Project No. 93-T19B - Studies on Control Armillaria Root Rot and Other Wood Decay of Almonds

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Objectives:

1. To continue to evaluate fumigants used in the polt established in 1992 in regard to tree survival.
2. To critically determine the species of Armillaria in California almond orchards and to relate this information to current concepts in taxonomy, biology, and populations in an orchard.
3. To evaluate systemic fungicides as control strategies against wood decay fungi.

Results:

In the central valleys of California, Armillaria root rot caused by the putative species *Armillaria mellea* (Vahl.: Fr.) Kummer is a lethal disease of *Prunus* and other tree species. The disease has been controlled with some success with soil fumigants such as methyl bromide or Enzone (e.g. CS2, MeBr) and resistant rootstocks, but not with other fungicides.

1) ***Evaluation of fumigants.*** In an almond orchard with numerous trees infected with *Armillaria*, infected trees were removed and sites were prepared for fumigation. The following treatments will be done: (1) Preplant Enzone or tetrathiocarbonate (TTC forms CS_2); (2) Pre- and Postplant TTC; (3) Postplant TTC; (4) Preplant TTC/*Trichoderma* & Postplant TTC/*Trichoderma*; (5) Preplant Methyl Bromide; and (6) Nontreated check sites. Additionally, infected root segments were buried at two depths (1 and 3 ft) prior to treatment and sampled at two time periods (5 and 12 months) after fumigation. The orchard was replanted with the susceptible peach rootstock Lovell. **None of the fumigation treatments eradicated the fungus from the buried root segments after 5 or 12 months. After 1 year, however, a significant reduction in the recovery of the fungus from buried root segments was shown from methyl bromide, pre-plant TTC, and pre-/post-plant combination treatments of TTC as compared to the check.** After 10 and 22 months, none of replant trees including the check died due to Armillaria root rot. As expected, Armillaria root rot requires several years to develop. Tree survival decreased only slightly in the pre- and post-plant

treatment of TTC. In the post-plant TTC treatment, tree survival due to phytotoxicity decreased significantly compared to the other treatments. In additional studies, trees that died from Armillaria root rot were cut down and the stumps were treated with the fumigants metam sodium (Vapam), TTC-liquid formulation, and TTC-gel formulation. Survival of the fungus in treated stumps is currently being evaluated.

Registration of TTC (Enzone) for the control of Armillaria root rot may provide an effective alternative control practice to methyl bromide for this disease. Potentially, with the use of resistant rootstocks (e.g. Mariana 2624 for certain cultivars), TTC as pre- and postplant fumigation treatment, and with systemic fungicides such as propiconazole growers may be able to replant into infection centers of *Armillaria* and thus, be able to effectively manage Armillaria root rot and other wood decay fungi of almond. Currently, a Section-18 has been approved for pre- or postplant use of Enzone for control of *Phyloxera* on winegrape.

2) ***Biological studies***. Mating-type and vegetative incompatibility studies demonstrated that the fungus causing Armillaria root rot of almond in California is *Armillaria mellea*. For this, fruiting bodies of the fungus were collected from an infection center, single-spore isolates were retrieved, and pairings of isolates were done. Additionally, mating tests were done with tester strains to confirm the species of *Armillaria* based on current taxonomic understandings. This research was done in cooperation with the University of Minnesota and the USDA, Forest Products Laboratory in Madison, WI.

3) ***Evaluation of Systemic Fungicides.*** Propiconazole (Alamo 1.1EC) was evaluated as protective or therapeutic treatments against Armillaria root rot caused by *Armillaria mellea*. In laboratory studies, potato-dextrose agar (PDA) was amended with the fungicide Alamo 1.1EC to give a final concentration of 0.01, 0.1, 1.0, or 10.0 μg/ml propiconazole (a.i.). For each of 3 isolates, a 4-mm diam. agar plug was placed on PDA or fungicide amended PDA. Colony diameter was measured weekly for 4 wk. The $\log_{10}$ of fungicide concentration was regressed on the probit of the percent reduction of growth. The model was significant ($P < 0.05$) and linear ($R^2 = 0.88$). The equation was $Y = -0.82 + 0.5X$ and the EC_{50} was calculated as 0.15 μg/ml. Propiconazole was completely inhibitory at concentrations of 10 μg/ml.

In June 1992 and 1993, therapeutic passive injections of Alamo (400 μg a.i./ml) were made in five, 7- or 8-yr old almond trees (Lovell peach rootstock) infected with the fungus. On a rating of 0 to 4 (4=death), initial mean disease severity (DS) ratings were 1.8 for treated and 2.0 for nontreated trees. In 1992, after 5 months, all treated trees were alive (DS=1.8), whereas 4 of 5 nontreated trees were dead (DS=3.6). In 1993, the same trees were rated (DS=2.0), treated again in June, paired with non-treated trees (DS=2.0), and evaluated after 5 months. Four of the five treated trees (DS=2.5) survived another season; whereas four of the five trees in the second set of non-treated trees died (DS=3.8). Foliar applications and preharvest soil drenches of propiconazole (Orbit 3.6EC, Alamo 1.1EC) are currently being evaluated as a noninjurious application method for preventative control and as a possible compliment for fumigants for control of this disease.