Annual Progress Report – May 2017

Funding Agencies: The Environmental Institute for Golf and Georgia Golf Environmental Foundation

Project Title: An enzymatic approach to remediate water repellency of turfgrass soils.

Investigators:
Paul Raymer, Ph.D.
Jack Huang, Ph.D.
David Jespersen, Ph.D.

Soil water repellency occurs on sandy turfgrass soils as localized dry spots (LDS) and within the dry area of fairy ring disease areas. Soil water repellency causes serious soil water infiltration/runoff problems and reduces turf quality. Our research explores a new and novel approach to alleviate soil water repellency by using direct application of enzymes that are specific for degradation of hydrophobic organic fractions believed to contribute to soil water repellency. Since these enzymes directly degrade or alter the organic coatings, they should provide for longer-term and more effective alleviation of soil water repellency than the current management approach that involves repeated use of wetting agents.

This current research builds on our previous research efforts and proposes both greenhouse and field studies using direct application of enzymes or combinations of enzymes and wetting agents as a means to degrade certain organic fractions believed to contribute to soil water repellency. The enzyme proposed is found in natural systems, and enzyme activity is much less affected by changes in field environmental conditions than are specific microbial populations. We would anticipate that enzyme treatments could be confined to the localized soil water repellency areas (spot treatment) as a corrective and possibly preventive measure.

The objectives of the proposed project are to refine application protocols through laboratory experiments that determine the most cost-effective enzyme application rate and application frequency for the treatment of soil water repellency/LDS. Additionally, the effectiveness of adding wetting agents in combination with enzyme to enhance enzyme penetration is being evaluated. Field evaluations involving the most effective and economic treatments based on our greenhouse research will be evaluated for both short-term (< 2 weeks) and long-term (season-long) effectiveness in small-scale plot trials on the University of Georgia Griffin Campus and with more limited treatments at The Old Colliers Golf Course in Naples, Fla. or a similar suitable location.

Research to Date

Objective 1: Research efforts during 2016 were focused on goals outlined by Objective 1 of our proposal. In July of 2016, we initiated laboratory studies designed to refine application protocols with regard to enzyme application rate, application frequency, and the potential to

improve results by adding a wetting agent. Details of the results of this experiment were presented in the December 2016 Annual Report.

In 2017, a second laboratory study based on the same protocol was initiated. Our findings from the 2016 study were used to further refine laccase and wetting agent treatments. Specifically, in the second study, we increased the rate of enzyme used and shorted the re-treat interval to 30 days after initial treatment. Treatments for the 2017 laboratory study are shown in the table below.

Treatment #	**Treatment**	**Enzyme Rate[1]**	**App. Freq.**	**Wetting Agent[2]**
1	NH Sand[3]	0	0	0
2	Control	0	0	0
3	8uE	8	1	0
4	8uE & WA	8	1	6 oz.
5	12uE	12	1	0
6	12uE & WA	12	1	6 oz.
7	16uE	16	1	0
8	16uE & WA	16	1	6 oz.
9	WA	0	1	6 oz.
10	8uE + WA fb 8uE	8 + 8	30days	6 oz. + 0
11	12uE + WA fb 12uE	12 + 12	30 days	6 oz. + 0
12	16 uE + WA fb 16uE	16 + 16	30 days	6 oz. + 0

1. Enzyme rates are 8, 12, or 16 units of enzyme activity / cm2.
2. Rate of Revolution equivalent to 6.0 oz. / 1000 ft2
3. NH Sand = non-hydrophobic sand. All other treatments are with hydrophobic sand.

A summary of soil moisture content by weight as influenced by selected treatments from the first 4-week irrigation cycle are presented in Figure 1 below. Note that water retention of non-hydrophobic sand (NH sand) was significantly higher that the non-treated control (hydrophobic sand) for the first three irrigation events until the NH sand reached field capacity at around 25% soil moisture. In contrast, the hydrophobic sand used for all other treatments has a field capacity of approximately 50% soil moisture.

The effects of enzyme rate on soil moisture content during the 1st irrigation cycle are also illustrated in Figure 1. The addition of laccase at a rate equivalent to 8 units / cm^2 improved water retention, 8.5 % above that of the untreated control. However, rates of 12 and 16 units / cm^2 greatly improved water retention, increasing soil moisture content by 23 and 25.9 % respectively over that of the non-treated control (Figure 2).

The addition of a wetting agent to the hydrophobic sand (treatment WA) resulted in a dramatic improvement of the soil's ability to retain water. Pots treated with wetting agent acted similar to pots filled with non-hydrophobic sand and the mean soil moisture content in the WA treatment was 63.2% higher than that of the non-treated control (Figures 1 and 2).

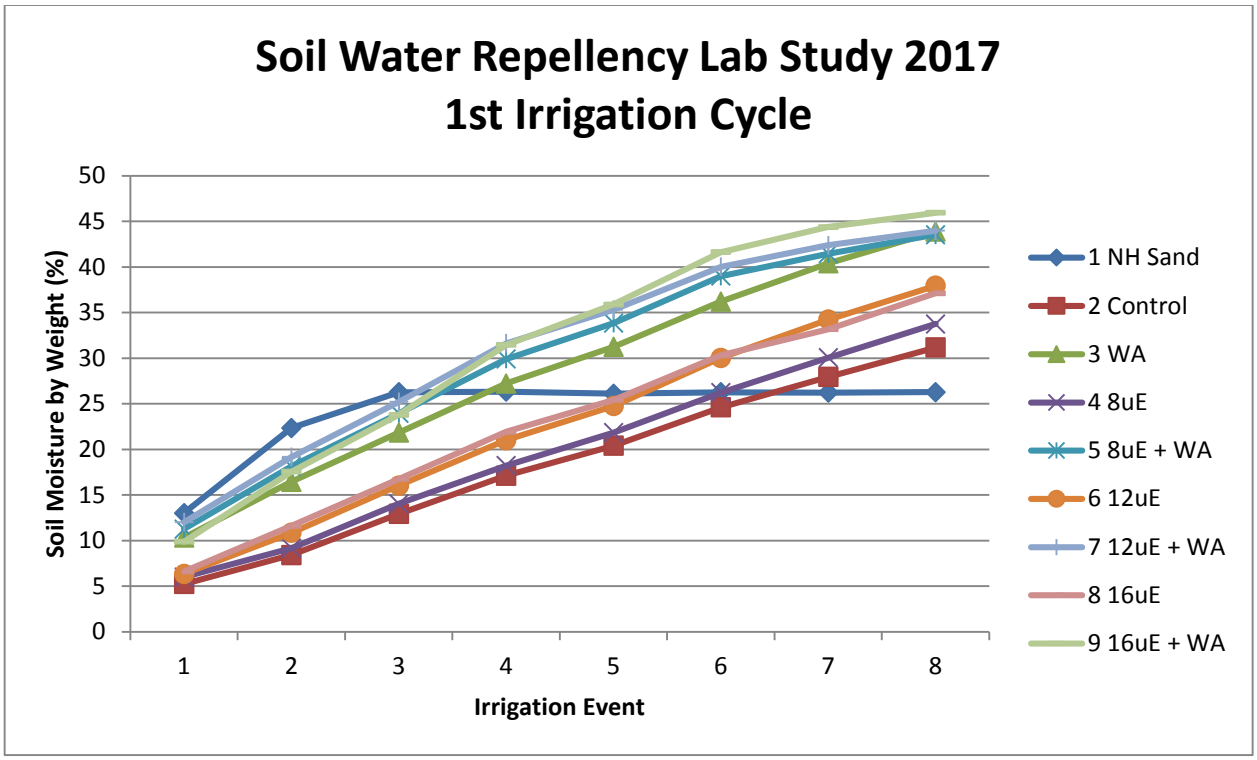

Figure 1. Treatment responses as observed by differences in soil moisture content over eight irrigation events during a four week period.

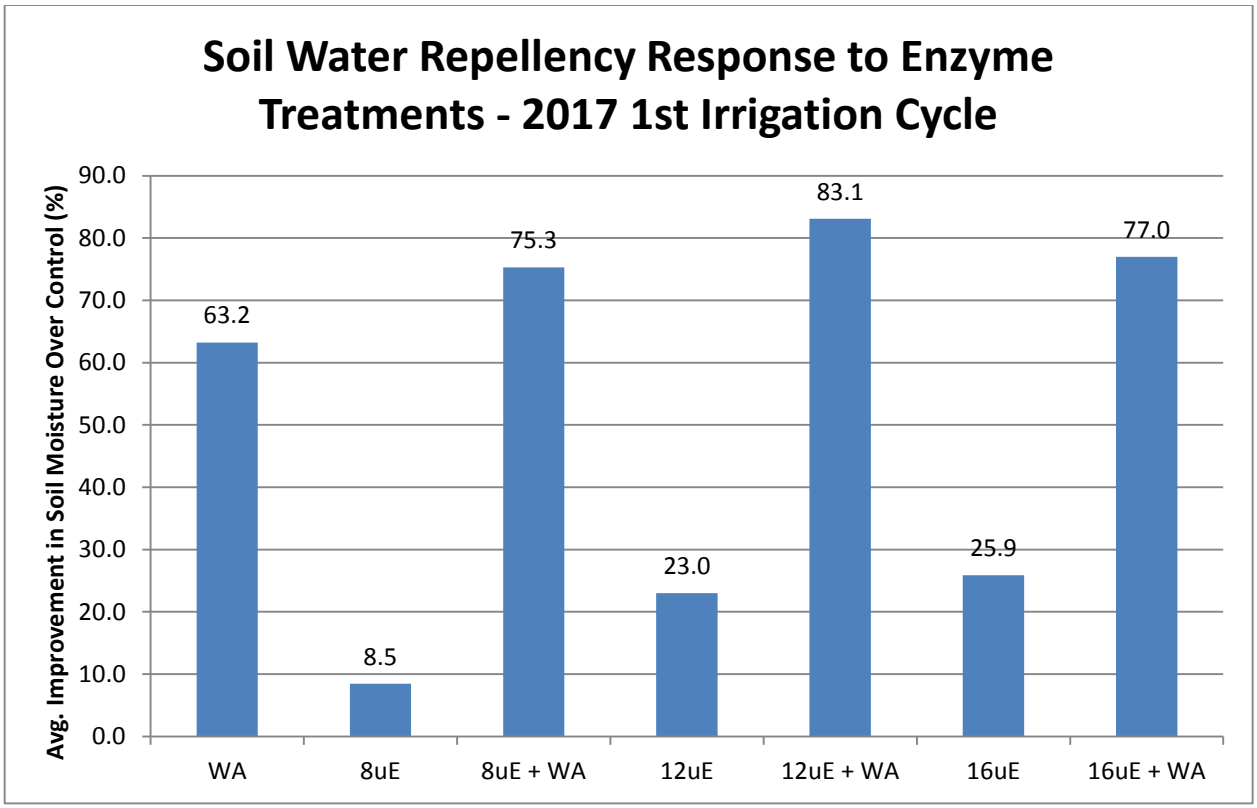

Figure 2. Comparison of responses to enzyme treatments with and without a wetting agent added as observed by differences in soil moisture content over eight irrigation events during a four week period.

The response of hydrophobic sand to three enzyme rates in combination with a wetting agent can be seen in both Figures 1 and 2. In treatments with wetting agent applied in combination with enzyme rates of 8, 12, and 16 units / cm^2, average soil moisture was improved by 12.1, 19.9, and 13.8%, respectively, over the soil moisture content where wetting agent was applied alone. These results provide further encouragement that laccase enzyme when used in combination with a wetting agent may further improve our ability to effectively treat strongly hydrophobic soils.

Future Research Plans

The overall goal of this research project is to maximize the potential of this new technology to alleviate soil water repellency. At the time of this report, the second laboratory experiment is still ongoing. However, we have learned much from these laboratory experiments already. We have learned that an enzyme application rate of 12 units /cm^2 provides a consistent response and that enzyme should be combined with a wetting agent to provide maximum relief of soil water repellency. Based on these data we have selected three treatments for more detailed study in field plots at the Griffin Campus as proposed to fulfill Objective 2 of this research project.

Proposed treatments for field study include:
1) 12 units / cm^2 of enzyme in combination with wetting agent (6 oz. Revolution / 1000 ft^2)
2) Wetting agent alone
3) Non-treated control.

Each of these treatments will be replicated 10 times in the study area. The study site is a sports field research area planted in seashore paspalum on the UGA Griffin Campus. The field is approximately 17 years old and was constructed using USGA profile specifications. Localized dry spot is frequently observed on this area. We have postponed field studies planned for testing our best treatments in a golf course setting until the fall of 2017.

Note: An abstract summarizing the 2016 laboratory experiment (see the December 2016 research report) has been submitted to the American Horticultural Society for presentation at their annual meeting in September of 2017.

Paul Raymer (praymer@uga.edu), is a professor, Jack (Qingguo) Huang, is an associate professor and David Jespersen is an assistant professor in the Department of Crop & Soil Sciences on the Griffin Campus of the University of Georgia, Griffin, Ga.