better this year, or my nutrient management is better than when I used granular fertilizers.

I honestly don't think there is any way to tell for sure if the microbes and carbohydrates have made a difference without conducting a lot of expensive research. However, I am not willing at this time to take the microbial products out of the program. Not until someone proves to me that using microbial products is not good science.

Do I think there should be money laid aside to research microbial products? Absolutely! In my opinion, with all the radical environmental groups trying to get us shut down, anything we can do that is environmentally responsible is worth researching..

Mike Hamilton, CGCS
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Editor's Note: *At its fall board meeting the FGCSA agreed to submit a proposal from Dr. Monica Elliott on microbes to the GCSAA for research funding. The purpose of the project will be to determine if* Bacillus *microbes applied to bermudagrass putting greens do survive and establish on either the turf or in the soil. The project will also determine the effect of frequent, multiple applications on the* Bacillus *populations. The research will be conducted on a portion of the FGCSA's Otto Schmeisser Research Green at the University of Florida's Research and Education Center in Ft. Lauderdale*

Microbes Play Varied Roles in All Facets of Human Existence

If champagne, a loaf of freshly baked bread and a fragrant cheese will figure prominently in your Year 2000 celebration, then you can thank your local microbe. Human beings are dependent on microbes for many foods such as yogurt, sauerkraut, sour cream, beer and other fermented drinks.

There is also a type of bacterium that lives in the human intestine that makes vitamin K, a factor needed to clot blood.

In addition we take advantage of bacteria for their ability to protect us from microbial invaders. Human beings have their own special bacteria that have adapted to life in a salty, ocean of sweat on our skin. These bacteria keep out pathogenic fungi and bacteria. We also have a host of bacteria living in our throats, noses, intestines and other areas of the body. These friendly bacteria are tremendously effective at keeping the disease-causing bacteria away from their homes, our bodies!

A diversity of bacteria that associate with plant roots serve the same purpose of holding pathogenic microbes at bay.

Biological control agents, such as bacteria and fungi, work through a variety of mechanisms. These mechanisms include the production of antibiotics and other inhibitors; simple competition for food, water and space; stimulation of the plant's own system of defenses; and an environment around the plant roots that encourages growth of beneficial microbes.

Beneficial bacteria and fungi can form a barrier against pathogen invasion of plant roots. Because turfgrass's roots are surrounded by a host of friendly bacteria, it is much more difficult for *Gaeumannomyces* (take all disease organism) to reach its intended target.

In laboratory testing, conclusive tests have shown that *Gaeumannomyces* is sensitive to substances produced by several different species of bacteria. When a diverse group of microbes exists in the soil in the plant root zone, many reciprocal benefits are derived from that relationship. When bacteria and fungi colonize the rhizosphere, they are fed a steady diet of plant sugars. The plants in turn benefit from colonization of non-pathogenic microbes.

What happens if friendly plant bacteria are not available to protect plants? Soil that has been treated with harsh chemicals may deplete soil of the beneficial bacteria and fungi. When fungi and bacteria are no longer available as a shield pathogenic microbes may then be able to invade plants.

Within the past 50 years, the public has been taught that the only good microbe is a dead microbe. Nothing could be further from the truth. Without beneficial microbes, our plants would die and our own existence would be in jeopardy. And yet we continue to douse microbes with bactericides and fungicides in an effort to exterminate the pathogens, but in doing so many beneficial are also depleted in numbers.

Some helpful bacterial species include *Pseudomonas, Bacillus, Cellumonas, Corynebacterium, Rhodococcus,* and other member of the *pseudomonads actinomycetes.* Some species of *Pseudomonas* help break down urea-based fertilizers enzymatically and convert urea to ammonia. Ammonia is then converted by nitrifying soil bacteria to nitrates, a form of nitrogen readily available for plant utilization

Certain species of *Bacillus* produce insect toxins as well as antibiotics that inhibit fungal growth. *Bacillus* is an extremely hardy microbe. These bacteria form endospores under adverse conditions, enabling the microbe to withstand drought, high heat and adverse pH conditions. *Cellumonas* is extremely helpful in producing substances that break down dead plant material in the soil, thus helping remove thatch buildup. *Rhodococcus, Bacillus* and *Pseudomonas* are proven pesticide and herbicide degraders; therefore much of the excess biodegradable pesticides are devoured by microbes.

One important factor to remember is that just one bacterial type cannot do a job alone.

This is the reason why it is important to maintain a highly diverse population of microbes. What one bacterium can break down in the soil may not be an available food source for another microbe. As mentioned above, several different bacteria are needed in the first step of converting urea to ammonia. Without a team of urea-degrading organisms, the nitrifiers would be powerless to use urea-based fertilizers as a nutrient and thus produce nitrates for plants.

Without many different bacteria and fungi in the soil, a healthy environmnent cannot be maintained. In the decomposition of dead plants and animals, certain inorganic elements such as phosphates are released and made available for plant nutrition. Many different bacteria utilize common organic wastes and produce carbon dioxide and water.

Without microbial diversity, nutrient

cycling would be incomplete and the soil could be said to be "imbalanced." When nutrient/mineral imbalances occur, it leads the way for certain microbial populations to proliferate and dominate. If pathbgenic species dominate an area, then sensitive plants are in danger of becoming infected and an epidemic ensues.

While only a relatively few microbes, both bacterial and fungal, cause disease in plants and animals, a single infestation of *Rhizoctonia* (brown patch) or *Gaeumannomyces* can devastate a green. When a fungus invades an area it is difficult and costly to eradicate. From a fungal point of view, all any fungus wants is a warm moist place to live with an ample supply of food close at hand. A golf course usually provides the precise conditions that not only allow certain fungi a free ride, but in a sense, invite them in to stay.

However, certain defenders of the turf can and will defend grasses and other plants from the insidious invaders. Over the past 20-30 years, the prevalent method of ridding a green of the fungal marauders was to add fungicides. In recent years, golf courses and farms have come under attack for their supposed contamination of the environment with major amounts of chemicals and fertilizers applied in an effort to grow lush green lawns and a food supply to feed the world respectively.

In response to new governmental restrictions on chemical use, some operators are trying the natural approach of building and maintaining organic golf courses. A recent innovative approach is to add small doses of nutrients and microbes simultaneously to the courses. The result is efficient use of the fertilizers with the added bonus of inoculation with a diverse bacterial population.

This method of microdosing is being implemented successfully by such golf course superintendents as Jon Snider (Texas Star GC, Dallas/Ft. Worth) and Nels Lindgren (Loch Lloyd, Kansas City).

Use of the microdosing technique allows a reduction in the amount of chemicals applied and also allows the elimination of certain growth regulators. The use of such microbially-based inoculants as SuperBio microorganisms, a diverse group of 30 different microorganisms, promotes the growth of healthy grass and other vegetation. Microbial products are not meant to replace traditional uses of fungicides, but may allow fewer chemicals to be applied. When SuperBio microorganisms are applied several days after application of fungal control agents, the bacterial diversity in the treated area is restored. In preliminary tests, certain of the SuperBio bacteria are showing promise in retarding growth of selected fungi such as *Gaeumannomyces* (take all) and *Cylindrocladium* (damping off).

Traditionally, the scientific community has been slow to support the need for research in microbial diversity since much of academic bacterial research is performed on pure cultures made up of only one bacterial type.

The problem in this approach lies in the fact that bacteria and indeed all other organisms on earth rarely if ever exist in pure cultures. All creatures on earth need help from other organisms, whether they are microbes, animals, plants, scientists or golf course superintendents.

However, within the past 10 years, the scientific community has begun to view microbial diversity in a different light. More research is now being done on mixed cultures of microbes in their natural habitats. The time has come to work together, microbes and man, for a healthier, safer place to live, work and play in the new millennium.

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