

Effect of Biochar Application on Cabbage Production

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Introduction

Biochar is a soil amendment produced by the process called pyrolysis, which is the burning of biomass in a limited oxygen environment. Potential benefits of biochar in sandy soils include addition of organic matter, nutrient retention and recycling, enhanced microbial activity, and long-term carbon sequestration. Adoption and use of biochar by vegetable growers has been slow, because information is lacking on how biochar will affect crop production on a long-term basis.

In the area of vegetable production, information is needed on rate of biochar application, incorporation technique, types, and quality attributes of biochar. This study investigated the potential use of biochar for commercial cabbage production. The core objective of the study was to determine an optimal application rate of biochar and evaluate its effects on crop yield and quality.

Materials and Methods

The study was conducted at the Muscatine Island Research Farm, Fruitland, Iowa. Soil type was Fruitfield coarse sand with 0 to 2 percent slope and less than 1.5 percent soil organic matter. Four biochar treatments were set up on April 12, 2012 (0, 2.5, 5.0, or 10.0 tons/ac). Biochar was applied using five gallon buckets and later disked in. No further biochar was applied in 2013, 2014, or 2015. Each treatment plot measured 15 ft by 30 ft. Experimental design was a randomized complete block design with four replications.

Bronco cabbage (Seedway, Elizabethtown, PA) was transplanted on May 6 and 12, 2014 and 2015, respectively. Each treatment had three rows of cabbage with the middle row as the data row and the sides as the guard rows. On May 14, 2014, herbicide Dacthal[®] (active ingredient dimethyl tetrachloroterephthalate) was applied at the rate of 6 lb/acre over the crops and in the alleyways. On May 23, 2014, nitrogen was applied at the rate of 46 lb/acre. Plot was cultivated on May 30, 2014 to manage weeds. Cabbage loopers were managed by spraying bifenthrin insecticide on June 5, 2014. Equus[®] (active ingredient chlorothalonil) was sprayed on June 21, 2014 to manage fungal diseases. Cabbage was harvested July 25, 2014, and data was collected on marketable weight, number, and head quality.

In 2015, weeds were managed by spraying Volunteer[®] (active ingredient clethodim) on June 9. Leaf blight and cabbage looper incidences were higher in 2015 and were managed using Echo 720[®] (chlorothalonil) and Mustang Max[®] (zeta-cypermethrin), respectively. Crop was harvested on August 11, 2015.

Results and Discussion

Soil pH ranged from 6.7 to 6.9 with no difference between treatments. The 2014 growing year is the third year after soil application of biochar. Previous crops grown in the same location include potato (2012) and sweet corn (2013). Although there were visible differences in plant growth, there were no statistically significant differences in marketable and non-marketable head number or weight (Table 1). Similar results were observed in 2015. Between growing years, 2014 produced a higher number of marketable heads than 2015. This could be attributed to more than average rainfall and higher degree

of disease pressure in 2015. There was no difference in total soluble solid concentration (measured in brix) between treatments in cabbage heads either of the years (Table 2).

Several biochar studies, especially in agronomic crops, have shown yield reductions during initial years (one to three) after biochar application. In this study, we did not find any detrimental effect of biochar on crop yield or quality. We are continuing research in these plots to evaluate differences in water holding capacity, cation exchange capacity, nutrient

retention, and bulk density in biochar amended soils. Biochar could be a valuable tool for management of soils that are either degraded or have poor nutrient status. However, it could take time to observe significant changes in soil and crop attributes after biochar addition.

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Table 1. Effect of biochar application on cabbage yield characteristics (2014-2015).[†]

Treatment*	Marketable number ^{NS}	Marketable weight ^{NS} (kg)	Non-marketable number ^{NS}	Non-marketable weight ^{NS} (kg)
	2014			
Control	20	31.1	1	0.42
2.5 T/A	19	31.3	0	0.21
5.0 T/A	18	29.8	1	0.81
10.0 T/A	19	34.2	1	0.87
2015				
Control	9	6.1	12	8.89
2.5 T/A	6	4.1	14	11.84
5.0 T/A	6	5.0	14	12.21
10.0 T/A	6	4.8	14	13.03

^{NS}Non-significant. Mean separation by Fisher's protected LSD ($P \leq 0.05$).

[†]Data collected from 30-ft long rows.

*Biochar application in tons/acre.

Table 2. Effect of biochar application on total soluble solids in cabbage.[†]

Treatment*	Total soluble solids (Brix) ^{NS}	
	2014	2015
Control	7.2	5.9
2.5 T/A	6.9	6.1
5.0 T/A	6.9	5.9
10.0 T/A	7.1	6.0

^{NS}Non-significant. Mean separation by Fisher's protected LSD ($P \leq 0.05$).

[†]Data collected by juicing of a longitudinal wedge from one head, randomly selected from each replication.

*Biochar application tons/acre.