Pear Research Advisory Board

Project Report 2000

STUDIES IN THE BIOLOGY AND CONTROL OF OAK ROOT FUNGUS

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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 ~~has~~ 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 preplant and postplant treatments chemical controls

We are currently testing both preplant and postplant 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. Postplant 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.

Two trial sites have been established in Lake County. Three treatments were applied in spring 1997, spring 1999, and spring 2000 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. Continued post-plant applications were made in 1999 and July 2000. The following treatments have been applied:

1. metam sodium (Vapam®), 2 qts./100 gpa (pre-plant only)
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. propIconAzole (Orbit) (post plant only)
4. untreated control

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 in April 1998, November 1999, and November 2000 utilizing calipers at 10 cm above the graft union (Table 1). Differences between treatments were not significant. Three trees in the Vapam treatments and one control tree have died in the first year, although not from *Armillaria*. Additional replications will be added in 2001 to the original sites; new orchards will also be added in 2001.

Table 1. Caliper data after three years from pre-and post plant treatments in Lake County.

Scotts Valley overall caliper data, 1999 & 2000 treatments			
Treatment	**Number of Trees**	**1999 Average Diameter (mm)**	**2000 Average Diameter (mm)**
Vapam	17	20.69	27.52
Enzone, pre- only	9	22.37	25.91
Enzone, pre- & post-	7	33.67	45.68
Orbit	4	25.25	33.86
Control	10	34.35	45.80

Upper Lake 1999, 2000 Caliper Measurements. Diameter (mm)			
Treatment	**Number of Trees**	**Average Diameter (mm)**	**Average Diameter (mm)**
Vapam	12	22.83	34.11
Enzone, Pre- & Post-	5	25.81	43.89
Orbit	9	24.07	35.56
Control	8	24.79	35.60
Enzone, Pre-	7	26.25	38.64

Control of Armillaria with mustard

Wild mustard is an indigenous weed in California. *Brassica* spp. are known to have sulfur compounds which have anti-fungal activity. Residues of cruciferous plants incorporated as soil amendments reduce incidence of disease from several important fungal plant pathogens, including *Rhizoctonia solani*. In our studies in 1997, radial mycelial growth of *Armillaria* was inhibited in the presence of water extracts from wild mustard seed. Growth of all isolates tested averaged 66% that of the control at the 50% dilution, and averaged 61% that of the control at the 80% dilution. Radial mycelial growth of all isolates tested was also reduced in the presence of

macerated mustard plant tissue. Radial growth was 49-80% of the unamended control.

We have established a field trial in Lake County to determine the efficacy of mustard in controlling the spread and impact of *Armillaria* in a commercial orchard. A replicated experiment of paired treatments (four pairs) was planted in fall 2000. The total experiement covers approximately 8 acres. Seed (10 lbs./acre) was broadcast in row middles, leaving tree rows bare as much as possible. Selections of Cutlass Indian mustard was utilized. *Armillaria* infection presence and severity at the site has been previously mapped at this site. In addition, individual genotypes of the pathogen have also been mapped. Because of this we have true replication of the treatment; i.e., the same genotype of the pathogen is receiving different treatments. Changes in pathogen distribution and tree condition will be monitored over the next several years. The mustard will be re-seeded if necessary to increase biomass.

Biology of Armillaria in pear orchards

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 done in conjunction with monitoring the infection center for water stress (~~see~~ K.Shackel project report). 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 100psi. 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 visualize 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 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. Of the seven remaining trees, overall vigor has

improved for six; one tree has had the same crown vigor rating for 3 straight years. Water status of these trees has also continued to improve (K. Shackel, 2000 project report).

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.

Future Plans

Development of effective controls for Armillaria root disease is a long term project. Research in 2001 will focus on: 1) establishment of additional chemical-control trials and monitoring of existing trials 2) continuation of long-term irrigation plots and short term studies on the effects of water on *Armillaria* inoculations of the various rootstocks; and 3) studies into the effectiveness of root collar excavations as a control of the disease. We will also initiate screening of newly developed rootstocks for resistance to *Armillaria*.

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**	***Armillaria* Status 2000**
P13	2.5	2.5	1.5	No *Armillaria* noted
Q12	3	3	2	No *Armillaria* noted
Q13	4.5	5	-	Tree removed 1999
BB8	2	1.5	1	No *Armillaria* noted, *Trichoderma* noted on N side roots.
CC8	3	3	3	No *Armillaria* noted, *Trichoderma* present on root surfaces; old lesions scattered
CC9	4	3.5	-	Tree removed 2000
CC12	4	3.5	1.5	No *Armillaria* noted
DD8	4	4	-	Tree removed 2000
DD9	3	3	2.5	No *Armillaria* noted
EE12	4	4	3.5	No *Armillaria* noted. *Trichoderma* on root surfaces.
EE13	4	4	-	Tree removed 2000