REPLANTING ALMOND AND STONE FRUIT ORCHARDS WITH LESS FUMIGANT: A RESEARCH UPDATE

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We are conducting team research on management of almond and stone fruit replant problems with little or no soil fumigant. Elements of the work include 1) unraveling the etiology of the Prunus replant disease (PRD) complex, 2) developing methods to predict PRD incidence and severity, 3) facilitating commercial use of GPS-controlled spot fumigation of tree sites, 4) testing of anaerobic soil disinfestation (ASD) for control of PRD, and 5) selection of rootstocks with improved resistance or tolerance to soilborne pathogens, including the PRD complex and *Phytophthora* species. Current status of our work in these areas is highlighted below.

Etiology of the PRD complex. Among 10 species of *Pythium* that we found associated with PRD, five were pathogenic, significantly reducing root and shoot weights of Nemaguard peach in repeated greenhouse experiments. The pathogenic species were re-isolated and identified from the inoculated, diseased greenhouse plants to fulfill Koch's postulates. Compared to the pathogenic species of *Pythium*, *Cylindrocarpon macrodidymum*, which we previously associated with PRD at some sites, caused less disease. In greenhouse trials, we are currently examining interactions among *Trichoderma* species, which become abundant on roots of almond and peach trees replanted in fumigated soil, and the pathogenic *Pythium* and *Cylindrocarpon* species. Since our results indicate that *Pythium* species contribute to PRD at some orchard replant sites, we will test use of oomycete fungicides for management of the complex in field settings.

Methods to predict PRD incidence and severity. We hypothesize that although PRD etiology may vary among orchards, there are likely key causal organisms that contribute to the complex in predictable ways in most replanted orchards, depending on soil type and other edaphic factors. We have developed a greenhouse bioassay to test this hypothesis using soils from many orchard locations in the Central Valley of California. The objectives of this soil testing are: 1) to further validate the greenhouse bioassay for predicting incidence and severity of PRD in replanted orchards, 2) to learn about consistency of PRD etiology and expression among diverse almond and peach replant soils, and 3) to support development of practical DNA-based assays that detect and quantify key PRD agents in soils of orchards, thereby providing molecular methods to predict PRD. For initial tests of the greenhouse bioassay, we collected replant soil from two commercial orchards (one standing, the other cleared of trees, neither fumigated) and one experimental orchard (cleared, with fumigated and non-fumigated plots). The bioassay results indicated usefulness of the assay: growth of Nemaguard peach seedlings was stunted in each of the non-fumigated replant soils (i.e., from the commercial orchards and the non-fumigated portion of the experimental orchard), compared to growth in the soil from the field-fumigated

plot. Pre-plant pasteurization or fumigation of the collected soils resulted in optimal growth in all soil portions, whether or not they had been fumigated in the orchard from which they were collected. We have initiated soil collections in both the San Joaquin and Sacramento Valleys for bioassay testing in 2013/14.

GPS-controlled spot fumigation. In work with TriCal, Inc. we have developed and validated GPS hardware and software for pre-plant spot fumigation of tree planting sites in orchards being replaced. However, the technology needs further use in commercial settings to stimulate commercial adoption of the system. Recent advances in the precision and general availability of GPS data are facilitating this process. In 2013 and 2014, we will work with TriCal, Inc. and commercial growers to commercially implement the GPS-controlled spot fumigation system.

Anaerobic soil disinfestation. We have established two trials for initial evaluation of ASD for management of PRD of almond. The trials are established at Kearney Ag Center, near Parlier, CA. ASD is being compared with conventional pre-plant soil fumigation in two orchard settings, with and without sudan grass rotation and deep pre-plant soil ripping. The ASD treatments have generated and sustained desirable negative reduction potentials to at least 18" in soil depth in a Hanford Sandy loam soil. The plots will be planted to almond in 2014.

Rootstock development. We are evaluating resistance of commercially available and novel rootstocks for almond and stone fruits to the PRD complex and to *Phytophthora* species. PRD resistance is being evaluated in replicate fumigated and non-fumigated orchard plots, while Phytophthora resistance is being evaluated in greenhouse trials. Although all tested rootstocks (among 22 tested to date) have exhibited some susceptibility to PRD, some of the genotypes have been more tolerant than others. Most genotypes with only peach parentage have been highly susceptible to the PRD complex in nonfumigated soil, but 'Empyrean 1', also a peach, has had relatively low susceptibility. Hybrid rootstocks that combine peach and almond parentage have been less susceptible to PRD than most peaches. Rootstocks with plum parentage have varied in susceptibility to PRD. Among the rootstocks with peach and almond parentage, high levels of inherent vigor corresponded with resistance to the PRD complex and, conversely, susceptibility to *Phytophthora niederhauseri*. Continued rootstock development and integrated soilborne disease control strategies will be essential for reducing dependence on soil fumigation.

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