1st Emerald® fungicide is the first innovation in fungicide chemistry for dollar spot control in years — a true resistance-management tool.

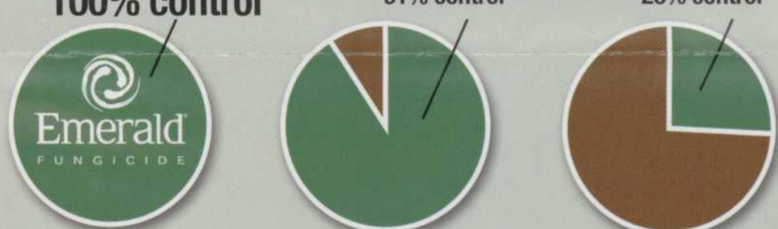
- Excellent in a resistance management program for difficult to control dollar spot when used either in rotation or a tank mix.
- **Emerald** inhibits a system called complex II in the mitochondria of fungal cells.
- **Emerald** deprives the fungal cells of energy, disrupting fungal growth and development, and halting disease development.
- Both the mode and site of action of **Emerald** differ from any other fungicides used to control dollar spot.
- **Emerald** can effectively control pathogens that have developed resistance to other fungicides.

AS LOW AS $166^{00}*

100% In numerous university trials on creeping bentgrass, Emerald achieved 100% control of dollar spot. Others didn't.

Control of Dollar Spot in Creeping Bentgrass in Michigan, 2002

100% control | 91% control | 26% control



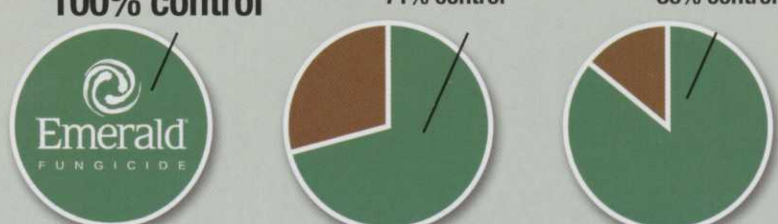
Emerald® fungicide 70wg (0.13 oz/14 day/1,000 sq ft) (0.18 oz/21 day/1,000 sq ft) (4.0 oz/14 day/1,000 sq ft)

Daconil Ultrex® 82.5wg (3.2 oz/14 day/1,000 sq ft)

Cleary's 3336™ 50wp (4.0 oz/14 day/1,000 sq ft)

Control of Dollar Spot in Creeping Bentgrass in Wisconsin, 2001

100% control | 71% control | 86% control



Emerald® fungicide 70wg (0.13 oz/14 day/1,000 sq ft) (0.18 oz/28 day/1,000 sq ft)

Daconil Ultrex® 82.5wg (3.2 oz/14 day/1,000 sq ft)

Banner MAXX® 1.2mc (1.5 oz/28 day/1,000 sq ft)

Cooperator: J. Gregos, University of Wisconsin

Research shows that Emerald provides excellent dollar spot control in every region of the country and in these 14 major turf species:

- Creeping Bentgrass
- Colonial Bentgrass
- Perennial Ryegrass
- Annual Ryegrass
- Kentucky Bluegrass
- Common Bermudagrass
- Hybrid Bermudagrass
- Annual Bluegrass
- St. Augustinegrass
- Tall Fescue
- Bahiagrass
- Zoysiagrass
- Centipedegrass
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- Aids in control of eight other diseases including brown patch, leaf spot, red thread and melting out.
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- **Iprodione Pro 2SE fungicide** prevents and cures key turfgrass diseases, including brown patch and dollar spot, in cool- and warm-season grasses.
- Provides cost-effective control with long residual.

Propiconazole Pro Fungicide

- **Propiconazole Pro fungicide** controls nearly 20 key diseases in turfgrass, including dollar spot, brown patch, anthracnose, take-all patch, leaf spot, and pink and gray snow molds.
- Excellent, system, broad-spectrum control.

Always read and follow label directions.

Some products not registered for use in all states.

Biopesticides Bazaar

If you're looking for alternatives to vary your pest control options, here are some good places to start

On the Environment

It's always good to have a variety of weapons in your pest control arsenal. Keeping the storage facility stocked with a number of options allows superintendent the flexibility to meet different challenges as they appear each year.

One alternative that more superintendents are adding to the mix are biological pesticides, particularly in the face of increased scrutiny by governments who want to limit the cosmetic use of pesticides (a quick shout-out here to Montreal, Quebec, and Madison, Wis., just to name two of the latest examples). Researchers are looking more closely at the possibilities of biological control (see Sarah Thompson and Rick Brandenburg's article, "Scientists Pursue Biological Control for Turfgrass Pests Despite Challenges," in TurfGrass Trends on page 55), and more companies are realizing the possibilities of the products. Here is a list of some of the biopesticide products available from which you can choose.

Microbial fungicide

EcoGuard, a Novozymes Biologicals product, is a microbial biofungicide that the company says controls dollar spot as well as chemical fungicides when used in a rotation with them. EcoGuard is a concentrated suspension of the bacterial spores of the organism *Bacillus licheniformis SB3086*, which has been demonstrated to be a natural inhibitor of dollar spot and other pathogens.

Improved disease resistance

BioSafe Systems offers superintendents OxyGROW, a biological inoculant that combines oxygen, calcium and beneficial mycorrihizae to help establish healthy root systems. The product provides a slow-release oxygen, giving the root system an environment for establishing beneficial organisms. The calcium component helps the turf develop cell membranes that are more resistant to disease pathogens, according to the company.

Soil amendment

RUTOPIA is a soil amendment from Poulenger USA that the company says helps protect turf from soil-borne pathogenic fungi. The amendment contains six species of trichoderma, which the company says surrounds the root system and produces antibiotics, destroying the spores of pathogenic fungi and preventing diseases such as recurring fairy ring. The product also contains four strains of *bacillus thuringiensis* (Bt), which have an impact on plant-damaging nematodes and grubs, according to Poulenger.

Biological insecticide

Certis USA offers Deliver, a biological insecticide designed to control caterpillar pests on trees, ornamentals and turf with low risk to humans, wildlife and nontarget insect species. Deliver is a Bt biopesticide that provides excellent coverage and is easy to use, according to the company. Certis says it controls a broad spectrum of worm pests, including leaf rollers, cutworms, budworms and sod webworms. It's EPA-registered.

Worm control

Worms can be a big problem in golf course turf, flower beds and ornamental trees, but DiPel Pro DF from Valent works to control them, according to the company. DiPel provides control of worms, including loopers, tobacco budworms and armyworms. Its dry, flowable formulation is dust-free and allows convenient handling and measuring. DiPel Pro DF is also biodegradable and will not harm beneficial insects, the company says.

All-natural insecticide

St. Gabriel's Laboratories provides its SharpShooter insecticide, a product that kills common insects such as ants, flies, roaches and mites. The new formula now includes peppermint, clove oil and other environmentally friendly ingredients. SharpShooter is available in convenient 24-ounce and gallon ready-to-use sizes. For larger jobs, the quart or gallon-size concentrate will tackle the job quickly in a hose-end sprayer.

Mole cricket control

Mole crickets can cause devastating damage to turf. Becker Underwood says Nematac S, a strain of the insect pathogenic nematode *Steinernema scapterisci* that's a biological predator of the insects, quickly attacks and destroys mole cricket adults (and late instars) before they destroy turf.

Nematac S is easy to apply and safe to use. It poses no threat to people, turf or beneficial insects, according to the company. ■

Most Architects Don't Bite, Really

BY GEOFF SHACKELFORD

On a recent visit with a green chairman who commands a very nice club course, the following nightmarish discussion took place. You see, the green chairman isn't too enthusiastic about bringing in an architect to sort out opinions and help create a long-range plan for the course.

"Why is that?" I inquired.

"They add another layer of bureaucracy," he said, grumbling utter disdain for the men in plaid.

The confidence in his own view was so strong, I thought he might have been joking. Deciding it would be rude to pull out my trusty notebook that comes along just for conversations like this one, the fading memory of the conversation will have to do.

"So you want to do a master plan without an architect?" I asked with a chuckle.

He didn't laugh. Yep, he was serious. Keep in mind that he's also your basic overempowered, self-involved baby-boomer with a few bucks in the bank, which makes him think he's entitled to wisdom on all subjects.

"Well, I guess the good thing is an architect would do what I tell him to do," this member of the Lamest Generation said. "I can pencil out sketches, and he can do the presentations for the committee."

While you're at it, you can attach little strings to his hands, sit behind a curtain and call yourself the Wizard of Oz.

The conversation reminded me of an old Samuel Johnson adage that says advice is seldom welcome. And "those who need it most, like it least."

A disturbing number of courses, both famous and infamous, are going it alone these days with very mixed results. It was one thing if they did this in the 1950s and '60s when there were fewer architects and an overall lack of golf course design awareness. But times have changed and there are plenty of architects from whom to choose.

My advice is to find one. They can come in handy.

Sometimes — believe it or not — the green chairman doesn't know what he doesn't know.

YOU DON'T HAVE TO USE ALL OF THE ARCHITECT'S IDEAS, AND YOU CAN QUESTION HIM ALL YOU WANT

Sometimes, the superintendent or his boss thinks he's Robert Trent Jones reincarnated.

Sometimes, architects *can* show managers how to make improvements that will save money over time.

You pay an architect to take the heat, answer questions and weed through ideas thrown his way. You hire an architect to come up with the best and most economically viable solution for the majority of golfers. You ask an architect to take his experience studying courses and to offer ideas that will improve your course strategically, aesthetically and economically. You pay an architect to ask him about trees that should be taken out, or the pluses and minuses of adding length.

You don't have to use all of the architect's ideas, and you can question him all you want.

Yes, there certainly have been plenty of bad and overpriced architectural redesigns that can be pinned on the architect and nobody else. It's true that a few architects think they're big golden labs and your golf courses are nothing but fire hydrants where they're supposed to leave their marks.

Most often, though, no one was asking questions or telling architects what they wanted in those cases.

With all of the pain-free opportunities for green committees, managers, pros and superintendents to read up on the basics of design, they can ask intelligent questions. Knowledge-based debate and discussion always leads to better remodels and better master plans.

But to get there, you've got to add that most important layer of bureaucracy.

Seriously, hire an architect. They don't bite. Not all of them anyway.

Geoff Shackelford can be reached at geoffshackelford@aol.com

TURFGRASS TRENDS

BIOLOGICAL PESTICIDES

Scientists Pursue Biological Control for Turfgrass Pests

By Sarah R. Thompson and Rick L. Brandenburg

No one will deny the pressures often placed on turfgrass managers to achieve perfection. Placing a dollar figure on the aesthetic quality of turfgrasses is difficult, and damage thresholds are usually low. As a result, many turfgrass managers rely on conventional pesticides. These pesticides, although effective, are often costly and require caution during application because of their chemical nature. By definition, pesticides are meant to kill the targeted pest. Unfortunately, some insecticides have the potential to cause deleterious effects to nontarget arthropods, wildlife or even humans.

Recently, the public has become more vocal over the potential risks involved with pesticide use and called for change. In Canada, for example, numerous cities will soon decide if pesticides should be banned when applied solely for cosmetic purposes. Isolated communities in the United States have followed suit.

Never before have turfgrass managers been asked to reduce or eliminate their pesticide choices more than now.

Those who support these bans feel chemicals should only be applied when human or animal health is at risk. Overall, societal concerns have increased because of greater awareness of pesticide use, combined with increased media coverage of the occasional problems.

Turfgrass managers are also plagued by the restricted use and loss of many of the older classes of chemicals. These products often provided broad-spectrum control quickly for little expense. The broad-spectrum nature of these chemicals posed problems for off-target organisms, and some of them contaminated groundwater sources. The newer products are typically more expensive (due to the long and rigorous research-and-development processes), may not have as long of a residual period and have a much narrower control spectrum.

Never before have turfgrass managers been asked to reduce or eliminate their pesticide choices more than now. As a result, all of the above factors support the need for research on biological control, which means using living organisms for pest management.

A number of biological control agents are available for insect management in turfgrass, including bacteria, fungi, nematodes and others. Historically, many of these agents showed promise under controlled laboratory conditions, but have failed to deliver in the field.

At North Carolina State University, we feel our resources are well spent exploring the factors that contribute to the lack of success of biological control agents in turfgrass. By determining why some biological control agents have not been successful in the field, we hope the limitations can be overcome. One area of recent research has focused on the evaluation of an entomopathogenic fungus, *Beauveria bassiana*, for mole cricket control.

Mole crickets are extremely damaging pests of turfgrasses in the southeastern United

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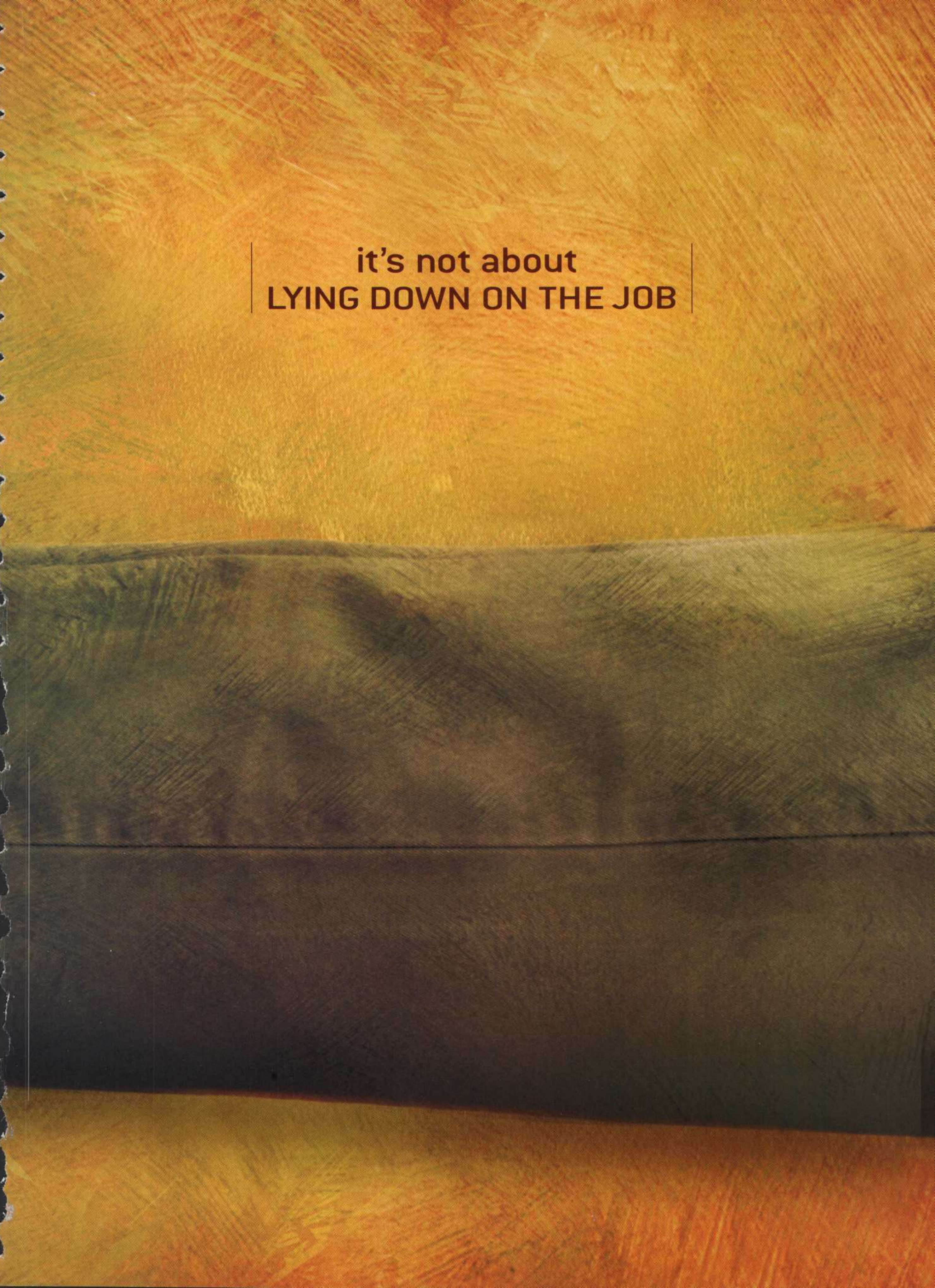
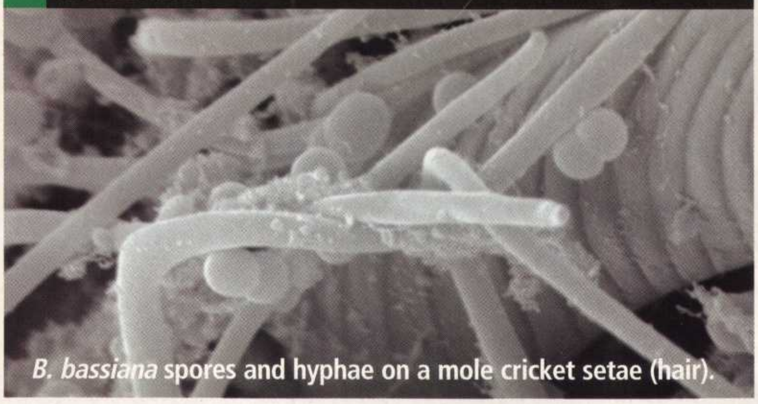

it's not about
LYING DOWN ON THE JOB

FIGURE 1



B. bassiana spores and hyphae on a mole cricket setae (hair).

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States. There are two major species of concern, introduced from South America around the turn of the 20th century (Walker and Nickle, 1981). Damage is caused when the crickets feed on the roots of turfgrass and produce surface tunnels. The root feeding can lead to total plant loss and eventual weed invasion. The production of surface tunnels and large megaphone-shaped calling chambers (in the spring) are unsightly, but also lead to desiccation and plant stress.

Most superintendents and sod farmers in the Southeast will agree that mole crickets are their No. 1 insect pest. We feel they make a great model insect for our studies because they are so large, mobile and damaging.

A number of studies conducted since 2001 explore the factors that may contribute to the disappointing results seen with entomopathogenic fungi in the field. *Beauveria bassiana* kills insects when the spores attach to the insect cuticle (Figure 1), penetrate into the body cavity and proliferate within the pest's body. Mortality results from toxemia from fungal metabolites or when the insect becomes depleted of nutrients (Jaronski and Goettel, 1997). Eventually, the fungus exits the cadaver and produces additional spores, capable of infecting other nearby crickets (Figure 2). Based on this mode of action, the spores need to come into contact with the pest for infection to occur.

There are a number of factors that may interfere with this necessary contact, including the efficacy of different strains towards the pest of interest, whether or not the spores can remain viable under harsh environmental conditions and any avoidance behaviors that may be exhibited by the pest. We examined these three factors in laboratory, field and greenhouse studies during 2001, 2002 and 2003.

Efficacy studies

Adult mole crickets were exposed to three different strains of *B. bassiana* in a topical bioassay. Each strain was originally isolated from a different host (darkling beetle, corn borer and grasshopper). This is important point because of the common belief that the most efficacious strain for a particular pest will be one isolated from that insect or another closely related species (Xu, 1988).

In our case, the grasshopper strain was isolated from its most closely related species, since mole crickets and grasshoppers are in the order *Orthoptera*.

Adult mole crickets were exposed to four different rates of each strain by coating them with a liquid/spore suspension. After treatment, the crickets were placed individually into separate containers and were examined daily for mortality. Cadavers were incubated at an optimal temperature for fungal growth and observed (Figure 2). Results from these studies support the theory concerning efficacy of original host strains since the grasshopper strain killed the most crickets in the shortest amount of time.

Current studies are examining the effects of pretreating mole crickets with sublethal doses of conventional and organic insecticides to test for synergies. Specifically, the crickets are being pretreated with imidacloprid and diatomaceous earth since literature suggests synergies between *B. bassiana* and these agents. Additionally, all strains currently being tested are isolated from *Orthoptera* and one specifically from a tawny mole cricket.

Spore viability studies

Another factor that determines the success of entomopathogenic fungi is the ability of the spores to remain viable in the field until contact occurs. Traditionally, viability studies have been conducted by plating spores on a growth agar, incubating the petri dishes for 24 hours or less and examining the spores under a microscope to determine the percentage germination (Schading et al, 1995).

In our studies, we used a different type of evaluation technique, since germination is not necessarily a measure of spore viability. During the summers of 2002 and 2003 at two different coastal North Carolina sites, we applied the spores in an emulsifiable oil formulation to the surface of bermudagrass plots. Post-application irrigation was applied to wash the spores into the thatch and soil.

At various dates after treatment (one, two,

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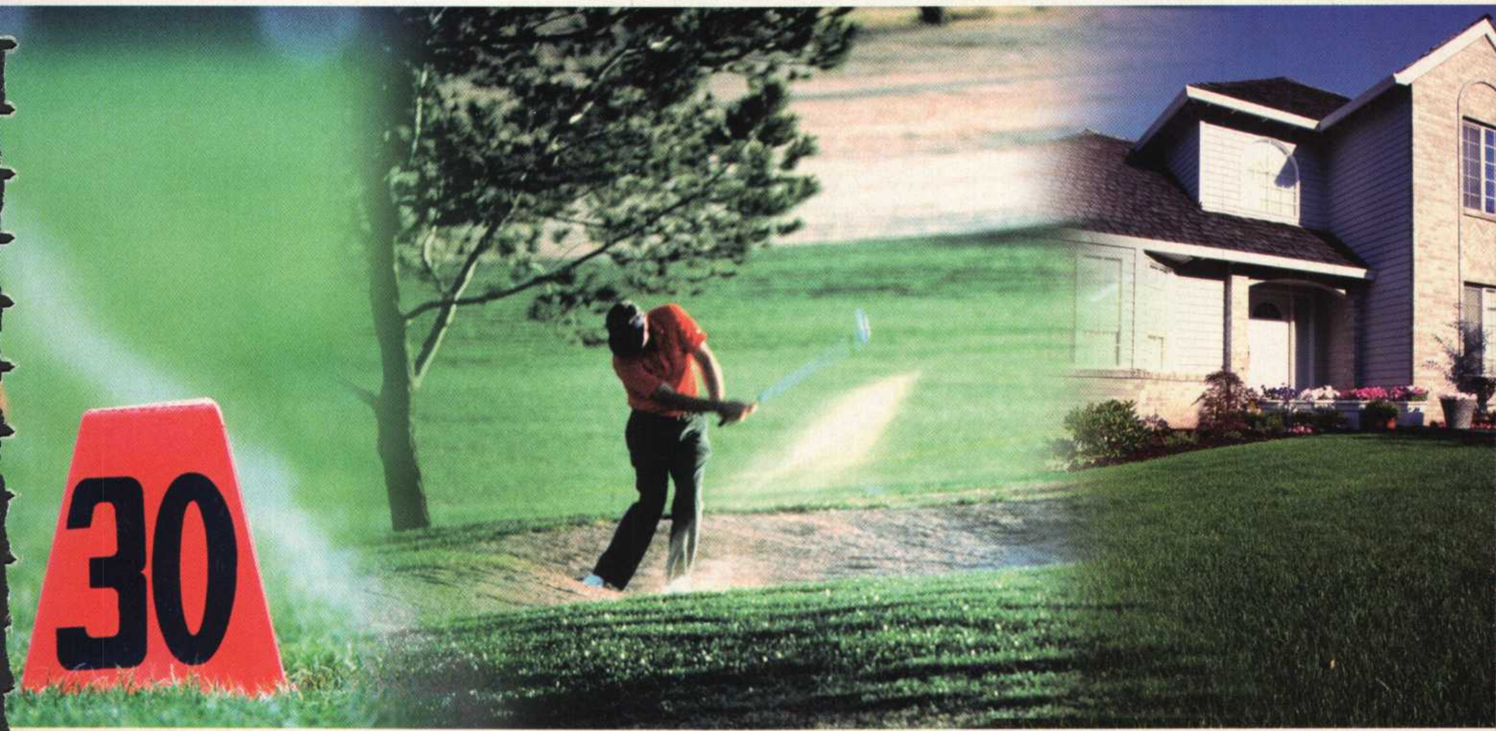
The Choice is Yours.



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three, 14, 21 and 28 days), cup-cutter samples were taken, and we washed the spores from the sod samples. We exposed the spore suspension to a nucleic acid stain, which labels cells green or red (for viable and nonviable, respectively) when illuminated by fluorescent light (Schading et al 1995).

Data show there are significant differences between each strain in their ability to remain viable in the environment. Overall, spores from all three strains were able to persist and remain viable (although at a small percentage) for up to a month after treatment (Figures 3 and 4). There were no significant differences between the darkling beetle (DB-2) and corn borer (10-22) strains, but a greater percentage of spores from both remained at various dates after treatment compared to the grasshopper strain (BotaniGard). These studies give hope for the use of *B. bassiana* as a biological control agent in turfgrass since the spores are able to maintain viability over time. Most likely, practical usage of *B. bassiana* in the field would still require multiple treatments.

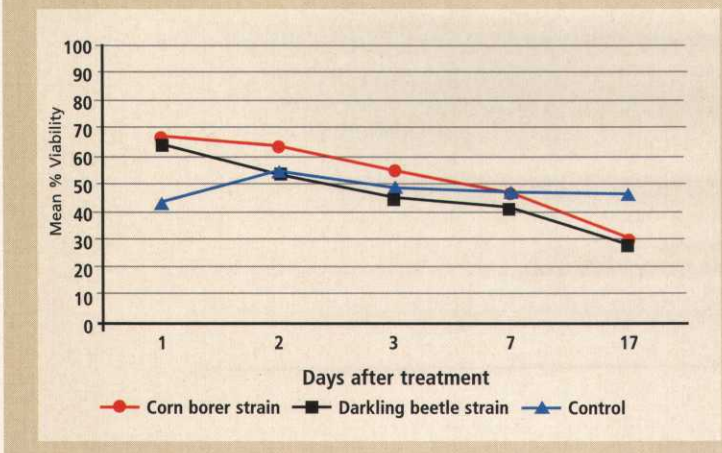
The objective of future research is to determine the most important environmental condition contributing to spore mortality. Studies will take place in the summers of 2004 and 2005, looking specifically at the effects of irrigation (available water) and ultraviolet (UV) degradation on spore viability. If this information is known, suggestions can be made on the best time for application, proper irrigation schedules and formulation choice for field treatments.

FIGURE 2

Mole cricket sporulating with *Beauveria bassiana.*

FIGURE 3

Mean percentage spore viability in 2002 field study (Sea Trails Plantation in Sunset Beach, N.C.) 1, 2, 3, 7 and 17 days after treatment.



Behavioral tests

For the critical contact to occur, the target pest needs to be incapable of detecting and avoiding the fungal spores.

We are all familiar with cases of repellency that exist between pests and chemical insecticides, but whether these same avoidance behaviors occur with biological control agents is something that we wished to explore. Previous work at Cornell University (Villani et al., 2002) has suggested that mole crickets are capable of detecting and avoiding contact with fungal spores of *B. bassiana* and *Metarhizium anisopliae* (another entomopathogenic fungus). Research was conducted in the fall and winter of 2001, 2002 and 2003 to quantify and classify these avoidance behaviors. Additionally, we wanted to determine if repellency existed for all strains of *B. bassiana* or if avoidance was a strain-specific occurrence.

Individual mole crickets were placed into large plastic containers filled with moist sand. On the sand surface, *B. bassiana* spores were sprayed and not watered in to create a spore layer. On top of this treated layer, an additional 2 inches of soil was added and smoothed flat. Bermudagrass sod pieces were added to the top of the new sand layer to serve as a food source (Figure 5). This setup encouraged the mole crickets to tunnel through the spore layer to reach the sod food source.

Various behaviors were measured after 24 hours to determine if the mole crickets were attempting to avoid contact with the fungus. By removing the sod, observations were made on the presence of 24-hour surface tunneling (confirming passage through the spore layer), the type of tunnels that were produced (horizontal vs. vertical

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