USING BIOSOLARIZATION WITH ALMOND PROCESSING RESIDUE AMENDMENTS TO DISINFEST ORCHARD SOIL

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Introduction: Soil biosolarization (SBS) is a soil disinfestation technology where moist, amended soil is covered with a transparent plastic tarp. It combines solar heating from the tarp with the accumulation of fermentative organic acids (OAs) from the incorporated organic waste to control infested soils. Soil microorganisms under anaerobic conditions consume available carbon from organic amendments, such as almond byproducts, accumulating OAs under the tarped soil. SBS offsets the environmental, health, and safety risks of conventional soil fumigant application while providing value to food processing waste. Moreover, in-situ application of agricultural wastes can also offset transportation costs and environmental impact of the transfer to organic wastes treatment facilities. The objectives of the study were: 1) to assess the ability of almond processing byproducts—almond hulls (ALH) and a mixture of hulls and shells (ALMix)—to induce microbial fermentation and OA accumulation; 2) to monitor soil temperature during SBS; and 3) to assess the nematicidal effect of the treatment. In addition to residue type, performance was assessed across different soil depths and treatment times.

Methods: The efficacy of SBS using almond processing waste was assessed during a six-week field trial on a commercial almond orchard owned by the Nicolaus Nut Company in Chico, CA. The trial took place from June to August of 2017 during the pre-plant period, with four sampling periods throughout: 0, 10, 31, and 42 days after application. Four treatments were applied randomly to the 8-acre field site: control, solarized non-amended, solarized with ALH, and solarized with ALMix. Three replicate plots were used for each treatment. At each sampling time point, 12-inch soil core samples were extracted from each plot. The cores were divided into two layers representing 2 different depths: 0-6 inches and

6-12 inches. Replicate cores from the same plot and depth were then pooled and homogenized. Samples were analyzed for organic acid content and viable nematode levels. OAs were extracted from the soil with water and filtered. Seven OAs were quantified using HPLC: formic, acetic, propionic, butyric, isobutyric, lactic, and succinic acid. Nematicidal activity was monitored by counting live parasitic nematodes extracted from the soil samples. Soil temperature sensors were buried at 1 inch and 8 inches to monitor soil temperature every 30 min throughout the 6-week treatment.

Results: HPLC analysis confirmed that both ALH and ALMix induced OA accumulation in the soil (fig. 1). Particularly, acetic acid and lactic acid were detected and peaked after 10 days of treatment. ALH-amended soil resulted in greater organic acid accumulation (4 mg/g soil) than the ALMix (1 mg/g soil). No OAs were detected in the non-amended, solar-heated plots or in the untreated control plots. The top 0-6 inches of soil experienced higher levels of OAs than the 6-12 inch depth. At 1-inch depth, all solarized soil, amended or non-amended, had higher temperatures (45 ºC average, 65 ºC max) than control plots (37 ºC average, 60 ºC max) (fig. 2). There was significantly greater cumulative heating of the solarized plots compared to the untarped control. Root lesion nematodes (*Pratylenchus neglectus*) was initially observed in all plots. After 10 days of treatment, all solar-heated treatments showed near complete inactivation of nematodes. However, total eradication down to 1 foot of soil was only seen in plots biosolarized with ALHs (fig. 3).

Conclusions: These results demonstrated that biosolarization using almond industry byproducts could effectively inactivate phytoparasitic nematodes in orchard soil on a commercial scale. Hulls-rich residues were more effective in producing acids then a hull and shell mixture. This effect likely contributed to the complete nematode inactivation observed on the plots treated with ALH. Nematode inactivation in the top layer of the non-amended plots indicated that cumulative heating also played a significant role in nematode deactivation. Lower inactivation at the lower layer of the non-amended and ALMix amended soil confirmed that amendment treatment, temperature, and soil depth impacted efficacy. Further studies are needed to monitor soil nematode re-infestation as well as to assess the impact of the changes of the phytonutrients levels and soil quality on the orchard performance.

Advantages

- Valorizes abundant organic waste stream
- 10 – day treatment duration.
- Complete disinfestation of treated plots down to 12 inches
- Assayed bio-pesticides have low human toxicity.

Disadvantages

- Long term effects of yield, plant health are unknown.
- Long term risk of re-colonization by the pests are unknown.

Figure 1. Total organic acids (OA) extracted from field soil as a function of amendment type, soil depth, and treatment time. Total OA accumulation was significantly different depending on treatment, duration, and depth. HPLC analysis confirmed that only amended soil induced OA accumulation, which peaked after 10 days of treatment. Non-amended solarized and control treatments not shown

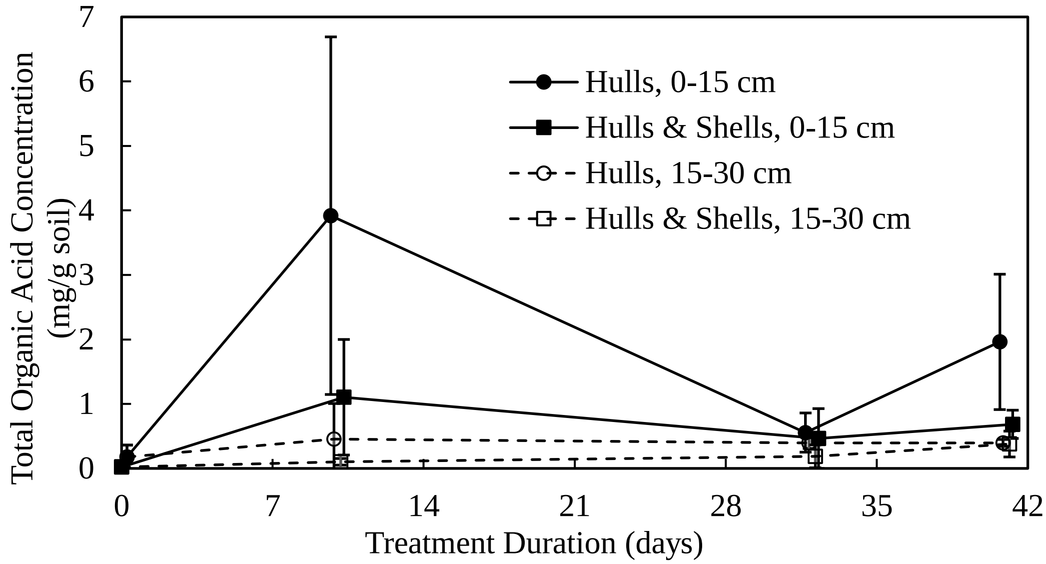

Figure 2. Average temperature during one week of the field trial. Soil heating was significantly different depending on treatment and depth. Soil in the top 3 cm (A) had significantly higher average temperatures than soil in the 15 cm layer (B). Biosolarized and solarized treatments experienced higher temperatures than the un-tarped control. A one-week representative subset is shown.

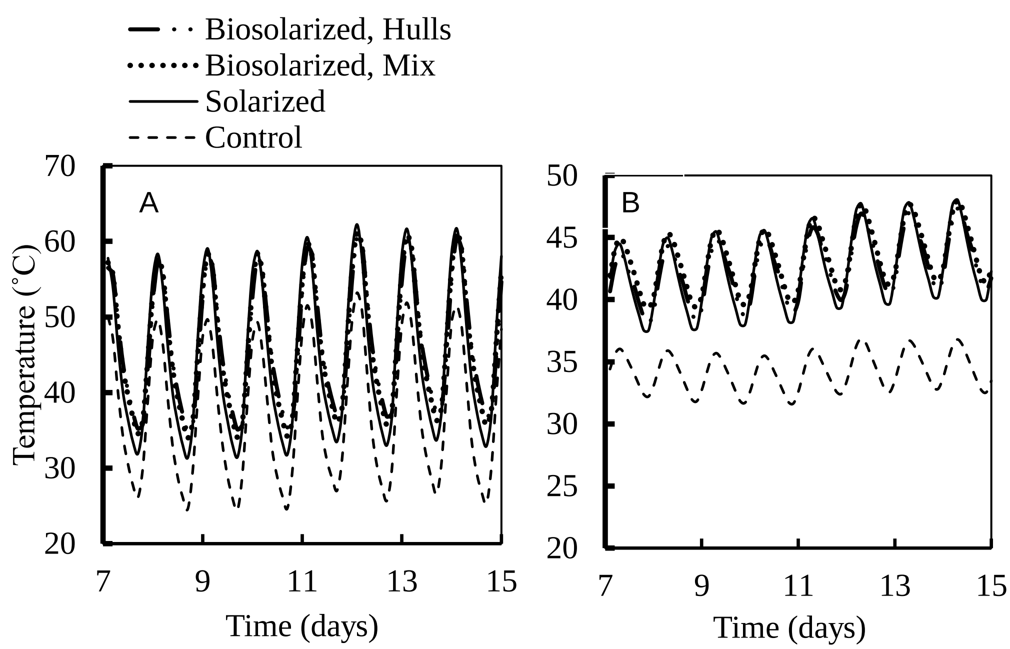

Figure 3. Median total abundance of lesion nematodes sampled at 0-30 cm.