Developing Improved Strategies for Management of Replant Problems

Greg Browne[1], Leigh Schmidt[1], Natalia Blackburn[2], Michael Devengenzo[2], G. Brar[2], D. Doll[2], B. Holtz[2], S. Gao[1], D. Kluepfel[1], B. Lampinen[2], M. Aradhya[1], and C. Ledbetter[1]
[1]USDA-ARS, [2]UC Davis / UCCE

BACKGROUND AND OBJECTIVES

This project focuses on biology and management of replant problems, especially almond replant disease (RD). RD suppresses root development, slowing canopy development and reducing yield (**Fig. 1**). The disease is caused by a complex of soilborne microorganisms in almond replanted after almond or other stone fruits; it is separate from nematode-inflicted disease. We have determined that *Cylindrocarpon* and *Pythium* species contribute to the disease and are continuing work to elucidate additional RD causes (**Objective 1; Figs. 2,3**). Also, we are developing improved approaches to predict and manage RD with less dependence on soil fumigation (**Objective 2, Figs. 4-10**).

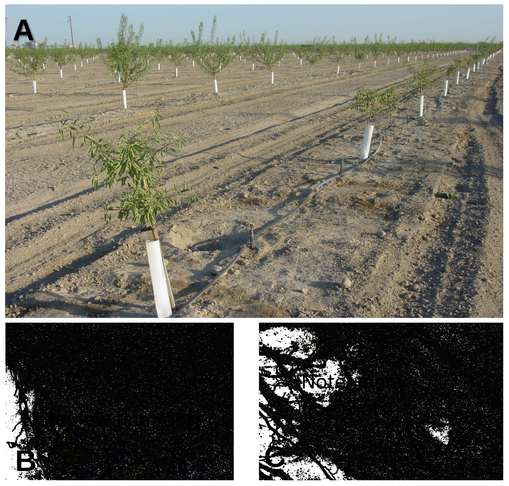


Fig. 1. A, Trees affected by replant disease (RD) in non-fumigated soil (foreground, right) and healthy trees in fumigated soil (background, left); **B,** PRD-affected roots from non-fumigated soil. and **C**, healthy roots from preplant fumigated soil.

DETERMINING RD CAUSES

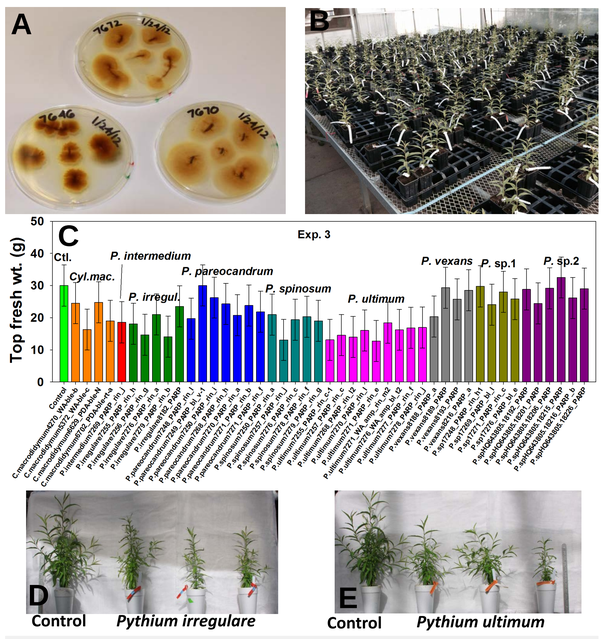


Fig. 2. Determining contributors to RD. **A**, Isolating microbes from affected roots; **B**, testing pathogenicity; **C**, Pathogenicity of *Cylindrocarpon* and *Pythium* species; **D** and **E**, stunting caused by *P. irregulare* and *P. ultimum*.

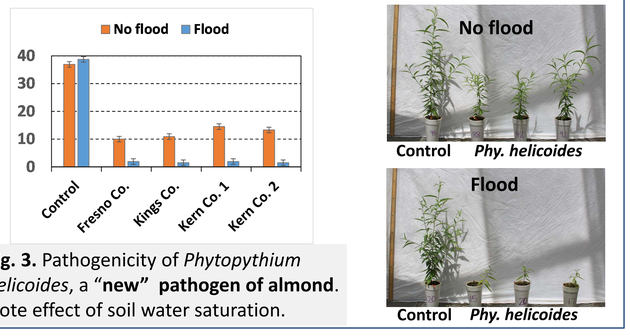


Fig. 3. Pathogenicity of *Phytopythium helicoides*, a "**new" pathogen of almond**. Note effect of soil water saturation.

BIOASSAY SURVEY, REPLANT SOILS

In fall 2014 we collected soils from 20 almond and stone fruit locations that were to be replanted or had been replanted in our previous trials. The soils were used for bioassays in a greenhouse. The purpose of the bioassays was to 1) see if they can predict severity of RD (and, therefore, the need to fumigate) 2) use them to gain knowledge on RD potential and contributing organisms among different soils.

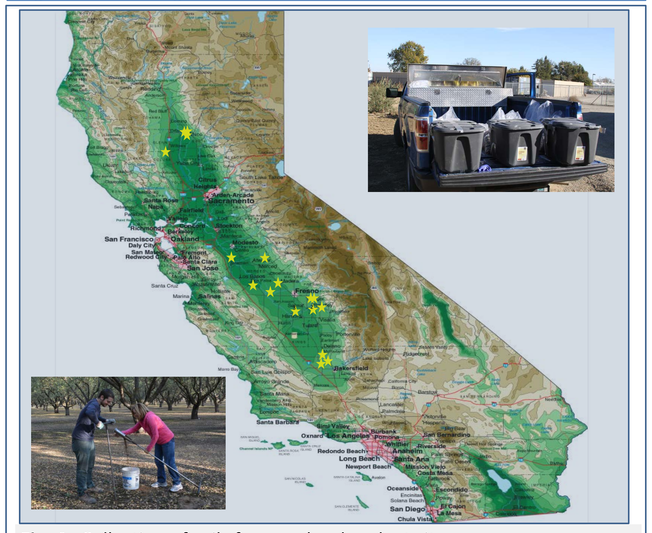


Fig. 4. Collection of soils from orchard replant sites

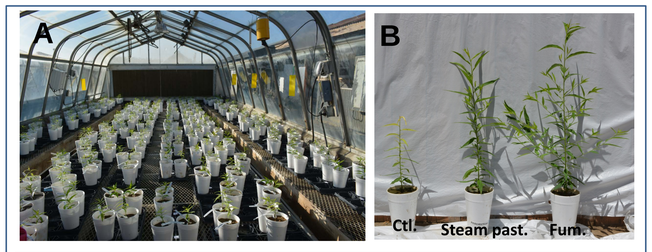


Fig. 5. **A**, Soils in greenhouse after pretreatments (control, steam pasteurization, or fumigation) and transplanting with Nemaguard seedlings; **B**, Representative growth of Nemaguard peach seedlings 2 months after pretreatments and transplanting in a soil conducive to RD (note: either steam or fumigation greatly improved Nemaguard growth).

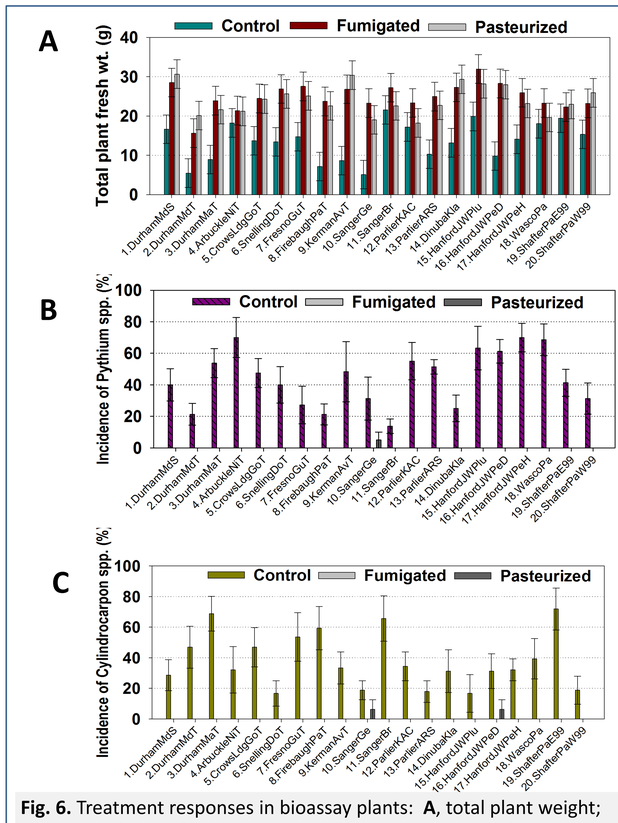


Fig. 6. Treatment responses in bioassay plants: **A**, total plant weight; **B,** root incidence of *Pythium* spp.; and **C**, root incidence of *Cylindrocarpon* spp. at end of trial (in B and C, absence of bars indicates no incidence Plant weights negatively correlated with *Pythium* and *Cylindrocarpon* incidence (r=-0.67, P<0.0001 for each pathogen genus).

ANAEROBIC SOIL DISINFESTATION (ASD) AND OTHER NON-FUMIGANT APPROACHES

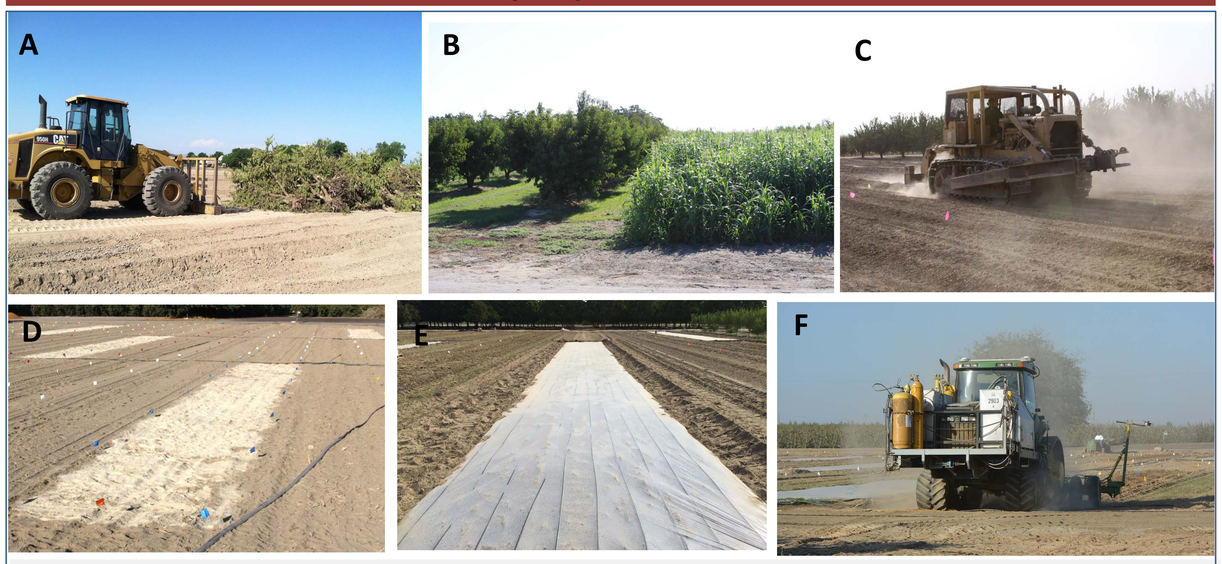


Fig. 7. Preplant treatment procedures in two almond replant trials at Kearney Ag. Ctr., 2013-14. **A**, tree removal-date treatments were May and Oct; **B**, short-term rotation treatments were sudan grass and a bare control; **C**, soil ripping-depth treatments were 2- and 4-ft. ASD treatments were initiated with **D**, rice bran (9 tons/ac), which was: incorporated to 6" depth then **E**, covered with TIF tarp (to retain heat and moisture and exclude O_2) and irrigated by drip (to maintain soil moisture near field capacity for 6 wks). Non-treated control and **F**, strip fumigation treatments (Telone C35, 540 lb/trtd. Ac; Oct or Dec) were used for comparison. Treatment efficacy was assessed by monitoring survival of *Pythium* buried in small bags of soil during treatments (**Table 1**) and growth of trees in the replanted almond orchard (**Figs. 9-11**).

Fig. 8. Effects of ASD, compared to controls, on temperature and reduction potential (Eh) in soil. Eh values more negative than -200 mv (dotted red line) are anaerobic. **A**, data from experiment 1; **B**, data from experiment 2. In ASD plots, molasses was added with rice bran in experiment 1, whereas only rice bran was used in experiment 2.

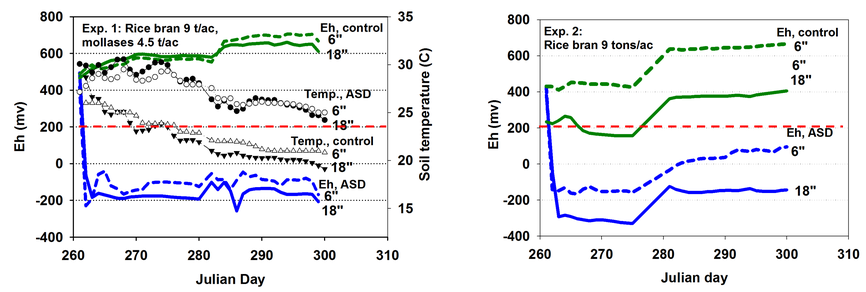


Table 1. Effects of selected pre-plant treatments on survival of *Pythium ultimum*, which was buried in the field soil in nylon bags before each treatment and retrieved several weeks later

Exp.	Inoculum set	Date of placement	Date of removal	Soil treatment	Depth of bioassay inoculum in soil (cm)	Survival of bioassay inoculum (cfu / g soil) Mean	(S.E. of mean)
1	1	9/18/2014	11/18/2013	Sudan control	15	6140	(450)
					46	3180	(801)
				Sudan+ASD	15	0	(0)
					46	20	(20)
	2	10/29/2020	11/18/2013	Control (+/- sudan)	15	4010	(502)
					46	4345	(313)
				Oct. fum. (+/- sudan)	15	0	(0)
					46	0	(0)
	3	12/9/201	1/4/2014	No-sudan Control	15	4300	(384)
					46	4392	(558)
				No-sudan + Dec. fum.	15	0	(0)
					46	0	(0)
2	1	9/18/201	11/18/2020	No-sudan Control	15	5717	(994)
					46	6383	(2036)
				No-sudan + ASD	15	0	(0)
					46	0	(0)
	2	10/29/2020	11/18/2013	No-sudan Control	15	3667	(1135)
					46	4167	(775)
				No-sudan + Oct. fum.	15	0	(0)
					46	0	(0)

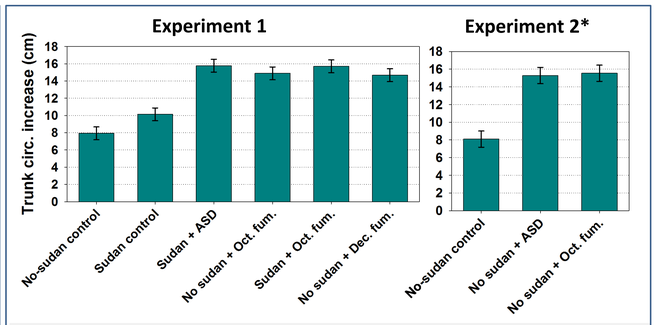
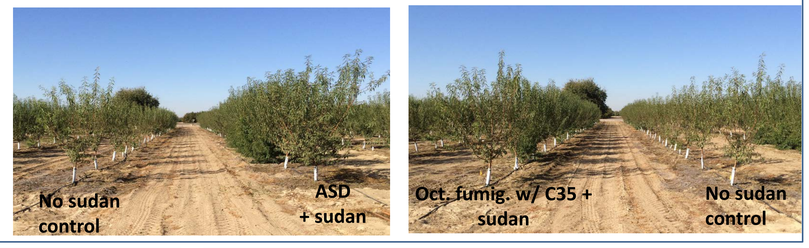


Fig. 9. Effects of preplant treatments on tree growth, almond replant trial at Kearney Ag. Center. In experiment 2, there was not a significant effect of preplant soil ripping depth (i.e., 2 vs. 4 ft.) Error bars are 95% confidence intervals for means. Note that Dec. fumigation was as effective as Oct. fumigation (dry, warm year?), and that ASD was as effective as soil fumigation. Error bars are 95% confidence intervals.

Fig. 10. Representative photos of tree growth in selected treatments of Kearney Ag. Center almond replant trial, Experiment 1, Oct 28, 2014.



KEY POINTS

- RD is a complex, *Pythium* and *Cylindrocarpon* contribute to it.
- *Phytopythium helicoides* is a "new" root pathogen of almond.
- Work continues to elucidate additional RD causes.
- Potential for RD varies significantly among almond orchard soils statewide, prediction of severity may be possible.
- Root incidence of *Cylindrocarpon* and *Pythium* species was positively correlated with degree of Nemaguard bioassay growth suppression among 20 almond/peach replant soils.
- ASD was as effective as soil fumigation in preventing RD in the first year after replanting; ASD trials continue.

TESTING OPPORTUNITY

Growers considering replanting in 2015-16 and interested in greenhouse bioassay/orchard fumigation trials are encouraged to contact principal the investigator at gtbrowne@ucdavis.edu

ACKNOWLEDGEMENTS

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