# CARBON SOURCE AND IRRIGATION AFFECT ANAEROBIC SOIL DISINFESTATION IN STRAWBERRY

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Anaerobic soil disinfestation (ASD) was 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).

Water use efficiency and utilization of feasible carbon sources have been important factors for successful implementation and adoption of ASD in California and are the focus of current research. In the 2014-15 study at Santa Paula, CA we compared ASD with 9 t of rice bran bed-incorporated with either delaying irrigation for one week (ASD 1 wk delay), without irrigation (ASD w/o water) or immediate irrigation with 1,480$m^3$/ha = 3 acre-feet (ASD regular). Glycerin was used as liquid carbon source treatment, and applied at 4% by volume via three drip lines per bed as a one-time injection. Untreated check was included in this RCBD experiment with four replications. Delaying or avoiding irrigation would allow sufficient time for field irrigators to connect and check all drip lines, potentially minimizing water loss and save water, thus making ASD application more user-friendly. Soil at the site was silty clay loam with pH 7.3 and ECe 0.7 dS/m.

All three rice bran treatments induced strong anaerobic conditions which persisted for at least four weeks surpassing 120,000 cumulative Eh mV hours of anaerobiosis, more than twice the threshold previously developed for control of soil-borne pathogen *Verticillium dahliae*. Glycerin-based ASD created very strong anaerobic conditions in soil but only for three days after application and resulted in about 70,000 Eh mV cumulative hours.

At this study site, significant soil-borne disease development or strawberry mortality were not observed. However, during the first three months after planting rice bran based ASD treatments reduced weed populations nearly 90% (mostly common lambsquarters, annual sowthistle and burning nettle), while glycerin treatment did not reduce weed densities relative to the no untreated check. .

Plant performance was similar among ASD regular, ASD w/o water and ASD 1 wk delay treatments and improved early marketable fruit production compared to untreated check 100-118% (Figure 1). Glycerin treatment had no significant effect on early production (Dec 2014-Jan 2015) but provided yield improvement from February to May and 46% yield increase for the whole season (Figure 1). Delayed plant response to glycerin treatment is likely due to

distribution of the glycerin solution near and below the drip lines used for application, a region of the soil profile not reached by strawberry roots during the first 2-3 months after planting. In contrast, rice bran was uniformly distributed throughout the bed profile, which resulted in immediate root contact with treated soil and accelerated plant growth and fruit production (data not shown).

Even at the end of the growing season (June 2015), ten months after incorporation the following effects of rice bran on soil were observed:

a) lower bulk density compared to untreated and glycerin treatments
b) lower ECe (measure of salinity) than in untreated and glycerin treatments (likely due to differences in infiltration and leaching)
c) 30-35% greater volumetric water content at 8-16 cm soil depth at tensions from 0-80 CB, compared to untreated, indicating greater water holding capacity
d) 180 ppm residual Olsen $P_20_5$ at 0-30cm (12 inch) soil profile in planting holes compared to 78 and 71 ppm in untreated and glycerin treatments, respectively.
e) Similarity of microbial communities among all treatments with rice bran, which were distinctly different from those observed in untreated and glycerin treatments.

The differential effects of carbon sources and application methods on physical, chemical and microbiological properties of soil have been also observed in other trials (data not shown) and emphasize the complex and interactive nature of changes in soil that lead to successful ASD. This study also showed that at least in clay loam soil, moisture at bedding may be sufficient for ASD and growers may save water and associated expenses, provided soil parameters are closely monitored during the ASD process. Beds in clay soils should be formed at optimal moisture to avoid clod formation that may interfere with ASD and other opertaions.

## RERERENCES


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Figure 1. Marketable fruit yields of San Andreas strawberry (December-March), in ASD (anaerobic soil disinfestation) treatments with 9 t/acre of bed applied rice bran with either immediate irrigation, one week delay or without irrigation compared to drip-applied glycerin at 4% volume and the untreated check at Santa Paula, CA in 2014-2015.