed, jimsonweed, morninglory species, and yellow nutsedge may only be suppressed. Tank-mix with metribuzin to increase the spectrum of weeds controlled. Always check and follow the application instructions on the label for both herbicides related to the size of the crop, size of the weeds, and weather conditions when applying as a tank-mixed combination. Add nonionic surfactant to be 0.25 percent of the spray solution (1.0 quart per 100 gallons of spray solution) to improve weed control. DO NOT exceed a total of 4.0 dry ounces of product per acre per year. **Labeled for use on processing and fresh market tomatoes in all states, except California.**

Rimsulfuron (Matrix 25DF) is an ALS inhibitor. Herbicides in this class of chemistry have a single site of action in susceptible plants. Always use sequentially or in a tank-mixed combination with other herbicides with a different site of action in the plant to prevent the development of resistant weed populations. Read and follow label cautions and resistance management recommendations.

S-metolachlor--0.95 to 1.9 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E as a shielded directed spray to control annual grasses, yellow nutsedge, nightshade species, galinsoga, and certain other broadleaf weeds. Posttransplant banded directed shielded sprays should be applied to weed-free soil after the first soil settling rainfall or overhead irrigation after transplanting. Dual Magnum wil l not control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Apply only when the soil surface is dry to avoid risk of vapor drift injury to the crop. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Make only one application during the growing season. DO NOT apply within 30 days of harvest if 1.33 pints per acre or less is used, or within 90 days of harvest if more than 1.33 pints per acre is used except in VA, where a 60 day PHI must be observed when 1.67 pints or less Dual Magnum is used per year. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Sethoxydim--0.2 to 0.4 lb/A. Apply 1.0 to 2.0 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Insect Control
Field Tomatoes (Fresh Market and Processing Tomatoes)

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Cutworms (Also see Section E in “Soil Pests--Their Detection and Control”.)

Apply one of the following formulations:

Preplanting Field Treatment

Just before seeding or transplanting, broadcast on the soil surface the following:

bifenthrin--3.4 to 6.8 fl oz/A Capture LFR (or OLF)
diazinon--2.0 to 4.0 qts/A Diazinon AG500 (or OLF)

Postplanting Treatment

If control is required after seedling emergence or after transplanting, treat soil thoroughly beneath plants with the following:

beta-cyfluthrin--2.1 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)

cyfluthrin--2.1 to 2.8 fl oz/A Tombstone (or OLF)
esfenvalerate--4.8 to 9.6 fl oz/A Asana XL
gamma-cyhalothrin--1.92 to 3.20 fl oz/A Proaxis
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--5.0 to 8.0 fl oz/A Voliam Xpress
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Colorado Potato Beetle (CPB)

Rotation to crops other than potato, tomato, and eggplant is extremely important in reducing CPB problems. Also, transplants placed into no-till fields, mulches or other crop residue will reduce or delay potato beetle infestations.

Look for CPB adults shortly after seedling emergence or transplanting. Early season populations tend to be concentrated in areas where tomatoes or potatoes were previously grown. For direct-seeded tomatoes during emergence, treat when CPB adults are reducing plant densities below recommended levels for maximum yields. Thoroughly scout tomato fields and spray only when necessary. Also spot treatment of "hot spots" only is recommended if infestation is localized. For established direct-seeded or transplant tomatoes, begin treatment if the population level exceeds 15 CPB adults per 10 plants throughout the field. If early treatment is not applied, wait for egg hatch and spray when larvae are young and exceed 20 CPB larvae and/or adults per 10 plants. Reassess after each treatment. Avoid the application of late-season sprays to prevent the buildup of insecticide-resistant beetles. Apply one of the following formulations:

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
acetamiprid--1.5 to 2.5 oz/A Assail 30SG (or OLF)
bifenthrin+imidacloprid--5.10 to 9.85 fl oz/A Brigadier
chlorantraniliprole--**drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cryolite **(not cherry types)--**8.0 to 16.0 lbs/A Kryocide 96WP (or Prokil cryolite 96)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
thiamethoxam--**soil 1.66 to 3.67** oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Flea Beetles

Apply one of the following formulations:
beta-cyfluthrin--2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin+imidacloprid--3.80 to 9.85 fl oz/A Brigadier (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid--**soil** 7-14 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SC; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil/drip** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Aphids (Green Peach and Potato)

Apply one of the following formulations:

Note: Thorough spray coverage beneath leaves is important.

acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)
bifenthrin+imidacloprid--3.80 to 9.85 fl oz/A Brigadier
Chenopodium extract--2.0 to 3.0 qts/A Requiem
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50 SG
imidacloprid--**soil** 7.0 to 14.0 fl oz/A Admire Pro (or OLF), **foliar** 1.3 to 2.2 fl oz/A Admire PRO (or OLF)
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl (**green peach aphid only**)--0.75 to 3.00 pts/A Lannate LV (or OLF)
oxamyl--2.0 to 4.0 pt/A Vydate 2L
pymetrozine--2.75 oz/A Fulfill 50WDG
spirotetramat--4.0 to 5.0 fl oz/A Movento
sulfoxaflor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Caterpillars Tomato Fruitworm also called Corn Earworm (CEW), Hornworm (HW), European Corn Borer (ECB), Cabbage Looper (CL)

Apply one of the following formulations:
Bacillus thuringiensis (**CL, HW only)--**1.0 lb Dipel (or OLF)

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture (Sniper, or OLF)
chlorantraniliprole--**soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone
emamectin benzoate **(except CL and ECB**)--2.4 to 4.8 oz/A Proclaim 5 SG
esfenvalerate (**except ECB**)--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin (**except ECB**)--10.67 fl oz/A Danitol 2.4EC
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
indoxacarb--3.5 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC
tebufenozide--6.0 to 8.0 fl oz/A Confirm 2F
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Leafminers

Treat with one of the following formulations when first mines appear and repeat every 7 days or as needed.

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
chlorantraniliprole (**larvae only) soil/drip/foliar--**5.0 to 7.5 fl oz/A Coragen 1.67SC
cyromazine--2.66 oz/A Trigard
dimethoate--0.50 to 1.0 pt/A Dimethoate4EC (or OLF)
dinotefuran**--soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
emamectin benzoate--4.8 oz/A Proclaim 5 SG
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 10.0 fl oz/A Entrust SC

True Armyworm (TAW), Fall Armyworm (FAW)

beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin+imidacloprid--5.10 to 9.85 fl oz/A Brigadier
chlorantraniliprole**--soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5 SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F
novaluron--9.0 to 12.0 fl oz/A Rimon 0.83EC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Beet Armyworm

Apply one of the following formulations:
chlorantraniliprole**--soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5 SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--3.5 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
methomyl--3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F
novaluron--9.0 to 12.0 fl oz/A Rimon 0.83EC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi

Mites

Mite infestations generally begin around field margins, grassy areas, and windbreaks. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated.

Note: Thorough spray coverage beneath leaves is important. The use of dimethoate for aphids and leafminers will reduce spider mite populations. Apply one of the following formulations:

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
bifenazate--0.75 to 1.00 lb/A Acramite 50WS
fenpyroximate--2.0 pt/A Portal
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC

Pinworms

- This pest is introduced on southern transplants. Begin sprays if leaf damage is observed. Late evening sprays may be most effective when moths are active. Apply one of the following formulations:

abamectin--3.5 fl oz/A Agri-Mek 0.7SC (or OLF)
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
chlorantraniliprole **(larvae) soil/drip/foliar--**3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
emamectin benzoate--2.4 to 4.8 oz/A Proclaim 5 SG
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
indoxacarb--3.5 oz/A Avaunt 30WDG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)

lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
methomyl--3.0 pts/A Lannate LV (or OLF)
novaluron--9.0 to 12.0 fl oz/A Rimon 0.83EC
NoMate TPW--200 spirals/A

Note. NoMate is a technique using a mating disruption pheromone useful for preventing mating of emerging adults from young transplants. The pheromone is applied to a hard plastic matrix formed into a hanging "spiral" for dispersal into the air. Apply at first sign of pinworm larvae in leaves.

spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang MAX (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Several species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when thrips are observed. Do not produce vegetable transplants with bedding plants in the same greenhouse. Apply one of the following formulations:

acetamiprid--1.5 to 2.5 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
cyfluthrin--1.62 to.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
gamma-cyhalothrin (**except Western flower thrips**)--2.56 to 3.84 fl oz/A Proaxis
imidacloprid--**soil** 14.0 fl oz/A Admire Pro (or OLF)
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin (**except Western flower thrips)--**1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+thiamethoxam **(except Western flower thrips)--**4.0 to 4.5 fl oz/A Endigo ZC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo

Stink bug

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
bifenthrin+imidacloprid--5.10 to 9.85 fl oz/A Brigadier, Swagger or OLF
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--1.6 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
fenpropathrin **green stinkbug only--**10.67 fl oz/A Danitol 2.4 EC
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid+beta-cyfluthrin--3.8 to 4.1 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.24 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Whiteflies

Apply one of the following formulations:
acetamiprid--1.5 to 2.5 oz/A Assail 30SG (or OLF)
buprofezin--9.0 to 13.6 fl oz/A Courier SC or OLF
Chenopodium extract--2.0 to 3.0 qt/A Requiem
chlorantraniliprole--**soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
fenpyroximate--2.0 pt/A Portal
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WDG
pyriproxyfen--8.0 to 10.0 fl oz/A Knack
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC
spirotetramat--4.0 to 5.0 fl oz/A Movento
sulfoxaflor--4.25 to 4.5 fl oz/A Closer SC
thiamethoxam--**soil 1.66 to 3.67** oz/A Platinum 75SG; **foliar** 2.0 to 3.0 oz/A Actara 25WDG
thiamethoxam+chlorantraniliprole--**soil** 10.0 to 13.0 fl oz/A Durivo; **foliar** 4.0 to 7.0 oz/A Voliam Flexi

Greenhouse Tomatoes
see Table E-10

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	7
azadirachtin	G	4	0
bifenthrin	R	12	1
bifenthrin + imidacloprid	R	12	1
bifenazate	G	12	3
buprofezin	G	12	7
Chenopodium extract	G	4	0
chlorantraniliprole (soil/drip/foliar)	G	4	1
chlorfenapyr	G	12	0
clothianidin (soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	0
diazinon	R	24	1
dimethoate	R	48	7
dinotefuran (soil/foliar)	G	12	21/1
emamectin benzoate	R	12	7
esfenvalerate	R	12	1
fenpropathrin	R	24	3
fenpyroximate	G	12	1
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide + buprofezin	G	12	1
gamma-cyhalothrin	R	24	5

(table continued in next page)

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE *(cont'd)*			
imidacloprid (soil/drip/foliar)	G	12	21/0
imidacloprid + cyfluthrin	R	12	0
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	5
lambda-cyhalothrin + chlorantraniliprole	R	24	5
lambda-cyhalothrin + thiamethoxam	R	24	5
malathion	G	12	5
methamidaphos	R	48	7
methomyl	R	48	1
methoxyfenozide	G	4	1
novoluron	R	12	1
oxamyl	R	48	3
pymetrozine	G	12	0
pyrethrins	G	12	1
pyriproxyfen	G	12	14
rosemary oil + peppermint oil	G	0	0
spinetoram	G	4	1
spinosad	G	4	1
spiromesifen	G	12	1
spirotetramat	G	24	1
sulfoxaflor	G	12	1
thiamethoxam (soil/drip/foliar)	G	12	30/0
thiamethoxam + chlorantraniliprole (soil/drip/foliar)	G	12	30/1
zeta-cypermethrin	R	12	1
zeta-cypermethrin + bifenthrin	R	12	1
FUNGICIDE (FRAC code)			
Actigard (Group P1)	G	12	14
Aliette (Group 33)	G	12	14
Cabrio (Group 11)	G	12	0
Catamaran (Groups M5+33)	G	12	0
chlorothalonil (Group M5)	G	12	0
Contans WG (biological)	G	4	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Endura (Group 7)	G	12	0
Flint (Group 11)	G	12	3
Flouronil (Groups 4 + M5)	G	48	14
Fontelis (Group 7)	G	12	0
Forum (Group 40)	G	12	4
Gavel (Groups 22 + M3)	G	48	5
mancozeb (Group M3)	G	12, 24	5
ManKocide (Groups M3 + M1)	G	48	5
Micora	G	4	0
Previcur Flex (Group 28)	G	12	5
Presidio (Group 43)	G	12	2
Priaxor (Groups 7 + 11)	G	12	7
Quadris (Group 11)	G	4	0
Quadris Top (Groups 3 + 11)	G	12	0
Rally (Group 3)	G	12	0
Ranman (Group 21)	G	12	0
Revus Top (Groups 3 + 40)	G	12	1
Ridomil Gold (Group 4)	G	48	0
Ridomil Gold Bravo (Groups 4 + M5)	G	48	14
Ridomil Gold Copper (Groups 4 + M1)	G	48	14
Scala (Group 9)	G	12	1
Switch (Groups 9 + 12)	G	12	0
Tanos (Groups 11 + 27)	G	12	3
Terraclor (Group 14)	G	12	AP
thiophanate-methyl (Group 1)	G	12	14
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

1 G = general, R = restricted,

2 Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

3 AP=At Plant

Nematode Control

See Chapter E "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Disease Control

Seed Treatment

Check with your seed company to determine if seed is hot water treated. Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens that may be found within the seed coat. Heat treatment is particularly useful for crops, such as tomato and pepper, that are prone to seed-borne bacterial infections. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heat cycle is for 10 minutes at 100ºF (38ºC) followed by the effective temperature. Soak tomato seed at 122^{o}F (50^{o}) for 25 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper. Do not use pelleted seeds because moisture results in the loss of coating material. Heat treat only seed that will be used during the current production season.

An alternative to hot water seed treatment is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1 to 2 minutes under constant agitation and rinse for 5 minutes in cool running water. Following either treatment above, dry the seed, then dust with captan 50WP or thiram 480DP at 1 level tsp/lb seed (3.0 oz/100 lbs).

Damping-Off

Greenhouse: Use seed treatment and plant in a disease-free mix.

Field: At planting apply one of the following:

Aliette--2.5 to 5.0 lb 80WDG/A,

mefenoxam (Ridomil Gold--1.0-2.0 pt 4SL/A or 2.0 to 4.0 pt Ultra Flourish 2E/A). Apply in a 7-inch band at transplanting. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

metalaxyl (MetaStar--2.0 to 4.0 pt 2E AG/A)

Additional field applications may be made as needed, see label for specific instructions.

Fumigants will also offer some suppression of in-field damping-off.

Bacterial Wilt

Use certified transplants. Avoid growing tomatoes in fields where bacterial wilt has occurred. Crop rotation to non-host crops is the best measure to reduce levels of bacterial wilt. In particular, avoid planting where tomatoes or peppers were grown in the preceding year. Some resistant cultivars, such as BHN669, are also available. Soil fumigation with a fumigant that contains either methyl bromide/iodide or chloropicrin may reduce disease occurrence. Ponds that are adjacent to previously diseased fields may be contaminated with the causal agent. Avoid irrigating with pond water when possible, especially avoiding those ponds that may be contaminated.

Bacterial Canker

Use certified transplants. Rotate to allow 3 years between tomato plantings. When producing transplants, be sure to clorox or heat-treat seed as described under the "Seed Treatment" section in Chapter E to help prevent bacterial canker. When producing transplants, in addition to using seed treatment, be sure to treat used transplant growing flats with sodium hypochlorite (bleach). See the "Treatment of Flats and Trays" section of Plant Growing in Chapter A. For staked tomatoes, stakes from bacterial canker infested fields should be power washed to remove excess debris and soil, soaked into in a 20% (one part bleach plus four parts water) commercial bleach solution for at least 30 minutes, and powerwashed a second time prior to use. Pruning and stringing particularly when foliage is wet, will promote spread of disease in infested fields. Avoid working plants when foliage is wet to reduce spread within the field. Applicitions of Actigard 50WG (0.33 oz/A increasing to 0.75 oz/A when plants are full size, see label for details) plus fixed copper (1.5 lb active/A) have been shown to reduce bacterial canker symptoms on fruit.

Bacterial Speck and Bacterial Spot

When producing transplants, be sure to clorox- or heat-treat seed as described under the "Seed Treatment" section to help reduce seed infestation and carryover into transplant production. Apply streptomycin (Agri-Mycin 17, Agri-Strep) sprays (1.0 pound per 100 gallons, 1.25 teaspoon per gallon) when the first true leaves appear and continue every 4 to 5 days until transplanting. Streptomycin cannot be used after transplanting. Be sure to reduce moisture on foliage and injurous handling in the greenhouse. Rotate to allow 2 to 3 years between tomato plantings. There can be a high risk of developing bacterial leaf spot and/or speck when using southern-produced transplants. Use only certified transplants. Strains of copper resistant bacterial spot are common in some areas of the mid-Atlantic particularly on the Eastern Shore of Virginia. To ensure successful disease control, utilize Actigard either alone or in conjunction with copper-containing materials. Where disease is present or anticipated, do not work in fields when plant surfaces are wet. Apply one of the following beginning shortly after transplanting and repeat every 7 days.

Actigard--0.33 to 0.75 oz 50WG/A (follow label instructions),
copper, fixed--1.0 lb ai/A *plus* mancozeb--1.5 lb 75DF/A or OLF,
ManKocide--2.5 to 5.0 lb 61WP/A
Cuprofix MZ--1.75 to 7.25 lb 52.5DF/A

Postharvest Rots

To prevent rots in mature green tomatoes, avoid washing freshly harvested fruit in cold water. Avoid harvesting fruit when the foliage is wet. Maintain water temperature in flumes and tanks by not allowing temperature to get 10 degrees F above fruit temperature to prevent movement of bacteria into the stem end of the fruit. Use a minimum 100 ppm free chlorine and keep pH between 6.5 and 7.0 in the flume. Store at 55 degree F with relative humidity of 80%. For more information on methods for reducing postharvest losses see the website: http://edis.ifas.ufl.edu/HS131.

Powdery Mildew

For more control options on selected tomato diseases in greenhouses and high tunnels see Table E-14**. "**Selected Fungicides and Bactericides Labeled for Greenhouse Use".

The disease has been observed in unsprayed fields, and has resulted in defoliation. When the disease first appears, apply one of the following and repeat every 14 days:

Cabrio--8.0 to 12.0 20EG/A,
Rally--2.5 to 4.0 oz 40WSP/A,r
Revus Top--5.5 to 7.0 fl oz 4.16SC/A

In greenhouse settings, apply one of the following with thorough coverage of the upper and lower leaf surface and repeat at 7-day intervals:

JMS Stylet Oil--1.0 to 2.0 gal/100 gal,
Scala--7.0 fl oz 5SC/A

Timber Rot (*Sclerotinia*)

Rotate away from fields where snap or lima beans, peas, peanuts, lettuce or cucurbits have been grown. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches. However, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer **do not plow** between treatment and transplanting times.

Timber rot occurs during prolonged periods of moisture and cooler temperatures (<80°F). Timing fungicide applications to be either just prior to or to coincide with favorable conditions for disease is essential for optimal disease control.

Control of white mold in the field:

Applying Contans in all areas within 300 ft of structure because the fungus produces spores which can travel via air currents into structures. Do not discard plant material within 300 ft of greenhouse or high tunnel.

Southern Blight (Sclerotium rolfsii)

Southern blight is more commonly seen in the southern portion of the Mid-Atlantic region. High soil moisture and temperature favor disease development. Long crop rotations with corn and small grains help reduce disease incidence. Weed control is also important since *Sclerotium rolfsii* can also infect a number of commonly encountered weeds in the Mid-Atlantic. Soil fumigation and staking tomatoes will greatly reduce disease incidence.

Fusarium and Verticillium Wilts

Be certain that you select a variety with resistance to Fusarium wilt. Soil fumigation and crop rotation are essential components of a successful management program for these wilts. For Fusarium wilt, select cultivars that are resistant to Races 1, 2, and 3 as all are prevalent on in the Mid-Atlantic region.

Leaf Spots (Early Blight, Septoria leaf spot) and Fruit Rots (Early blight, Anthracnose)

Follow a crop rotation that provides at least 2 years without tomatoes or potatoes. Use disease-free transplants and disease-resistant varieties when possible. For fields in mountainous areas, fields not rotated away from tomatoes, and in late planted fields, begin sprays shortly after transplanting. In all other areas, either follow a regular (7-day) spray schedule starting when crown fruit are one-third their final size, or time sprays based on a locally-verified forecaster such as Tomcast® or TomFAST®.

Rotate one of the following fungicides to help delay the development of resistant pathogen strains:

Alternate:
chlorothalonil--2.0 to 3.0 pt 6F/A or OLF (also for gray leaf spot, black mold and soil rot)
mancozeb--3.0 lb 75DF/A or OLF (also for gray leaf spot and leaf mold)
Gavel--1.5 to 2.0 lb 75DF/A

With one of the following:
Cabrio--8.0 to 12.0 oz 20EG/A
Endura--2.5 to 3.5 oz 70W/A (also for Botrytis at 9.0 to 12.5 oz/A)
Flint--4.0 oz 50WDG/A, (Do not apply near Concord grapes)
Fontelis--10.0 to 24.0 fl oz 1.67SC/A
Priaxor--4.0 to 8.0 fl oz 4.17SC/A
Quadris--5.0 to 6.2 fl oz 2.08SC/A (Also for buckeye rot and black mold. Do not apply near apples: see label for details)
Quadris Top--8.0 fl oz 2.72SC/A
Revus Top--5.5 to 7.0 fl oz 4.16SC/A
Tanos--8.0 oz 50W/A *plus* protectant fungicide (also for buckeye rot suppression and gray leaf spot).

To provide effective late-season control, one additional may be necessary after the application of a fruit-ripening agent.

Materials in different FRAC codes should be alternated to reduce the chances for fungicide resistance development.

Late Blight

Transplants that are disease free should be used for plantings. If possible, produce your own transplants under sanitary conditions, since the use of transplants produced in other regions may increase the risk of a late blight infestation. When plants are 6 inches tall, apply one of the following *protectant* fungicides and repeat every 7 days, or follow a locally-verified disease forecasting system such as BLITECAST® to schedule the fungicide applications:

chlorothalonil--1.0 to 3.0 pt 6F/A or OLF,
Gavel--1.5 to 2.0 lb 75DF/A,
mancozeb--3.0 lb 75DF/A or OLF.

Protectant fungicides should only be applied preventatively. Monitor for movement of the disease by contacting your local extension professional or visiting the following website to receive updates on where the disease is currently located (www.usablight.org). Once late blight is detected in your area, tank mix one of the following translaminar fungicides which can move into and through leaves with a protectant fungicide. Products containing mefenoxam (Ridomil Gold brand names) should not be used unless your extension professional or the aforementioned website are certain that current strains are sensitive. To achieve the best control initially rotate between one of the following options:

Curzate--3.2 to 5.0 oz 60DF/A *plus* a protectant fungicide
Forum--6.0 fl oz 4.18SC/A *plus* a protectant fungicide
Presidio--3.0 to 4.0 floz 4SC/A *plus* a protectant fungicide
Previcur Flex--1.5 pt 6F/A *plus* a protectant fungicide
Ranman--2.10 to 2.75 fl oz 400SC/A *plus* a protectant fungicide
Reason--5.5 to 8.2 fl oz 500SC/A *plus* a protectant fungicide
Revus Top--5.5 to 7.0 fl oz 4.16SC/A *plus* a protectant fungicide (Not for use on small fruited varieties)
Tanos--8.0 oz 50WG/A *plus* a protectant fungicide

In greenhouse settings late blight can be particularly damaging. A strong scouting and preventative fungicide program is essential to reduce potential impacts. Microclimate management to reduce levels of free moisture on foliage is essential to reduce disease spread. The following materials permit greenhouse applications. You should consult fungicide labels to ensure greenhouse applications are permitted. The following materials can offer suppression and are labeled for greenhouse applications, apply one of the following:

Heritage--1.6 to 2.0 oz 50WG/A
Catamaran--5.5 to 7.0 pt 5.3F/A

Fruit Rot caused by Pythium and Buckeye Rot caused by Phytophthora

Apply mefenoxam (Ridomil Gold at 1.0 pint 4SL per acre or Ultra Flourish at 1.0 quart 2E per acre) as a soil surface application under the vines 4 to 8 weeks before harvest. Apply broadcast or banded (see Chapter E the section on "Calibrating Granular Application Equipment" for the amount needed per acre). Irrigate after application. An alternative to soil application of mefenoxam is to apply one of the following as a foliar spray beginning when crown fruit are one-third their final size and repeat every 14 days up to a total of 3 times:

mefenoxam + chlorothalonil (Flouronil, Ridomil Gold Bravo)--2.0 lb 76WP/A,
Ridomil Gold Copper--2.0 lb 65WP/A

If weather and soil conditions continue to favor disease development apply one of the following between applications of the above listed fungicides:

Gavel--1.5 to 2.0 lb 75DF/A,
Tanos--8.0 oz 50WG/A

Botrytis Fruit Rot (Gray Mold)

Gray mold is a problem during the fall in fields with dense foliage and poor drainage. For fall production, select fields with good drainage. Shortly before harvest when conditions are wet and cool, apply one of the following:

chlorothalonil--2.0 to 2.75 pt 6F/A or OLF (also very good for late blight),
Endura--9.0 to 12.5 oz 70WG/A (also very good for early blight; not for use in greenhouses),
Switch--11.0 to 14.0 oz 62.5WG/A

Leaf Mold (Fulvia/Cladosporium)

Leaf mold may occur during periods of high moisture particularly within the canopy. The disease is can also cause damage in greenhouse and high tunnel tomato plantings. In both settings, if the disease is present, precautions should be taken to minimize canopy moisture. For field outbreaks, the following fungicide can be used:

Revus Top--5.5 to 7.0 fl oz 4.16SC/A
Catamaran--4.5 to 7.0 pt 5.3F/A

Tomato Spotted Wilt Virus (TSWV)

TSWV can be serious and result in severely stunted plants. The virus is spread by thrips from ornamental plants (flowers), field crops, and weeds to tomatoes. TSWV can be particularly devastating in southern and eastern parts of Virginia. Use resistant varieties when available. Do not grow any ornamental bedding plants in the same greenhouse as tomato transplants. Control weeds in and around greenhouses. Monitor greenhouses and tomato fields for thrips and begin an insecticide control program once thrips are observed. Use of reflective mulch can help repel thrips and can reduce the incidence of spotted wilt. If tomato crops are near wheat/barley fields be aware of increased thrips pressure (potentially increasing the likelihood of TSWV transmission) once the crop starts to turn brown in the spring.

WATERMELONS

Varieties[1]

Seeded
Crimson Sweet (AR,FR1,OS)
Sangria*
Jamboree*(AT,FT)
Mardi Gras* (FR 1, AR)
StarBrite (AR, FR1,OS)
Top Gun*

Seedless
(all seedless varieties are triploid hybrids)
SS 7167
Gypsy
Troubadour
Fascination (FR 1, AR)
Crisp N Sweet
Sugar Coat
Sugar Heart
Tri-X 212
Tri-X-313 (OT, AR)
Liberty
Tri-X Palomar
SS7187
SS7197
ACX 6177 Plus
Super Crisp
Maxima
Revolution (oblong) (OT)
Amarillo (yellow)
SugaRed
Declaration
Crunchy Red

Seedless Personal (3-7 lbs)
(all seedless varieties are hybrids)
Extazy
Solitaire
Vanessa

Pollenizers
Standard diploid pollenizers
Stargazer
Sangria
SF 800
Mickylee
Jade Star

Special diploid pollenizers
SP 5
SP 6
Pollen Pro
Accomplice
Sidekick

[1] Varieties listed by maturity, earliest first.
* Indicates hybrid varieties.
Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
	Pounds N	Low	Med	High (Opt.)	Very High	Low	Med	High (Opt.)	Very High	
Watermelons	**per Acre**	**Pounds P_2O_5 per Acre**				**Pounds K_2O per Acre**				**Nutrient Timing and Method**
Nonirrigated	80-100	150	100	50	0[1]	200	150	100	0[1]	Total nutrient recommended.
	50	150	100	50	0[1]	200	150	100	0[1]	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run.
Irrigated	125-150	150	100	50	0[1]	200	150	100	0[1]	Total nutrient recommended.
	25-50	150	100	50	0[1]	200	150	100	0[1]	Broadcast and disk-in or follow fertigation schedule for potassium in table.
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run or follow fertigation schedule in table.
	25-50	0	0	0	0	0	0	0	0	Sidedress after first harvest or follow fertigation schedule in table.

For seedless watermelons, high rates of nitrogen may increase the risk of hollow heart.

[1]In Virginia, crop replacement values of 25 lbs. P_2O_5 and 50 lbs. K_2O per acre are recommended on soils testing Very High.

Suggested Fertigation Schedule for Coarse-Textured Soils - Watermelon

	Daily		Cumulative	
Days After Planting	**Nitrogen[1]**	**Potash[1,2]**	**Nitrogen[1]**	**Potash[1,2]**
	-----------------------lbs/A---------------------			
Preplant[3]	---	---	25	50
0-14	1.0	1.0	39	64
15-28	1.5	1.5	60	85
29-56	2.0	2.0	116	141
57-78	1.5	1.5	137	166
79-93	1.0	1.0	150	175

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are based on 8 foot bed centers. If beds are narrower, fertilizer rates per acre should be adjusted proportionally. Drive rows should not be used in acreage calculations. See Fertigation in C-Irrigation Management for more information.

Suggested Fertigation Schedule for Fine-Textured Soils - Watermelon

Days After Planting	**By Days After Planting Period**		**Cumulative Amount Applied**	
	Nitrogen (N)[1]	**Potash (K_2O)[1,2]**	**N[1]**	**K_2O[1,2]**
	lb/acre			
Preplant[3]	-	-	57	62
0-14 (14 days)	4	4	61	66
15-28 (13 days)	6.5	6.5	67.5	72.5
29-56 (27 days)	18.5	18.5	86	91
57-78 (21 days)	6.5	6.5	92.5	97.5
79-93 (14 days)	4	4	96.5	101.5

[1]Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Rates above are based on 8 foot bed centers. If beds are narrower, fertilizer rates per acre should be adjusted proportionally. Drive rows should not be used in acreage calculations. See Fertigation in C-Irrigation Management for more information.

Plant Tissue Testing and Petiole Sap Analysis

Plant tissue testing and petiole sap analysis are useful tools to monitor watermelon plant nutrient status, especially for nitrogen and potassium. For tissue testing, take the most recent fully expanded leaves at early bloom and send to a laboratory for testing according to their instructions. Sufficiency ranges for nitrogen are between 2.5 to 3.5 percent and for potassium are between 2.7 to 3.5 percent.

Petiole sap testing can be performed with portable meters. See section B-6 for sampling details for petiole sap testing. When vines are 6" in length, sap nitrate-N should be between 1200-1500 ppm and potassium 4000-5000 ppm. When fruits are 2 inches in length, nitrate-N should be 1000-1200 ppm and potassium 4000-5000 ppm. When fruits are one-half mature, nitrate-N should be 800-1000 ppm and K should be 3500-4000 ppm and at first harvest, nitrate-N should be 600-800 ppm and potassium 3000-3500 ppm.

Critical watermelon tissue test values.

Timing	Value	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu
		%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
Most recently matured leaf when vines touch	Deficient	<3.0	0.3	3	1	0.25	0.2	<30	20	20	20	5
	Adequate range	3	0.3	3	1	0.25	0.2	30	20	20	20	5
		4	0.5	4	2	0.5	0.4	100	100	40	40	10
	High	>4.0	0.5	4	2	0.5	0.4	>100	100	40	40	10
	Toxic (>)	-	-	-	-	-	-	-	800	-	-	-
Most recently matured leaves at first flower	Deficient	<2.5	0.3	2.7	1	0.25	0.2	<30	20	20	20	5
	Adequate range	2.5	0.3	2.7	1	0.25	0.2	30	20	20	20	5
		3.5	0.5	3.5	2	0.5	0.4	100	100	40	40	10
	High	>3.5	0.5	3.5	2	0.5	0.4	>100	100	40	40	10
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-
Most recently matured leaf at first fruit	Deficient	<2.0	0.3	2.3	1	0.25	0.2	<30	20	20	20	5
	Adequate range	2	0.3	2.3	1	0.25	0.2	30	20	20	20	5
		3	0.5	3.5	2	0.5	0.4	100	100	40	40	10
	High	>3.0	0.5	3.5	2	0.5	0.4	>100	100	40	40	10
	Toxic (>)	-	-	-	-	-	-	-	-	-	-	-

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. See the Disease section for more information to prevent disease.

Plant Production

Transplants should be grown in plug trays with cell size at least 1.5 inches in diameter and 2 inches deep for each plant. Smaller pots or cells will restrict root growth and provide less protection to the newly set transplant. Plant one seed per cell. Triploid (seedless) watermelon seeds require a special regime to germinate well. The seed coat of seedless watermelons tends to adhere to the seedling as it emerges, at times slowing growth or reducing stand and seeds are of lower vigor than standard diploid types.

Seedless watermelon plant production can be broken into 6 phases: sowing, initial germination, emergence, seed leaf stage to first true leaf, first true leaf to second true leaf, and hardening-off.

Seeding

Trays should be evenly filled with a general commercial greenhouse growing medium like Pro-Mix BX®, Fafard® #2, or Sunshine® #1 (these all have a starter fertilizer). Do not use fine seed starter or plug mix types. Do not compress the growing media. Trays should be watered to capacity and then allowed to drain off excess for 24 hours. During this 24 hour period, trays should be placed in a heated area so that the media reaches a temperature of 85°F. Make planting holes 1” deep and plant seeds with the “pointed” side up. Cover with a small amount of warm moist media just enough to fill over seeds in the holes. Do not water after seeding. Seeding should be done in a way that trays stay at 85° F (do not allow trays to get cold).

Initial Germination

Germination should be done in a room or chamber where temperatures can be maintained at 85-90°F and where there is high humidity. Uniform tray temperature is critical. This phase will last 48 hours. To insure even germination, it may be necessary to move trays around after 24 hours (trays on bottom shelves moved to top shelves and vice versa) to ensure even temperature exposure. In this phase the seed root will emerge but the epicotyl (“crook”) that will carry the seed leaves above the surface should not be visible. If you see crooks, you have left trays in the germination area too long and you may experience plant “stretch” during emergence (if plants have emerged you are too late – stretch has already occurred). Stretching results in poor transplant quality.

Emergence

After initial germination, it is critical to move plants immediately from germination areas to the greenhouse for emergence. If you are having another grower germinate your seeds, it is important to schedule pickup or delivery so that there are no delays. Greenhouses should be set for 72-75°F day temperatures and 65°F night temperatures. Do not water until after you observe crook emergence. Thereafter, water sparingly as needed to keep trays and emerging seedlings from drying out. Excess water and high greenhouse temperatures during the emergence phase will lead to stretch.

Seed Leaf Stage to First True Leaf

Maintain greenhouse temperatures in the 72-75°F day and 65°F night range during this period. Water moderately to keep plants from drying out but do not fertilize during this period if you are growing in a medium tha has starter fertilizer. Plants should grow slowly for highest quality.

First True Leaf to Second True Leaf

Continue maintaining greenhouse temperatures in the 72-75°F day and 65°F night range during this period. You can fertilize once the first true leaf emerges. Generally 2 fertilizations of 100 ppm nitrogen concentration one at first true leaf and one at second true leaf will be sufficient. If a constant feed system is used, set for 50 ppm nitrogen each watering once the first true leaf has emerged. These fertilization rates are for the media listed in the seeding section that contain a starter fertilizer charge. Avoid using fertilizers with high amounts of ammonium N as the nitrogen source as this can lead to stretch (use fertilizers with calcium nitrate and potassium nitrate as the main nitrogen sources). Avoid over-watering. Some growers use media with no starter fertilizer charge. If that is the case, a different fertilizer program will be needed. Use fertilizers with calcium nitrate and potassium nitrate as nitrogen sources. Use 50 ppm N from emergence to first true leaf every 3 days, 200 ppm N every other day from first true leaf to second true leaf.

Hardening Off

It will take 4 to 6 weeks from sowing to finish transplants. Prior to transplanting into the field, harden off plants for one week. This is accomplished by lowering day time temperatures in the greenhouse (if greenhouses have side curtains roll them up during days if temperatures are not too cool). Reduce watering and stop fertilization. Some growers have the ability to place plants on wagons or move benches outside during the day, bringing them in at night. This is advised where possible but make sure the area is sheltered from high winds and avoid days where the temperature is below 60°F.

Pollenizers

The above information is for growing the seedless watermelons. Seeded pollenizers and standard seeded watermelons do not need special germinating conditions and can be grown directly in the greenhouse. It is of crucial importance to time the production so that plants are produced and hardened off at the same time as the seedless types. They also should be grown slowly and attention should be paid to avoid stretch. Follow the same recommendations from seed leaf stage through hardening off.

Planting and Spacing

Transplants: Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (15.6°C). Planting dates vary from May 1 in southern regions to June 20 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers, or rye windbreak strips.

Direct-seeded: Seed April 20 to May 15 in Virginia and normally warmer areas, and May 15 to June 10 in Pennsylvania and normally cooler areas. Seed 3 to 5 pounds of seed per acre.

The recommended spacing for watermelons is 6 to 8 feet between rows with 3 to 4 feet between plants in the row.

Seedless Varieties: See Pollination and Pollenizers section for planting recommendations.

Mulching

The majority of watermelons are grown on black plastic mulch with trickle (drip) irrigation (see Chapter C). Weed control under the plastic is performed by using labelled herbicides (see Weed Control section) or by fumigation. Fumigation is also used to control soil borne diseases such as *Fusarium.* See section E6 for fumigation recommendations. Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Plastic and fumigant should be applied on well-prepared planting beds 30 days before field planting. Plastic should be 3-4 feet wide and laid on 6- to 8-foot centers immediately over the fumigated soil. The soil must be moist when laying the plastic. IRT plastic has been used in cooler areas for additional soil heating. Fertilizer must be applied during bed preparation. At least 50% of the nitrogen (N) should be in the nitrate (NO_3^{-1}) form. Direct seeding through the mulch is possible for seeded types but is not generally recommended for seedless varieties

Pollination and Pollenizers

Watermelon fruit set and enlargement is dependent upon growth regulators from the pollen grains and from embryos in developing seeds within the fruit. Inadequate pollination results in triploid watermelon fruits that are triangular in shape and of inferior quality. Inadequate pollination may increase the incidence of hollowheart. Triploid watermelon flowers do not produce sufficient viable pollen to induce fruit set and development. Therefore, pollen from a normal or a special diploid pollenizer watermelon variety must be present. Fields should be inter-planted with triploid and pollenizer plants, There are three methods that can be used to incorporate pollenizer plants into the field. Pollenizer plants may be dedicated to every third row. A second alternative is to plant a pollenizer every third or fourth plant in-row with additional spacing for pollenizers. A third alternative is to plant the pollenizer between every third and fourth plant in-row without changing plant spacing. When this method is chosen, the use of a special pollenizer is recommended. The use of standard diploid varieties planted in-row may decrease yields of closely associated triploid plants. Special pollenizer varieties have been developed solely for pollen production and most do not produce marketable fruit. The use of special pollenizers planted in-row allows the field to be 100% seedless. Special pollenizer varieties found to perform well are listed above in the "variety" table. Follow suppliers' instructions. **Under no circumstances should the pollenizer variety and the seedless variety be planted in separate but adjacent blocks!**

When using pollenizer plants arranged in dedicated rows, it is important to use a pollenizer variety that is marketable because up to one-third of all melons produced in the field will be of this variety. The rind pattern and/or shape of the seeded pollenizer fruit should be easily distinguished from that of the triploid fruit to reduce confusion at harvest. Most special pollenizers are distinguishable from triploid fruit by size however, if mini seedless watermelons are planted rind pattern must be used to distinguish pollenizer and seedless fruit. Selection of a pollenizer variety that will be harvested should also take into account the market demand, plant vigor, pollen production, disease resistance, and environmental conditions.

It is important that pollen from the diploid pollenizer variety be available when the female blossoms on the triploid plants are open and ready for pollination. The following recommendations pertain only to pollenizers planted in dedicated rows, special pollenizer plants should be transplanted at the same times as triploid plants. As a general rule, direct field seeding of the pollenizer variety should be done on the same day the triploid seed is planted in the greenhouse. If transplants are used for pollenizers, they can be seeded a few days after triploid transplants are scheduled to be seeded.

Honeybees, squash bees, bumblebees and other wild bees are esssential for proper watermelon pollination and fruit set. Honeybee or bumblebee colonies are commonly rented or purchased. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See the section on "Pollination" in Chapter A, the General Production Recommendations, and/or Table D-6 for relative toxicity of various pesticides for hazards to bees.

Windbreaks

Use windbreaks as necessary especially in windy areas. Small Grain windbreaks are recommended and may be established between every bed, every 2-3 beds, or in drive row areas (every 6-8 beds). Use windbreaks between every row for earliest plantings for additional protection. Rye is the most common small grain used for windbreaks due to height and rapid growth. Establish windbreaks in the fall, either as a solid planting or spacing windbreak rows at intervals the width of the rows. Plant at high density to insure a good stand. In the spring, for solid plantings, till areas where plastic is to be laid before small grain starts to elongate. Windbreaks may be eliminated with herbicides or mowed out after the crop is well established.

Vine Turning

It is important to move vines in outer rows out of driveways so they are not damaged by vehicle traffic. This reduces disease incidence. Several trips over the field may be necessary.

Irrigation

Watermelons can be grown under dryland conditions, however highest yields are obtained with irrigation. Irrigation is recommended for seedless watermelons. Schedule irrigation so that soil moisture does not drop below 50 percent of field capacity. At peak, during fruit set and full vine cover, watermelons will use up to 0.30 inches of water per day.

Harvest and Post Harvest Considerations

Watermelons are hand harvested into bins, trucks, or buses for shed packing. Use every sixth or eighth row as a drive row for field access. Ripeness is indicated by a creamish to slight yellowing of the white background color of the part of the melon that rests on the ground. Drying of the stem tendril nearest the attachment point of the watermelon and green color tone of the rind are also indicators of ripeness but these vary with cultivar. Melons should be cut from the vine rather than pulled, twisted, or broken off.

Harvested watermelons should be stored at 50° to 60°F and a relative humidity of 90% during storage and shipping. Watermelons are not adapted to long storage. At low temperatures the are subject to various symptoms of chilling injury and loss of quality, and at high temperatures they are subject to decay.

Watermelons should be consumed within 2 to 3 weeks after harvest, primarily because of the gradual loss of crispness. Quality in watermelons is determined largely by high sugar content, a deep red fresh color, and a pleasant crisp texture of the edible flesh. These factors are dependent on maturity, cultivar, and handling methods.

Commercial melons for distant market are usually harvested when mature, but before full ripeness, to minimize handling damage and flesh breakdown. .

Watermelons are sensitive to high levels of ethylene gas during storage, watermelons should not be stored or shipped with fruits that emit substantial amounts of ethylene.

Rough handling will result in serious losses. Bulk bins with pallets, if used, can speed handling and minimize melon damage

Watermelons are marketed by weight and bin counts: large, or 32-35 (more than 18 lbs per melon) per bin, medium, or 45 per bin (14-18 lbs) and smaller, or 50-60 per bin (14 lbs or less). The wholesale grower is generally paid by the pound. “Personal” (very small) watermelons are maketed by box counts and weight. The trend in consumer preference has been increased demand for smaller sizes.

Watermelon Disorders

Misshapen Fruits

Poor pollination due to low bee activity, may result in "bottlenecks", or constricted growth at the stem end of the fruit, especially in seeded/elongated watermelons. Research has shown that a minimum of 1,000 grains of pollen are required to be distributed over the three lobes of the stigma of the female flower to produce a uniformly shaped fruit.

In seedless watermelon, poor pollination may lead to undesirable “triangular” fruits.

Sunscald

Sunscald occurs when fruits are exposed to direct sunlight, especially on extremely hot days. Under these conditions, rind surfaces can reach temperatures exceeding 140º F killing cells and resulting in sunburn spots. Fruits with little or no foliar cover are at most risk. Sunscald or sunburn first appears as a gray or white area on the exposed upper surface of the fruit. Fruit with dark rinds are more susceptible to sunscald than those with light colored rinds.

Sunscald severity is related directly to fertility regime and and foliage cover. Proper fertility and soil management promotes adequate vine growth and coverage of fruit.

Sunscald severity is also associated with diseases that reduce foliage cover, such as anthracnose, alternaria, gummy stem blight and downy mildew. Recommendations for managing these diseases may be found in the Disease Control section below.

Hollow Heart

Hollow heart is an internal crack in the flesh of the melon. The cause(s) of hollow heart is/are not known. Hollow heart is generally more severe in seedless varieties and in crown-set fruit. Inadequate pollination, cold weather during fruit set, poor fruit set and low fruit load, excess nutrients (especially nitrogen), and factors producing rapid growth have been reported to impact the severity of hollow heart.

Water Soaking

This disorder occurs where excess water accumulates at the bottom of the fruit resulting in a water soaked appearance of internal flesh. Water accumulates during cloudy weather when transpiration from vines is low. Water soaking sometimes appears in fruits where foliage has deteriorated since excess eater cannot be transpired

Splitting

Splitting during handling occurs in fruits under excessive water pressure. Excess irrigation or rainfall are the usual causes.

Irregular Ripening

Irregular ripening can be a problem in some years and varieties. Watermelons are classified as non-climacteric since they do not continue to ripen significantly after harvest. However, recent research has shown that watermelon fruit produce a burst of ethylene at the white fruit stage and factors that reduce ethylene will slow ripening. Watermelon fruit development and ripening are also dependent on the accumulation of sugars. Loss of foliage or stem tissue due to diseases such as gummy stem blight or insect or mite feeding can reduce the amount of sugars available to the fruit. Different varieties, low potassium nutrition, or variability in vine health will lead to variability in fruit ripening.

Internal Rind Necrosis

Internal rind necrosis is indicated by the presence of a corky, red-brown layer of tissue that occurs on the inside of the rind of affected fruit but that does not extend into the fruit flesh. The disease occurs sporadically and is thought to be caused by bacteria (Erwinia) that are naturally present on fruit. Drought stress has been implicated in this disorder.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in watermelons.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tubing left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Note: All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.5 to 0.75 a dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay seeding or transplanting the crop for 7 days after the application of Sandea under plastic mulch. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.75 dry ounces of Sandea, applied preemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year. Observe a 57 day PHI (PreHarvest Interval).**

Terbacil--0.1 to 0.2 lb/A. Apply 2.0 to 4.0 dry ounces of Sinbar 80WP preemergence in a band under the plastic, immediately before laying the mulch, to control many annual broadleaf weeds under the mulch and around the planting hole. Sinbar will not control pigweed species. Condensation that forms on the underside of the mulch will activate the herbicide. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Sinbar may be used for direct seeded or transplanted watermelons. **DO NOT apply "over the top" or allow spray to contact crop foliage, or injury may result. Observe a 70 day PHI (PreHarvest Interval).**

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.

1. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
2. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
3. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Bensulide *plus* naptalam--5.0 to 6.0 lb/A *plus* 2.0 lb/A. Apply 5.0 to 6.0 quarts Prefar 4EC plus 1.0 gallon Alanap 2SC as a banded directed shielded spray preemergence before seeding or transplanting. Tank-mix is approved.

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME as a banded directed shielded spray preemergence to the weeds to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use, or use Strategy, the jug-mix that contains clomozone (Command) and ethalfluralin (Curbit).
WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.
Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 1.12 lb/A. Apply 1.0 to 3.0 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC as a banded directed shielded spray preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2.0	0.4	0.125
3.0	0.6	0.188
4.0	0.8	0.250
5.0	1.0	0.312
6.0	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Flumioxazin 0.125 lbs. **A Special Local-Needs Label 24(c) has been approved for the use of Chateau SW in watermelons in Delaware only. This label is administered through the Delaware Fruit/Vegetable Association and requires a signed authorization and waiver of liability. Without a signed authorization and waiver this is a misuse of the product.** Apply Chateau SW up to 4 oz product to row middles of raised plastic-mulched beds that are at least 4 inches higher than the treated row middle and the mulched bed must be a minimum of a 24-inch bed width. Spray must remain between raised beds and contact no more than the bottom 1 inch of the side of the raised bed Do not apply after crops are transplanted/seeded. **All applications must be made with shielded or hooded equipment.** For control of emerged weeds, a burn down herbicide may be tank-mixed. Do not apply more than 4 oz during any single application. Tank-mixtures with labeled residual grass herbicides are allowed.

Halosulfuron--0.023 to 0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray between rows of plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. Do NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, in a 1 year (12 month) period.**

Pendimethalin--1.0 lb/A. Apply 2.1 pints per acre Prowl H_2O as a banded directed shielded spray before transplanting, or before seeded crop has emerged. Activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. A second treatment at the same rate may be applied as a banded directed shielded spray postemergence a minimum of 21 days after the first application, but before the vines begin to run. **DO NOT apply "over the top" of the crop, or severe injury may occur. Observe a 35 day PHI (PreHarvest Interval).**

S-metolachlor--0.64 to 1.21 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds between the rows of plastic mulch in watermelons in Delaware. The use of this product is legal ONLY if a waiver of liability is completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.67 to 1.27 pints per acre Dual Magnum 7.62E to control annual grasses, galinsoga, and certain other broadleaf weeds, and to suppress or control yellow nutsedge. Use as a surface-applied shielded and directed spray preemergence to the weeds before crop emergence or before transplanting. DO NOT apply Dual Magnum to the plastic mulch, or allow the spray to contact watermelon foliage. DO NOT preplant- incorporate Dual Magnum into the soil. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Observe a minimum preharvest interval of 60 days.**

Terbacil--0.1 to 0.2 lb/A. Apply 2.0 to 4.0 dry ounces of Sinbar 80WP preemergence as a banded, shielded, directed spray between rows of plastic mulch to control many annual broadleaf weeds. Sinbar will not control pigweed species. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Sinbar may be used for direct seeded or transplanted watermelons. **Do NOT apply "over the top" or allow spray to contact crop foliage, or injury may result. Observe a 70 day PHI (PreHarvest Interval).**

Postemergence

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.5 to 0.66 dry ounce Sandea 75WG as a banded, shielded, directed spray between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarters or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, in a 1 year (12 month) period.**

Pendimethalin--1.0 lb/A. Apply 2.1 pints per acre Prowl H_2O as a banded directed shielded spray before transplanting, or before seeded crop has emerged. Activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds emerging from seed (preemerngence). Tank-mix with Gramonone plus a nonionic surfactant or another recommended postemergence herbicide to control emerged weeds. **DO NOT apply "over the top" of the crop, or severe injury may occur. Observe a 35 day PHI (PreHarvest Interval).**

Paraquat--0.6 lb/A. A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF postemergence as a banded directed shielded spray between the rows of plastic mulch in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a banded directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. If rainfall does not occur, irrigate to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

Bensulide *plus* naptalam--5.0 to 6.0 lb/A *plus* 2.0 lb/A. Apply 5.0 to 6.0 quarts Prefar 4EC *plus* 1.0 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment before seeding or transplanting or as a preemergence treatment after seeding. Tank-mix is approved.

Preemergence

Clomazone--0.094 to 0.188 lb/A. Apply 4.0 to 8.0 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38 to 0.94 lb/A. Apply 1.0 to 2.5 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin *plus* Clomazone (jug-mix)--0.394 to 1.575 lb/A. Apply 1.5 to 6.0 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips Between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023 to 0.031 lb/A. Apply 0.5 to 0.75 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.75 dry ounces of Sandea, applied preemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Terbacil--0.1 to 0.2 lb/A. Apply 2.0 to 4.0 dry ounces of Sinbar 80WP preemergence to control many annual broadleaf weeds under the mulch and around the planting hole. Sinbar will not control pigweed species. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Sinbar may be used for direct seeded or transplanted watermelons. Apply to seeded watermelons after planting, but before emergence. Apply to transplanted watermelons before transplanting (PRE-transplant). **Do NOT apply "over the top" or allow spray to contact crop foliage, or injury may result. Observe a 70 day PHI (PreHarvest Interval).**

Postemergence

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest
With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0** or OLF **for postharvest desiccation of the crop in Delaware, New Jersey and Virginia**. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft^2).

Pollinators and Pesticides

Honeybees, squash bees, bumblebees and other wild bees are important for proper set and pollination. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on "Pollination" in the General Production Recommendations and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

Seed Corn Maggot

Maggot problems can occur in the field and in transplant bedding trays in the greenhouse. An application of a soil-incorporated insecticide may be needed immediately before planting. Also, see Chapter E "Maggots" section in "Soil Pests--Their Detection and Control". **Note:** The use of imidacloprid at planting may reduce seed corn maggot populations.

Cucumber Beetle

Watermelons are resistant to bacterial wilt; however, control may be needed to prevent feeding damage to seedlings. Treat with one of the following formulations when an average of two beetles per plant is found.

acetamiprid--2.5 to 5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--2.4 to 2.8 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--1.0 lbs/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyfluthrin--2.4 to 2.8 fl oz/A Tombstone (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
fenpropathrin--10.67 to 16.0 fl oz/A Danitol 2.4EC
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Apply one of the following formulations:
beta-cyfluthrin--0.8 to 1.6 oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--**(**variegated cutworm only**)** 1.5 pts/A Lannate LV (or OLF)
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
zeta-cypermethrin--1.28 to 4.00 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Pickleworm, Melonworm

Make one treatment prior to fruit set, and then treat weekly. Use one of the following formulations:

acetamiprid--5.3 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
carbaryl--0.5 to 1.0 lbs/A Sevin XLR Plus (or OLF)
chlorantraniprole--(melonworm) **drip** 2.0 to 3.5 fl oz/A, **foliar** 2.0 to 5.0 fl oz/A Coragen 1.67SC; (**pickleworm**) **drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--(pickleworm only) 5.8 to 9.6 fl oz/A Asana XL

flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Aphids

Note. Aphids transmit multiple viruses. Cultivars that are resistant to multiple aphid-transmitted viruses are available. For chemical control of aphids, apply one of the following formulations:

acetamiprid--2.5 to 4.0 oz/A Assail 30G (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC; **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
flonicamid--2.0 to 2.8 oz/A Beleaf 50 SG
imidacloprid--**soil only** 7.0 to 10.5 fl oz/A Admire PRO (or OLF)
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--(melon aphid only)1.5 to 3.0 pts/A Lannate LV (or OLF)
pymetrozine--2.75 oz/A Fulfill 50WP
sulfloxafor--1.5 to 2.0 fl oz/A Closer SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG (or OLF); **foliar** 1.5 to 3.0 oz/A Actara 25WDG

Leafminers

Apply one of the following formulations:
abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
chlorantraniprole--**soil/drip** 5.0 to 7.5 fl oz/A, **foliar** 5.0 to 7.0 fl oz/A Coragen 1.67SC
cyromazine--2.66 oz/A Trigard 75WSP
dimethoate--0.5 to 1.0 pt/A Dimethoate 400 4EC (or OLF)
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF); **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
permethrin--8.0 fl oz/A Perm-Up 3.2EC (or OLF)
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 8.0 fl oz/A Entrust SC
thiamethoxam--**soil** 1.66 to 3.67 oz/A Platinum 75SG (or OLF)

Rindworms (Cucumber Beetle Larvae.)

Damage to the rinds may result from a complex of insects including cucumber beetle, wireworms, and a number of “worm” species, (beet army worm, etc). Control of adult cucumber beetles early in the season may help reduce rindworm damage. For Lepidopteran rindworms, use one of the following formulations:

flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress

Beet Armyworm

chlorantraniprole--**soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
flubendiamide--1.5 fl oz/A Belt SC
indoxacarb--3.5 to 6.0 oz/A Avaunt 30WDG
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
spinosad--4.0 to 8.0 fl oz/A Entrust SC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC

Cabbage Looper

Apply one of the following formulations:
Bacillus thuringiensis--0.5 to 1.0 lb/A Dipel (or OLF)
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
chlorantraniprole--**soil/drip/foliar** 3.5 to 5.0 fl oz/A Coragen 1.67SC
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
flubendiamide--1.5 fl oz/A Belt SC
flubendiamide+buprofezin--12.0 to 17.0 fl oz/A Vetica
indoxacarb--2.5 to 6.0 oz/A Avaunt 30WDG
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methoxyfenozide--4.0 to 10.0 fl oz/A Intrepid 2F
permethrin--4.0 to 8.0 fl oz/A Perm-Up 3.2EC (or OLF)
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 8.0 fl oz/A Entrust SC
thiamethoxam+chlorantraniliprole--4.0 to 7.0 oz/A Voliam Flexi
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Mites

Mite infestations generally begin around field margins and grassy areas. **CAUTION:** DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season. Apply one of the following formulations:
Note: Continuous use of Sevin, or the pyrethroids may result in mite outbreaks.

abamectin--1.75 to 3.5 fl oz/A Agri-Mek 0.7 SC (or OLF)
bifenazate--0.75 to 1.00 lbs/A Acramite 50WS
etoxazole--2.0 to 3.0 oz/A Zeal Miticide[1]
fenpyroximate--2.0 pts/A Portal
spiromesifen--7.0 to 8.5 fl oz/A Oberon 2SC

Stink bug

Apply one of the following formulations:
beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL
bifenthrin--2.6 to 6.4 fl oz/A Bifenture 2EC (Sniper, or OLF)
cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF)

dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG (or OLF), **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
lambda-cyhalothrin+chlorantraniliprole--6.0 to 9.0 fl oz/A Voliam Xpress
lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC
methomyl--1.5 to 3.0 pts/A Lannate LV (or OLF)
permethrin--8.0 fl oz/A Perm-Up 3.2EC (or OLF)
zeta-cypermethrin--2.8 to 4.0 fl oz/A Mustang Maxx (or OLF)
zeta-cypermethrin+bifenthrin--4.0 to 10.3 fl oz/A Hero EC

Thrips

Apply one of the following formulations:
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL or 5.0 to 6.0 oz/A Venom 70SG (or OLF)**; foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG (or OLF)
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (LambdaT, or OLF)
oxamyl--2.0 to 4.0 pts/A Vydate L
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--6.0 to 8.0 fl oz/A Entrust SC

Pesticide	Use Category[1]	Hours to Reentry[2]	Days to Harvest[3]
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	0
Bacillus thuringiensis	G	4	0
beta-cyfluthrin	R	12	0
bifenthrin	R	12	3
bifenazate	G	12	3
carbaryl	G	12	3
chlorantraniprole	G	4	1
clothianidin (soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	0
dimethoate	R	48	3
dinotefuran (soil/foliar)	G	12	21/1
esfenvalerate	R	12	3
etoxazole	G	12	7
fenpropathrin	R	24	7
fenpyroximate	R	12	3
flonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide+buprofezin	G	12	7
imidacloprid (soil)	G	12	21
indoxacarb	G	12	3
lambda-cyhalothrin	R	24	1
lambda-cyhalorthin + chlorantraniliprole	R	24	1
lambda-cyhalothrin + thiamethoxam	R	24	1
methomyl	R	48	3
methoxyfenozide	G	4	3
oxamyl	R	48	1
permethrin	R	12	0
pymetrozine	G	12	0
spinetoram	G	4	3
spinosad	G	4	3
spiromesifen	G	12	7
sulfloxafor	G	12	1
(table continued next column)			
Pesticide *(continued)*	**Use Category[1]**	**Hours to Reentry[2]**	**Days to Harvest[3]**
INSECTICIDE *(continued)*			
thiamethoxam -- soil/drip	G	12	30
foliar	G	12	0
thiamethoxam+chlorantraniliprole			
soil/drip	G	12	30
foliar	G	12	1
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	3
FUNGICIDE (FRAC code)			
Actigard (Group P1)	G	12	0
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Folicur (Group 3)	G	12	7
Fontelis (Group 7)	G	12	1
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
Inspire Super (Groups 3 + 9)	G	12	7
Luna Experience (Groups 7 + 3)	G	12	7
Luna Sensation (Groups 7 + 11)	G	12	0
mancozeb (Group M3)	G	24	5
MetaStar (Group 4)	G	48	AP
Presidio (Group 43)	G	12	2
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quadris Top (Groups 11 + 3)	G	12	1
Quintec (Group 13)	G	12	3
Rally (Group 3)	G	24	0
Ranman (Group 21)	G	12	0
Reason (Group 11)	G	12	14
Revus (Group 40)	G	4	0
Ridomil Gold (Group 4)	G	48	5
Switch (Groups 9 + 12)	G	12	1
Tanos (Groups 11 + 7)	G	12	3
thiophanate-methyl (Group 1)	G	24	1
Torino (Group U6)	G	4	0
Ultra Flourish (Group 4)	G	48	5
Uniform (Groups 4 + 11)	G	0	AP
Zampro (Groups 45 + 40)	G	12	0

See Table D-6.
[1] G = general, R = restricted, AP = At planting
[2] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL
[3] AP = At plant

Nematode Control

See Chapter E "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" in the same section or apply Vydate L--1.0 to 2.0 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2.0 to 4.0 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Seed Treatment

Check with your seed company to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480DP 4.5 fl oz/100 pounds) and an approved commercially available insecticide.

Damping-Off

Apply the following in a 7-inch band at planting. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular

Application Equipment to determine amount of Ridomil Gold, Ultra Flourish, or MetaStar needed per acre:

mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A or Ultra Flourish--2.0 to 4.0 pt 2E/A)
metalaxyl (MetaStar)--4.0 to 8.0 pt 2E/A
Uniform--0.34 fl oz 3.66SE/1000 ft row

Bacterial Fruit Blotch (BFB)

Obtain seed or seedlings that were tested and found to have "no evidence" of the pathogen, which will reduce the risk of BFB development. Practice good sanitation during transplant production. Segregate different seed lots in the transplant house to reduce the chance of cross contamination. Scout seedlings daily, have suspect plants tested and destroy all diseased plants. Use only transplants from houses in which there were no seedling symptoms or fruit blotch disease. Rotate to allow 2 years between watermelon plantings and control volunteers during those years. Apply one of the following fungicide schedules beginning before the first flower is open and continuing until three weeks after flowering. Subsequent fruit sets must also be protected.

copper, fixed--at labeled rates
copper plus Actigard--0.5 to 1.0 oz 50WG/A (Actigard applications must begin one or two weeks prior to flowering to be effective)

AngularLeaf Spot

At first sign of disease, apply the labeled rates of fixed copper *plus* mancozeb. Repeat every 7 days. To minimize the spread of disease, avoid working in field while foliage is wet.

Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2 followed by PRSV, ZYMV, and CMV. Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

Ozone Injury

Ozone is a common air pollutant. When present in high concentrations in the atmosphere, ozone will cause chlorosis and upper surface bronzing and scorching on the older leaves, which leads to defoliation. 'Sugar Baby' is one of the more sensitive varieties.

Fusarium Wilt

Use a long rotation of at least 5 years and resistant varieties when possible. Several newly released seedless varieties have resistance to Fusarium wilt caused by race 1. However, their level of resistance is lower than in resistant seeded varieties varieties and race 2 also occurs in our region. Some pollinizers have good resistance to Fusarium wilt caused by race 1.

Anthracnose

Excellent resistance is available in some varieties. Use resistant varieties when possible. Begin fungicide applications when vines run or earlier if symptoms are detected.

Under light or moderate disease pressure:

Alternate:

chlorothalonil--2.0 to 3.0 pt 6F/A or OLF (Use low rate early in season)

With:

chlorothalonil--2.0 to 3.0 pt/A *plus* thiophanate-methyl--0.5 lb 70WP/A
mancozeb--2.0 to 3.0 lb 80DF/A *plus* thiophanate-methyl--0.5 lb 70WP/A

Under high disease pressure, tank-mix:

chlorothalonil--2.0 to 3.0 pt 6F/A

with one of the following fungicides:

Pristine--18.5 oz 38WG/A
Quadris--11.0 to 15.5 fl oz 2.08F/A
Cabrio--12.0 to 16.0 oz 20EG/A
Tanos--8.0 oz 50DF/A
Quadris Top--12.0 to 14.0 fl oz 2.7F/A

And rotate every 7 days with:

chlorothalonil--2.0 to 3.0 pt/A *plus* thiophanate-methyl--0.5 lb 70WP/A
mancozeb--2.0 to 3.0 lb 80DF/A or OLF *plus* thiophanate-methyl--0.5 lb 70WP/A

If resistance to FRAC code 11 (strobilurin) fungicides has been detected in the area, do not use Quadris, Quadris Top, Tanos or Cabrio.

Downy Mildew

Scout fields for disease incidence on a regular basis. Begin targeted sprays when disease occurrence is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (http://cdm.ipmpipe.org) for current status of the disease. Preventative applications are much more effective than applications made after downy mildew is detected. The following are the most effective materials (tank-mix one of these products with a protectant fungicide such as chlorothalonil--1.5 to 2.0 pt 6F/A or OLF):

Ranman--2.10 to 2.75 fl oz. 400SC/A
Previcur Flex--1.2 pt 6F/A
Zampro--14.0 fl oz 525SC/A

Other materials for use in rotation as tank mix partners with a protectant:

Forum 6.0 fl oz 4.17SC/A
Tanos--8.0 oz 50DF/A ,
Gavel--1.5 to 2.0 lb 75DF/A (Gavel contains mancozeb, which is a protectant, and does not need a tank-mix partner),
Curzate--3.2 oz 60DF/A
Presidio--3.0 to 4.0 fl oz 4SC/A

Materials with different Modes of Action (FRAC groups) should be alternated.

Sprays should be applied on a 7-day schedule when disease is forecast or present in region. Under severe disease conditions and conducive weather, spray interval may be reduced if label allows.

Alternaria Leaf Blight.

Begin sprays when vines begin to run.

Alternate one of the following:

chlorothalonil--2.0 to 3.0 pt 6F/A, or OLF (Use low rate early in season),
mancozeb--2.0 to 3.0 lb 75 DF/A or OLF

With:

Pristine--12.5 to 18.5 oz 38W/A,
a tank-mix of chlorothalonil *plus* one of the following every 14 days:
Quadris--11.0 to 15.5 fl oz 2.08F/A (do not apply near apples, see label for details)
Cabrio--12.0 to 16.0 oz 20EG/A

Reason--5.5 fl oz 500SC/A
Inspire Super--16.0 to 20.0 fl oz 2.8 F/A
Quadris Top--12.0 to 14.0 fl oz 2.7 F/A
Luna Sensation--7.6 fl oz 4.25SC/A

If resistance to FRAC code 11 fungicides exist in the area, do not use Cabrio, Pristine, Quadris, Quadris Top or Luna Sensation. Use a fungicide with a different FRAC code.

Gummy Stem Blight

Fungicide solo products within the FRAC code 11 (Cabrio, Quadris and Flint) are not recommended in the mid-Atlantic region. Pristine or Luna Sensation, which contain both FRAC code 11 and 7 components should always be tank-mixed with a protectant fungicide to reduce the chances for resistance development (see Table E-13). When tank-mixing use at least the minimum labeled rate of each fungicide in the tank mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. Begin sprays when vines begin to run, apply the following:

Under low disease pressure:
chlorothalonil--2.0 to 3.0 pt 6F/A every 7 days

Under high disease pressure:

Alternate:
chlorothalonil--2.0 to 3.0 pt 6F/A

With one of the following:

tebuconazole 8.0 fl oz 3.6 F/A or OLF
Fontelis--12.0 to 16.0 oz 1.67SC/A
Luna Experience--10.0 to 17.0 fl oz 3.34SC/A
Pristine--12.5 to 18.5 oz 38WG/A
Switch--11.0 to 14.0 oz 62.5WG/A
Inspire Super--16.0 to 20.0 fl oz 2.8 F/A

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Watermelon should be grown on raised beds and fields should be adequately drained to ensure that water does not accumulate around the base of the plants. Rotate away from susceptible crops (such as cucurbits, peppers, lima and snap beans, eggplants and tomatoes) for as long as possible. Preplant fumigants also will suppress disease. In addition, when the vines begin to run, subsoil between rows to allow for faster drainage following rainfall. Apply one of the following and always tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only):

Revus--8.0 fl oz 2.08 F/A
Ranman--2.75 fl oz 400SC/
Presidio--3.0 to 4.0 fl oz 4SC/A
Forum--6.0 fl oz 4.17SC/A
Gavel--1.5 to 2.0 lb 75DF/A
Zampro--14 fl oz 525SC/A
Tanos--8.0 to 10.0 oz 50DF/A *plus* mancozeb

Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Presidio may also be applied through the drip irrigation (see supplemental label for details). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

Powdery mildew

This disease was observed for the past few seasons in Delaware and Maryland and could occur in other States. Detection of powdery mildew is more difficult in watermelons than in other cucurbits because sporulation is sparse and masked by leaf color. Look for chlorotic spots on upper leaf surface of young, fully expanded leaves, and then inspect the corresponding lower leaf surface with a hand lens to confirm presence of the fungus.

The fungus that causes cucurbit powdery mildew can develop resistance to high risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S. Proper fungicide resistance management should be followed.

Powdery mildew generally occurs from mid-July until the end of the season. Observe fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves, begin the following fungicide program:

Tank mix one of the following *with* chlorothalonil***:***

Quintec--6.0 fl oz 2.08SC/A
Luna Experience--10.0 to 17.0 fl oz 3.34SC/A
Luna Sensation--7.6 fl oz 4.25SC/A
Torino--3.4 fl oz 0.85SC/A

And alternate with one of the following:
Fontelis--12.0-16.0 fl oz 1.67SC /A *plus* chlorothalonil--2.0 to 3.0 pt 6F/A
Procure--4.0 to 8.0 fl oz 480SC/A *plus* chlorothalonil 2.0 to 3.0 pt 6 F/A
Rally--5.0 oz 40WSP/A *plus* chlorothalonil 2.0 to 3.0 pt 6 F/A
tebuconazole--4.0 to 6.0 fl oz 3.6F/A or OLF) *plus* chlorothalonil 2.0 to 3.0 pt 6 F/A

Inspire Super 16.0 to 20.0 fl oz 2.8F/A *plus* chlorothalonil 2.0-3.0 pt 6F/A,
Pristine--12.5 to 18.5 oz 38WG/A *plus* chlorothalonil 2.0-3.0 pt 6 F/A

Materials with different modes of action (FRAC codes) should always be alternated.

2014 PESTICIDE APPLICATION RECORD

Location of Application				Pesticide Product Used			Mixture Recipe per Product Label		Total Volume Applied Total Volumen Aplicar	Date *(M/D/Y)* & Time (*am/.pm*)		Applicator Full Name/ Pesticide License or Handler Number
Farm Name & Address; City or Township; and County of Application	Field Name Sitio Aplicado	Acres Treated/ Tratado	Crop Treated Cosech Tratado	Brand Name of Pesticide Nombre del Pesticida	EPA Registration Number Numero de Registracion EPA	Active Ingredient(s) Ingrediente Acitvo	Amount of Pesticide Concentrate used before mixing*	Total Diluent Candidad Usada		Date/Time Application Completed Fecha y Hora de la Aplicacion	Date/Time of Reentry Fecha y Hora de Reentrada	

**Aumente el pesticida concentrado usarlo antes mesclarlo*

R1

2014 PESTICIDE APPLICATION RECORD

New Jersey regulations require growers [private applicators] to maintain records of **all applications** of pesticides (both general and restricted use) for 3 years. All records should be recorded in writing as soon as possible, but no later than 24 hours. These records must be made available to the New Jersey Department of Environmental Protection and medical personnel (for emergencies) upon request.

Below is an example using a one-page format for keeping your records. The most current version can be found on the Rutgers Pest Management Office website at www.pestmanagement.rutgers.edu/PAT/record_forms.htm. You can use your own recordkeeping format as long as you include all of the information required by State regulations (NJAC 7:30-8.8 Records). If you don't include it as part of your application record, keep a separate list of handlers working under the private applicator's supervision.

The crop/field designation must be specific. *For example*- assign a number to each field, or the parts of a field planted to different crops, or the parts of a field planted to the same crop in a different growth stage. Then use this number on the application record for each application to that specific location. For all pesticides having a reentry time, enter the date and the hour hat the application was <u>completed</u>.

Location of Application				Pesticide Product Used			Mixture Recipe per Product Label		Total Volume Applied Total Volumen Aplicar	Date *(M/D/Y)* & Time (*am/.pm*)		Applicator Full Name/ Pesticide License or Handler Number
Farm Name & Address; City or Township; and County of Application	Field Name Sitio Aplicado	Acres Treated/ Tratado	Crop Treated Cosech Tratado	Brand Name of Pesticide Nombre del Pesticida	EPA Registration Number Numero de Registracion EPA	Active Ingredient(s) Ingrediente Acitvo	Amount of Pesticide Concentrate used before mixing*	Total Diluent Candidad Usada		Date/Time Application Completed Fecha y Hora de la Aplicacion	Date/Time of Reentry Fecha y Hora de Reentrada	
XYZ Farm 1234 Farm Road; Agriville; Cumberland County	G-11	8	Tomatoes	Vydate L	352-372	Oxamyl	12 qts.	400 gal	400 gal	6/15/12- 9:30 a.m.	6/17/12- 9:30 a.m.	John Smith C080569

**Aumente el pesticida concentrado usarlo antes mesclarlo*

PESTICIDE REGISTRATION NUMBERS

Use the space below to list the pesticides that you use and their EPA registration numbers. These numbers are printed on the label.

Pesticide*	**EPA Registration No.***	**Active Ingredient***	**Formulation**
Example: Rally	62719-410	myclobutanil 40%	40 WSP

* In New Jersey, a form listing all pesticides stored on site must be sent each year to your local Fire Department with an explanatory cover letter. It must include a description or diagram of the exact location of the storage area. See www.pestmanagement.rutgers.edu/PAT/record_forms.htm for template

VEGETABLE SEED SIZES

Table R-1. Vegetable Seed Sizes[1]

Crop	Seeds/Unit Weight	Crop	Seeds/Unit Weight
Asparagus	13,000-20,000/lb	Mustard	15,000-17,000/oz
Beans: baby lima	1,150-1,450/lb	Okra	450-550/oz
fordhook	440-550/lb	Onions: bulb	105,000-144,000/lb
snap	1,600-2,200/lb	bunching	180,000-200,000/lb
Beets	24,000-26,000/lb	Parsnips	7,500-12,000/oz
Broccoli	8,500-9,000/oz	Parsley	240,000-288,000/lb
Brussels sprouts	8,500-9,000/oz	Peas	1,440-2,580/lb
Cabbage	8,500-9,000/oz	Peppers	4,000-4,700/oz
Carrots	300,000-400,000/lb	Pumpkins	1,900-3,200/lb
Cauliflower	8,900-10,000/oz	Radishes	40,000-50,000/lb
Celery	60,000-72,000/oz	Rutabaga	150,000-192,000/lb
Collards	7,500-8,500/oz	Spinach	25,000-50,000/lb
Cucumbers	15,000-16,000/lb	Squash: summer	3,500-4,800/lb
Eggplants	6,000-6,500/oz	winter	1,600-4,000/lb
Endive, escarole	22,000-26,000/oz	Sweet corn: normal, sugary enhanced	1,800-2,500/lb
Kale	7,500-8,900/oz	Super sweet (Sh)	3,000-5,000/lb
Leeks	170,000-180,000/lb	Tomatoes: fresh	10,000-11,400/oz
Lettuce: head	20,000-25,000/oz	processing	160,000-190,000/lb
leaf	25,000-31,000/oz	Watermelons: small seed	8,000-10,400/lb
Muskmelons	16,000-19,000/lb	large seed	3,200-4,800/lb

[1]Use this table to estimate your seed requirements. Varieties and seed lots can differ in seed size. Check with your seed supplier and the label on the container for more precise information.

PLANT SPACINGS AND POPULATIONS

Table R-2. Population of Plants per Acre at Several Between-Row and In-Row Spacings

Inches between Rows	Inches Apart in Row												
	2	4	6	8	10	12	14	16	18	24	30	36	48
7	448,046	224,023	149,349	112,011	89,609	74,674	64,006						
12	261,360	130,680	87,120	65,340	52,272	43,560	37,337	32,670	29,040	21,780	17,424	14,520	10,890
18	174,240	87,120	58,080	43,560	34,848	29,040	24,891	21,780	19,360	14,520	11,616	9,680	7,260
21	149,349	74,674	49,783	37,337	29,870	24,891	21,336	18,669	16,594	12,446	9,957	8,297	6,223
24	130,680	65,340	43,560	32,670	26,136	21,780	18,669	16,335	14,520	10,890	8,712	7,260	5,445
30	104,544	52,272	34,848	26,136	20,909	17,424	14,935	13,068	11,616	8,712	6,970	5,808	4,356
36 (3 ft)	87,120	43,560	29,040	21,780	17,424	14,520	12,446	10,890	9,680	7,260	5,808	4,840	3,630
42 (3½ ft)	74,674	37,337	24,891	18,669	14,934	12,446	10,668	9,334	8,297	6,223	4,978	4,149	3,111
48 (4 ft)	65,340	32,670	21,780	16,335	13,068	10,890	9,334	8,167	7,260	5,445	4,356	3,630	2,722
60 (5 ft)			17,424	13,068	10,454	8,712	7,467	6,534	5,808	4,356	3,485	2,904	2,178
72 (6 ft)			14,520	10,890	8,712	7,260	6,223	5,445	4,840	3,630	2,904	2,420	1,815
84 (7 ft)			12,446	9,334	7,467	6,223	5,334	4,667	4,149	3,111	2,489	2,074	1,556
96 (8 ft)			10,890	8,167	6,534	5,445	4,667	4,084	3,630	2,722	2,178	1,815	1,361

USEFUL WEBSITES

The following is a list of websites that may be of interest and value to vegetable growers. Growers should carefully evaluate the source and accuracy of the information. Cooperative Extension DOES NOT confirm the accuracy of information at these websites. No endorsement of the information found at these websites is implied and no lack of endorsement is implied for sites not listed.

AGRICULTURAL SEARCH ENGINES	
cris.csrees.usda.gov	USDA Agricultural Search Engine
www.produceoasis.com/	About produce--recipes, nutrition, etc.
www.agricultureinformation.com	Agricultural Search Engine
www.agfind.com/	Agricultural Search Engine
VEGETABLE PRODUCTION	
njaes.rutgers.edu/pubs/	2014 Commercial Vegetable Production Rec.& Fact Sheets
aesop.rutgers.edu/~horteng	Horticultural Engineering
extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program	Delaware Extension Vegetable and Small Fruit Program
vric.ucdavis.edu/	California Vegetable Crops Information
edis.ifas.ufl.edu/topic_commercial_vegetable_production	Florida Commercial Veg. Information
weedid.aces.uiuc.edu	Univ. of Illinois Weed Identification
edis.ifas.ufl.edu/HS131	Reducing Postharvest Losses
www.ces.ncsu.edu/hil/veg-index.html	North Carolina Vegetable Information
Hightunnels.org	High Tunnel Information
msucares.com/index.html	Mississippi Vegetable Information
extension.psu.edu/vegetable-fruit	Penn State Vegetable and Small Fruit Production Information
plasticulture.cas.psu.edu	Penn State Center for Plasticulture
www.ppath.cas.psu.edu/EXTENSION/VEGDIS/Identification.html	Penn State Disease Management Publication
www.msue.msu.edu/	Michigan State University Extension
www.vegetables.cornell.edu/	Cornell Vegetable Information
extension.oregonstate.edu/	Oregon State Extension
ag.arizona.edu/hydroponictomatoes/	Growing Hydroponic Tomatoes
www.umassvegetable.org/	Univ. of Mass. Veg. Information
www.pollinator.com/	The Pollination Home Page
www.ext.vt.edu/	Virginia Cooperative Extension Information
www.xerces.org/pollinator-conservation	Pollinator Conservation
ohioline.osu.edu/lines/facts.html	Ohio State Fact Sheets
www.ppws.vt.edu/weedindex.htm	Virginia Tech Weed ID
www.ca.uky.edu/agc/pubs/id/id36/id36.htm	Kentucky Vegetable Growers Guide
Pubs.ext.vt.edu/438/438-012/438-012.html	Virginia Tech White Potato Production
www.bae.ncsu.edu/ people/faculty/boyette/pubs/sweetpotatoes postharvest-1.pdf	Post harvest handling of sweet potatoes
www4.ncsu.edu/~clrivard/TubeGraftingTechnique.pdf	Tube Grafting Publication NCSU
Farmassist.com	Syngenta (Special labels)
VEGETABLE PRODUCTION IN GREENHOUSES	
www.caes.uga.edu/publications/pubDetail.cfm?pk_id=6281	University of Georgia Greenhouse Production Guide
msucares.com/pubs/publications/p1828.pdf	Mississippi State Greenhouse Tomato Handbook
edis.ifas.ufl.edu/topic_book_florida_greenhouse_vegetable_production_handbo ok	University of Florida Greenhouse Vegetable Production Handbook

Continued

USEFUL WEBSITES (continued)

SUSTAINABLE/ALTERNATIVE CROP PRODUCTION (continued)	
www.ibiblio.org/farming-connection	Sustainable Farming
www.sarep.ucdavis.edu	California Sustainable Ag Program
www.sfc.ucdavis.edu	California Small Farm Center
www.hort.purdue.edu/newcrop	Purdue's New Crop Information
www.nal.usda.gov/afsic/	Alternative Farm Systems Inform. Ctr.
attra.ncat.org/horticultural.html	ATTRA horticulture series
www.sare.org	Sustainable Agriculture Network
www.kerrcenter.com/	The Kerr Center for Sustainable Agr.
INTEGRATED PEST MANAGEMENT (IPM)	
www.omri.org	Approved organic nutrients and sources
njaes.rutgers.edu/weeds	New Jersey Weed Photos
www.nysaes.cornell.edu/recommends/	Cornell Vegetable IPM
www.pestmanagement.rutgers.edu/IPM/Vegetable/index.htm	Rutgers Veg. IPM Program
www.ipm.ucdavis.edu	California IPM
www.hort.uconn.edu/ipm/ipmveg.htm	U Connecticut Vegetable IPM for growers
www.vegedge.umn.edu/MNFruit&VegNews/mnindex.htm	Minnesota IPM Newsletter
www.nysipm.cornell.edu/	New York Vegetable IPM
www.nysaes.cornell.edu/ent/biocontrol/	Biocontrol NY
ag.udel.edu/extension/IPM/index.html	Delaware IPM
www.mdipm.umd.edu/	University of Maryland IPM
cdm.ipmp.pe.org	Cucurbit Downy Mildew Forecasting
www.pestwatch.psu.edu	Penn State Pest Watch
itunes.apple.com/us/app/sample-submission/id669269520?mt=8	Diagnostic Lab Application (Ala, U of Conn., U of Ill., U. of Ky, MSU, U. of NH, Ohio State U.)
PESTICIDE NEWS AND INFORMATION	
www.ace.orst.edu/info/nptn/	Natl. Pesticides Information Center
www.cdms.net/manuf/manuf.asp	Pesticide Labels & MSDS sheets
www.greenbook.net/	C&P Press Greenbook.net
www.ipmcenters.org/	Office of Pest Management Prog. USDA
www.irac-online.org	Insecticide Resistance Action Committee
www.epa.gov/pesticides/	US EPA Office of Pesticide Programs
www.pcpnj.org	NJDEP Pesticide Control & Local Prog.
maarec.psu.edu/pdfs/WilliamsWinfree_NativeBees2009 1.pdf	Native Bee Benefits
www.usablight.org	Late Blight
NEWSLETTERS	
njaes.rutgers.edu/pubs/plantandpestadvisory/	NJ Plant & Pest Advisory Newsletter
agdev.anr.udel.edu/weeklycropupdate/	University of Delaware Weekly Crop Update
www.ag.ohio-state.edu/~vegnet/	Ohio Weekly Newsletter
www.ipm.uiuc.edu/ifvn/index.html	Illinois Weekly Newsletter
www.ag.arizona.edu/crops/vegetables/vegetables.html	SW Arizona Vegetable Pest Reports
MARKETING	
www.ams.usda.gov/marketnews.htm	USDA Agr.Mkt.Service Reports
www.farmersmarketonline.com/marketwa.htm	Terminal Market Prices for U.S. Crops
www.fas.usda.gov/commodities.asp	Terminal Mkt.Prices around the World
www.sfproduce.org/home.html	San Francisco Wholesale Mkt.Listings
www.nass.usda.gov/	USDA Nat'l Agr. Statistics Service

Continued

USEFUL WEBSITES (continued)

MARKETING (continued)	
www.ams.usda.gov/directmarketing/	USDA's Direct Marketing Information
www.pafarm.com/	PA Farm Market Association
www.worldcrops.org	Ethnic vegetable production & marketing
www.pma.com/	Produce Marketing Association
www.todaymarket.com/	Today's Market Prices
FARM MANAGEMENT	
www.aesop.rutgers.edu/~farmmgmt/	Farm Management
www.ers.usda.gov/	USDA Economic Research Service
www.farminfo.org/	The Small Farm Resource
dda.delaware.gov/plantind/forms/publications/FarmManagementforNativeBees-AGuideforDelaware.pdf	Farm Management for Native Bees Guide
WILDLIFE MANAGEMENT	
www.berrymaninstitute.org/	The Jack H. Berryman Institute
wildlifecontrol.info/newdm/Pages/default.aspx	The Northeast Wildlife Damage Management Research and Outreach Cooperative
icwdm.org/handbook/index.asp	Internet Center for Wildlife Damage Management
EDUCATION	
njaes.rutgers.edu	Rutgers NJ Agricultural Experiment Station
www.cpe.rutgers.edu	NJAES Office of Continuing Profess. Ed.
GOVERNMENT AGENCIES RELATED TO AGRICULTURE	
www.usda.gov/	US Department of Agriculture
dda.delaware.gov	Delaware Department of Agriculture
www.state.nj.us/agriculture/	NJ Department of Agriculture
www.mda.state.md.us	Maryland Department of Agriculture
www.nj.gov/dep/enforcement/pcp	NJ Pesticide Control Program
www.agriculture.state.pa.us	Pennsylvania Department of Agriculture
www.vdacs.virginia.gov	Virginia Department of Agriculture
www.rma.usda.gov/	Risk Management Agency USDA
www.wvagriculture.org/	West Virginia Dep
TRADE PUBLICATIONS	
www.americanfarm.com/	American Farm Publications
www.meistermedia.com/	American Vegetable Grower
www.vegetablegrowersnews.com	The Vegetable Grower News
www.agriculture.com/	Agriculture Online
www.growermagazine.com/	The Grower Magazine
WEATHER	
www.nws.noaa.gov/	National Weather Service
climate.rutgers.edu/stateclim/	NJ State Climatologist
www.deos.udel.edu/index.html	Delaware Environmental Observing System
www.usna.usda.gov/Hardzone/	Natl.Arboretum--Hardiness Zone Map
FOOD SAFETY	
ecommons.library.cornell.edu/handle/1813/2209	Growers Guide to Food Safety
www.caleafygreens.ca.gov/food-safety	Food Safety Practices
www.foodsafety.gov	National Food Safety Programs

PUBLICATION RESOURCES

The following publications are suggested for agents, growers, agriculture-industry representatives, and others who desire more detailed information on specific crops or production practices.

General Texts and Handbooks

Holcomb, E.J., editor. 1994. *Bedding Plants IV*. 516 pages. Fourth edition. Pennsylvania Flower Growers, Ball Publishing Co., P.O. Box 9, Batavia, IL 60510-0009. A manual on the culture of bedding plants as a greenhouse crop.

Uva, Richard H., Joseph C. Neal and Joseph M. DiTomaso, 1997; *Weeds of the Northeast;* 416 pages, Cornell University Press, 750 Cascadilla St., Ithaca, NY 14851. Comprehensive handbook for identifying 299 common and economically important weeds. 46 color photos and 118 drawings.

Maynard, D.N., and George Hochmuth. 2006. *Knott's Handbook for Vegetable Growers*. 582 pages. Fourth edition, John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158. A practical handbook on commercial vegetable production.

Meister, R.T., editor. July issue. *Annual Buyer's Guide: American Vegetable Grower*. Meister Publishing Co., 37841 Euclid Ave., Willoughby, OH 44094.

Phillips, Roger, and Martyn Rix. 1993. *The Random House Book of Vegetables*. Random House Publishers, New York, NY. Illustrations and photographs of 650 vegetables with some production information included.

Pierce, Lincoln C. 1987. *Vegetables: Characteristics, Production, and Marketing*. 433 pages. First edition, John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158. A good technical textbook for temperate vegetables.

Plucknett, D.L. and H.B. Sprague. 1989. *Detecting Mineral Nutrient Deficiencies in Tropical and Temperate Crops*. Westview Tropical Agriculture Series No. 7, Westview Press, Boulder, CO 80302.

Scaife, A. and M. Turner. 1984. *Diagnosis of Mineral Disorders in Plants. Volume 2: Vegetables*. Chemical Publishing Co., New York, NY 10000.

Shepersky, K. 1984. *The Rain Bird Landscape Drip Irrigation Design Manual*. Rain Bird Sprinkler Mfg. Corp., Glendora, CA 91740.

Sherf, A.F., and A.A. MacNab. 1986. *Vegetable Diseases and Their Control*. 728 pages. Second edition. John Wiley & Sons, Inc., 605 3rd Ave., New York, NY 10158. Information on diagnosis, disease cycles, and control; includes over 400 diseases and over 200 illustrations.

Swiader, John M., George W. Ware, and J.P. McCollum. 1992. *Producing Vegetable Crops.* Fourth Edition. Interstate publishers, Inc., 510 N. Vermillion Street, PO Box 50, Danville, IL 61834.

Anonymous. 1990. *Western Fertilizer Handbook*, Interstate Publishers, Inc., Danville, IL, 279 pp.

Anonymous. 2007. *Crop Protection Handbook,* Meister Media, Inc., Willoughby, OH, 828 pp.

Barenklau, K. E. 2001. *Agricultural Safety*, Lewis Publishers, Boca Raton, FL, 135 pp.

Brase, T. A. 2005. *Precision Agriculture*, Thomson Delmar Learning, Clifton Park, NY, 224 pp.

Cloyd, R. A., Nixon, P. L., and Pataky, N. R. 2004. *IPM For Gardeners*, Timber Press, Portland, OR, 204 pp.

Decoteau, D. R. 2000. *Vegetable Crops*, Prentice-Hall, Upper Saddle River, NJ, 464 pp.

Jones, J. Benton Jr. 2005. *Hydroponics: A Practical Guide for the Soilless Grower*, CRC Press, Boca Raton, FL, 423 pp.

McElhatton, A. and Marshall, R. J. 2007. *Food Safety – A Practical and Case Study Approach*, Springer, New York, NY, 311 pp.

McKinlay, R. G. 1992. *Vegetable Crop Pests*, CRC Press, Inc., Boca Raton, FL, 406 pp.

Monaco, T. J., Weller, S. C., and Ashton, F. M. 2002. *Weed Science: Principles and Practices, 4th Edition*, John Wiley & Sons, New York, NY, 669 pp.

Naylor, R. E. 2002. *Weed Management Handbook, 9th Edition*, Blackwell Publishers, Oxford, UK, 423 pp.

Rechcigl, N. A. and Rechcigl, J. E. 1997. *Environmentally Safe Approaches to Crop Disease Control*, CRC Lewis, Boca Raton, FL, 386 pp.

Rubatzky, V. E. and Yamaguchi, M. 1997. *World Vegetables: Principles, Production, and Nutritive Values*, Chapman and Hall, New York, NY, 843 pp.

Singh, H. P., Batish, D. R., and Kohli, R. K. 2005. *Handbook of Sustainable Weed Management*, Food Prod. Press, New York, NY, 892 pp.

Snowdon, A. L. 1990. *Color Atlas of Post-Harvest Diseases and Disorders Vol. 2: Vegetables*, CRC Press, Inc., Boca Raton, FL, 416 pp.

Van Emden, H. F. and Service, M. W. 2004. *Pest and Vector Control*, Cambridge University Press, Cambridge, UK, 349 pp.

Publications from Universities, USDA, Societies, and Commercial Companies

Compendium of Bean Diseases, Compendium of Beet Diseases and Insects, Compendium of Corn Diseases, Compendium of Pea Diseases, Compendium of Potato Diseases, Compendium of Sweet Potato Diseases, Compendium of Tomato Diseases. Available from APS Press, The American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121.

Hardenburg, R.E., A.E. Watada, and C.Y. Wong. 1995. *The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks*. 136 pages. USDA Agricultural Handbook No.66 (revised).

Kader, Adel A., et al. 1985. *Postharvest Technology of Horticultural Crops*. 192 pages. Special Publication 3311. Univ. of CA, 6701 San Pablo Ave, Oakland, CA 94608-1239.

Integrated Pest Management for Cole Crops and Lettuce. 1992. Publication of the Div. of Agric. and Natural Resources. Univ. of CA, 6701 San Pablo Ave., Oakland, CA 94608-1239.

MacNab, A.A., A.F. Sherf, and J.K. Springer. 1983. *Identifying Diseases of Vegetables*. 62 pages. Order from Publications Distribution Center, Penn State University, 112 Agricultural Administ. Building, University Park, PA 16802. Color photos and description of common vegetable diseases.

PUBLICATION RESOURCES

Publications from Universities, USDA, Societies, and Commercial Companies (continued)

McGregor, S.E. (continuously updated). *Insect Pollination of Cultivated Crop Plants*. USDA Agricultural Handbook 496. 411 pages. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Specialty and Minor Crops Handbook. 1991. Publication 3346. Publication Div. of Agric. and Natural Resources. Univ. of CA, 6701 San Pablo Ave., Oakland, CA 94608-1239.

Stephens, J.M. 1989. *Manual of Minor Vegetables*. 123 pages. Florida Cooperative Extension Service, Univ. of FL, Gainesville, FL 32611.

Weeds of the North Central States (Bulletin 7). 303 pages. Illustrated book that lists and describes most of the weeds found in New Jersey. Available from the University of Illinois, Champaign, IL 61820.

Grubinger, Vernon P. 1999 *Sustainable Vegetable Production from Start-Up to Market*. 280 pages. Guide for those who are considering beginning a vegetable production business. The Natural Resource, Agriculture, and Engineering Service. Contact NRAES by phone (607) 255-7654 or www.nraes.org.

Zitter, Thomas A., Hopkins, Donald L., and Thomas, Claude E. 1996. *Compendium of Cucurbit Diseases*, American Phytopathological Society, 140 pp. www.shopapspress.org/42074.html

FREQUENTLY USED WEIGHTS & MEASURES

Table R-3. Frequently Used Weights and Measures and Approximate Metric Equivalents

Liquid				Dry			
Pint	**Liters**	**Gallons**	**Liters**	**Ounces**	**Grams**	**Pounds**	**Kilograms**
0.5	0.24	1	3.8	0.25	7.1	1	0.5
1.0	0.47	2	7.6	0.50	14.2	2	0.9
1.5	0.71	3	11.4	0.75	21.3	3	1.4
2.0	0.95	4	15.1	1.0	28.4	4	1.8
2.5	1.18	5	18.9	2.0	56.7	5	2.3
3.0	1.42	6	22.7	3.0	85.0	6	2.7
3.5	1.65	7	26.5	4.0	113.4	7	3.2
4.0	1.90	8	30.3	5.0	141.7	8	3.6
4.5	2.13	9	34.1	10.0	283.5	9	4.1
5.0	2.37	10	37.9	16.0	453.6	10	4.5

Length and Area

1 acre	= 0.405	hectares		1 inch	= 2.54	centimeters	
1 square mile	= 2.39	square kilometers		1 foot	= 30.3	centimeters	
1 square yard	= 0.836	square meters		1 yard	= 0.914	meters	
1 square foot	= 0.0929	square meters		1 mile	= 1.61	kilometers	
1 square inch	= 6.45	square centimeters					

PLANT GROWING MIX

Making a Plant-Growing Mix. Many pre-mixed growing media products suitable for conventional and organic production are available commercially. A good, lightweight, disease-free, plant-growing material can also be made from a mixture of peat and vermiculite. A formula for a very simple mix for conventional production is given in Table R-4, but a preferred formulation is shown in Table R-5. If plants are to be grown in a mix longer than 8 weeks, use the formula in Table R-5. Organic growing media differ from conventional media because all components used must be allowable under organic production standards. When mixing your own formulation it is important to verify with your certifier that the materials you are using will not compromise your certification. For more information on organic growing media including several formulations can be found in:

- *Potting Media and Plant Propagation* - http://extension.psu.edu/start-farming/vegetables/potting-media-and-plant-propagation
- *Potting Mixes for Certified Organic Production* - https://attra.ncat.org/attra-pub/viewhtml.php?id=47
- *Organic Potting Mix Basics* - http://www.extension.org/pages/20982/organic-potting-mix-basics

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Table R-4. Simple Plant-Growing Mix

Materials	**Cubic Yard (22 Bushels)**	**2 Bushels**
Shredded sphagnum peat moss	11 bu	1 bu (10 gal)
No. 2, 3, or 4 domestic or African vermiculite[1] or horticultural grade (dust-screened)	11 bu	1 bu (10 gal)
Pulverized limestone		
use *dolomitic* lime for mixes made with *domestic* vermiculite	10 lb	1 lb (1¼ cups)
or		
use *calcitic* lime mixes made with *African* vermiculite	6 lb	9 oz (3/4 cup)
Superphosphate (20% P_2O_5) or	2½ lb	4 oz (½ cup)
Triple superphosphate (46% P_2O_5)	1¼ lb	2 oz (¼ cup)
Fertilizer (5-10-10)	5 lb	8 oz (1 cup)

[1] Vermiculite should be pea-sized and relatively free of fines and dust. Final mix should have a pH of 6.0-6.5.

Notes. Good results for growing lettuce and cabbage transplants have been obtained by diluting this mix with an equal part of sand.

This mix will only get the seedlings up. Supplemental fertilizing will be needed to grow plants to transplant size. About 3 weeks after seeding, begin liquid fertilizing the plants with a soluble fertilizer, such as a 20-20-20, at the rate of 2-3 teaspoons per gallon of water. This rate should be applied at least weekly. More frequent applications may be desirable.

Table R-5. Preferred Plant-Growing Mix

Materials	**Cubic Yard (22 Bushels)**	**2 Bushels**
Shredded sphagnum peat moss	11 bu	1 bu (10 gal)
No. 2, 3, or 4 domestic vermiculite[1] or horticultural grade (dust-screened)	11 bu	1 bu (10 gal)
or		
African vermiculite[1]	11 bu	1 bu (10 gal)
Pulverized limestone		
use *dolomitic* lime for mixes made with *domestic* vermiculite	10 lb	1 lb (1¼ cups)
or		
use *calcitic* lime mixes made with *African* vermiculite	6 lb	9 oz (3/4 cup)
Superphosphate (20% P_2O_5) or	2½ lb	4 oz (½ cup)
Triple superphosphate (46% P_2O_5)	1¼ lb	2 oz (¼ cup)
Sulfate or muriate of potash (50%-60% K_2O)	½ lb	1 oz (2 tbs)
Osmocote[2] (18-6-12)		
Tomatoes	4 lb	6 oz (3/4 cup)
Eggplants	8 lb	12 oz (1½ cups)
Peppers	8 lb	12 oz (1½ cups)
Micronutrient mix	Use according to mfgr.'s recommendations	
Wetting agent (such as Aqua-Gro granular)	1½ pt	1 oz (4 tbs)

[1] Vermiculite should be approximately pea-sized and relatively free of fines and dust. Final mix should have a pH of 6.0-6.5.

[2] Osmocote is a slow-release fertilizer. Use a formula that will release nutrients over a period of 8 to 9 months. Therefore, mixes should be made just prior to seeding. Plants grown in mixes containing Osmocote must be carefully watered and the temperature carefully controlled prior to field planting. Reduced rates are suggested to control plant height when using small cells.

Regardless of which formula is chosen, unless good mixing procedures are used, the results will be less than optimal. For best mixing, use a horizontal-type paddle mixer that folds or blends the components, such as lime and fertilizer, evenly throughout the mix. With tilted or other types of mixers, the components tend to segregate or separate out, resulting in erratic performance of the mix.

Good procedures to follow when preparing a mix are:

1. **Use a respirator to prevent inhalation of dust when mixing peat, vermiculite and additives.**
2. For small quantities of mix preparation--1 cubic yard or less--place 4 to 5 inches of vermiculite in the bottom of a 5-gallon pail. Add all the additives (lime, fertilizer, micronutrient, etc.) to the vermiculite in the pail and mix thoroughly.
3. Fluff the recommended amount of peat. Start mixer and begin blending the peat.
4. While blending, add water according to the dampness of the peat. You will need approximately 1 gallon of water per bushel of peat in the mix.
5. While blending, slowly pour the additives, which you have already mixed thoroughly with a small amount of vermiculite, into the mixer and blend for 3 to 5 minutes.

6. Add the recommended amount of vermiculite after the other ingredients and blend for 1 minute or less, depending on the consistency of the vermiculite. It should be mixed thoroughly without breaking down. Soon after mixing, use the mix for growing your plants. It is not a good practice to stockpile the mix in large piles for long periods of time.
7. Read all labels of the ingredients used, and heed all warnings that may be marked on the labels or bags.

Appendix A

Methods to measure honeybee colony size and strength

Colony strength can be assessed in several ways.

1. **Inspect hives**. This method is the most time-consuming, but also the most accurate. Colonies used for springtime pollination should have at least:
   - a laying queen
   - one and one-half or two stories (hive bodies or boxes)
   - four to six frames of brood
   - enough adult bees to cover six to eight frames

These are minimum requirements; stronger colonies with larger populations make superior pollination units and may command a higher price. As these stronger colonies are opened, bees will "boil out" or cover the tops of the frames. When smoked, however, the bees move down onto the frames and may not cover the frame tops. In this case, the frames themselves should be covered with bees. Note that there will be some variability in the quality of the colonies you rent. As a general rule, a group of colonies where 10 percent fall below the minimum standard is acceptable if 10 percent are also above the minimum standard. Also, for a variety of reasons, some colonies may become queenless for a time; however, if these colonies meet all the other minimum requirements they still will be effective pollination units.

You can request hives to be inspected. In Pennsylvania, The Pennsylvania Department of Agriculture Apiary Inspection Service runs a hive evaluation program for colonies used for pollination. Requests may be made by either the grower or the beekeeper and should be arranged through the state apiarist at the PDA Bureau of Plant Industry, 2301 North Cameron Street, Harrisburg, PA 17110; telephone 717-772-5225. Requests should be made as early as possible to facilitate scheduling. If an evaluation is requested by the grower, the beekeeper will be informed that a request has been made. Colonies are inspected to determine the colony size (number of supers), the presence of a laying queen, the number of frames of brood and adult bees, and the presence of disease and parasites. At least 10 percent of the colonies in an apiary, or a minimum of five colonies, are selected at random for inspection. Inspected colonies are identified by sticker. If selected colonies are banded or stapled, these are not refastened by the inspector. A copy of the evaluation report is given to both the grower and the beekeeper.

2. **Assess traffic at hive entrance**. This method is less time- consuming but also less accurate. On a warm (70 to 80˚F), calm day between 11 AM and 3 PM, bee traffic at hive entrances should be heavy. During a one-minute observation period, strong colonies should have 50 to 100 or more bees arriving and leaving the hive. Bees also should be seen arriving with pollen pellets on their back legs. In weak colonies, less than 40 bees will be seen arriving and leaving per minute. Colonies that are being used for summer pollination should have heavier traffic at the hive entrance.

   Another crude way to assess colony strength is to observe entrances when temperatures are cool (between 55 and 60˚F). In strong colonies, flights will be observed when temperatures are between 55 and 60°F, but in weaker colonies bees rarely fly when temperatures are below 60°F. Honeybees very rarely fly when the temperature is below 55°F.
3. **Assess bee density on the crop**. This method allows you to assess the contribution of feral or other honeybee colonies in the area in addition to rented bees. If you are using rented colonies, however, this method tells you little about the quality of the bees. We suggest that if you use this technique and find that the number of bees on the crop is low, you then use options (1) or (2) to assess colony strength before renting additional bees.

Additional information

The publications listed below are available on the MAAREC Web site at **MAAREC.cas.psu.edu**.

- *Beekeeping Basics*

Appendix A *(continued)*

- *Beekeeping Topics: Sources of Bees for Pollination in Pennsylvania, Bees and Insecticides, Pollination Contracts, Basic Biology and Management of the Japanese Hornfaced Bee*

U.S. distributors of “Fruit Boost” that was recommended in the Pollination for attracting bees section are located in the Pacific Northwest. For more information, contact Phero Tech, Inc., 7572 Progress Way, RR 5, Delta, British Columbia, Canada V4G 1E9; phone: 604-940-9944; fax: 604-940-9433.

Other sources of information for bee guides in your area see the websites listed below:
www.state.nj.us/agriculture/divisions/pi
anr.ext.wvu.edu/bees
www.virginiafruit.ento.vt.edu/VAFS-bees.html
www.attra.org/attra-pub/beekeeping.html
dda.delaware.gov/plantind/forms/publications/FarmManagementforNativeBees-AGuideforDelaware.pdf
maarec.psu.edu/pdfs/WilliamsWinfree_NativeBees2009%201.pdf
ohioline.osu.edu/cv-f**act**/pdf/1003.pdf

NOTES

RESOURCE MATERIALS

The following publications are suggested for agents, growers, agriculture-industry representatives, and others who desire more detailed information on specific crops or production practices.

Rutgers Cooperative Extension Publications

The publications listed below are available from county Extension offices and the Rutgers Cooperative Extension web site: www.rce.rutgers.edu. Out of state requests for the 2012 Commercial Vegetable Production Recommendations should be addressed to:

Rutgers Ag. Research & Extension Center
Att: Dr. Tom Orton
121 Northville Rd.
Bridgeton, NJ 08302
Phone: 856/455-3100 ext. 4112
Fax: 856-455-3133

E285 *Soil Nitrate Testing as a Guide to Nitrogen Management for Vegetable Crops*
FS337 *Complying with the NJ Right-to-Know Law*
FS399 *Vole Ecology and Management*
FS603 *Pesticide Storage Facilities*
FS604 *Handling Emergency Situations on the Farm*
FS605 *Accident Proofing Farms and Stables*
FS608 *Fire Prevention and Safety Measures Around the Farm*
FS619 *Farm Machinery and Equipment Safety--Part I-Recognizing and Understanding Hazards*
FS620 *Farm Machinery and Equipment--Part II-Preventing Machinery Accidents During Operation*
FS628 *Cleaning and Storage of Pesticide Sprayers*
FS657 *Irrigation Scheduling with Tensiometers*
FS658 *Irrigation Scheduling with the Feel Method*
FS683 *Organic Certification of Agricultural Products*
FS760 *Presidedress Soil Nitrate Test (PSNT) Recommendations for Sweet Corn*
FS784 *A High-Productivity Strawberry Production System for NJ*
FS793 *Using Irrigation Water Tests to Predict and Prevent Clogging of Drip Irrigation Systems*
FS794 *Preventative Maintenance for Irrigation Equipment*
FS795 *Treating Drip Irrigation Systems with Chlorine*
FS796 *Controlling Bacteria, Algae, and Weeds in Ponds*
FS824 *Plant Nutrients in Municipal Leaf Waste*
FS849 *Cover Crops and Green Manure Crops: Benefits, Selection, and Use*
FS871 *Understanding Fertilizer Labels:*
FS873 *Boron--Evaluating Needs of Soils and Crops in NJ*
Land Application of Sewage Sludge Series:
FS951 *#1: Questions to Ask Before Application*
FS952 *#2: Regulations and Guidelines*
FS953 *#3: Different Types of Sewage Sludge*
FS954 *#4: Guidelines for Land Application in Agriculture*
FS955 *#5: Heavy Metals*
FS956 *#6: Soil Amendments and Heavy Metals*
FS957 *#7: Organic Contaminants*
FS958 *#8: Pathogens*
FS1017 *Regulations Governing the Management of New Jersey Wildlife*
FS1020 *Sweet Corn Crop Nitrogen Status Evaluation by Stalk Testing*
FS1023 *Nutrient Management of Land Applied Grass Clippings*

Natural Resource, Agriculture, and Engineering Service Publications

Available from NRAES, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701 (607/255-7654).
Web site: www.NRAES.org

NRAES-3 *Energy Conservation for Commercial Greenhouses.* ($17)
NRAES-4 *Trickle Irrigation in the Eastern United States.* ($6)
NRAES-10 *Farm Accident Rescue*. ($12)
NRAES-22 *Refrigeration and Controlled Atmosphere Storage for Horticultural Crops*. 42 pages. ($8)
NRAES-104 *Sustainable Vegetable Production From Start-up to Market ($38)*

Electronic Information

Rutgers Cooperative Extension maintains a worldwide web site on the internet. Information available at the site includes:

- Rutgers Cooperative Extension Calendar of Events
- County Office Information--telephone numbers and travel directions
- Employment Opportunities
- Fact Sheets--more than 250 fact sheets related to agriculture, family and consumer science, and 4-H
- Newsletters--Plant and Pest Advisory Newsletters
- Pesticides for New Jersey
- Marketing Information--Farmers markets, organic farms, and pick-your-own farms
- Fruit and Vegetable Guides
- Weed Images and Descriptions

The address for the Rutgers Cooperative Extension web site is:
njaes.rutgers.edu/extension/

For the Disposal of Pesticides, Call:
Bureau of Hazardous Waste Regulation
Department of Environmental Protection
Trenton, NJ 08625 - 609/292-7081

For Help in a Pesticide Emergency, Call:
New Jersey Poison Information & Education System - 800/222-1222
or
DEP, Trenton - 877/927-6337

In Case of a Pesticide Spill, Call:
DEP Hotline - 877/927-6337

For Information on Pesticide Applicator Certification and Pesticide Laws and Regulations, Call:
Pesticide Control Program - 609/530-4070
or
Rutgers Cooperative Extension Pesticide Office – 732/932-9801

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Vegetable Crops On-line Resource Center
www.njveg.rutgers.edu

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