35. Gray Mold

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Hosts

Gray mold is caused by the fungus *Botrytis cinerea*. Hundreds of woody and herbaceous species are affected. Spruce, redwood, giant sequoia, hemlock, larch, and Douglas-fir are all very susceptible. Container seedlings, bareroot seedlings grown at relatively high densities, and seedlings with some dieback (lower needle dieback or tissue damage caused by frost or other factors) are especially prone to infection.

Distribution

Botrytis cinerea is present in temperate regions worldwide.

Damage

Botrytis primarily affects needle tissue. Under heavy infection, it can penetrate stem tissues and kill the seedling. Roots tend to be unaffected while in the bareroot bed or in a container; however, after removal from the bed or container and placement in storage, roots can also be susceptible. Damage can occur in patches or can cause significant mortality in highly susceptible plants. Cold storage (at or above 0 °C, 32 ºF) for longer than 2 weeks increases the risk of gray mold developing at damaging levels. *Botrytis* growth is inhibited in freezer storage (below 0 °C, 32 ºF).

If less than 25 percent of the needles are damaged and no damage is observed on the stem, affected seedlings will often survive and grow well after outplanting where warmer, drier, aerated conditions are inhospitable to the mold. Seedlings with 25 to 75 percent needle loss and no stem damage may also survive in favorable outplanting environments but could have stunted growth in the first 1 to 2 years because of the reduced photosynthetic area. Seedlings with stem damage or a musty or pungent odor, regardless of the amount of gray mold present, are likely compromised and should be discarded.

Diagnosis

Symptoms usually occur in late summer and early fall but can arise year-round under favorable conditions in the nursery or in storage. *Botrytis* appears as a grayish-brown mold (mycelium), often on the lowermost foliage (fig. 35.1). Development of the mold leads to foliage discoloration and death (fig. 35.2). Microscopic fruiting bodies develop on infected seedlings and release puffs of spores when agitated (fig. 35.3). As the disease builds on dead needle tissue, it can spread into healthy shoots and into the stem, causing bark sloughing, cankering, and girdling.

Biology

Botrytis is a common saprophyte in forest nurseries. It can tolerate a wide temperature range (0 to 26 °C, 32 to 78 ºF) with optimal development at 20 to 24 °C (68 to 75 ºF). Inoculum usually originates from dead organic matter in or around the nursery and from senescent needles on the seedling shoot. *Botrytis* spores spread by air, water, and insects and can build to epidemic levels in a short time. The spores require free water to germinate. Under moist conditions, gray mold can spread vegetatively throughout the shoot

Figure 35.1—*Development of gray mold on lower foliage of stored Douglas-fir seedlings.* Photo by Diane L. Haase, USDA Forest Service.

Figure 35.2—*Extensive gray mold on foliage of containerized Engelmann spruce seedling.* Photo from USDA Forest Service Archive, at http://www.bugwood.org.

Figure 35.3—Botrytis cinerea *sporulating on Scots pine needles.* Photo by Petr Kapitola, State Phytosanitary Administration, Czechia, at http://www.bugwood.org.

and onto adjacent seedlings, especially with dense foliage conditions (such as tight spacing or after seedling canopy closure in late summer). In storage, dark, moist conditions and stagnant air further favor gray mold development.

Control

Cultural

Gray mold is best controlled by minimizing conditions that favor this disease. It is essential to keep the seedling canopy dry and well aerated. Humidity can be controlled in greenhouses with proper ventilation and spacing among plants. Irrigation can be applied in early morning to ensure foliage dries during the day. Nursery sanitation is critical. Removal of diseased seedlings and dead or dying organic matter (culls, weeds, etc.) minimizes sporulation of the pathogen. Storage units should be kept clean, cool, and well ventilated. In addition, minimizing cold storage duration and outplanting seedlots with incipient molding as soon as possible can greatly reduce or eliminate the impact of gray mold.

Chemical

Many fungicides are effective in gray mold control, most need direct contact with the affected material. Few are limited to use during specific life stages of the plant or fungus. It is important to rotate among at least three different chemical families to reduce the risk of the pathogen developing fungicide resistance. In greenhouses, applications should begin when the canopy closes and lower lying foliage reduces drying and air circulation, and should continue depending on species susceptibility or disease incidence until seedlings are hardened off. When applying to dense foliage, irrigation pressure and application rate should enable adequate canopy penetration. Application intervals should be 1 to 4 weeks, depending on species susceptibility or disease incidence. In bareroot nurseries, fungicides are applied as a gray mold preventative for highly susceptible species such as redwood or sequoia; otherwise, applications are made after the fungus is present, especially in high-density crops.

Biological

Application of beneficial bacteria (for example, *Streptomyces griseoviridis*) or fungi (for example, *Trichoderma* or *Gliocladium* species) have been shown to suppress incidence of *Botrytis* in forest nurseries.

Selected References

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