Effects of Biochar and Nutrient Management on Growth, Yield and Bioenergy Production of Sunflower *(Helianthus annuus)*

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INTRODUCTION

Biochar is of specific interest as it has the ability to alter nutrient and water holding capacity in soils, as well as, alter soil pH [1&2]. This study was focused on the extent of biochar's potential as a soil amendment and the effects it may have on overall soil and feedstock quality in sunflower, a fast-growing annual feedstock. Sunflower was grown under differing fertilizer and biochar treatments.

Objectives

1. Determine the effectiveness of biochar as a soil amendment in the production of sunflower
2. Evaluate the effects of nutrient management in relation to biochar application
3. Measure any significant changes in feedstock production and quality

METHODOLOGY

Greenhouse Conditions

This study was conducted at Georgia Southern Universities' biological sciences greenhouse, in Statesboro, GA. The greenhouse is regulated for large variances in temperature, sunlight exposure and humidity. The seeds were germinated the second week of July, with a primary growing season of 80 days, from July 13- October 1, 2015.

Experimental Design

This experiment utilized a simple randomized block design, with a total of eight blocks and nine treatments within each block (table 1). A total of 72 plants were measured in this experiment (Figure 6).

Monitoring and Data Collection

Data was collected to determine average soil moisture, water usage, pH, total biomass, caloric content and ash levels of pelletized biomass. Chemical analysis was conducted at GSU's chemistry and biology departments, while the milling of biomass was processed at Herty Advanced Materials Development Center (Herty AMDC).

Throughout the growing season pH, soil moisture, total water used and height measurements were collected. pH was collected bi-weekly using a field probe (Figure 7). Soil moisture was taken prior to watering and was collected every five days, at the time of watering (Figure 9). Each sunflower was watered until water could be seen dripping out of the drainage holes.

Biochar/Fertilizer Ratios			
	Biochar Rate		
Fertilizer Rate	0 t/ha	25 t/ha	50 t/ha
0%	0/0	0/25	0/50
50%	50/0	50/25	50/50
100%	100/0	100/25	100/50

Table 1: Biochar/Fertilizer treatment ratios

RESULTS

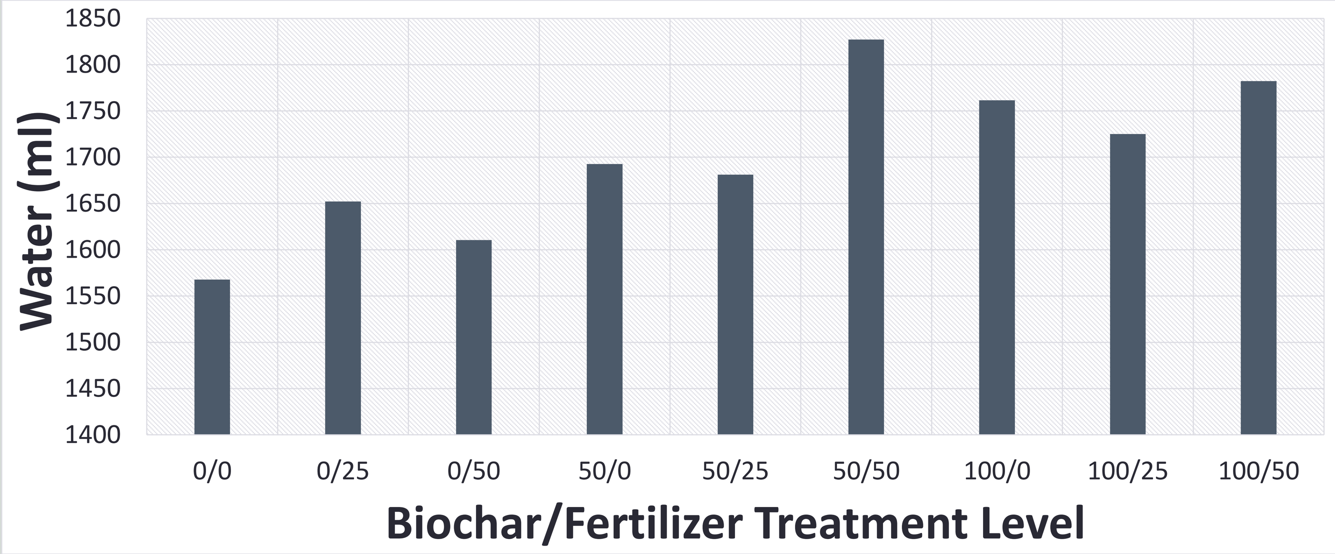

Figure 1: Overall average of total water consumption with connecting letters report. Water usage, oneway ANOVA, p=0.9002.

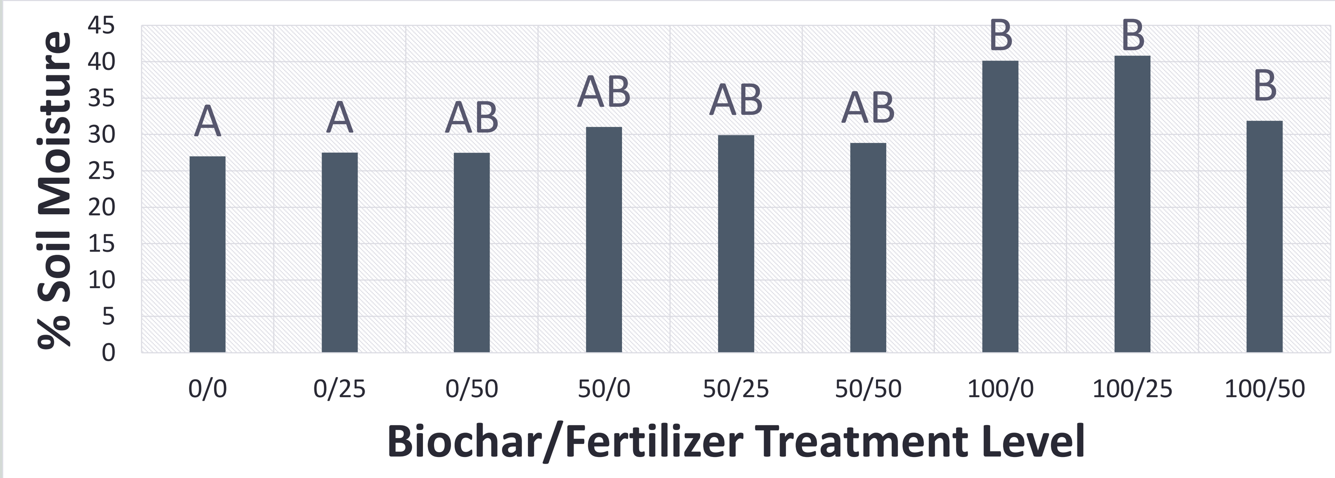

Figure 2: Average of soil moisture with connecting letter report. % Soil moisture, oneway ANOVA, p=0.0008, Tukey HSD w/ connecting letters report

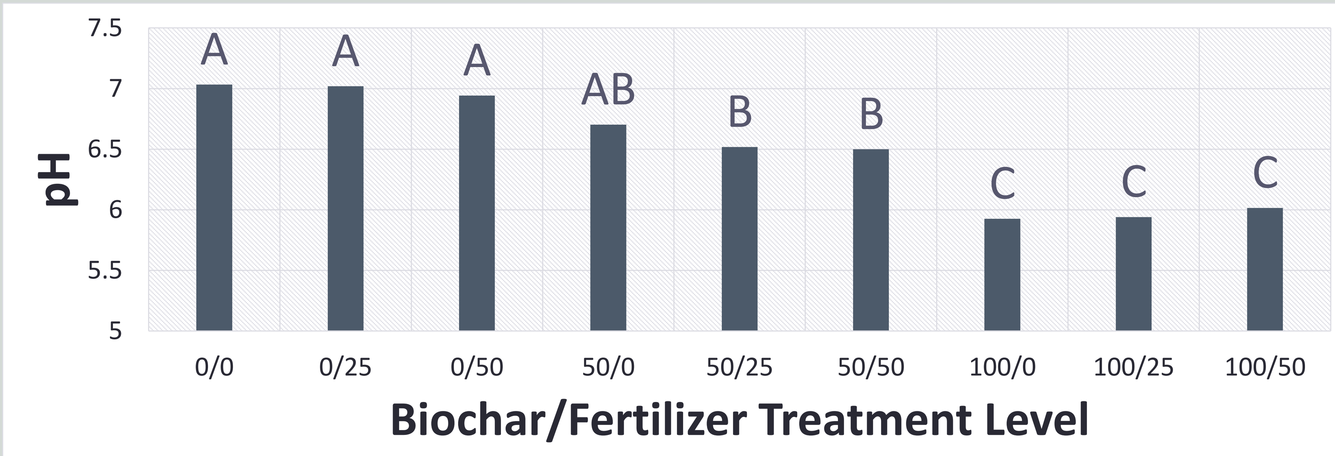

Figure 3: Overall average of pH pH readings. pH average, oneway ANOVA, p<0.0001, Tukey HSD w/ connecting letters report

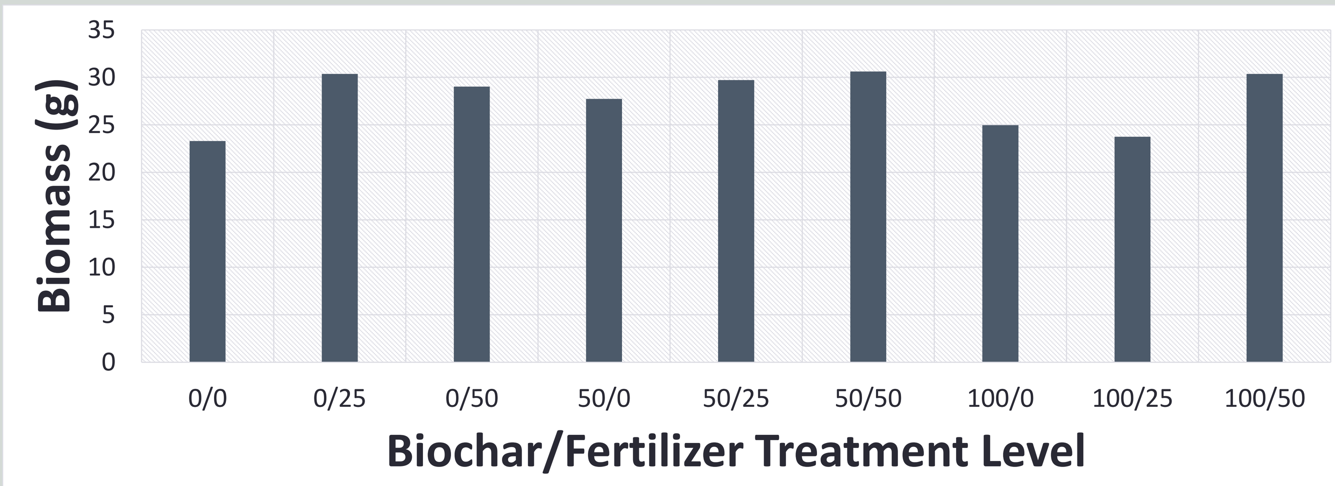

Figure 4: Overall average of total biomass production. Total biomass oneway ANOVA, p=0.0859.

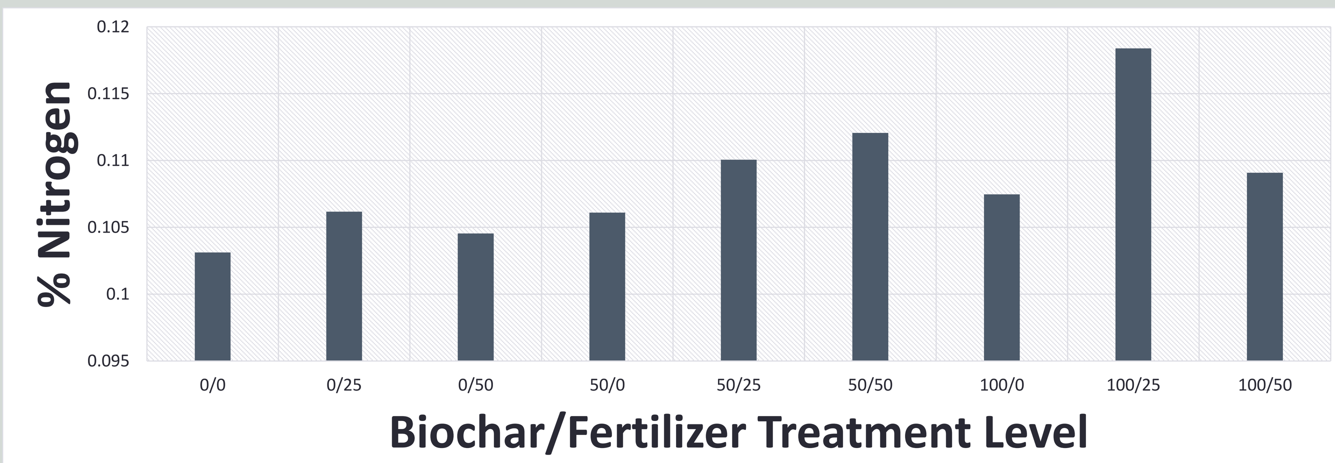

Figure 5: Remaining percent soil nitrogen. Soil nitrogen, oneway ANOVA, p=0.69.

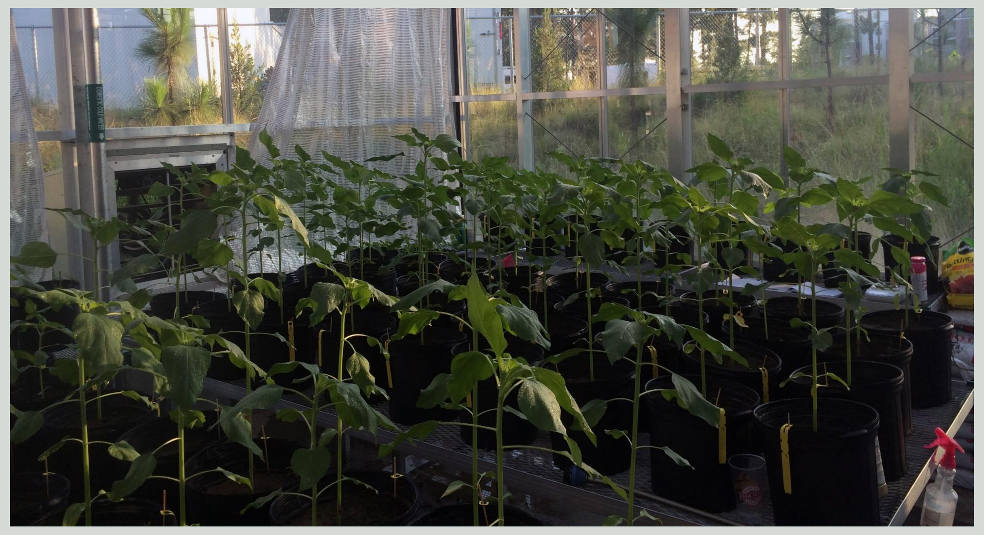

Figure 6: Blocked deign, growth at week 3

Figure 7: Field probe pH reading

Figure 8: Final height reading and biomass collection

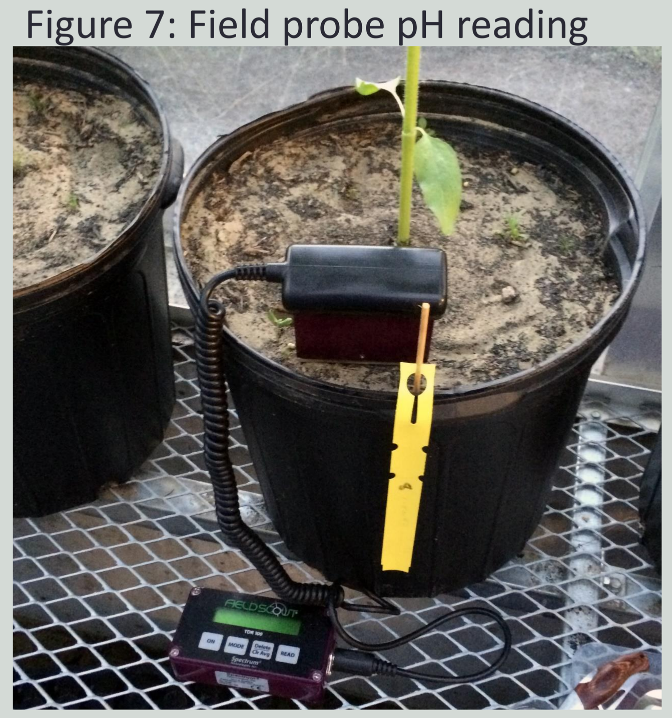

Figure 9: Soil moisture reading

DISCUSSION

- Figure 1: No significant difference was found in total water consumption between treatment levels. Indicating all plants had sufficient water throughout the growing season.
- Figure 2: Significant increases in soil moisture were noted with increasing levels of biochar. Water retention was higher as a result of higher levels of biochar.
- Figure 3: pH was lowered as biochar application increased, with significantly reduced pH in the highest 50 t/ha application.
- Figure 4: While no significance was found, it appears that there is a trend to increased biomass production with increased fertilizer dosing.
- Figure 5: No significant improvements in nitrogen retention were noted as a result of biochar application.

*Note: Connecting letter reports indicate significance difference between treatment groups if letters are different. e.g. A would indicate a significant different from B

REFERENCES

- [1] Borchard N, Wolf A, Amelung W, et al. Physical activation of biochar and its meaning for soil fertility and nutrient leaching - a greenhouse experiment. *Soil Use & Management*. June 2012; 28(2):177-184
- [2] Laird, D. A. The charcoal vision: a win–win–win scenario for simultaneously producing bioenergy, permanently sequestering carbon, while improving soil and water quality. *Agronomy Journal*, 2008; *100*(1), 178-181.
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