39. Seed Fungi

Stephen W. Fraedrich and Michelle M. Cram

Hosts

Seedborne fungi can potentially affect seed quality of any forest tree species. Some seedborne fungi are saprophytes and have no affect on seed quality, but others are pathogenic and can cause germination failure or seedling diseases. The best known and most studied seedborne fungi are those that affect conifer species. *Diplodia pinea, Lasiodiplodia theobromae, Sirococcus conigenus*, and *Fusarium* species such as *F. circinatum* and *F. oxysporum* are pathogenic fungi routinely associated with conifer seeds. The dogwood anthracnose pathogen, *Discula destructiva* has been found on dogwood seeds. Other species in genera such as *Pencillium, Aspergillus, Pestalotia, Trichoderma*, *Mucor,* and *Rhizopus* are associated with various tree seeds, although their role in seed deterioration and quality is often not clear.

Distribution

Seedborne fungi are widely associated with forest tree seeds in all regions of the United States. Specific fungi, however, can be limited in their range because of climatic conditions and host type. For example, *F. circinatum* (pitch canker fungus) has been associated with southern pine and Monterey pine seeds in California maritime areas. In contrast, *S. conigenus* and *C. fulgens* are only associated with conifer seeds in the Northern United States.

Damage

Some seedborne fungal pathogens primarily cause disease in seeds and appear to have little-to-no effects on other developmental stages of trees. These pathogenic fungi infect the internal tissue of seeds, destroying the embryo and endosperm or gametophyte tissue (figs. 39.1 and 39.2). Examples include *L. theobromae,* which destroys slash pine seeds in the Southern United States, and *C. fulgens,* which affects seed quality of conifers in Canada and the Northern United States. In contrast, there are several notable conifer pathogens found on seeds that may have little effect until after seed germination, when they can cause damping-off, root rot, and seedling blight (fig. 39.3). These pathogens frequently reside on or in the seedcoat and initially cause little damage to the seeds. Occasionally, seedborne pathogens will infect the cotyledons of developing seedlings that have the seedcoat still attached (fig. 39.4). Some pathogens of this type can have severe economic and ecological consequences if they are introduced into regions of the world where they are not native. These pathogens include *D. pinea* (syn. *Sphaeropsis sapinea*), *S. conigenus, F. circinatum*, and *F. oxysporum*.

Figure 39.1—*Hyphae of a fungus on the seedcoat of a contaminated pine seed after incubation in the laboratory.* Photo by Stephen W. Fraedrich, USDA Forest Service.

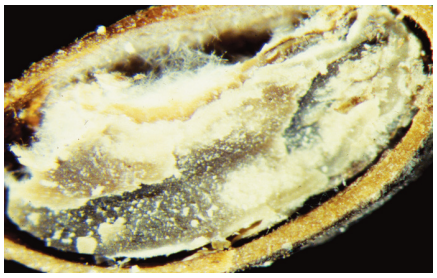

Figure 39.2—*Black seed rot of slash pine caused by* Lasiodiplodia theobromae. Photo by Stephen W. Fraedrich, USDA Forest Service.

Figure 39.3—*Mortality of longleaf pine seedlings caused by the pitch canker fungus* (Fusarium circinatum) *that was associated with contaminated seed sources.* Photo by Stephen W. Fraedrich, USDA Forest Service.

Figure 39.4—*Primary needles of a pine seedling infected by a seedborne fungus.* Photo by Michelle M. Cram, USDA Forest Service.

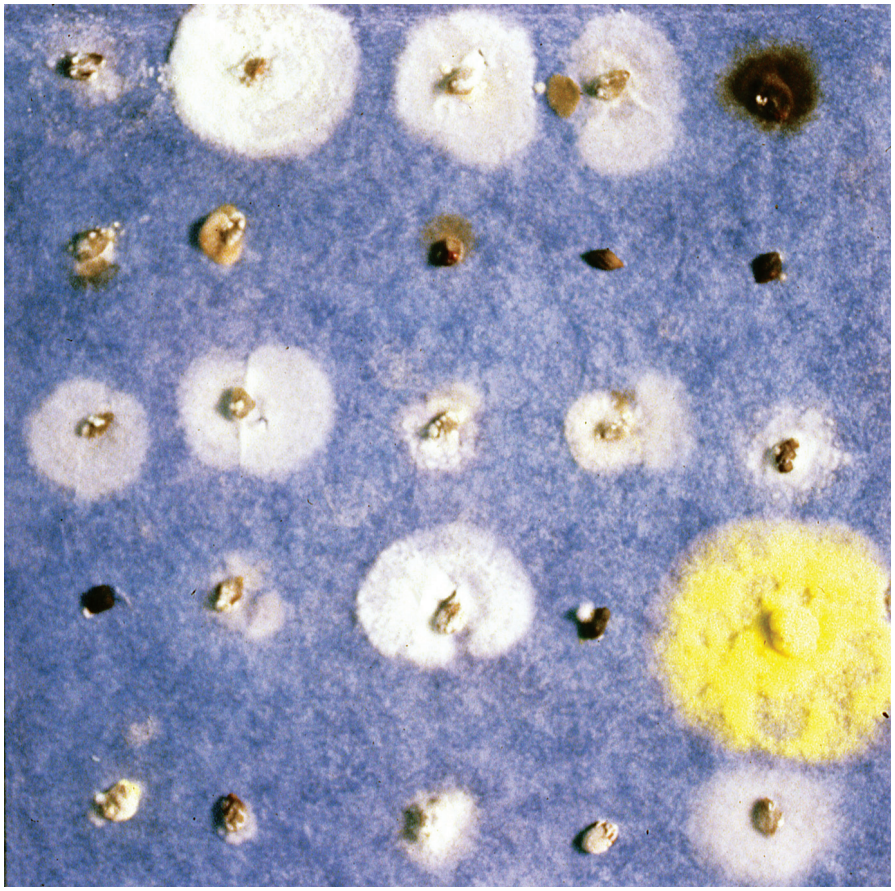

Figure 39.5—Fusarium *species and other fungi growing from seeds placed on a sterile blotter with nutrient growth media.* Photo by Michelle M. Cram, USDA Forest Service.

Diagnosis

Seed diseases can go unnoticed until an unusually high germination failure or damping-off episode occurs in the nursery. Seedlot germination tests can screen for potential seed disease problems. The incidence of seeds with internal damage caused by pathogenic fungi can be determined for individual seedlots by cutting open a sample of seeds and examining for presence of fungal mycelium. Radiographic techniques can also be used to detect internal seed damage caused by fungal pathogens. Specific fungi associated with seeds can be determined by pathologists who can process samples on artificial media and examine the samples microscopically (figs. 39.5 and 39.6). Although this procedure is widely employed, it is time consuming and may not always detect pathogens at low levels. Efforts are being made to develop molecular tools for detection of pathogens such as *F. circinatum* and *D. pinea*. Molecular techniques could prove to be less time consuming for making diagnoses and may provide more sensitive techniques for screening larger samples of seeds for specific pathogens.

Biology

Seeds may be infected internally, resulting in the destruction of endosperm and embryo or externally on the seedcoat. Fungi exist in seeds as spores and hyphae, and they can survive for long time periods on the seedcoat and in the internal, diseased seed tissue. These features make seeds an ideal means for the long distance transport of pathogens.

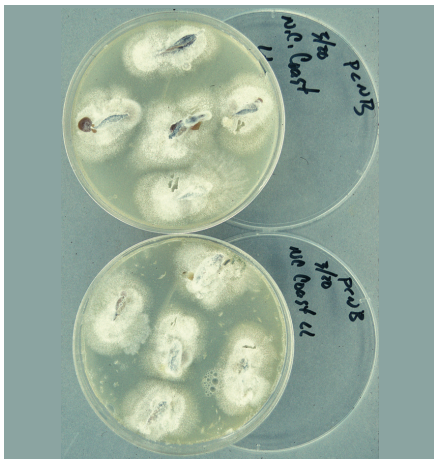

Figure 39.6—Fusarium *species growing from longleaf pine seeds placed on an agar media selective for* Fusarium *species.* Photo by Stephen W. Fraedrich, USDA Forest Service.

Seedborne fungi such as *Penicillium, Aspergillus, Mucor,* and *Rhizopus* are often regarded as saprophytes, and their association with seeds is usually an indication of poor seed quality. These fungi often colonize seeds as a result of physical damage or adverse environmental conditions such as high temperatures or moisture conditions that may affect seeds during collection, extraction, and storage.

Other fungi such as *S. conigenus, F. circinatum,* and *D. pinea* are seedborne pathogens capable of causing other diseases such as stem cankers and shoot dieback. *S. conigenus* becomes established in seedlots when older cones are inadvertently included in the cone harvest. The conditions that favor this pathogen's establishment in seeds include high humidity, low light, and cool temperatures ranging from 10 to 20 °C (50 to 68 ºF). Seed contamination levels by *Fusarium* species can vary by collection date and by orchard. Fresh wounds are known to provide infection courts for *F. circinatum* and various agents can wound reproductive structures, including insects, high wind, hail, and cone handling practices. Seed contamination by *F. circinatum* can also vary greatly among clones in seed orchards. Cones from clones that are highly susceptible to pitch canker tend to have greater levels of seed contamination. These diseased cones can contaminate the cones and seeds from less susceptible clones when they are included in bulk collections. Not all *Fusarium* species are pathogenic to tree seeds and isolates of some species (for example, *F. oxysporum*) can vary greatly in pathogenicity.

Control

Prevention

Proper cone and seed collection, storage, and extraction techniques are essential to seed disease prevention. Some seedborne diseases can be prevented by not collecting old cones or cones that have been in contact with the ground for extended periods. The potential for seed diseases can also be reduced by collecting mature cones with a specific gravity less than 0.89 and storing them in dry, aerated conditions. Avoid collecting diseased and damaged cones, or sowing highly infested seedlots.

Cultural

Collecting seeds by clone may help to reduce the incidence of seedborne contamination in clones unaffected by the disease. Mechanical seed treatments, such as specific gravity tables and the IDS (Incubation Drying Separation) system, can be used to remove fungus-damaged seeds from seedlots. Avoid damaging seeds during cleaning, dewinging, and treatment. Seed treatments such as water rinses and heat treatments have been shown to control some seedborne pathogens without deleterious effects on seed germination. Although these treatments may reduce the incidence of seedborne fungi, they may not be as effective as some chemical seed treatments.

Chemical

Seed treatments primarily reduce or remove pathogens from the seed coat. Nurseries commonly use labeled fungicides, and in some cases disinfectants, as seed treatments. Seed treatments can have a negative effect on germination and should be applied with caution to avoid unnecessary damage. Disinfectants such as sodium hypochlorite, hydrogen peroxide, and hydrogen dioxide can be used to reduce fungal contamination and improve seed germination. Hydrogen peroxide has long been known to eliminate seedborne mycoflora and stimulate seed germination.

Selected References

Anderson, R.L.; Miller, T. 1989. Seed fungi. In: Cordell, C.E.; Anderson, R.A.; Hoffard, W.H.; Landis, T.D.; Smith, Jr., R.S.; Toko, H.V., tech. coords. Forest nursery pests. Agriculture Handbook 680. Washington, DC: USDA Forest Service: 126–127.

Cram, M.M.; Fraedrich, S.W. 2010. Seed disease and seedborne pathogens of North America. Tree Planters' Notes. 53(2): 35–44.

Sutherland, J.R.; Miller, T.; Quenard, R.S. 1987. Cone and seed disease of North American conifers. North American Forestry Commission. Pub. 1. Victoria, British Columbia, Canada. 77 p.

USDA Forest Service. 2008. The woody plant seed manual. Agriculture Handbook 727. Washington, DC: USDA Forest Service. 1233 p.