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WHAT ABOUT *PHYTOPHTHORAS* IN THE PACFIC NORTHWEST?

There is no doubt in our minds that members of the genus *Phytophthora,* with which most nurserymen in the U. S. are familiar (at least in name), rank at or near the top of the list of our most serious pathogens. The most widespread of the *Phytophthoras. P. cinnamomi*, has been aptly called "the plant killer" because of its devastating impact on so many plant species of major economic and aesthetic significance. We point fearfully at the ravages of this killer fungus in the jarrah forests of Western Australia where it threatens to reduce vast forested areas to grassland. And, here at home in the Pacific Northwest, we have come to know too well what this fungus can do to our nursery stock. Since the first report of their occurrences in the Northwest, 30-40 years ago, the *Phytophthoras* have established themselves as major concerns in nursery production practices, and despite efforts to avoid them, the root rot and wilt disease caused by species of *Phytophthora* still are present in our nurseries (sometimes quite extensively).

Over the past several years, we have attempted to assess the amount of loss to these fungi which growers have experienced. We have found that losses vary from grower to grower and from year to year, but in most cases growers have not kept a close enough tally to be sure of loss percentages. However, based on the frequency of isolation in our two labs and impressions based on numerous conversations with growers and extension personnel, we are convinced that the *Phytophthoras* are nearly always a serious threat to nursery production in the Northwest. For this reason, we want to point out a few pertinent things about *Phytophthora,* which all growers should have well in mind.

THE DISEASE:

Phytophthora root rot, wilt, or decline infections begin on nursery stock as the fungus contacts susceptible roots. But because growing conditions in our nurseries are quite favorable for the plant, the root disease may not progress enough to cause foliar or top symptoms for some time. In fact, if the infection only begins in the middle of a 4-year production cycle, obvious wilt or decline symptoms may never occur before the plant is shipped. But the ultimate responsibility for the infection is the grower's, whether in the Pacific Northwest or elsewhere. Our job is to see that infected plants don't originate in the Pacific Northwest! Right now, we know that some of our stock is infected. During the last year, we have isolated *P. cinnamomi* from rhododendron, azalea, heather, juniper, andromeda, Douglas Fir, salal, and wild azalea, to mention a few. In most of these cases, the plants were either in a state of decline or had severe root rot and even

sudden wilt.

Our assessment of how the *Phytophthora* diseases occur is shown in the life cycle diagram in Figure 1. Most root infections on nursery plants probably begin either during or soon after rooting or the early liner stage. Depending on the amount or extent of the initial infection, temperature, availability of water, and environmental stress on the plant, the disease may progress at a moderate pace or rapidly. If the conditions favor the disease, top symptoms will probably occur within weeks or a few months. If the conditions are generally unfavorable for the disease (i.e., cool temperatures, well-drained soil, no environmental stresses on the plant), the plant may not show top symptoms for a long time, even years.

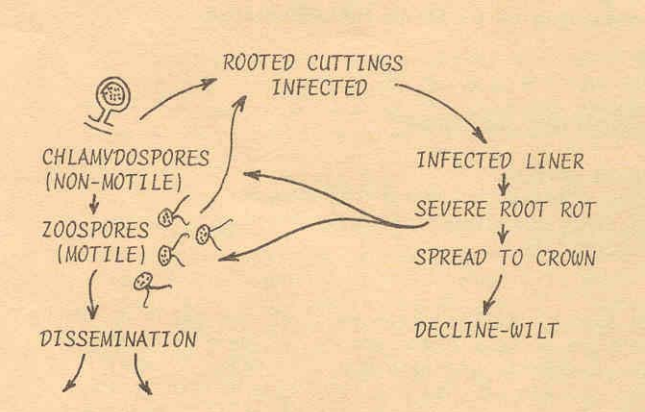

Figure 1. Life cycle of a typical Phytophthora disease.

The fungus life cycle begins as a chlamydospore (resting, thick-walled survival spore) in soil. When this spore germinates, the germ tube itself may contact, penetrate, and cause an infection in a susceptible root. More frequently, however, the chlamydospore germinates in the soil and immediately produces a sporangium from which swimming zoospores are released. These motile zoospores are attracted to susceptible roots, which they may then infect. Once a root has been infected by either means, the fungus grows in the cortex, but more important, it produces new sporangia on the root surface, which release a new swarm of zoospores to seek out and infect healthy roots. Thus the disease spreads within the root system. If these zoospores become encysted (no longer motile), they may be carried along passively in moving soil water to another adjacent plant, and thus the disease is spread from plant to plant. Run-off water from an infected plant area may drain into streams or irrigation ponds. Thus these waters may become contaminated with *Phytophthora* and logically should not be re-cycled back through the irrigation system onto susceptible plants.

Considering the ability of *Phytophthora* zoospores to spread in free waters (in soil or in run-off), one can see the advantage of maintaining good drainage around the plant roots. With good drainage, free water in the soil spaces is absent, and spread of *Phytophthora* by zoospores is minimized.

The final stage of the fungus life cycle is to form the resting stage again (chlamydospores). These spores form in infected roots and eventually slough off into the soil as free spores or root debris. The chlamydospores can thus rest in soil until a susceptible host root becomes available to start the infection cycle again.

SUGGESTIONS FOR CONTROL:

The thrust of any control recommendation on *Phytophthora* disease must be to avoid or prevent the disease from ever occurring, i.e., prevention. There are no fungicides available that will effectively eradicate the pathogen from infested roots (chemical therapy). Thus growers must focus their attention on sanitation practices in order to grow a healthy plant. In order to do this, one must eliminate all the potential sources of inoculum: growth media, cuttings, containers (or benches), water, tools, and most important, neighboring infected plants. If one considers that all the above are potential sources of *Phytophthora* inoculum, then he must take all necessary precautions to eliminate the organism from each.

DISEASE PREVENTION IN PROPAGATION:

1. The propagation area, benches, flats, and tools must be cleaned up (all debris and plant material must be removed) and treated with a disinfectant or steam.
2. The propagation medium should be made from fresh, sterile components, or, if re-used, it should be fumigated prior to sticking new cuttings.
3. Cuttings should be surface disinfected as necessary to be sure surface contaminates are removed. Taking clean cuttings from the upper portion of stock plants may be enough to insure that cuttings are not contaminated.

If the above precautions are taken, resultant rooted cuttings should be pathogen-free. If disease should occur in the propagation flats or beds, infected plants and medium should be removed. A buffer zone around an obvious infection center should also be removed as plants adjacent to infected symptomatic plants are probably also infected but symptomless.

DISEASE PREVENTION IN GROWING-ON BEDS OR CONTAINERS:

1. Benches should be disinfected prior to adding medium as in propagation.
2. Growth medium should be pathogen-free. If pathogens like *Phytophthora* are present in the medium (often a mixture of conifer bark or peat, soil and sand), then the medium should be treated by gas fumigation or steam.
3. Growth medium should be porous and well drained to avoid standing, free water in which the pathogen can spread.
4. Eliminate any plants (and neighboring plants) that show decline or wilt symptoms.

DISEASE PREVENTION IN THE FIELD:

1. Growers should give prime consideration to seeing that infected liner plants are not carried into clean fields**.**
2. Fields should be cultivated and prepared to give maximum drainage away from the root ball. This may be accomplished in part by incorporating amendments to improve drainage and by planting on raised beds. Avoid low, poorly drained areas. Drainage tiles may help.
3. Do not irrigate from ponds that collect run-off water from production fields or stock blocks.
4. Place field containers on gravel (not plastic) so that drainage from one container does not wash to another, carrying the pathogen spores.

5. Remove (and destroy) infected plants as detected by decline or wilt symptoms. Also remove as much of the root system as possible. Remember that the infected roots will contain chlamydospores as residual inoculum to start the disease over again.
6. If a field becomes or is already infected with *Phytophthora*, and the grower wants to grow a susceptible host in the field, there is no known alternative to gas fumigation of the soil. However, the hazards of fumigation (not to mention the cost) are that the elimination of the pathogen may not be complete, or if initially complete, the fumigated soil may be re-invaded from adjacent sources of contamination. When all the organisms in the soil are killed, as by fumigation, the soil becomes a biological vacuum devoid of organisms capable of competing with or otherwise inhibiting the pathogen. Frequently the disease incidence in fumigated soils where the pathogen was not completely eliminated is more severe than in non-fumigated fields.

ON THE HORIZON:

We believe it is possible to commercially grow species of ornamental plants that are susceptible to *Phytophthora* in the Pacific Northwest. If the guidelines mentioned are followed, the product will be a premium, healthy plant. There are still some loopholes, however, which we hope research efforts will fill. For example, the whole production scheme described above depends on : a) reliable means of eradicating *Phytophthora* from all production stages, and, b) reliable means of detecting the pathogen in soil and in infected plant tissue in time to take corrective action. We need, also, to develop a better understanding of the microbial ecology of *Phytophthora* in soil with the hope of eventually understanding and taking advantage of natural or biological means of controlling these devastating pathogens.
