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New Sapwood Challenges “Perfect Storm” of Pine Fungal Infection

by Stephanie Siegel, USDA Forest Service Contract Science Writer • September 16, 2021

Stem occlusion and new sapwood of plantation loblolly pine receiving the low (left) or high (right) inoculation density treatment. Courtesy photo by John Mensah, Auburn University.

Loblolly pine trees may tolerate some fungal infection if they can form new sapwood.

USDA Forest Service plant physiologist **Mary Anne Sword Sayer**, on a team with Ph.D. candidate **John K. Mensah** of Auburn University’s Forest Health Cooperative, conducted two studies in Alabama, one of young trees and one of mature trees.

Loblolly pine (*Pinus taeda*) is the dominant tree species in commercial forest plantations across the southeastern U.S. While southern pine beetle (*Dendroctonus frontalis*) is its most destructive pest, root-feeding bark beetles also pose a threat to loblolly pine under unique conditions.

Bark beetles carry fungi that can infect trees while feeding on trunks or woody roots. In the case of root-feeding beetles, these fungi alone, including *Leptographium terebrantis*, generally don’t cause tree death, but they contribute to it.

“Several things set the trees up for this moderate pathogen to become more dangerous,” says Sayer. A predisposing factor weakens the trees. This could be a moisture shortage or a genetic propensity for underdeveloped root systems. Trees may be planted on a steep slope or eroded site or in a deep sandy soil.

Next, an inciting factor, like a drought or two, really knocks the trees back.

Stressed trees are attractive to pests, including root-feeding beetles. “They bite into the juicy roots,” Sayer says. And the fungus they carry enters the roots.

“A wilt pathogen, like this fungus, likes to live and grow in the sapwood — the water-conducting part of the root or stem,” says Sayer. “The tree deposits defense compounds where the pathogen is, walling it off. That’s a good idea, except this also blocks off the tree’s water-conducting tissue.”

Trees attacked by the beetle-fungus duo tend to develop sparse and yellow-tinged crowns, short needles, reduced radial growth, and fine root deterioration. Such sick trees have appeared in small patches in many states, but mainly in Alabama and Georgia. On a small acreage farm, even a patch of dying trees is a big deal.

“You have to have pretty stressed-out trees before you’re going to have decline take place,” adds Sayer. “The problem is complex because it arises from several factors coming together for a bad outcome. In other settings, any one or even two of these

factors would not be detrimental to production and survival. It’s a ‘perfect storm’ situation.”

In some cases, predisposing and inciting factors limit the water available to the tree. The fungus further reduces water transport through the roots to the trunk, and through the trunk to the needles. With insufficient water uptake, photosynthesis will greatly decrease. Worse droughts and higher temperatures predicted for the South will further shrink available water.

SRS cooperator Mensah artifically inoculates a young loblolly pine stem with toothpicks cultured with *L. terebrantis*. Courtesy photo by John Mensah, Auburn University.

In both studies, deliberate inoculation of the trunk was used as a surrogate for woody root infection — because digging to reach roots would injure the trees.

The young trees the team studied were growing on high-quality soil containing plenty of water. In a fairly open space, they received unlimited light, so photosynthesis could produce a lot of carbon in the crown with some used for new sapwood.

When the scientists stuck the fungus into these young trees to see what it would do, the fungus grew inward, into the older sapwood. There the trees deposited resin and other defense chemicals, decreasing water movement. But as the trees made new sapwood, the fungus did not enter it.

“The trees continued to grow this marvelous sapwood outside the infection,” says Sayer. Water and nutrients traveled through the new sapwood and reached the crown, where photosynthesis thrived.

Sayer and colleagues also studied mature loblolly pines growing in a plantation during a drought. These trees were in different soil and planted closer together than those in the previous study. When the highest of three amounts of fungus was put into the trees, their crowns deteriorated and sapwood growth decreased. If they could not produce new sapwood around the occluded sapwood, the trees died. With medium or low doses of fungus, though, the pines survived by forming uninfected sapwood that continued to transport water and nutrients.

“We found a way that trees can potentially tolerate this type of infection if they have enough carbon fixation and enough water to support the carbon fixation,” says Sayer. “It gives us ideas on how foresters can proactively manage on sites where decline is a risk.”

Read the 2021 study in Fungal Ecology.

Read the 2020 study in Trees.

For more information, email Mary Anne Sword Sayer at mary.sword@usda.gov.

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