Bio-Trek 22G—

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eratures between 70°F and 90°F.

The first commercial *T. harzanium* products were available for sale in 1995. These were granular formulations designed for broadcast application. Efforts to evaluate these products in our lab were primarily concerned with assessing the level of establishment of the fungus on roots. Roots from sites around the USA indicated that establishment did occur.

There were some problems, however. First, the product was formulated for multiple uses and was quite dusty. This made broadcast application difficult. Second, while the product was quite effective for many applications, we found that transfer of the fungus from the granule to the roots was not as effective with broadcast application as it was when the granules were directly incorporated into soil. As a consequence, even though the fungus did become established, in some cases its population level remained at suboptimal levels.

Therefore, in 1996, TGT Inc. will formulate Bio-Trek 22G specifically for broadcast application to turf, and its properties will be different from the general use material. The turf product will have a larger particle size to facilitate broadcast application, the dust level will be substantially reduced and its concentration of *T. harzanium* will be higher to enhance root and soil colonization. We expect that this product will be effective for its intended uses.

The Development of Future Technologies

Bio-Trek 22G is highly useful but, as noted above, it has limitations. Most notably, since the product is applied to the soil and the fungus is located in the root-soil zone, it cannot protect against foliar pathogens. With this factor in mind, we have begun testing a spray formulation that consists primarily of conidia (spores of the fungus). The first trials, conducted in 1994, were successful. Levels of control were equivalent to standard chemical fungicides for brown patch, dollar spot, and Pythium root rot and blight (**Fig. 4**) when a surfacant (Triton X-100) was included in the spray mixture.

When disease pressure was light, a monthly spray schedule sufficed, but applications had to be increased to once a week when disease was more severe. As a bonus, this spray application resulted in root colonization that was nearly as effective as the granular product. These results give promise of a largely biological turf management option, but problems remain.

Difficulties were evident when we attempted to apply the 1994 findings to commercial golf course trials in 1995. Little or no efficacy was obtained; this problem appears at least in part to be related to toxic fungicide residues in the spray tank. As the biocontrol agent was suspended in tanks that have been used repeatedly to apply fungicides, some factor, probably low levels of residual pesticides, prevented spores of the fungus from germinating.

Other problems also remain. Technologies for large-scale manufacture of sprayable biological formulations at a reasonable cost are not full developed, and so only prototype preparations are available now. Further, *T. harzanium* is useful only as a preventative application and cannot cure existing disease. Of course, like all materials available to golf course managers, this fungus will not be effective against all diseases. These last two factors indicate a need for the development of integrated biological-chemical control systems that reduce the need for chemical fungicides.

Research efforts at Cornell University will focus on the development of spray formulations for commercial golf

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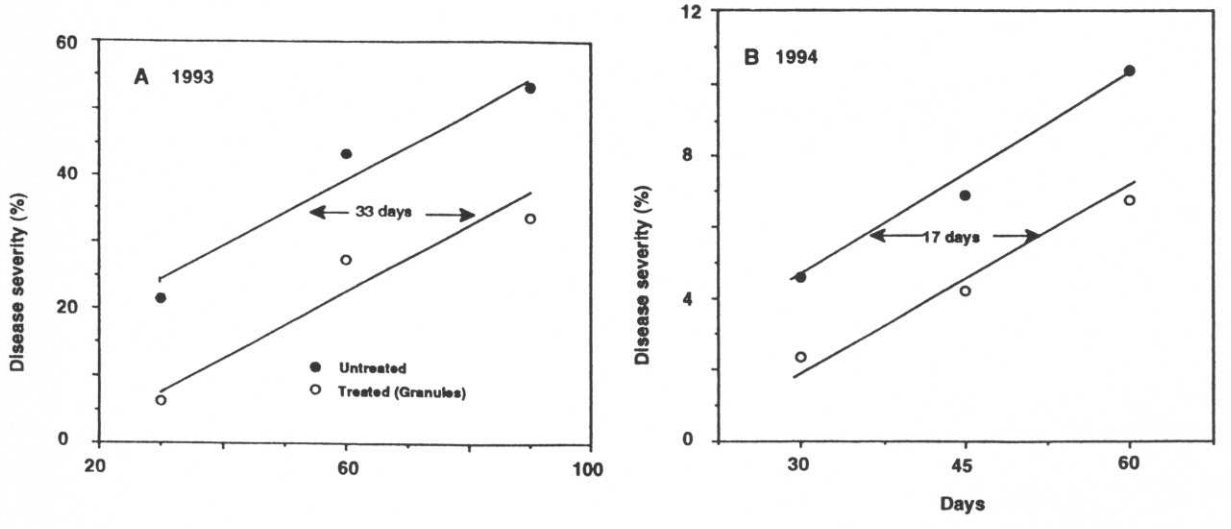

Fig. 2. Disease progress of dollar spot in replicated trials in 1993 and 1994 in the presence and absence of Bio-Trek 22G. Lines were fitted using the general models program (SAS, Cary, NC). Disease severity is defined as the percentage of total plot area with diseased turf. The differences between treatments and time required to reach specific disease levels were significantly different. These data are used with permission of the American Phytopathological Society, and are from Lo, C-T, Nelson, E. B., and Harman, G. E. 1996. Control of turfgrass diseases with a rhizosphere competent strain of *Trichoderma harzianum*. Plant Dis. (accepted for publication with revision).

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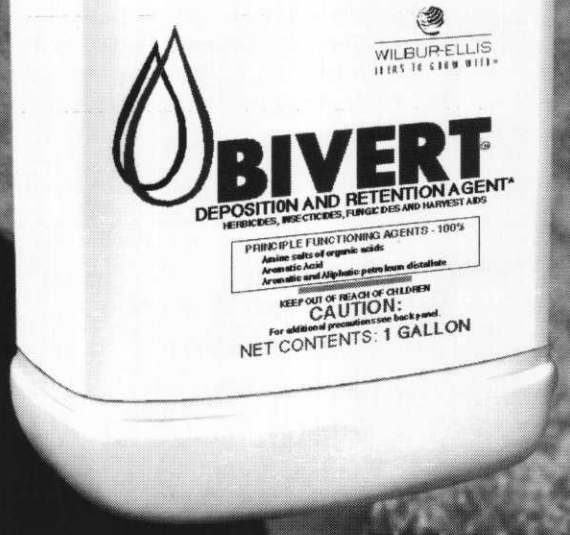

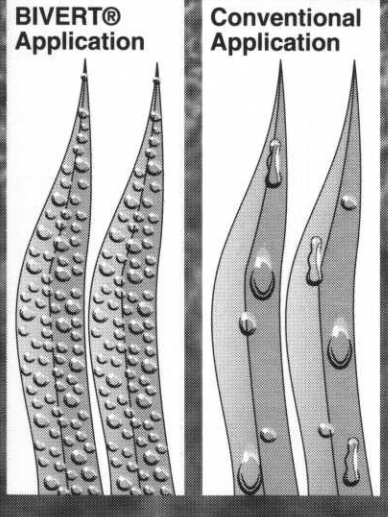

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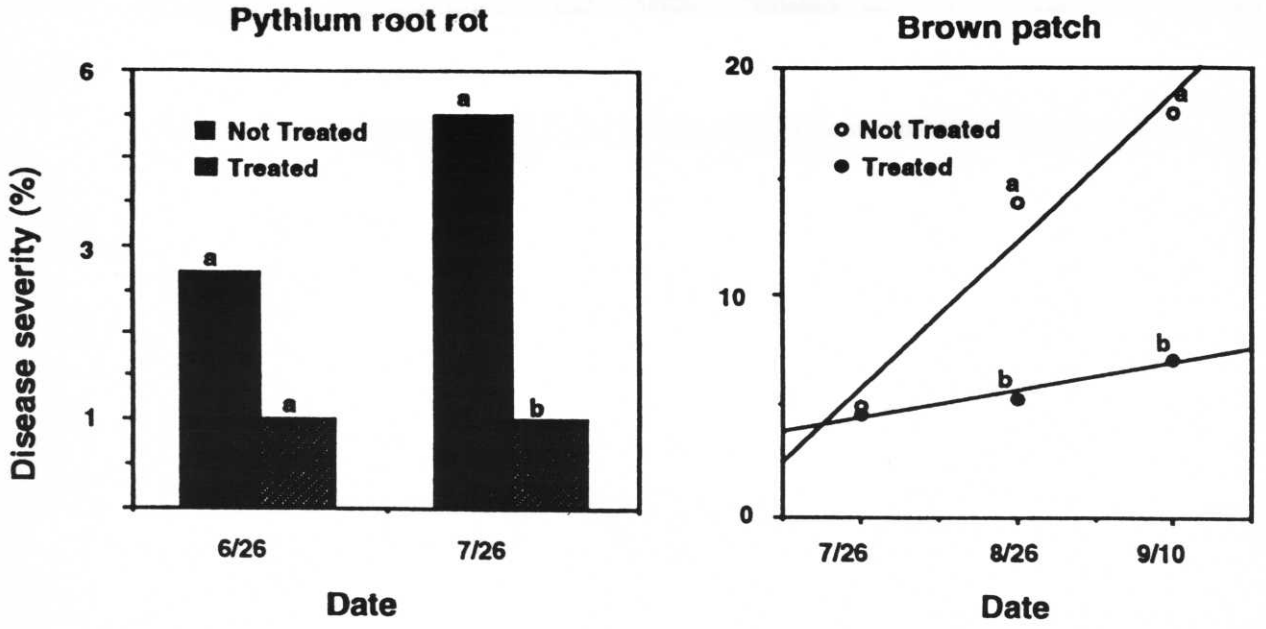

Fig. 3. Incidence of Pythium root rot and brown patch in replicated plots on a creeping bentgrass green after no treatment and treatment with Bio-Trek 22G. Disease severity is defined as the percentage of total plot area with diseased turf. Numbers followed by dissimilar letters are significantly different for the date shown. Data is from Lo, C-T, Nelson, E. B., and Harman, G. E. 1996. Improving the biocontrol efficacy of *Trichoderma harzianum* 1295-22 for controlling foliar phases of turf diseases by spray applications. Plant Dis. (in preparation).

Table 1. Fungicides compatible or incompatible with Bio-Trek 22G

Compatible fungicides	Incompatible fungicides
Chloroneb(e.g. Chloroneb, Terreneb)	Benomyl (e.g. Tersan 1991)
Etridiazole(e.g. Koban, Terrazole)	Propiconazole (Banner)
Iprodione (e.g. Chipco 26019)	
Mancozeb (e.g. Fore)	Questionable, or no data
Metalaxyl (e.g. Subdue)	Anilazene (e.g. Dryene)
Quitozene(e.g. PCNB, Terrachlor)	Chlorothalonil (e.g. Daconil 2787)
Triadimefon (e.g. Bayleton)	Fenarimol (e.g. Rubigan, Lesco Twosome)
Vinclozolin (e.g. Vorlan, Touche, Curalan)	Thiram (e.g. Spotrete)
Fosetyl Al (e.g. (Aliette)	Thiophanate methyl (e.g. Clearys 3336,Fungo)

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courses. We will determine which chemicals cannot be used in sprayers employed for *T. harzanium* application, and attempt to devise methods for removal of the most important toxic materials. We anticipate that only a few of the incompatible materials in **Table 1** will cause most of the problems. At least, we should be able to make recommendations regarding fungicides to be avoided.

We will also test prototype commercial products and develop full dosage information for them. And we will determine spray adjuvants, primarily spreader/sticker materials, that provide the best results with *T. harzanium*.

With this information, we will develop recommendations for using *T. harzanium* that will be tested on golf courses and other commercial sites. In addition, we will investigate develoment of integrated sprays that combine reduced rates of a compatible fungicide with the beneficial fungus. An integrated biological-chemical system may lessen fungicidal use, provide some of the curative ability of fungicides, result in root colonization of *T. harzanium*, establish diverse microbial soil populations that promote

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The facts are here in black and white. Not to mention classic orange and tournament green.

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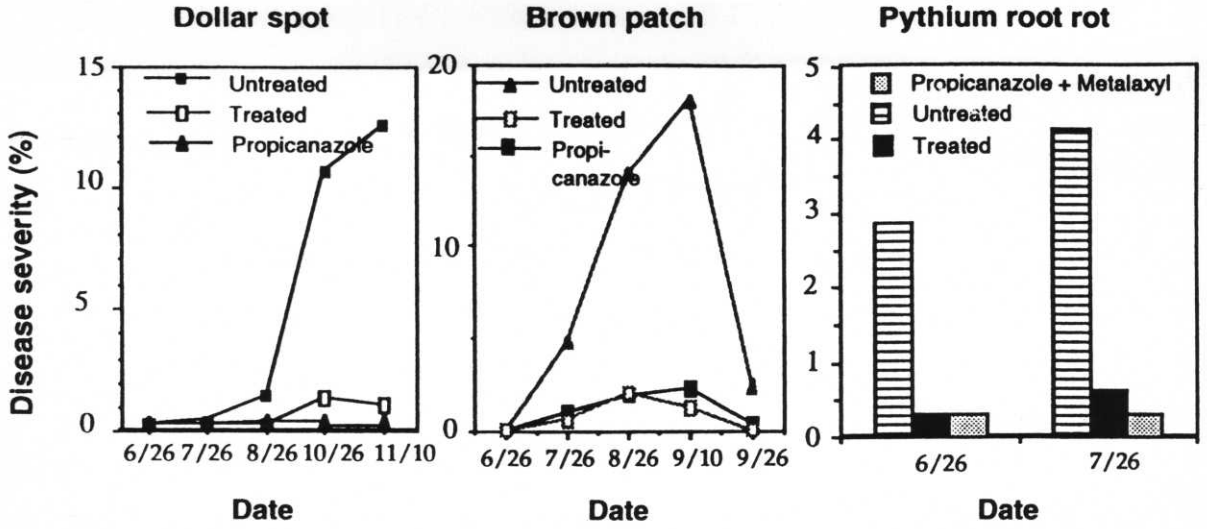

Fig. 4. Severity of dollar spot, brown patch, or Pythium root rot in replicated plots on a creeping bentgrass green after no treatment, treatment with a standard fungicide, or treatment with sprays containing spores of *T. harzianum* and Triton X-100. Disease severity is defined as the percentage of total plot area with diseased turf. *T. harzianum* treatments were applied monthly until July 26, and thereafter weekly. In all cases, the disease severity in nontreated plots was significantly different from treated plots, but fungicide and *T. harzianum* treatments were not significantly different. Data is from Lo, C-T, Nelson, E. B., and Harman, G. E. 1996. Improving the biocontrol efficacy of *Trichoderma harzianum* 1295-22 for controlling foliar phases of turf diseases by spray applications. Plant Dis. (in preparation).

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plant health, and be competitively priced. We hope to begin research scale trials of both full biological and biolgocial-chemical control systems this summer.

In Summary

The first registered biological control product, Bio-Trek 22G, for the control of turf diseases is now available. This product contains a strain of the beneficial soil fungus, *Trichoderma harzanium*, and is designed for broadcast application to turf. The fungus becomes established on the roots and in the soil of turf and persists for months after application. Once establishement occurs, it can become a component of a healthy soil microbial community and reduce soilborne disease. It cannot control foliar diseases, however, and therefore must be used in conjunction with compatible fungicides. We anticipate that Bio-Trek 22G will be the first of several biological products for turf disease control. Other biological and integrated biological chemical control products products will be manufactured by TGT that will extend the usefulness of Bio-Trek 22G.

***Gary E. Harman** is a Professor in the Departments of Horticultural Sciences and Plant Pathology at Cornell University's New York State Agricultural Experiment Station, Geneve, N.Y. He has a B.S. from Colorado State University and a Ph.D. from Oregon State University. Dr. Harman has devoted much of his career to the development of biological alternatives to chemical pesticides for a variety of applications, including perennial, row and greenhouse crops, as well as turf. He has focused recently on identifying gene products that may be useful in agriculture, and developing biocontrol systems based on beneficial fungi.*

***Chair-Tsuen Lo** is an Associate Plant Pathologist in the Department of Pathology at the Taiwan Agricultural Resarch Institute, Taichung, Taiwan, Republic of China. His major responsibilities are in biocontrol of plant diseases. He is currently completing his Ph.D. degree at Cornell University under the direction of Dr. Harman and Dr. Eric Nelson in the area of the biological control of turf diseases.*

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Milorganite Announces Turfgrass Research Donation Program

Golf course superintendents can help suppport turfgrass research when they buy natural organic Milorganite fertilizer this fall, says Larry Lennert, Manager of Research and Product Development. For each ton of Milorganite purchased and delivered between August 1 and November 30, 1996, Milorganite will donate $10 to the superintendent's favorite turfgrass research organization.

"Milorganite and its distributors have long supported turfgrass research at the national level through the O.J. Noer Research Foundation," said Lennert. "This program enables Milorganite customers to support turfgrass research at the local level."

This is the second year that Milorganite has sponsored its Turfgrass Research Donation Program. Last year, Milorganite donated more than $17,000 to turfgrass research organizations across the U.S. and Canada.

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Earthgreen granular Menefee Humate™ contains more than 35% organic matter, a guaranteed minimum of 35% humic acid, and freshwater diatomaceous earth in a rich environment. This is the only humate on the market with a minimum 35/35/35 percent guarantee of consistent quality.

Some or all of these benefits may be observed depending on the soil, species of plant or grass used, and management program. Variations may be expected from different locations as soil structure, soil fertility, and rate of Menefee Humate™ applied is varied. Care must be taken not to water or fertilize excessively.

Although Earthgreen Granular Menefee Humate™ may markedly improve poor soils when used alone, optimum results will realized when it is used in combination with fertilizer and organic materials such as composts, manures, grass clippings, etc. Like all organic soil additives, humates work best when minimum daily soil temperatures reach 55° F. Used properly, Earthgreen Granular Menefee Humate™ will not burn plant material, is non-toxic and non-staining.

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