Management of Phytophthora Root Rot in Conifer Nurseries of the Pacific Northwest

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Various cultural and chemical strategies to reduce the incidence and severity of phytophthora root rot on conifers in bareroot nurseries are discussed. Tree Planters' Notes 38(4) :37-.40;1987.

Phytophthora root rot has caused locally severe losses in many species of conifer and hardwood seedlings throughout the United States. Management of phytophthora root rot can be approached culturally and chemically. Both methods give some control of the disease. The best strategy is to use good cultural practices and supplement, when needed, with fungicides and fumigants.

Cultural Management

Cultural practices that discourage the development of phytophthora root rot include good water management, sanitation, and use of tolerant or resistant species in areas where phytophthora root rot is or may be a problem.

Water management. Because the development and spread of phytophthora root rot is very dependent on high soil moisture and water movement, management of water in the nursery is integral to controlling the disease. Good water management often involves the following practices:

1. Ideally, your nursery should be located on light, well drained soil; realistically, very few nurseries in the Pacific Northwest have the good fortune to be situated on light-textured soils.
2. Those nurseries with heavy, slow-percolating soils must add drainage systems. Sub surface drainage systems are common in Pacific Northwest nurseries; some were in stalled at the very onset when the area was initially developed and some were in stalled years later after the field has grown numerous crops.
3. Drainage of surface water from nursery beds and onto roads or ditches can be enhanced by crowning fields and ensuring that all bed areas slope downwards to wards roads or ditches.
4. Beds can be raised above the level of the tractor paths to allow water to run from beds into paths. When paths be come compacted or beds are not raised, tractor paths can be "subsoiled" to allow water to drain into the cut made by the subsoiler. Several) Pacific Northwest nurseries routinely subsoil 1-year-old fields in the fall before the onset of rainy weather. Similarly, wrenching will enhance drainage in the bed itself.
5. Low, poorly drained areas in fields should be noted, and after the crop is lifted, these areas can be filled in or taken out of production until corrective work can be done in them.
6. Irrigation practices often influence the development of phytophthora root rot. Watering needs should be coordinated to avoid constant saturation of soils, particularly during the spring, summer, and fall when the fungus is active. Irrigation for cooling, pesticide application, or following fertilization should coincide as much as possible with routine irrigation. Over-irrigation and alternating drying and saturation should be avoided, particularly in areas known to be infested with the fungus.

Sanitation. Sanitation practices are a vital part of the management of any disease. Phytophthora root rot is no different. Diseased seedlings should be removed from nursery beds and disposed of, particularly if you do not plan to fumigate before planting the next

Paper presented at the Western Forest Nursery Council Meeting, Tumwater, Washington, August 1215, 1986.

crop. Rogued seedlings and packing house culls should not be returned to the fields as organic matter.

Resting spores are able to survive in dead plant tissue and could serve as a source of infection if left in the field. Even composted culls are suspect. I believe that composting will not kill 100% of *Phytophthora* spp. inoculum in seedling tissue; various fungi, including *Pythium* (closely related to the genus *Phytophthora),* have been recovered from seedlings composted for over 1 year (2).

Diseased seedlings and seedlings from diseased areas of a nursery should not be moved to other nurseries or to "clean" fields within the same nursery. Moving diseased stock will introduce the disease, and once there, it is extremely difficult, if not impossible, to get rid of. Also, additional species of *Phytophthora,* not present previously, could be introduced into a nursery by contaminated stock.

Similarly, equipment that has been in diseased fields should be washed free of soil to prevent contamination of the next field it enters. This is very important for nurseries that borrow or trade equipment.

Resistance. Tree species vary in their susceptibility to phytophthora root rot. True firs, western and mountain hemlock, and Douglas-fir are very susceptible to *Phytophthora* species found in Pacific Northwest nurseries. Pine species, spruce, larch, and incense cedar are moderately susceptible. Western redcedar is resistant. These groupings are based both on field observations and greenhouse pathogenicity tests.

In areas of your nursery that are poorly drained, prone to flooding, or where phytophthora root rot was present in the previous crop, resistant or tolerant species should be sown or transplanted. Very susceptible species should be planted in areas that are well-drained, and if possible, have not had a history of phytophthora root rot.

Chemical Management

Various fumigants and fungicides are available to control phytophthora root rot.

Fumigants. Fumigants are volatile liquids, gases, or granular pesticides used to treat fallow soil before sowing or transplanting. The fumigants methyl bromide + chloropicrin, metam sodium, and dazomet will reduce soil populations of *Phytophthora* spp. when used correctly. For nurseries with widespread, continuous problems with phytophthora root rot and other soildborne diseases, fumigants are an efficient and effective way to reduce disease levels.

Phytophthora root rot can occur in fumigated fields, however, if the fungus is reintroduced. The fungus can be reintroduced by transplantation of diseased stock, irrigation with contaminated water, or movement of contaminated soil during flooding or on equipment.

Fungicides. A number of fungicides are registered for use on conifer seedlings for control of *Phytophthora* and *Pythium* species:

1. metalaxyl (e.g., Subdue®, a product of Ciba Geigy),
2. phosethyl Al (e.g., Aliette®, a product of Rhone-Poulenc),
3. propamocarb hydrochloride (e.g., Banol® a product of Nor-Am Chemical Co.)
4. fenaminosulf (e.g., Lesan®, a product of Mobay),
5. ethazole-methyl thiophanate (e.g., Banrot®, a product of Mallinckrodt).

Fungicides should be used to supplement cultural practices. They should not be depended upon to protect or cure seedlings, especially those that are growing in an environment that promotes diseases, such as a wet, poorly drained field.

We have sufficient data and experience to demonstrate the effectiveness of metalaxyl. The other fungicides have been used with success on other crops, but we have not yet been able to show their effectiveness on conifers against *Phytophthora* spp.

There are several reasons for this: There have been relatively few field trials in conifer nurseries in which the intensity of the disease has been high enough to conduct a meaningful test. In addition, application techniques and timing, particularly with new products such as Aliette, have not been optimal, so that the full potential of the fungicide has not been seen.

Metalaxyl is a systemic material that is taken up by the roots and moved acropetally (upwards and outwards) in the plant. It can be applied as a liquid onto the foliage and then watered into the root zone (Subdue 2E) or it can be incorporated as granules into the soil or onto the surface of the soil, with release of the product occurring after watering (Subdue 5G).

Once in the plant, metalaxyl inhibits further development of *Phytophthora* so that the progression of the disease is halted. The fungus is not eradicated from the seedling, however. The consequences of non-eradication can be either minimal, such as when you outplant a treated but infected seedling into a dry, well drained forest environment, or quite severe, such as when you transplant a treated, but infected, seedling into a poorly drained portion of another nursery.

Metalaxyl should be used sparingly and thoughtfully, because strains of *Phytophthora* that are tolerant to metalaxyl can become predominant in soils that have received repeated frequent applications of the fungicide. Repeated use can also result in decreased effectiveness because of the build-up of soil microbes capable, of degrading metalaxyl. Highly susceptible seedling species in high-risk areas (areas that are poorly drained, prone to flooding, or that have had disease in the previous crop) should have the first priority for treatment.

One well-timed application of metalaxyl per year can adequately control phytophthora root rot in most cases. Several applications in 1 year will give increasingly more benefit with each additional application cost (3). Application in the fall or spring prior to the development of symptoms will be the most effective. Timing of fungicide applications, as well as cultural activities, are discussed in detail by Cooley et al. (1).

Chlorination. In some locations, water supplies that are used for irrigation are contaminated with *Phytophthora* spp. Inoculum in the water can be eliminated or reduced to nondamaging levels by chlorination of the water before it enters the irrigation lines. We are still learning to adequately measure and interpret chlorine levels; for example, How much chlorine gas needs to be added to get 5 ppm free chlorine? How much free chlorine is required to reduce *Phytophthora spp.* to undetectable levels in the water? Other factors, such as pH and the amount of organic material in the water, will also affect how chlorine reacts and how much is needed to kill propagules of *Phytophthora* species.

Some sources of water are more likely than others to become contaminated with *Phytophthora* species. Well-water and municipal water are probably more disease-free than water from open canals and agricultural districts. To determine if your water source is contaminated, *Phytophthora* spp. can be detected by "baiting," that is, placing unripe fruit (apples or pears) in the water. Spores of the fungus are attracted to the fruit and will enter it and cause decay. The fungus can then be isolated from the decayed tissue on a petri plate and identified by a plant pathologist.

In conclusion, I would urge all of you who have experienced phytophthora root rot in your nursery to keep at your drainage problems, continue to upgrade your field topography, be conscientious about coordinating your water uses, and keep good histories of your fields so that you can plan where to sow or transplant your susceptible species. I urge you not to depend on fungicides; they are for emergencies, for marginal situations, not for routine applications. Fortunately, because *Phytophthora* species are very dependent on their environment, they can be very easily controlled with good cultural practices.

References

1. Cooley, S.J.; Hamm, P.B.; Hansen, E.M. Management guide to phytophthora root rot in bareroot conifer nurseries of the Pacific Northwest. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest management; 1985.
2. Cooley, S.J. Unpublished data.
3. Hamm, P.B.; Cooley, S.J.; Hansen, E.M. Response of Douglas-fir and *Phytophthora* spp. to metalaxyl in forest tree nurseries in the Pacific Northwest. Plant Disease 68:671-673.