Testing effects of a biochar blend on container-grown Albion strawberries

Melanie Handley; Dr. Maria Pereira; Dr. Bryan Sales UNC Pembroke Department of Biology

Abstract

Biochar as a soil amendment seems, in a majority of studies, to affect the physical and chemical properties of container substrates (Elad et al. 2012). These properties include bulk density, total porosity, container capacity, nutrient availability, pH, electrical conductivity and cation exchange capacity (Huang and Gu 2019). The same study has shown that biochar can affect soil microbiota. Several studies have also conveyed the ability of biochar to trigger defense-related genes in plants, which aid the plants in disease suppression (Elad et al. 2012). Because of the potential benefits of biochar in agriculture and nurseries, this study was aimed at analyzing any effects of a biochar blend on the growth and flowering of container-grown strawberries. This study was divided into two separate experiments, both using everbearing bare root Albion strawberries (*Fragaria x ananassa* "Albion"). The first experiment tested the effects of varying percentages of a biochar blend on container-grown Albion strawberries in greenhouse conditions. The second experiment also tested the effects of the biochar blend on container-grown Albion strawberry plants- but in field conditions. Results so far imply that the plants treated with lower percentages of biochar had more vegetative growth, but less flowering overall. This could be because of excess moisture, an overload of nutrients, and/or pathogens from the biochar blend suppressing plant growth.

Methods

Treatments were 0% biochar blend, 0% biochar blend + 30% sand, 5% biochar blend, 10% biochar blend, 20% biochar blend, and 30% biochar blend for both the outdoor and indoor experiments. The biochar blend consisted of 75% coffee skins and 25% biochar, by weight (Vermont Organics 2020). This blend was designed to prevent the need to mix biochar with a fertilizer prior to adding it to soil. The remaining percentages of substrate in the containers consisted of Miracle Grow® potting soil.

There were 5 containers of each of the 6 treatments for the greenhouse experiment (GH), so 30 containers total. There were 4 of each of the 6 treatments for the outdoor experiment (OUT), so 24 total plants. Height and number of flowers was measured the second and third week after planting to test the effects of the biochar blend. On the 4th, 5th, and 6th weeks, we measured plant width (mm) and leaf width (mm), as well as plant height (mm) and number of flowers. Flowers were cut off of each plant as they were counted each week. Rain gauges were used to measure the average amounts of water the plants received. Water was measured weekly (and divided into daily averages) for GH. For OUT, water was only measured after rain fell. Plants were organized in the greenhouse by randomized block design.

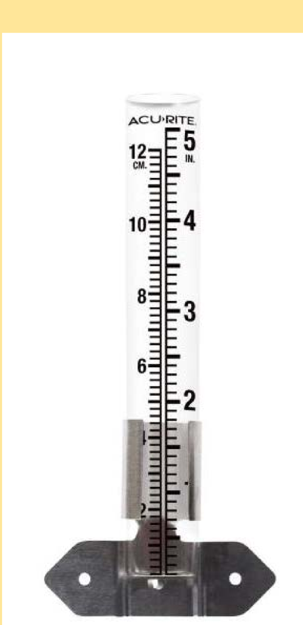


Figure 1. The rain gauges used to measure amounts of overhead water per week in the GH, and rain measurements of the OUT.

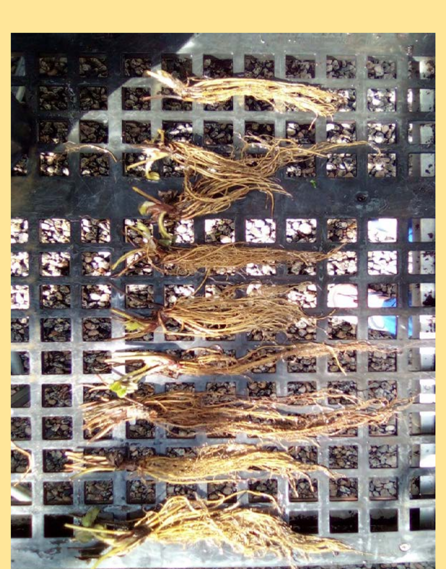


Figure 2. The bareroot ever-bearing strawberry plants before planting.

Materials

Figure 3. The biochar blend used. It was ordered from Amazon.

Outdoors


Figure 4. The vertical planters used in OUT.

Greenhouse

0%

0% +30% Sand

5%

10%

20%

30%


Figure 5. Pictures of the GH plants of each trials. The trials were only lined up as such for pictures. Otherwise, the plants were placed by random block design.

Results

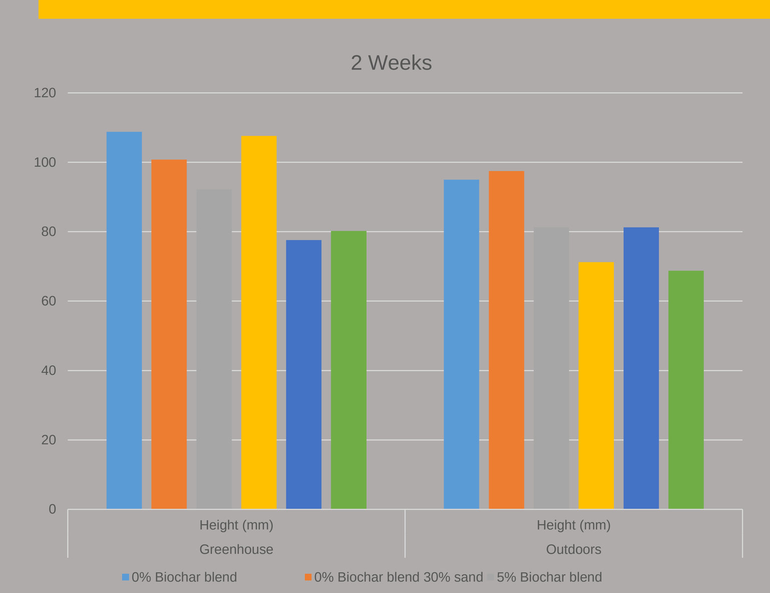


Figure 6.

Figure 6. These graphs show the compiled average heights (in mm) of the GH and OUT trials 2 weeks after transplanting. This data shows that for the GH Albion plants, the 0% biochar blend, 10% biochar blend, and 0% biochar blend + 30% sand were the tallest. These three treatments were followed by the 5% biochar blend, 30% biochar blend, and 20% biochar blend. In OUT, the 0% biochar blend + 30% sand, 0%, 5%, and 20% were the tallest. These were followed by 10% and 30%.

Figure 7. In the GH on the third week, the 0%, 10%, and 5% biochar blends were the tallest. These treatments were followed in succession by 0% +30% sand, 30%, and 20% biochar blend. OUT, the tallest plants were from the 0%, 0% +30% sand, and 5% biochar blends. The next tallest were the 20%, 10%, and 30% treatments.

Figure 7.

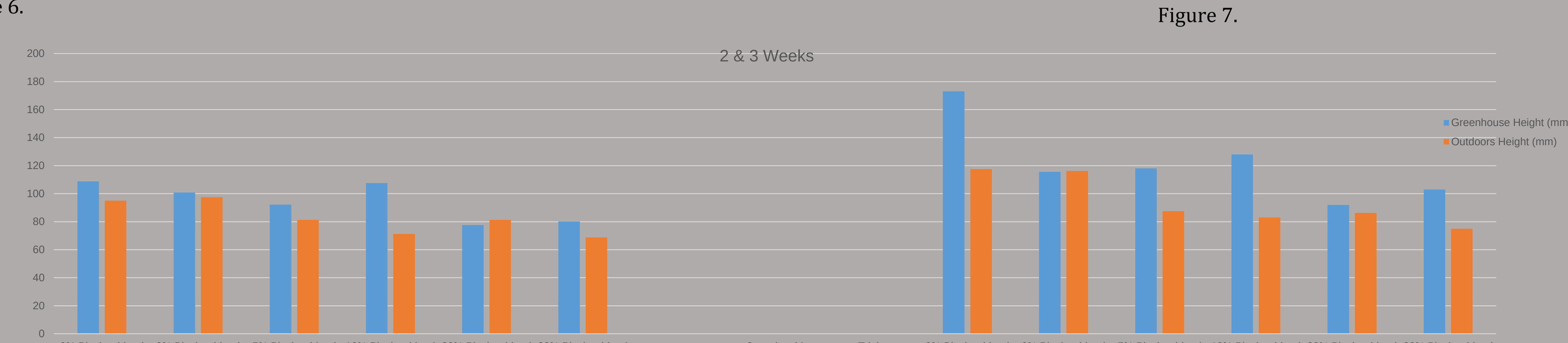


Figure 8. This graph show a side-by-side view of the height data from the 2nd and 3rd weeks. The GH heights on average are shown to be higher than the heights of the OUT in both weeks 2 and 3. The 20% biochar blend treatment was the only treatment where the OUT height exceed the greenhouse height (in the 2nd week). In the third week, the 30% biochar blend was the only treatment where the OUT height exceeded the GH height.

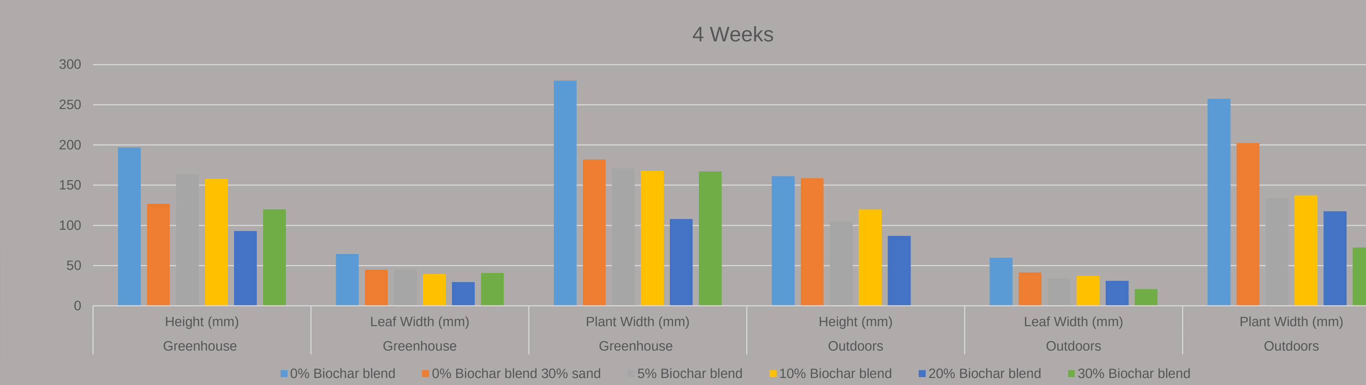


Figure 9. On the 4th week, we began measuring leaf width and plant width as well as plant height and number of flowers. In both OUT and GH, the 0% biochar treatment plants had the greatest average heights, leaf widths, and plant widths. The second highest averages were from treatment 0% biochar blend + 30% sand, with the exception of the GH heights. The second highest GH plant height was the 5% blend. The trend for the lowest measurements belongs to the 20% and 30% biochar blend treatments.

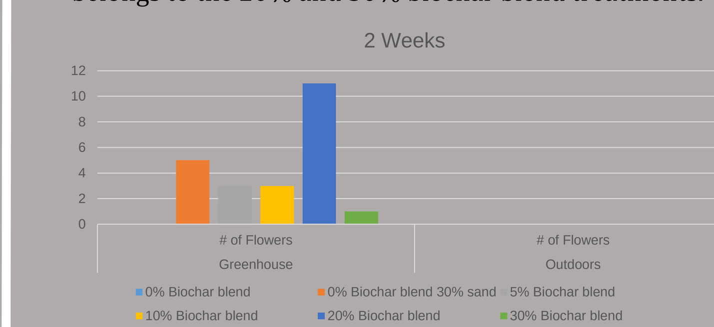


Figure 10. In the 2nd week after transplantation, the OUT plants produced no flowers at all. The GH plants did though. Among the GH trials, the 0% biochar (control) did not have any flowers. The 20% biochar blend treatment had the highest amount of flowers- significantly more than the other treatments. This is interesting because the 20% treatment plants (according to previous graphs) are shown to be lower in height on average than the rest of the treatments.

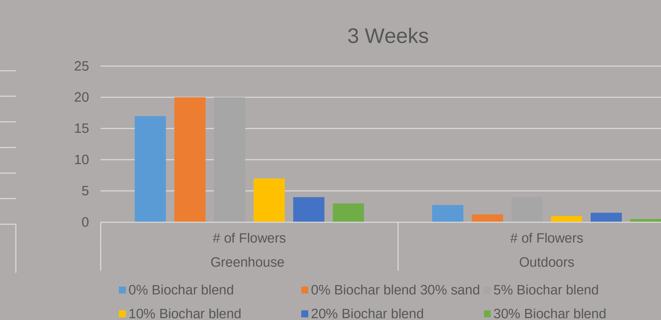
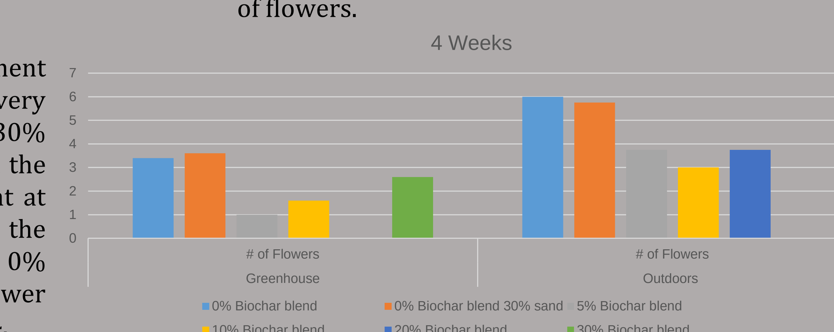


Figure 11. At 3 weeks, the OUT trials had grown flowers, with the 5% treatment containing the most flowers on average. Of the GH trials, the 5% and 0% + 30% sand had the highest numbers of flowers. The 0% biochar blend had the 3rd highest amount of flowers on the GH trials, and the 2nd highest number of flowers in the OUT trials. The 30%, 20%, and 10% treatments in both GH and OUT experiments had the lowest number of flowers.

Figure 12. At 4 weeks, the OUT experiment was producing more flowers in every treatment category except for the 30% biochar blend. There were no flowers in the 30% blend at all in the OUT experiment at week 4. There were no flowers at all in the 20% blend for the GH experiment. The 0% and 0% +30% sand were the highest flower producers in both experiments in week 4.



Results & Discussion

Three plants have died, 2 in the GH (20% and 0%+30% sand) and 1 from OUT (30%). Excess moisture could have been the cause of death in the GH, and lack of water could have been the cause of death for the OUT plants. According to Burpee Seeds and Plants (2020), Albion strawberry plants are usually planted 18-24 inches apart in rows in crop fields for best results, but the OUT experiment that was performed was meant to mimic field conditions as closely as possible while still planting in containers. However, the overall vegetative growth performance of the GH plants was better than OUT plants. This is probably because of the daily access to water, versus the OUT plants depending on occasional rainfall.

GH plants had faster vegetative growth than OUT plants. The biochar blend seems to aid in water retention, which can be detrimental in a GH with daily watering. On average, the controls in both experiments fared better with growth and survivorship. On average, the plants grown in higher percentages of biochar blend produced more flowers. The numbers of flowers is decreasing for GH plants but increasing for outdoor plants. The controls and lower biochar percentage-plants will probably be better fruit producers next year because they will have the vegetative mass to create and hold more fruit.

Conclusions

In short, higher percentages of this biochar blend seems to give short terms results of increased flowering, but at the expense of vegetative growth. If applied regularly, the biochar blend may give enough benefits to promote flowering and vegetative growth. Because of Huang and Gu's research (2019), and advice from Dr. Bryan Sales in the UNC Pembroke Biology Department, we decided it would be beneficial to send samples of the biochar blend to a soils lab at NC State for analyzing. We would like to know the pH and nutrient content. According to Huang and Gu (2019), the production and feedstocks of biochar affect it's chemical and physical properties, and this is why my mentor and I would like to know the specifics of our biochar blend. In conclusion, more information is needed on the properties of this specific blend of biochar before we can make any more assumptions. More repetitions are also needed.

Acknowledgments

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