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

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.

We know indigenous soil microorganisms provide many benefits to turfgrass. They play a key role in decomposition organic matter to control the thatch layer and release nutrients in forms that can be used by the turf. The decomposition of organic matter leads to the formation of humus that improves soil structure, leading to improved water holding capacity and aeration. They also enrich the nutrient content of the soil through nitrogen fixation and mycorrhizal relationship with the turf. Moreover, soil is full of microorganisms that are suppressive of plant diseases. It is therefore logical to ask this: can we enhance the beneficial roles of soil microorganisms to decrease external inputs and maintain a healthy and sustainable turfgrass system? Can biological products play a role in achieving this goal? This requires proper understanding of the impact the products on the health of the soil biology 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 the 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 abundance of cyanobacteria and arbuscular mycorrhizal fungi are indicative of the soil’s ability to fix nitrogen and improve phosphorus and water availability. Measuring these parameters will, therefore, indicate the soil’s biological health. If a biological product is improving any of these beneficial roles in the soil it is said to have improved the soil biological health. It is logical to assume that improved soil biological health will ultimately result in improved turf quality. The overarching 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? Do biological products have a role to play in this regard?

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 will examine if applying the products at the surface vs below surface with Air_2G_2 will make any difference in the performance of the products. We will have access to an Air_2G_2 & injector system through the manufacturer Air2G2, injector developer Bio Soil. This is a Project cost savings of @$37,000.

Objectives

- Determine the impact of 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)
- Determine the relationship between turf quality and soil health

Experimental Design and Methodology

The field studies will include the following treatments:

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

The biological product will be applied based on the recommendation rate on the label. Field plots will be established on greens at two separate locations – UGA Griffin Campus (A1-A4 Bentgrass) and Rivermont Golf Club (Tifgreen Bermudagrass) in Johns Creek, GA. Each plot will be 8 ft x 8 ft. Each treatment will be replicated four times in a completely randomized design.

Before the start of the experiment, the biological products will be tested for their nutrient content as well as type and abundance of microorganisms that are listed as part of the product. Once treatment application starts, samples will be collected periodically (early, middle and end of treatments) to capture short and long term trends over a two-year period. Soil samples will be collected from each plot from the top 4 inches.

Soil temperature and moisture will be monitored with automatic sensors. Before treatment application starts, samples will be collected from plot areas to obtain base-line data on organic matter and nutrient contents (nitrogen, phosphorous, potassium). Samples will be sent to the UGA's Environmental and Agriculture Services Laboratory (http://aesl.ces.uga.edu) for analysis. Location specific weather data will be collected from The University of Georgia Weather Network (http://www.georgiaweather.net/)

Turfgrass quality will be assessed visually to assess color, uniformity, texture and density. The scale ranges between 1 (poorest quality) to 9 (best quality). This method is subjective and could vary from one person to another, but we want to include it as this method is commonly used by superintendents. However, we will also measure turf quality by using an optical sensor that measures reflectance from the turf canopy to calculate the Normalized Difference Vegetation Index (NDVI). The use of NDVI will provide the objective assessment of the overall turf quality by estimating color and ground cover. It generates quantitative data for robust statistical analysis. We will use the GreenSeeker Hand Held Optical Sensor (NTech, Ukiah, CA) for this purpose according to the manufacturer's instructions.

We will monitor biological soil health indicators that are reflective of the activity and abundance of soil microorganisms. The activity indicators will include soil respiration (generic indicator of microbial activity) and enzymes that mediate nitrogen and phosphorous transformations (e.g. urease, phosphatase). The abundance of key groups of organisms that carryout beneficial functions (e.g., ammonia oxidizers, arbuscular mycorrhizal fungi) will be quantified. Soil respiration and enzyme assays will be determined based on standard protocols (Wallestein and Weintraub, 2008; Tabatabai, 1994). Microbial abundance will be determined by a combination of traditional culture based and quantitative polymerase chain reaction techniques (e.g., Habteselassie et al., 2013, Coelho et al., 2009).

Statistical analysis

The data will be summarized into descriptive statistics (e.g., mean, range and standard errors). Analysis of variance will be carried out to test the statistical significance of the effects of the biological products on turf quality and soil health. To determine the relationship between turf quality and soil biological health, we will carry out multivariate statistical analysis to identify soil biological health indicators that can best predict turf quality. The data on soil biological health and turf quality will be interpreted in relation to other soil and weather data.