Diagnostics and Non-Fumigant Management Approaches for Prunus Replant Disease

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BACKGROUND, PAST FINDINGS

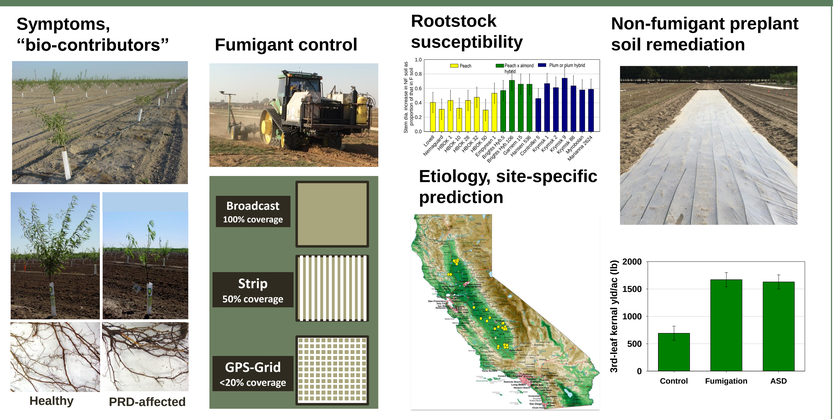

Fig. 1. This project has had a long-term focus on the biology and management of almond replant disease (RD), which is biologically mediated and can occur in the absence of plant parasitic nematodes. RD suppresses root development, slowing canopy development and delaying yield (**A**). We determined the optimal preplant soil fumigation practices to prevent RD; GPS-controlled spot treatment with fumigants containing chloropicrin is sufficient and uses little material (**B**). We determined that peach x almond hybrid rootstocks are less susceptible to RD than peach rootstocks (**C, top**). In statewide bioassay trials with replant soils (**C, bottom**), incidence and severity of RD varied significantly, suggesting a need for predictive diagnostics and further RD characterization. In small orchard plots, anaerobic soil disinfestation (ASD) was as effective as optimal preplant soil fumigation for control of RD (**D**). ASD, developed first in the Netherlands and Japan, uses readily available carbon, high soil moisture, and tarp to generate anaerobic conditions, organic acids, and volatiles that, can kill or suppress soilborne pathogens. Further research is needed to improve feasibility and affordability of ASD for orchards.

Objectives

1) Develop molecular diagnostics for prediction and characterization of RD.
2) Optimize anaerobic soil disinfestation (ASD) for affordability and ease of commercial implementation.

Objective 1, Microbial community analysis steps

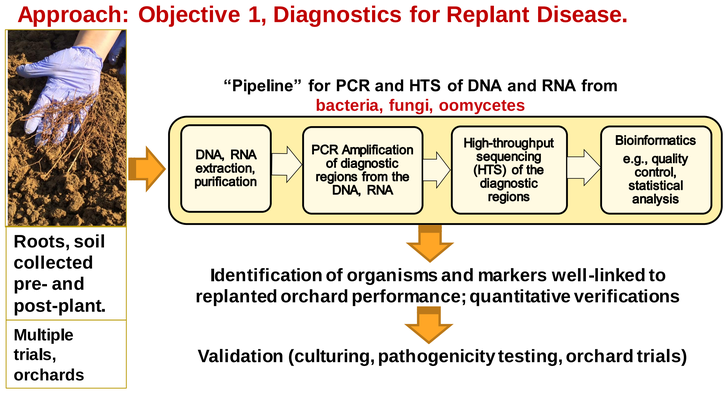

Fig. 2. Approach being used to characterize microbial mediation of replant disease and develop predictive diagnostics for the complex.

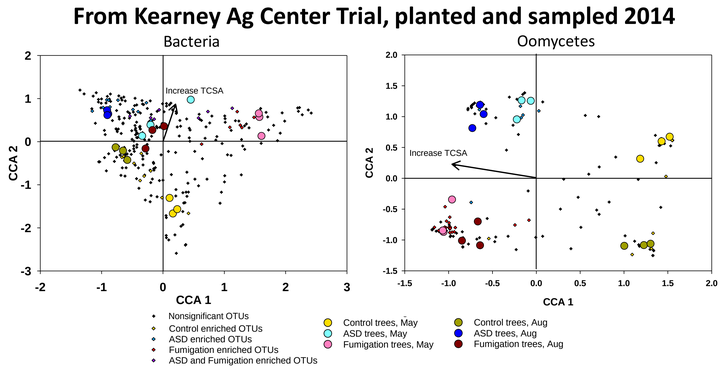

Fig. 3. Canonical correspondence ordination analysis being used to determine how microbial community shifts relate to preplant soil treatments and increases in trunk cross sectional area (TCSA).

Objective 1: Microbial Community Analysis, cont.

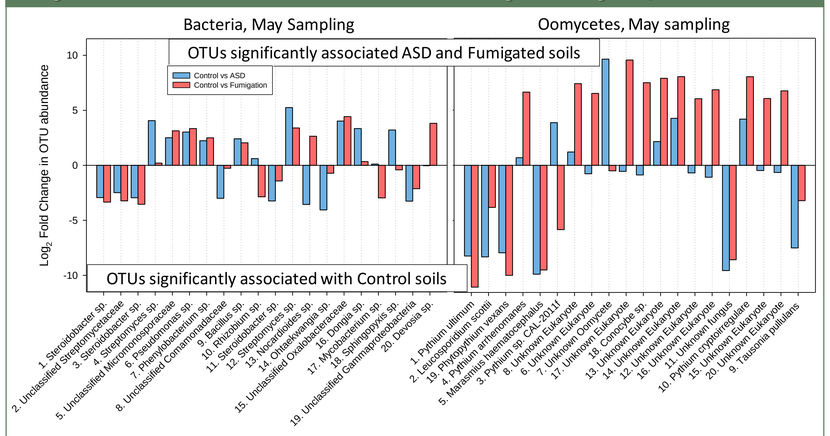

Fig. 4. Summary of DESeq2 analysis for bacteria and oomycetes of highest relative abundance on roots from RD-affected trees in control plots and from healthy trees in ASD treated and fumigated plots, Parlier trial sampled May 2014.

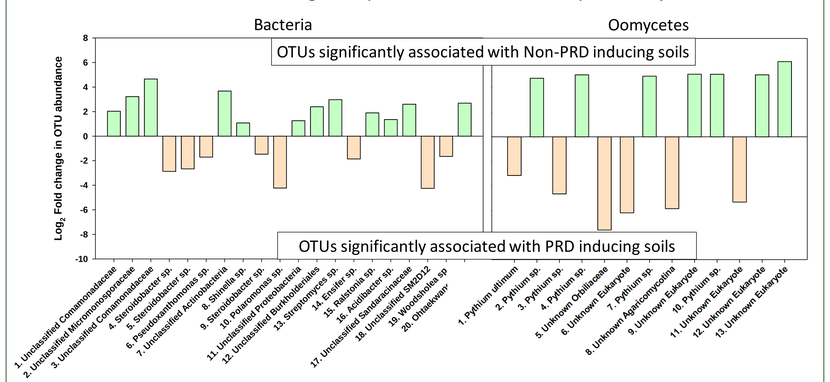

Fig. 5. Summary of DESeq2 analysis for bacteria and oomycetes of highest relative abundance in roots collected from statewide replant soil survey. Soils were classified as PRD-inducing or non-PRD inducing based on growth of Nemaguard peach seedlings, in a greenhouse bioassay.

Objective 2: 2017 ASD trial at CSU Fresno

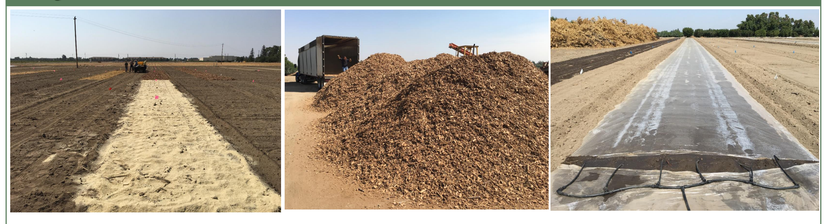

Fig. 6. Scenes from establishment of the 2017 ASD trial, CSUF. Elements of ASD optimization treatments being tested include different ASD carbon substrates, i.e. rice bran, almond hull and shell mixture, and tomato pomace. The almond hull and shell medium was applied at three different rates (9, 12, and 16 tons/ac), with and without ammonium sulfate and whole orchard recycling chips. The rice bran and almond hull and shell carbon sources were applied: (i) without tarp or water; (ii) with water but no tarp; and (iii) with tarp and water, to determine the value of the carbon source alone, and the additional value of water and tarp components.

Objective 2: 2016 ASD trial at Parlier

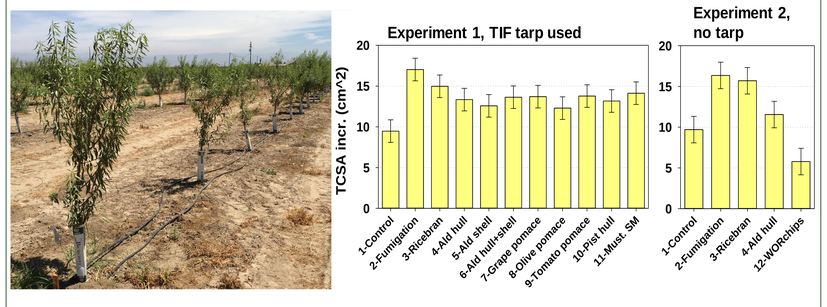

Fig. 7. First-year tree growth responses to treatments being tested in the two trails trial at Parlier (increases in trunk cross sectional area from the time of planting to November, 2017).

Objective 2: 2016 ASD trials in Kern County

Table 1. Treatments in almond hull+shell ASD & whole orchard recycling trials at Wonderful Orchards (Fig. 8).

Mainplot treatment	Subplot treatment	Subplot treatment details
No orchard recycling chips	Control	--
	ASD	Almond hull:shell substrate; 4-drip line soil wetting + TIF tarp; 4 weeks
	Strip fumigation	11.7 ft-wide strips, down tree rows
	Spot fumigation	8 x 8 ft spots, centered on tree sites
Recycled almond orchard chips	Control	--
	ASD	Almond hull:shell substrate; 4-drip line soil wetting + TIF tarp; 4 weeks
	Strip fumigation	11.7 ft-wide strips, down tree rows
	Spot fumigation	8 x 8 ft spots, centered on tree sites

Table 2. Treatments in rice bran ASD-optimization trials at Wonderful Orchards (Fig. 9).

Treatment number and name	ASD treatment component included: Rice bran; 9 tons/treated ac	Soil water at ~field capacity during treatment	TIF tarp covering, row strip	Fumigation treatment included: Row strip; 1,3-D, 340 lb/ac + Pic 200 lb/ac; treated area 50%	Tree spot; 1,3-D, 340 lb/ac + Pic 200 lb/ac; treated area 16%
1. Control	-	-	-	-	-
2. Rice bran + water + tarp (ASD)	+	+	+	-	-
3. Substrate	+	-	-	-	-
4. Water	-	+	-	-	-
5. Tarp	-	-	+	-	-
6. Rice bran + water	+	+	-	-	-
7. Rice bran + tarp	+	-	+	-	-
8. Water + tarp	-	+	+	-	-
9. Strip fumigation	-	-	-	+	-
10. Spot fumigation	-	-	-	-	+

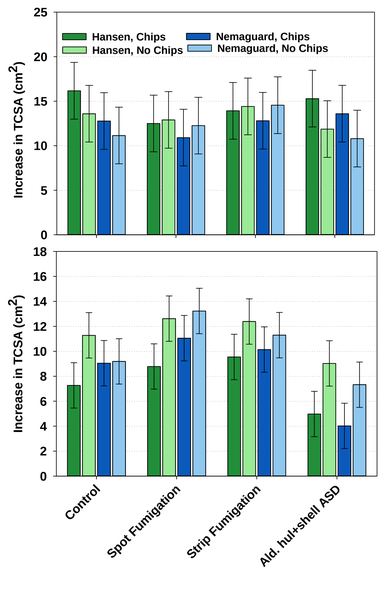

Fig. 8. Top graph, Ranch 3371; **Bottom graph**, Ranch 3381.

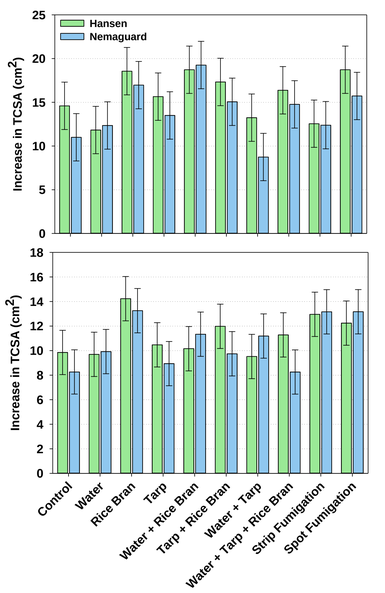

Fig. 9. Top graph, Ranch 3371; **Bottom graph**, Ranch 3381.

Objective 2: First gen ASD trials, Kearney Ag Center

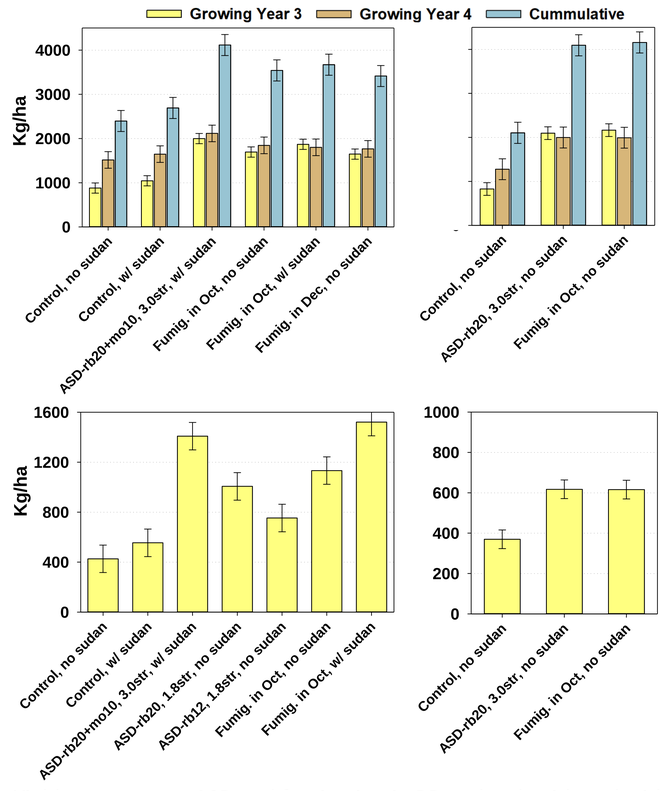

Fig. 10. Yield responses to ASD and fumigation in RD orchard, with and without preceding sudangrass rotation. **Top graphs**: orchard removed 2013, replanted 2014. **Bottom graphs**: orchard removed 2014, replanted 2015.

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