

<i>DESCRIPTION:</i>	Studies in the Biology and Control of Oak Root Fungus
<i>PROJECT LEADER:</i>	Dave Risso – UC Davis
<i>2002 FUNDING:</i>	\$8,163
<i>FUNDING SOURCE:</i>	California Pear Advisory Board

STUDIES IN THE BIOLOGY AND CONTROL OF OAK ROOT FUNGUS

Project Report 2002

Project leader: Dave Rizzo, Department of Plant Pathology, University of California, Davis

Collaborator: Rachel Elkins, University of California Cooperative Extension,
Lake and Mendocino Counties

Summary

Armillaria root disease is an important disease of pears that is apparently increasing in prevalence. Over the past four years we have conducted a number of studies into the basic biology of the pathogen. Our data supports several conclusions: 1) Much of the increase in Armillaria root disease in pears is due to changes in cultural practices, most likely irrigation, rather than changes in pathogen populations; 2) Spread of the pathogen is primarily by growth of rhizomorphs through the soil, with root to root contact being a minor form of spread; 3) Rhizomorphs rarely extend greater than 30 cm into the soil; 4) Initial infection is as likely to take place at the root collar as on peripheral parts of the root system; and 5) Pear trees appear to tolerate infections on peripheral parts of the root system, but decline quickly when infection reaches the root collar.

Progress to Date:

Evaluation pre-plant and post-plant treatments chemical controls

We are currently testing both pre-plant and post-plant treatments in Lake County utilizing several different fungicides. Following the initial treatments the orchards are monitored each year for symptoms associated with Armillaria root disease. Because of the nature of this disease we do not expect to see dramatic results each year. However, it is important to continue to observe these trials. Post-plant trials are intended to test the possibility of prophylactic protection against infections by rhizomorphs, now thought to play a large role in infecting pear trees on the North Coast.

We are continuing to monitor a trial in Lake County. Treatments were applied in 1998-2001 according to label instructions to randomly selected replant sites in *Armillaria*-infected pear orchards planted in loam or sandy loam soils in Scotts Valley and Upper Lake. The following treatments have been applied:

1. metam sodium (Vapam), 2 qts./100 gpa (pre-plant only) (through 2000)
2. Sodium tetrathiocarbonate (Enzone), 2.5 gallons /site pre-plant alone or followed by 1 pint per 100 gallons post-plant each year in nonbearing years)
3. untreated control

The systemic fungicide propiconazole (marketed under several different trade names, Syngenta Corp.) was dropped as a treatment in 2001 due to a lack of company interest in registration for pears. The Vapam treatment was also dropped in 2001 due to grower concern about phytotoxicity.

Prior to treatment, diseased trees and accompanying soil were removed to a depth of about 6 feet by backhoe. All visible roots to about ½” diameter were removed by hand from the hole and surrounding soil. The hole was then refilled and material applied by hand from a spray tank. Applications were timed to ensure uniform volume at each site.

Growth was measured after the trees became dormant each year utilizing calipers at 10 cm above the graft union. Differences between treatments began to show in 2002 as the average caliper of trees treated with Vapam® were smaller than the other treatments (data not shown). Several trees in the treatments and controls died in 1999-2001, although not from *Armillaria*. No tree deaths occurred in 2002. (Table 1).

Table 1. Oak Root Fungus Control Project, 1998 to 2002 - summary of tree deaths at Ivceovich Orchard, Scotts Valley, Lake County.

Treatment	Year of Tree Death				Total Tree Deaths
	1999	2000	2001	2002*	
Vapam	K-14	G-6		0	2
Pre + post Enzone			G-7 N-11		2
Pre Enzone			H-5 H-6		2
Control			J-11 K-12		
		V-9			3

* no tree deaths occurred in 2002

Control of *Armillaria* by root crown excavation

In 1998, the root systems of 21 mature pear trees were excavated at a Lake County orchard. The trees were located within and on the edge of known *Armillaria* infection centers. This work was originally done in conjunction with monitoring the infection center for water stress. Root systems were excavated using super sonic air excavation system. Soils were removed from around the trees by an air jet flowing at 330 cfm at 100 psi. The root systems were excavated to a minimum diameter of 2 meters and a minimum depth of 1 meter. Following soil removal, root systems were individually dissected using hand tools. Using this method, we were able to view the root systems of the trees as they would naturally appear. As with our previous excavations, there was a general lack of root overlap between adjacent trees. No between-tree root contact was detected. There was no consistency in root architecture among the excavated

trees; trees had between 4 and 9 major lateral roots. In many instances, large lateral roots made sharp turns when they encountered the more compact soils between the rows of trees. Fibrous roots were found primarily at the peripheral areas of the root systems.

Prior to excavation, tree crowns were visually rated on a scale of 1 to 5 (1, healthy, full crown with good shoot growth; 2, reduced top shoot growth; 3, most shoots with reduced growth; 4, dieback evident, leaves small and lighter in color; 5, dead.) (Table 2). Signs of *Armillaria* were found on 11 of the 21 trees. *Armillaria* was mostly found in the form of discrete lesions scattered on root surfaces. These lesions ranged in size from several square centimeters to large lesions covering hundreds of square centimeters. All trees were left with the root systems exposed for the next year.

Of the 11 trees with *Armillaria* detected on their root systems 1998, four trees have been removed (Table 2). One tree was observed to have died between 1998 and 1999. Three trees were removed during 1999-2000; these trees were not examined before removal. Each of these trees originally had evidence of dieback. On the other 7 trees, *Armillaria* mycelial fans that occurred above the soil line were no longer viable one year after excavation. Mycelial fans were generally discolored and dry. In several instances, mycelial fans could not be relocated one year later. Isolations made from this tissue were negative for *Armillaria*. In all cases, *Trichoderma* species were isolated from the mycelial fans. *Trichoderma* is a soil-borne fungus that is well-known biological control agent. Commercial formulations of the fungus are available. However, all *Trichoderma* isolates from our plots were native to the orchard.

Overall vigor of the trees improved for the seven remaining trees over the first three years of observation. This year, three trees had the same crown rating in 2002 as 2001. However, four trees showed more dieback and crown thinning this year than in 2001. This appears to be due to the fact that the excavations are filling back in with soil and other debris. The root collar area is no longer exposed on these trees. On at least one tree, *Armillaria* had worked its way back up to the soil line and was observed for the first time in 3 years. This suggests that the treatments does not eliminate *Armillaria* but rather creates an environment where the pathogen is unable to successfully colonize the most vulnerable parts of the tree.

Most pear trees are planted with the root collar up to 50 cm below the soil line. Our previous research has shown that pears may be tolerant of infection on roots, but succumb quickly when infection is at the root collar. In many studies it has been shown that *Armillaria mellea* rarely colonizes trees above the soil line. Exposure of the root collar region may have several effects: 1) keep the bark dry and offset the influence of excessive moisture; 2) prevent initial infection of the root collar by rhizomorphs and restrict infections to peripheral parts of the root system; and 3) allow for recovery of infected tissues. It is our recommendation that all new pear trees be planted with the major roots and root crown as close to the soil surface as possible. It is also becoming clear that excavated trees be monitored at least once each year and that excavations are repeated as necessary to keep the root collar exposed on mature trees.

New root blasting trial

A large trial is being established in Scotts Valley in an orchard heavily infected with *Armillaria*. Nearly 500 mature trees were rated for vigor on October 8, 2002. The crown and upper roots of these trees will be excavated using an Air Spade® Handtool, Series 2000 (Concept Engineering Group, Inc., Verona, PA). Tree survival and vigor ratings will be assessed each spring and fall following treatment.

Table 2. Status of root excavation experiment. All trees were observed with *Armillaria* on roots in 1998. Tree crown vigor ratings: 1, healthy, full crown with good shoot growth; 2, reduced top shoot growth; 3, most shoots with reduced growth; 4, dieback evident, leaves small and lighter in color; 5, dead.

Tree Number	Crown Vigor 1998	Crown Vigor 1999	Crown Vigor 2000	Crown Vigor 2001	Crown Vigor 2002	<i>Armillaria</i> Status 2000
P13	2.5	2.5	1.5	1.5	1.5	No <i>Armillaria</i> noted
Q12	3	3	2	2	3.5	Excavation has filled back in, <i>Armillaria</i> has returned to soil line
Q13	4.5	5	-	-	-	Tree removed 1999
BB8	2	1.5	1	1	1	No <i>Armillaria</i> noted, <i>Trichoderma</i> noted on N side roots.
CC8	3	3	3	2	2.5	No <i>Armillaria</i> noted, heavy sucker growth, , Excavation filling back in
CC9	4	3.5	-	-	-	Tree removed 2000
CC12	4	3.5	1.5	1	2	No <i>Armillaria</i> noted, Excavation filling back in
DD8	4	4	-	-	-	Tree removed 2000
DD9	3	3	2.5	2.5	3	No <i>Armillaria</i> noted, Excavation filling back in
EE12	4	4	3.5	2.5	2.5	No <i>Armillaria</i> noted.
EE13	4	4	-	-	-	Tree removed 2000