AMENDMENT CARBON RATE AND C:N RATIO IMPACTS THE EFFECTIVENESS OF ANAEROBIC SOIL DISINFESTATION

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Summary
Anaerobic soil disinfestation (ASD) is a biologically-based soil treatment that is driven by the incorporation of labile organic matter to provide a carbon (C) source to soil microbes in saturated soil mulched with polyethylene. Treatment by ASD effectively controls a range of plant pathogens in specialty crop production under diverse environmental conditions and treatment methodology, although results can be variable (Shennan et al., 2014). Successful ASD treatment implementation on a commercial-scale will require substantial adaptation to local production systems, pathogen pressure and organic amendments. This is both because ASD is a biologically-driven process that inherently is influenced by a range of fluctuating and variable environmental conditions, and because the mechanisms of pathogen control have not been well-detailed across diverse systems to date. A greater body of knowledge on ASD treatment mechanisms will facilitate more timely development of treatment recommendations across a range of production system variables.

To meet this need, a series of growth chamber and field studies were initiated at the University of Tennessee in 2013 at moderate soil temperatures (15 to 25°C) to evaluate 1) the impact of organic amendment C:N ratio on ASD treatment effectiveness and 2) the impact of organic amendment C rate on ASD treatment effectiveness. Growth chamber studies were implemented to evaluate four C:N ratios (10:1, 20:1, 30:1 and 40:1) of soil amendment mixtures composed primarily of a) dry molasses or b) wheat bran. Experimental design was a completely randomized factorial with four replicates; a nonamended, untreated control was included also. Treatments were amended at a constant rate of 4 mg C g^{-1} soil. Survival of inoculum of *Fusarium oxysporum* and *Sclerotium rolfsii,* soil anaerobic activity, soil properties, and organic acid production were evaluated. Similarly, a field study was established to evaluate four C:N ratios (10:1, 20:1, 30:1 and 40:1) at a C rate of 4 mg C g^{-1} soil, a C:N ratio of 30:1 at a C rate of 2 mg C g^{-1} soil, an untreated control, and a MeBr-fumigated control. Treatments were arranged in a randomized, complete block design with four replicates. Survival of introduced inoculum of *F. oxysporum* and *S. rolfsii,* soil anaerobic activity, soil properties, and bell pepper yield were evaluated. Growth chamber studies were also initiated to evaluate the impact of amendment rates of 2, 4, 6 and 8 mg C g^{-1} of soil (maintained at a C:N ratio

30:1) on ASD treatment. Experimental design was completely randomized with four replicates, and nonamended, untreated controls (plastic-covered and uncovered) were included. Survival and parasitism of *S. rolfsii*, soil anaerobic activity, and soil properties were evaluated.

In growth chamber studies comparing amendment C:N ratios, soil anaerobic activity was generally highest and soil pH was generally lowest at amendment C:N ratio of 10:1. At the same time, the highest mortality of *F. oxysporum* inoculum was generally observed at amendment C:N ratios of 20:1 and 30:1, although responses differed for amendments composed primarily of dry molasses versus those composed primarily of wheat bran. Germination of *S. rolfsii* following treatment generally did not differ among ASD treatment C:N ratios. For both pathogens, ASD treatment enhanced pathogen mortality as compared to untreated controls. Acetic, butyric and isobutyric were the primary organic acids observed in soil solution during treatment. Total organic acids in soil at 7 and 14 days post treatment initiation were highest at an amendment C:N ratio of 40:1 (Figure 1). While soil anaerobic activity did not differ significantly among amendment C rates of 2 to 8 mg C g^{-1} soil, rates at or above 4 mg C g^{-1} soil were most effective in suppressing germination of *S. rolfsii.* Sclerotial parasitism at 2 and 4 mg C g^{-1} soil was primarily (>90%) driven by *Trichoderma* spp., but *Trichoderma* spp. parasitism was less than 60% at 6 mg C g^{-1} soil where parasitism by other fungi and bacteria was more pronounced. Amendment C:N ratio and C rates are important determinants of the effectiveness and control mechanisms of ASD treatment at moderate soil temperatures.

References

Shennan, C., J. Muramoto, M. Mazzola, N. Momma, Y. Kobara, J. Lamers, E.N. Rosskopf, N. Kokalis-Burelle and D.M. Butler. 2014. Anaerobic soil disinfestation for soil borne disease control in strawberry and vegetable systems: current knowledge and future directions. *Acta Horticulturae* 1044:215-220.

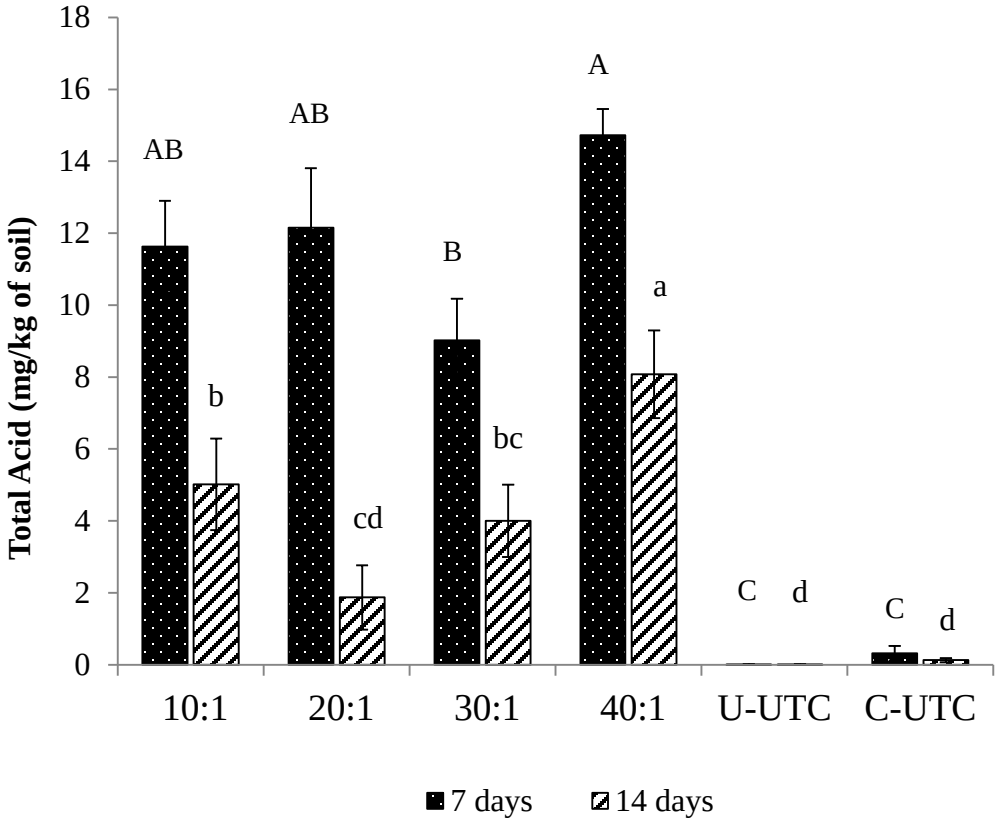

Figure 1. Total organic acids present in soil at 7 and 14 days post treatment initiation. Bars indicated by the same letters are not significantly different ($p > 0.05$). 10:1 = C:N ratio 10:1, 20:1 = C:N ratio 20:1, 30:1 = C:N ratio 30:1, and 40:1 = C:N ratio 40:1, all at C rates of 4 mg C g^{-1} soil; U-UTC = uncovered and untreated (nonamended) control, C-UTC = plastic covered and untreated (nonamended) control. Error bars represent standard error.