Biochar Effects on Soil Chemical Properties and Corn Yield

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Abstract

Biochar application to soil is proposed as a novel approach to establish a long-term sink for carbon sequestration in terrestrial ecosystems. In 2012, an experiment was established at the University of Tennessee's Milan Research and Education Center in Milan, TN to determine the effects of bio-char and nitrogen rate on soil chemical properties and corn yield. The experimental design was a split plot with nitrogen rate as the main plot and biochar rate as the split plot. Nitrogen rates used were 134 kg ha^{-1} and 202 kg ha^{-1}, and biochar rates were 0, 13, 27, and 67 Mg ha^{-1}. The treatments were replicated four times on a Grenada silt loam (fine-silty, mixed, active, thermic Oxyaquic Fraglossudalfs) with a 0-2% slope. The biochar was applied dry using a drop spreader and then incorporated using a chisel plow followed by a disc to prepare the seedbed. Due to the extreme drought in 2012, no corn yield data were taken. In 2013, the corn was planted using no-tillage into the previous year's residue. Corn yields in 2013 and 2014 were significantly affected by N-rates with the 202 kg ha^{-1} rate being higher, but there were no significant differences between bio-char rates. Soil organic carbon was significantly increased as biochar rates increased.

Biochar application in progress using a Gandy drop spreader.

Biochar chisel plowed and disc in after application.

Materials and Methods

Biochar was provided by Pacific Northwest National Laboratory and was made at the National Renewable Energy Laboratory, Golden, CO. The biochar was a mixture of feedstocks that included corn stover, wheat straw, switchgrass, distiller's grain and mixed oak hardwood. The biochar was made with gasification at a temperature of 650 C. Biochar rates and nitrogen rates were applied in a split plot design with nitrogen rate as the main plot and biochar rate as the sub-plot with four replications. In the Spring, before biochar application, the field was chisel plowed to a depth of approximately eight inches then disc to smooth and level. The material was surface applied using a drop spreader then chisel plowed and disc once more to incorporate. University of TN Extension recommendations were used. Plots are 4 m by 1 m. Yield was calculated by harvesting the center 2 rows of corn in each plot. Soil samples were taken each year in the Fall for chemical analysis.

Results and Discussion

In 2012, high temperatures and drought during the growing season resulted in a non-harvestable corn crop. Yields were measured in 2013 and 2014. Across biochar treatments, there were no significant differences in corn yield. The 202 kg/ha nitrogen rate produced significantly higher yields compared to the 134 kg/ha rate. (figure 1)

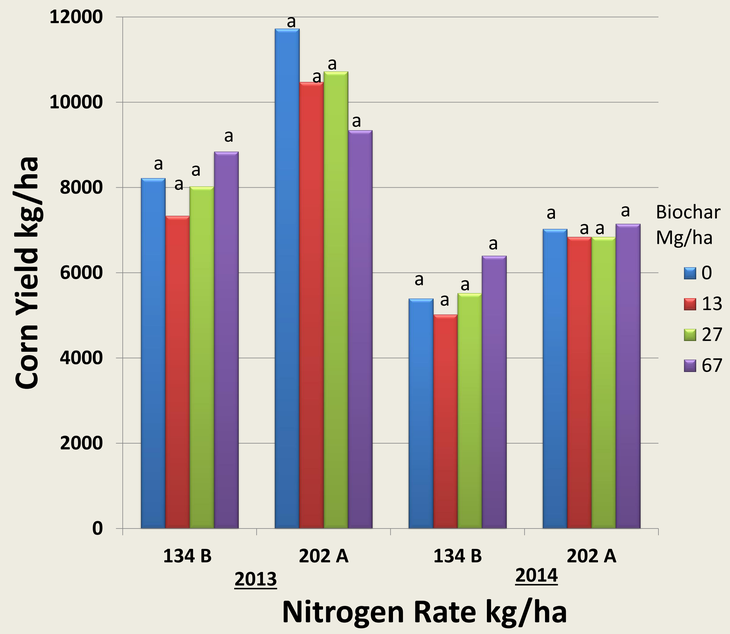
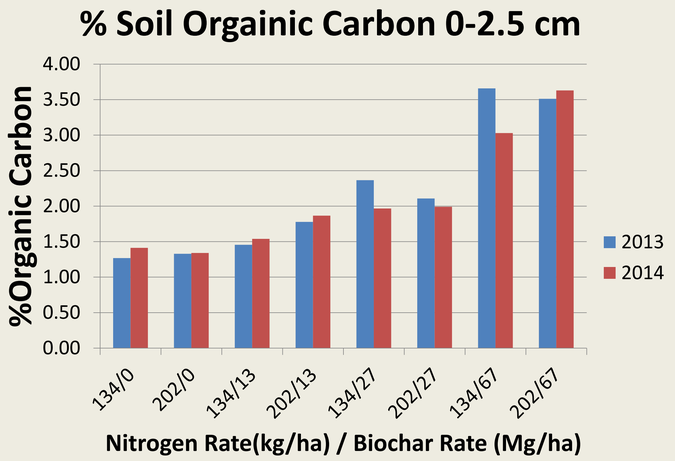


Figure 1. Corn yield effected by nitrogen and biochar rate. Within a year, nitrogen rates followed by different capital letters are significantly different at the 0.05 % level. Within a year, columns with the same lower case letter are not significantly different at the 0.05% level.

Soil organic carbon increases significantly with increasing biochar application rates.



Applying material was a dirty job, requiring proper PPE for protection while trying to minimize offsite movement. Field application methods need to be further researched to minimize dust.

Analysis using ICP resulted in the following concentrations (mg/kg)

Al	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn	Si
1020	6069	12	1904	15460	1360	309	529	727	264	44	31630