EVALUATING C-SOURCES FOR ANAEROBIC SOIL DISINFESTATION

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Soilborne disease management without chemical fumigants is a major challenge for strawberry production in California. Among non-chemical alternatives to fumigants, anaerobic soil disinfestation (ASD) has shown to be effective in reducing *Verticillium dahliae* microsclerotia in soil by 80 to 100% providing comparable yield with fumigants in coastal CA when rice bran (RB) at 9 t/ac is used as a C-source (Shennan et al., 2014). Consequently, CA berry growers began to adopt ASD at a commercial scale. However, applying 9 t/ac of RB may release excess nitrogen to the environment and the increasing cost of RB may limit further adoption of ASD. In addition, the capacity to generate biologically effective microbial communities and fungicidal volatiles during the ASD process has been shown to vary in a carbon input-dependent manner (Hewavitharana et al., 2014). Here we present the results from field trials where different C-sources and input rates were tested to reduce N input from ASD C-sources. Analysis on microbial community shift under different C-sources are also discussed. We also evaluated the potential for eliminating pre-plant fertilizer application in ASD.

Experiments: A range of C-sources and rates were tested in field trials on sandy-loam sites at Plant Sciences, Inc (PSI) in Watsonville, CA, in two growing seasons. The first trial was conducted in the 2012-13 season. Treatments applied were: ASD with RB (6 and 9t/ac), ASD with molasses (Mol) (6 and 9t/ac), ASD with RB and Mol at 4.5t/ac each, Pic-Clor 60, methyl bromide + chloropicrin (MB/Pic), and untreated control (UTC). Plots were arranged in randomized block design with 4 replicates. The second trial was conducted in the 2013-14 season at an adjacent site at PSI. Main treatments were: ASD with RB (6 and 9t/ac), ASD with dry ground grape pomace (GP) at 9t/ac, MB/Pic, and UTC. Further, sub plots of with and without pre-plant fertilizer (PPF. 650 lb/ac of 18-6-12 fertilizer) were established within each main plot arranged in completely randomize block split-plot design with four replicates. Variety “Albion” was used for both trials.

Yield: In the first trial, ASD treatments using RB 6 and 9 t/ac and RB in combination with Mol obtained the best yield, equal to PicClor-60 and higher than MB/Pic treatments (Fig.1A). Similar results were obtained in the second trial where ASD-RB 6 and 9 t/ac performed the best and equal to MB/Pic treatments when PPF was added (Fig.1B). For treatments without PPF, both ASD-RB 6 and 9 t/ac yielded higher than MB/Pic. Notably, no difference was found between with and without PPF of ASD-RB at both rates. ASD-GP 9 t/ac performed equal to ASD-RB and MB/Pic treatments when PPF was added. Without PPF, yield in ASD-GP was lower than ASD-RB though it was similar to MB/Pic either with or without PPF (Fig 1B). Results suggest that the rate of RB can be reduced from 9 to 6 t/ac without yield reduction. Further, pre-plant fertilizer may not be necessary when 6 t/ac of RB is used. GP appears to be another good candidate for ASD C-source but PPF is necessary. ML produced comparable yield with RB only when applied in combination with RB 4.5 t/ac.

Soil inorganic N: Changes in soil inorganic N in 0”-6” depth was monitored throughout the growing season in the 2nd trial. Given that no yield difference was found between ASD-RB 9 t/ac and 6 t/ac with or without PPF, soil inorganic N of ASD-RB 6 t/ac without PPF showed that 30-40 mg/kg of inorganic N from November to May was sufficient to achieve the highest yield obtained (Fig. 2A) and that additional inorganic N did not increase fruit yield (Fig. 2B).

Soil microbial community: Post-treatment T-RFLP analysis showed distinct shifts in soil microbial community composition at both fields in response to treatments as previously reported. Notably the fungal communities in the ASD-ML treatments were unchanged relative to UTC during the first trial (Fig. 3A). On the other hand, in the second trial, the use of GP as C-source produced a shift in fungal community similar to RB (Fig.3B). The higher fruit yield recorded in RB and GP than ML as a carbon source suggest that the observed shifts in microbial community structure may contribute to overall plant performance and further demonstrate the importance of carbon input when formulating the use of ASD for soil-borne disease management.

Issues still to be addressed: Because of its ease of injection application, growers have interests in liquid C-source such as molasses for ASD. However, uniform distribution of liquid C-source across bed profile may be a challenge. A combined use of solid and liquid C-source may be more effective, but will require further study. A trial using cover crop alone or in combination with reduced rate of rice bran as a C-source for ASD is in progress.

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References

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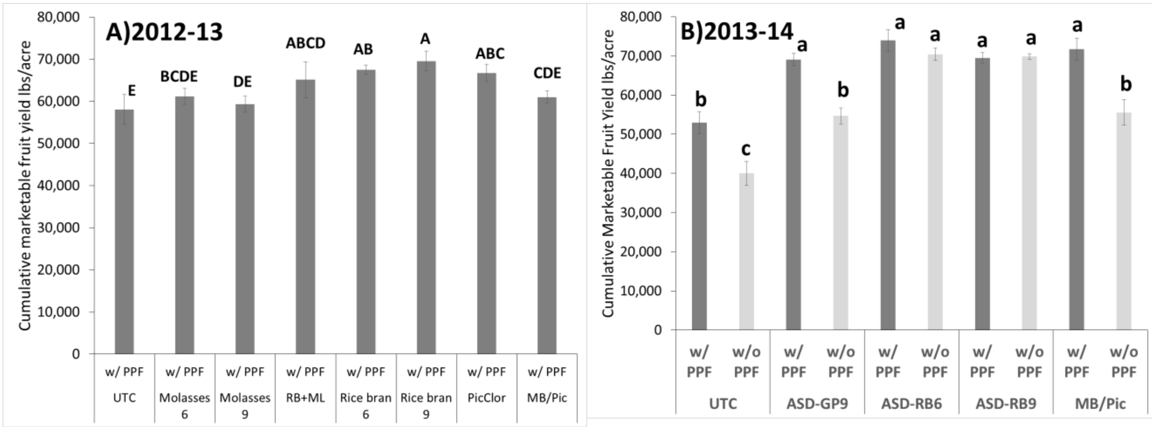


Figure 1: Cumulative marketable fruit yields from A) the 2012-13 season, and B) the 2013-14 season trial at PSI, Watsonville. Means marked with the same letter have no significant difference according to protected-LSD test (*P*=0.05).

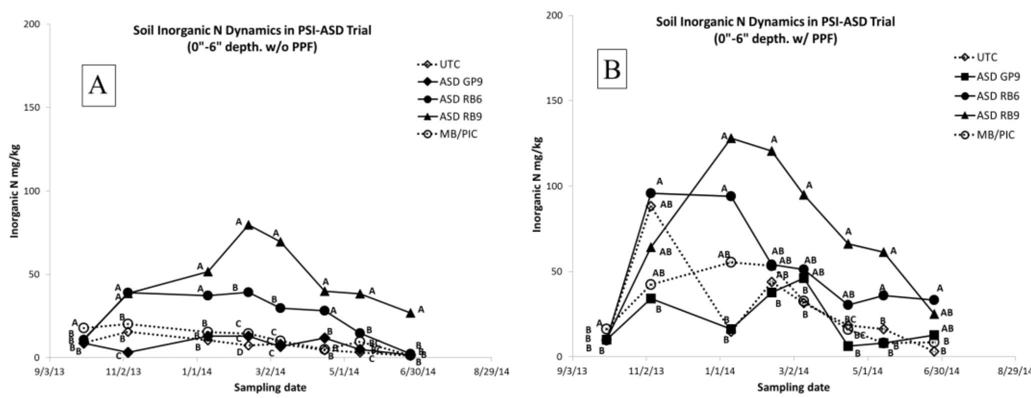
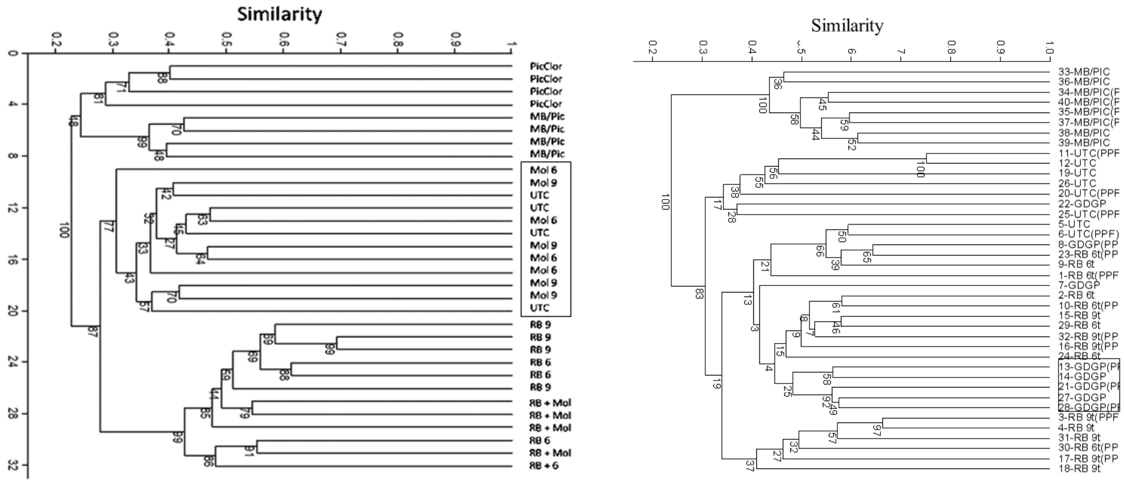


Figure 2. Changes in soil inorganic N (NO_3-N+NH_4-N, 0”-6” depth) in without pre-plant fertilizer plots (A) and with pre-plant fertilizer plots (B) at the PSI trial in the 2013-14 season. Means marked with the same letter on the same date have no significant difference according to protected-LSD test (*P*=0.05).



A) B)

Figure 3. Effect of soil treatments on fungal community composition in PSI strawberry field soils as assessed by principal component analysis of T-RFLP data. A) First trial (the 2012-13 season). Treatments: UTC=control; RB= Rice bran-based ASD at either the 6 t/ac (RB 6) or 9 t/ac (RB 9); Mol= molasses-based ASD at either 6 t/ac (Mol 6) or 9 t/ac (Mol 9); RB/Mol= Rice bran/molasses-based ASD 4.5 t/ac each; Pic-Clor and MB/Pic= pre-plant soil fumigation with Pic-Clor 60 or methyl bromide/chloropicrin, respectively. B) Second trial (the 2013-14 season). Treatments: UTC=control; RB= Rice bran-based ASD at either the 6 t/ac (RB 6) or 9 t/ac (RB 9), GDGP=dry grape pomace -based ASD at 9 t/ac.