University of Arkansas – Fort Smith

The Effects of Biochar on Turf Grass: An introductory investigation

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Abstract

This semester we have taken charcoal typically used for agricultural purposes, and inoculated it with an aerobic fish emulsion made up of microorganisms and various plant nutrients. From the biochar collected from the inoculation, it was filtered into five different particle sizes in order to quantify the size of charcoal used, and then remixed to form a homogenous mixture of particle sizes. With the homogenous mixture completed, the biochar was applied to half of the containers of grass to see if it assists in grass (fodder) production. Each fodder sample used in this research will be grown in 275 gallon chemical totes and the treatment given to each tote is randomized, with six being used with biochar treatment and six being used without. Each tote will receive the same amount of light, water, and care to ensure accurate and unbiased results. Once growth has been initiated, the grass will be cut at scheduled times to simulate the grazing of livestock herbivory, or hay cutting. Finally, the dry matter that is accumulated after allowing the cut grass to dry will be calculated. This will simulate hay drying after tedding and before baling, and give us results as to if the inoculated biochar had a direct correlation to the growth of the fodder.

Introduction

This semester we have taken charcoal typically used for agricultural purposes, and inoculated it with an aerobic fish emulsion made up of microorganisms and various plant nutrients. From the biochar collected from the inoculation, it was filtered into four different particle sizes in order to quantify the size of charcoal used, and then remixed to form a homogenous mixture of particle sizes. With the homogenous mixture completed, the biochar was applied to half of the containers of grass to see if it assists in grass(fodder) production. Each fodder sample used in this research will be grown in 275 gallon chemical totes and the treatment given to each will be randomized, with six being used with biochar treatment and six being used without. Each tote will receive the same amount of light, water, and care to ensure accurate and unbiased results. Once growth has been initiated, the grass will be cut at scheduled times to simulate the grazing of livestock herbivory, or hay cutting. Finally, the dry matter that is accumulated after allowing the cut grass to dry will be calculated. This will simulate hay drying after tedding and before baling, and give us results as to if the inoculated biochar had a direct correlation to the growth of the fodder.

From these results gathered, our current research team will attempt to identify the possible implications the data proposes. If the given results are negative in biochar assistance in fodder production, we will have support to reject our hypothesis. This rejection would allow us to hypothesize that commercially produced biochar has no strong correlation with substantial growth of agricultural crops and fodder. From such an assumption, we could further the research to test individual commercially produced biochar to better see if it challenges our rejected hypothesis. If the implications of our research supports our hypothesis of biochar's ability to aid fodder production, we will be given the unique opportunity to hypothesize further into the possibilities of applied biochar. Through positive results, the reality of understanding how biochar can affect regions experiencing habitat loss, agricultural deterioration, and underdeveloped agricultural techniques becomes a possibility. This would guide further research in performing more unbiased and direct tests, and new hypotheses able to be supported or rejected through statistical chi-square tests. Overall, rejection or acceptance of the given hypothesis for the research performed this semester allows for a major question and controversial practice to be further explored.

Materials and Methods

For this project, twelve 275-gallon chemical totes were used to hold the soil tested in this project. Inside each tote, varying soils were used. The surface area of the soil in each pot was measured at 11.25 square feet per pot.

The seed used was a triple-tall fescue with a recommended application of eight pounds per 1,000 square feet. According to this application rate, each container would receive approximately 0.09lb seed, with a total of 1.08lb of seed used on all twelve containers. Due to lower greenhouse temperatures than optimal, the seed mix was overseeded by approximately 100% at 2.0 pounds total, with approximately .167lb of seed broadcast per container. Before seed application, beds were properly hydrated and scarified with a garden rake. Seed was broadcasted via hand in order to get a uniform distribution of seed over the soil in the container. After application, the soil was smoothed and agitated with the backside of a garden rake to ensure seed-soil contact and higher germination rates. The seed was then watered in to further improve success rates. Approximately two weeks after first seed application, the beds were reseeded with the same amount of seed due to lower than expected germination rates. This application of seed was only broadcast evenly within the bed and watered in as to reduce stress on the existing stand of grass. In total, each bed received 82 grams of seed, with a total of 1.89 kilograms of seed being used amongst all 12 beds after both seedings.

For preparation of biochar, wood was placed in a heated, low oxygen environment that facilitated the dehydration and degassing of the wood, resulting in charcoal. For this experiment, hard wood wastes were used for producing charcoal. This charcoal was then inoculated in an aerobic fish emulsion for 15 days in order to provide an abundance of microbes that will aid in soil health.

Biochar was crushed by hand into pieces small enough to be applied to the containers. After crushing, the biochar was sorted into five sizes, xmm, ymm, zmm, amm, and bmm. The bmm group was discarded due to being mostly composed of uncrushable biochar that was not completely crystallized, its utility being of minimum importance.

For the purposes of this experiment, it was decided that half of the containers would receive the biochar treatment, while the other half of the containers would receive no treatment. Containers were initially numbered 1-12, and six of those numbers were randomly chosen via computer program to receive biochar treatment.

Biochar was spread approximately four weeks after initial seeding of the containers. For each container that received biochar, approximately 10.1 pounds of crushed homogenized biochar was broadcast by hand evenly across the surface of the soil. The grass was agitated to facilitate the biochar falling to the soil, and the biochar was then watered in.

pH of the soil was measured before and after the application of biochar in order to quantify the quality of the soil for growing condition of the fodder.

During the growing period, the seeds were watered once a day, until the grass reached a height of approximately 30 centimeters. The grass will be cut at a height of approximately 10 centimeters in order to allow the grass to ensure an exponential growth rate after being cut. After the application of biochar, neither groups of containers received any input other than watering.

Quantitative Data and Observations

Container (Before Application)	**pH**
1	6.94
2	6.92
3	6.96
4	6.88
5	6.93
6	7.04
7	7.15
8	6.78
9	6.52
10	6.63
11	5.92
12	6.90
Biochar Container	6.80

The pH of the containers before the application of the biochar were well within normal ranges of a ranch operation and are perfectly in the range for fescue growth, which usually prefers a pH between 5.5 and 7.5. Biochar was recorded at an acceptable pH level and was not significantly more or less acidic than the soil it was being applied to.

Container	First cut dry mass (g)	Second cut dry mass (g)
1	103.8	
2	160	
3		156.2
4		127.3
5	73	
6	78.5	
7	22.6	
8	179.4	
9	78.4	164.2
10	100	106.7
11	46.3	190.3
12		131.4

Data collection at the time of the symposium was hampered due to 24–hour wait times on grass drying. For the first cut, containers 3,4, and 12 were not fully dried, and containers 1, 2, 5, 6, 7, and 8 were also not fully dried. This caused very incomplete data that did not allow for statistically significant data, and no reliable way to reject a null hypothesis.

Mathematical/statistical analysis was not allowed to be fully analyzed due to incomplete data, and no experimental conclusion has been reached at the time of writing this paper. However, upon initial survey of graphical data, it appears that biochar does have an identifiable connection to greater dry mass in most containers. One outlier on the second cutting showed much higher dry mass than recorded in any other non-biochar treated containers, which was unable to be accounted for. Complete data for the second cut will be needed in order to fully analyze this unexpected jump in dry mass.

Qualitative Data and Observations

After initial seeding, germination was low, and growth was spotty in all containers. After second seeding, more uniform growth was observed. After application of biochar, grass appeared to grow thicker, all containers with uniform and prolific growth.

Approximately two weeks after biochar, there was no qualitative evidence to suggest that biochar had a positive or negative effect on growth in the containers.

After the first cutting, color differences could be found between treated and untreated containers, with biochar treatments on average being darker than its untreated counterparts. Growth also seemed to be more prolific amongst biochar containers with more coarse blades of grass.

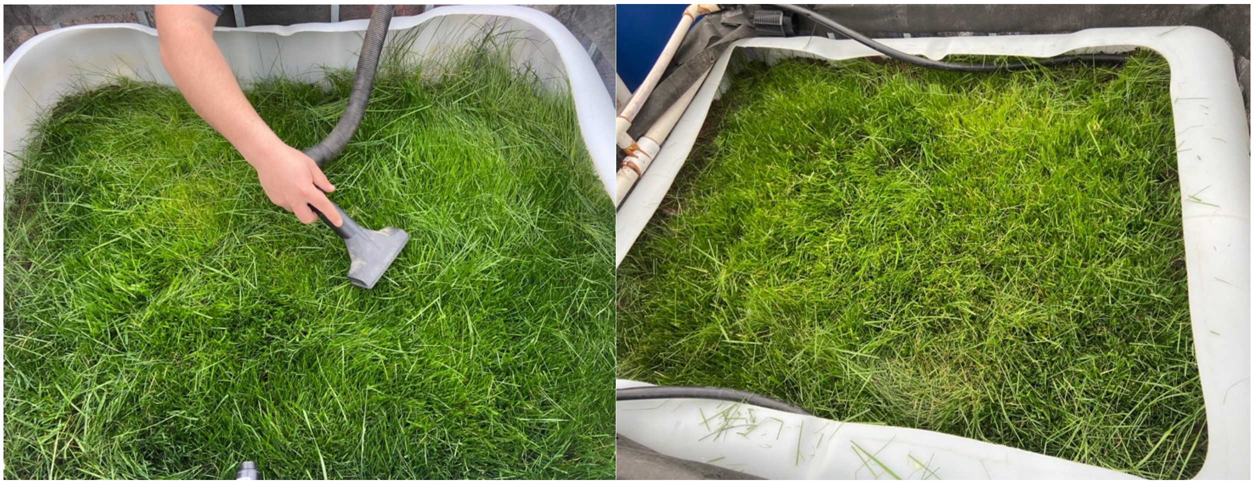

Figure 1&2: Collection of small grass parts after cutting, and fully cut container

Figure 3: Crushed biochar ready to be applied

Discussion

Although the results were inconclusive, they did however justify continued research on the topic. Further data will be collected and observed over the next two semesters to determine if a significant difference is noticed between the biochar and the production of fodder. There were inconsistencies in procedure and operator error, but these were negligible in regard to overall results. As the application is moved to a larger commercial area, a more conclusive study can be observed as well as minor differences in procedure can be eliminated for a more uniform process from collection to drying. The main goal of this particular experiment was to see if anything observable was significant enough to justify further experimentation and research with biochar.

Conclusion

From a qualitative perspective, biochar appears to have a strong correlation with greater fodder production. From the quantitative perspective, specific treatments support qualitative growth, while others enforce outliers that skew the data. As each cutting was performed, biochar treated grass appeared to have thicker and blusher regrowth within a week's time. Non-biochar treated fodder, qualitatively appeared more coarse and lighter in pigmentation. As re-seeding was done, both the treatment and control group experienced these physical attributions at an elevated level. As time progressed from the first biochar application, random experimental plots began experiencing patchy dead spots, implying possible acidification or lattice breakdown. Following this incomplete and inconclusive data, further experimentation must be conducted. As planned in the future, biochar applications will be tested on fodder in a natural environment, rather than varied experimental totes. From this data collected, and a stipulated hypothesis that biochar offers effective aid in fodder production, future sub-discipline studies become feasible. Such studies would include ecological research on biochar's effect on habitat rehabilitation in ecosystems with extensive vegetative loss. This would be further built on, by experimenting with biochar's potential to absorb atmospheric carbon, as it is already a high carbon source. To further branch on these studies, biochar could also be studied as a succor for cash crops at the commercial level. Through positive experimentation, biochar's supplemental aid could re-define basic agricultural techniques in waste management, seasonal plantings, and average biomass of vegetation at the end of production. Moving forward with the project will prove to make a final conclusion for biochar's effect, and allow us to break down our previous understandings of plant supplements and their symbiotic relationship with their hosts.

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