ANAEROBIC SOIL DISINFESTATION FOR SOUTHERN CALIFORNIA STRAWBERRIES

Oleg Daugovish[1]*, Joji Muramoto[2], Carol Shannon[2], Mark Bolda[3] and Steven Koike[4].

[1] University of California Cooperative Extension, Ventura, CA, [2]University of California, Santa Cruz, [3] University of California Cooperative Extension, Watsonville, CA [4] University of California Cooperative Extension, Salinas, CA

Anaerobic soil disinfestation (ASD) has been developed in Japan (Shinmura, 2000; Momma, 2008) and Netherlands (Blok et al., 2000; Messiha et al., 2007) as an alternative to soil fumigation. Pest suppression with ASD relies on anaerobic soil conditions created after incorporation of readily available carbon-sources into soil that is covered by plastic mulch and irrigated until saturation. This technique has been investigated in California strawberry production areas and several parameters have been optimized (Shennan et al. 2009). For example, rice bran incorporation followed by drip irrigation with three acre inches under low density polyethylene (LDPE) mulch produced anaerobic conditions sufficient for 75% reduction of *Verticillium dahliae* microsclerotia compared to untreated check. This level of pathogen control was similar to that obtained with greater amounts of irrigation water and under virtually impermeable film(VIF).

In the 2010-11 study at Santa Paula, CA we evaluated effects of ASD in silty clay loam soil infested with *V. dahliae* (16 microsclerotia/gram soil) on pathogen survival, weed densities and strawberry performance. The treatments were: type of tarps (standard black 1.5 mil, and standard clear 1.25 mil) applied to main plots, and untreated check (UTC), UTC + irrigation without rice bran (UTC+Water), ASD 3 weeks, and ASD 6 weeks as split plots arranged in a randomized block split plot design with 4 replicates. Each plot was a 4 ft wide and 25 ft long bed. Prior to irrigation, rice bran at 9 tons/acre was mixed into the top 12 inches of the beds in ASD plots by a rotor tiller with attached bed shaper on Oct. 18, 2010. After laying two drip tapes per bed, the assigned type of plastic tarp was laid and 3.5 acre-inches of water were applied intermittently through drip irrigation to UTC+Water and ASD plots. ASD plots were aerated by punching holes through mulch 3 weeks later (ASD3) or 6 weeks later (ASD6). Soil at 0-6 inch depth from each plot was collected for testing for viable *V. dahliae* microsclerotia after 3 weeks (all plots except ASD6 plots) and 6 weeks (all plots). High elevation bare-root transplants of 'Ventana' strawberry were planted to all plots on Oct 12, 2010 and established using standard grower practices. Weeds were counted and then removed each time on Oct 16, Nov 9 and Dec 10, 2010 in treatments with clear mulch. Two dimensional plant canopy measurements of 16 plants per plot were taken on Nov 22, 2010 and areas calculated. Marketable yields were evaluated from Jan 13 to Apr. 14, 2011 by harvesting fruit from the same 16 plants.

All data were analyzed using SAS; model assumptions of equal variance and normal distribution were checked using the General Linear Model procedure. The overall error rate for multiple comparisons was controlled by Tukey-Kramer adjustment.

ASD plots developed strong anaerobic conditions regardless of tarp type and duration: cumulative Eh reached 90,000 mVhr after 3 weeks from the first irrigation in all ASD plots. Soil temperature was higher under clear plastic (average 91 ºF) than black plastic (average 83 ºF). Native *V. dahliae* populations in soils in ASD plots were reduced 71 to 94% from UTC and UTC+Water, which were similar (Fig. 1). Weed densities under clear mulch at the three evaluation dates were 55%, 67% and 92% lower in ASD plots compared to UTC and UTC+Water plots (P=0.003 to 0.008). Weed species were predominantly broadleaf: annual sowthistle (*Sonchus oleraceus*), little mallow (*Malva parviflora*), nettleleaf goosefoot (*Chenopodium murale*) and common purslane (*Portulaca oleracea*). Strawberry canopies were about 70% larger (P<0.001) in ASD plots compared to UTC and UTC+Water, which were similar in size. Marketable fruit yield increased 46% by using clear plastic (vs. black plastic. P=0.0013) and 95% by ASD treatments (vs. UTC. P<0.0001) (Fig. 2).

This study showed that ASD can effectively reduce populations of important soil-borne pathogens, such as *V. dahliae,* and densities of broadleaf weeds, thus reducing weeding costs. Improved strawberry plant vigor after ASD treatment resulted in earlier and substantially improved fruit production compared with untreated check. The results of this and previous work suggest that adequate distribution of carbon source in soil, three inches of irrigation and standard LDPE mulch kept intact for three weeks are necessary components of effective ASD treatment in southern California strawberry production.

RERERENCES

Blok, W.J., J.G. Lamers, A.J. Termorshuizen, and G.J. Bollen. 2000. Control of soilborne plant pathogens by incorporating fresh organic amendments followed by tarping. Phytopathology. 90:253-259.

Messiha, N.A.S., A.D. van Diepeningen, M. Wenneker, A.R. van Beuningen, J.D. Janse, T.G.C. Coenen, A.J. Termorshuizen, A.H.C. van Bruggen, and W.J. Blok. 2007. Biological Soil Disinfestation (BSD), a new control method for potato brown rot, caused by *Ralstonia solanacearum* race 3 biovar 2. European Journal of Plant Pathology 117:403-415.

Momma, N. 2008. Biological soil disinfestation (BSD) of soilborne pathogens and its possible mechanisms. Jarq-Japan Agricultural Research Quarterly 42:7-12.

Shennan. C., J. Muramoto, S. Koike ans O. Daugovish. 2009. Optimizing soil disinfestation for non-fumigated strawberry production in California. MBAO proceedings, 101:1-4. San Diego, CA.

Shinmura, A. 2000. Causal agent and control of root rot of welsh onion. PSJ Soilborne Disease Workshop Report 20:133-143 (in Japanese with English Summary).

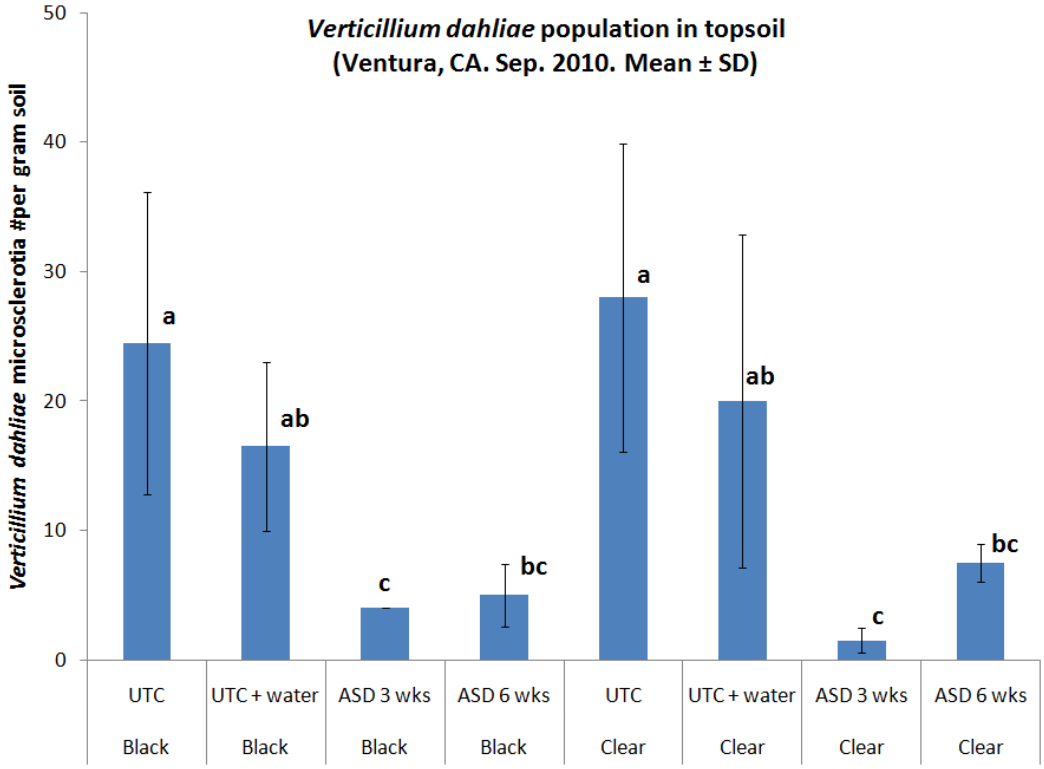

Figure 1. *Verticillium dahliae* microsclerotia in top six inches of soil at Santa Paula, CA on Sept 30, 2010. Anaerobic soil disinfestation treatment for three weeks (ASD3wks) and six weeks (ASD6wks) is compared to untreated check (UTC), and untreated check plus irrigation without carbon source (UTC + Water) under black 1.5 mil plastic mulch (Black), and clear1.25 mil mulch (Clear). 9 tons/acre of rice bran was applied to ASD plots. Values are back-transformed means with standard deviations. Treatments with the same letter for each mulch type are not significantly different at P=0.05.

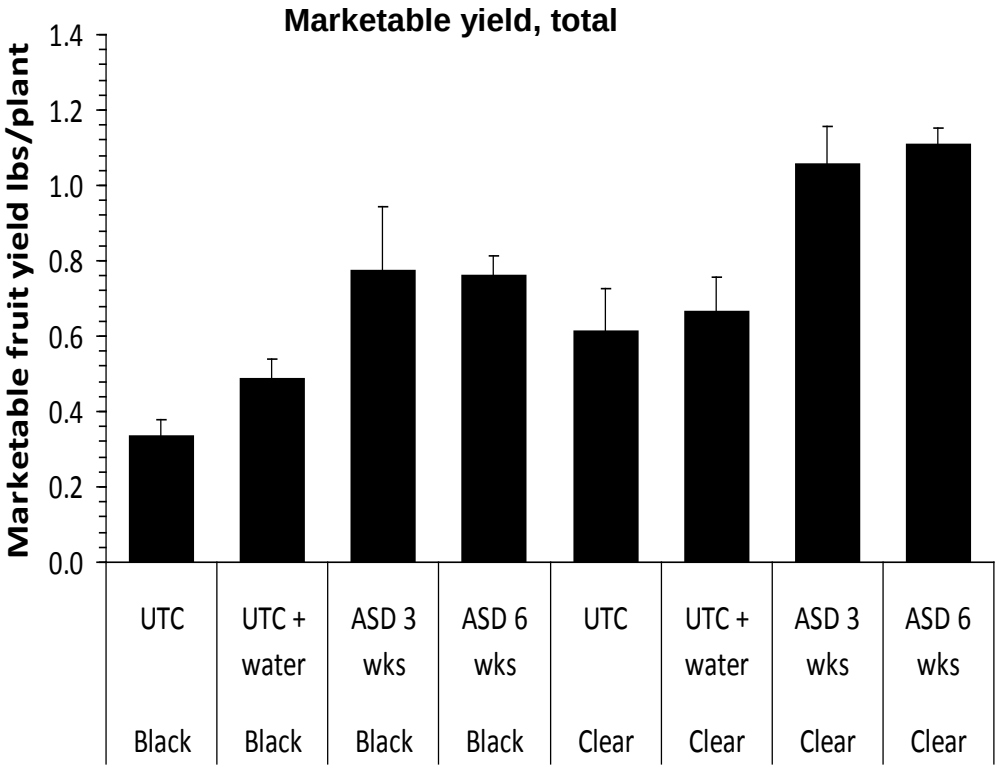

Figure 2. Marketable fruit yield of 'Ventana' strawberry at Santa Paula, CA on Jan-Apr 2011. Anaerobic soil disinfestation treatment for three weeks (ASD3wks) and six weeks (ASD6wks) is compared to untreated check (UTC), and untreated check plus irrigation without carbon source (UTC + Water) under black 1.5 mil plastic mulch (Black), and clear1.25 mil mulch (Clear). 9 tons/acre of rice bran was applied to ASD plots. Values are back-transformed means with bars representing standard deviations.