CONTAMINATION OF PINE SEEDS BY THE PITCH CANKER FUNGUS'

L. D. Dwinell and S. W. Fraedrich²

The pitch canker fungus, *Fusarium subglutinans* f. sp. *pini*, has been identified as a significant problem in many pine seed orchards and nurseries in the South. The fungus causes strobilus mortality, seed deterioration, and cankers on the main stem, branches, and shoots of pines (Dwinell and others 1985). The pitch canker fungus causes damping-off (Blakeslee 1980) and stem cankers on seedlings in southern pine nurseries (Barnard and Blakeslee 1980). Contaminated seeds may be a source of inoculum for diseases in nurseries caused by *F.* subglutinans f. sp. *pini.*

CONES

In 1979, Miller and Bramlett established that the pitch canker fungus was pathogenic to both first- and second-year female strobili of slash and loblolly cones inoculated with *F. subglutinans* f. sp. *pini.* Inoculated cones became necrotic, and the pitch canker fungus could be isolated from the cone scales, the axis, and the seeds.

We have studied the natural infection of shortleaf pine cones by the pitch canker fungus at a Federal seed orchard in North Carolina (Dwinell and Fraedrich 1997b). It was isolated from the surface and interior of immature cones. There was no apparent correlation between necrotic cones with external wounds caused primarily by insects and the isolation of the fungus from internal tissues (fig. 1). We found no external symptoms indicative of fungal infection. Barrows-Broaddus (1987) reported that infected loblolly pine cones tend to be misshapen and smaller than normal, and some cones have a necrotic tip characterized by internal resin pockets. Mycelium of the causal fungus has been observed on the outer surfaces of badly deteriorated cones of slash and loblolly pines. The mode of entry of *F. subglutinans* f. sp. *pini*, a wound parasite (Dwinell and others 1985), is currently unknown.

SEEDS

Miller and Bramlett (1979) isolated the pitch canker fungus from gametophyte and embryo tissue of slash and loblolly pine seeds. They reported that isolation of the pathogen appeared considerably less in loblolly than slash pine seeds. Radiographs of seeds in advance stages of disease may show deterioration of the embryo and that the gametophyte has shrunken away from the seed coat. Microscopic examination may reveal the presences of hyphae throughout these seed (Barrows-Broaddus 1987). Often, however, evidence of internal infection is not apparent in radiographs of seeds from which the fungus is isolated. This may be due to its confinement to the outer seed coat, or because the disease is in its initial stages of development.

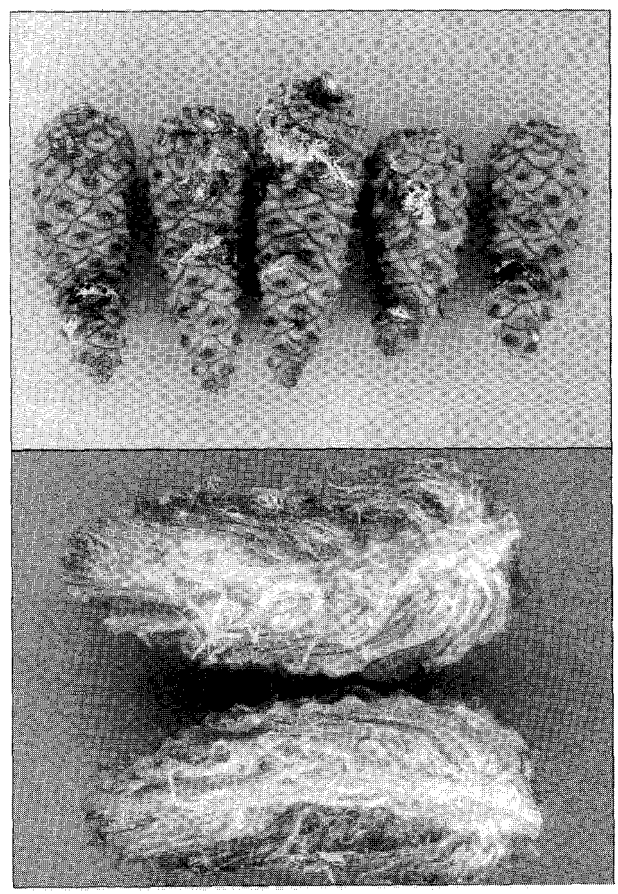

Figure 1-Shortleaf pine cones. (Top) These cones illustrate the extent of external wounds caused primarily by insects in a Federal seed orchard in 1995. The pitch canker fungus was often isolated from the surface of the cones and from the external necrotic tissue. (Bottom) The pitch canker fungus was isolated from internal tissue of asymptomatic cones, as well as cones with internal necrosis. Shown here, cross section of a shortleaf pine cone with necrotic tissue (Dwinell and Fraedrich 1997b).

'Dwinell, L.D.; Fraedrich, S.W. 1999. Contamination of pine seeds by the pitch canker fungus. In: Landis, T.D.; Barnett, J.P., tech. coords. National proceedings: forest and conservation nursery associations-1998. Gen. Tech. Rep. SRS-25. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 41-42.

*Research Plant Pathologists, USDA Forest Service, Southern Research Station, 320 Green Street, Athens, GA 30605; TEL: 706/546-2446.

Seed contamination may be largely restricted to the seed coat in some pine species. *Fusarium subglutinans* f. sp. *pini* was isolated from an average of 61 percent of the freshly extracted shortleaf pine seeds; but only 1.6 percent of the seeds were infested internally (Dwinell and Fraedrich 1997b). Research on longleaf pine seeds also suggests that the pitch canker fungus may be primarily associated with the seed coat, and infection of the endosperm and embryos is rare (Dwinell and Fraedrich 1997a).

The external contamination of pine seeds by fungal pathogens can be eradicated by appropriate seed treatments. Hydrogen peroxide, for example, shows promise as a seed disinfectant (Barnett 1976). We have found that longleaf pine seeds can be decontaminated by treatment with a 30-percent hydrogen peroxide solution for 55 minutes (Dwinell and Fraedrich 1997a). In 1997, we operationally treated 3.63 kilograms of shortleaf pine seeds with a 30-percent hydrogen peroxide for 15 minutes and, after stratification, sowed them in a Georgia nursery. When the seedlings were lifted in the fall, there was no evidence of pitch canker in the treated or control plots. We concluded that the seed treatment was not detrimental. We are currently focusing on biological control, e.g., *Burkholderia cepacia,* and other seed treatment agents, such as benomyl (Dwinell and Fraedrich 1987b).

NURSERIES

There is little empirical data linking seed contamination by *F. subglutinans* f. sp. *pini* with seedling canker that occurs in nursery beds and on outplanted sites. In a current greenhouse study, we artificially contaminated Monterey, slash, and longleaf pine seed lots with an isolate of *F. subglutinans* f. sp. *phi.* Of the total container-sown seeds, 57 and 30 percent, respectively, of the Monterey and slash pine seedlings had damped-off and 22 percent of the Monterey pine seeds had damped-off prior to emergence. The longleaf pine seed lot was poor and the data were non-conclusive. Preliminary data suggests that the major result of seed contamination by the pitch canker fungus is pre- and post emergence damping-off. Understanding possible linkages between seed contamination and pitch canker in the nursery is a major area of our current research. Such understanding will help nurseries develop control strategies to pine seed contamination and diseases.

CONCLUSIONS

There is little information about the contamination of pine seeds and cones by *F. subglutinans* f. sp. *pini* and other fungal pathogens. Factors affecting the contamination of pine seeds need to be identified. The extent of internal and/or external contamination appears to vary by species, but the external contamination of longleaf and shortleaf pine seeds by fungal pathogens can be eradicated by appropriate seed treatments.

REFERENCES

Barnard, E.L.; Blakeslee, G.M. 1980. Pitch canker of slash pine seedlings: a new disease in forest tree nurseries. Plant Dis. 64: 695-696.

Barnett, J.P. 1976. Sterilizing southern pine seeds with peroxide. Tree Planters' Notes. 27: 17-19.

Barrows-Broaddus, J.B. 1987. Pitch canker. In: Sutherland, J.R.; Miller, T.; Quinard, R.S., eds. Cone and seed diseases of North American conifers. Publ. 1. Victoria, British Columbia, Canada: North American Forestry Commission: 42-49.

Blakeslee, G.M. 1980. Pitch canker in forest tree nurseries. In: Proceedings 1980 southern nursery conference; September 2-4; Lake Barkley, KY: 116-l 17.

Dwlnell, L.D.; Barrows-Broaddus, J.B.; Kuhlman, E.G. 1985. Pitch canker: a disease complex of southern pines. Plant Dis. 69: **270-276.**

Dwinell, L.D.; Fraedrich, S.W. 1997a. Management of disease losses through seed treatments of longleaf and shortleaf pines. Ann. intl. res. conf. on methyl bromide alternatives and emissions reductions; 1997 November 3-5; San Diego: 44-1, 3.

Dwlnell, L.D.; Fraedrlch, S.W. 1997b. Recovery of *Fusarium subglutinans* f. sp. pinifrom shortleaf pine cones and seeds. In: James, R.L., ed. Proceedings of the 3rd meeting of IUFRO working party S7.03-04 diseases and insects in forest nurseries; 1996 May 19-24; Orlando-Gainesville, FL. Rep. 97-4. U.S. Department of Agriculture, Forest Service, North. Region, Forest Health Protection: 42-47.

Miller, T.; Bramlett, D.L. 1979. Damage to reproductive structures of slash pine by two seed-borne pathogens: *Diplodia gossypina* and *Fusarium moniliforme* var. *subglutinans.* In: Bonner, Frank, ed. Proceedings flowering and seed development in trees: a symposium. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 347-355.