Tree Heartwood Extracts Halt Sudden Oak Death

In the mid-1990s, a new plant disease surfaced on the West Coast and quickly spread through several counties in California and Oregon. Sudden oak death (SOD) is, as the name implies, a rapidly spreading disease that can kill or injure several oak species and more than 100 other plant species.

While most known host plants suffer only minor leaf and twig damage, the disease is devastating for susceptible oaks and tanoaks. The California Oak Mortality Task Force estimates that more than 1 million trees are currently infected and at least that many have already died.

Scientists have not yet found a cure for SOD, but help may be on the way. Daniel Manter, a plant physiologist in the ARS Soil Plant Nutrient Research Unit at Fort Collins, Colorado, working with Rick Kelsey, of the USDA Forest Service, and Joe Karchesy, at Oregon State University, have found that extracts from tree heartwood can limit the growth and sporulation of the agent that causes SOD. The extracts can't cure infected trees, but they could be used to halt the disease's spread.

PEGGY GREB (D1085-1)

Technician Susan Crookall prepares to extract compounds from Alaska yellow cedar heartwood for antimicrobial activity testing.

Sick to Death: Oaks in Trouble

The fate of a SOD-infected oak is grim. Its leaves turn pale, then brown. Bark splits and cankers appear on the surface, secreting a burgundy, saplike ooze. New shoots wilt and die. Beetles begin to bore into the wood and eventually—often between 6 months to 2 years after the initial infection—the tree will die.

The source of this devastation is a funguslike microorganism, *Phytophthora ramorum*. Unknown before the 1990s, *P. ramorum* has since been discovered in several European countries. Though it has cropped up in nurseries in more than 20 U.S. states, in the wild it has not been observed outside of California and one county in Oregon.

P. ramorum causes the typical SOD symptoms in more than 30 plant species, including rhododendron, maple, honeysuckle, and California bay laurel. *P. ramorum* can also infect more than 100 other plant species, giving rise to a milder foliar disease called "ramorum blight." Though generally nonfatal, these infections render ornamental plants unmarketable and have the potential to harm the $16 billion U.S. nursery, landscape, and floral plant industry.

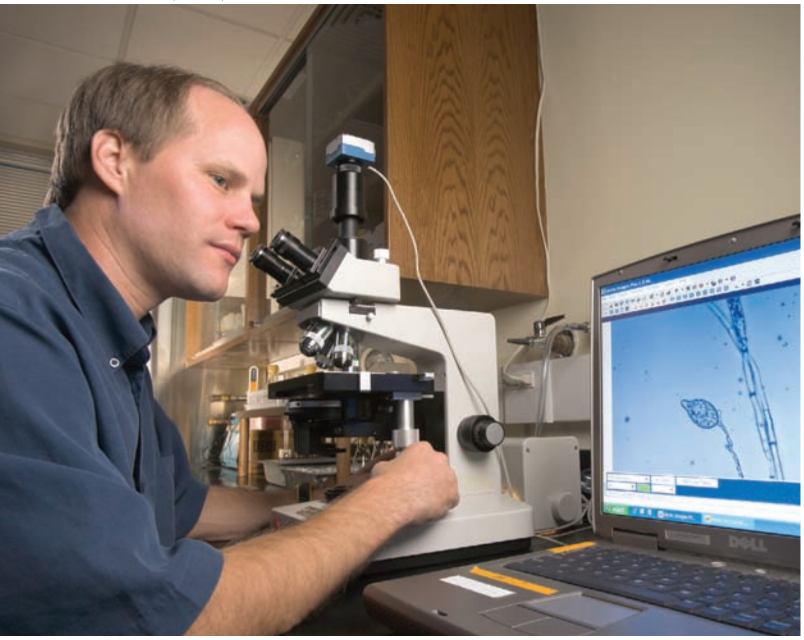
P. ramorum is related to other *Phytophthora* species that seriously affect economically valuable crops such as sugar beets, potatoes, and soybeans. Knowing how to protect against *Phytophthora* species could have additional agricultural benefits.

Plants that succumb to SOD without dying still act as vectors, or carriers, increasing the likelihood that the disease will reach—and kill—other vulnerable plants. Though many plant species are known to host *P. ramorum,* they vary in susceptibility. This variation may be influenced by elicitins—*Phytophthora* proteins that are related to resistance of certain diseases.

Working with Kelsey and Karchesy, Manter isolated two elicitins and showed that, when applied to leaves, both elicitins started a decline in photosynthesis in three *P. ramorum* hosts. Further study could determine whether variations in how host plants respond to elicitin exposure correlate to their SOD susceptibility.

To date, there is no known cure for SOD, so management strategies focus on preventing it from moving to new hosts. Manter and his colleagues tested the effectiveness of heartwood from a variety of trees in destroying fungal spores—the main means of dispersal for *P. ramorum*.

PEGGY GREB (D1084-1)



Plant physiologist Daniel Manter takes a closer look at a *Phytophthora* culture. *P. ramorum* is the microorganism that causes sudden oak death.

Straight From the Heartwood

For years, scientists have known that tree heartwood—the older, nonliving wood—contains protective antimicrobial compounds. The compounds found in the heartwood of Alaska yellow cedar, for example, are known to prevent decay for up to a century after the tree has died. Compounds from the heartwood of several other conifer species are known to have similar antimicrobial properties. Could any of these compounds offer protection against *P. ramorum*?

To find out, the scientists exposed *P. ramorum* spores to various compounds, wood chips, and essential oils extracted from heartwood. They found that extracts from incense cedar, western red cedar, Alaska yellow cedar, western juniper, and Port Orford cedar exhibited antimicrobial activity against *P. ramorum*—destroying the spores and inhibiting the growth of fungal cells.

"Under a microscope you can actually see the spores explode," Manter says. "The outer membrane ruptures and releases the cell contents after it's been exposed to the extracts."

Extracts from western red cedar and incense cedar damaged twice as many spores as those taken from Alaska yellow cedar, western juniper, and Port Orford cedar. Douglas fir and redwood extracts, which were also examined in the study, showed little to no antimicrobial activity against the pathogen.

The potential application of these heartwood compounds is not limited to *P. ramorum.* Similar levels of activity have been observed in trials using *P. sojae* and *P. erythroseptica,* two *Phytophthora* species that attack agricultural crops.

The chemical composition of heartwood varies among individual trees, Manter says. Further studies are needed to confirm which compounds offer the best protection against SOD.

"Individual heartwood compounds might be developed into environmentally friendly fungicides that could protect plants against *P. ramorum* infection," he says. This is particularly important work because no effective commercial fungicides are being used in the United States to counter the spread of SOD.

Using tree heartwood extracts has the potential to be an easy-to-implement, environmentally friendly, and effective method of SOD control. Western red cedar, Manter says, is the best candidate, because it is extremely effective and the trees grow naturally in the continental United States. Yellow cedar, though somewhat less effective, is abundant in Alaska and can also be processed into shavings, sawdust, or wood chips.

Lightweight and easily transportable, these antimicrobial materials could be distributed without further processing in areas with high human activities—such as park trails, walkways, and bike paths—to reduce spore movement and prevent eastward spread of the disease.—By **Laura McGinnis,** ARS.

This research is part of Soil Resource Management (#202), an ARS national program described on the World Wide Web at www.nps.ars.usda.gov.

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PEGGY GREB (D1086-1)

Technician Susan Crookall (left) and biological science aide Brittelle Bowers begin an analytical gas chromatography run.