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Subtle Aspects of Microbes Determine Performance

A Healthy Ecosystem

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The recent ruling in Hudson, Ontario, Canada that bans all pesticide use in the community is currently under discussion in Toronto. Several counties in New York State have phased out the use of pesticides on municipal property. Other government bodies are legislating the use of Integrated Pest Management (IPM) in schools as a means of eliminating pesticide use.

In every case, the cry from the public to implement IPM or eliminate pesticides includes an emphasis on the use of biological control. A scientifically illiterate public falls prey to a variety of advocacy groups touting the successes of biological control of plant pests. Unfortunately, the industry as a whole has little understanding of the processes, opportunities and limitations of biological control of turf pests.

Turfgrass managers are regularly inundated with sales material that touts a myriad of benefits from using a particular product. In some cases, actual research data is available, however, many times the data is from controlled laboratory studies or with plant material other than turf. While this should not always disqualify the data, studies under field conditions that generate consistent measurable responses are clearly lacking. A working understanding of the dynamic relationship among plants, soils and biological control agents such as microorganisms is vital for increasing success.

Microbes for Disease Control

"The most common approaches for implementing biological control strategies for plant diseases have involved the use of microbial inoculants or organic amendments," states Eric Nelson, Turfgrass Microbiologist at Cornell University. "In either case, the goal is to increase populations and activity of disease-suppressive microbes in association with turfgrass plants and treated soils."

Microbial inoculants have been used for a variety of purposes in turfgrass management. Researchers have investigated the use of nematodes to control insects, bacteria for annual bluegrass control, and even as means of reducing thatch. Still, the lion's share of the research has focused on the use of microbes for disease control. Unfortunately, the disease research has focused on control efficacy, with little emphasis on the relationships among the plants, microbes, and the soil.

Microbes have specific traits that influence biological control activity such as the production of toxic compounds that influence the growth of a disease organism. This mechanism is similar to how a pesticide would work. A second trait is the competition among the inoculant and the disease-causing organism, where

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Microbes

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the biocontrol agent out-competes the disease-causing organism for a particular resource. Interestingly, there is no definitive evidence that resource competition is an important aspect of biological control.

Several other mechanisms of biological activity that afford disease control include one organism attacking another, an organism inducing plant defenses to a disease, and finally how competently an organism can colonize the root zone.

Much of the activity expected from microbial inoculants stems from the population levels supplied and sustained. For example, *Trichoderma harzianum*, sold as Turf Shield and developed by Cornell University microbiologist Gary Harman, must be present in the soil between 100,000 and 1,000,000 colonies (groups of organisms) per gram of soil. If levels drop below 100,000 then control efficacy is lost.

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Your Daily Microbe?

A system was developed (BioJect System, Ecosoil, Inc.) to deliver an biological control organism (TX-1), proven in the laboratory to control dollar spot, brown patch and *pythium* diseases of turf. This system is currently being used on several golf courses in the U.S., however, actual performance data has not been available. The Bioject System injects organisms that produce an antibiotic substance into the irrigation system.

Researchers Bresnahan and Drohen at the University of Massachusetts, in cooperation with three golf courses, conducted evaluations of the BioJect Systems at their facilities. The objectives of the study were: 1) evaluate the ability of the BioJect to suppress dollar spot on fairways, 2) evaluate the ability to suppress nematodes on greens, and 3) evaluate the ability to distribute the biocontrol organism through the system.

For the dollar spot trial, daily application of the biocontrol organism was made following a 12-hour fermentation cycle. The organism was applied with a watering can between the hours of 9 pm and 12 am, to simulate nightly irrigation, not through the BioJect System.

Dollar spot levels in the untreated plots were significantly greater than the action threshold that would require treatment (5 spots per 18 square foot plot). Dollar spot levels did not reach the action threshold in BioJect treated plots on the Orchards Golf Course with mostly bentgrass, and Twin Hills Golf Course with low-maintenance Kentucky bluegrass blend. In fact, BioJect treatments were similar to Daconil and Banner fungicide programs.

Under more severe disease pressure, the BioJect treatments provided 86% control but did not maintain acceptable quality turf, as dollar spot levels were well above threshold. Still, the BioJect treated plots that only received Daconil or Banner when threshold levels were reached, reduced fungicide use approximately 70 to 80% as compared to fungicide treated plots without BioJect treatment.

Nematode treatments were applied to a 75-year-old annual bluegrass/bentgrass putting green with high populations of certain parasitic nematodes. Application methods were similar to those made to fairways in the dollar spot experiments, relative to fermentation and watering can. Except for two dates, for one species (*Tylenchorhyncus* spp.), neither the BioJect, nor Nemacur treatments significantly suppressed nematode populations.

The experiment to evaluate distribution was conducted on three golf courses in eastern Massachusetts. Population counts were taken after the fermentation cycle and at various distances from the irrigation pump house. In the cases where the system performed adequately, counts were at or above what is required to achieve acceptable activity. However, in every case where irrigation water was sampled from the sprinkler heads, populations were often 1000 times less than at the pump. The lack of disease incidence on the courses at the time of the study limited the researcher's ability to determine the actual impact of reduced population amounts on control.

The TX-1 organism developed by Dr. Joe Vargas at Michigan State University, when applied in the correct amount, is capable of eliminating or reducing the need for some fungicides. Yet, the inadequacies of the BioJect System to deliver the populations needed for control leaves many questions unanswered.

Shift in Thinking

While biological control will be held to the same performance standards as chemical control, a disparity exists in our willingness to understand the differences inherent with each system. When a turf manager applies chlorothalonil at the recommended rate for 10 to 14 days of dollar spot control, then notices a severe infestation in 5 days, the immediate response is to blame it on intense disease pressure. Regardless of conditions, in most cases a follow up application will be made with little thought given to product failure. Yet, when a biological control fails to provide acceptable protection, the entire technology is criticized.

Chemical pesticide technology has alleviated the burden of understanding the dynamic ecological and biological processes in turf systems. One has no need to understand why dollar spot invades a putting green, only what is needed to control the problem. In fact, there is little motivation for determining ways of preventing the problem, when such simple curative measures are available. How long can we avoid conducting the research to understand these problems? How long will we allow expectations to be the driving force for technological advances?

Clearly, regulation will drive the shift from chemical pesticide use to biological-based management. Until there is a mainstream shift in thinking by the turf industry—whether user motivated or community advocated—the subtleties that inhibit our understanding of biological control will persist. Turf users must be included in this discussion to ensure their support.

We have evidence now that certain cultivars of bentgrass respond differently to biological control. This may explain the well-documented inconsistencies with certain biological control programs. It also means that companies may have to develop cultivar specific microbes and golf course superintendents will need to know the cultivar to utilize the technology.

The days of being able to toss a water-soluble packet into a spray tank on any day a problem is noted and expect 100% control may be numbered. Our commitment to continued research and education on biological control will determine the success of the transition from chemical pesticides to a biologically based system of management.

Frank S. Rossi

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