- 11 -
Control of Phytophthora and Other Major Diseases of Ericaceous Plants

Harry A. J. Hoitink, Steven T. Nameth, and James C. Locke

Introduction

Phytophthora diseases affect many nursery crops. They can be divided into dieback diseases that involve blights of leaves and shoots, and root and crown rots. Many nursery crops are susceptible. Plants in the family Ericaceae (rhododendrons, azaleas, etc.) are among the most susceptible.

Phytophthora diseases, such as root rot of Fraser fir and of *Chamaecyparis lawsonii*, apparently are caused by a single species of the *Phytophthora* fungus. Others, such as Phytophthora root rot of rhododendron, may be caused by any of eight *Phytophthora* species.

Three different species of *Phytophthora* have been isolated from the same infected rhododendron plant, demonstrating rhododendron's high level of susceptibility to this root-rot disease. Azalea and *Pieris*, like rhododendron, are susceptible to both root rot and dieback.

Harry A. J. Hoitink and Steven T. Nameth, Professors, Department of Plant Pathology, Ohio Agricultural Research and Development Center, The Ohio State University; and James C. Locke, Research Plant Pathologist, U.S. Department of Agriculture, Agricultural Research Service, Application Technology Research Unit, Wooster, Ohio.

Lilac is another crop highly susceptible to *Phytophthora* root rot and dieback. *Potentilla* is susceptible to dieback only, and *Taxus* and junipers to root rot only. Crabapples and several other rosaceous plants are also susceptible to collar rots.

In the 1960s and early 1970s, root rots were the most common diseases of nursery plants. They were especially severe on plants in poorly drained soils or in peat mixes. Bark-amended media, now used widely for disease control in the industry, helped suppress root rots.

After reducing the threat of root rot through the use of bark mixes, nurserymen were able to increase fertility levels and shorten production cycles. After increasing fertility, Phytophthora dieback (foliar and stem diseases) became more important than root rots on plants grown in containers.

Subsequent research showed that the nitrogen concentration in the new growth of rhododendron plants is directly related to Phytophthora dieback susceptibility. This relationship probably applies to other crops as well. For example, plants of *Rhododendron* cv. Roseum Elegans with a nitrogen concentration greater than 2.0% in young foliage (last flush) are very susceptible. Lesions on

new growth of high-nitrogen plants may extend down to the crown in 10 days or less. The same infection on a low-nitrogen plant (1.2% N in new growth) remains small (pin head in size) and may not be detected.

Native rhododendrons growing in unfertilized natural settings have such low nitrogen levels that they produce only one flush of growth per year. The disease has not been observed on wild plants, even though the pathogen is very widespread in distribution.

The best way to control Phytophthora dieback in the landscape is to maintain moderate nitrogen fertility levels. For nursery production in containers, this practice is not practical because young plants maintained under lower fertility levels grow too slowly to permit economic production. In field-grown rhododendrons, dieback is less severe. In part, this is due to lower fertility levels maintained in the field.

The Life Cycle of Phytophthora Diseases

Phytophthora species associated with woody plants generally over-winter in infected plants or in decaying infested plant debris in the soil or container medium. They generally do not survive after infested crop residues have decomposed in soil. Most do not survive extremely cold winters in crop residue.

An exception is *Phytophthora citrophthora,* which causes a severe crown rot and shoot blight problem on *Pieris japonica.* It also causes dieback on rhododendron and root rot of *Taxus.* This species can survive in infested tissues on the surface of the soil even in winters with -252°F temperatures.

Irrigation water collected from streams or irrigation ponds typically is contaminated with *Phytophthora* spp. Water used for greenhouse crops should be disinfested but that is not practical for the large volumes of water used on containers. Slow sand filters have been developed recently that are very effective for treatment of irrigation water for greenhouse crops.

Phytophthora spores germinate in water droplets or in a film of water. Spores may be splashed with water droplets onto foliage or be moved in running water in the soil or on the soil surface. Some spores known as zoospores are motile and swim towards root tips or stomata on leaves where they cause infections. Leaves must be wet for at least two hours for infections to be successful. Dry leaves do not become infected even when the humidity is high.

Disease Prevention During Propagation

Propagation benches must be raised and must provide excellent drainage. If a second crop is to be grown in the same medium, it should be a cultivar that roots quickly and is not susceptible to the same diseases as the first crop. The floor and walks between beds should be free of puddles and weeds. Proper management of irrigation water is a key to management of these diseases. **Puddling and flooding should be avoided at all cost to reduce sporulation and spreading of the pathogen.**

Before new propagation media are placed in the greenhouse, the headhouse, greenhouse, and benches should be brushed free of all organic debris and old propagation media. Infected residues need to be removed from container production areas between crops, if at all possible.

All cleaned surfaces should be washed with sanitizing agents such as Physan 20 or Greenshield (PT-2000) or other similar ma-

terials. Propagating knives and other toolsshould be dipped from time to time when harvesting cuttings. Watering hoses must be kept off the floor to reduceintroduction of pathogen inoculum onto the bench with the hose.

A common propagation medium for Ericaceae (particularly azalea) is a 1:1 mixture of fibrous light Sphagnum peat and coarse Perlite. Mixtures of aged pine bark and fibrous peat (6:4) are used widely for rhododendron cultivars. The percent air-filled pore space in rooting media should be as high as possible (25 to 35%). In a poorly aerated propagation medium (15 to 20%), large calluses are formed on rhododendron cuttings and root initiation is delayed.

If fine, rather than fibrous, peat is used, the air-filled pore space often is below 20%. This results in less rooting and more disease caused by stress pathogens. This is a very common problem encountered in propagation. Always use fibrous peat in propagation media!

Cuttings should be taken from plant parts free of soil, and stock plants must be treated with fungicides as described later.

Propagation Fungicide Schedule

The fungicide schedule used during propagation must be adjusted to the needs of the crop. On rhododendrons and azaleas, *Phytophthora, Cylindrocladium, Botryosphaeria,* and *Rhizoctonia* are the most important pathogens in Ohio. *Fusarium, Phomopsis,* and *Pestalotia* are minor pathogens but need to be controlled also to avoid infection of cut stem surfaces on cuttings. *Botrytis* also can cause problems, and Cercospora leafspot may be present as well. The surface of plants during propagation is continuously wet; therefore, fungicide treatments often have short-term effects.

To obtain effective control of this wide range of pathogens under these high disease-pressure conditions, broad spectrum fungicides must be applied on a preventive basis Some of the effective fungicides for Pythium and Phytophthora diseases include: Subdue MAXX, Chipco Aliette, Banrot, and Truban. Fungicides such as Domain, Topsin-M, Cleary's 3336 (thiophanate methyl),Ban -rot, and Terraclor are used for Botryosphaeria, Rhizoctonia, and Cylindrocladium.

Terraguard is an excellent fungicide for control of Thielaviopsis black root rot. Mancozeb (e.g., Dithane or Fore), Stature, chlorothalonil (Daconil Ultrex), Chipco 26019 and copper fungicides such as Kocide 2000, Champ DP, Champion WP, Camelot, Phyton 27, and Bordeaux mixture are excellent broad spectrum fungicides for control of leaf spots. These fungicides need to be applied weekly during mist propagation on crops such as rhododendron. Be sure to follow all instructions on the label. The best procedure is to alternate fungicides with different modes of action.

Control of Dieback

One principal objective of nursery production is to keep the cropping cycle as short as possible by providing high-fertility conditions. Therefore, plants in containers are maintained under conditions that make them highly prone to development of Phytophthora dieback throughout high-temperature growing seasons. This places more importance on disease management in nurseries through the use of fungicides, appropriate irrigation methods, and disease-suppressive container media. In and climates, plants dry quickly enough after irrigation to avoid infection by *Phytophthora* spp. on the foliage.

Proper management of irrigation is basic to disease management, especially for plants

produced in containers. Irrigation should be applied early in the day so that foliage dries quickly. Trickle irrigation is preferred for crops highly susceptible to Phytophthora dieback, because it keeps the foliage dry and avoids splash dispersal of pathogens. Flood irrigation should not be used because it can severely enhance the spread of Phytophthora root-rot pathogens in particular. Unfortunately, Ohio summers often are humid and high in temperature. Therefore, fungicide sprays may have to be applied frequently.

Phytophthora dieback and root-rot epidemics generally occur from early summer to early fall and mostly on container-grown stock when temperatures range from 75 to 95°F, particularly when the relative humidity is high. In some parts of the world, low-temperature Phytophthora diseases are active during mild winters as well. The authors have not isolated such *Phytophthora* spp. in Ohio. Sprays generally need to be applied thoroughly to all above-ground plant parts because all leaves, buds, and meristematic tissues protruding through resistant bark tissues on branches are susceptible.

Examples of fungicides that can provide effective control of dieback are mancozeb (e.g., Dithane M-45), Stature, chlorothalonil (e.g., Daconil Ultrex), and copper fungicides such as Kocide 2000, Champ DP, Champion WP, Camelot, Phyton 27, and Bordeaux mixture, in addition to fosetyl-Al (Chipco Aliette) and mefenoxam (Subdue MAXX). Subdue MAXX and Chipco Aliette are narrow-spectrum systemic fungicides. They should be applied once per month, but follow the label. Depending upon irrigation method, temperature, and rainfall, some fungicides may have to be applied weekly or even more frequently. Again follow labels precisely!

Other Dieback Diseases

During the spring, when covers are removed from houses, winter injury and other stresses, such as browning of leaves, become evident due to inadequate spacing of plants. Plants also break dormancy at that time, and *Botryosphaeria dothidea* becomes active. *B. dothidea* is a serious dieback pathogen that causes symptoms very similar to Phytophthora dieback. It is very difficult to control. The only totally effective control procedure is to avoid stress.

Botryosphaeria also infects plants affected by frost injury or sun scald. During the summer, it becomes active on plants severely affected by mite infestations. During propagation of cuttings, it becomes active after rooting, as new stem tissues develop. At this stage, spread of the disease can be controlled.

Inoculum of *Botryosphaeria* is present in cankers of many trees and shrubs. It spreads as airborne spores early in the spring. Chemical control is effective only if used on a preventive basis. The most active fungicides are the benzimidazoles (e.g., Domain, Topsin-M, Cleary's 3336-F). Sprays must be applied immediately after the damage has occurred. Plants such as rhododendron and *Pieris* do not recover once dieback symptoms have developed. Pruning of affected stems often does not prevent further decline.

Control of Root Rots

Cultural practices are very important for control of root rots. The most important factors are the container medium, the irrigation system (irrigation and pond systems, container base, etc.), and fungicide drenches.

Cultural Practices

The most widely used Phytophthora-suppressive container media are those amended with tree barks. Both composted

hardwood and pine barks suppress root rot caused by *Phytophthora cinnamomi*. Part of this effect is due to the improved aeration and drainage properties as compared to peat-sand container media. The percent air-filled pore space after saturation and drainage must be 25% or higher. The percolation rate must be greater than 0.5 inch per minute. Puddling on the surface of media must be avoided because it clearly enhances root rot. Containers should never be placed on plastic film because this allows *Phytophthora* to spread from pot to pot in puddles on the plastic.

Composted rice hulls, sewage sludges, cow manures, etc., also can be added to mixes. Most of these materials contain fine particles and therefore only small amounts can be added to mixes to avoid drainage problems. Composted sewage sludges and manures also may contain high levels of nutrients, and this is an advantage if the right amounts are used. Generally, it is best to incorporate 5 to 10% by volume of these materials in mixes containing 60% or more aged pine bark. These mixes supply adequate amounts of trace elements for one year after potting.

The container medium formulations presented here are examples of those that naturally suppress Phytophthora root rots. The quantity of lime added to the three media listed here varies with the quality of the irrigation water available at nurseries. It typically ranges from 3 to 8 lbs. per cubic yard of mix to maintain the pH within the range of 5.3 to 6.3. Micronutrients do not have to be added to mixes if composted biosolids or manures are included in the mix.

None of the control procedures described here are fully effective without the use of strict sanitation procedures during propagation and a proper layout in the container area. The base on which containers are placed should consist of gravel, stone, or well-drained sand. Covering such a base with the "plastic screen" mulches that control weeds but do not allow puddles to form is ideal. This is because propagules of pathogens present in abscised leaves, as well as pruning residues and other forms of crop infested residues, can be removed easily from this base before the next crop is introduced.

Water draining away from crops should be recycled to a primary settling pond. From there it should drain to a second pond from which irrigation water is pumped. Ponds should be cleaned out occasionally so that ample depth for settling remains. This approach is not totally effective, however. Phytophthora inoculum is disseminated in most irrigation systems used at nurseries. To control Phytophthora inoculum that is disseminated in these systems, nurseries can install a slow-sand filtration system for water that is used in the greenhouse production area of nurseries.

Some nurseries store water in two separate pond systems, each used for a particular container area. The second pond contains runoff from the first production area. The greatest potential for pathogen recirculation, therefore, is associated with the second system. Crops that are more resistant to Phytophthora root rots and salinity should be irrigated with water draining from the production area where susceptible plants are produced. It is important to monitor chlorides and salinity in water. They specifically increase root rot and can break down resistance in plants to these diseases.

Root Rot Fungicides

Chipco Aliette and Subdue MAXX are examples of fungicides that are very effective when applied as drench treatments for control of Phytophthora root rots. Follow the label for each crop.

Resistant Varieties

A large number of rhododendrons and azaleas have been screened for resistance to root rot and dieback. Varieties and species somewhat resistant to root rot were found. However, this resistance can be broken down under conditions of severe drought, high salinity, or other stress conditions. Furthermore, the most popular varieties are highly susceptible. Resistance to these diseases therefore typically is not a realistic control option.