Pitch Canker of Southern Pines and Recent Cases in Florida, Louisiana, Mississippi, and Texas

Dale Starkey
Jim Meeker
Alex Mangini

Dale Starkey is Plant Pathologist, USDA Forest Service, Southern Region, State and Private Forestry, Forest Health Protection, Alexandria Field Office, 2500 Shreveport Hwy, Pineville, LA 71360; Tel: 318.473.7293; E-mail: dstarkey@fs.fed.us. **Jim Meeker** is Entomologist, USDA Forest Service, Southern Region, State and Private Forestry, Forest Health Protection, Alexandria Field Office, 2500 Shreveport Hwy, Pineville, LA 71360; E-mail: jrmeeker@fs.fed.us. **Alex Mangini** is Entomologist, USDA Forest Service, Southern Region, State and Private Forestry, Forest Health Protection, Alexandria Field Office, 2500 Shreveport Hwy, Pineville, LA 71360; E-mail: amangini@fs.fed.us.

In: Riley, L. E.; Dumroese, R. K.; Landis, T. D., tech. coords. 2007. National proceedings: Forest and Conservation Nursery Associations—2006. Proc. RMRS-P-50. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Online: http://www.rngr.net/nurseries/publications/proceedings

Abstract: Pitch canker disease causes a multitude of problems in all life stages of southern pines. It occurs in most southern states and can affect mature stands, plantations, seed orchards, and nurseries. It is now also known to occur in California and at least 6 other countries. Recent occurrences in the western Gulf region are typical of those farther east. Long-term solutions to the disease should include exploitation of genetic resistance in hosts.

Keywords: *Fusarium circinatum*, eastern pine weevil, Nantucket pine tip moth, seed orchard diseases, genetic resistance, poultry production, fertilization

Pitch Canker in the South

Pitch canker disease of southern pines is caused by the fungus *Fusarium circinatum* Nirenberg & O'Donnell. Symptoms include the reddening and browning of needles on infected shoots and branches (fig. 1). Copious external resin flow is often evident at canker loci and the underlying xylem is resin-soaked, usually to the pith. Canker loci are generally located on smaller, terminal shoots and are believed to originate at the site of a wound caused by abiotic or biotic agents. Fungal infection and canker development typically remain rather localized with minimal longitudinal spread. During canker development, resinosis occurs as the tree reacts and the distal portion of the shoot soon dies, causing the needles to redden, brown, gray, and eventually fall. Proximal portions of infected shoots generally remain alive and green.

Pitch canker was first described in 1946 by Hepting and Roth (1946) when it was observed on Virginia (*Pinus virginiana*), shortleaf (*P. echinata*), and pitch (*P. rigida*) pines near Asheville, Morganton, and Charlotte, North Carolina, as well as Walhalla, South Carolina. Isolations from infected cankers yielded a *Fusarium* species that they did not name because they were unable to find any associated fungal structures or reproductive stages. Inoculations with the fungal isolates reproduced disease symptoms in all three pine hosts. They also stated they had seen similar symptoms on slash (*P. elliotii*) pine in Georgia and Florida and were studying those occurrences as well.

In 1949, the causal fungus was assigned the name *F. lateritium* f. sp. *pini* (Snyder and others 1949). Since then, several names have been used by mycologists and pathologists in the research literature—*F. moniliforme* var. *subglutinans* (Kuhlman and others 1978), *F. subglutinans* (Nelson and others 1983), *F. subglutinans* f. sp. *pini* (Correll and others 1991), and most recently *F. circinatum* (Nirenburg and O'Donnell 1998). Searching out and reviewing published reports on pitch canker necessitates looking for all these names.

After the initial report and description, little research appears in the literature until the early 1970s when outbreaks of pitch canker in Florida slash pine plantations caused concern. Severe crown dieback was prevalent in individual stands and

Figure 1—Pitch-soaked cankers on pine shoots; foliar browning and shoot dieback.

tree mortality rates of up to 25% recorded (Blakeslee and Oak 1979). Damage was associated with outbreak populations of the eastern pine (deodar; *Pissodes nemorensis*) weevil (Blakeslee and others 1978b). Fungal fruiting structures (*sporodochia*) were also documented on infected tissues for the first time (Blakeslee and others 1978a).

Pitch canker has since been diagnosed in seed orchards in various southern states in slash, loblolly (*P. taeda*), shortleaf, Virginia, and longleaf (*P. palustris*) pines (Dwinell and others 1985). Cankers are related to wounding from orchard activities like cone picking and tree shaking, as well as damages due to insects and severe weather. Cone shaker wounding on tree trunks led to pitch canker infections on the main boles, and shaker pads often transferred the fungus to additional trees (fig. 2). Infections in the crowns resulted in dieback and cone loss, and cones became infected through wounds created by seedbugs and coneworms. Seeds became contaminated or infected within infected cones and, subsequently, the disease appeared in pine seedling nurseries (presumably from contaminated or infected seeds) and caused scattered to localized mortality (Dwinell and others 1985; fig. 3). The disease has been recorded in both bareroot and container seedlings of several southern pine species. In addition, outplanted seedlings have, on occasion, been affected in regeneration areas. Therefore, every life stage of southern pines can be affected by the disease and all southern pines are, to some degree, susceptible to infection.

Pitch Canker Elsewhere

In the 1980s, a new area of concern arose when pitch canker was discovered infecting Monterey pine (*P. radiata*) in coastal California in Santa Cruz County (Gordon and others 2001). Initially, the disease seemed to be affecting older landscape-type trees, but has since spread to forest situations, Christmas tree plantations, and ornamental nurseries, and is now known from 18 California counties. Several other species of western pines are also susceptible and infected. In addition, a non-pine host, Douglas-fir (*Pseudotsuga menziesii*), is known to be susceptible.

Much of the concern over the California situation is due the widespread international use of Monterey pine as a commercial plantation tree and the potential for pitch canker to be spread to, and cause, serious problems in countries where it is widely grown, such as Australia, Chile, and New Zealand (Gordon and others 2001). Pitch canker has been documented outside the United States (Dwinell 1999), first in Haiti (1953), and more recently in other countries and on other pine species. It was found in eight states in Mexico in the 1980s (and has probably been there a long time), Japan in 1987, Chile in the 1990s, South Africa in 1990 on seedling roots, and Spain in 1997 on seedlings. The causal fungus is now known to occur in a number of countries and continents and has been found infecting many pine hosts besides southern pines. This has recently become important because in 2003, New Zealand found *F. circinatum* causing

Figure 2—Large pitch canker on seed orchard tree and symptoms of pitch canker on infected cone.

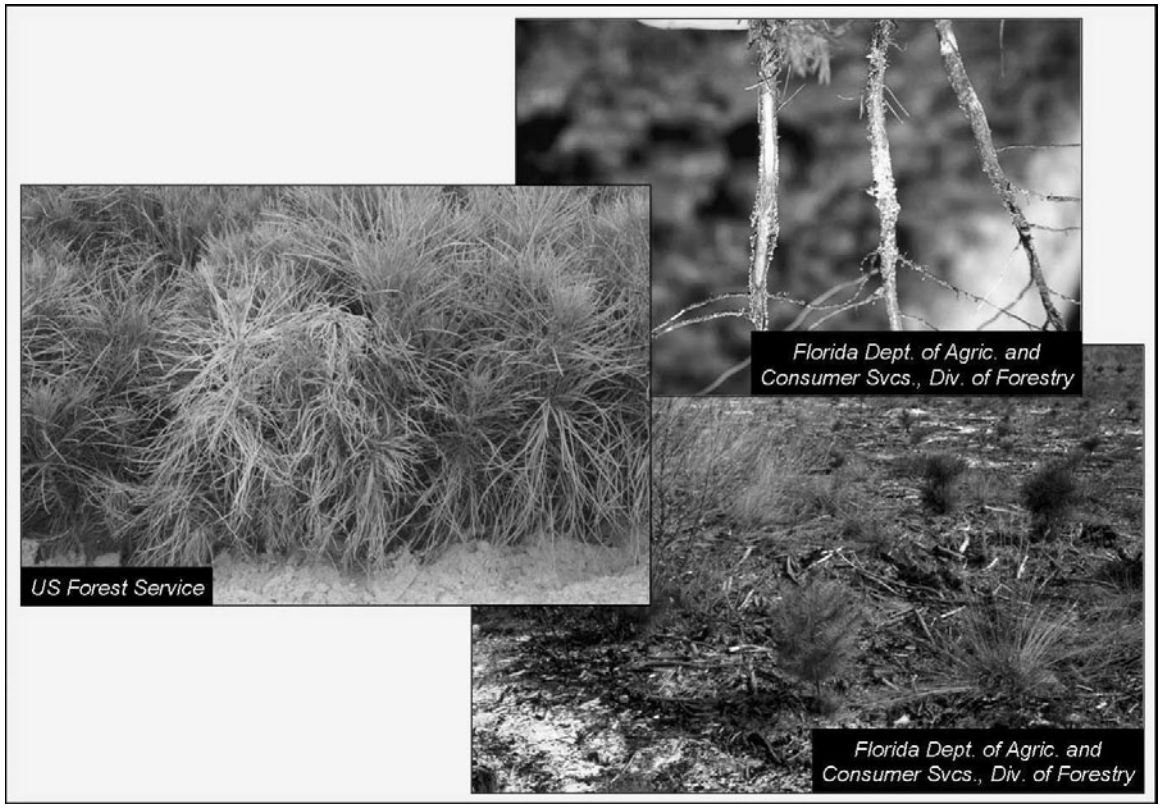

Figure 3—Pitch canker on seedlings in the nursery bed and mortality of outplanted seedlings.

disease symptoms on imported Douglas-fir scion material from California being held in a quarantine facility (Ormsby 2004). Thus, an introduction of the fungus to a country with millions of hectares of *P. radiata* plantations was avoided, at least temporarily.

Recent Occurrences and Concerns

One recent and interesting phenomenon involving pitch canker disease arose in Florida where slash pine plantations adjacent to and downwind from poultry operations sustained epidemic levels of pitch canker disease (fig. 4). A study by the Florida Division of Forestry and the University of Florida (Barnard and others 2005) found a direct association between the air exhausted from poultry houses and high levels of pitch canker. Disease incidence and severity was highest nearest the exhaust ends of the poultry houses and diminished with distance. Nitrogen levels in the forest floor and tree foliage were highest nearest the houses. Tree mortality followed the same pattern. Impacts from the poultry houses were found for a distance of at least 500 m (1,640 ft). The large amount of nitrogen, in the form of ammonia, blown out from the poultry houses enhances the susceptibility of exposed pines to pitch canker infection. Similar situations were reported to the authors in 2004 from central Mississippi, where loblolly pine stands on the Bienville National Forest were apparently being impacted by adjacent poultry operations (fig. 5). The authors diagnosed pitch canker in several of these locations. Similar reports and observations have also come out of Georgia and Louisiana.

Concurrent with the poultry production phenomenon, reports came to the authors from a variety of sources indicating loblolly pine plantations were possibly being affected by pitch canker in a number of areas in Mississippi, Louisiana, and east Texas (fig. 5). We diagnosed pitch canker in several of these and also observed activity by a variety of insects, such as the eastern pine weevil, Nantucket pine tip moth (*Rhyacionia frustrana*), pine engraver beetles (*Ips* spp.), pitch twig moth (*Petrova comstockiana*) and others. Most plantations were young, dense, and growing in a fertile situation on old agricultural sites or on industrial land (fig. 6). A few cases, however, were in natural, mature-sized pine stands. It is not known why the disease has seemingly become more abundant in the western Gulf area recently, but the rainfall for 2004 was unusually high. The wet conditions could have favored disease development. It could also be that the causal fungus has just become more prevalent after several decades of buildup in seed orchards and forest stands. In any case, pitch canker behavior in Florida and in seed orchards across the region tends to be cyclical, and these recent instances appear to be following that pattern as suggested by the apparent recovery of some infected stands.

Management Guidelines

Direct control measures for pitch canker are currently unavailable or not economically feasible; managers must

Figure 4—Pitch canker associated with poultry production.

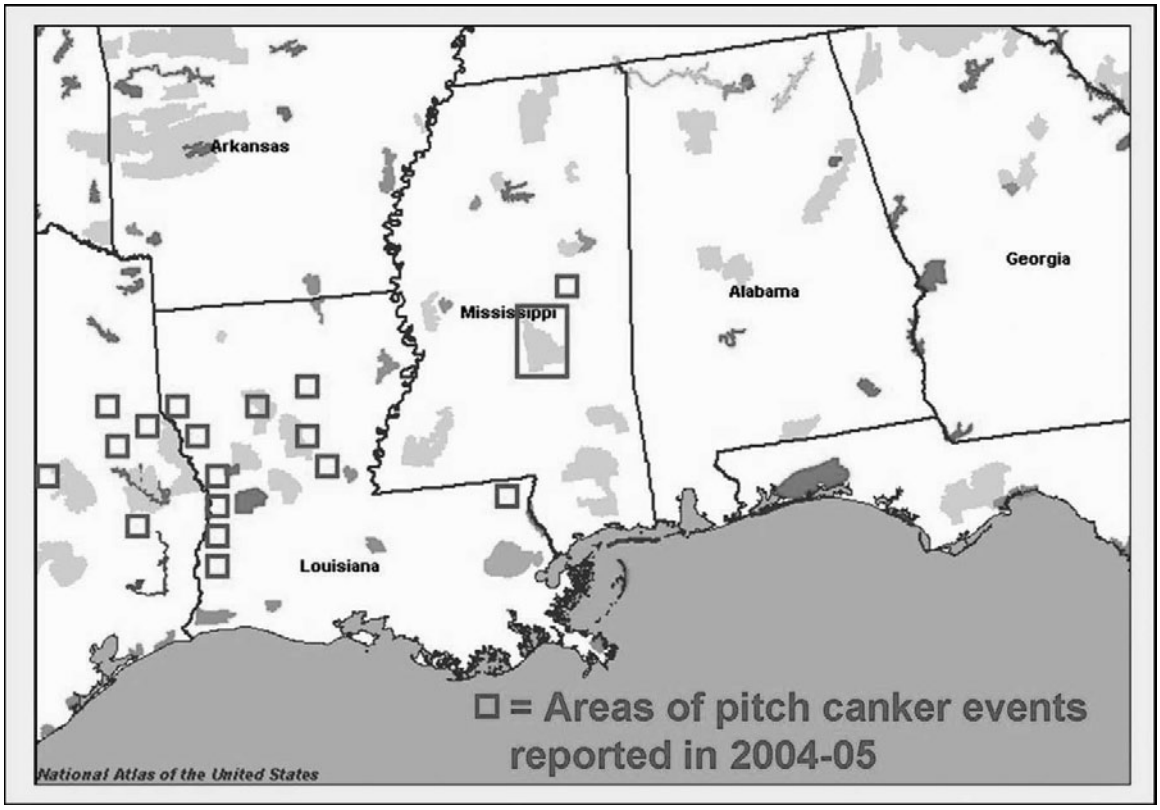

Figure 5—Areas of pitch canker events reported in 2004 to 2005 in the western Gulf region.

Figure 6—Severe pitch canker symptoms in loblolly pine plantations.

rely on good cultural activities to mitigate severe disease activity. Some general recommendations for management of pitch canker are:

1. Plantations
   a. Plant pine species best adapted to specific sites;
   b. Avoid overstocking (for example, thin early and often);
   c. Control tip moth where feasible;
   d. Selectively remove infected/susceptible stems at thinnings (sanitation);
   e. Avoid excessive or unnecessary fertilization (especially nitrogen); and
   f. Avoid wounding trees.
2. Seed orchards
   a. Avoid wounding trees with cone shakers or cone harvesting operations;
   b. Avoid excessive fertilization (especially nitrogen);
   c. Rogue out highly susceptible/damaged clones; and
   d. Protect trees from insect wounding by tip moth, coneworm, seed bug, and so on.
3. Nurseries
   a. Screen seed sources for contamination and use clean or treated seeds;
   b. Use sterile media for containers or fumigate soil to prevent buildup of the pathogen; and
   c. Rogue out infected/dying seedlings as soon as possible.

One service that can aid in identifying heavily contaminated or infected seeds is the screening procedure offered by the USDA Forest Service, Forest Health Protection at the Resistance Screening Center in Asheville, North Carolina. A seed sample is placed on blotter paper, over-sprayed with a selective media for *Fusarium*, and the level of seed contamination evaluated (fig. 7). Screening can help orchard and nursery managers avoid using heavily contaminated seed lots and can identify lots for seed treatments to reduce fungal populations prior to their use.

Long-Term Control With Genetic Resistance

Long-term management of this disease must be accomplished by exploiting genetic resistance available in pine species populations. It is clear when observing clonal differences in infection severity in seed orchards that genetic resistance exists and "resistant" individuals can also be found in severely affected plantations. Experimentation by Rockwood and others (1988), for instance, determined that resistance to pitch canker exists in slash pine and is negatively correlated with good growth characteristics and fusiform rust resistance. The authors calculated potential genetic gains from various techniques as about 10% to 43% (table 1). Another service available at the Resistance Screening Center to aid in selecting and using genetically resistant material is screening seed lots from controlled crosses. Seed lots grown for testing have their shoots clipped followed by inoculation with *F. circinatum* and the resulting shoot dieback assessed as an indication of resistance (fig. 8). In 2004 and 2005, screening activity, as well as seed fungi screening, increased in response to the increased occurrences of this disease (table 2).

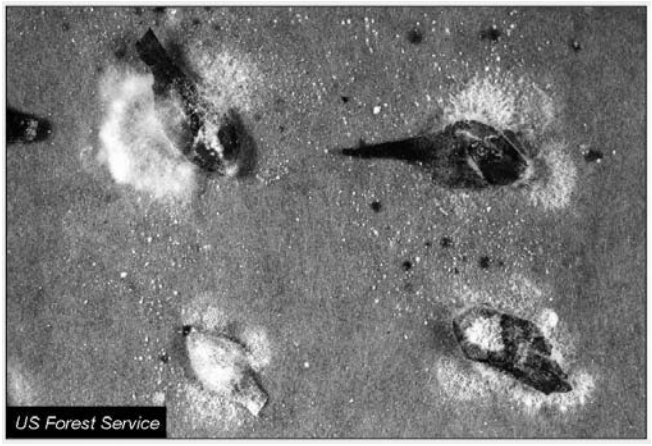

Figure 7—*Fusarium* colonies forming during seed screening procedures.

Summary

Pitch canker is a worldwide problem for pine forestry and culture and can cause serious damage in all pine life phases. It will continue to cause localized, sporadic problems in plantations, seed orchards and nurseries in the south; California will continue to contend with pitch canker in Monterey pine. Internationally, a number of countries will have serious concerns and problems with the disease or its potential introduction. Only exploitation of genetic resistance offers any long-term solution to the problem, although cultural activities and regulatory efforts may help to minimize disease impacts and spread.

Acknowledgments

For their contributions to this report, the authors wish to thank Billy Bruce, Tim Haley, Nolan Hess, Wood Johnson, Ron Kertz, Jim Smith, Chris Steiner, Carol Young, and Steve Oak, USDA Forest Service, Southern Region, State and Private Forestry, Forest Health Protection; the silviculture and tree improvement staffs from Boise Cascade (now Forest Capital); Tom Byram, Don Grosman, and Joe Pase, Texas Forest Service; and Dr. Ed Barnard, Florida Division of Forestry.

Table 1—Potential gains in pitch canker resistance from various strategies (Rockwood and others 1988).

Strategy	Minimum gain
	percentage
Short-term	
Seed production area	10.9
Resistant clones in existing seed orchard	11.9
Long-term	
Orchard of pitch canker selects	15.1
Orchard of tested clones	42.7

Figure 8—Resistance screening procedures for controlled crosses of pines.

Table 2—Number of recent seed screening and disease resistance tests for pitch canker (Young 2006).

Year	Seed screening, loblolly or slash pine	Resistance testing		
		Loblolly pine	Slash pine	Other pine species
2002	4	0	0	316
2003	1	11	0	89
2004	4	0	10	174
2005	16	84	9	0

References

Barnard EL, Lopez-Zamora I, Bliss CM, Comerford NB, Jokela E, Grunwald S, Vasquez G. 2005. Spatial evaluation of nitrogen emissions from poultry operations and their influence on the impact of pitch canker in slash pine (*Pinus elliotii*) plantations. Gainesville (FL): Florida Department of Agriculture and Consumer Services, Division of Forestry and University of Florida, Department of Soil and Water Science and School of Forest Resources and Conservation. 35 p.

Blakeslee GM, Oak SW. 1979. Significant mortality associated with pitch canker infection of slash pine in Florida. Plant Disease Reporter 63:1023-1025.

Blakeslee GM, Kratka SH, Schmidt RA, Moses CS. 1978a. Sporodochia of the pitch canker fungus (*Fusarium moniliforme* var. *subglutinans*) as found in diseased slash pines in Florida. Plant Disease Reporter 62:656-657.

Blakeslee GM, Oak SW, Gregory W, Moses CS. 1978b. Natural association of *Fusarium moniliforme* var. *subglutinans* with *Pissodes nemorensis* (Abstr.). Phytopathology News 12:208.

Correll JC, Gordon TR, McCain AH, Fox JW, Koehler CS, Wood DL, Schultz ME. 1991. Pitch canker disease in California: pathogenicity, distribution, and canker development on Monterey pine (*Pinus radiata*). Plant Disease 75:676-682.

Dwinell D. 1999. Global distribution of the pitch canker fungus. In: Devey ME, Matheson AC, Gordon TR, editors. Current and potential impacts of pitch canker in radiata pine. Proceedings IMPACT Monterey Workshop; 1999 Nov 30 - Dec 3; Monterey, CA. CISRO, Australia. p 54-57.

Dwinell LD, Barrows-Broaddus J, Kuhlman EG. 1985. Pitch canker: a disease complex of southern pines. Plant Disease 69:270-276.

Gordon TR, Storer AJ, Wood DL. 2001. The pitch canker epidemic in California. Plant Disease 85:1128-1139

Hepting GH, Roth ER. 1946. Pitch canker, a new disease of southern pines. Journal of Forestry 44:742-744.

Kuhlman EG, Dwinell LD, Nelson PE, Booth C. 1978. Characterisation of the *Fusarium* causing pitch canker of southern pines. Mycologia 70:1131-1143.

Nelson PE, Toussoun TA, Marasas WFO. 1983. *Fusarium* species: an illustrated manual for identification. University Park (PA): Pennsylvania State University Press. 193 pp.

Nirenburg HI, O'Donnell K. 1998. New *Fusarium* species and combinations within the *Gibberella fujikuroi* species complex. Mycologia 90:434-458.

Ormsby M. 2004. Report on the interception of *Fusarium circinatum* (pitch canker) on imported seedling of Douglas fir (*Pseudotsuga menziesii*), 11 February 2004. Wellington (New Zealand): National Advisers—Forestry Imports & Exports, Forest Biosecurity, BioSecurity New Zealand. URL: http://www.biosecurity.govt.nz/imports/forests/emergency-measure.htm (accessed 26 July 2006).

Rockwood DL, Blakeslee GM, Lowerts GA, Underhill EM, Oak SW. 1998. Genetic strategies for reducing pitch canker incidence in slash pine. Southern Journal of Applied Forestry 12(1):28-32.

Snyder WC, Toole ER, Hepting GH. 1949. Fusaria associated with mimosa wilt, sumac wilt, and pine pitch canker of southern pines. Journal of Agricultural Research 78:365-382.

Young C. 2006. Personal communication. Asheville (NC): USDA Forest Service, Southern Region, State and Private Forestry, Forest Health Protection.