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Preliminary Field Studies on Enzyme Technology to Alleviate Soil Water Repellency in Turfgrass Situations

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Background:

Enzymes are large biological molecules, usually proteins. They are selective catalysts for specific substrates and greatly enhance the rate of specific reactions on the substrates. In plant or animal cells, almost all reactions are controlled by enzymes. The most common enzymes found in plants or soil microorganisms are also naturally present in soils, either due to excretions from or decomposition of the plant and soil organisms. However, these are present at very low levels.

It is very difficult to maintain viable, specific microbial populations in turf management systems that may excrete extracellular enzymes that could alter an organic compound – such as sustaining the white-rot fungi population that excrete laccase enzyme that degrade lignin bonds, hence opening up of the structure of thatch biomass for other microbes to decompose cellulosic and hemi-cellulosic sugars. However, the direct application of laccase enzyme in turfgrass ecosystems was found to be effective for organic matter decomposition in thatch/mat by Sidhu et al. (2012, 2013a, b) in research partially supported by the Georgia Golf Environmental Foundation. This was the first reported research on direct enzyme application for enhancing organic matter decomposition.

Soil Water Repellency Project

Soil water repellency (SWR) is where a soil does not spontaneously wet when a drop of water is applied to the surface – i.e., the soil is hydrophobic. On sandy turfgrass soils and grasslands, SWR is a reoccurring problem, where the normal situation is called “localized dry spot” (LDS), and SWR appears as irregular dry areas from a few inches to several feet in diameter with the repellency usually in the surface 0 – 2 inch depth. A second SWR situation on turfgrass sites is within the dry area of basidiomycete induced “fairy-ring” on all soil types. Soil water repellency on sand soils is universally attributed to hydrophobic organic matter coating on the sand particle surfaces and hydrophobic organic particulate matter from plant debris or added as an amendment, while high organic matter in the thatch/mat layer may also contribute.

Based on the positive results in studies on organic matter decomposition, we proposed a novel approach by using direct application of enzymes or combinations of enzymes that are specific for degradation of certain organic fractions believed to contribute to soil water repellency (SWR) – i.e., the organic compounds that are adhered to the sand particles and in the particulate organic matter that cause SWR. Since enzymes have the potential to degrade or alter the organic coatings, they should provide for longer term and more effective alleviation of SWR than the most current management approach, which is use of surfactants on a repeated basis (Moore et al., 2010; Muller and Deurer, 2011). Greater attention to SWR in recent years is due to increased awareness of its negative implications, especially on water relationships and associated environmental issues, such as: reduction in soil water intake/infiltration; uneven wetting patterns; reduced irrigation efficiency and capture of precipitation; increased preferential flow that can have adverse effects on aquifer contamination; greater runoff and erosion; limited seed and vegetative establishment; and reduced plant growth and quality (Moore et al., 2010; Muller and Deurer, 2011).

In 2012 we collected eight SWR soils from different turfgrass sites, with all but one were from golf courses. We conducted a series of proof-of-concept laboratory studies, funded by the UGA Technology Commercialization Office, to see if selected enzymes would effectively alleviate SWR under optimal lab conditions. We evaluated enzymes present in a crude enzyme extract obtained during fungal pretreatment of switchgrass in a biofuel study as well as 10 specific enzymes. Four types of enzymes were found to be very effective in laboratory conditions as well as the crude enzyme extract in remediating SWR. These studies have been submitted for publication in science journals as the first to use this technology for SWR (Liu et al., 2013; Zeng et al., 2013).

With positive laboratory results, we submitted a grant proposal to the GGEF in fall 2012 and recently to the United States Golf Association Product Testing program to conduct field assessment in 2013 and 2014. The GGEF 2012 funding was used to obtain soil moisture monitoring instrumentation, soil sampler and tubes, and enzymes. Initial field studies are planned for late June or early July 2013 and studies will continue through 2014. The first studies will be small plot studies to determine enzyme effectiveness, which enzymes to use alone or in combination, rates, effectiveness with and without a wetting agent in the first application, etc.

We wish to thank the GGEF for sponsoring this novel and new enzyme technology application to an important turfgrass issue.

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