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 **KALO**

Bio-Trek 22G—

(Continued from Page 20)

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 fac-

tor 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 surfactant (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 fully 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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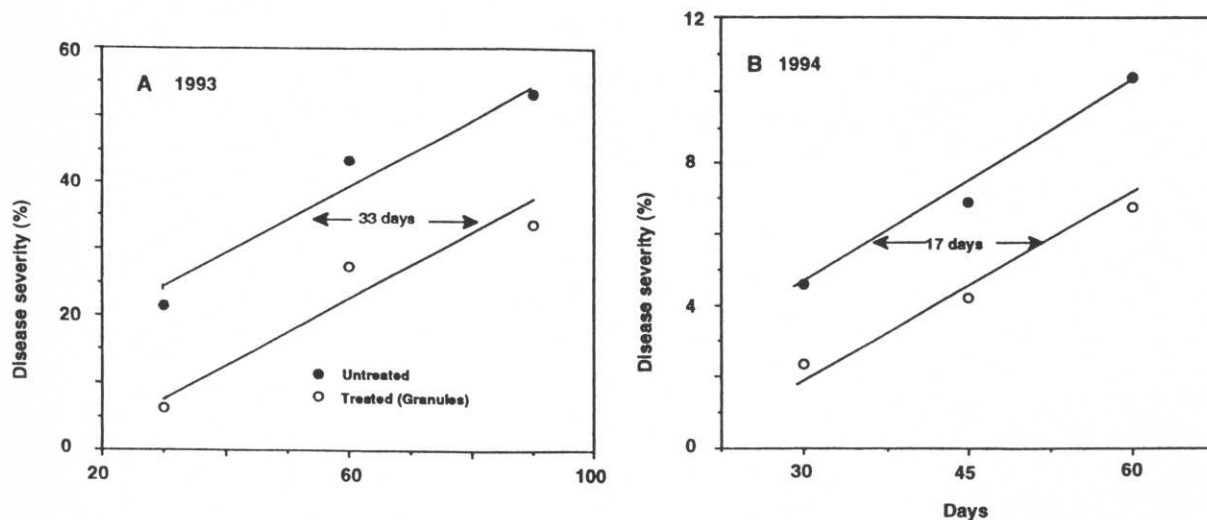


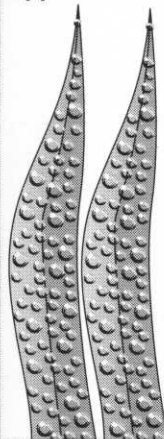
Fig. 2. Disease progress of dollar spot in replicated trials in 1993 and 1994 in the presence and absence of Bio-Trek 22G. Lines were fitted using the general models program (SAS, Cary, NC). Disease severity is defined as the percentage of total plot area with diseased turf. The differences between treatments 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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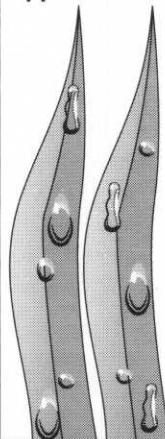
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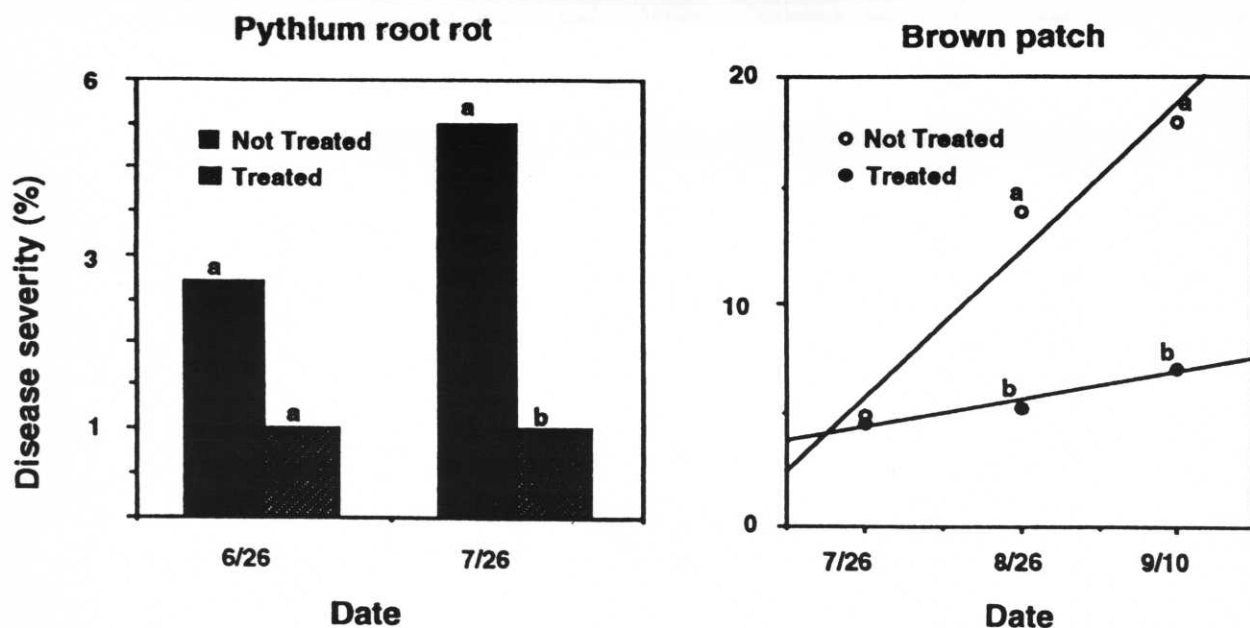


Fig. 3. Incidence of *Pythium* root rot and brown patch in replicated plots on a creeping bentgrass green after no treatment and treatment with Bio-Trek 22G. Disease severity is defined as the percentage of total plot area with diseased turf. Numbers followed by dissimilar letters are significantly different 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

<u>Compatible fungicides</u>	<u>Incompatible fungicides</u>
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)	<u>Questionable, or no data</u>
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, Lescro Twosome)
Vinclozolin (e.g. Vorlan, Touche, Curalan)	Thiram (e.g. Spotrete)
Fosetyl Al (e.g. Aliette)	Thiophanate methyl (e.g. Clearys 3336, Fungo)

Bio-Trek 22G—

(Continued from Page 22)

courses. We will determine which chemicals cannot be used in sprayers employed for *T. harzianum* 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. harzianum*.

With this information, we will develop recommendations for using *T. harzianum* that will be tested on golf courses and other commercial sites. In addition, we will investigate development 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. harzianum*, establish diverse microbial soil populations that promote

(Continued on Page 26)



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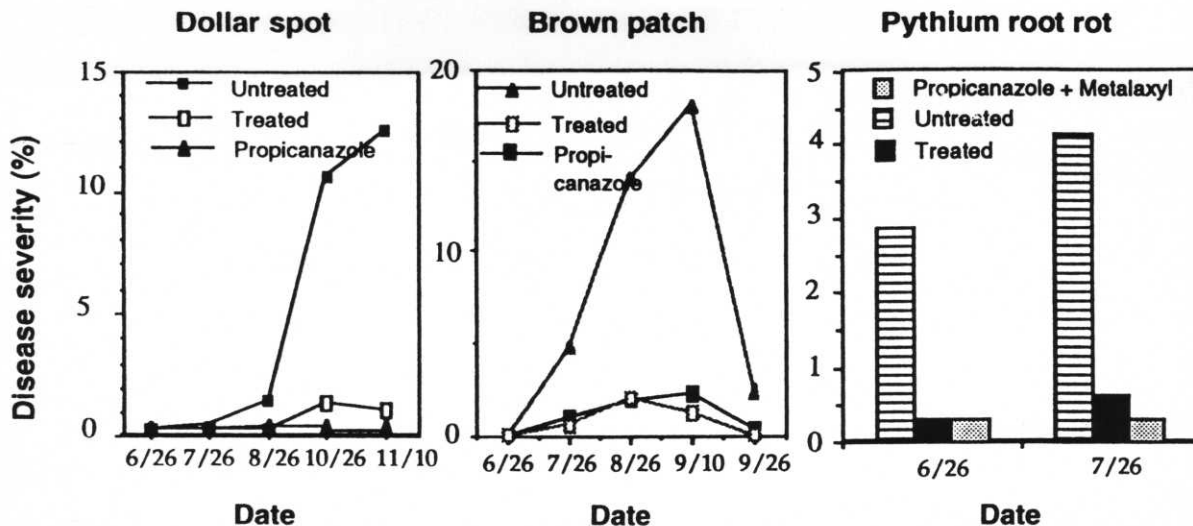


Fig. 4. Severity of dollar spot, brown patch, or Pythium root rot in replicated plots on a creeping bentgrass green after no treatment, treatment with a standard fungicide, or treatment with sprays containing spores of *T. harzianum* and Triton X-100. Disease severity is defined as the percentage of 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.-I., 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).

Bio-Trek 22G—

(Continued from Page 24)

plant health, and be competitively priced. We hope to begin research scale trials of both full biological and biological-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 harzianum*, 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 establishment 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 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, Geneva, 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 Research 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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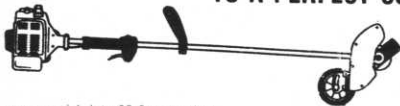
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"Milorganite and its distributors have long supported turfgrass research at the national level through the O.J. Noer Research Foundation," said Lennert. "This program enables Milorganite customers to support turfgrass research at the local level."

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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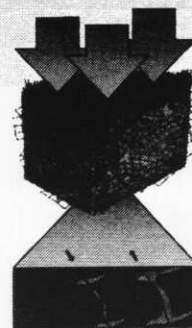
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