REFINING ASD FOR DISEASE MANAGEMENT IN STRAWBERRY AND APPLE PRODUCTION

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Anaerobic soil disinfestation (ASD) has been studied as an industry level option for replacing soil fumigants to manage soil-borne diseases in both annual and perennial crop production systems. Although ASD has proven effective for the suppression of certain soil-borne pathogens in both strawberry and apple production systems, the extent of disease control attained often varies in a pathogen-specific manner. For instance, although ASD has provided effective suppression of *Verticillium dahliae*, *Fusarium oxysporum* f. sp. *fragariae*, causal agent of Fusarium wilt of strawberry, has been among the more intractable targets when attempting to broadly implement ASD as a commercially viable disease control method in strawberry production. In apple, use of ASD for management of apple replant disease has been limited due to various horticultural issues including the availability of effective substrate and integration into the annual production cycle. Studies were undertaken i.) to discern whether incubation temperature, duration or interaction among these variables influenced the disease control efficacy in response to ASD and ii.) evaluate different carbon inputs on efficacy of ASD for the control of target soil-borne pathogens.

Overall, ASD treatment and incubation temperature, but not duration of the incubation period, significantly influenced suppression of soil-borne pathogens limiting strawberry yields. Fusarium wilt and charcoal rot suppression was superior when ASD was conducted at elevated temperatures in combination with a 3-week incubation period. In terms of plant growth, ASD implemented with grass residues was more effective than ASD utilizing rice bran when evaluated under medium (32/26 ºC) and high (40/34 ºC) temperature incubation conditions: although, pathogen suppression was not always directly linked to strawberry growth response. Findings indicate that ASD-mediated disease suppression may partly stem from the toxic volatile compounds generated in an incubation temperature-dependent manner. ASD performed using either wheat or grass residues significantly reduced charcoal rot severity relative to a no treatment control, or ASD with rice bran as the carbon input. All ASD treatments generated volatile compounds that suppressed *Macrophomina phaseolina* mycelial growth *in vitro*. However, growth of the fungus was retarded to a greater degree when exposed to volatiles produced during ASD with wheat or grass residues compared to those with rice bran. Volatiles produced during ASD were fungistatic towards

M. phaseolina in nature and hindered microsclerotia development of this fungal pathogen.

Apple replant disease caused by a pathogen complex consisting of fungi, oomycetes, and lesion nematode, causes economic loss in both production orchards and nursery settings. Apple replant disease can negatively impact tree quality by reducing growth in nurseries and affected stock can potentially serve as a pathogen inoculum source when planted into production orchards. In controlled environment experiments, anaerobic soil disinfestation provided effective control of the replant disease pathogen complex, but did so in a carbon source-dependent manner. Disease suppression was associated with specific changes in the metabolome and microbiome.

Controlled environment and nursery field trials were conducted using a carbon source selected based upon results from prior studies. Trials employed multiple apple rootstocks reportedly varying in tolerance to replant disease and ASD was conducted using orchard grass as the carbon input at a rate of 10 t ha^{-1} (ASD-GR10) or 20 t ha^{-1} (ASD-GR20). Rootstock growth in ASD-treated soils was comparable to that attained in response to soil pasteurization (controlled environment) or fumigation with Telone® C35 (field trial) and was superior to the no treatment control (NTC). In greenhouse trials, growth performance and pathogen suppression in ASD treated soils was realized in a grass amendment rate-independent manner. Rootstock genotype influenced the relative incidence of root infestation by the replant pathogens *P. ultimum* and *R. solani*. Interestingly, in the field trial, quantities of *Pythium ultimum* and *Rhizoctonia solani* AG-5 DNA detected in apple roots were higher in the replant 'tolerant' G.41 rootstock than the susceptible rootstock M.9. This finding indicated that superior growth performance of rootstocks previously described as tolerant may depend upon factors other than resistance mechanisms as suggested by Atucha et al. (2014). At the end of the two year field trial, there was no significant difference in rootstock growth increment between fumigated and ASD treatments, with the exception of G.41 rootstock where growth was significantly greater in response to ASD. As observed previously (Hewavitharana and Mazzola, 2016) effective ASD treatments were associated with a rhizosphere microbiome that was significantly different from the control in controlled environment and the field trial at 4 months and 20 months after planting, respectively.

References:
Atucha, A., Emmett, B., and Bauerle, T. L. 2014. Growth rate of fine root systems influences rootstock tolerance to replant disease. Plant Soil 376:337-346.

Hewavitharana, S.S. and Mazzola, M. 2016. Carbon source-dependent effects of anaerobic soil disinfestation on soil microbiome suppression of *Rhizoctonia solani* AG-5 and *Pratylenchus penetrans*. Phytopathology 106:1015-1028.