

PITCH CANKER OF LOBLOLLY PINE IN SEED ORCHARDS

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Abstract.--A shoot dieback of loblolly pine (Pinus taeda L.) is endemic in many seed orchards across the South, but in 1975 it suddenly became severe in two loblolly seed orchards. This disease has been identified as pitch canker and the causal organism as Fusarium moniliforme var. subglutinans Wr. F Reink. The pathogenicity of the fungus has been confirmed. Susceptibility among clones varies from apparently immune to highly susceptible. In some clones, 81-100% of the ramets are affected. Disease severity varies from 1-2 affected branches to a killing of more than half the crown. In orchards, symptoms of the disease develop throughout the year. In fall, needles on cankered shoots turn yellow to reddish brown. Buds and expanding new shoots often die and rapidly turn a vivid brown the following spring as the disease girdles the branches. Several environmental and cultural factors that may contribute to disease development are being investigated. Controls have not yet been developed.

Additional Keywords: Fusarium lateritium f. sp. pini, stress, geographic source, fusiform rust, wounds, Contarinia sp.

INTRODUCTION

A disease called shoot dieback has been known by seed orchard managers for at least 15 years (B. Zobel personal communication). Incidence of the disease has waxed and waned in various orchards across the South. Limited attempts by pathologists, entomologists, soil scientists, and tree improvement personnel had failed to identify the cause of the problem.

In early 1971, Howard Johnson of International Paper Company noted a shoot dieback of several loblolly pines in the McNair Seed Orchard near Natchez, Mississippi. An April 1971 survey showed 80 ramets in 17 clones had dieback symptoms. Damage was most prevalent, however, in three clones. When the trees appeared to recover, little attention was paid to the problem, but in 1975 shoot dieback became severe in the McNair Orchard as well as in the Piedmont section of the J. P. Weyerhaeuser Seed Orchard near Washington, N. C. Disease spread was rapid in the McNair Orchard in 1975 and a survey made in July and August indicated that 18% of the ramets were affected. By December, 45% of the trees

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had moderate to severe shoot dieback. The effect on seed production was catastrophic. In 1975 a record 3,428 bushels of cones were harvested at the McNair Orchard. A year later, production was only 467 bushels, largely because of the dieback problem.

At the Weyerhaeuser Orchard a concurrent symptom of severe defoliation in the summer of 1975 greatly increased the dramatic appearance of the dieback. Some trees were so completely defoliated that at least one was erroneously considered dead and so was felled. An April 1976 survey indicated 48% of the trees in the Piedmont section were affected by the dieback. The trees in both orchards now appear to be recovering, but branches and new shoots are still dying, especially on ramets of highly susceptible clones.

Research during the past year indicates that shoot dieback is a disease known as pitch canker. The causal fungus is Fusarium moniliforme var. subglutinans Wr. E Rienk.

LITERATURE

Pitch canker was first observed on Virginia pines (P. virginiana Mill.) in 1946 (Hepting and Roth 1946). The disease occurs on pines from Virginia to southern Florida and West to Mississippi (Hepting and Roth 1953). In 1953, it was reported that loblolly pine was not a host of the fungus which causes pitch canker (Hepting and Roth 1953). However, a separate strain of the fungus was later reported to attack loblolly pine in eastern North Carolina (Hepting 1971). Recent studies show that current isolates of the pitch canker fungus from several pine species are able to attack loblolly pine (Dwinell 1976, 1977).

CAUSAL AGENT

The nomenclature of the fungus that causes pitch canker is being re-evaluated. In 1946 it was determined that the causal fungus was a species of Fusarium, possibly in the section Liseola (Hepting and Roth 1946). However, in 1949, the fungus was named F. lateritium (Nees) emend Snyder and Hansen f. sp. pini Hept. (Snyder, Toole, and Hepting 1949), placing it in a distinctly different section of a very large and diverse genus. Current isolations made from shoot cankers in seed orchards consistently yield a fungus which has been identified as F. moniliforme var. subglutinans, a member of the section Liseola. This species is a pathogen of corn, cereals, and a host of other agronomic crops (Booth 1971). Since Fusaria are ubiquitous as saprophytes, it was thought this species was a secondary invader. However it was subsequently isolated from pitch cankers on slash (P. elliottii Engelm. var. elliottii), South Florida slash (P. elliottii var. densa Little and Dorman), shortleaf (P. echninata Mill.), longleaf (P. palustris Mill.), and Virginia pines (Dwinell 1977).

Because this fungus was isolated from more than 95% of the affected sample branches, pathogenicity tests were undertaken (Dwinell 1976, 1977). Table 1 shows some of the results of inoculating loblolly pine seedlings with isolates identified as F. moniliforme var. subglutinans (Dwinell 1977).

Table 1.--Mortality of new shoots of 1-year-old seedlings of loblolly pine inoculated with isolates of *F. moniliforme* var. *subglutinans* from various pine sources (Dwinell 1977).

Pine Source	Number of Isolates	Number of Seedlings Inoculated	Shoot Mortality (Mean % + s.d.)
Loblolly	27	327	39 + 27
Slash	16	194	27 + 18
Shortleaf	6	63	14 + 14
Virginia	6	58	13 + 17

A mycological study now underway will characterize the fungus that causes pitch canker. Based on interpretation of the original description of the pitch canker fungus (Snyder, Toole, and Hepting 1949) and pathogenicity studies (Dwinell 1976, 1977), we believe we are dealing with the same fungus that was described in 1949 as the cause of pitch canker.

SYMPTOMS

Shoot dieback in the upper crown is the predominant symptom of pitch canker in loblolly seed orchards as well as in slash pine plantations in Florida (Dwinell and Phelps 1977). Shoot dieback is prominent in the fall, when the fully developed needles turn yellow to reddish brown. Usually an entire flush is killed back, creating a bright red-brown flag. Close examination of shoots in the upper crown reveal early symptom development. Initially only one or two needle fascicles will be dead. Resin is often exuded. As the disease develops, more needles turn reddish brown; and once the stem is girdled all needles distal to the girdle become dehydrated and die. Spread down the stem appears to be arrested by nodes. In the spring, shoot dieback resumes because some infections near the end of the shoot do not kill the buds. Since the shoot is unable to supply water, the expanding bud dies. The flush may be fully expanded before being killed by the infection on the older tissue. The foliage rapidly changes from green to brown so that new flagging with vivid brown symptoms may seem to occur overnight. In orchards, symptoms occur throughout the year.

The cambium and young phloem in the infected area turn a bright reddish brown. Developing cankers can be located on shoots where one or more needle fascicles are dead and fresh resin is present. Removal of the outer bark at these spots reveals the discolored cambium from which the fungus can be readily isolated.

Dead shoots remain in the crown for several years as indicators of the disease. In more resistant clones only a few dead laterals occur, whereas in highly susceptible clones the upper one-fourth to one-half of the crown is often dead. Small witches' brooms develop in some trees as adventitious buds form in response to repeated infections and diebacks.

The classic symptoms of pitch canker are bleeding resinous cankers on the trunk and larger branches (Hepting and Roth 1946). This type of bole canker, though uncommon on loblolly pine, retains the bark and is slightly depressed. Resin production varies just as it does on affected shoots. The underlying wood usually contains wedges of pitch-soaked tissue. On branches, pitch cankers are frequently associated with cone removal injuries. The degree of pitch soaking of the underlying wood is sometimes quite extensive. The cankers are sunken, but little external resin may be noticed.

GEOGRAPHICAL AND CLONAL VARIATION

There is considerable variation in the susceptibility of loblolly pines to pitch canker. At the Weyerhaeuser Seed Orchard, pitch canker incidence was markedly higher in the Piedmont seed source than in the Mississippi-Alabama, or north and south Coastal Plains sources. At the McNair Seed Orchard the incidence of pitch canker was highest in the seed source from south-central Arkansas and north-central Louisiana (Table 2). However, it is fairly uniformly distributed over all geographic sources.

Table 2.--Incidence of pitch canker at McNair Seed Orchard in 1975 by geographic source.

Geographic Source	Number of Clones	% Ramets with Pitch Canker
E. Texas	1	50.8
S. W. Arkansas	3	33.3
N. W. Louisiana	3	40.6
S. Cent. Arkansas-N. Cent. Louisiana	4	72.5
S. E. Arkansas	2	44.6
Cent. Louisiana	10	40.0
S. W. Mississippi	9	38.6

There is a marked clonal variation in disease susceptibility at both orchards (Table 3). At McNair only one clone from Northwest Louisiana has a history of no pitch canker infection. At Weyerhaeuser, even in the hard hit Piedmont section, six clones have no damage and four others have only minimal damage. Clone 9-18 is highly susceptible at Weyerhaeuser and has also shown symptoms of pitch canker on ramets in orchards at Tillery and Lumberton, N. C. Pitch canker incidence in the other geographic sources at Weyerhaeuser is limited to a few clones.

Incidence of the disease on ramets of some clones at McNair has varied with time, For example, clone HO-8 ranked first in susceptibility in 1971, but dropped to 15th out of 32 clones in 1975. On the other hand, clone OH-7 was 2nd in 1971 and 4th in 1975.

At Weyerhaeuser and McNair the disease is spread randomly throughout the orchard on the susceptible clones. There is no indication that ramets on either the edge or the middle of the orchard are more heavily infected. Variation in incidence is dependent only on the clone.

WOUNDING AND INSECTS

Without wounds *F. moniliforme* var. *subglutinans* probably could not attack a host plant, Insect wounds have been suggested as places of infection (Berry and Hepting 1959). Matthews (1962) reported an association of tip moth damage with pitch canker in north Florida slash pine. McGraw et al. (1976) reported no correlation of subtropical pine tip moth (*Rhyacionia subtropica* Miller) with incidence of pitch canker in central and southern Florida slash pine. Pitch canker damage in seed orchards is occurring on 15 to 20-year-old trees where tip moth damage is not extensive. Needle midge (*Contarinia* sp.) is common in seed orchards (Overgaard et al. 1976), and causes a needle wound that is colonized by *F. moniliforme* var. *subglutinans*. However, we do not know if the fungus is able to grow to the stem from these needle wounds.

Pitch canker is also associated with mechanical wounding. Infections at cone scars in the McNair Seed Orchard have already been mentioned. Bole cankers may be related to damage caused by seed orchard equipment. In slash pine seed orchards, bole cankers are often associated with injuries caused by mechanical shakers used for cone harvest (Dwinell and Phelps 1977).

The pitch canker fungus also attacks fusiform rust galls (Berry and Hepting 1959). The fungus has been isolated from pitch-cankered fusiform rust galls on loblolly pines in Florida and Georgia. The fungus probably enters the galls through insect wounds.

Table 4.--Effect of carbofuran on pitch canker in McNair Seed Orchard in 1975.

Furadan® Applied per inch DBH (Ounces)	Number of Ramets Treated ^a /Pitch Canker	% Ramets with Pitch Canker
0	12	33
4	12	33
8	12	25
16	12	25

^a

Six clones; two ramets per clone. Based on southwide Furadan® study established by G. L. DeBarr, USDA Forest Service, Athens, Georgia.

CONCLUSIONS

Pitch canker has become an important tree disease. In addition to **loblolly** seed orchards, it is heavily damaging slash pine in plantations and orchards (Phelps and Chellman 1976). Pitch canker on loblolly pines has also been found in plantations, on roadside trees, and in residential plantings. Outbreaks on shortleaf pine plantings in Tennessee and a short-leaf seed orchard in Mississippi have also been reported.

The South's tree improvement program could be critically damaged by the increasing presence of pitch canker. Two **loblolly** pine seed orchards in opposite parts of the South have been severely affected by pitch canker. There is an urgent need to learn more about pitch canker and to find control measures before it invades more seed orchards.

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