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## Progress Report to Georgia Golf Environmental Foundation

# Title: Field Assessment of the Impacts of Wetting Agents and Plant Growth Regulators on Turfgrass Soil Microbial Communities

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## Introduction

Because of the pressure to maintain high quality turf under climatic, pest and use-induced stresses, superintendents use several turfcare products. Among the most commonly used products are wetting agents and plant growth regulators (Karnok et al., 2004). However, the impacts of these products on soil microbial communities is not clear.

Wetting agents are used to address the problem of localized dry spots (LDS) prevalent in turfgrass soils during the summer and caused by soil water repellency. The occurrence of LDS causes water stress and negatively affects turf quality. Despite differences among products, several studies have reported wetting agents to be effective in reducing LDS in golf courses. However, some wettings agents can cause phytotoxicity in turf and require irrigation immediately following application to minimize turf damage (Karnok, 2006). The effect of wetting agents on the turfgrass soil microbial communities is unknown. Some studies have reported the inhibition of microbially mediated decomposition of pollutants due to surfactants in non-turfgrass soils, with subsequent changes in microbial populations (e.g., Laha and Luthy, 1991).

Plant growth regulators are used to promote healthier turf with the ability to withstand various types of stresses. Growth regulators are designed to slow down production of hormones (e.g., gibberellic acid) and thereby to minimize vertical shoot growth while promoting lateral and below-ground root growth. There are several studies that tested their efficacy on turfgrass growth and quality with mixed results (McCann and Huang, 2007; Gardner and Wherley, 2005) but their impact on the turfgrass soil microbial communities has not been examined. It is important to study whether these products have similar inhibition effect on the microorganisms, and what the implications would for their use in turfgrass system.

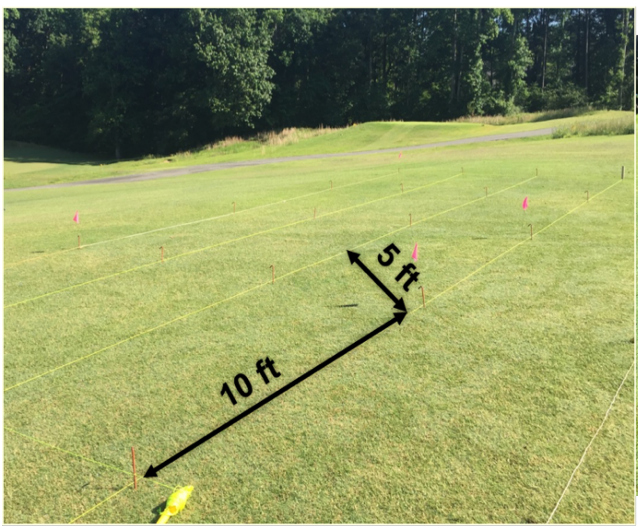
Research is needed to understand how wetting agents and growth regulators affect the soil microbial communities, which play a central role in the establishment and maintenance of a healthy and sustainable turfgrass system. Decomposition of organic matter is one of the central roles microorganisms play. This process releases nutrients from organic to inorganic forms that can be used by the turf and controls the excessive accumulation of thatch (Myrold and Bottomley, 2008). Microorganisms also contribute to the nutrient content of the turfgrass soil through nitrogen fixation and mycorrhizal relationship (Hartnett and Wilson, 2002; Charest et al., 1997; Boddey et al., 1986). The role of soil microorganisms in disease suppression is well documented too (Kerry, 2000).

The objectives of the project are to: 1) determine the impact of selected wetting agents and plant growth regulators on the abundance of turfgrass soil microbial communities, and 2) determine the impact of selected wetting agents and plant growth regulators on the activity/function of turfgrass soil microbial communities.

## Methods and Materials

*Test products, study site and experimental plots*

Fields studies were started in May 2018 to examine the impacts of three wetting agents (Sixteen 90, Cascade/Duplex, Revolution) and three plant growth regulators (Trimmit, Primo Maxx, Cutless). The plots for the wetting agents (WAs) were established on greens on the UGA Griffin Campus. The plots for the plant growth regulators (PGRs) were in established on fairways in the Rivermont Golf Club, Johns Creek (see figure below). Each set of plots included a water control (non-treated), and treatments were replicated five times with randomized complete block design. Each plot is 5 ft x 10 ft. Treatments are applied monthly at half field use rates to provide double coverage with a backpack sprayer. As of May 2018, there are a total of 11 applications in Griffin and 13 applications in Rivermont. Treatment of wetting agent plots in Griffin stopped in August due to decline in overall turf health. The turf has since been re-seeded and re-established for spraying applications to continue next year.




Fields plots for PGRs in Rivermont Golf Club

Fields plots for WAs in UGA Griffin Campus

*Sample collection and analysis*

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 respectively). To quantify microbial abundance, DNA were extracted from all the samples with DNeasy PowerSoil kit (QIAGEN, Germantown, MD, USA). Quantitative polymerase chain reaction was employed to quantify the abundance of ammonia-oxidizing bacteria and archaea that are often used as indicators of soil biological health. Increase in indicators is generally considered to be an improvement in soil biological health.

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 wetting agents and plant growth regulators on indicators of soil health at $\alpha = 0.05$.

***Results summary***

**A. Wetting Agents**

- All wetting agents showed significant increase in turf quality as compared to the control treatment (data not shown).
- The treatments did not significantly impact soil respiration (Fig. 1A) or the abundance of ammonia-oxidizing bacteria and archaea (data not shown).
- Revolution was the only wetting that consistently  impacted urease activity by stimulating it significantly (Fig 1B). The difference between Revolution and the other treatments was more pronounced in June 2019 than the other times, indicating its cumulative impact over time.
- Similarly, Revolution was the only wetting agent that significantly increased phosphatase activity as compared to the Control in May 2018 and June 2019.

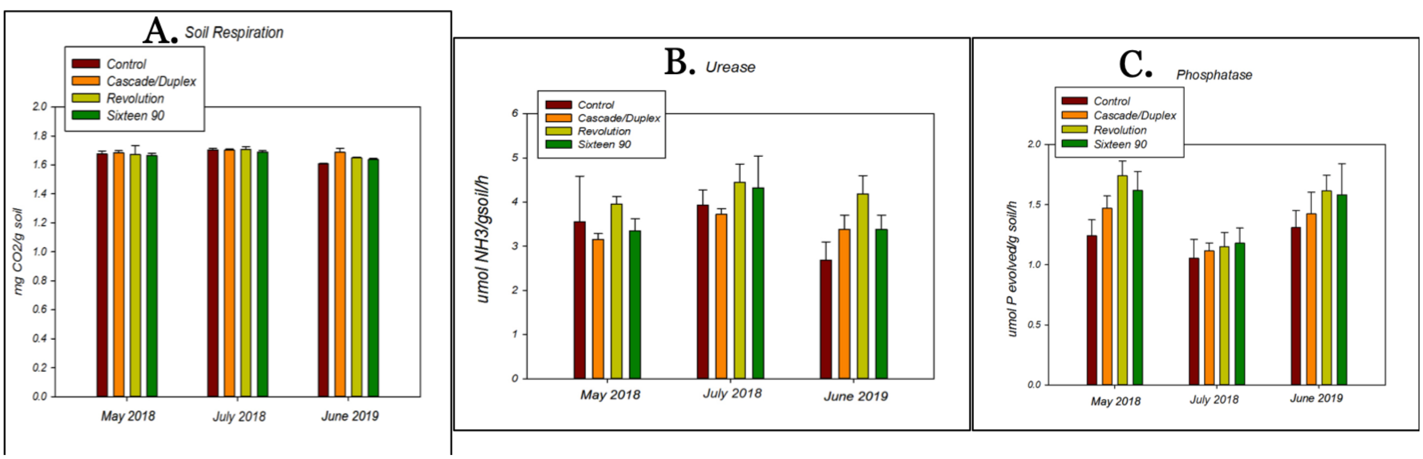



**Figure 1:** Soil respiration (A), urease (B) and phosphatase activities (C) in A1-A4 Creeping Bentgrass in Griffin, GA**.**

**B. Plant Growth Regulators (PRGs)**

- None of the PGRs significantly impacted turf quality, soil respiration or the abundance of ammonia-oxidizing bacteria and archaea (data not shown). However, when looking at heterotrophic bacteria, they exhibited a temporary increase in their abundance in response to PrimoMaxx.

- While none of PGRs negatively impacted urease in June 2018, after multiple applications, Cutless and PrimoMax depressed it in June 2019 (Fig. 1A). Cutless and Trimmit, on the other hand, enhanced phosphatase activity after multiple applications in June 2019 (Fig. 2B).

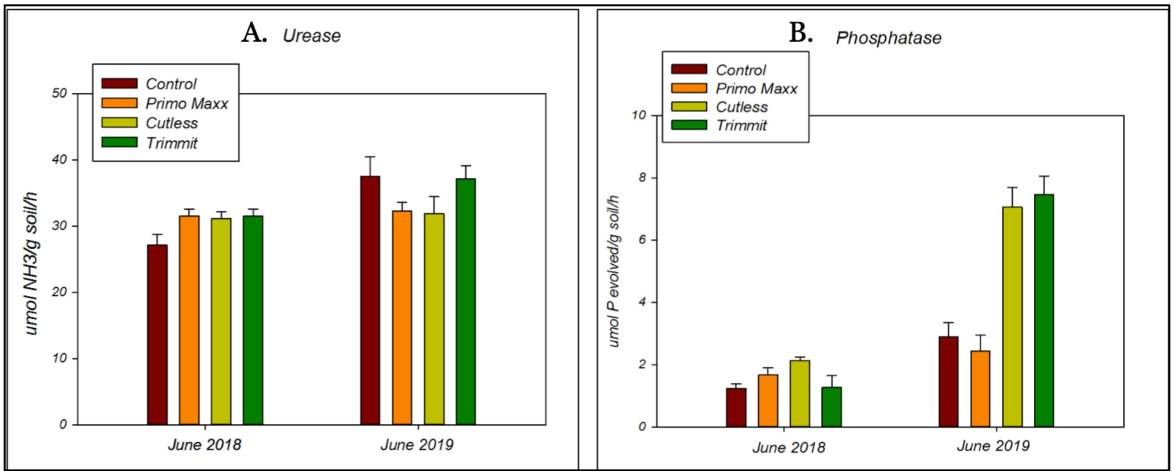



**Figure 2:** Soil urease and phosphatase activities (mean + 1SE) in Tifgreen Bermuda turfgrass in Johns Creek, GA.

**Preliminary Conclusion**

- Overall, most of the wetting agents and the plant growth regulators did not negatively impact soil biological health. In fact, some (Revolultion, Cutless and Trimmit) improved phosphatase activity probably due to their impact on soil moisture and root growth. However, we also noted that Cutless and Primo Maxx depressed urease activity after multiple applications. We will continue to monitor the plots going forward to affirm the trends we saw so far.

**Collaborators**:

- Mr. Mark Hoban, superintendent at Rivermont golf club

**Literature Cited**

Boddey, R.M. and Victoria, R.L. 1986. Estimation of biological nitrogen-fixation associated with *Brachiaria* and *Paspalum* grasses using $^{15}$N labelled organic matter and fertilizer. Plant and Soil 90:265-294.

Charest, C., Clark, G. and Dalpe, Y. 1997. The impact of arbuscular mycorrhizae and phosphorus status on growth of two turfgrass species. Journal of Turfgrass Management 2: 1-14.

Gardner, D.S. and Wherely. 2005. Growth response of three turfgrass species to nitrogen and triexapac-ethyl in shade. HortScience 40:1911-1915.

Hartnett, D.C. and Wilson, G.W.T. 2002. The role of mycorrhizas in plant community structure and dynamics: lessons from grasslands. Plant and Soil 244:319-331.

Karnok, K. 2006. Which wetting agent is best? Golf Course Management. July 2016.
Karnok, K., Xia, K and Tucker, K. 2004. Wetting agents: what are they, and how do they work? Golf Courese Management. July, 2004. Pp 84-86.
Kerry, B.R. 2000. Rhizosphere interactions and the exploitation of microbial agents for the biological control of plant-parasitic nematodes. Annual Review of Phytopathology 38:423-441.
Laha, S. and Luthy, R.G. 1991. Inhibition of phenanthrene mineralization by nonionic surfactants in soil-water systems. Environmental Science and Pollution 25: 1920-1930.
McCann, S.E. and Huang, B. 2007. Effects of trinexapac-ethyl foliar application on creeping bentgrass response to combined drought and heat stress. Crop Sci 47:2121-2128.
Myrold, D.D. and Bottomley, P.J. 2008. Nitrogen minearlization and immobilization. In Nitrogen in Agricultural Systems. J.S. Schepers & W.R. Raun (eds). Madison, WI: American Society of Agronomy, Inc.; Crop Science Society of America, Inc. Soil Science Society of America, Inc. p157-172.