Biosolarization - a method to recycle almond waste biomass and disinfest orchards during replant

UC DAVIS

Western Center for Agricultural Health and Safety

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INTRODUCTION

There is a need for soil fumigation alternatives that promote a circular economy, improve sustainability, and negate the health and safety risks of conventional soil fumigants. Biosolarization is one such alternative that utilizes solar heating and soil fermentation to create pest-inactivating soil conditions (Figure 1).

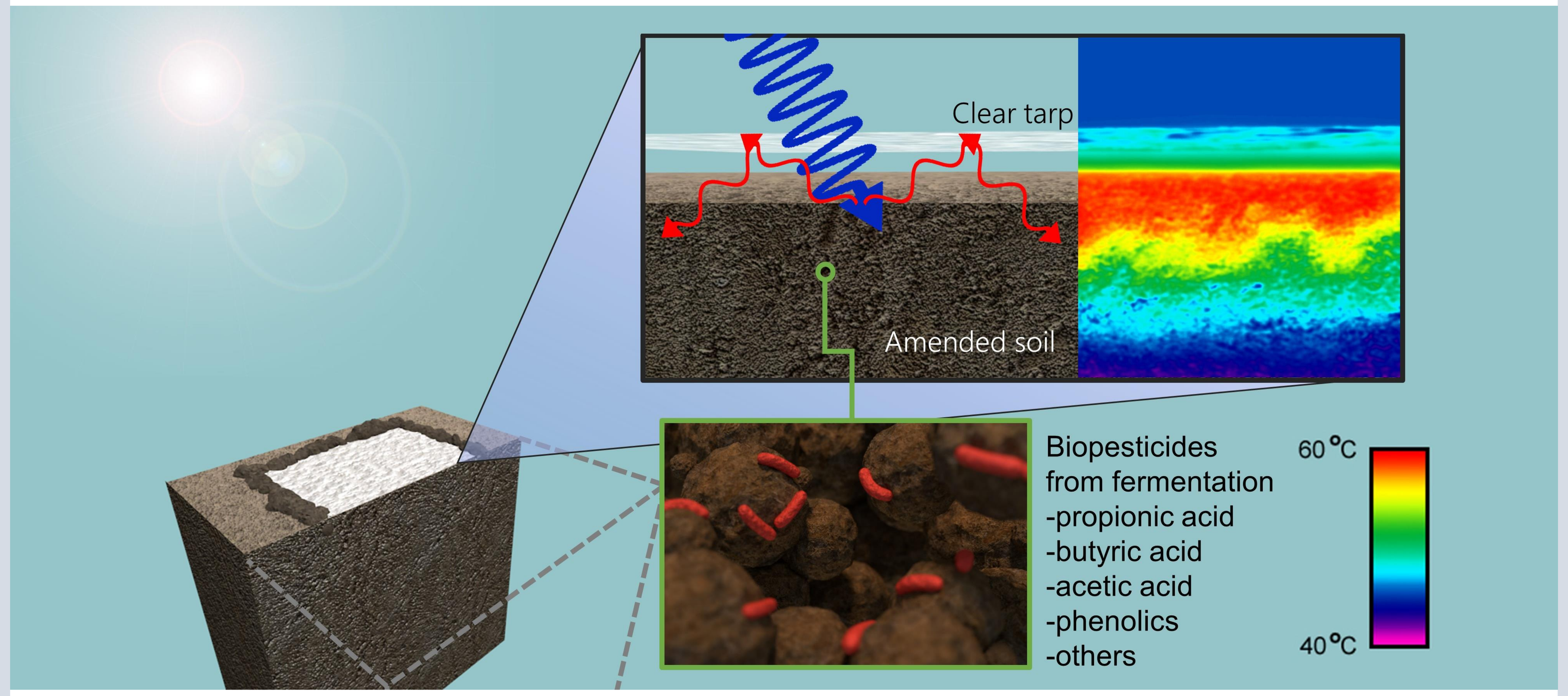

Figure 1. Soil is amended with solid organic matter, irrigated, and covered with clear plastic tarp to induce a greenhouse heating effect and generate anaerobic fermentation products.

The goal of this project was to assess the potential to use almond processing residues (nonpareil hulls, pollinator hulls and shells, and pollinator shells) as soil amendments to induce beneficial soil microbial activity during biosolarization. Such activity can manifest as accumulation of organic acid fermentation products, such as acetic, propionic, and lactic acids, which are biopesticides that can inactivation a broad range of pests but are largely inocuous to humans.

Laboratory and field studies were conducted to examine the performance of biosolarization with almond residue amendments in terms of generating organic acids in the soil and inactivating root lesion nematode (*Pratylenchus* spp.), a soil parasite that challenges many almond orchards.

METHODS

Closed-vessel anaerobic bioreactors were run in the laboratory to initially gauge waste stream compatibility with biosolarization. Tubes containing orchard soil amended with 5% (dry weight) of each almond residue were incubated for 8 days. Acidification of the soil was monitored via a pH meter and HPLC to detect organic acids. Soil extracts were assayed for nematicidal activity via exposure to cultured nematodes and visual observation of non-responsiveness to physical stimulation.

METHODS cont.

Lab results informed a following field trial where biosolarization using hull or hull/shell amendments (1.25% amendment by dry weight down to 7 inches depth) was compared against solarized soil (tarped and irrigated soil with no almond biomass amendment) and untreated soil (no tarping, irrigation or amendment) (Figure 2).

Figure 2. Biosolarization field trial at a Nicolaus Nut Company almond pre-plant site in Chico, CA. The trial was conducted from June to August of 2017. Three replicate plots were used for each amendment treatment.

12-inch soil core samples were periodically extracted from the plots across the 6 week treatment period and analyzed for organic acid content and viable nematode levels.

RESULTS

Laboratory screening of almond residue amendments in soil bioreactors showed that only nonpareil hulls and pollinator hull/shell mix led to fermentation and accumulation of organic acids in the soil. Pollinator shells did not lead to acidification and were excluded from further study. Extracts from the hull-amended soils were screened for nematicidal activity against root lesion nematode (Figure 3).

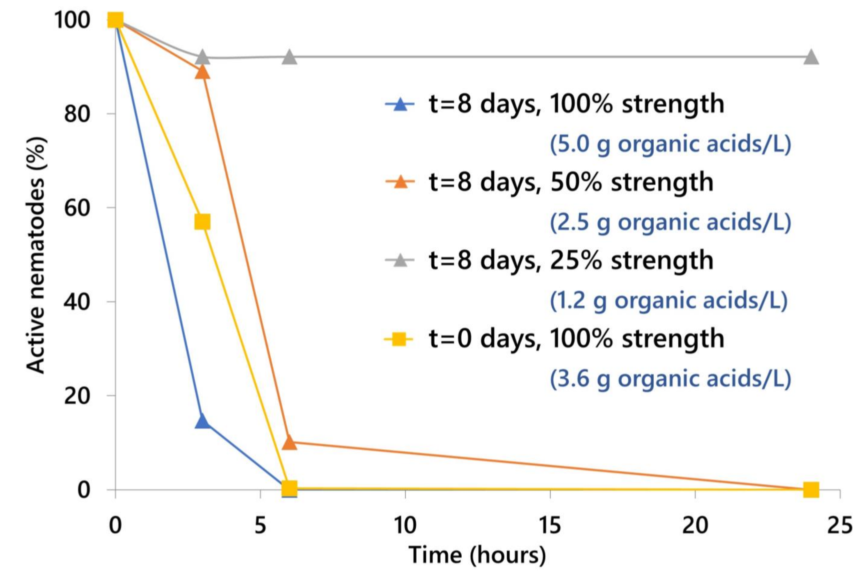

Figure 3. Inactivation of root lesion nematodes in response to exposure to extracts from soils amended with 5% nonpareil hull. Extracts from amended soils prior to and following an 8-day anaerobic incubation were tested. Additionally, dilutions of the 8-day extracts were examined. The horizontal axis denotes nematode exposure time to the extracts.

RESULTS cont.

Additional bioreactor studies showed that organic acids within the almond residues yielded acidification of the soil immediately after amendment in proportion to the biomass added. Likewise, fermentation of the amendments led to accumulation of more acids in the soil in proportion to the amendment level (Figure 4).

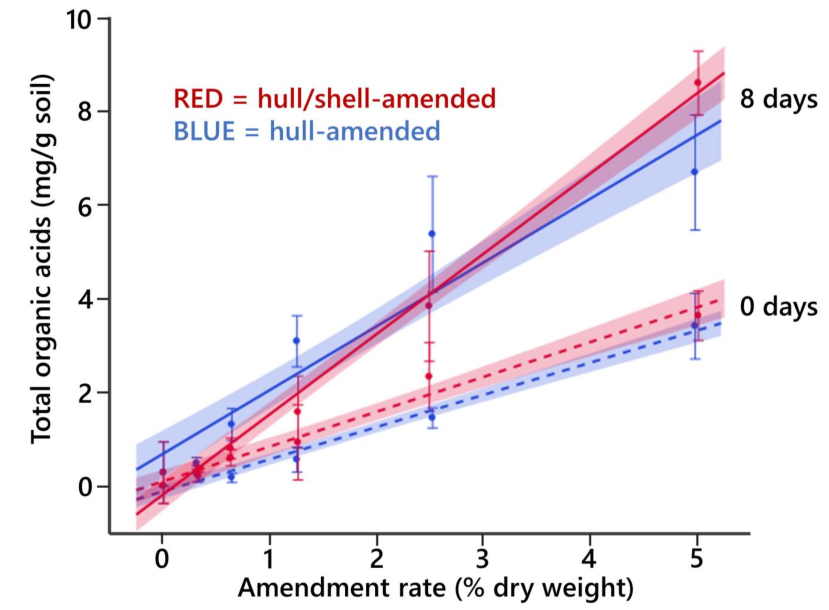

Figure 4. Initial and final organic acid levels in hull- or hull/shell-amended soils incubated anaerobically for 8 days. Measured organic acids include acetic, butyric, isobutyric, formic, lactic, propionic, and succinic acids.

Field trial data confirmed that both hull and hull/shell amendments induced organic acids accumulation in the soil, which peaked at 10 days of treatment (Figure 5). Plant parasitic nematodes (root lesion and ring nematodes) initially infested all plots. By 10 days of treatment, all solar–heated treatments showed near complete inactivation of nematodes with total eradication in the plots biosolarized with hull amendment (Figure 6).

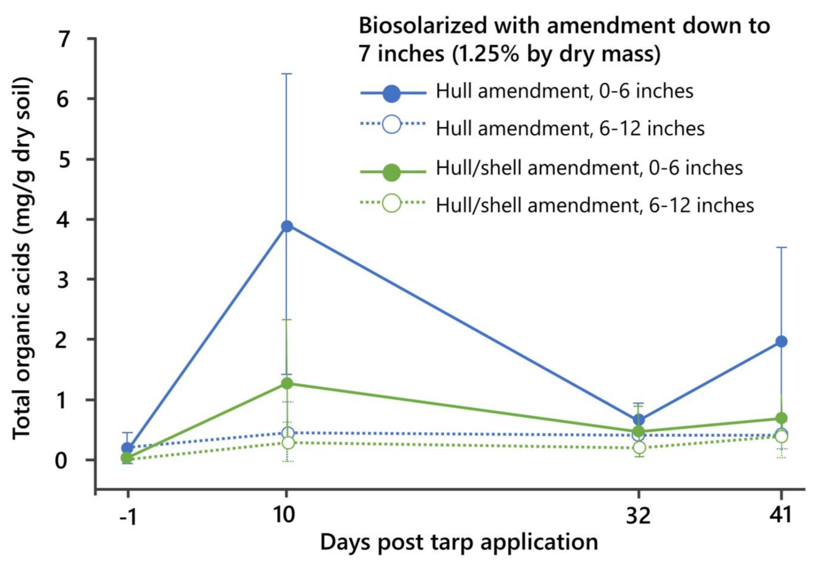

Figure 5. Soil organic acid levels during the 6-week biosolarization period. No organic acids were detected in the non-amended but solar-heated plots or in the untreated control plots.

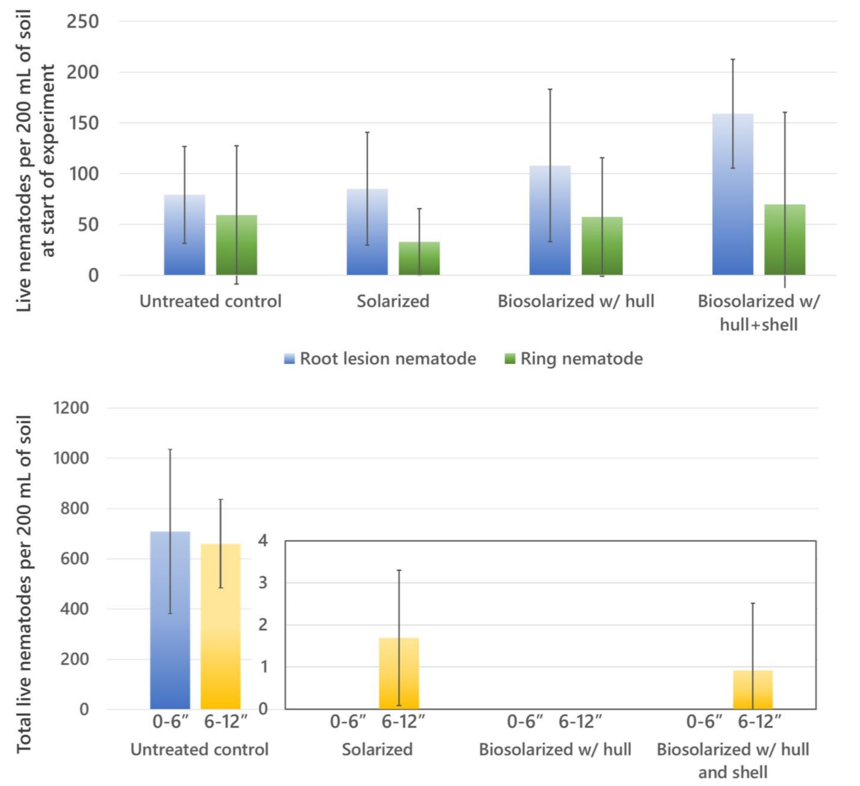

Figure 6. Initial parasitic (top) and final total (bottom) viable nematode counts.

ACKNOWLEDGEMENTS

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