CHAPTER SEVEN

Seed Fungi

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Several different species of fungi are associated with conifer seed. Early studies linked declines in germination in conifer seedlots to high levels of seedborne mold fungi. However, such occurrences are sporadic and hard to predict. Cone handling and storage practices after harvest affect levels of seedborne fungi significantly.

Seedborne fungi also contribute to outbreaks of Fusarium and Sirococcus diseases in container and bareroot conifer nurseries. These problems are covered elsewhere in this book.

Fungi and hosts

Seedborne fungi (Figure 7-1) are very common in conifers and other plant species. The literature contains numerous references to fungi isolated from cone integuments (bracts and scales), seed coats, and embryos. The seedborne fungi of Douglas-fir and ponderosa pine have been studied more thoroughly than those of other Pacific Northwest timber species. Some of the more common fungi are listed in Table 7-1 on page 24.

Fungus biology

The process through which fungi become established on Douglas-fir seed has been well documented. Less information is available for other tree species, but similar circumstances surrounding the buildup of inoculum on cones and its subsequent transfer to seed can be inferred. Fungal infection of seed before the ripening of the cones appears to be minimal. Exterior portions of the cone may have a high degree of fungal association, even though interior infection levels may be low. The loose association of the inoculum with the cone surface strongly suggests that airborne spores are deposited there.

Once spores are deposited on seeds in open ripe cones or transferred from cone surfaces to the seed, they remain on the seed in a dormant state until environmental conditions are conducive to their germination. The opportunity for spores to germinate and infect seed can occur many times between cone harvest and sowing of seed, such as in cone bags when humidity and temperature build up or during stratification when seeds are kept moist. Spread of fungi on cones or fungi already on seed to uncontaminated seed can occur during seed extraction, stratification, and sowing, as well as at other times.

Seed fungi symptoms appear:
1+0
Late spring
through early summer

Figure 7-1. Fungi growing from true fir seed in a germinator. The amount of fungal contamination can vary by tree species and method of collection, and between seedlots.

Loss potential

It is difficult to predict damage from seedborne fungi. The most common fungi are saprophytic or even beneficial because they compete with other potentially pathogenic species. Some, however, are consistently associated with reduced germination rates and vigor. In general, fungi that are present within seed are more damaging than those that merely contaminate the outer seed coat. *Trichothecium*, for example, can reduce germination of Douglas-fir seedlots by 20 percent. *Caloscypha* is still more damaging; this fungus penetrates and kills seeds before germination. It can spread during cool, moist storage and even after sowing. Damage from *Caloscypha* has been most severe in British Columbia and in Europe.

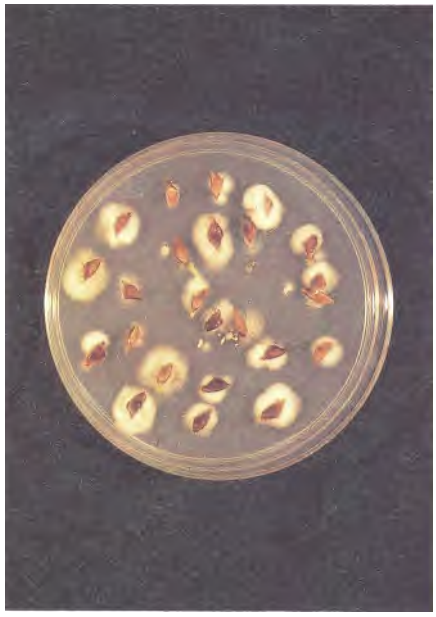

Figure 7-2. Douglas-fir seed in a petri plate. Notice that most seeds have white, cottony colonies of fungi growing from them.

Management

Seed fungi are common in the environment and increase rapidly under warm, wet conditions. Preventing contamination is generally more successful than trying to cure diseased seedlots. Collecting clean cones, drying them, and extracting seed promptly are essential first steps. Storage of cones on the forest floor is important in the transmission of the seed fungus *Caloscypha.* Molds can develop in cone storage bags even with proper handling. Levels of seedborne fungi have been shown to be significantly higher following cone storage and extraction. This evidence might pinpoint the extraction phase as the primary stage when inoculum transfer occurs. Because cones appear to be a prime source of inoculum, the potential for cross-contamination between seedlots during cone processing is high.

Seed may be tested for the presence of fungal inoculum by plating seed on agar media. Testing should be selective enough to pinpoint the pathogen and to identify individual seedlots that need treatment. Fast-growing fungi and bacteria are readily isolated on non-selective media such as potato dextrose (PDA) or 2-percent malt extract (Figure 7-2). Selective or semi-selective media may be used to detect most seed fungi.

Detecting internal fungi requires sterilization of the seed surface with 1-percent bleach or 30-percent hydrogen peroxide, or a combination of the two. This will remove approximately 90 percent of the surface fungi. Better results can be achieved by increasing the soaking time, washing seed in a surfactant, and rinsing repeatedly in sterile distilled water.

Certain pathogens can be detected more quickly and accurately with monoclonal antibody tests in an enzyme-linked immunosorbent assay (ELISA). To date, ELISA tests are available for *Sirococcus* and *Caloscypha* on spruce seedlots.

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Table 7-1. Common seedborne fungi in Pacific Northwest conifer species.

FUNGUS	HOSTS	APPEARANCE IN CULTURE	DISEASE PROBLEMS
Alternaria	many conifers	gray-green to black; septate, club-shaped spores	radicle and cotyledon disease of white spruce
Caloscypha (= Geniculodendron)	pine, spruce true fir, Douglas-fir	beige, whitish gray, orange to pale yellowish brown; smooth, colorless round spores	seed rot, reduced germination
Cladosporium	many conifers	dark velvety green; pickle-shaped conidia	reduced vigor of germination
Fusarium	many conifers	white, salmon to pinkish-red; macroconidia sickle-shaped with 3-4 septations	reduced germination disease in seedbeds
Penicillium	many conifers	green to bluish-green; small, round conidia	reduced vigor of germination
Trichoderma	many conifers	white turning to green, fast-growing; small, round conidia	none; this is usually a beneficial fungus
Trichothecium	many conifers	pinkish, two-celled conidia	reduced germination

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