SEPARATING THE MYTHS FROM THE TRUTHS OF TURFGRASS SOIL MICROBIOLOGY

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Turfgrass represents a significant amount of land area and economic impact in the US. A well-maintained lawn, athletic field or golf course makes a significant contribution to "the good life." When properly managed, turfgrass can improve the quality of life and offer environmental benefits such as air and water quality improvement, erosion control and noise abatement. In recent years, research at the University of Nebraska and other locations has concentrated on trying to better understand the microbial ecology of turfgrass soils. Although this research has created new and academically interesting challenges for future research, fundamental questions have been answered and common perceptions have been found to be untrue. This article will attempt to summarize these studies and make assumptions based on these data concerning the use of microbial inoculants for turfgrass management.

The following are common perceptions about the microbial relationships in turfgrass soils:

- Excessive pesticide applications adversely affect soil microbiology.
- Sand-based rootzones are relatively sterile.
- Soil inoculums/additives can alter soil microbiology.
- Turfgrass soils are lower in microbial biomass/diversity than other soils.

From 1996 to 1998, golf course greens located on 16 golf courses in eastern Nebraska were sampled for microbial properties in a project funded by the O.J. Noer Turfgrass research program and the United States Golf Association (USGA). This work was conducted by graduate student Mine Aslan under the direction of Drs. Rhae Drijber and Bill Powers. The 16 courses were separated into three distinctly different management groups based on pesticide inputs, fertility and other pertinent management practices. All greens had sand-based rootzones and ranged in age from 1 to 28 years. Results indicated that:

- The age of green was the most significant factor in microbial biomass/diversity.
- Management level did not influence microbiology, indicating that higher levels of management, including relatively high pesticide inputs, did not adversely affect soil microbiology.
- Significant microorganism levels and stability occurred within 18-24 months after establishment.
- Microbial biomass of sand-based turfgrass soils 18-24 months after establishment was less than native undisturbed soils, but greater than traditional row crop soils.

This work also indicated that as a golf green matures, the microbial population is more associated with particulate organic matter (POM) than the mineral fraction. POM is the residue produced from the turnover of the plant root system as it matures and dies, sloughing off roots, root hairs, etc. into the rhizosphere. The rhizosphere is the region in the rootzone that is immediately adjacent to the root system. This region is critical for nutrient transfer and plant uptake, pathogen competition, and ultimately plant health.

Similar results concerning microbial levels and stability were reported by Bigelow & Bowman in 1999 in work conducted in North Carolina. Their data indicated that sand-based turfgrass rootzones reached significant microorganism levels and stability relatively quickly (within 12-18 months), and these levels were equal to native soils in the region. They also reported the temporal effects of microbial populations, with the largest populations being associated with the periods of greatest plant growth, i.e., spring and fall.

It is interesting to note that the period associated with the lowest microbial numbers in Bigelow and Bowman's work also coincides with the period of greatest root pathogen activity and other stresses, i.e., summer. Obviously, these other stresses such as heat and drought are contributing to the grass decline during the summer, but the soils microbial "health" should not be overlooked.

The research at Nebraska and North Carolina indicated that in a relatively short time, sand-based turfgrass rootzones reach microbial levels comparable to other "native" soils. This information can be used to develop a theoretical scenario for the use of *microbial inoculants*. These are products that are packaged and marketed to turfgrass managers as tools to improve the microbiology of the soil. These are often beneficial organisms packaged with other ingredients such as iron or biostimulants, or in some cases packaged as spores of the desired microbe. These products may contain up to 10^9 organisms per milliliter of product, and application rates range from 1 to 6 ounces per 1000 ft^2 . The soil contains 10^8 bacteria per gram of soil. The relative quantity of actinomycetes is approximately 100 times less than the bacteria and fungi 100 times less than the actinomycetes, but for our theoretical example, we will disregard both the native fungi and actinomycetes. Realizing that many soil microorganisms are sensitive to UV light and/or heat instability, and therefore survival from purchase to application is suspect, let us assume that all applied microorganisms survive and that the maximum use rates of the product are applied – the ratio of applied vs. native bacteria is approximately ***6000 native: 1 applied***, or the applied represent ***0.02*** percent of the total bacterial population. It appears that the applied microorganisms have little or no chance of effectively competing with the already established population. Further, Boehm's work at Ohio State University showed that at approximately two years post-construction in a soil/sand/compost vs. sand/peat green, microbial diversity was not different, even though the former green was significantly higher at establishment. While the compost increased microbial taxa initially, a natural equilibrium ultimately occurred.

Do microbial inoculants therefore have no merit? Other research has shown the benefits of the addition of biological pest control products, such as nematodes for grub control, where the goal is control of a specific pest as opposed to increasing beneficial microorganisms in the soil. Structured research is limited, but scientific work in this area is increasing. Since it appears that new sand-based rootzones take 1-2 years to reach equilibrium, perhaps the use of microbial-based products has merit during establishment of turf on sand rootzones. A study was conducted in 2000 at the University of Nebraska with the Emerald Isle (EI) products GrowIn and Optimil for the establishment of bentgrass. The EI grow-in resulted in faster establishment than traditional grow-in procedures, and after the growing season, the EI plots had higher fungi and bacterium levels. Work in this area continues, and perhaps future research will shed more light on the use of microbial inoculants in turfgrass management.

In summary, it appears that some common perceptions about turfgrass soils were not true:

- Relatively high pesticide applications do not appear to adversely affect soil microbiology.
- Sand-based greens are not sterile, but in fact, reach levels of native soils in a relatively short time.
- Soil inoculums/additives can alter soil microbiology in the *short term*, but their use on established soils is questionable.

For information on data or studies described herein, please contact the author at rgaussoin1@unl.edu.