Diseases Associated With Containerized Seedling Soil Mixes

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Although most peat-vermiculite mixes are relatively pathogen free, disease organisms can be introduced into containers on seed and plant debris or in irrigation water. Major root pathogens of containerized conifers include species of Fusarium, Pythium, *and* Phytophthora. Fusarium *spp. are the most common and produce several different signs of disease, including stunting, chlorosis, and needle tip dieback, and well as killing some seedlings. Composted tree bark included in the medium will suppress many pathogenic fungi.*

Production of containerized conifer seedlings by northern Rocky Mountain nurseries is increasing, and as it does so, associated disease problems have become more important. The most serious diseases of containerized seedlings are foliage and stem blights (24). Foliage pathogens spread rapidly, and environmental conditions within greenhouses are often ideal for infection and buildup of pathogens (2, 25).

Damping-off and root diseases may also be important in container operations. Most root pathogens are probably introduced either on contaminated seed or from infected plant debris within or adjacent to greenhouses (1, 9, 14, 17). In general, most container soil mixes are relatively pathogen free (25). However, some growers have used soil mixes containing sufficient pathogen populations to cause disease.

Most soil mixes for containerized conifers contain vermiculite or perlite incorporated with sphagnum peat. This type of mix is usually well drained and acidic, two factors that help reduce diseases (11, 20). Peat-vermiculite mixes are also lightweight, uniform in composition, relatively inexpensive, and readily available; they have high water-holding capacity and their acidic nature is conducive to growing conifers (20). Soil mixes with a pH of 4.5 to 6.0 are best for proper growth of seedlings and reduced incidence of disease (16).

Diseases

Major groups of pathogens associated with root diseases of containerized seedlings are species of *Fusarium* and water molds such as *Pythium* and *Phytophthora* (18). Although water molds may be seedborne (10), they are more often introduced into container nurseries through contaminated irrigation water (17). These fungi cause disease on very young seedlings and are favored by poorly drained soil mixes and prolonged wet conditions within greenhouses.

Root diseases associated with *Fusarium* are usually more common than those associated with *Pythium* or *Phytophthora*. These fungi may colonize seeds (7, 9, 19), either causing damping-off shortly after seedlings emerge or killing older seedlings. Several species of *Fusarium* are important causes of root disease of containerized conifers. These include *F. oxysporum* Schlecht. (7, 9), *F. solani* (Mart.) Sacc (7), and *F. moniliforme* Sheld. (17). These pathogens may cause chlorosis (11), stunting (22, 25), and needle tip dieback (8), as well as seedling mortality. *Fusarium* often produces spores on structures called sporodochia at the base of infected seedlings (22). These spores may spread to nearby seedlings and cause infection during watering (19). *Fusarium* may occur within peat-vermiculite mixes (8), but disease development is usually restricted if the mix is acidic (pH less than 6.0).

Disease Control

Root diseases in containerized conifer nurseries are usually sporadic, cause little damage, and do not require specific control measures. However, if disease levels are high, several procedures can help reduce losses.

Seeds should be as free of pathogens as possible. Seeds collected directly from the tree are usually less contaminated than seeds collected from the ground or squirrel caches (24). Seeds can easily be treated before sowing

to remove surface-contaminating fungi. A continuous tap water rinse for 48 hours is usually effective in removing most seedcoat fungi (7, 20). Seeds can also be treated with hydrogen peroxide or fungicides, although some effects on germination may occur (7, 24, 25).

Greenhouses should be kept clean to reduce damage from all diseases. Plant debris should be removed periodically, and benches and walls sterilized between crops (25). Diseased seedlings should be removed as soon as they are discovered (11). A noncontaminated water supply is also important (9, 17).

Soil mixes suspected of containing high populations of pathogens should be treated to reduce or eliminate these pathogens. Chemicals used to sterilize soil mixes include formaldehyde, chloropicrin, methyl bromide, and metham (Vapam) (20). The most widely used system of soil mix sterilization is heating with steam to about 82 °C (180 °F) for 30 minutes (2, 4). This will kill most harmful bacteria, fungi, nematodes, insects, and weed seeds. *Fusarium* species are killed at even lower temperatures (57 °C or 135 °F) (4). The treated soil mix should be placed in containers and handled as little as possible to reduce chances for reinfestation by pathogens (2).

Fungicides applied after root disease symptoms appear may not always be effective (24). Fungicides added to soil mixes may retard seedling growth (25). If fungicides are to be used, they should be applied as a drench immediately after sowing (19). Benomyl may control *Fusarium* and ETMT (Truban) may control *Pythium*. However, because of their uncertain effectiveness, fungicides should only be used when other control measures fail.

Another approach to controlling root diseases of containerized plants is to use composted tree bark in the soil mix. Composted bark has replaced peat in soil mixes for several ornamental species grown in containers (5). One of the major advantages of composted tree bark is that it suppresses several important plant pathogens, including *Phytophthora* (6, 22, 23), *Fusarium* (21), and *Rhizoctonia* (12, 13).

Composting is a process of partially decomposing conifer or hardwood bark to produce a more absorptive, uniform material. The process includes a thermophilic phase, during which high temperatures (40 to 80 °C) kill most organisms, and a stabilization phase, during which the rate of decomposition decreases, temperatures decline, and microorganisms, some of which are antagonistic to plant pathogens, recolonize the compost (5). Most growers use a 4:1 (v/v) mixture of bark and peat as the organic component of the soil mix. This ratio results in almost complete suppression of root diseases without the need for sterilizing the soil mix or applying fungicide.

There are three major mechanisms of root pathogen suppression from composted bark. Bark particles are generally coarser than peat, resulting in improved aeration, which is less conducive to disease occurrence (5). Composted bark supports high levels of antagonistic organisms, whereas peat does not (13). Also, water extracts from composted bark have fungicidal properties (6, 12). Composted tree bark has been used effectively in soil mixes to control plant pathogens in several ornamental plant industries. This approach should also be considered in containerized conifer seedling operations.

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