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Effect of Biochar on Sweet Corn Production

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Abstract
Biochar is an organic amendment produced by a process called pyrolysis. Pyrolysis is the burning of biomass in a limited oxygen environment. In the recent past, agricultural use of biochar has been steadily increasing and attracting research interest. Biochar has been shown to reduce leaching of critical nutrients thereby providing greater soil availability and crop uptake. Potential use of biochar in cropping systems could include nutrient recycling, soil conditioning, and longterm carbon sequestration. Biochar as a biorenewable resource has the potential to positively impact several key areas of our production systems such as soil organic matter and quality, water quality, crop growth, yield, and productivity

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Effect of Biochar on Sweet Corn Production

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Introduction

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In the United States, most biochar research has been conducted in warmer regions. Little has been published on how biochar will affect crop production in northern climate zones such as the Midwest. In addition, most of the work has been conducted with agronomic crops. Because biochar use in vegetable cropping system is still in the nascent stage, there are no standards or application strategies (amount, incorporation technique, etc.) that are available to vegetable growers. The objective of this study was to optimize the application rate and evaluate the effect of biochar on sweet corn production.

Materials and Methods

The study was conducted at the Muscatine Island Research and Demonstration Farm, Fruitland, Iowa. Soil type was Fruitfield coarse sand with 0 to 2 percent slope and less than 1.5 percent soil organic matter. The plot was chisel plowed in March and disked in April 2012. On April 5, a pre-plant fertilizer application of 250 and 400 lb/acre of 0-0-60 and 13-13-13, respectively, was made. Four rates of biochar (0, 2.5, 5.0, or 10.0 ton/acre and 0 tons/acre referred to as Control) were applied by hand using buckets (Figure 1). Each plot measured 15 ft by 30 ft. Experimental design was a randomized complete block design with four replications.

Temperature sensors were installed to monitor soil temperature at 4-in. depths throughout the growing season. Sweet corn Temptation (a biocolor-sugar enhanced cultivar) was seeded on April 17, which was followed by Dual II Magnum + Atrazine for weed control. Insect control was achieved using Mustang Max®. On May 11, urea and ammonium sulfate were broadcast to provide 114 and 15 lb/acre of nitrogen and sulfur. At eight-leaf stage, five random plants were selected from each treatment and data was collected on plant height. Sweet corn rows were thinned to one plant every 10–12 in. on May 29. To enhance crop growth, additional nitrogen (20 lb/acre) was applied through overhead irrigation on June 20. Soil samples were collected in the beginning, mid, and end of the season. Two 30-ft rows of sweet corn from each treatment were harvested on July 5 and data was collected on marketable and non-marketable weight and number of ears. Ten ears were randomly collected from each treatment to record husked ear weight, ear length, and diameter. Further, two husked ears were randomly selected and analyzed for sweetness using a refractometer.

Results and Discussion

At the end of the growing season, soil pH ranged from 6.1–6.4. Biochar has been shown to increase soil pH, although, we did not observe statistically significant differences between treatments (Table 1). There was a general trend of increasing soil pH with increasing biochar rates. Similarly soil electrolytic conductivity did not show statistically significant differences. Soil temperature measured 4 in. below the surface during the growing season did not show differences among treatments (Figure 2).

We expected to see an effect of biochar on plant growth; however, plant growth did not show any visible differences. Plant height measured four weeks after seeding was statistically similar among treatments. Biochar significantly affected the number and weight of marketable ears. With higher rates of biochar, (5 and 10 tons/acre) there was a reduced number and weight of marketable ears. However, the 5 tons/acre biochar rate did not reduce yield and was statistically similar to the control treatment (0 tons/acre biochar).

The effect of biochar on vegetable crop yields are not widely available, however, data is available for field crops. A number of studies have shown yield reductions in the first year of biochar use followed by increases in subsequent years. Increases in crop yields have been attributed to better water holding capacity, higher cation exchange capacity, increased nutrient retention, and the ability of biochar to reduce bulk density.

In terms of ear quality, we did not find any significant differences in husked weight, ear length, and ear width of sweet corn or sweetness (brix).

This was the first year of the study and it is early to speculate effects of biochar on soil properties, crop growth, and yield. Biochar could be a valuable tool for management of soils that are either degraded or have poor nutrient status; however, it will take time to observe significant changes in soil and crop attributes after biochar addition.

Table 1. Effect of biochar on soil pH and electrolytic conductivity at the time of sweet corn harvest.

Treatment	Soil pH^NS	Electrolytic conductivity (mS/cm)^NS
Control	6.2	0.37
2.5 ton/acre	6.1	0.31
5.0 ton/acre	6.3	0.23
10.0 ton/acre	6.4	0.26

NSNon-significant.
†Mean separation within columns; means followed by same letter(s) are not significantly different ($P \leq 0.05$).

Table 2. Effect of biochar on sweet corn (Temptation) growth and yield characteristics.

Treatment	Plant height (cm)^NS	Marketable		Non-marketable^NS	
		Number†	Weight (kg)	Number	Weight (kg)
Control	20.5	56 a	16.8 ab	3	0.8
2.5 ton/acre	20.8	57 a	17.1 a	2	0.6
5.0 ton/acre	19.3	51 b	15.3 bc	6	1.4
10.0 ton/acre	20.3	52 b	15.6 c	4	0.9

NSNon-significant.
†Mean separation within columns; means followed by same letter(s) are not significantly different ($P \leq 0.05$).

Table 3. Effect of biochar application on sweet corn (Temptation) quality attributes.

Treatment	Husked weight (kg)^NS	Ear length (cm)^NS	Ear width (cm)^NS	Brix^NS
Control	0.23	18.1	4.8	24.6
2.5 ton/acre	0.23	18.3	4.8	25.4
5.0 ton/acre	0.24	18.4	4.8	25.3
10.0 ton/acre	0.23	18.6	4.8	24.5

NSNon-significant.
†Mean separation within columns; means followed by same letter(s) are not significantly different ($P \leq 0.05$).

Figure 1. Hardwood biochar used for soil incorporation.

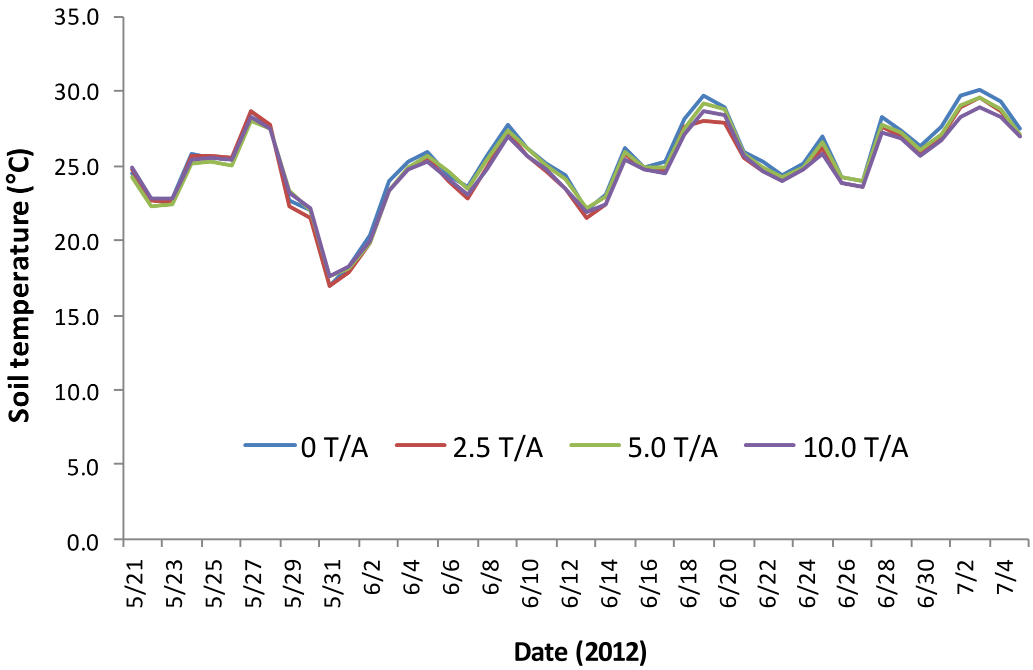

Figure 2. Soil temperature 4 in. below the surface during sweet corn growing season within biochar treatments.