ANAEROBIC SOIL DISINFESTATION: CALIFORNIA

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Anaerobic soil disinfestation (ASD), a non-chemical alternative to methyl bromide (MeBr) fumigation developed in Japan (Shinmura, 2000; Momma, 2008) and the Netherlands (Blok et al., 2000; Messiha et al., 2007), can control soilborne pathogens and nematodes in strawberries and vegetables. Hundreds of growers use ASD to control soilborne pathogens and nematodes in strawberries and vegetables grown in greenhouses in Japan (Momma et al., 2010) whereas it has been used mainly in strawberry nurseries and asparagus production in the Netherlands (Lamers et al., 2010). ASD integrates principles behind solarization and flooding to control nematodes and pathogens in situations where neither practice alone is effective or feasible. ASD works by creating anaerobic soil conditions by incorporating readily available carbon-sources into topsoil that is irrigated to saturation (not flooded) and subsequently covered with a plastic tarp. The tarp is then left in place to maintain soil moisture above field capacity. Anaerobic decomposers are then able to respire using the added carbon, which results in the build-up of anaerobic by-products (e.g. acetic acid, butyric acid, etc.) that are toxic to pathogens (Katase et al., 2009), but that are degraded rapidly once the tarp is removed or holes are made through the tarp for planting.

To optimize ASD for California strawberries, a series of pot and field trials have been conducted since 2004 (Shennan et al., 2007). Field experiments with fumigant controls were conducted in Watsonville and Salinas in the 2009-10 season, and are being repeated in Ventura, Watsonville and Castroville in the 2010-11 season. Soil types in trials ranged from sandy loam to silty clay loam. Randomized block experiments with four replicates were established to compare ASD treatments with different carbon sources including rice bran 4.5 tons/acre (ASD1), rice bran 9 tons/acre (ASD2), and rice bran 8 tons/acre plus mustard seed cake 1 ton/acre (ASD3) with untreated checks (UTC) and MeBr or PicChlor 60 fumigation controls (except at the Ventura site). For ASD treatments carbon sources were rotor tilled into the soil before or after bed formation and drip tape and plastic tarp installed, a standard practice. Then 3 to 6 acre-inches of drip-irrigation was applied intermittently and left for three weeks at which time holes were punched in the plastic and transplants planted ~7 days later. Resident *Verticillium dahliae* populations in soil (0-6” depth) were quantified before and after treatments and during the harvest period. During the ASD treatments, anaerobicity (Eh), temperature, and moisture content were continuously monitored at 6” depth. Marketable fruit yield was evaluated. Soil Eh reduction near or exceeding 50,000 cumulative Eh mVhr below 200mV (a threshold for suppressing *V. dahliae* at 77 °F suggested by earlier pot experiments) was observed for most ASD plots across trials. ASD led to a 71 to 100% reduction in

V. dahliae in soils compared to the UTC in Salinas, Ventura and Castroville under moderately high *V. dahliae* pressure (11 to 25 microsclerotia/gram soil (see Fig. 1 for the Castroville trial in 2010-11). Strawberry fruit yield in ASD plots in Salinas (2009-10) with moderate *V. dahliae* pressure was similar to MeBr and UTC. In Watsonville (2009-10) with 0 microsclerotia/lbs soil, marketable yield was the highest in MeBr (100%), followed by ASD3 (85%), ASD2 (82%), ASD1 (76%), and UTC (75%). In the summer-planted Ventura trial (2010-11) with moderately high disease pressure, marketable yield in ASD plots was 95% greater than UTC (P<0.0001).

Overall, ASD was very effective in suppressing *V. dahliae* in soils and resulted in 85 to 100% of the marketable fruit yield observed with fumigated controls in coastal CA strawberries. In on-going trials at Watsonville and Castroville (Fig. 2), as of mid June, cumulative marketable yields from ASD plots are similar or numerically higher than PicChlor 60 control plots, and significantly greater than UTC (P=0.05). A large-scale demonstration trial of ASD will be conducted in Salinas, CA in 2011-2012 season.

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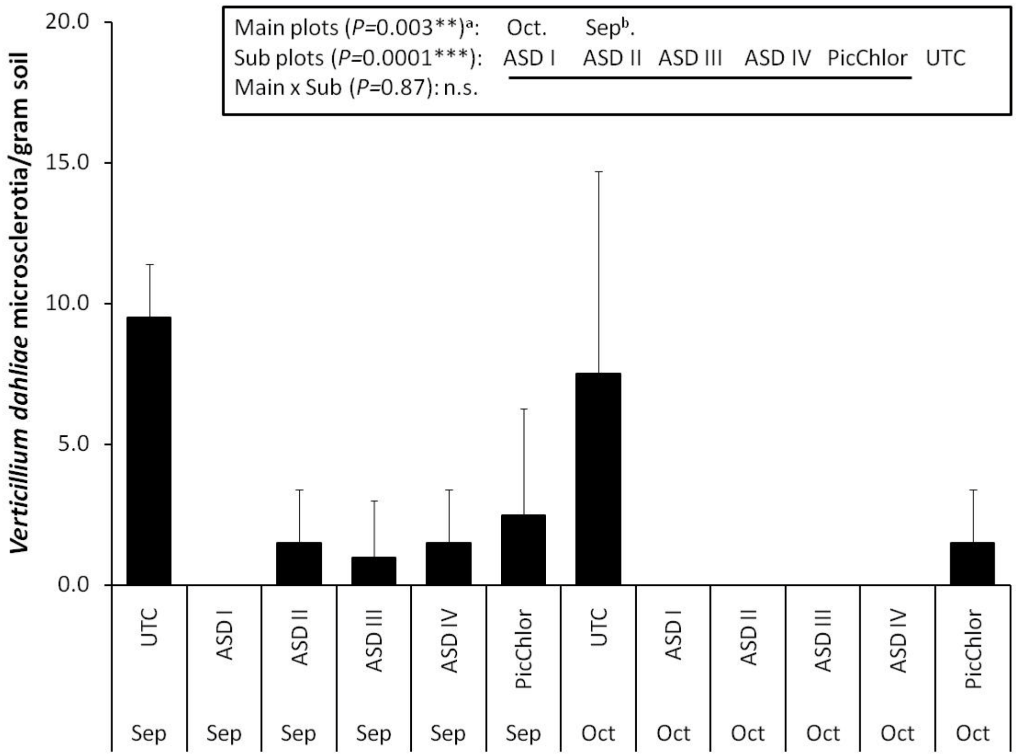

Figure 1. Resident *Verticillium dahliae* population in soils after ASD treatment in the Castroville trial (sampled on 11/29/2010). Baseline *V. dahliae* population averaged 11 microsclerotia/gram soil. UTC: untreated check, ASD I: rice bran 9.0 tons/acre-3 weeks, ASD II: rice bran 8.0 tons/acre + mustard cake 1.0 ton/acre-3 weeks, ASD III: rice bran 9.0 tons/acre-6 weeks, ASD IV: rice bran 8.0 tons/acre + mustard cake 1.0 ton/acre-6 weeks, PicChlor: PicChlor 60 fumigation, Sept.: September ASD treatment, Oct.: October ASD treatment. Values are back-transformed means + SDs (n=4). [a] Number in parenthesis indicates significance probability by ANOVA test. [b] No significant difference was observed between treatments on the same line by Tukey's HSD test at the *P*=0.05.

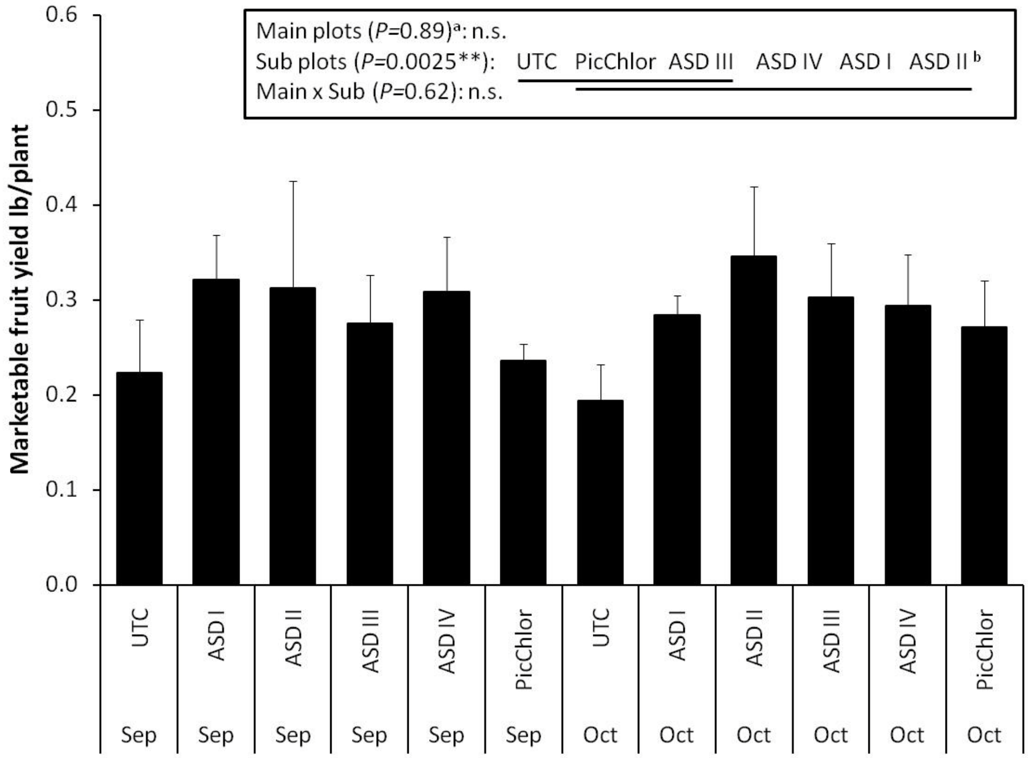

Figure 2. Early marketable fruit yield for cv. Albion in the Castroville trial (as of 6/15/2011). See Fig. 1 for legend. Values are means + SDs (n=4). [a] Number in parenthesis indicates significance probability by ANOVA test. [b] No significant difference was observed between treatments on the same line by Tukey's HSD test at the *P*=0.05.