What will biologicals do for turfgrass management?

by Christopher Sann

BIOLOGICAL CONTROL PRODUCTS are not new to the plant management business. For over thirty years, turf managers have used milky spore disease to control grubs. Several companies have made advances recently in the use of parasitic nematodes as an effective alternative to chemical controls for grubs, molecrickets, and billbugs. Most recently, several organic based fertilizers and compost amendments have become available that have shown varying degrees of pathogen suppression in the field.

In agriculture and horticulture, a series of microbial insecticides based on the "BT" bacteria, *Bacillus thuringiensis,* are used for the control of a ever widening group of insect pests. Although not microbial based, naturally rendered soap or fatty-acid based insecticides have become popular in the ornamental plants industry.

Additionally, in agriculture, inoculants are added to silage, to augment the fermentation process. Several broadleaf "bio-herbicides" are also in use. One called "Devine" is based on *Phytophthora spp.* It has been successfully used for control of weeds in citrus groves. Another is called "Collego", based on *Colletotricum spp.,* for control of Northern Joint Vetch in rice and soybean fields.

A variety of bio-news is on the way

AS MORE RESOURCES are directed at increasing our knowledge about the turfgrass micro-environment, many new approaches to the science of turfgrass management will develop. Not only will new products and procedures be identified, but this increase in knowledge will help fine tune the use of existing control products through better timing of applications at reduced rates.

Future bio-products probably will be separated into several types:

- EXISTING MATERIALS THAT CONTROL or suppress pests and pathogens;
- FORMULATED "SPECIES SPECIFIC" microbial fungicides, insecticides, or herbicides— designed to control certain pathogens, insects or weeds;
- BIO-ENGINEERED TRANSGENIC TURFGRASS species that exhibit some of the genetic traits from microbes that are involved in pest control;
- AND BIO-ENGINEERED or naturally selected, endophytic fungi-enhanced turfgrasses that exhibit disease suppression, similar to those that now show insect resistance.

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Of the four types listed above, the hunt for naturally occurring suppressive materials is ongoing, and provides the greatest possibility for immediate applications of biologically suppressive products. This process requires the identification of possible suppressive microbes or organic materials, the collection of microbes or matertials, and a thorough sorting-out process to confirm their suppressive nature. Once they have been identified as suppressive, they must be analyzed to see if they can be formulated or processed into a form that the turfgrass manager can use without too much disruption to existing techniques.

Several of these suppressive products are being marketed as organic based fertilizers - Sustane (5-2-4), Ringer "Compost Plus", Ringer "Lawn Restore", and Ringer "Greens Restore". These and similar products have been tested at Cornell University and Michigan State University. They were found to provide varying levels of suppression to certain pathogens.

At Cornell, three organic fertilizers were included in a field test for the control of dollar spot, brown patch, red thread and gray snow mold *(see Tables 1 and 2: Brown Patch and Red Thread on page 11).*

Michigan State University researchers evaluated various combinations of commercially available organic fertilizers, wetting agents, synthetic fertilizers, and fungicides applied at different rates—for suppression of the pathogens that cause summer patch and necrotic ring spot *(see Tables 3 and 4: Summer Patch and Necrotic Ring Spot on page 11).*

The mechanism by which these materials work vary from product to product and in many cases have yet to be thoroughly understood. In the case of Sustane, applications of the product after it had been sterilized to kill any microbial antagonists present, produced the same results as applications of unsterilized Sustane. This result indicated that the factor that is effective in Sustane is likely of a chemical nature, rather than biological.

Very slow release synthetic fertilizers, such as IBDU, and other organic based fertilizers are probably effective because they reduce the expression of symptoms—by avoiding fertilizer stress during periods of high environmental stress. And products like Aqua Gro L probably work by reducing excess root zone moisture and thereby disrupting the reproductive cycle of the pathogens.

HOW EFFECTIVE ARE BIOCONTROLS AT DISEASE SUPPRESSION?

TABLE 1

BROWN PATCH FIELD STUDY

TREATMENT	% DISEASED
Banner (fungicide)	8%
Sustane	18%
Ringer "Compost Plus"	18%
Ringer "Greens Restore"	24%
End. sludge compost	42%
End. leaf compost	44%
Peat moss	50%
Brewery compost	54%
Cow manure compost	54%
Mushroom compost	54%
Balt. sludge compost	60%
Schen. sludge compost	66%
Moody cow compost	72%
CONTROL	**72%**

TABLE 2

RED THREAD FIELD STUDY

TREATMENT	% DISEASED
Sustane (fungicide)	10%
Ringer "Compost Plus"	20%
Balt. sludge compost	23%
Brewery compost	30%
Peat moss	37%
End. sludge compost	40%
Cow manure compost	43%
Ringer "Greens Restore"	43%
CONTROL	**47%**
End. leaf compost	53%
Moody cow compost	53%
Mushroom compost	53%
Schen. sludge compost	57%

Source for Tables 1 and 2: Field studies by Dr. Eric B. Nelson (Cornell University, 1989).

TABLE 3

SUMMER PATCH FIELD STUDY

TREATMENT.	% DISEASED
Ringer "Turf Restore" + Bayleton (.5N/m, 2 oz. May)	1.00%
Sustane + Aqua Gro L (.5N/m, 8 oz/m)	1.00%
Biogroundskeeper + G.P. 27-2-3 (2 oz/m, .5N/m)	1.67%
Turf "Restore" + Rubigan (.5N/m, 2 oz. May)	1.67%
Rubigan + NPK 10-3-4 (2 oz. M, J, J & .5N/m)	2.33%
Biogroundskeeper + Rubigan (2 oz./m, 2 oz. May)	3.00%
Sustane (.5N/m)	3.33%
Biogroundskeeper + Bayleton (2 oz./m, 2 oz. May)	3.67%
Turf Restore (.5N/m)	4.00%
IBDU 18-3-24 (.5N/m)	5.00%
Biogroundskeeper (2 oz/m)	8.00%
Aqua Gro L (8 oz/m)	11.33%
CONTROL	**18.33%**
Urea (.5N/m)	20.00%

▲ These four tables of results compare use of a chemical fungicide and use of a variety of potential biocontrol materials with an untreated control plot.

Other potential products, especially from compost sources, are being evaluated for incorporation at turf sites, either by top dressing in mixtures with sand or by incorporation at the initial construction phase as an organic matter source. Work at Cornell by Dr. Nelson has demonstrated that when suppressive materials are incorporated into putting greens, by either of these means, they have shown significant control of Pythium Root Rot— a very difficult to control disease of the northern tier of states.

Dr. Nelson also has looked at aqueous extracts or teas of these same materials. The tea is produced by soaking a quantity of the suppressive material in water, draining the water off and filtering out larger organic particles. A spray is then produced by mixing the concentrated tea with a larger amount of water. The resulting spray mixtures have proven to be pathogen suppressive, but they usually are only half as effective as the solid material and on occasion is totally ineffective. These drawbacks have to be successfully addressed, before suppressive teas become viable alternatives to solid applications—or occasionally even chemical fungicides.

Nematode-based soil insecticides have come of age

RECENTLY, FOUR COMPANIES have released three nematode-based soil insecticides, "Exhibit" by Ciba-Geigy, "Biosafe" by Ortho and SDS Biotech, and "Vecter" by Biosys. These products target

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TABLE 4

NECROTIC RING SPOT FIELD STUDY

TREATMENTS	% DISEASED
Ringer "Lawn Restore" (1#N/m)	10%
IBDU 18-3-24 (1#N/m)	10%
Sustane (1#N/m)	11.7%
Sustane + Aqua Gro L (1#N/m, 8 oz./m)	13.3%
Urea (1#N/m)	23.3%
Aqua Gro L (8 oz./m)	41.7%
Biogroundskeeper (./m)	50.0%
CONTROL	**61.7%**

Source for Tables 3 and 4: Summer Patch and Necrotic Ring Spot field studies by Vargas, Melvin, Berndt, Detweiler, Golembiewski, Slater (Michigan State University, 1989).

What will biologicals do *continued from page 11*

caterpillars, billbugs, leatherjackets, mole crickets, and white grubs. The latest research data has shown that nematode-based insecticides offer efficacy of control that rivals traditional chemical controls. Several well-know turfgrass entomologists now endorse the concept of nematode based insecticides.

In 51 trials of three species of parasitic nematodes species versus two chemical controls for white grubs, the average percent control reached 73% +/- 8.7% for the nematodes versus 83% +/- 7.9% for the chemical controls.

In 24 trials of two parasitic nematodes versus two chemical controls for Tawny mole crickets, the average percent control for the nematodes was 63.4% +/- 13.9% and 70.8% +/- 8.3% for the chemical controls.

In 25 trials for Black cutworm control two parasitic nematodes averaged 86.1% control +/- 8.6% versus 99.1% +/- 5.3% for the single chemical control. And 14 trials for billbug control yielded 77.2% control +/- 7.6% for the average of two parasitic nematodes and 83.6% +/- 5.9% for the one chemical control.

The care and handling of nematode-based insecticides will require some changes in approach and timing. There are considerable differences in the storage, mixing, and use of these materials compared to chemical controls. Manufacturers recognize this potential barrier to the widespread use of these alternative pesticides, and are making a concerted effort to close that gap.

Microbial fungicides may be available within 10 years

MICROBIAL FUNGICIDES MAY OFFER an effective alternative to fungicides sometime in the near future. Microbial fungicides will be mixed and sprayed in a manner similar to existing chemical fungicides; they will offer efficacy that rivals existing fungicides with a duration of control that matches current controls. Depending on the biology of the selected antagonist, they may offer long-term control.

Research at Cornell has indicated that several antagonist microbes offer control of disease expression that rivals current chemical fungicides, when they are applied at the optimum time and in the best manner. In field trials for dollar spot, when rated thirty days after two successive applications, a bacterium, *Enterobacter cloacae*, showed disease control that was 60% and 59% as successful at controlling as a labeled fungicide. Applications of *Typhula phacorrhiza* provided 74% control of gray snow mold, caused by *Typhula incarnata* and *T. ishakariensis*. Also, isolates of binucleate *Rhizoctonia spp.* and *Laetisaria arvalis* produced up to 90% control of brown patch.

Once an individual or group of antagonist species have been identified as suppressive, checked for mechanism of action, tested for efficacy and duration of control, monitored for consistency of control under varying micro-environments and checked for cost and difficulty of production, they can be formulated into an appropriate delivery system and sent to the EPA for approval. As they become available these microbial fungicides may be packaged in several different ways. They could be

- AVAILABLE IN EITHER A FREEZE DRIED FORM (a technique that was successfully developed at the University of Idaho) or as granular organic materials colonized by the appropriate micro-organisms,
- AVAILABLE AS STARTER CULTURES that are mixed with water and require incubation for a period of time following a specific procedure,
- OVERNIGHT EXPRESS MAIL ready to be mixed by the user just before their scheduled application.

Most single species microbial fungicides, herbicides, and insecticides will be narrowly focused. With some exceptions, like *Enterobacter cloacae,* which has provided effective control of multiple pathogens, many microbial antagonists suppress only one or two closely related pathogens. Where possible, mixtures of antagonists may be able to broaden the spectrum of control, but that will only happen where the antagonists are compatible.

Concurrent applications of broad-spectrum chemical fungicides may not be compatible with the use of microbial fungicides, as they could inadvertently target the antagonist microbes as well as the target pathogens. Also, chemical fungicides might stimulate microbes that are antagonistic to the applied antagonists—rendering the microbial fungicides ineffective.

Transgenic turfgrasses may be closer than you think

TRANSGENIC PLANTS MAY HAVE specific genes (from antagonist microbes) spliced into their DNA, to endow them with the desired characteristic of the antagonist. Such plants are already in the testing stage. Several species of agricultural plants, including cotton, have had controlling genes from the BT bacteria spliced into their DNA. The plant then produces the BT's natural insecticides. New transgenic agricultural plants should be available in a few years.

In addition to being pathogen resistant, bio-engineered turfgrasses could include spliced genes from antagonist microbes and other sources that produce

- INCREASED INSECT RESISTANCE
- RESISTANCE TO WEED INFESTATIONS
- IMPROVED UTILIZATION OF NUTRIENTS AND WATER
- IMPROVED HEAT AND DROUGHT RESISTANCE
- REDUCED VERTICAL LEAF GROWTH
- INCREASED ROOTING and root mass regeneration
- INCREASED SEED PRODUCTION

- AND ANY NUMBER of additional desirable traits.

Transgenic plants have "the greatest chance at improving turfgrass management of all the biologically based solutions," according to Dr. Nelson. The sad news is that these benefits for the turfgrass industry are probably at least ten years away.

Up to now, the association of endophytic fungi and turfgrass species has meant increased resistance to some insects. These naturally selected endophyte infected plants live a symbiotic life style: the fungus receives the benefit of living between the cells of the plants, and the turfgrass gets the benefits of improved pest resistance that the waste products of the fungus provide.

There are hundreds of species of endophytic fungi, and probably dozens of varieties that can provide other benefits. Research at Rutgers University recently established a link between high endophyte levels in some varieties of fine fescues and considerable dollar spot resistance. Carefully selecting "wild" types that exhibit disease suppression from endophytic fungi is probably the quickest way to produce edophitically enhanced resistance to disease.

Dr. Lea Brillman, the plant breeder at Seed Research, Inc., in Corvalis, Oregon (a major producer of high endophyte turfgrass seed) says that Seed Research had only moderate success in isolating other promising endophyte strains from multiple sources and introducing them into commercially desirable turfgrasses with low endophyte levels. Because the company has had greater success by cross-breeding varieties with desirable high endophyte levels , Dr. Brillman says that, for now, they would concentrate on identifying desirable "wild types" for their sources of new endophytic species.

Bio-engineering has the potential to produce desirable traits that do not occur naturally in a single variety of turfgrass, but for now traditional hybridization is the road being followed.

Some biological controls are currently available for plant managers, but over the next twenty years a whole range of new products, supplies, and procedures will enable tomorrow's turfgrass manager to get pinpoint, long-term control of turf problems that are hard to control today. ■

REGULATORY WATCH

Massachusetts charters a different course on recertification

AS OF JANUARY 1, Massachusetts will substantially broaden the number and types of activities that qualify as pesticide recertification training, according to Mark Buffone of the Massachusetts Department of Food and Agriculture Pesticide Bureau.

To reduce the paperwork burden of approval required under its current system and to provide a set of guidelines that event producers can follow, Massachusetts will replace the existing system of credits assigned to a course with a new concept of contact hours—50 minutes of continuous exposure to educationally designed lectures, short courses, study courses, correspondence school, degree and non degree academic courses in the biological sciences, or self study materials.

The concept is designed to give the producers of materials and events with a guideline for evaluating the content of their productions and assigning it a value. The participant at an event will be given a certificate to keep and turn into the Bureau. The certificate would be good unless otherwise notified. The Bureau will randomly audit the productions, and provide their producers with comments on its appropriateness.

Mr. Buffone also noted that the first criteria that will be used when evaluating a program is how the material relates to pesticide use. The primary charge of his department is to regulate the use of pesticides. Programs or materials about alternate management strategies and biocontrols will be considered appropriate if the information presented is related to the use and regulation of pesticides.

Other regulatory changes effective this January also include:

- AN EXPANSION OF THE NUMBER of individuals required to be licensed or certified to include all public and private employees who use pesticides as part of their duties.
- ALL APPLICATOR AND CERTIFICATION EXAMS will be closed book exams.
- WITH THE EXCEPTION of dealer certification exams, all certification tests will be of two parts, a core exam and a specialty exam.
- CERTIFICATION CANDIDATES must have a minimum of two years related work experience.
- CERTIFICATION CANDIDATES must be at least 18 years old.
- A CANDIDATE WHO FAILS an exam may apply at the next available test date. After two failures, a candidate must wait three months before another re-examination.
- PESTICIDE DEALERS MUST GET THE SIGNATURE of an agent of a certified applicator and the signature of the certified applicator when that agent seeks to purchase restricted use pesticides for the certified applicator. ■

TGT's view: *The expansion of the number of people that require some sort of training to handle or apply pesticides to include anyone who has to use pesticides on the job is the logical extension of this sort of regulation. The expansion of the number and types of recertification avenues is a excellent idea, and is long overdue. This greatly increases the turfgrass managers flexibility in dealing with his and his employees certification requirements.–CS*