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Second Year Results Using Biochar as a Soil Amendment in a High Tunnel, Polybag Growth System

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Objectives

The purpose of this trial was to determine if using biochar a second year has an effect on yield and quality of cucumber (*Cucumis sativus*, cv. Diva), tomato (*Solanum lycopersicum*, cv. Brickyard), basil (*Ocimum basilicum*, cv. Italian Large Leaf), Swiss chard (*Beta vulgaris* subsp. c*icla, cv.* Technicolor), snap dragon (*Antirrhinum majus*, cv. Rocket Mix), and lettuce (*Lactuca sativa*, cv. Tropicana) in a high tunnel, polybag production system.

Summary

Using a soil mix containing 0, 0.5, 1, 2, 4, or 8% by volume of biochar to Morgan's 301 mix had little effect on yield and quality of cucumber, tomato, Swiss chard, basil, lettuce, and snap dragons grown in a high tunnel, polybag production system. The only statistical difference determined was in number two fruit in Diva cucumber.

Methods

Soil Mix

In 2014, biochar was combined with Morgan's 301 Mix at a volume ratio of 0, 0.5%, 1%, 2%, 4%, and 8% and placed into 5-gallon polybags. Biochar was supplied by Biogenic Reagents and met the following standards:

Surface Area:	400 m^2/g (min)
Ash	5% (max)
Volatile matter	5% (max)
Carbon	90% (min)
pH	7-9

Biochar was combined with Morgan's 301 by placing the appropriate ratios into a cement mixer and tumbling until they were well mixed. The mix was then placed into the bags. The mix was moistened and allowed to sit a minimum of two weeks before planting. Bags with the soil mix were overwintered in the high tunnel.

Planting

Six crop species were evaluated in 2015: cucumber (*Cucumis sativus*, cv. Diva), tomato (*Solanum lycopersicum*, cv. Brickyard), basil (*Ocimum basilicum*, cv. Italian Large Leaf), Swiss chard (*Beta vulgaris* subsp. c*icla, cv.* Technicolor), snap dragon (Antirrhinum majus, cv. Rocket Mix), and lettuce (*Lactuca sativa*, cv. Tropicana). The tomato was set as a transplant on June 5, one plant per bag. Cucumber and Swiss chard were direct seeded June 8, one seed per bag for cucumber and three seed per bag for Swiss chard. Snapdragons were planted June 5, three plants

per bag. Basil and lettuce were set as transplants, three plants per bag on June 8. Weeds and plant debris from the previous year were removed prior to planting.

Fertilizer

Plants were fertilized weekly with liquid 28-0-0 and 0-0-30 at a rate of 1 lb. nitrogen and 2 lb. potassium (K_2O) /acre/day. Fertilization began the week of June 6 and ended the week of August 24. Brandt GH Vegetable Mix Extra was also added weekly at a rate of 1 quart/acre to supply magnesium (2%), boron (1%), copper (0.25%), iron (1.75%), manganese (0.5%), and zinc (0.5%).

Weed Control

Weeds were controlled by covering the ground in the tunnel with black ground cloth.

Plant Care

Plots were irrigated as needed through a drip irrigation system. No insect control was needed but it was necessary to control downy mildew with Ranman® applications on the cucumbers.

Harvest and Data Collection

Plots were harvested at the suitable stage for that species and graded according to commercial standards (tomato and cucumber), weighed (lettuce, Swiss chard, basil), or number of marketable flower stems counted (snap dragons). Plots were standardized to one or three plants per bag and the data subjected to statistical analysis. The trial was planted and analyzed as a completely randomized design with four replications. Each plot consisted of four, 5-gallon polybags.

Results

Just as in 2014 (Goldy and Wendzel, 2014), biochar treatments largely had no effect on the species evaluated and the traits measured (Table 1). The only significant difference was for weight of cucumber number two fruit.

Reasons for lack of separation are unclear. Previous biochar studies (Major et al., 2010) have found no differences the first year but significant differences in subsequent years, and that is why this trial was repeated over the two-year period. Biochar has a greater effect in low organic matter and low nutrition soils. Morgan's 301 is a high organic soil mix that contains a significant amount of nutrients since cow manure is a main component.

High initial nutrient and organic matter levels could explain the lack of separation. Fertilizer was applied in 2015 since previous trials using Morgan's 301 for a second year gave poor plant performance if no additional nutrients were supplied (especially micronutrients), and plants were already showing low fertility symptoms at the end of 2014. Perhaps separation would have been observed if this was not done.

Literature Cited

Goldy, R. and V. Wendzel. 2014. Biochar as a Soil Amendment in a High Tunnel, Polybag Growth System. Available online ag.purdue.edu/hla/fruitveg/MidWest%20Trial%20Reports/2014/06-01_Goldy_MixedBiochar.pdf.

Major, J., Rondon, M.A., Molina Lopez, D.L., Riha, S.J., and Lehmann, J. 2010. Maize yield and nutrition during 4 years after biochar application to a Colombian savanna oxisol. Plant and Soil 33:117–128. Available online

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Table 1. Total yield of six crop species grown a second year in polybag culture in a high tunnel system at the Southwest Michigan Research and Extension Center, Benton Harbor, Michigan, in 2015. Treatments were 0 to 8% by volume of biochar to Morgan's 301 mix.

Treatment (% by vol.)	Tomato (grams/bag)	Cucumber (grams/bag)	Lettuce (grams/bag)	Basil (grams/bag)	Swiss Chard (grams/bag)	Snap Dragons (stems/bag)
0	2,717	885	153	147	188	41
0.5	2,610	915	151	246	214	36
1	2,384	848	154	208	218	37
2	2,578	922	162	158	163	37
4	2,484	946	118	226	275	37
8	2,789	786	122	250	184	34
Lsd 0.05	ns	ns	ns	ns	ns	ns