Yield Comparison of Sweet Potato Grown in Four Commercial Organic Soils

ABSTRACT

Aims: The experiment was conducted to observe the effects on comparative yields of sweet potato (Ipomea batatas 'Beauregard') grown in four different soilless media**Study design:**Mention the design of the study here.
Place and Duration of Study: Pullen Farm at Murray State University, in Murray, Kentucky, USA., between May 2018 and August 2018.
Methodology:16 3.048m x .3046m troughs (four of each treatment) each containing five sweet potato plants were established. No treatments received supplemental fertilization. Descriptive statistics and quantitative analysis were performed on yield characteristics of the sweet potato crop (sweet-potato tuber and biomass yields).
Results: While a significant difference in mass of above-ground biomass between the treatments could not be determined, growth parameters of the Organiloc treatments (A, B) were marginally greater than treatments C and D (Table 1). The fresh weight of treatments A (38.91 t ha^{-1}) and B (42.75 t ha^{-1}) were statistically greater than treatment C (21.23 t ha^{-1}). Treatment B was also statistically greater that treatment D (23.92 t ha^{-1}). The number of tubers in treatment A and B were not significantly different than treatment D, but were significantly greater than treatment C (Figure 2).
Conclusion: The results of this one cropping season study suggest that yields of sweet potatoes grown in these two biochar-based treatments (A + B), in which they were statistically greater than the Miracle Gro treatment (C), and Treatment B was statistically greater than the Magic Dirt treatment (D), may help to fulfill the increasing demand for locally-produced food and agricultural products while providing an efficient means of disposing of agricultural waste products and may promote sustainable crop production and food security.

Keywords: Biochar; sweet potato; Ipomea; organic; yield comparison

1. INTRODUCTION

Between 691 and 783 million people in the world faced hunger in 2022[1]. In 2022, 12.8% of American households in were food insecure [2]. Over 20% of arable land in the United States is currently degraded [3], which is defined as "a long-term decline in ecosystem function and productivity" [4]. Food producers currently require man-made chemicals that are expensive and may require multiple applications. Organic and environmentally friendly methods of production are desirable due to potential environmental and human health concerns [5], and to meet increased market demand [6].

The total value of the United States sweet potato crop in 2016 exceeded $598 million [7]. Kentucky agriculture produces over $6.5 billion in annual revenue [8], which includes industries such as horse breeding, fish and chicken processing, and timber harvesting. These industries generate waste which could be diverted/redirected from landfills and put to good use. An organic soil product made from such waste products could fulfill needs considered urgent in agritech and waste to energy (WTE) industries [9].

The media tested in this experiment help to meet these needs, as they are created from agronomic waste products. The purpose of this project is to evaluate the effectiveness of different organic soils (including these two novel biochar-based organic growing soils), on growth, tuber yield, and nutrient uptake of sweet potato.

Biochar is a high-carbon solid product often produced by pyrolysis of biomass in a low-oxygen atmosphere [10]. LEI Products (LEI) states that they make biochar as a continuous by-product of their bio-burner combustion process. Biochar can be produced using different biomass feedstocks, such as lumber waste products or equine bedding. According to Nair et al, the use of biochar could have beneficial agronomic effects such as "nutrient recycling, soil conditioning, and long-term carbon sequestration" [11]. Nair continues stating that other examined benefits of biochar are increased nutrient retention and cation exchange capacity.

2. MATERIAL AND METHODS

2.1. Study Site

Trough experiment was carried out on the Pullen Farm at Murray State University, in Murray, Kentucky (36.6103 N, 88.3148 W), USA.

2.2. Treatments

For treatments A and B (Organilock Horse Manure based All-Purpose Soil (Organilock A) and Organilock All-Purpose Soil (Organilock B), Organilock, Inc., Madisonville, KY) are formulated from locally sourced fresh biomass and whole animals. The biomass base for Treatment A was a non-composted horse manure while the base for Treatment B was a non-composted pine wood. Other ingredients for both treatments include non-composted conifer bark, re-purposed biomass, proprietary organic fertilizer, biochar, minerals, and both treatments were inoculated with michronizedendomycorrhial from Bio Organics, LLC. Animal tissue biomass was sourced from local commercial agriculture production. Treatment A included fresh horse manure while treatment B included chicken manure. Treatment C (Miracle Grow Raised Bed Soil, ScottsMiracle-Gro, LLC, Marysville, OH) is described by the manufacturer as formulated from (one or more of the following: peat, processed forest products and/or compost), and (sphagnum peat moss and/or coir), poultry litter, alfalfa meal, bone meal, kelp meal, and earthworm castings. Treatment D (Magic Dirt Premium Potting Soil, Magic Dirt Horticultural Products, Inc., Little Rock AR.) is described by the manufacturer as consisting of anaerobically digested organic farm waste and composted forest products.

2.3. Experimental design

The experiment consisted of a group of raised troughs 3.048m in length, .3048m in width, and .3048m in height (.2832 cubic meters). The 16 troughs were placed side by side lengthwise, with the beam running east-west. The randomized design included four replications of each treatment.

Sweet potato cultivar *Ipomea batatas* 'Beauregard' were planted five slips per trough. The troughs were provided with a supplemental automatic watering system to ensure adequate soil moisture. Total rainfall and mean daytime temperature during the growing season were 37.11 cm and 26.62 °C, respectively.

2.4. Growth, yield, and nutrient uptake of sweet potato

Slips were planted May 12, 2018 and the crop was harvested 109 days after planting August 28, 2018. Tubers were counted and weighed and above-ground biomass was oven dried and weighed. A subsample of each treatment's above-ground biomass was analyzed for total N, P, and K. The testing standard for plant analysis was acid digestion of nitric peroxide. High Temperature Combustion (HTC) with Total Nitrogen (TNb) by Chemiluminescence Detection (CLD). Chemical analysis of plant tissue was conducted by Waters Agricultural Laboratories, Inc., of Owensboro, KY, USA.

2.5. Statistics

Descriptive statistics and quantitative analysis were performed on yield characteristics of the sweet potato crop (sweet-potato tuber and biomass yields) using Microsoft Excel.

3. RESULTS AND DISCUSSION

While a significant difference in mass of above-ground biomass between the treatments could not be determined, growth parameters of the Organiloc treatments (A, B) were marginally greater than treatments C and D (Table 1).

Table 1. Dry mass of aboveground biomass / t hectare^{-1}

Treatment A	Treatment B	Treatment C	Treatment D
	10.38	4.69	10.31

The fresh weight of treatments A (38.91 t ha-1) and B (42.75 t ha-1) were statistically greater than treatment C (21.23 t ha-1). Treatment B was also statistically greater that treatment D (23.92 t ha-1) (Figure 1).This is contrary to the findings of a similar study conducted in Nova Scotia in which it was found thatoverall yield was lower for organically grown potatoes compared to conventionally grown potatoes [12].

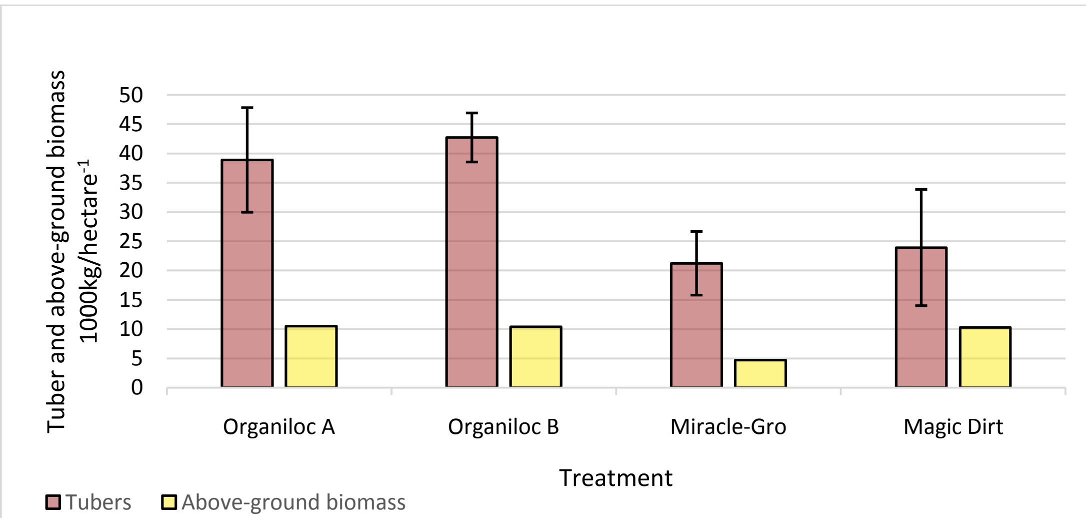

Fig. 1. Effect of treatment on tuber and above-ground biomass yield.

Increased aboveground biomass is important when determining plant productivity as generally, the absolute leaf area of foliage is linearly related to economic yield [13].The yields of treatments A and B in Figure 1 are greater than would be anticipated based on established productivity models for sweet potato. The University of Kentucky Extension Service states that Kentucky farmers should expect average yields of approximately 22.42 t ha^{-1}[14] while the University of California at Davis Agriculture Extension Service lists approximately 35.85 t ha^{-1}[15].

The number of tubers in treatment A and B were not significantly different than treatment D, but were significantly greater than treatment C (Figure 2).

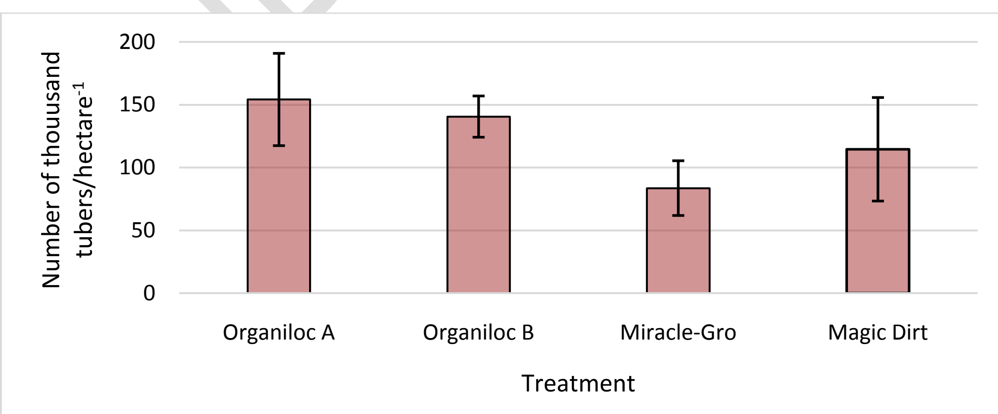

Fig. 2. Number of tubers per treatment per ha^{-1}

Chemical testing of aboveground biomass composition found that treatments A, C, and D were marginally greater in nitrogen than treatment B (Table 2). Treatments A, B, and C were marginally greater in P and K than treatment D. Based on measures of critical nutrient concentrations for deficiency, all four treatments were found to be lacking in nitrogen. Critical concentrations are those concentrations associated with 90% of maximum yield. Treatment D was below the critical threshold for potassium [16,17].

Table 2.Nutrient content (%) of aboveground biomass and critical nutrient concentration deficiency

Treatment	N	P	K
A	3.30	0.40	3.11
B	2.60	0.39	3.03
C	3.16	0.42	3.29
D	3.10	0.31	2.20
Deficiency	4.0	0.22	2.6

4. CONCLUSION

The results of this one cropping season study suggest that yields of sweet potatoes grown in these two biochar-based treatments (A + B), in which they were statistically greater than the Miracle Gro treatment (C), and Treatment B was statistically greater than the Magic Dirt treatment (D), may help to fulfill the increasing demand for locally-produced food and agricultural products while providing an efficient means of disposing of agricultural waste products and may promote sustainable crop production and food security. Assuming roughly equal costs of production and yields, treatments A and B may be preferred to treatments C and D while diminishing the need for added inorganic chemicals. The author recommends replications of this experiment in other locations and over time, as year-over-year yield data is a stronger predictor of future outcomes.

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