Management of Phytophthora Root and Runner Rot in Cranberry

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Phytophthora is a genus of plant pathogens, many species of which live in water or soil. The name means "plant destroyer" in Greek. *Phytophthora* species are common pathogens in agricultural systems, especially in those where the crop is irrigated with surface or recycled water. In cranberry culture, the most troublesome species is *P. cinnamomi*, the cinnamon fungus. This pathogen causes a very common disease of cranberry, Phytophthora root and runner rot (PRRR).

Disease development. The life cycle of *P. cinnamomi* is described in Figure 1. Motile spores, called zoospores, of *Phytophthora* species are carried in irrigation water from surface sources (but not from well water, which is typically sterile) and are regularly introduced into cranberry beds. Symptoms of infection develop in only a small percentage of the exposed acreage, however, due to the excellent drainage and low pH values (3.0–4.5) of cranberry soils in most beds. Development of a *Phytophthora* infection is associated with poor drainage (Figure 2). In water-saturated soil, *Phytophthora* can reproduce and spread quickly. Infections in roots and runners produce sporangia that release swimming zoospores that carry infection to other vines, and these cycles of infection continue as long as the soil is wet and temperatures are favorable (see Figure 1).

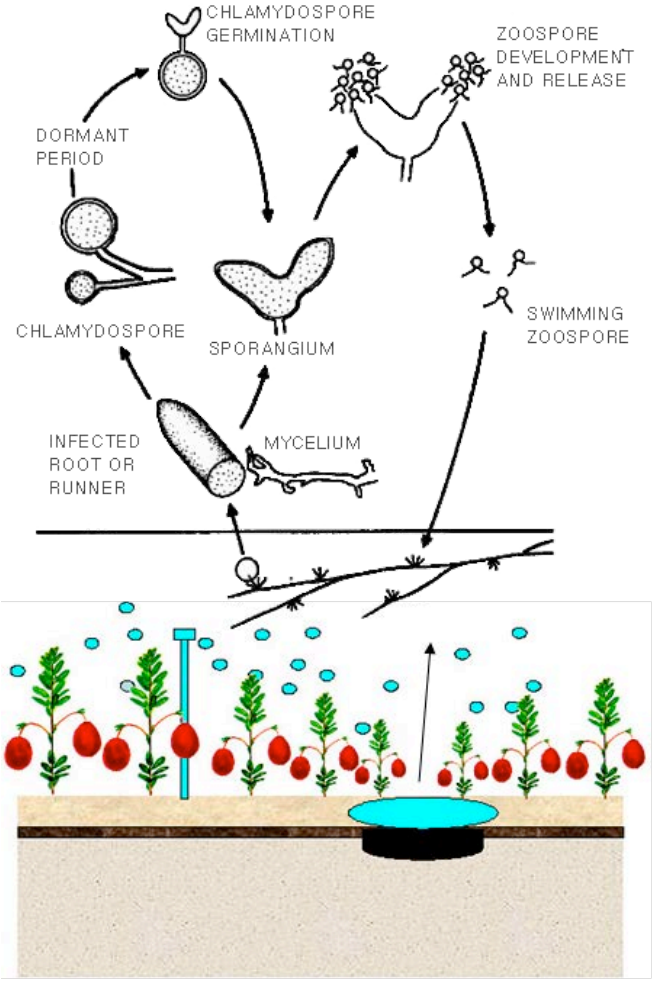

Figure 1. A typical *Phytophthora* life cycle.

Phytophthora cinnamomi can survive low temperatures but grows and reproduces best at higher temperatures. Zoospores are detected in irrigation systems when surface water temperatures exceed 60° F. Zoospores are carried to cranberry vines in irrigation water. Infection requires prolonged soil wetness from flooding or poor drainage as well as soil temperatures above ~50° F. Under these conditions, zoospores that reach susceptible vines germinate to produce a mycelium that colonizes and kills roots and runners. Fruiting bodies called sporangia form on the mycelium and release more zoospores. Zoospores are attracted to nearby uninfected vines by chemical signals and swim toward them, spreading infection. When the soil dries out or temperatures drop, chlamydospores (resting spores) form in rotted root and runner tissues. Chlamydospores are resistant to drying and freezing, and allow *Phytophthora* infections to overwinter in cranberry beds. When soils are once again warm and wet, chlamydospores germinate to form sporangia, beginning the infection cycle again.

Symptoms. Vines affected by PRRR will decline from the root system up.. Discolored areas (brown to black) appear beneath the bark on the runners. The root system is weakened and reduced in mass, which causes secondary symptoms such as stunting, nutrient deficiency, and reduced drought tolerance.

Phytophthora can produce chronic as well as acute infections in cranberry beds, and symptoms of chronic infection may not be easy to spot initially. Affected areas appear green and normal from a distance, but vines are stunted and vigor and yield are reduced. They may die rapidly if subjected to a stress such as drought. Because cranberry plants spread by runner growth, poor root development in the runners also slows coverage of a bed by vines. As a result, vine density in beds with chronic PRRR may be uneven, with many open spots colonized by weeds. Rushes (*Juncus* spp.) are common invaders in *Phytophthora*-infected areas and are indicators of poor drainage.

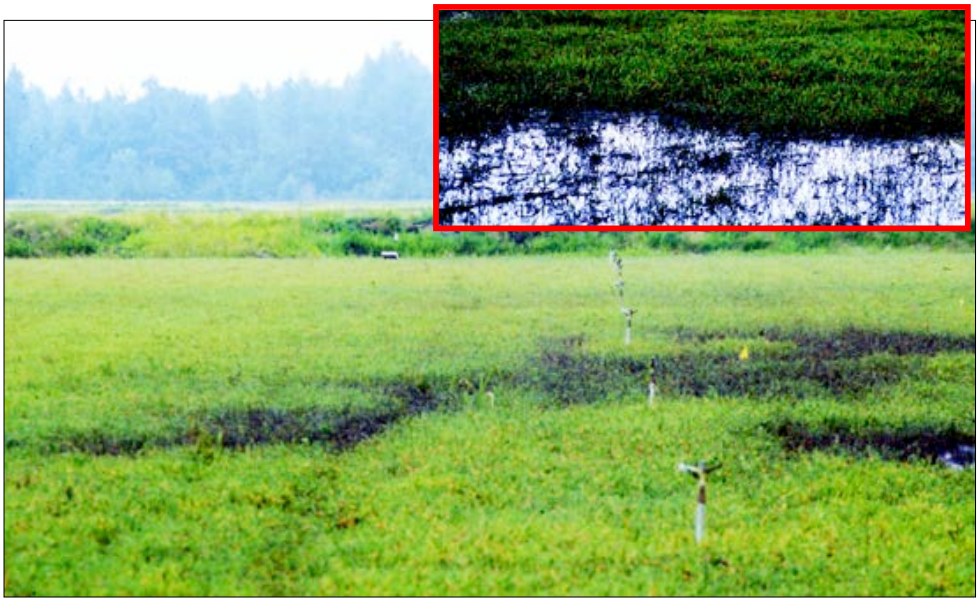

Fig. 2. Acute symptoms of Phytophthora root rot in the field. Inset: Dead vines appear in flooded areas.

Recent research has shown that compared to the occasional acute infection, chronic infections may result in greater yield loss over time because they tend to be more widespread. Chronic infections are common, and detection methods such as remote sensing are very useful (Fig. 3).

Diagnosis. Symptoms of PRRR are similar to those of related root disorders such as damage by root-feeding insects and nematodes, other fungal diseases such as fairy ring, or simply “wet feet.” Because management of each of these problems differs, it is extremely important to get an accurate diagnosis before undertaking any control measures.

Identification is accomplished in various ways. Field identification based on symptomology is the most rapid method and, with experience, can be relatively accurate. It is not definitive, however, and should be followed up with a laboratory test, especially in new locations where the pathogen has not been seen previously or when there is any doubt. The pathogen can be isolated in the laboratory from symptomatic root or runner tissue by using a special microbiological growth medium (PARPH) that contains a unique blend of antibiotics. Few organisms besides *Phytophthora* are capable of growing on PARPH medium. A trained plant pathologist or diagnostician generally makes the positive identification by microscopic observation. For more information about the Rutgers Plant Diagnostic Laboratory, see back panel for addresses.

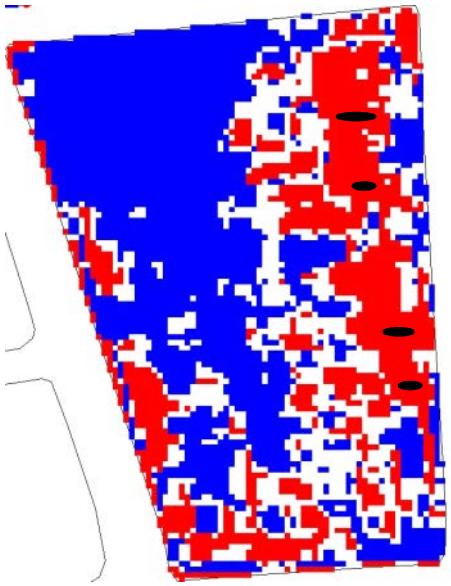

Fig. 3. Distribution of *Phytophthora cinnamomi* in a single cranberry bed. Areas in black show acute symptom development; areas in red show chronic infections. Areas in blue are healthy and are yielding 60–100 bbl/acre more than red areas.

Although the primary pathogen that causes PRRR is *Phytophthora cinnamomi*, several different species of *Phytophthora* have been found on cranberry. Each species exhibits its own temperature preferences, fungicide sensitivity, and disease cycle. Two species of *Phytophthora* occur in New Jersey, and they differ in temperature preference and fungicide sensitivity. Accurate species diagnosis is essential for proper management of this disease.

Management. In cranberry, there are a number of strategies for managing this disease. It is critical to emphasize that, although the pathogen is widely distributed, symptoms do not occur under all conditions because of variation in internal soil drainage. It should be possible to manage the pathogen by managing the soil water. The following checklist can be used to assess the "root" of the problem and identify some solutions.

Key factors for effective PRRR management

- Identification of the pathogen
- Soil drainage rates
- Soil drainage uniformity
- Irrigation uniformity
- Irrigation volume
- Timing of fungicide applications

a) Map out the affected area(s).
b) Examine the distribution of sprinkler heads to confirm that they match the design specifications (e.g., 40x50, 50x60 or 60x70).
c) Determine the total capacity of the irrigation system for each zone and confirm that the system is delivering the rate specified in the design (e.g., 0.1 acre-inch/hour).

d) Following a rain or irrigation event, examine the soil surface for standing water. Check the area over a 24-hr period to determine if drainage is visibly slower in affected than unaffected areas.
e) Examine the bed for low points and determine whether these are related to symptom development.

Cultural controls. Controlling cranberry root rot requires the integration of several practices. Drainage is the most important soil property determining the degree of damage caused by *Phytophthora*, thus water management is most critical, in particular, eliminating the causes of soil saturation. Uniform drainage allows soil water content to be managed to a level where infections are minimized. Problems arise where soil drainage is highly variable and it is not possible to irrigate sufficiently in well-drained areas without over-irrigating poorly drained areas. Uniform drainage should be a key consideration in establishing new beds. Puddles or standing water are the first places *Phytophthora* infections occur. Drainage methods that remove standing water, such as ditches or under-drains, are very useful in controlling root rot.

Irrigation uniformity is also crucial because over-watering can increase the chance of infection. Repeated cycles of wetting and drying, especially extreme cycles, are conducive to root rot. Schedule irrigation timing to consistently maintain soil moisture near the optimum level, rather than leaving long intervals between irrigation events. Soil pH is of questionable value for *Phytophthora* control. Since cranberry is an acid-loving plant, it can tolerate relatively low pH levels. However, the use of sulfur to reduce pH in areas with symptoms of root rot can lead to additional damage if the soils are poorly drained. This practice should therefore be used with extreme caution.

Sanitation practices to prevent introduction of the pathogen are generally recommended in cranberry culture, as the pathogen is widely distributed. Exercise caution when moving plant material or soil between watersheds with different *Phytophthora* species.

Chemical controls. Fungicides can be used to protect living plants from PRRR. Once appropriate cultural practices have been implemented, treatment with fungicides can aid in the establishment of new vines. There are two major groups of fungicides for *Phytophthora*:

- Mefanoxam is a *Phytophthora*-specific fungicide that is applied to the bed surface and irrigated into the soil. The fungicide travels to the root and runner tissues, where it is taken up and carried systemically with the flow of water.
- Phosphorous acid is the active ingredient for a number of fungicides (e.g., Aliette®, Phostrol™, ProPhyt®, AgriFos®) that are applied to green foliage and transported downward to the root tissues. Newly planted vines may not be able to absorb the phosphorous acid fungicides until sufficient shoot growth has occurred, whereas mefanoxam can be irrigated into the root zone. These materials can be applied through chemigation systems and offer excellent root uptake. Always check the label restrictions on these materials since there are minor differences that can affect the proper usage

Both types of fungicides perform best when used to protect plants following improvements to drainage or rectification of over watering.

Fungicides are most useful when:

- There are living plants present.
- Soil temperatures are in a range where the pathogen is active (e.g., November applications are generally useless in NJ).
- Drainage issues have been resolved.
- The target is a new planting that requires significant irrigation for rooting.

New beds: New beds should be constructed with the aim of providing uniform drainage. Irrigation systems should be carefully laid out so that sprinkler heads are placed according to design specifications. For irregular beds, sprinkler heads placed closer than specified in the design should be outfitted with reduced-volume nozzles. Unevenly drained beds will result in creation of zones with different irrigation requirements and will become very difficult to manage. Before planting, the grower should examine the bed for low points or poorly drained areas that may be vulnerable to development of PRRR. Implementing a drainage plan during new bed construction will avoid problems down the road.