Preliminary Progress Report

Evaluating the Impact of Biological Products on Turf Quality and Soil Biological Health

1. BACKGROUND

Due to the need for aesthetics, the maintenance of golf courses entails extensive use of various inputs (e.g., fertilizers, pesticides, wetting agents, plant growth regulators, water). This makes it among the most expensive sector in agriculture (cost of input/acre). Reducing inputs is therefore important for the future of the golf course industry. This is particularly applicable to low and medium size clubs that have limited financial capacity. Reducing input is also important from the point of view of reducing the environmental footprint of golf courses. Environmental concerns have led to the proliferation of biological products that are collectively called biostimulants. These products contain microorganisms (bugs in a jug) and/or organic products that are often marketed as being more sustainable and cheaper alternatives to current products that are commonly used in the golf course industry. This assumes that the biological products are better in stimulating the indigenous soil microorganisms that provide beneficial services. However, there is lack of research in evaluating how effective biological products are and how they affect the health of the turfgrass system and turf quality.

According to United State Department of Agriculture, soil health is defined as, "how well the soil performs its function now and how well the functions are preserved for future use." The way golf courses are managed can result in three scenarios in relation to soil health: it can improve it; it can sustain it; It can degrade it over time. Soil health is evaluated by measuring indicators that are reflective of changes in physical, chemical and biological properties of the soil in response to management practices. Microorganisms are central to the biological health of the soil. Biological soil health indicators are reflective of how well microorganisms function (i.e., how well they provide all the beneficial services mentioned above) in the system. For instance, soil respiration and enzyme activity measurements are indicative of the microorganisms' role in degrading organic matter and recycling nutrients. The goal of this proposal is, therefore, to examine the impact of biological products on turf quality and soil health. We are interested in examining the relationship between soil health and turf quality, i.e., will improvement in soil health lead to improvement in turf quality?

One important consideration when evaluating biological products is the method of application. Products are commonly surface applied, leading to exposure of microorganisms contained in biological products to extreme climatic fluctuations (e.g., heat and UV exposure from sun). This exposure can reduce the survival and establishment of microbial inoculants in the soil. This can be minimized through subsurface application of the product. One way of achieving this is by using a unique tool such as Air_2G_2 as a delivery system directly to the root zone, which was originally designed to aerate the soil by blasting air below surface but has been modified to inject products. As part of this project, we have started examining if applying the products at the surface vs below surface with Air_2G_2 will make any difference in the performance of the products.

2. OBJECTIVES

- Determine the impact of two biological products on turf quality and soil health

- Determine how the performance of the biological products is affected by method of application (surface vs subsurface)

3. STUDY APPROACH

3.1. Field Plots and Treatments

Field plots were established on greens in June 2018 at two separate locations – UGA Griffin Campus (A1-A4 Bentgrass) and Rivermont Golf Club (Tifgreen Bermudagrass) in Johns Creek, GA. Each plot is 8 x 8 ft in dimension. There are seven treatments, with two biological products (see below). The treatments were designed to apply the two biological products both above and below surface with A2G2 injection system. The surface applications of the products were done coupled with and without A2G2 aerification. The biological products were applied on the top of the standard turf management inputs, including fertilization, irrigation and top dressing. The Control treatment received all standard inputs except for the biological products. Each treatment was replicated four times in a randomized complete block design.

The two biological products that are being tested are KaPreRemeD8-NSL (BP1) and KaPreRemeD8-NSP (BP2) from Performance Nutrition (LidoChem, Inc., Hazlet, NJ). They were applied based on the recommendation rates on the labels at 1 and 19 ounces per 1000 ft^2, respectively. KaPreRemeD8-NSP is described as a proprietary mixture containing *Saccharomyces cerevisiae* where as KaPreRemeD8-NSL is described as a proprietary mixture including fulvic acid.

Treatments were applied monthly since June 2018. Plots in Johns Creek have received six treatments so far (till Dec 2018). Treatment applications in January and February will be dependent on weather conditions. It will begin again in March determined by soil temperatures. Plots at the UGA Griffin campus received only three treatments (June to August), and treatments were stopped thereafter because the grass was not doing well. It has already been reseeded and re-established, and treatment applications will resume again March 14th once the weather allows it. Results in this report will therefore be for the Johns Creek plots only.

The treatments included the following:

1. None-treated control (water) – No product or aerification
2. BP1 surface application without aerification
3. BP2 surface application without aerification
4. BP1 surface application and Air_2G_2 aerification
5. BP2 surface application and Air_2G_2 aerification
6. BP1 subsurface application with Air_2G_2
7. BP2 subsurface application with Air_2G_2

3.2. Sample Collection and Analysis

Before the start of the experiment, the biological products and the soils at both locations were tested for some basic properties (e.g., nutrient contents and organic matter) at the UGA's Environmental and Agriculture Services Laboratory (http://aesl.ces.uga.edu). Once treatment application started, samples were collected periodically (early and after multiple applications) from the top 4 inches. The plots were also fitted with automatic soil moisture and temperature sensors (Campbell, Logan, UT).

Turf Quality: Turf quality was assessed by taking images of the plots with a digital camera and analyzing the images with the Assess 2.0 image analysis software (American Phytopathological Society) as percent green cover (ratio of green to total pixels). It provides an objective assessment of the overall turf quality and quantitative data for robust statistical analysis.

Indicators of Soil Biological Health: We monitored biological soil health indicators that are reflective of the activity and abundance of soil microorganisms. The activity indicators include soil respiration (generic indicator of microbial activity) and enzymes that mediate nitrogen and phosphorous transformations (urease and phosphatase). Higher enzyme activities indicate improved soil health. Enzyme activities were measured based on standard protocols (Wallestein and Weintraub, 2008; Tabatabai, 1994). To quantify microbial abundance, DNA were extracted from all the samples with DNeasy PowerSoil kit (QIAGEN, Germantown, MD, USA). We are processing the DNA extracts using quantitative polymerase reactions to quantify total bacteria, total fungi, arbuscular mycorrhizal fungi and ammonia oxidizers but we don't have the completed data as of yet. It will be included in the next report.

3.3. Statistical analysis

The data were summarized into descriptive statistics (e.g., mean and standard errors). Analysis of variance was carried out to test the statistical significance of the effects of the biological products on turf quality and indicators of soil health at $\alpha = 0.05$. Once we have the complete data set, we plan on determining the relationship between turf quality and soil biological health with multivariate statistical analysis to identify soil biological health indicators that can best predict turf quality.

4. RESULTS AND DISCUSSION

4.1. Turf quality: There was no significant treatment effect on turf quality (Figure 1), meaning the treatment did not improve or negatively impact the turf quality regardless of how they were applied and when they were compared to the control.

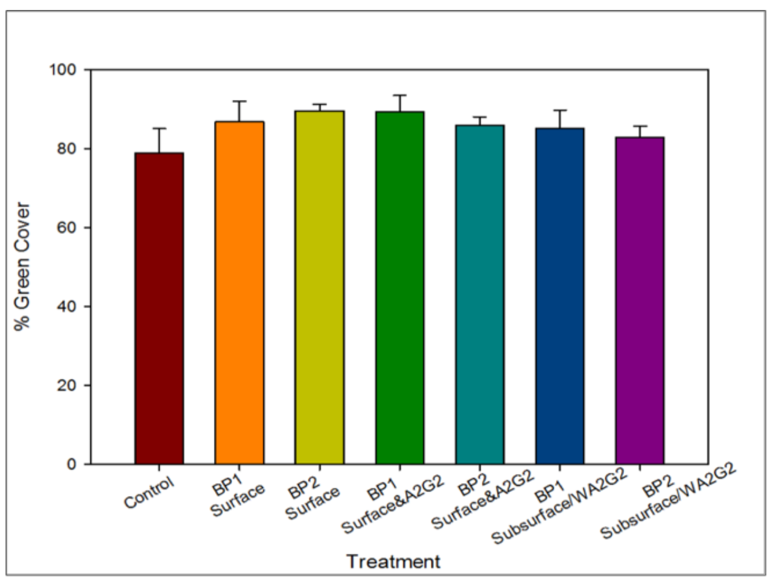

Figure 1: Turf quality (as % green cover; mean ± 1SE) in Tifgreen Bermuda grass in Johns Creek, GA in response to the treatments after four applications.

4.2. Phosphatase activity: The effect of the treatment on phosphatase activity was significant only in June in which applying BP1 resulted in significantly lower activity than the Control. This decrease was only after one-time application, and we did not see similar effect in October after multiple applications. The other treatments did not differ from each other significantly in June.

The treatments appeared to have improved phosphatase activity in October, but the differences were not significantly different between the Control and biological products.

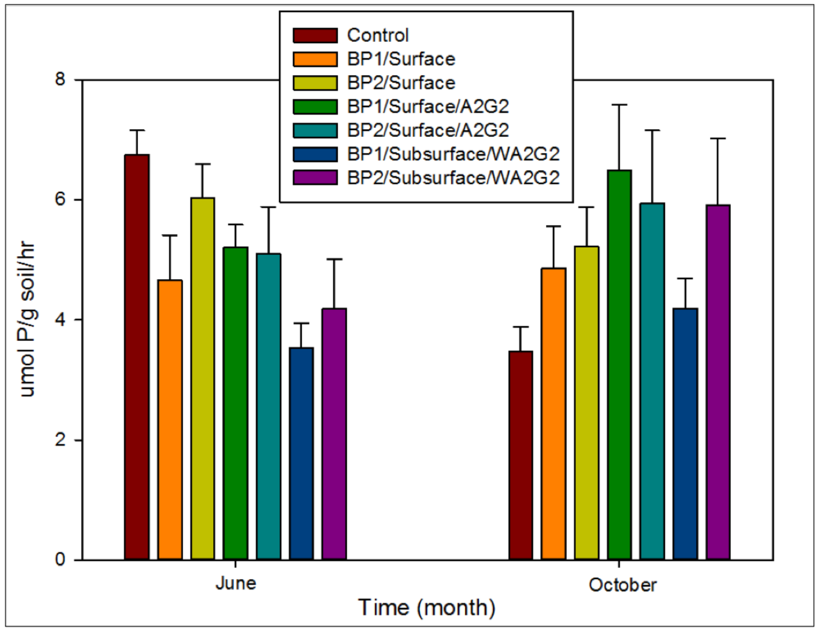

Figure 2: Soil phosphatase activity (mean ± 1SE) in Tifgreen Bermuda turfgrass in Johns Creek, GA after single (June) and five treatment applications (October). Treatment application continued in December too.

4.3 Soil respiration: No treatment effect was observed on soil respiration. The only difference was as a result of time in which respiration was lower in October than June, mainly due to climatic differences between the two months.

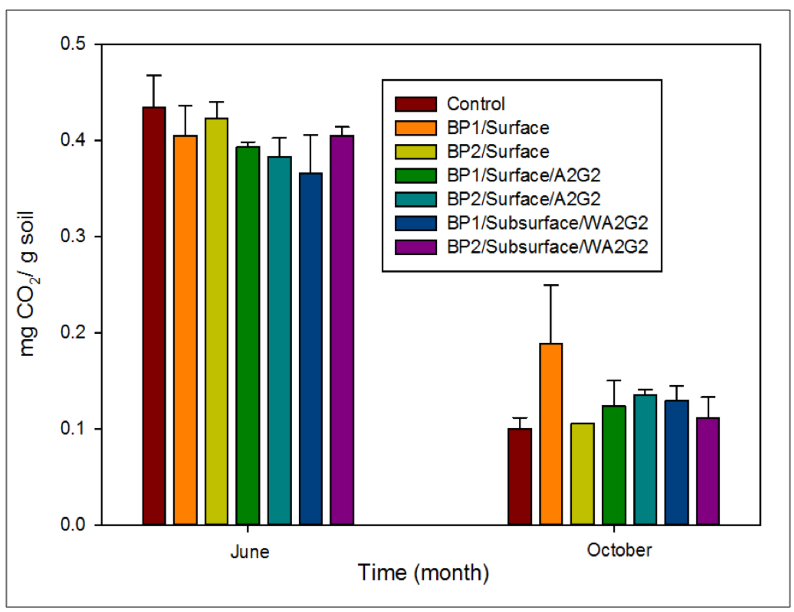

Figure 3: Soil respiration (mean ± 1SE) in Tifgreen Bermuda turfgrass in Johns Creek, GA after single (June) and five treatments applications (October).

4.4. *Urease activity*: No significant treatment effect was seen on urease activity similar to the previous indicators. The treatments seemed to have caused a decrease in urease activity, but the differences were not statistically significant.

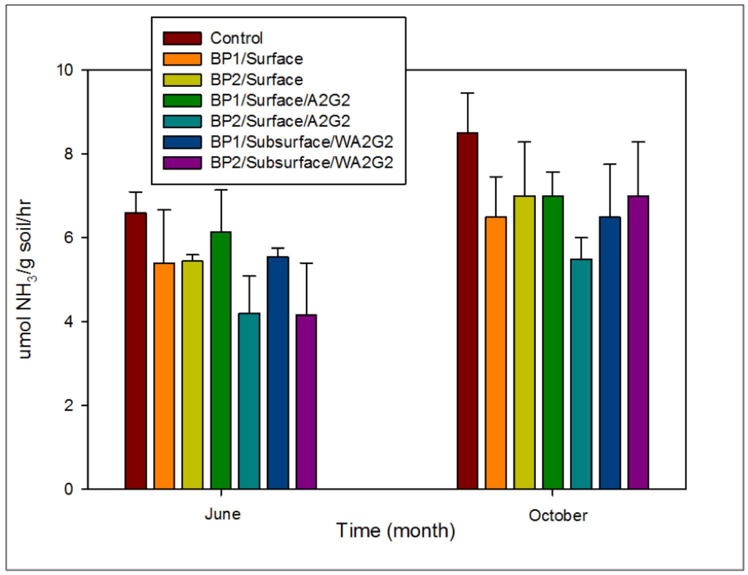

Figure 4: Soil urease activity (mean + 1SE) in Tifgreen Bermuda turfgrass in Johns Creek, GA after single (June) and five treatment applications (October).

5. Preliminary (Tentative) Conclusion

Based on the data that have been gathered so far, the biological products have not led to any significant improvement in either turf quality or soil biological health. Unlike some conventional inputs (e.g., fertilizers or pesticides), these products might take some time to effect any change on the soil microorganisms. We plan on continuing the study for the coming 18 months in an effort to examine the impacts over a longer period.

6. Future plans / On-going activities

- Finish analyzing soil DNA extracts that will be used to enumerate (count) microorganisms in plots under each treatment. The abundance of microorganisms is another indicator of soil health.
- Resume treatment applications in both sets of plots (in Griffin and Johns Creek) as soon as the weather allows it.
- Continue taking regular measurements on turf quality and biological soil health indicators at both sites.
- Undergo plant disease suppression tests at both sites. This will be done by inoculating a subset of each plot with either *Sclerotinia homoeocarpa* (dollar spot), *Bipolaris sorokiniana* (leaf spot) or Pythium and monitoring the progression of the diseases over time. The idea is to test if the treatment had any effect on the disease suppressive nature of the soil.
- Send out progress report by end of December 2019.

Please let us know if you have any questions.

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Appendix

Some pictures from field work at Johns Creek, GA.