Genoa Trees Biochar Product Review Report

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Abstract

Qualitative observations were made throughout all trials performed in this study. The Genoa composted soil was not homogenous and seedlings did not emerge uniformly; sometimes not at all, regardless of the treatment. The heterogeneity of the Genoa soil also led to uneven water infiltration, and when watered from overhead, held a characteristic similar to water-wicking, causing the water to not infiltrate below the surface in many areas. At day 43 of the first trial, the worst-faring boxes were 2,4,5,10,12, and 13. There were extreme variations in growth, very poor growth overall, and several sites were unoccupied by a lettuce plant. These boxes were all Genoa boxes, ranging from 0% concentration to 10% concentration. There was a small population of aphids and whiteflies beginning to establish, and they were notably concentrated on the plants in boxes 10 and 12. During trial 1, lettuce showed possible signs of bacterial infection. This was mentioned by the farm manager for the Desert Farming Initiative and would require additional testing of the soil, but could be one possibility for lack of robust growth in addition to poor water infiltration. Trials 2 and 3 were irrigated via drip lines and led to great water retention within the Genoa biochar soil. Daily soil moisture readings were taken and the soil was nearly always towards the upper limits of the meter. This improved water retention led to visually better biomass growth in comparison to trial 1. Overall, there were no significant findings among the treatment groups to indicate an impact from biochar addition on lettuce growth.

Introduction

Biochar is defined as what remains when wood or other organic material is pyrolyzed at high temperatures; such as, trees from forest fires. When buried in soil, this carbon rich substance appears to enrich the soil. In addition, it could lock-up carbon and reduce greenhouse gas emission. There is global interest in biochar; however, limited research is found for its effects on produce production. This study is a trial test to determine the effects of biochar on lettuce growth subcontracted by Resource Concepts Inc. (RCI), using biochar from the US Forest Service.

Materials and Methods

Red leaf lettuce was chosen due to the quick time to maturity and the ability to replicate the experiment within a reasonable time period. The duration of each experiment was determined to be 45 days from planting because red leaf lettuce is a loose leaf head and common practice is 40-50 days to maturity for a full head and single harvest. 32”x32”x8” raised garden boxes were used to allow for proper drainage with drip irrigation. Electric fencing was erected to protect the seedlings from ground squirrels. Biological controls were used throughout the experiment, consisting of green lacewings, ladybugs, *Encarsia Formosa*, and yellow sticky paper.

Genoa Tree and Landscape Materials in Minden, NV, processed and composted the biochar used in this experiment. Pinyon-Juniper was the initial feedstock and it was obtained from the U.S. Forest Service. The pyrolysis method they used is unknown, and inquiries have provided very little information, so it is difficult to ascertain the exact properties of the biochar received for this experiment. Initial samples have been set aside to run analysis on immediately after the data collection for growth trials has wrapped up.

The Genoa compost was delivered in two separate piles; one contained a 10% biochar concentration and the other a 0% concentration. Since the Genoa composted soil was not homogenous and the bulk density of its components were drastically different, we chose to comprise our concentrations of biochar for each treatment based on a known volume and its corresponding weight. We obtained a cubic foot of the Genoa compost with and without biochar three times and weighed them to obtain an average weight for each pile. We used this weight to measure out the appropriate amount of cubic feet for each treatment (i.e. 1 cubic foot of Genoa compost without biochar weighed 19.3 kg therefore to obtain a 0% biochar treatment, we multiplied 19.3 kg by the total volume of the box, 9 cubic feet). The cubic feet of soil were derived for the 2.5%, 5%, and 10% biochar treatment boxes, and weighed out per the method above. We followed this method for the pro-mix boxes as well.

The drip irrigation was set on timers to water once per day for 5-9 minutes, or 279 to 299 mL per row per day. We made this determination by preliminary irrigation trials and not allowing the soil moisture content to fall below 1.8 on the soil moisture meter. This was a qualitative determination. Seedlings were planted at 0.5-inch depth and culled at 14 days, when it was clear that no additional seedlings were going to germinate. Miracle Grow fertilizer was prepared according to the 'outdoor plant' guidelines of 3.5 g diluted in 946 mL water and applied at an initial rate of 10 mL per site occupied by a plant starting at day 14 and then again every 7 days thereafter at a rate of 5 mL per site, until day 42.

VitiCanopy was chosen to evaluate leaf area index and canopy cover of the lettuce once germination occurred because it is an efficient and non-evasive way to gauge the rate of above-ground biomass growth throughout the experiment. Other canopy cover apps and software were evaluated for use in our experiment but VitiCanopy was the only one that was able to pick up both the green and red pigments of the red leaf lettuce successfully throughout the duration of the experiment.

At day 45, the lettuce plants were cut right above the soil and each plant was weighed and recorded individually on site. The samples were then placed in an oven and dried at 60 degrees Celsius for 48 hours and weighed after drying.

Results

The average weight of fresh biomass for each treatment indicates in this experiment, the 2.5% treatment group yielded the most biomass on average (Table 1) by a small amount (.95

grams). The next highest yielding treatment group was the 0% biochar concentration then the 10% and 5% treatment groups. The standard deviation for each treatment group for fresh lettuce biomass can be observed in both Table 1 and Figure 1 (indicated with error bars). Although different in overall production, the statistical analysis (t-test) showed that none of the treatment groups showed statistically significant differences from the control group ($p<0.05$). However, it is notable that the Genoa 5% treatment group was closest at a P-value equal to 0.08.

Dry biomass (Table 2) indicates the highest average weight was the 0% treatment group. The range from the lowest in the 5% group at 2.11 g and the control with the highest with 2.73 g. Just as with the fresh biomass, dry biomass standard deviations for each group can be seen in Table 2 and Figure 2. The t-test analysis did not show any statistically significant difference ($p<0.05$) between any of the treatment groups when compared to the control. Additionally, a two-way variable analysis (Anova) was done to test if there was statistical significance across all groups for fresh and dry biomass. The results from the Two-way Anova did not show any significant difference in either fresh or dry biomass across all groups.

Table 1. Fresh lettuce biomass (g) comparison among biochar percent treatments.

Concentration	Total Plants (N)	Total Weight (g)	Avg Weight (g)	SD (+/-)	P-value	T-test
Control 0%	27	2727.19	101.01	53.12	N/A	N/A
Genoa 2.5%	23	2345.02	101.96	52.42	0.95	2.5% vs Control
Genoa 5.0%	26	1936.81	74.49	31.96	0.08	5.0% vs Control
Genoa 10.0%	16	1515.14	94.70	43.66	0.69	10.0% vs Control

*P-value < 0.05 designates significant findings.

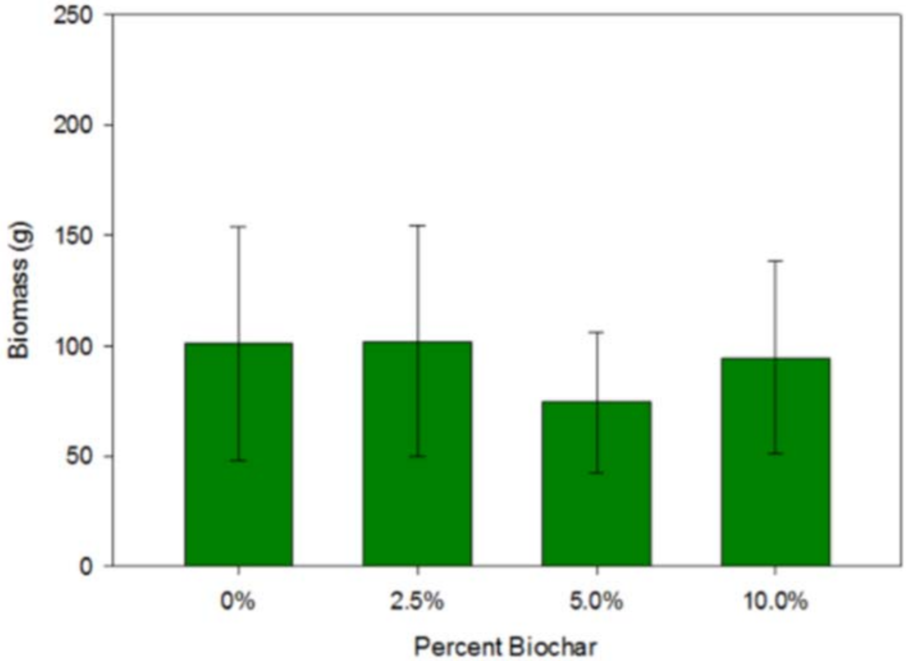

Figure 1. Fresh lettuce biomass production comparison in grams (g) among each treatment group biochar in percent of total volume.

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Table 2. Dry lettuce biomass in grams (g) comparison among biochar percent treatments.

Concentration	Total Plants (N)	Total Weight (g)	Avg Weight (g)	SD (+/-)	P-value	T-test
Genoa 0%	27	163.97	6.07	2.73	N/A	N/A
Genoa 2.5%	23	133.37	5.80	2.55	0.72	2.5% vs Control
Genoa 5.0%	26	147.07	5.66	2.11	0.54	5.0% vs Control
Genoa 10.0%	16	95.61	5.98	2.62	0.91	10.0% vs Control

*P-value < 0.05 designates significant findings.

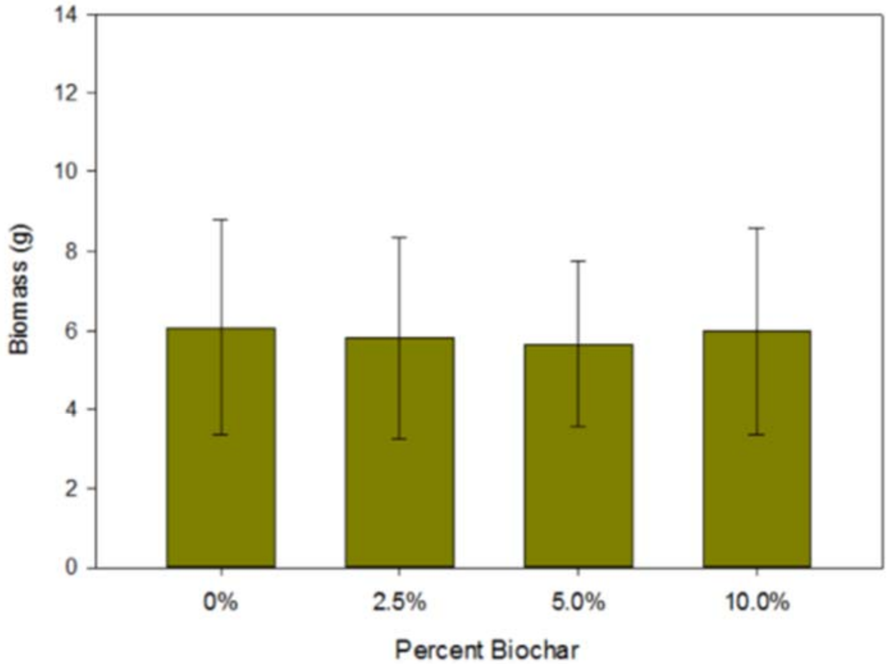

Figure 2. Dry lettuce biomass comparison in grams (g) among each treatment group of biochar in percent of total volume.

Discussion and Conclusions

A possible conclusion to draw from the comparison between fresh and dry biomass weight is the Genoa 2.5% concentration led to the highest accumulation of water within the plant tissue, as seen in table one, the fresh biomass weight. For dry weight, Genoa 0% led to the highest average weight, which could indicate that the biomass took up more nutrients in the absence of biochar. It is unclear whether or not the biochar was properly 'charged' before compost integration and delivery. The feedstock preparation methods and pyrolysis methods contribute greatly to the positive characteristics found in biochar when added as a soil amendment. Preparation methods prior to integration are just as important. Research shows that plant growth indicators increase as the second and third trials progress over the first, assumedly due to the biochar becoming loaded with nutrients (Sarah Carter, 2013) and not having the reverse effects of immobilizing nutrients from the soil, reducing their phyto availability. Subsequent to this study and as is common to completion of many studies, questions have surfaced regarding the manufacturing of biochar; such as:

1. Which pyrolysis method is used?
    a. At what temperature does the process commence?
    b. What is the residence time of the material being processed?
2. What is the pH range for this biochar product?
3. What is the suggested concentration of biochar in amended soils?
4. What would the manufacturer and involved interests most like to learn from trials involving biochar?
5. What type of demand is seen for biochar?
6. Would the manufacturer be able to provide or be interested in learning these components of the biochar product:
    a. pH, cation exchange capacity, C-N ratio, available P, K, Mg, and Ca and water holding capacity.
7. Has the biochar been exposed to nutrients and/or atmospheric gases in order to absorb them prior to delivery?

Answers to these important factors could help to determine the underlying mechanisms biologically or abiotically. Although there were no significant findings among the treatment groups to indicate an impact from biochar inputs, it is important to consider biochar is reportedly stable for hundreds if not thousands of years (Kuzyakv et al., 2009). This indicates the necessity for additional long-term work on degradation to determine agricultural effectiveness and applications. This has not been indicated in previous studies' methodology or those from meta-analysis such as the one performed on 177 studies on the impact of biochar on plant biomass (Jeffrey et al., 2011). This would also be useful to determine any long-term consequences that may arise from biochar with respect to environmental toxicity.

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