ALABAMA A&M AND AUBURN UNIVERSITIES

ALABAMA COOPERATIVE Extension SYSTEM

ANR-571

Phytophthora Root Rot on Woody Ornamentals

Phytophthora root rot is the most damaging disease of many container- and field-grown woody ornamentals. Given favorable conditions, disease outbreaks may occur at almost any time during the production cycle as well as in landscape plantings. Rhododendrons are the most sensitive woody plants to this devastating disease. Complete losses of container-grown rhododendron to Phytophthora root rot have occasionally occurred. Serious losses have also been seen on ranges of container-grown Kurume azaleas and junipers (Figure 1). Other woody ornamentals that are hosts of Phytophthora root rot are listed in Table 1.

Symptoms

Phytophthora root rot greatly reduces the volume of the roots which are needed by the plant to absorb water and nutrients. The roots on diseased plants are brittle and brown to reddish-brown in color. A network of fine, discolored feeder roots may be confined to one area or include the entire root system. Then, the causal fungi usually colonize the crown of the diseased plants, often girdling the stem at or just above the soil line. A brown to reddish-brown discoloration of the tissues occurs just below the bark and may extend up the stem above the soil line. On some trees and large shrubs—such as dogwood—brown, water-soaked cankers oozing a dark-colored fluid or gum may develop at the soil line.

Symptoms vary according to the degree of root colonization by Phytophthora root rot fungi, plant age, plant susceptibility to root rot, and environmental stress. In both container areas and landscape beds, symptoms first appear on one plant and later on surrounding plants. Some yellowing of the foliage, particularly at the shoot tips, leaf shed, slowed plant growth, and possibly limb dieback may occur in early stages of the disease (Figure 2). However, it is not uncommon for liners or container-grown stock to remain almost symptomless until after transplanting into larger containers or landscape beds. On rhododendron, rolling of leaves is also an early symptom of root rot.

Figure 1. Severe Phytophthora root rot outbreak on Hino Crimson azalea

These symptoms, which can easily be overlooked, can easily be confused with those of a nutritional disorder, overwatering, drought stress, and a number of other factors. Slight yellowing of the leaves followed quickly by permanent wilting and plant death are the symptoms usually associated with Phytophthora root rot on container-grown Kurume azaleas and rhododendrons in Alabama. In landscapes, established plants may show symptoms of general decline for one or more years before succumbing to root rot, while newly planted azaleas will quickly die.

The foliage of azaleas and rhododendrons may also be invaded by some Phytophthora root rot fungi. Irregular blotches which are first olive-colored and later brown, sometimes with a red margin, develop on the leaves. Diseased leaves are usually shed by the plant. Damage usually appears on limbs near the base of the plant.

Disease Cycle

Phytophthora root rot is caused by several species of fungi in the genus *Phytophthora*. *Phytophthora cinnamomi* is usually credited with causing the greatest damage to container- and field-grown woody ornamentals. Several other *Phytophthora* species, including *P. parasitica, P. citricola,* and *P. cactorum*, are also known to attack woody plants, particularly azaleas and rhododendrons. *Phytophthora cryptogea* has been known to cause heavy damage on junipers in poorly drained landscape beds (Figure 3). Records of the Auburn University Plant Diagnostic Laboratory show that *P. parasitica* and *P. citricola* are the causal agents of Phytophthora root rot in Alabama (Figure 4).

Phytophthora root rot fungi are present in virtually every nursery in Alabama. These fungi are easily introduced into a nursery on anything from rooted cuttings to container stock, as well as by infested soil or potting media. In Alabama's mild climate, *Phytophthora* fungi survive as resting structures (chlamydospores and oospores) and mycelia in diseased roots, crowns, and other crop debris. The resting structures are released into the soil or potting media from infested crop debris and are readily spread from pot to pot throughout propagation and container production areas by soil and splashing or flowing water.

Spore production and release, as well as infection of the roots by *P. cinnamomi* generally occurs in warm (optimum 77 degrees to 82 degrees F.), water-saturated soils and potting media. Other *Phytophthora* fungi may be more active in cooler soils. Again, splashing and runoff water is often the primary means of pot-to-pot spread of *Phytophthora* spores. Recycled irrigation and runoff water

Figure 2. Phytophthora root rot on Hershey Red azaleas. Note the yellowing and wilting of the foliage of diseased plants.

Figure 3. Poor growth and discolored foliage typical of root rot damage on Blue Pacific juniper.

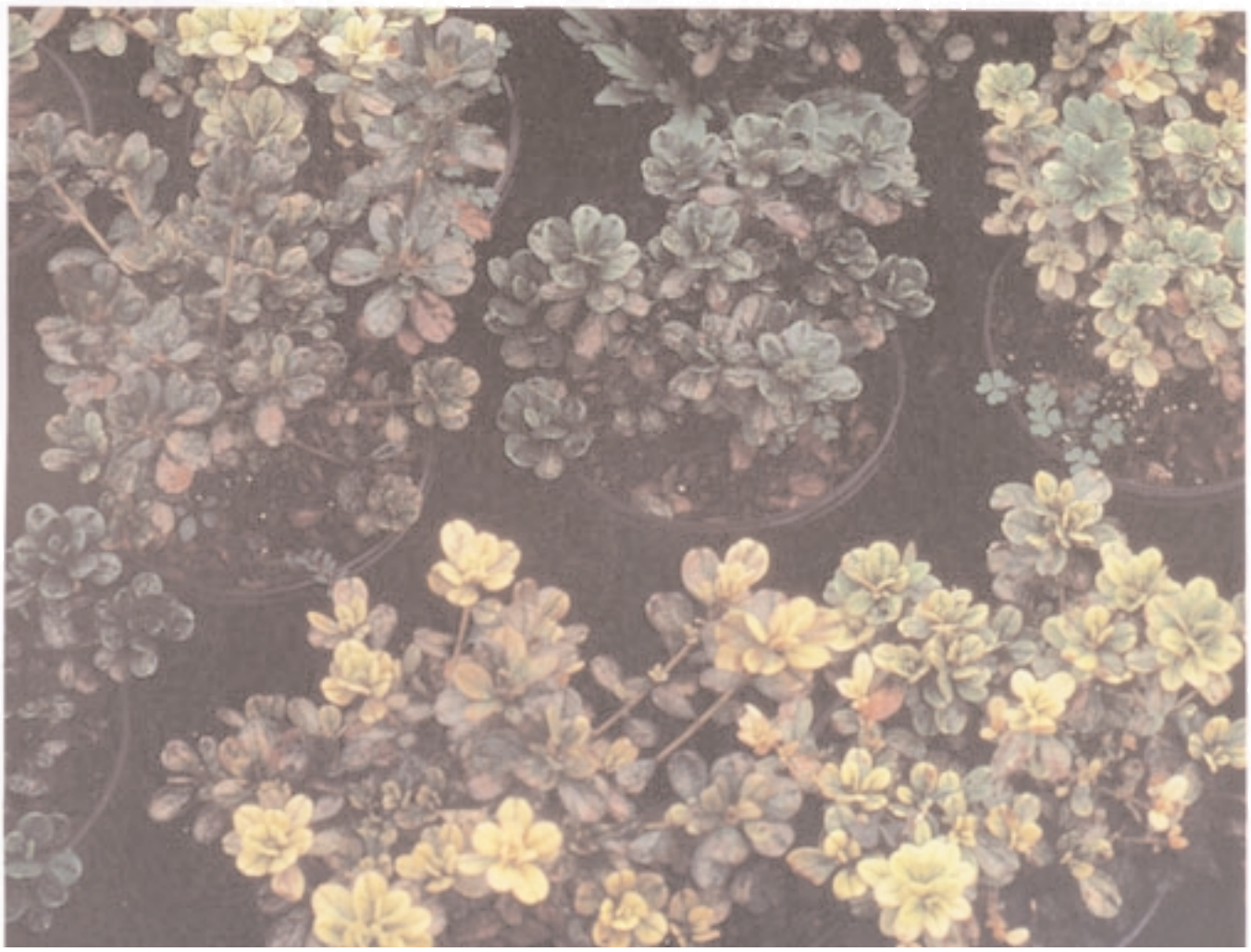

Figure 4. Unthrifty top growth and yellow leaves are also seen on some azalea cultivars.

has been implicated as a source of these fungi in rhododendron nurseries. The rate of disease development is closely tied to favorable soil moisture and temperature conditions for fungus activity.

Heaviest losses to root rot in most container production nurseries usually occur on flat, poorly drained beds where water is allowed to stand around container bases (Figure 5). Container stock that is grown in compacted, poorly drained potting media with little pore space is most likely to suffer from root rot. Overwatering in the nursery or landscape will also contribute to losses from the disease. Phytophthora root rot is most commonly seen in field production nurseries and landscape plantings on poorly drained, waterlogged soils that are prone to flood. Disease development is usually slow or absent on well-drained sites.

Low soil pH (3.5 to 4.5) will suppress spore release, thereby reducing disease. However, *Phytophthora* activity is not slowed at soil pHs most conducive to plant growth. Overfertilization with nitrogen can greatly increase susceptibility to this disease. Soft, succulent tissues produced in response to excess nitrogen are readily colonized by root rot fungi. Changes in the soluble salt levels in the potting media after heavy nitrogen fertilization may also increase *Phytophthora* activity, thereby encouraging disease development.

Control

Prevention is the key to controlling Phytophthora root rot in commercial nursery stock. Once symptoms start to appear, much of the damage has already been done. No single control measure will ensure protection from *Phytophthora*. Generally, several approaches must be directed at preventing the introduction and spread of these fungi and at preventing conditions favorable for disease development. These approaches include proper establishment and production practices, disease resistance (Tables 2 and 3), and chemical control (Table 4).

Figure 5. Flat, poorly drained container areas are often the site of the greatest root rot losses.

Establishment And Production

Propagation. Outbreaks of Phytophthora root rot in many nurseries can often be traced to contaminated potting media or diseased liners. Remove all debris from propagation and production areas before setting out the next liner or container crop. Annually treat or paint benches, flats, and other wooden items in propagation areas with 2-percent copper naphthenate or similar surface disinfectant. Components for container potting media should be stored on concrete pads to reduce contamination, and virgin, non-sterile soil must not be added to soil-less potting medium. Sterilization or pasteurization of soil or potting media in permanent propagation beds between each cutting crop is strongly recommended. Avoid reusing cell packs or containers unless they are first rinsed with water and then soaked in a disinfectant such as bleach or formaldehyde to kill any disease-causing fungi.

Cuttings for propagation should be taken from only disease-free stock plants. Pruning shears or knives should be cleaned with rubbing alcohol or a similar surface disinfectant after finishing with each stock plant. Wash off all soil and plant debris with a stream of water before lining out any cuttings. Stick cuttings in well-drained, soil-less media, preferably in new pots or cell packs. Place trays containing the cuttings on raised benches, a porous concrete pad, a thick layer of gravel, or similar coarse material (Figure 6). Do not put cutting trays on bare ground or soil covered just with black plastic.

Water Management. Container production areas should be crowned to speed water runoff and to prevent ponding around the base of the containers. Covering the crowned beds with black plastic or similar material along with a thick layer of gravel or oyster shells will greatly reduce the spread of *Phytophthora*. The drainage system should be designed to prevent runoff water from flooding container areas.

Stress caused by overwatering or lack of water can lead to increased root rot disease. Block plants by container size and water needs to prevent overwatering or underwatering. Be careful not to overwater container-grown deciduous trees and shrubs during the winter and early spring, particularly in areas likely to get heavy winter rains. Also, take daily rainfall into account when scheduling irrigation. Since root-rot resistance may be broken by drought stress, container-, field-, and landscape-grown plants should be watered as needed during periods of dry weather.

Phytophthora root rot fungi have been found in ponds receiving runoff from production beds. To reduce the chances of contamination of liner or container stock with root rot fungi, use either chlorinated, deep well, or quality surface water from a clean pond or stream. Ponds fed by runoff water from the nursery should not be used to irrigate liners or container plant material unless a chlorination-filtration system is installed.

Potting Media. Composted hardwood bark (red oak) and aged pine bark have been shown to reduce losses due to Phytophthora root rot on azaleas and rhododendrons. Composting hardwood bark releases chemicals that are toxic to Phytophthora root rot fungi. Improved drainage and microbial antagonists in bark compost also contribute to disease control. Disease suppression with pine bark is due largely to better drainage. The pH of pine bark media also affects disease. Far less disease occurs in pine bark at pH 4.5 than in bark at pH 6.5. To minimize disease losses, all potting media, regardless of composition, should have a high percolation rate throughout the production cycle as well as 20- to 30-percent air-filled pore space. Do not use fine silt, sand, clay particles, or other fine particulate material, which slows drainage, in potting media.

Landscape Beds. Plantings of azalea and rhododendron in nurseries and landscapes should also be established on crowned, raised beds. Incorporate pine bark or a similar coarse organic amendment to a depth of 6 to 8 inches to improve drainage. Flat planting of azaleas, rhododendrons, and other root rot-susceptible ornamentals is not recommended, particularly in poorly drained clay or clay-silt soils. Also, fertilize and lime according to soil test recommendations.

Disease Resistance

Azaleas and rhododendrons vary in their susceptibility to Phytophthora root rot (Figure 7). Among hardy azalea hybrid groups, the Indian, Glenn Dale, and Satsuki hybrids have better root-rot resistance than the more popular Kurume azaleas. In container nurseries, Kurume hybrids such as Hershey Red, Sherwood Red, Snow, Coral Bell, and Hino Crimson have suffered heavy Phytophthora root rot losses while nearby blocks of Indian and Satsuki (gumpo) hybrids were largely untouched by the disease. The reaction of many popular hybrid azaleas to Phytophthora root rot is listed in Table 2.

The majority of hybrid rhododendrons are very susceptible to root rot, with Boule de Neige, Lee's Dark Purple, and Purple Splendour being most sensitive to this disease. Resistant and moderately resis-

Figure 6. Container and liner production areas should be crowned and covered with a thick layer of gravel or similar material.

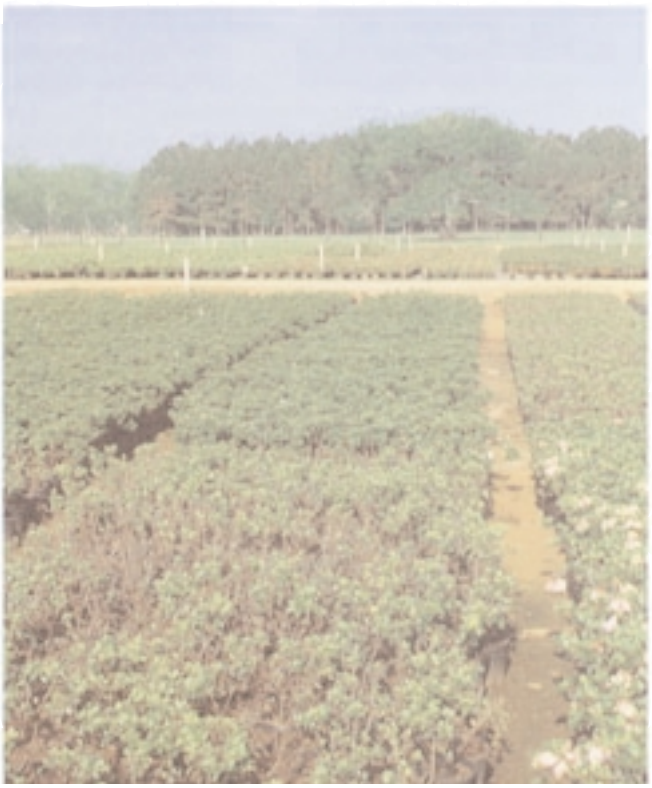

Figure 7. Azaleas differ in their susceptibility to root rot. Note the difference in root rot damage on the Kurume azalea cultivar (front) and Satsuki azalea cultivar (rear).

Table 1. Some Woody Plants That Are Susceptible To Phytophthora Root Rot.

Althea (Hibiscus)	Cotoneaster	Oak (various)
Apple	Dogwood	Pear
Arborvitae	Eleagnus	Pine
Azalea	Elm	Plum
Birch	Frazier Fir	Privet
Black Gum	Honeylocust	Rhododendron
Blueberry	Juniper	Sweet Gum
Boxwood	Lilac	Sycamore
Buckeye	Magnolia	Taxus
Cherry	Maple	Walnut
Chinese Chestnut	Mountain Laurel	Willow

Table 2. Reaction Of Hybrid Azalea Cultivars To Phytophthora Root Rot.

Resistant	Moderately Resistant	Susceptible
Formosa	Barbara Gail	Robinhood
Fakir	White Gumpo	Hershey Red
Corinne Murrah	Rentschler's Rose	Herbert
Merlin	Dorothy Gish	Fortune
Hampton Beauty	Pink Hiawatha	Catawba
Higasa	Margaret Douglas	Marian Lee
Glacier	Gaiety	Snow
Rose Greeley	Gloria	Royalty
Polar Seas	Kingfisher	Kwo-ko-ku
Redwing	White Christmas	Rosebud
Chimes	Sensation	Mrs. G. G. Gerbing
Alaska	Prince of Orange	Coral Bell
New White	White Jade	Treasure
Shin-ki-gen	Copperman	Pat Kraft
Rachel Cunningham	Hexe	Saint James
Pink Gumpo	Massasoit	Carror
Eikan	Martha Hitchcock	Purple Splendour
Sweetheart Supreme	China Seas	Pinocchio
Pink Supreme	Warbler	General MacArthur
Morning Glow	California Sunset	Pink Pearl
	Amaghasa	Johga
	Pride of Summerville	Sunglow
	Hinodegiri	Hino Crimson
	Flanders Field	Elaine
		Emily
		Pink Cloud
		Adelaide Pope
		Jane Spalding
		Sherwood Red
		Delaware Valley White

From: Benson, D. M., and F. D. Cochran. *Plant Disease* 64:214-215.

Table 3. Reaction Of Some Rhododendron Cultivars To Phytophthora Root Rot.

Resistant	
Caroline	Professor Hugo de Vries
Martha Isaacson	Red Head
Moderately Resistant	
Brickdust	Madame Carvalho
Broughtonii Aureum	Mrs. A. T. de la Mave
Disca	Mrs. C. B. Van Nes
Dr. A. Blok	Prize
Dr. Arnold W. Endtz	Bosely Dexter 1020
English Roseum	Rocket
Lucky Strike	Wilbrit
Van Veen	

From: Hoitink, H. A. J., and A. F. Schmithenner, 1974. *Plant Disease Reporter* 58:650-653.

Table 4. Suggested Fungicide Treatment Programs For Phytophthora Root Rot Control.

Fungicide	Rate	Re-treat after (months)	Comments
Potting and Transplanting Liners and Container Stock			
	per cu. yd.		
Aliette T/O Prodigy DG	8.0-12.8 oz.	1	**DRY SOIL MIX:** Use on well-rooted plants. Thoroughly incorporate into medium prior to planting or stepping up liners and container material. Begin drenches or sprays with recommended fungicide after potting plants.
Subdue GR	1.6 to 10 oz.	2-4	**DRY SOIL MIX FOR AZALEA AND RHODODENDRON:** Use on well-rooted plants. Thoroughly incorporate into medium prior to planting or stepping up liners and container material. Begin drenches or sprays with recommended fungicide after potting plants at interval specified.
	1.6 to 12.5 oz.	2-4	**DRY SOIL MIX FOR OTHER ORNAMENTALS:** See above comments. Do not plant euonymus in treated medium.
Banrot 8G	16 oz.	1	**DRY SOIL MIX:** Thoroughly incorporate into medium before planting. Use on well-rooted plants. Begin drenches no earlier than 1 month after potting. See product label for list of approved plants.
Truban 30W /Terrazole 35W	1.5-3 oz.	1	**DRY SOIL MIX:** Thoroughly incorporate into potting medium. Begin drenches or sprays with a recommended fungicide 1 to 3 months after potting plants.
Liner and Container Production			
	per 100 gallons		
Aliette T/O	6.4-12.8 oz.	1	**DRENCH:** Apply 0.5 to 1.5 pints solution per square foot or 100 gallons per 1000 square feet of drench or bed area. Repeat as needed but do not exceed one application every 30 days.
Prodigy DG	2.5-5 lb.	1	**FOLIAR SPRAY:** High product cost but offset by timely sprays and lower labor costs. Apply as needed but do not exceed one spray every 30 days. Do not add a wetting agent to spray solution.
Banol 67S	25 fl. oz.	3-4	**DRENCH:** Apply 1 pint solution per square foot of surface. For all woody ornamentals.
Subdue Maxx	0.6 to 1.25 fl. oz.	2-4	**DRENCH FOR AZALEA AND RHODODENDRON:** Use 1.5 to 2 pints solution per square foot for soil depth greater than 4 inches.
	1-2 fl. oz.	2-3	**DRENCH FOR OTHER WOODY ORNAMENTALS:** Do not apply to euonymus. Use 1.5 to 2 pints solution for soil depth greater than 4 inches.
Subdue 2X WSP	0.07 to 0.35 fl. oz.	2-3	**FOLIAR SPRAY FOR AZALEA AND RHODODENDRON:** Spray to run-off.
Banrot 40W	6-12 oz.	1-3	**DRENCH:** Use on well-rooted plants. Apply before watering. Use 0.5 pint. per 6-inch pot. Covers 400 square foot of bed or bench area or sufficient volume to set media or soil. Water immediately after application with at least one-half the drench rate. See label for list of approved plants.
Truban 30W /Terrazole 35W	3-10 oz.	1-3	**DRENCH:** Covers 400 square foot of bed area (0.5 pint per 6-inch pot). Irrigate immediately after treatment. Do not mix with other pesticides.
Truban 25E	4-8 fl. oz.	1-3	**DRENCH:** Covers 400 square foot of bed or bench area. Apply in sufficient volume to thoroughly wet media.
Field Production and Landscape*			
	per unit area		
Banrot 8G	8-12 lb./1,000 sq. ft. bed area	1	**POST-PLANT BROADCAST:** Apply with drop or cyclone spreader. See label for spreader settings. After application, rake-in or lightly cultivate.
	8-12 lb./1,000 sq. ft. bed area	1	**PRE-PLANT BROADCAST:** Apply with a cyclone or drop spreader. See label for spreader settings. Harrow or till upper 2 to 6 inches of soil prior to treatment.
Banrot 8G	6 oz.	1	**SIDE-DRESS ON FIELD STOCK:** Apply in 4- to 6-inch-deep furrow 8 to 10 inches on both sides of plant and then cover.
Truban 5G	4-6 oz./100 linear row ft.	1	**SIDE-DRESS ON FIELD STOCK:** Apply in 4- to 6-inch-deep furrow 8 to 10 inches from both sides of plant and then cover.
	6-8 lb./1,000 sq. ft. bed area	1	**BROADCAST:** Apply with cyclone or drop spreader. See label for spreader settings. Irrigate thoroughly after application.
Subdue GR	14-75 oz./1,000 sq. ft. bed area	2-4	**BROADCAST ON AZALEA:** Irrigate thoroughly after application.
	26-125 oz./1,000 sq. ft. bed area	2-4	**BROADCAST ON OTHER ORNAMENTALS:** Irrigate thoroughly after application.

*NOTE: Fungicides applied as drenches or foliar sprays in linear and container production also may be used in field nurseries and landscapes for the control of Phytophthora root rot.

tant hybrid rhododendrons are listed in Table 3. Among the *Rhododendron* species found in the nursery trade, *R. davidsoninaum* cv. Serenade, *R. delavayi*, and *R. poukhansnse* are resistant to root rot.

Junipers also differ in their sensitivity to Phytophthora root rot. Among the more susceptible are *Juniperus sabina* cv. Tamariscifolia, *J. chinensis* cv. Gold Coast, *J. scopulorum* cv. Wichita Blue, and *J. conferta* cv. Blue Pacific. Those with more root-rot resistance include *J. virginiana* cv. Prostrata, *J. chinensis* cv. Prostrata, and *J. horizontalis* cv. Bar Harbour and Prince of Wales. The disease is worse on junipers grown on poorly drained sites that are subject to flooding.

In landscape beds, replace plants killed by root rot with a disease resistant selection. If problems with Phytophthora root rot are anticipated on a particular site, establishment of root rot resistant plants is recommended. See Tables 2 and 3 for cultivars of Kurume azalea and rhododendron resistant to Phytophthora root rot. Other root rot resistant azaleas and juniper cultivars are described above. Other woody trees and shrubs resistant to this disease include ash, boxwood, California bay, California buckeye, cotoneaster, euonymous, linden, maidenhair tree, oleander, photinia, podocarpus, popular, tuliptree, and zelkova.

Chemical Control

Chemical control is successful only when combined with good nursery management practices. Fungicides act as a protective barrier around the root systems of healthy plants but will not kill the root rot fungi in root tissues. Best results have been obtained by scheduling fungicide applications from the time cuttings have rooted until the finished plants are shipped. A few, scattered applications of fungicides during the production cycle are likely to have little impact on the disease.

Fungicide drenches or foliar sprays on woody cuttings for root rot control should be delayed until the new roots start to appear. Use of fungicides may slow root initiation on freshly stuck cuttings.

Distribution of a fungicide throughout the potting media or soil is critical for root rot control. Prior to transplanting liners or container stock, incorporate a root rot fungicide into the potting media. Root rot fungicides may also be rototilled into the soil of landscape beds before planting root-rot susceptible woody shrubs. Incorporated fungicides, which are usually more uniformly distributed throughout the potting media or soil than those applied as a drench or spray, may give better protection to the roots of newly transplanted liners and container stock. Granular and wettable powder formulations of several fungicides may be added to potting media or the soil in landscape beds. Depending on the fungicide incorporated, start soil drenches from 1 to 4 months after establishment.

If a root rot fungicide was not added to the potting media, begin soil drenches or foliar sprays immediately after liners or container stock have been transplanted. Granular formulations of several root rot fungicides may be applied to field-grown woody ornamentals as a side-dress or broadcast treatment. Although these same fungicides may also be applied to landscape plantings, their routine use, except by commercial applicators or hobbyist breeders, is discouraged. To get better distribution of the fungicide throughout the potting media or soil, apply a drench or granular fungicide when the plants need to be watered. If necessary, water-in side-dress or broadcast applications of a granular fungicide. Depending on the root rot fungicide used, re-treat every 1 to 4 months. Soil drenches usually give better protection from root rot than foliar sprays, but routine treatments are costly in terms of labor and time.

Treatment schedules and application rates for a given fungicide will depend on the plant being grown and the level of disease pressure. Fungicides recommended for Phytophthora root rot control in container- and field-grown plants are listed in Table 4.

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