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ON DIVISION • VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY • BLACKSBURG, VIRGINIA 24061

PLANT DISEASE CONTROL NOTES

ORNAMENTAL AND FLOWER DISEASES

Revised July 1980 Control Series 90

PHYTOPHTHORA ROOT ROTS AND WILT OF WOODY ORNAMENTALS

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Root rot and wilt are symptoms of diseases caused by several species of the soil inhabiting water mold fungus, Phytophthora. In Virginia, Phytophthora cinnamomi, P. citricola, P. parasitica and P. cactorum are recovered from diseased plants. Many unrelated ornamentals including aucuba, forsythia, boxwood, dogwood, Pieris, Kalmia, heather, blueberry, Camellia, English and Japanese yew (Taxus), several species of heath (Erica sp.), Rhododendron, Japanese umbrella pine (Sciadopitys) and Eastern white pine have been found susceptible here or reported to be susceptible in other regions.

SYMPTOMS

On Rhododendron in early stages of disease, the symptoms consist of retarded growth, slight drooping of the foliage and "off-color" foliage (Fig. 1). Some broadleaf species wilt during the heat of the day and recover at night (Fig. 2). The roots on infected plants appear dark colored and die (Fig. 3). Dark streaks soon extend up into the wood of the lower stem (Fig. 4). The wilting on coniferous species in the field is less obvious, but is followed by yellowing and dieback (Fig. 5). Eastern white pine grown in containers show drooping of the upper branches. Among species of Taxus, newly infected tissue is lightly streaked with black.

FACTORS FAVORING DISEASE

Disease development is favored by high soil moisture and soil temperatures of 80°F (26.6°C) and above. Infected plants growing on

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Figure numbered 6 was provided by D. L. Coyier, Ornamental Plants Research Laboratory, USDA, SEA Corvallis, Oregon.

well-drained soils are generally not as seriously affected by the disease as those on poorly-drained soils. Plants do not recover from disease if the soil is maintained wet. The normal tendency is to apply more water when wilt appears. On well-drained soils, only feeder rootlets are rotted, but when the drainage is poor, the main stem becomes discolored and infected plants die.

Losses from this disease have increased with the increased use of containers for growing ornamentals, because the temperatures are higher in containers than in the field and over-watering frequently occurs. Container mixes frequently do not drain well. Losses in container plants are reported to be high where sawdust is used in the mix because poor drainage develops. Root rot occurs less frequently on plants grown in mixtures of materials with an air volume of 20-25%.

Phytophthora cinnamomi is common in soils of several different regions of the United States where Rhododendron, Taxus and azaleas are grown in the field. In the past, diseased plants have been purchased and brought into Virginia. These diseased plants appear healthy when received, but die from root rot when exposed to summer weather of high moisture and high temperature conditions. Feeder roots of such plants are commonly infected with Phytophthora, but not extensively enough to result in obvious foliage symptoms. Phytophthora cinnamomi has been spread in this fashion.

Root rot might be reduced by growing rhododendrons at a pH of 4.5-5.0. Unfortunately, at this pH, phosphorus is not sufficiently available for maximum plant growth. At the optimum pH of 5.5-6.5 for rhododendron growth, Phytophthora is not inhibited. Growing at a lower pH, even though it would minimize Phytophthora, root rot, would, therefore, not be a practical means of control for nursery production.

DISEASE PREVENTION IN PROPAGATION

1. Before sticking a new crop of cuttings, remove all old rooting media from the propagating benches and thoroughly clean all surfaces.

2. Propagate in raised benches to reduce the possibility of pathogen infestations originating from soil on the floor of the greenhouse.

3. Treat all unpainted woodwork, flats, baskets and greenhouse benches with a 2% copper naphthenate to eradicate plant pathogens from the surface of wood.

4. If all the plants are removed from the greenhouse, the interior can be disinfected with formaldehyde (1 part 37% solution in 50 parts of water). This treatment should be used at the beginning of the propagating season.

5. Spray the headhouse, under benches, painted woodwork and walkways in the propagating house with a solution of equal parts of LF-10® in 200 parts of water. (LF-10 is distributed by Lehn & Fink Product Corp., 4934 Lewis Avenue, Toledo, Ohio). Repeat this treatment at least once every 2 weeks. This disinfectant does not penetrate soil or organic matter. Soak or steam-sterilize all propagating tools such as knives in a commercial disinfectant. If a commercial disinfectant is not available, use household bleach containing sodium hypochlorite, such as Purex®, Clorox® or others, diluted 1 part of bleach in 9 parts of water.

6. Healthy stock plants used to grow cuttings should be sprayed with a fungicide such as maneb to protect against leaf and stem diseases. Avoid plants showing stem blight because Phytophthora may be present.

7. Steam sterilize propagating benches after filling with sterile rooting media and surface sterilize benches between each set of cuttings.

8. After the cuttings are rooted, ethazol (Truban® or Terrazole®) or Banrot® will help protect against water mold infection.

DISEASE PREVENTION IN CONTAINERS

Many ornamental plant growers have shifted from field growing to container production. Using various mixtures of organic and inorganic materials, most ornamentals can be grown successfully in metal cans, plastic containers or wooden boxes. The choice of growing medium selected often depends on past experience and the availability of porous materials. Frequently, peatmoss, pine bark or Perlite® are mixed with soil. If soil is included in the growing medium, it is important that before it is used the wilt-causing and root-rotting pathogens be eradicated with dry or aerated steam heat or non-selective fumigants like methyl bromide-chloropicrin mixtures or Vapam®.* Soilless mixtures will not ordinarily require pasteurization with heat or fumigation with chemicals if the constituents are not allowed to become infested with root rotting fungus pathogens during transportation or storage. Containers should be placed on well-drained sites and spaced apart, preferably on rock or gravel, so that surface water contaminated with Phytophthora zoospores cannot enter the container at the bottom or splash on the surface. Frequently, the growing areas are crowned to facilitate rapid runoff of water. Composted hard wood bark is reported to be inhibitory to Phytophthora. If the water used for irrigation of containers is recycled, water may become contaminated with zoospores of Phytophthora species. Chlorination of the water is reported to eliminate pathogens from the water. (Fig. 6).

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*Vapam is the trademark for the chemical that contains SMDC (sodium N-methyl dithiocarbamate).

DISEASE PREVENTION IN THE FIELD

Some growers have learned to reduce disease losses in heavy soils naturally infested with Phytophthora by growing plants on hills in rows or on well-drained, raised beds. A large percentage of plants grown in this fashion appear healthy when shipped, but quickly die from root rot when exposed to high moisture and high temperature conditions as that frequently exist under landscape conditions. Phytophthora cinnamomi is both soil- and water-borne and probably survives in decaying roots left in fields from which plants have been harvested. It is suspected that most of the field spread of Phytophthora results from movement of fungus zoospores in water.

Diseases caused by water mold fungi (Phytophthora and Pythium spp.) can be avoided by growing healthy plants on raised beds and having good sub-soil drainage. Frequently, fields to be planted to root rot susceptible shrubs are infested with water molds or other soil-borne fungi from previous crops. Therefore, preplant soil fumigation with methyl bromide-chloropicrin is suggested. The soil should be free of clods, loosened to a depth of 12" and in good seedbed condition. The soil temperature should be 50°F or higher at 6" depth with adequate moisture for seed germination. Methyl bromide is introduced as a gas under a gas-tight plastic sheeting over the area to be fumigated. The manufacturer's instruction on dosage rate and the aeration period needed prior to transplanting in the fumigated soil should be followed. It is important that the fumigant penetrates to the water table, which should be below the zone into which roots grow. A wet clay layer under peat beds is not penetrated by methyl bromide and allows spores of Phytophthora to survive.

Recontamination of methyl bromide fumigated fields, by Phytophthora and Pythium, may occur. Because the competitive soil-inhabiting microflora have been eliminated by fumigation, Phytophthora or Pythium can spread more rapidly when it re-enters wet fumigated soil. Zoospores of these fungi are attracted to plant roots and swim into the root zones, causing infection. Implements used in cultivation or land preparation can reinfest fumigated fields. Only healthy plants should be planted into fumigated fields. It is also possible that Phytophthora could be introduced into fields through an irrigation system that draws and recirculates water from a catch basin. Researchers have shown that plant pathogenic fungi can exist in irrigation ponds. Chlorination of the water will effectively eradicate pathogenic fungi.

In the home landscape, the planting site should be well-drained. The use of drain tiles to prevent rain water from collecting on the surface is suggested. Special care should be taken to see that plants are planted high so that the soil line is not more than one inch over the upper roots. Where subsoils are known to be poorly drained, planting on the top of the ground should be considered. After planting, the soil should not be mounded up around the stem, since this increases susceptibility to disease.

Chemical control of Phytophthora root rot in established plantings of Rhododendrons and azaleas is very difficult. However, the spread of the fungus to healthy plants adjacent to diseased plants may be checked by drenching the soil around the healthy plants with the fungicide ethazol (Truban® 30% WP or Terrazole® 35% WP) at a concentration of 8 oz. per 100 gallons of water spread on 400 square feet of soil surface. This is equal to 2 tablespoons per 10 gallons of water on 40 square feet of soil surface. Chemical penetration of the soil is improved if an additional amount of water equal to at least half the volume of the fungicide drench is applied. Retreat at 4-week intervals during the summer when environmental conditions are favorable for disease.

An alternate treatment is with diazoben (Lesan® 35% WP) at a concentration of 10 teaspoons per 5 gallons of water. This quantity is sufficient to treat an area of 20 square feet. Repeat applications are required at 7-10 day intervals throughout the normal growing season; failure of this may lead to disappointing results.

Where plants have died in the home landscape, remove all infested soil and infected roots from the location where the plant has died and replace with soil from an area where Rhododendron or other Ericaceous plants have not been grown. Replant the site with a non-ericaceous shrub to avoid disease.

RESISTANCE OF RHODODENDRON TO PHYTOPHTHORA CINNAMOMI

Under natural conditions in Virginia, many different hybrids have showed root rot symptoms. Laboratory culturing of these plants have shown that hybrids like 'Blue Ensign,' 'Blue Peter,' and 'Chinoides' are frequently infected. Hoitink and Schmitthenner of the Ohio Agricultural Experiment Station, Wooster, Ohio found under conditions of artificial inoculation in the greenhouse that many of the well known hybrids are susceptible (2). Some of the most susceptible were 'Boule de Neige', 'Lee's Dark Purple' and 'Purple Splendour'. They also reported that approximately 100 species were susceptible. Of these, R. carolinianum was one of the most susceptible. Resistance was shown to be based on the ability of the inoculated plant to regenerate new roots from the crown in well-drained superficial soil layers. Under the most severe conditions of high levels of fungus inoculum and growth media of less than 20% air volume, moderately resistant hybrids die from root rot.

HYBRIDS RESISTANT TO PHYTOPHTHORA CINNAMOMI	HYBRIDS MODERATELY RESISTANT TO PHYTOPHTHORA CINNAMOMI
Caroline	Brickdust
Martha Isaacson	Broughtonni Aureum
Pink Trumpet	Disca
Professor Hugo de Vries	Dr. A. Blok
Red Head	Dr. Arnold W. Endtz
	English Roseum (Grootendorst)

HYBRIDS MODERATELY RESISTANT TO PHYTOPHTHORA CINNAMOMI

Lucky Strike
Madame Carvalho
Mrs. A. T. de la Mare
Mr. C. B. Van Nes
Prize
Bosley's Dexter 1020
Rocket (Shammarello)
Wilbrit
Van Veen

SPECIES RESISTANT TO PHYTOPHTHORA CINNAMOMI

R. davidsonianum 'seranade'
R. delavayi
R. glomerulatum
R. hyperythrum
R. lapponicum
R. occidentale
R. pseudochrysanthum
R. poukhanense
R. quniquefolium
R. sanctum
R. simsii
R. websterianum

SPECIES MODERATELY RESISTANT TO PHYTOPHTHORA CINNAMOMI

R. aberconwayii
R. charitopes
R. ciliatum
R. hermitrichotum
R. nitens
R. oldhamii
R. ponticum I
R. ponticum II
R. racemosum
R. rigidum
R. schlippenbachii
R. shweliense
R. simiarum
R. spiciferum
R. yunnanense

Because of the genetic variability which exists among seedlings of a species, it would be possible to have a wide range of resistance within a species. There are several different species of *Phytophthora* capable of causing root rot of rhododendrons and these fungi may exist individually or in mixed populations. However, it was found that the resistance of 'English Roseum' to *P. cinnamomi* is also effective against the other pathogenic *Phytophthora* species.

RESISTANCE OF EVERGREEN HYBRID AZALEAS TO PHYTOPHTHORA CINNAMOMI

Under greenhouse conditions Benson found that the following azaleas, when artificially inoculated with *Phytophthora cinnamomi*, have a high or moderate degree of resistance to root rot (1). These plants

were grown under conditions designed to maintain the moisture in the containers near field capacity for 4 months.

RESISTANT	MODERATELY RESISTANT
Formosa	Barbara Gail
Fakir	White Gumpo
Corrine Murrah	Rentschler's Rose
Merlin	Dorothy Gish
Hampton Beauty	White Gish
Higasa	Pink Hiawatha
Glacier	Margaret Douglas
Rose Greely	Gaiety
Polar Seas	Gloria
Redwing	Kingfisher
Chimes	White Christmas
Alaska	Sensation
New White	Prince of Orange
Shin-ki-gen	White Jade
Rachel Cunningham	Copperman
Pink Gumpo	Hexe
Eikan	Massasoit
Sweetheart Supreme	Martha Hitchcock
Morning Glow	China Seas
	Warbler
	California Sunset
	Amaghasa
	Pride of Summerville
	Hinodegiri
	Flanders Field

Literature Cited

1. Benson, D. M. and F. D. Cochran. 1980. Resistance of evergreen hybrid azaleas to root rot caused by Phytophthora cinnamomi. Plant Dis. 64:214-215.

2. Hoitink, H. A. J. and A. F. Schmitthenner. 1975. Resistance of rhododendron species and hybrids to phytophthora root rot. American Rhododendron Society Bulletin 29:37-41.

Figure 1. Rhododendron wilt in the field, a symptom of Phytophthora root rot.

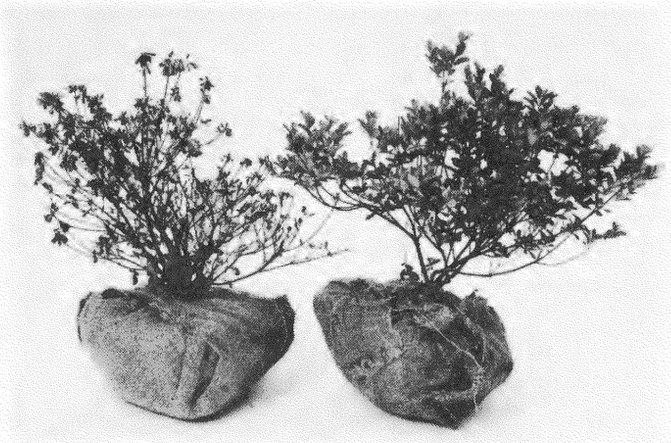

Figure 2. Azalea grown in the field with wilt symptoms on plant on left.

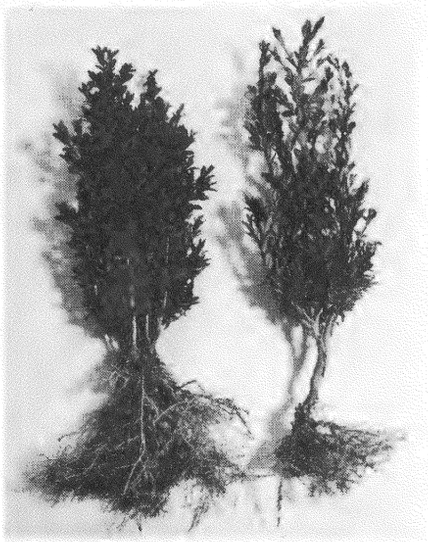

Figure 3. American boxwood grown in the field with diseased plant on the right showing dark roots and wilting of the top.

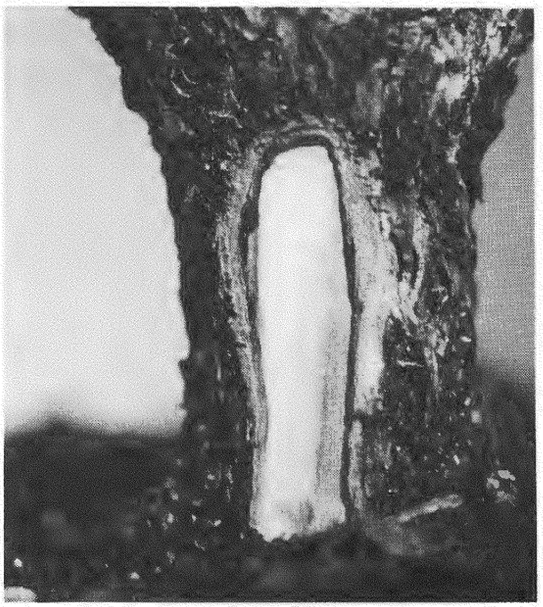

Figure 4. Rhododendron showing dark streaks in the wood near the ground line.

Figure 5. Taxus (yew) with diseased plant on the left showing dead roots and yellowing of the needles.

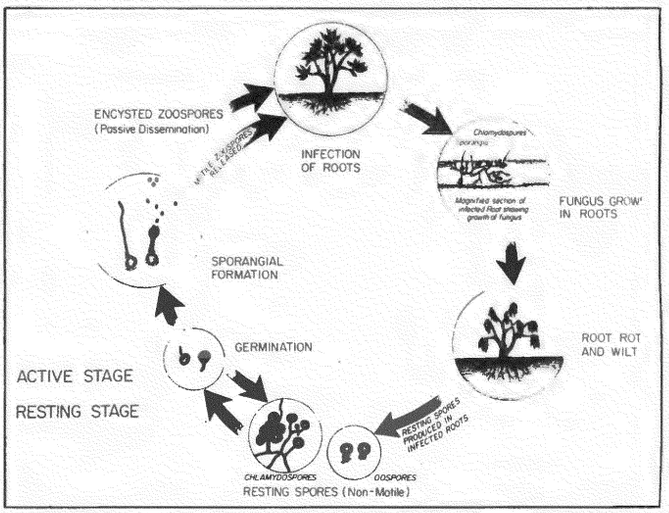

Figure 6. Life cycle of Phytophthora root rot of an ornamental.