CUTT

What Are Those Microbes?

A Healthy Ecosystem

In turfgrass management, soil health issues are becoming more important as managers are forced to manage turf under less-than-ideal agronomic practices.

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Microbial characteristics of soils and plant rhizospheres (where plant roots grow), are being viewed increasingly as sensitive indicators of soil health since there are clear beneficial relationships between microbial diversity, soil and plant quality, and ecosystem sustainability. In turfgrass management, soil health issues are becoming more important as managers are forced to manage turf under less-than-ideal agronomic practices. Furthermore, it is becoming more and more apparent that plant species and varieties strongly influence the types of microorganisms that predominate in the rhizosphere. Indirectly, therefore, turf varieties may also influence the microbiology surrounding soil health parameters.

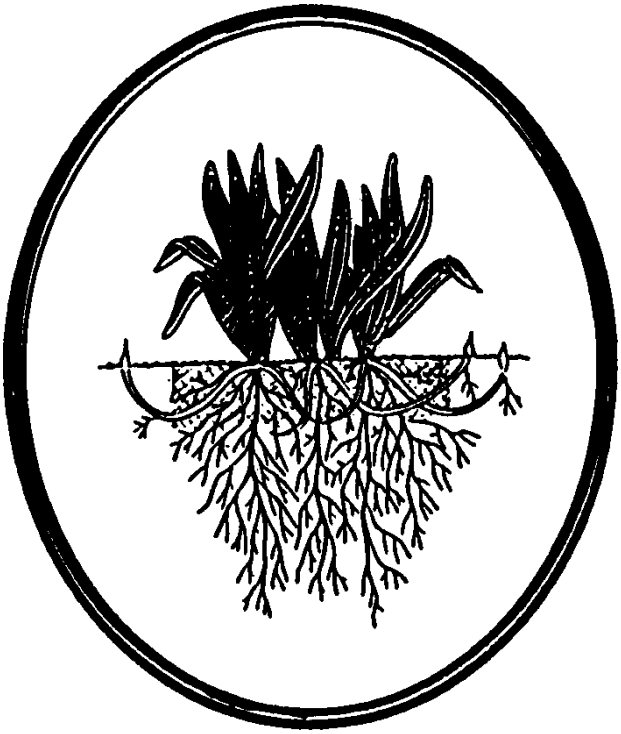
Most studies of soil and rhizosphere microbial properties have been conducted traditionally at relatively crude levels, in which biomass, respiration rates, and enzyme activities have been examined, with little attention given to specific community-level or organism-level responses. While these measurements provide important insights for understanding the role of microbial processes in soil health, they tell us little about specific qualitative and quantitative community-level changes since many microbial processes are shared among a diversity of organisms and they lack the specificity to describe a particular microbial ecosystem.

Since microbial community-level interactions in soils and rhizospheres are complex, with individual species relying on the presence and function of many other interacting species as well as the plant itself, changes in the structure of rhizosphere microbial communities can serve as important and sensitive indicators of both short and long-term changes in soil and plant health. Ideally, the analysis of soil and rhizosphere microbial communities should involve not only determinations of microbial biomass and diversity, but also determinations of microbial growth, distribution, function, and the nature of interactions among species.

As straightforward as soil microbial community analyses may seem, two of the long-standing challenges in soil microbiology continue to be the development of effective methods for determining which microorganisms are present in a given habitat such as soil or the rhizosphere, and determining the function(s) of these microorganisms in the field. These problems have been made worse by a number of technical difficulties including the problems separating microorganisms from the soil matrix and from plant tissues, the morphological similarities among many organisms found in soils and plant rhizospheres, and changing microbial taxonomies. Furthermore, the microscopic nature of these important organisms has made direct visualization more difficult than with other biological components of a turfgrass ecosystem.

Traditionally, the analysis of soil or rhizosphere microbial communities has relied on culturing techniques using a variety of culture media designed to maximize the recovery of different microbial populations. This is particularly the case for the limited studies in turfgrass soils. In many contemporary studies of soil microbial communities, these techniques have uncovered new microorganisms associated with various soil quality parameters. Although there have been recent attempts to devise suites of culture media to maximize the recovery of diverse microbial groups from soils, it has been estimated that less than 0.1% of the microorganisms found in soils are culturable using current culture media formulations. This is based on comparisons between direct microscopic counts and microbial populations recovered on conventional culture media. Therefore, for studies of the composition of natural microbial communities such as those found in turfgrass soils and rhizospheres, culture techniques, used alone, are generally inadequate. A combination of both culture-dependent and culture-independent approaches are now widely accepted as the best approach to microbial community analysis.

Because of the inherent limitations of culture-based methods of community analysis, soil microbial ecologists are turning increasingly to culture-independent methods of analysis. Using culture-independent methods, the structure of communities can be inferred based on 1) the



extraction and analysis of DNA molecules from soil that are specific to certain microorganisms or microbial groups, or 2) advanced microscopic techniques. In the past 5 years, revolutionary changes have occurred in the development of culture-independent approaches for the analysis of soil and rhizosphere microbial communities. A variety of new molecular methods and approaches are now available, allowing soil microbiologists to gain access to more of the microorganisms residing in soil and plant rhizospheres and allowing for better assessments of microbial diversity in these habitats.

Research Objectives

The overall goal of our research program is to understand the nature of microbial communities in turfgrass soils. Our work over the years has focused specifically on compost amendments for improving soil quality and soil health. We have focused on disease suppressiveness induced by compost amendments as an indicator of soil health since it is an easily observable response with which we can correlate qualitative and quantitative microbiological changes. It is possible that microbial communities from both high quality and low quality soils may share many common taxa, making quantitative aspect of specific populations important in soil health. However, it is also likely that there are unique populations associated with healthy soils that cannot be found in low quality soils making qualitative microbial characteristics more important.

Our current research focuses on bacterial components of the microbial community since relationships between bacterial activities and soil health have already been established. A specific goal of our research will be to determine whether there are specific bacteria that can be correlated with healthy soils and whether quantitative relationships among predominant organisms can also explain overall reductions in disease incidence and severity in these soils.

Expected Results

We have designed a series of studies to ask questions concerning the nature of bacterial communities in healthy and non-healthy turfgrass soils. Our approach for assessing microbial community composition will allow us to identify many culturable and non-culturable microorganisms that have previously not been studied in turfgrass microbiology. Our results will provide significant new information on the bacteria associated with soil health parameters.

Despite many limitations, our research represents a novel approach to study the microbiology of turfgrass soils. We expect to find bacteria in these soils that have never been described or studied before. We also expect to identify potential associations among organisms that will serve as a guide for future experiments aimed at more carefully defining important relationships among populations of bacteria in healthy and non-healthy soils.

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