CORNELL UNIVERSITY TURFGRASS TIMES

CUTT

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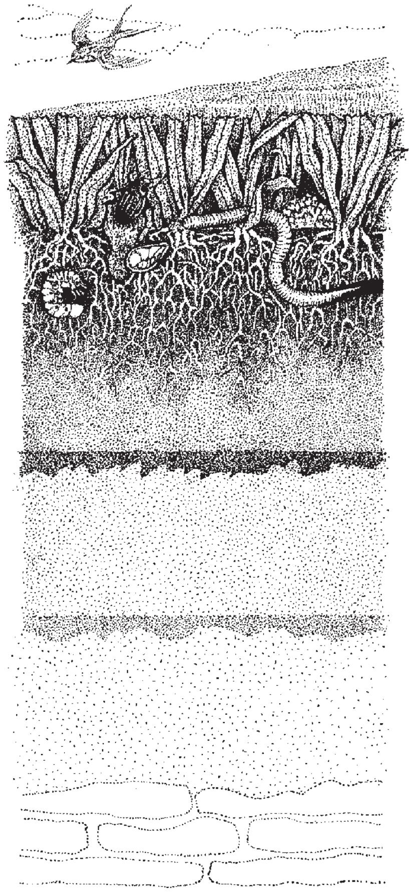
Special Research Issue



Research in Review

In conjunction with the 1993 Turfgrass Research Field Day, this expanded issue of CUTT was written to provide you with a synopsis of results from some of the turfgrass research projects on-going at Cornell. This report is not all inclusive. There are many other projects not reported here. It should, however, give you a taste of the direction the various programs have taken in turfgrass management, pathology, entomology, and weed science. ■

This Times

Turfgrass Research

Turfgrass research conducted at Cornell is under the direction of the five faculty members. The Department of Floriculture and Ornamental Horticulture is home for Norm Hummel, Marty Petrovic, and Joe Neal. Eric Nelson is housed in the Department of Plant Pathology, while Mike Villani is in the Department of Entomology at the Agricultural Experiment Station in Geneva.

Support for research projects comes almost exclusively from gifts and grants. Other than the salaries and benefits of the five faculty members and a couple of support staff, direct funding from New York State for Turfgrass Research is negligible. So, much of our time is spent scrambling for dollars to support our programs, and specific projects.

The New York State Turfgrass Association has long been an important source of programmatic dollars—discretionary money used to help support the research facility, as well as to hire technical staff. Equipment vendors such as S. V. Moffett, Eaton Equipment, and Lesco have also been major players by providing us with nearly all of our maintenance equipment. Likewise, we have never had to purchase seed, fertilizer, and chemicals due to the generosity of many suppliers.

Searching for Support

Most of our other monies are obtained through competitive grants and are earmarked for specific projects. Many days a year are spent writing proposals to various granting agencies in hopes of securing funding for research projects. Some of the more significant funding sources for the turf program have been the USGA, the USDA, and the NYS IPM Program. Technical staff are normally hired on this “soft money” for two or three years to work on these specific projects.

Research is expensive—beyond the comprehension of most lay people. Some of the data you see in this report may have required several hundred man hours to obtain—often from tedious and repetitive tasks. Besides having to pay for these staff salaries and their benefits, we also pay overhead costs to the University.

Equipment and supplies are also expensive. Dr. Nelson pays several hundred dollars per gram of antibiotic he needs to maintain some of his disease cultures. A good analytical balance alone costs over $5,000. No equipment donations here! This list goes on.

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Thanks also to our many subscribers.

We hope that we have provided useful information for your turf growing needs.

We appreciate your continued support.

Special Thanks to

The New York State Turfgrass Association

for their financial support

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Thanks also to the many associations and companies who have supported our research program.

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What is *CUTT* ?

CUTT is a quarterly newsletter from the Cornell University Turfgrass Faculty. The purpose of *CUTT* is to bring to you the latest research results from Cornell, as well as other universities, in a timely manner. Each issue, published to coincide with the change in seasons, will help you understand turfgrass better, enable you to manage your turf better, and maintain healthier turf with greater environmental protection. ■

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Research in Review

continued from cover

We only raise these points so that you understand the costs of research, and more importantly how important your support for research is.

Take a few minutes and read through this special Research Issue of *CUTT*. The authors may have more detailed reports on the studies included in this issue, as well as results from other studies. Feel free to contact any one of the turfgrass faculty members for more information.

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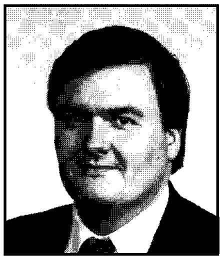

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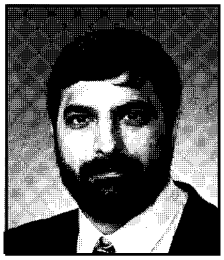

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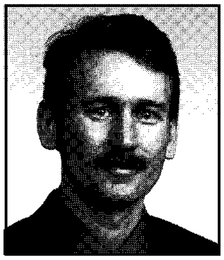

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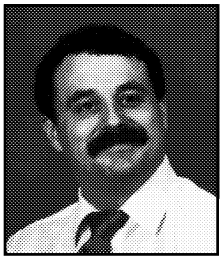

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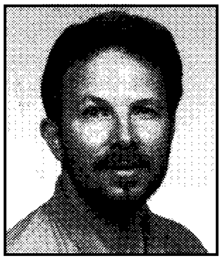

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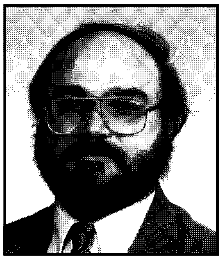

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This issue should give you a taste of the direction the various programs have taken in turfgrass management, pathology, entomology, and weed science.

Feel free to contact any one of the turfgrass staff members for more information.

Turfgrass Insect Biocontrol Project

MICHAEL VILLANI, DEPT. OF ENTOMOLOGY, AGRICULTURAL EXPERIMENT STATION, GENEVA

Fungal pathogen isolates of soil insects were tested against Japanese beetle grubs. There were considerable differences in performance under various common environmental conditions.

1992 studies suggest that under specific environmental conditions, commercially available entomopathic nematodes may outperform standard turfgrass insecticides for controlling grubs. Research in 1993 will focus on field studies to verify these laboratory and greenhouse results.

Studies during 1992-93 in our long-term research and development program to introduce biologically based control agents for scarab grub control in turfgrass has focused on evaluating a number of entomopathogenic agents (entomopathic nematodes and fungi) against Japanese beetle grubs.

Fourteen *Metarhizium anisopliae* isolates, a fungal pathogen of soil insects, were tested against Japanese beetle grubs. Two isolates, MADA and 1020 are currently being considered for commercialization. The other twelve isolates were chosen because they were isolated from scarab grubs from around the world. MADA and 1020 performed well at both treatment rates, but there were clearly isolates that performed consistently better over the study. There was considerable differences in how well several fungal isolates performed under a variety of environmental conditions that are commonly found in Metropolitan area golf courses. Studies were also initiated to determine if combinations of fungal pathogens and traditional insecticides might increase grub mortality and reduce the lag time common for many insecticides in soil. These preliminary studies suggest that this may occur. Further work in this area will be undertaken in 1993. The addition of fungal pathogens to composts for top dressings was also studied in 1992. Although this work is preliminary we have encouraging results and will continue this study during the rest of the project.

A second 1992 research focus was in evaluating entomogenous nematodes under a variety of environmental conditions to determine those conditions that promoted maximal grub mortality. These studies suggest that under specific environmental conditions, commercially available entomopathic nematodes may outperform standard turfgrass insecticides for controlling grubs. Research in 1993 will focus on field studies to verify these laboratory and greenhouse results. We have also studied several nematodes that have been collected by Cornell University entomologists that appear to compare favorably to commercially produced nematodes against Japanese beetle grubs. Large plot studies are planned for 1993.

Summary of Fungus Tests

All isolates

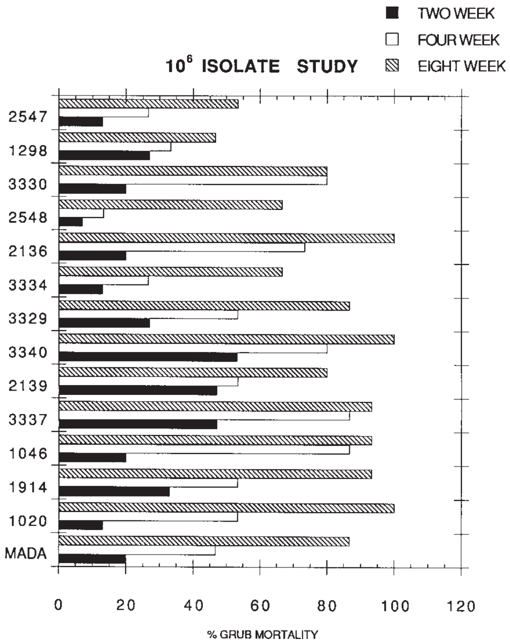
Twelve *Metarhizium anisopliae* isolates were obtained from the USDA-ARS collection of entomopathogenic fungal cultures (Plant Protection Research Unit, U.S. Plant Soil and Nutrition Laboratory, Tower Road, Ithaca, NY): 1046, 1298, 2547, 2548, 2136, 2139, 3329, 3330, 3334, 3337, 3340, 1914. Additionally two isolates of *M. anisopliae* were obtained as formulated mycelia (MADA and Bio 1020). All isolates were cultured on plates of one-half strength Potato Dextrose Agar (PDA). Conidia were harvested from these plates, dried and stored at 4℃. Conidia from each isolate mixed into soil at a rate of 10^7 CFU/g of soil. Grass seed was added. Five grams of the soil/seed/conidia mixture was added to a scintillation vial and a third instar Japanese Beetle grub was placed on the top. Fifteen insects were treated for each insect. The amount of condia permitting, this procedure was replicated three times at 10^7 CFU/g of soil and one time at 10^6 CFU/g of soil.

MADA and 1020 performed well at both treatment rates but there were clearly isolates that performed consistently better over the study (see figures 1 and 2). These isolates are being formulated and will be tested against third instar Japanese beetle grubs this fall. If there is adequate funding we would like to test these isolates against other common scarab grubs including Oriental beetles, Asiatic Garden beetles and European chafers. There was some inconsistency in the viability of the conidia so there may have been some underestimation of the rates applied.

continued on page 6

Figure 1

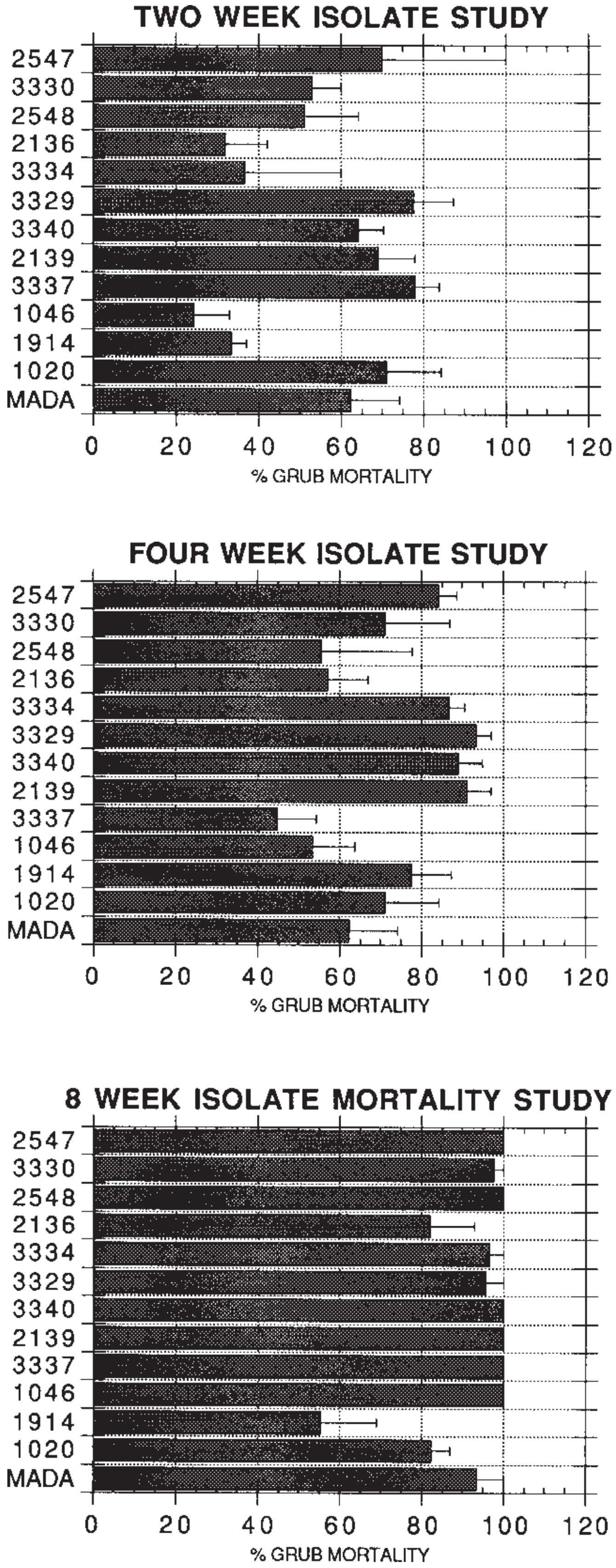
Effects of fungal isolates on grub mortality



Entomopathogenic fungal culture isolates (1046, 1298, 2547, 2548, 2136, 2139, 3329, 3330, 3334, 3337, 3340, 1914) of Metarhizium anisopliae. *MADA & 1020—two isolates of* Metarhizium anisopliae *as formulated mycelia isolates.*

Figure 2

Comparison of effects of fungal isolates on grub mortality



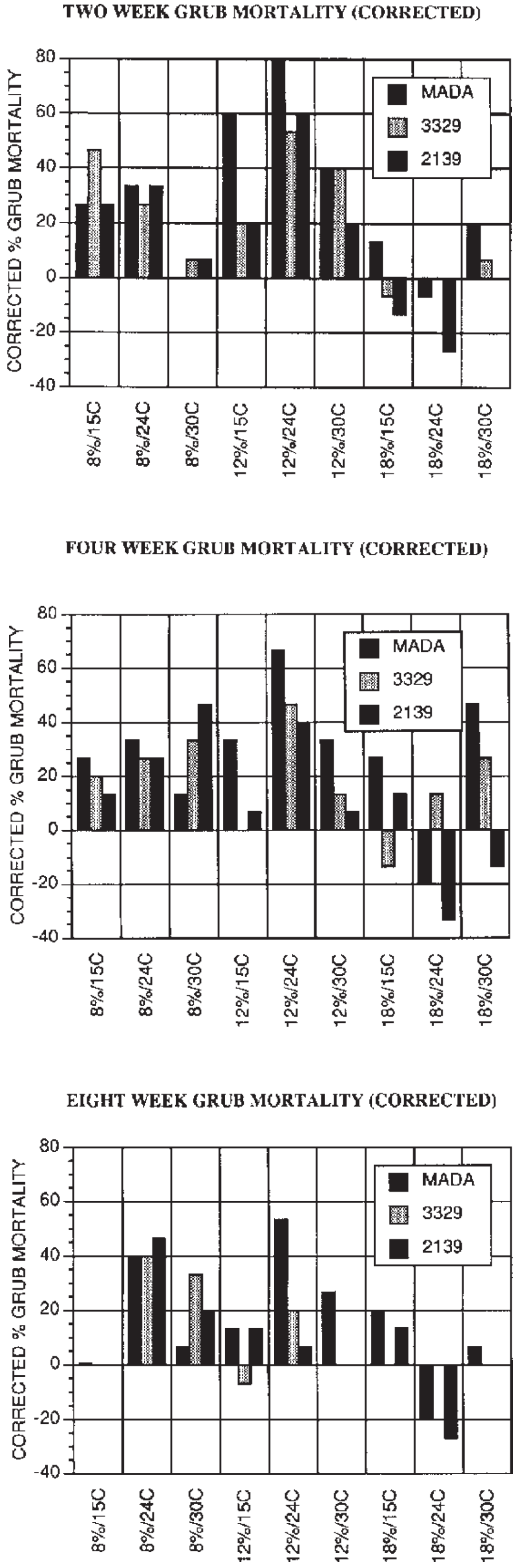
TWO WEEK ISOLATE STUDY

FOUR WEEK ISOLATE STUDY

8 WEEK ISOLATE MORTALITY STUDY

Figure 3

Influence of temperature and moisture on effectiveness of 3 fungal isolates



TWO WEEK GRUB MORTALITY (CORRECTED)

FOUR WEEK GRUB MORTALITY (CORRECTED)

EIGHT WEEK GRUB MORTALITY (CORRECTED)

Turfgrass Insect Biocontrol

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All isolates appeared to perform best under intermediate soil moisture and temperature conditions.

Clearly under these experimental conditions both MADA and 1020 performed extremely well. We would propose that a similar study be undertaken this coming year with the newly formulated isolates.

Fungus Isolates at 3 Temperatures and 3 Moistures

The effect of three fungus isolates, MADA, 3329, 2139, at three temperatures (15℃, 24℃, 30℃) and three soil moistures (8%, 12%, 30%) on Japanese Beetle mortality was investigated. Fungal conidia were mixed into soil at a rate of 10^6 CFU/g of soil. Each tube contained 4.7 g of soil. Third instar JB larvae were added to the top of each scintillation vial. Fifteen insects were set up in each treatment. Readings were done at 2, 4 and 8 weeks. Graphs were corrected for check mortality (see figure 3). An additional trial at 24°c and 12% soil moistures was set up with Cranberry root grubs (*Lichnanthz vulpina* Hentz) [not included in summary].

All isolates appeared to perform best under intermediate soil moisture and temperature conditions. The two additional isolates did not appear to provide significantly higher mortality at higher soil moisture. If this appears to be a limiting factor for use then we might screen additional isolates at higher or lower temperature and/or moisture conditions to identify these isolates. We will retest all formulated isolates at multiple temperature and moisture conditions against Japanese beetle grubs this fall.

Earth Gro and Bio 1020

Six treatments were set up:

1) Check with Earth Gro (20% by volume)—incorporated,

2) Check with Earth Gro (20% by volume)—top dressing (TD),

3) Bio 1020 (.48g/30g soil) with Earth Gro (20% by volume)—incorporated,

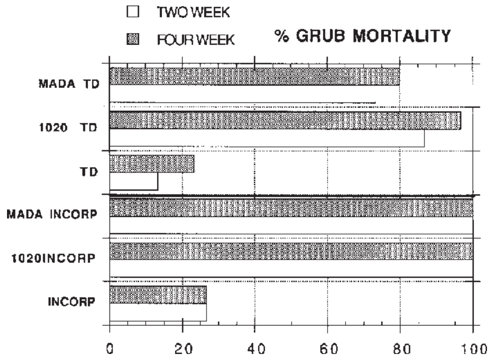
4) Bio 1020 (.48g/30g soil) with Earth Gro (20% by volume)—top dressing (TD),

5) MADA (.48g/30g soil) with Earth Gro (20% by volume)—incorporated,

6) MADA (.48g/30g soil) with Earth Gro (20% by volume)—top dressing (TD).

Figure 4

Comparison of effectiveness of top dressing (TD) or incorporating MADA & 1020 on grub mortality



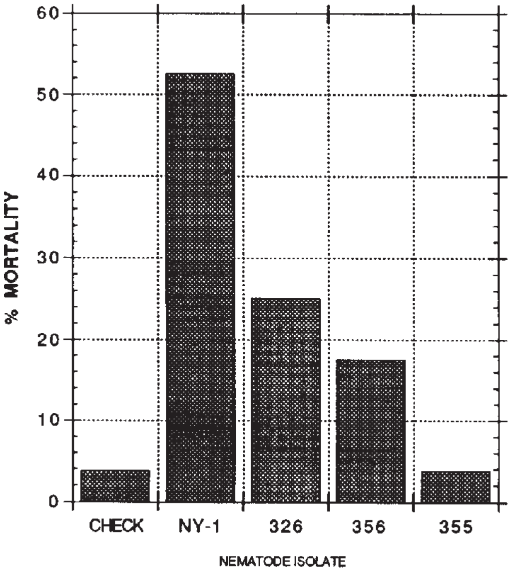
These rates were used to insure that grubs could be infected by a compost-based fungal product. If these studies are to continue then rate-response under the different application regimens should be studied. Thirty third-instar Japanese beetles (*Popilia japonica*) were used in each treatment. The appropriate formulated material was added into the Earth Gro compost and mixed in with a glass rod. For incorporated treatments, the Earth Gro/Formulated material was mixed into the soil. One-ounce cups were filled with this mixture. For top-dressed treatments, one-ounce cups were 4/5 filled with soil; the remaining 1/5 on the surface was filled with the Earth Gro/Formulated mixture. The insects were placed on the top of each cup and allowed to crawl into the soil. Readings were done at 2 and 4 weeks. Clearly under these conditions both MADA and 1020 performed extremely well (see figure 4). We would propose that a similar study be undertaken this coming year with the newly formulated isolates. Also, the shelf-life of formulated material in compost under a variety of moisture-temperature conditions should be studied.

Comparison of Entomogenous Nematode Strains for Japanese Beetle Grub Control

Four isolates of entomopathic nematodes were evaluated in the laboratory for efficacy against third instar Japanese beetle grubs. Our standard nematode was *Steinernema glaseri* (326) that is being commercialized by Biosys (Palo Alto, CA) for use against soil insects. We have studied this isolate in the laboratory and in the field for the past

Figure 5

COMPARATIVE ACTIVITY OF NEMATODE ISOLATES AGAINST JAPANESE BEETLE GRUBS



several years. Also tested in this study were two additional *Steinernema* isolates (Venezuela and Rio Bravo) and a *Heterorhabdtis* nematode (NY-1), isolated and cultured by P. Schroeder and C. Ferguson (in alfalfa, Oswego NY), was also evaluated. Grub mortality caused by the various nematodes can be seen in Figure 5.

Our studies indicate that Biosys 326 was the most effective *Steinernema* isolate evaluated but that *Heterorhabdtis* nematode (NY-1) clearly outperformed all other nematodes and should be considered in further studies. These results parallel similar comparisons between these nematode groups. *Steinernema* currently is of greater interest to commercial enterprises because as a group they tend to be more easily formulated and shipped than the more fragile *Heterorhabdtis*. For this reason considerable effort has been spent to improve the performance of this group. However, there is increasing interest from small commercial enterprises to produce *Heterorhabdtis* nematodes for use on high value horticultural crops (including lawns and golf courses). Since nematodes are not considered pesticides there are no regulatory roadblocks to their commercialization. The only roadblocks currently is the lack of comprehensive research to determine the best nematode isolates and the environmental conditions that will maximize their performance. Studies proposed for 1993 include the large scale testing of Biosys 326 and P. Schroeder and C. Ferguson NY-1 in high maintenance and low maintenance turfgrass.

Environmental Factors Influencing the Performance of *Steinernema glaseri* (326) Against Japanese Beetle Grubs in Turfgrass

Effective long-term control of the scarab grub complex was achieved with organochlorine and cyclodiene insecticides until their use was discontinued due to insect resistance and government intervention; less consistent control has been achieved with organophosphate and carbamate insecticides and with a variety of biological agents (nematodes, fungi, bacteria and viruses). The entomogenous nematode *Steinernema glaseri* (326) [Biosys, Palo Alto, CA] has shown promise for controlling grubs in turfgrass but the results have been inconsistent.

One reason for this inconsistency may be the lack of basic understanding in the interaction of the nematode, the grub population, and the soil physical and biotic environment (soil moisture, temperature, texture, compaction, and microbial flora, etc.). While each of these factors has been independently studied to varying degrees by basic and applied researchers, their interdependence has largely been ignored. The nature of the specific interactions between target insect population(s),

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Figure 6

Physical properties of 6 soil samples

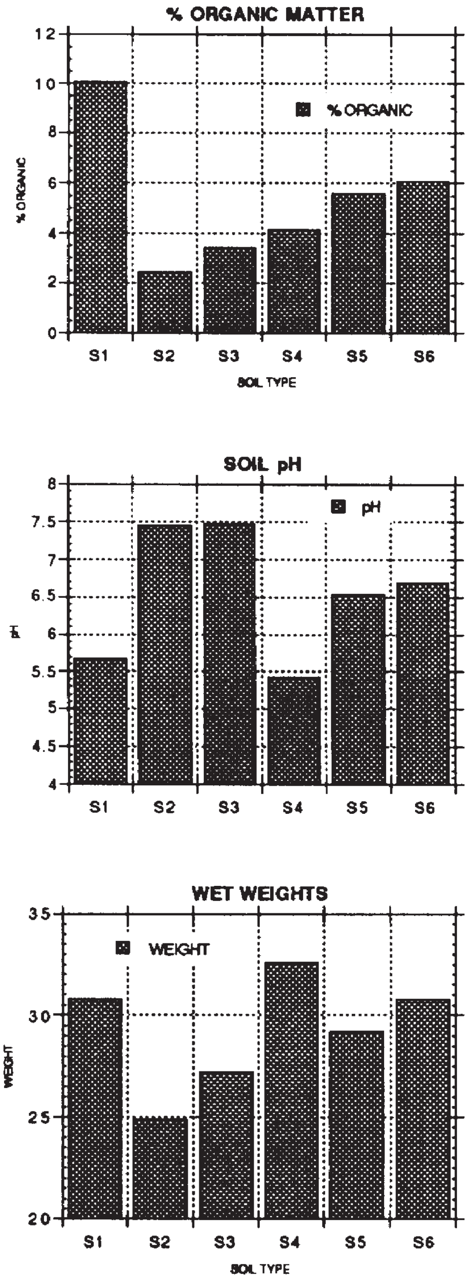
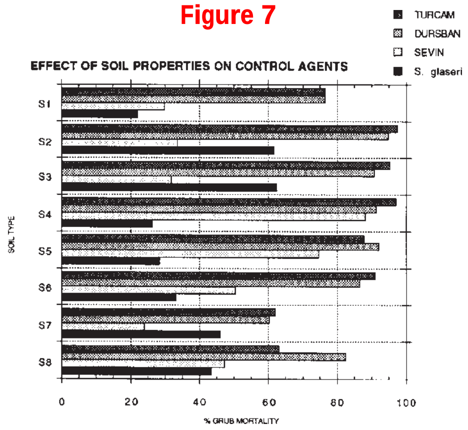


Figure 7



Heterorhabdtis ***nematode (NY-1) clearly outperformed all other nematodes and should be considered in further studies.***

Steinernema ***currently is of greater interest to commercial enterprises because as a group they tend to be more easily formulated and shipped than the more fragile*** **Heterorhabdtis.** ***For this reason considerable effort has been spent to improve the performance of this group.***

Turfgrass Insect Biocontrol

continued from page 5

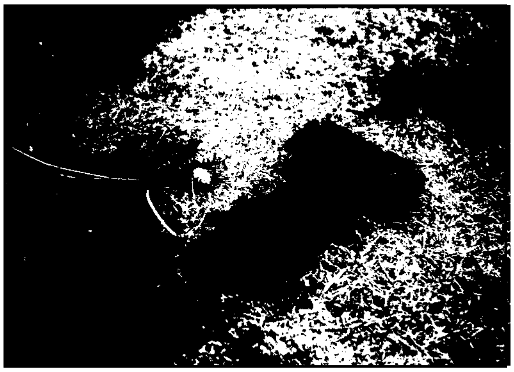
The nature of the specific interactions between target insect population(s), control agent(s) and the soil environment were examined in this study. While each of these factors has been independently studied to varying degrees by basic and applied researchers, their interdependence has largely been ignored.

control agent(s) and the soil environment were examined in this study. In the first stage of our study we hoped to determine the influence of soil physical properties (% organic matter, soil pH, soil bulk density) on the performance of *Steinernema glaseri* (326) against third instar Japanese beetle grubs.

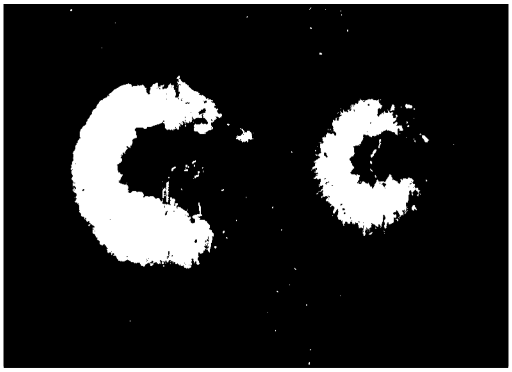
We determined the efficacy of this nematode in eight different soils with varying combinations of a number of potentially important soil characteristics. Six of these soils have been characterized (see figure 6) [2 pending at Cornell soil analysis lab in Ithaca]. The performance of *Steinernema glaseri* (326) was compared with the performance of three common grub insecticides (see figure 7). Our results indicated grub mortality of 22% to 64 % from our *Steinernema glaseri* (326) treatments in the various soil types.

Three soils (S1, S3, S4) were then selected for more comprehensive studies. These soils encompassed the range of soil factors (% organic matter, soil pH, soil bulk density (see figure 8)) and the range of grub control (22%, 66%, 30%) due to *Steinernema glaseri* (326). These studies were conducted in test chambers that allowed late third instar Japanese beetle grubs to escape through the soil profile during the four week experiment in response to internal physiological changes and /or changes to their external environment. Control agents were applied at the field rates and twice the field rate as a drench and then irrigated with 1.00 cm and .25 cm of distilled water. Results are indicated in figure 8.

Our results indicate that in our more complex bioassay arenas *Steinernema glaseri* (326) performed as well as or significantly better than either soil insecticide for grub control. There may be several reasons for our results: 1) Large third instar Japanese beetles are very tolerant of insecticides but show no increase tolerance to nematodes when compared to earlier stages. 2) Late instar grubs may be moving down into the soil profile to find pupation sites. Nematodes can and will move down through the profile and can reach grubs whereas soil insecticides are bound to the thatch soil interface. 3) Environmental factors that may move grubs down into the soil profile may also move nematodes down thereby increasing the opportunity for overlap and infection. Increases in irrigation and application rate also improved control agent effectiveness. The impact of increases in irrigation was most evident in high organic soil (S1) where free water was limiting at the lower irrigation rate.



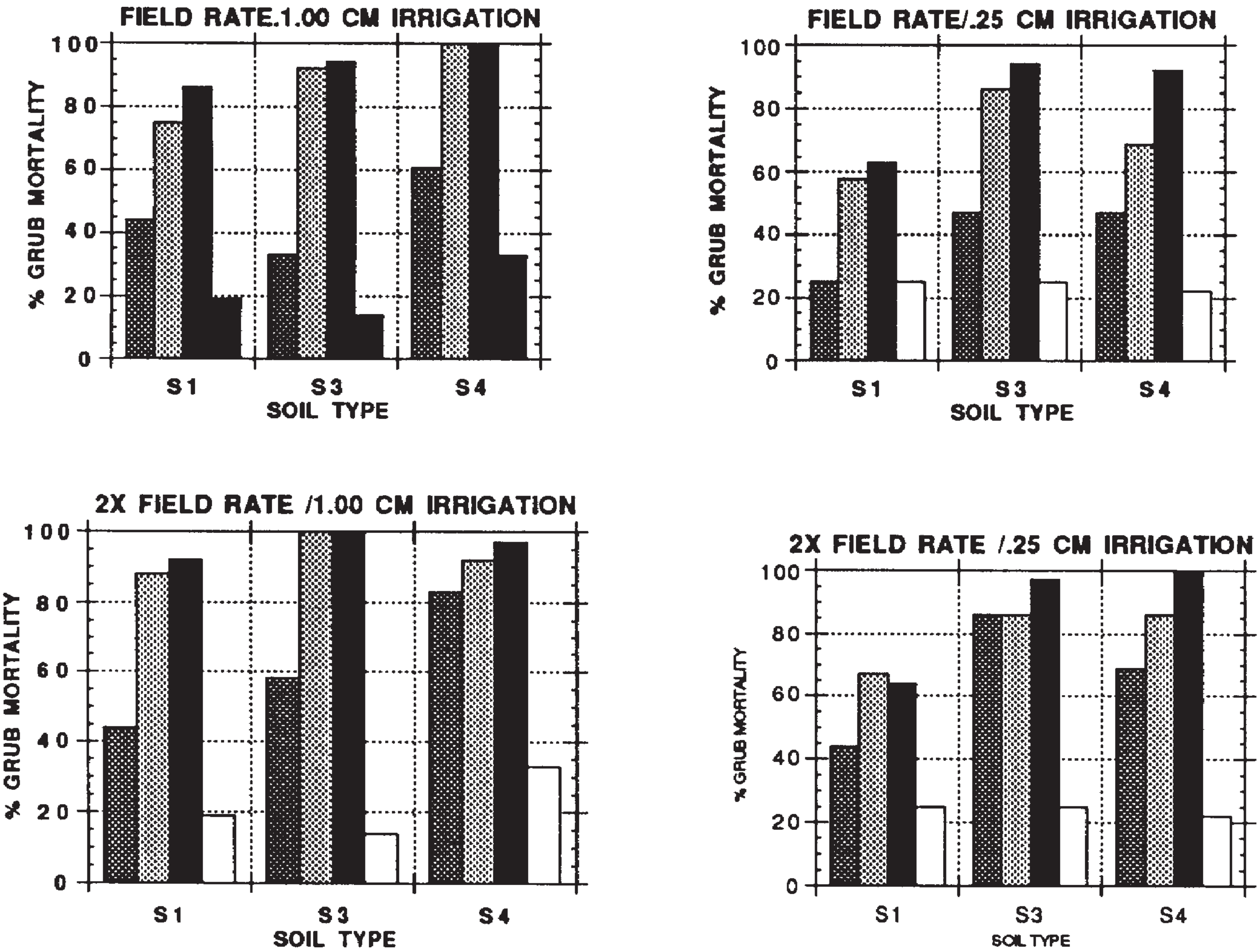
White grub damage



Grubs at different instars can be found in the same area.

Figure 8

Comparison of effects of insecticides and nematode treatments depending on soil type and irrigation



In each set, stippled bars indicate insecticides, solid black bar indicates nematode treatment and empty bar indicates check.

Microbial Basis of Disease Suppression in Composts Applied to Golf Course Turf

Eric Nelson and Cheryl Craft, Dept. of Plant Pathology

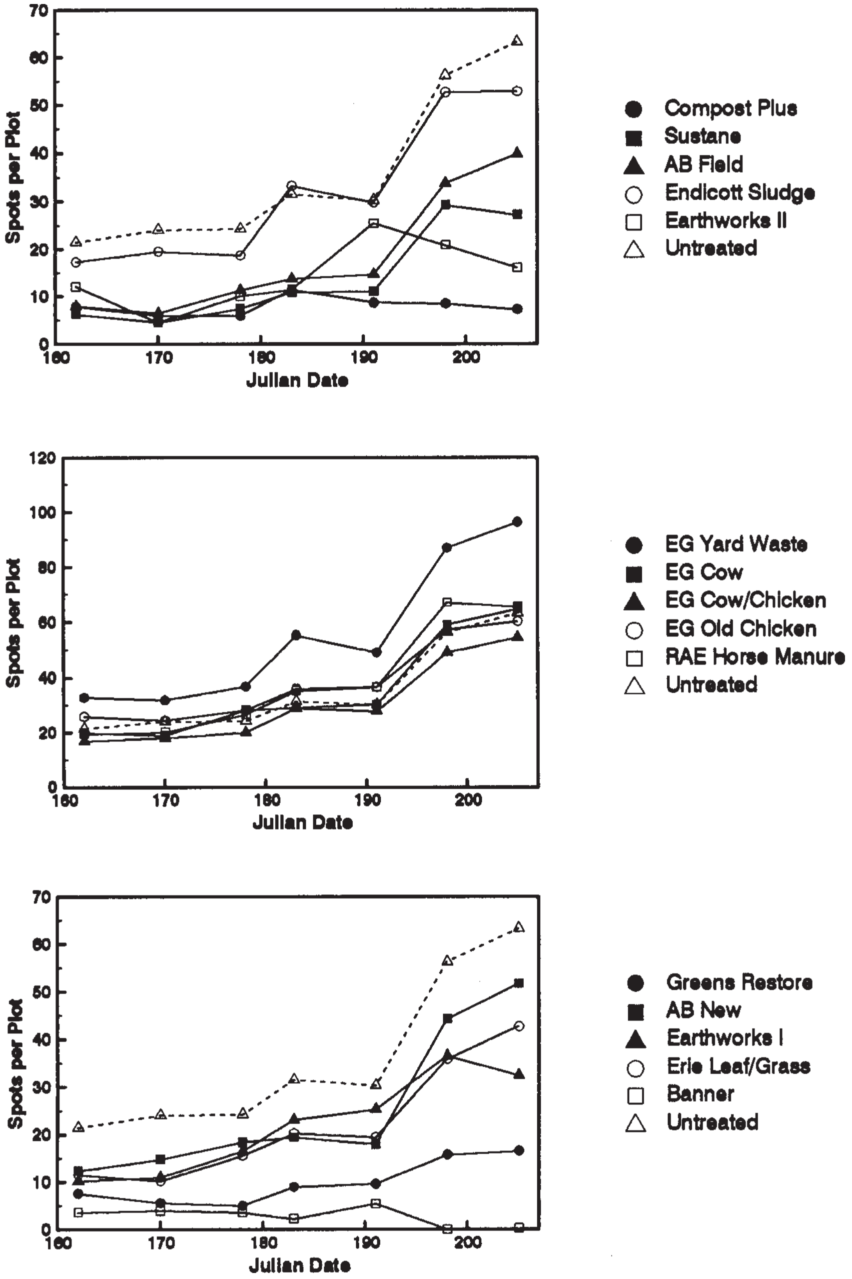


Figure 1

Effects of various composts on the development of dollar spot on a creeping bentgrass putting green at the Cornell University Turfgrass Field Research Laboratory. Disease development arose from natural inoculum and was monitored through June and July. Dashed line in all three figures represents untreated plots.

Our goal in this project is to develop more effective biological control strategies with compost-based organic fertilizers by understanding the microbial ecology of disease-suppressive composts. In particular, we hope to understand the microbiology such that disease-suppressive properties of composts might be predicted and an assemblage of beneficial microorganisms useful in the development of microbial fungicides for turfgrass disease control might be discovered.

The objectives of our study are to:

1) determine the spectrum of turfgrass pathogens suppressed by compost applications,
2) establish relationships between overall microbial activity, microbial biomass, and disease suppression in composts,
3) identify microorganisms from suppressive composts that are capable of imparting disease-suppressive properties to conducive composts or those rendered conducive by heat treatment, and
4) determine the fate of compost- derived antagonists in golf course putting greens following application of individual antagonists and composts fortified with these antagonists.

1992 Efforts

Over the past year, our efforts have been focused on:

1) further evaluating composts in the field for disease suppression (see figure 1); our goal has been to verify previous findings as well as expand the diseases for which composts are suppressive;
2) further developing laboratory assays to assess microbial activity and biomass; and
3) enumerating and recovering specific isolates of bacteria, fungi, and actinomycetes from suppressive composts. Much of our emphasis in 1992 was on objective 3.

Although 1992 was not a good year for disease development in our experimental plots, data were obtained for the suppression of dollar spot with various composts. Additional evaluations for snow mold suppression are underway.

Table 1. Pythium suppression and populations of fungi, bacteria, and Pythium-suppressive actinomycetes from composts

	Microbial Populations (log CFU/g dry wt. compost)			*Pythium graminicola* Suppression Disease Rating[d]	
Compost	Heterotrophic Bacteria[a]	Heterotrophic Fungi[b]	Antibiotic-producing Actinomycetes[c]	Uninoculated	Inoculated
Brewery Waste 1989	8.65	7.53	9.86	1.0	2.3
Brewery Waste 1991	9.85	5.73	8.00	1.5	3.5
Brewery Waste 1992	5.04	4.72	NA	1.0	2.3
Endicott Sludge 1989	9.65	6.54	6.43	1.0	1.8
Leaves A4-21-92	8.99	5.87	NA[e]	1.0	2.0
Leaves A5-20-92	9.34	5.04	6.34	1.0	3.3
Leaves B6-4-92	8.61	5.59	6.79	1.5	1.8
Leaves/Chicken Manure A4-21-92	8.90	3.77	NA	1.0	1.5
Leaves/Chicken Manure A5-20-92	9.23	5.23	6.91	1.0	4.8
Leaves/Chicken Manure A6-4-92	9.38	4.00	NA	1.0	2.0
Chicken Manure A6-4-92	8.80	3.65	<2.26	1.0	1.0
Chicken Manure B6-4-92	9.18	4.87	NA	1.0	1.0
Chicken/Cow Manure A6-4-92	9.36	5.04	NA	2.0	2.0
Yard Waste Grind B4-21-92	8.67	4.41	NA	1.0	1.5
Yard Waste Grind B5-20-92	9.43	5.04	6.68	1.0	3.3
Yard Waste Grind A5-20-92	9.34	5.04	6.89	1.0	4.5
Food Waste B6-4-92	9.36	3.90	NA	1.5	2.0
Food Waste B7-1-92	9.18	4.15	NA	1.0	2.0
Food Waste A6-4-92	8.70	3.83	5.23	2.3	2.8
Food Waste A7-1-92	8.62	3.49	NA	2.5	2.0

[a] Heterotrophic bacterial populations determined by plating on 1/10-strength trypticase soy agar (TSA).

[b] Heterotrophic fungal populations determined by plating on 1/3-strength potato dextrose agar (PDA).

[c] Pythium-suppressive antibiotic-producing actinomycetes determined by a triple-layer agar plating procedure described by Herr (1959).

[d] Compost mixed with sand at the rate of 80 mg dry wt/cm^3 sand. Rated after 5 days on a scale of 1-5 for which 1=no disease and 5=completely dead or unemerged seedlings of *Agrostis palustris.* Controls consisted of sand to which no compost was added (Disease rating 1.0 and 5.0 for uninoculated and inoculated, respectively).

[e] NA=data not yet available.

We have performed isolations of bacteria, fungi, and actinomycetes from over 20 different composts (see table 1). Actinomycetes have been the most difficult group to enumerate and purify since they are extremely slow-growing and cultures can be easily contaminated with bacteria and fungi. As a means of better recovering antagonistic actinomycetes, we have employed a triple layer agar technique to recover antibiotic-producing actinomycetes. We have over 100 strains of actinomycetes that are currently being evaluated for their disease-suppressive properties. We are currently in the process of characterizing the fungal and bacterial populations from composts and we are just beginning to screen these organisms for disease suppression.

We have also been successful in refining our microbial biomass assay. We are now able to generate repeatable standard curves from both inorganic phosphate and glycerol phosphate and we are proceeding to assess biomass with this procedure in a number of different composts. During the first half of 1993 we hope to be able to assess over 25 different materials for levels of biomass and activity to determine whether this method may be suitable for assessing and thus predicting disease-suppressive properties of composts.

We hope to understand how disease-suppressive properties of composts might be predicted.

Pesticide Leaching From Simulated Golf Course Fairways

A. Martin Petrovic, C.A. Sanchirico, Dept. of Floriculture and Ornamental Horticulture, D.J. Lisk, R. G. Young, Dept. of Fruit and Vegetable Sciences, and P. Larrson-Kovach, Dept. of Food Science, Geneva

The US EPA recently surveyed public and private drinking wells for the presence of pesticides. A surprisingly large number of well samples had pesticide or pesticide metabolite residues above detectable limits. Therefore, there is an urgent need to understand what, if any, contribution pesticides applied to turfgrass have on groundwater quality.

There is an urgent need to understand what, if any, contribution pesticides applied to turfgrass have on groundwater quality.

Golf courses are considered by many as a large user of pesticide. Many golf courses are irrigated and have highly sand soils on part of the course. These three factors (high pesticide use, irrigation and sandy soils) are important in pesticide leaching. Thus, golf course pesticide use has been a target for concern on environmental issues. To date, there has only been a few studies conducted to examine the extent of pesticide leaching from turfgrass sites. Though the results appear to be encouraging, these studies were done only with a few pesticides and on a limited number of soils. Therefore, the purpose of this study was to examine the leaching of three pesticides from several soils as influenced by precipitation from simulated creeping bentgrass fairways.

The site for the study was the ARESTS Facility at the Cornell University Turfgrass Field Research Laboratory, Ithaca, NY. The existing Kentucky bluegrass turf was killed and creeping bentgrass was over seeded in May, 1991. The site contains three soil textures (sand, Arkport sandy loam and a Hudson silt loam). Precipitation was applied during the growing season to provide at least 1"/wk of rainfall or irrigation. Two precipitation regimes were followed based on historic weather data for Ithaca, NY: an average precipitation pattern of "moderate" rainfall/irrigation and "high" precipitation pattern to simulate unusually wet years which are very conducive for leaching. Mecoprop (MCPP a broadleaf herbicide) and triadimefon (Bayleton, fungicide) were applied on Sept. 24, 1991. Triadimefon was reapplied on October 11, 1991. Trichlorfon (Dylox, insecticide) was applied on July 3, 1992. Any irrigation/rainfall event that caused water to drain from the plots was monitored for total volume of leachate and a subsample analyzed for pesticide residues.

Mecoprop and trichlorfon are considered highly leachable pesticides, whereas, triadimefon has a moderate potential for leaching. As expected, as shown in Tables 1 and 2 and Figures 1-3, the highly mobile pesticides (trichlorfon and mecoprop) when applied on a highly leachable soil (sand) resulted in substantial pesticide leaching. However, the extent of mecoprop leaching was not expected. This site was only four months old and the sand plots were sparsely covered with bentgrass. Thus, caution should be exercised when applying pesticides with thin turf and sandy soils if the pesticide has properties conducive to leaching. Also, the extent of trichlorfon leaching in all three soils was unexpected. This experiment will be continued in 1993 with further evaluation of mecoprop leaching.

Caution should be exercised when applying pesticides with thin turf and sandy soils if the pesticide has properties conducive to leaching.

Table 1. Percent of total applied mecoprop (MCPP) and triadimefon in leachate.

		Soil		
Pesticide	**Precipitation**	**Sand**	**Sandy Loam**	**Silt Loam**
		-------------------------% of applied pesticide-----------------		
MCPP	Moderate	34.85*	1.69	1.01
	High	73.76*	0.10	1.26
Triadimefon	Moderate	1.00	0.06	0.24
	High	2.44	0.01	0.28

* Sample analysis incomplete

Table 2. Percent of total applied trichlorfon found in leachate.

	Precipitation	
Soil Type	**Moderate**	**High**
	--------------- % of applied trichlorfon in leachate ----------	
Sand	1.2	3.4
Arkport sandy loam	1.1	4.4
Hudson silt loam	0.6	3.3

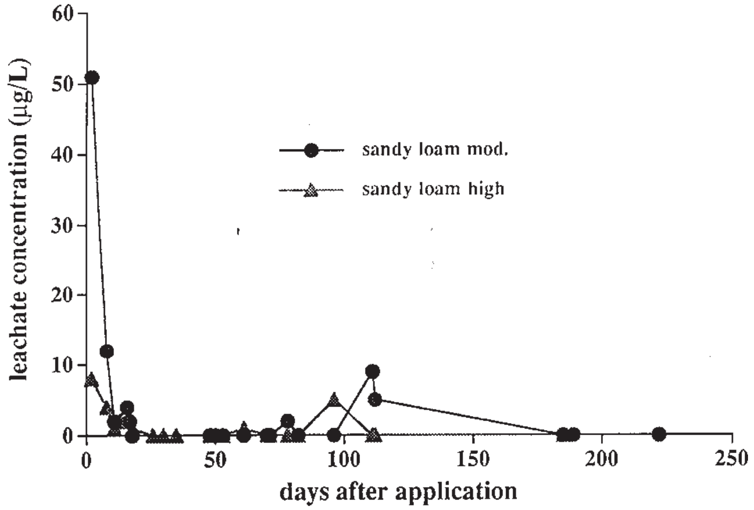


Figure 1

*The concentration of mecoprop in the leachate from **Arkport sandy loam** using moderate and high precipitation patterns.*

Each point is the average of four replicates.

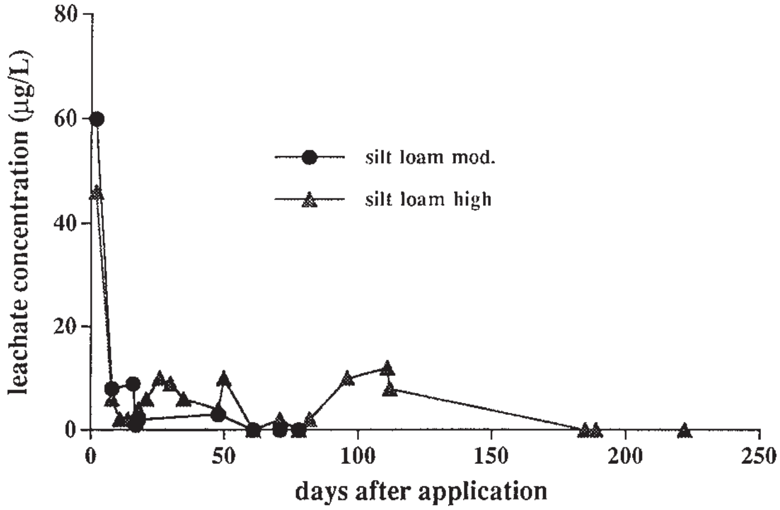


Figure 2

*The concentration of mecoprop in the leachate from **Hudson silt loam** following moderate and high precipitation patterns.*

Each point is the average of four replicates.

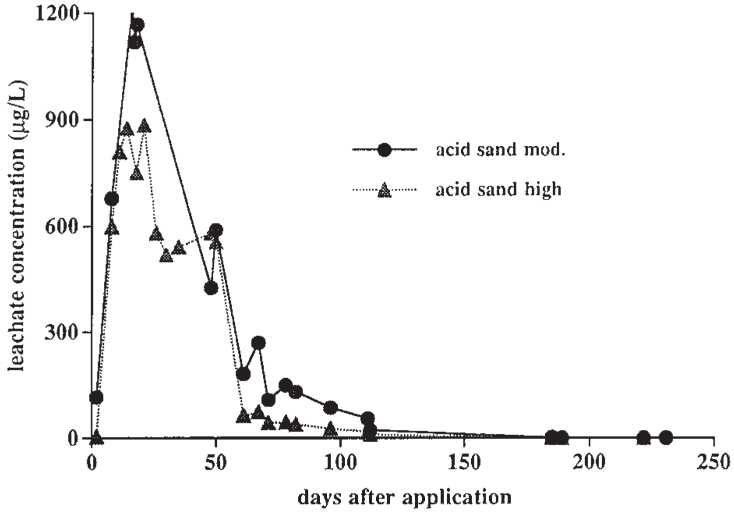


Figure 3

*The concentration of mecoprop in the leachate from **acid sand** following moderate and high precipitation patterns.*

Each point is the average of four replicates.

Turfgrass Weed Control 1992 Research Summary

Joseph Neal, Dept. of Floriculture and Ornamental Horticulture and
A. F. Senesac, Horticulture Research Station, Riverhead

Research in 1993 will investigate lower rates and tank mixtures for reducing bentgrass injury and enhancing goosegrass control.

The efficacy of granular formulations for postemergent broadleaf weed control was slightly less than comparable spray treatments. Fall applications of all products were more effective than spring or summer treatments.

Postemergent Goosegrass Control in Bentgrass Turf

Low rates of Acclaim (fenoxaprop) were evaluated for safety to 1/2 and 1/4 inch-cut Penncross creeping bentgrass and for efficacy on seedling goosegrass. Acclaim applied three times on 14-day intervals at 30 GPA caused noticeable turf yellowing. The discoloration was more severe and persisted longer at 1/4 inch than at 1/2 inch mowing height. However, applying Acclaim in 100 GPA (the same amount of a.i. but in a more dilute spray) produced no yellowing. In previous years some yellowing was observed with the 100 GPA treatment, but clearly, the level of injury can be reduced by using the higher gallonage.

While these low rates of Acclaim have been effective on seedling crabgrass, results on goosegrass have been inconsistent. In 1992, the results were again inconsistent. In a golf course fairway, these treatments provided only about 25% goosegrass control. In contrast, identical treatments at our research farm provided complete control. Possible reasons for this variability will be investigated in 1993.

The experimental herbicide Illoxan (diclofop) controlled goosegrass with a single application at 0.5 lb ai/A.; however, in 1992, 0.75 lb ai/A was necessary. Bentgrass injury increased with increased rate. Bentgrass mowed at 1/2 inch recovered more rapidly than did turf mowed at 1/4 inch. By 1 week after treatment, diclofop injury to 1/2 inch cut turf was barely noticeable, but 1/4 inch cut turf required two weeks for injury to reduce to the same barely noticeable level. While the degree of yellowing was slightly higher than that observed with Acclaim at 0.032, the fact that Acclaim must be reapplied three or more times results in a significantly longer period of time that the turf is yellow. Additionally, the Illoxan was also effective on tillered goosegrass whereas this low rate of Acclaim is not. Research in 1993 will investigate lower rates and tank mixtures for reducing bentgrass injury and enhancing goosegrass control.

Granular Herbicide Formulations for Postemergent Broadleaf Weed Control

Over the past two years we have evaluated several granular formulations of new herbicides for postemergent broadleaf weed control in turf. Applications of granular formulations of Confront (clopyralid + triclopyr) with quinclorac controlled clover, dandelion, and plantain as well as or better than a commercially available 2,4-D + 2,4-DP granule. The efficacy of granular formulations was slightly less than comparable spray treatments. Fall applications of all products were more effective than spring or summer treatments. The data suggests that Confront alone would adequately control these weeds. This will be investigated in 1993 tests.

Ground Ivy and *Veronica* Control

Several tests were conducted to evaluate Gallery (isoxaben) applied alone and in tank mixes with Turflon II Amine (2,4-D + triclopyr) for control of these hard to kill species. Previous data has shown that Gallery + Turflon II controls healall *(Prunella vulgaris)* and creeping speedwell *(Veronica filiformis)* better than either product applied alone. In 1992 Upstate tests, combining Gallery at >0.5 lb ai/A with the labeled rate of Turflon II Amine provided better ground ivy control than either product applied alone. While Turflon II provided rapid knockdown, weed regrowth was rapid. Gallery acted very slowly, with control increasing over time. In Long Island experiments, combining the rapid action of Turflon II and slow action of Gallery improved control of ground ivy, but not speedwell. These tests will be repeated in 1993 in an effort to better estimate the consistency (or lack thereof) of this tank mixture for ground ivy and *Veronica* control.

Biological Control of Annual Bluegrass with *Xanthomonas campestris pv. poannua*

In 1992 we investigated methods for enhancing the efficacy of this bacterium for control of established annual bluegrass including frequency of inoculation, and new strains of the bacterium. We also investigated several factors which could influence the level of control including N-fertility, soil moisture stress, and annual bluegrass subspecies differences.

Inoculation frequency

The bacterium was applied once, twice, or three times per week over 1, 2, 3, or 4 weeks. Annual bluegrass control increased with increased number of consecutive weeks of inoculation (See Figure 1). Number of applications per week was significant in one test but not in a second. The maximum control (as measured by reduction in above-ground live tissue) of about 40% in the first test and 30% in the second, was obtained when plots were inoculated with each mowing over four weeks.

Annual bluegrass subspecies and bacterium strains

In field and greenhouse tests, the perennial subspecies of annual bluegrass *(Poa annua* ssp. *reptans)* was slightly more tolerant than was the annual subspecies of annual bluegrass *(Poa annua* ssp. *annua)*. However, the differences observed between subspecies do not explain the dramatic differences in results between Northern U.S. experiments and Southern U.S. tests. Therefore, it is likely that our environmental conditions in N.Y. are not favorable to the bacterium. In these same tests, two isolates of the bacterium, one from Michigan and one from California, were compared and found not to differ in their efficacy.

Effects of Drought and Nitrogen Fertility on Annual Bluegrass Control

Results from growth chamber experiments suggests that if the annual bluegrass is experiencing any stress at the time of inoculation, control will be reduced. Inoculating vigorously growing weeds, then imposing drought (or other stress) appears to improve control.

These tests were conducted by Dr. Ting Zhou, a postdoctoral research associate, and by Ms. Nancy Williams, a graduate student. Although both Ting and Nancy have gone, the biocontrol work will continue in 1993.

Preemergent Herbicide Treatment to Seeding Intervals

1992 was the third year of this test in which Dimension (dithiopyr), Lesco Pre-M (pendimethalin) and Ronstar (oxadiazon) were applied 1, 2, 3, 4, or 5 months prior to seeding Kentucky bluegrass, perennial ryegrass, chewing fescue, and creeping bentgrass. When the three years are compared, dramatic variability between years is noted. Safe intervals for Dimension EC were between 2 and 5 months; for pendimethalin, 3 to 5 months; for Ronstar 4 to 5 months. These studies underscored the important role of weather conditions on preemergent herbicide residual longevity. In 1991, near-record drought prolonged residuals; in 1992, record rainfall reduced the length of the residual; and in 1990, an average year, the length of residual was between 1991 and 1992 figures.

Data suggests that use-rates of Dimension EC will have similar treatment to seeding intervals as does pendimethalin; and that Dimension granules will have a slightly longer residual similar to Ronstar 2G. It is important to note that when pre / post tank mixtures are applied for crabgrass control, special attention should be paid to the interval from such applications to overseeding dates. While such combinations would not have affected seedling establishment in 1992, these intervals would have decreased seedling establishment in the previous two years. Reducing the rates of residual herbicides used in pre/post combinations may avoid such effects. If herbicide residues are suspected, it is advisable to conduct a bioassay before seeding (see *CUTT* Vol. 2, No. 2 or *Weed Facts* No. 3).

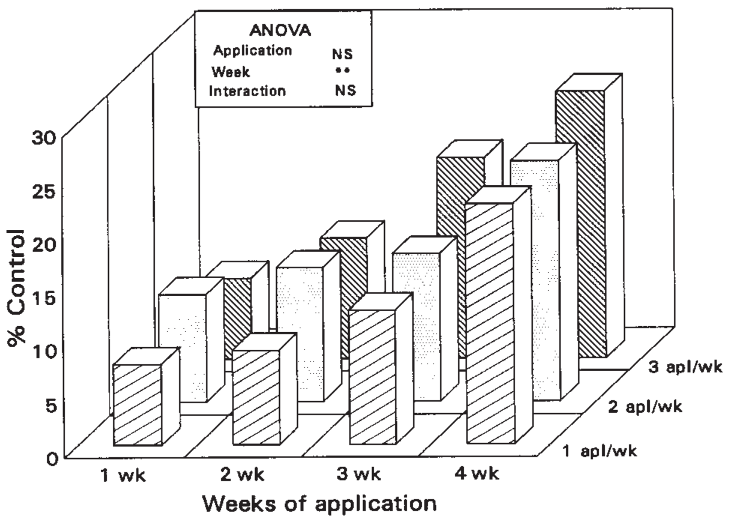


Figure 1
Bacterium inoculation frequency effects on pathogenicity towards annual bluegrass

The X-axis is the number of consecutive weeks of inoculation. The Z-axis is the percent control approximately 60 days after the first inoculation (and 30 days after the last).

***It is likely that environmental conditions in New York are not favorable to the bacterium* Xanthomonas campestris pv. poannua.**

Inoculating vigorously growing weeds with bacterium, then imposing drought (or other stress) appears to improve control of annual bluegrass.

These studies underscored the important role of weather conditions on preemergent herbicide residual longevity.

Factors Affecting Propagule Germination in Two Pythium Species Pathogenic to Turfgrasses

Dave Han and Eric Nelson, Dept. of Plant Pathology

Pythium root rot is a major problem for turf managers in the Northeast. It spreads rapidly through wet soil and causes severe damage in cool or warm weather. Several species of Pythium have been implicated as causes of root rot. Two of the most important seem to be *P. graminicola*, the most virulent species found on turf in the Northeast, and *P. torulosum*, the most common.

This project is intended to study how these two species propagate themselves. Most of the work to this point has been done with oospores, the long-lived sexual spores of Pythium. Since oospores are believed to be the primary means by which these organisms survive in turfgrass soils, understanding how they behave will tell us much about the way diseases caused by these two Pythium species develops. This will enable us to formulate better strategies for controlling Pythium root rot in the field.

Factors influencing germination of oospores were examined in a series of experiments using seed and root extracts from creeping bentgrass and perennial ryegrass. Oospores were grown on a culture medium developed in the laboratory for the culture of other Pythium species.

Germinability of *P. torulosum* oospores was found to depend on the age of the cultures. Oospores from seven-, eight- and nine-day-old cultures did not germinate, whereas by the time cultures were 12-16 days old, significant oospore germination was observed. *P. torulosum* oospores of this age will germinate at a moderate rate in distilled water, but adding ryegrass root exudate, ryegrass seed exudate or bentgrass seed exudate increases germination rates to as high as 80% (see figure 1). After about three weeks, germination rates leveled off.

P. graminicola oospores are much less germinable than *P. torulosum*. Cultures as old as 22 days show little or no germinability either in distilled water or exudate. Glucose, which has been shown to stimulate propagule germination in other Pythium species, does not stimulate oospore of either species to germinate.

The extremely high germinability of *P. torulosum* oospores may account for the high populations consistently recovered from turf. This species is ubiquitous in both healthy and diseased turfgrass stands. Conversely, *P. graminicola* oospores do not germinate readily, and it is not frequently recovered from turfgrass roots. However, the *P. graminicola* isolates that can be recovered tend to be much more virulent than *P. torulosum* in laboratory and greenhouse tests. The reasons for this are unclear at the moment.

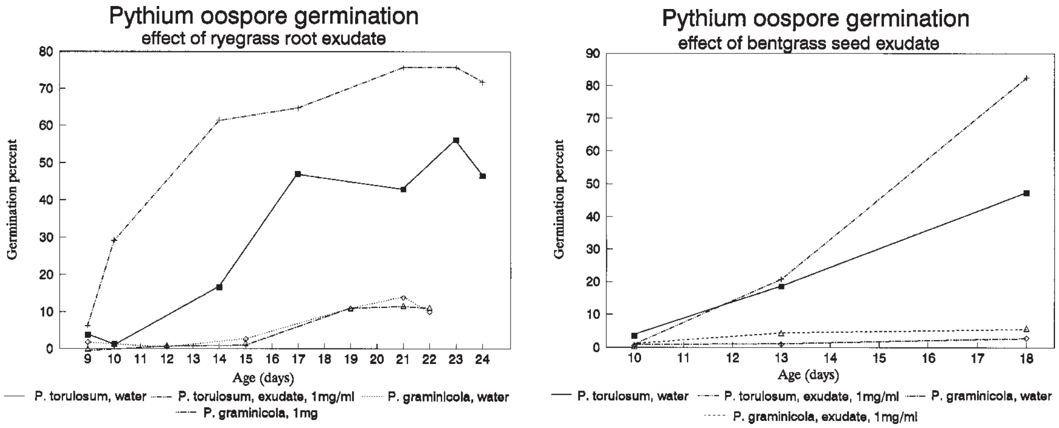
At this point, there are still many unanswered questions about the spread of Pythium root rot. In particular, what role do other propagules (such as sporangia and zoospores) play in the course of Pythium root rot disease? *P. graminicola* sporangia, for example, germinate as infrequently as oospores. Future research will be directed toward developing an understanding of how other Pythium propagules behave and the role that they play in disease development. Additional studies will focus on more specific aspects of the infection process in turfgrass plants.

Oospores, the long-lived sexual spores of Pythium, are believed to be the primary means by which these organisms survive in turfgrass soils.

Germinability of **P. torulosum** ***oospores was found to depend on the age of the cultures.***

P. graminicola ***oospores are much less germinable than*** **P. torulosum,** ***but are more virulent.***

Figure 1



The Utilization of Aqueous Compost Fermentation Extracts ("Compost Tea") for the Suppression of Turfgrass Pathogens

Eric Nelson and Peter Trutmann, Dept. of Plant Pathology

Our initial goal in this project was to expand upon work conducted over the past decade in Germany on compost teas. Our goal has been to optimize the fermentation process to maximize disease suppression, focusing on the microbiological changes that accompany this fermentation. In so doing we will be able to optimize fermentation parameters to maximize the proliferation and activities of the component microorganisms. A further goal is to integrate the fermentation processes with our knowledge of the composting process, so that optimum stages of composting can be identified as appropriate for extract preparation.

The objectives of the project are to:

1) determine the spectrum of composts that are suitable for the preparation of disease-suppressive fermentation extracts,
2) identify the stage of the composting process most suitable for the preparation of a highly disease-suppressive extract,
3) determine the fermentation parameters (i.e. temperature, aeration, extraction time, and selective microbial inhibitors) on the development of disease suppressiveness,
4) determine if the microflora is the active element in the expression of disease-suppressive properties in extracts,
5) identify the specific bacteria, fungi, and yeasts involved in disease-suppressive properties and determine the timing of their occurrence in fermentation extracts,
6) compare these microbial communities from among different composts to determine if the same microflora develops regardless of the starting material, and
7) evaluate extracts, produced under optimized conditions, for their efficacy against Pythium root rot in the field on a creeping bentgrass putting green.

Results thus far show compost extracts to be effective in the suppression of Pythium spp. affecting turfgrasses. Differences in quality of compost extracts exist depending on the composition of the compost. A study of the effect of fermentation time on the extract microflora indicated an early rise in bacterial populations with a concomitant drop in fungi and actinomycete populations. Subsequent experiments have shown that disease suppression is largely due to the microflora that develops during the fermentation process. Extracts that were filtered to remove microbial cells were ineffective in suppressing Pythium seed and seedling rots whereas the microbial pellet, when resuspended in a buffer and drenched into the Pythium-infested soil, completely restored the disease-suppressive properties of the crude extract. Selected bacterial strains from the microbial pellet were also effective in restoring disease suppression when applied individually.

An investigation of fermentation parameters important in disease suppression has revealed that the longer the fermentation period, the less active the extract. Similarly, the higher the extraction temperature, the less active the extract. We have also shown that composts (particularly yard waste composts) that are not particularly suppressive to Pythium spp. by themselves can give rise to extracts that are suppressive. Current investigations are focusing on the microbiological aspects of the fermentation process.

Our preliminary study of the bacterial flora has revealed a relatively non-diverse bacterial community; only two or three different morphological "types" predominate the extract. This suggests that the fermentation process provides a selection for a limited number of microbial groups from the compost that are capable of providing a high level of disease control. This further suggests that the study of these extracts may provide a ready means of recovering antagonistic microorganisms from composts that can be used subsequently as inoculants to provide consistently disease-suppressive composts.

Compost extracts are effective in the suppression of Pythium spp. affecting turfgrasses.

Disease suppression is largely due to the microflora that develops during the fermentation process.

An investigation of fermentation parameters important in disease suppression has revealed that the longer the fermentation period, the less active the extract. Similarly, the higher the extraction temperature, the less active the extract.

Organic Source Effects on Disease Suppression and Physical Stability of Putting Green Rootzone Mixes

Mary Thurn and Norman Hummel, Dept. of Floriculture and Ornamental Horticulture,
and Eric Nelson, Dept. of Plant Pathology

The results of these experiments suggest that composts may be satisfactory organic amendments for sand-based rootzones.

As peat becomes more difficult to mine, alternative organic sources will likely become common in putting green rootzones mixes. A two-year field study was established to evaluate four organic sources in sand-based rootzones for disease suppression, physical stability, and nitrogen mineralization. Field experiments were conducted to determine compost suppressiveness to Pythium root rot caused by *Pythium graminicola,* and the impact of phosphorus treatments on disease severity. Laboratory assays were done to assess persistence of suppressive properties in compost amendments.

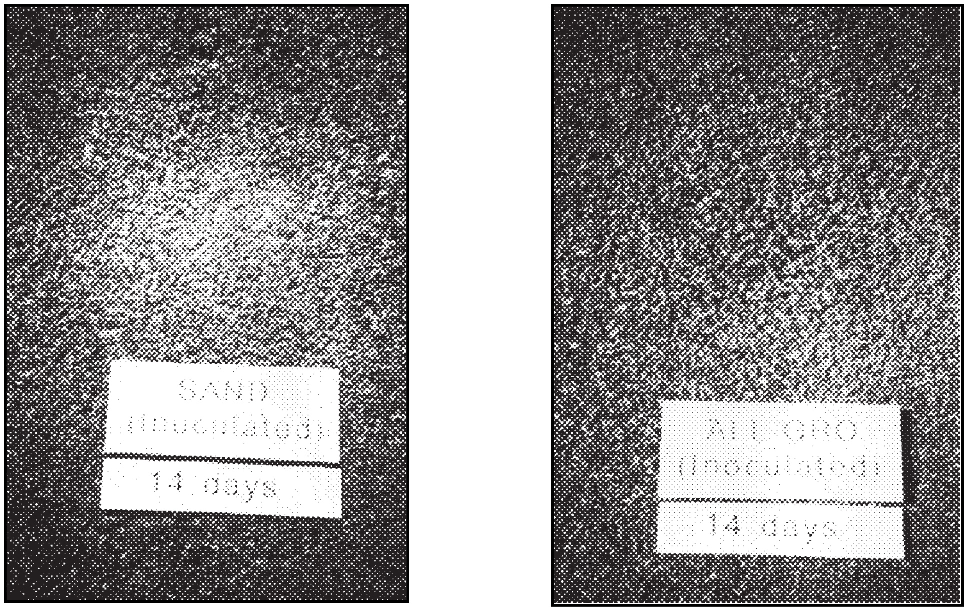
Physical properties of laboratory-packed soil cores and undisturbed field cores were determined according to USGA test protocols and included saturated hydraulic conductivity, bulk density, porosity, pore distribution at -4kPa water potential, and particle density. Mineralization samples were analyzed for total Kjeldahl nitrogen, ammonium nitrogen, and percent organic matter by loss on ignition.

Plots were inoculated with *Pythium graminicola* in October 1991 and June 1992. In both trials, a municipal sewage sludge compost, a brewery waste compost, and reed sedge peat provided significantly better disease control than either the sand control or a seaweed product, for all rating dates. The composts and peat generally provided better than 80% control. Laboratory assays showed similar degrees of disease suppression, regardless of age of the rootzone mix. As in the field trials, the sewage compost, brewery compost, and reed sedge peat provided significantly better disease control than the seaweed product or sand. Phosphorus treatments applied at rates of 49, 98, 196, and 294 kg of P/ha/yr, had no effect on disease ratings.

Physical properties of laboratory-packed samples were compared to undisturbed field cores taken one year after establishment. The objective of this study was to determine if measurements taken on laboratory-packed samples could be used to predict physical properties in the field. Simple correlation coefficients for the relationship between laboratory-packed samples and field samples showed significant correlation and regression relationships for bulk density and total porosity. Undisturbed cores removed from plots amended with peat, brewery compost, and sludge compost had desirable physical properties, especially in regards to bulk density, total porosity, and capillary porosity.

The results of these experiments suggest that composts may be satisfactory organic amendments for sand-based rootzones.

Undisturbed cores removed from plots amended with peat, brewery compost, and sludge compost had desirable physical properties, especially in regards to bulk density, total porosity, and capillary porosity.



Influence of compost on suppression of Pythium root rot in sand-based rootzone.

Annual Field Diagnostic Course For Residential and Institutional Lawn Managers

■ Mark your calendar today! On August 3, 4 and 5 Cornell Turfgrass Pest Management Specialists will use on and off campus sites to review identification techniques and control strategies for turfgrass insects, diseases and weeds. Sampling procedures, laboratory diagnosis and utilization of key diagnostic resources are essential components of the course. The enrollment is limited to 25 turfgrass managers to allow for the ideal learning situation. This is an advanced course and will be particularly beneficial to past Cornell Turfgrass Short Course graduates, graduates of other turfgrass management programs or individuals with 5 years of experience.

■ The tuition of $210 includes: instruction, study materials (textbooks and guides), breaks, lunches, BBQ and a certificate after completion of the course. *Registration will only be taken by mail and not by phone.* Use the registration form provided. General information and details on local accommodations will be sent with the registration confirmation. If you have any questions, please call Joann Gruttadaurio at 607-255-1792.

■ Please complete and mail the form and your check to:

Angelica Hammer, Cornell University,
20 Plant Science Building, Ithaca, New York 14853.

■ Make your check for $210 payable to Cornell University. Class enrollment is limited to 25 students. A cancellation fee of $20 will be charged to registrants who cancel after July 19. Please submit one form for each individual and print clearly.

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____

Disease Resistance of Bentgrasses

Norman Hummel, Dept. of Floriculture and Ornamental Horticulture and Eric Nelson, Dept. of Plant Pathology

There were few differences in cultivar resistance to Pythium root rot.

Studies were conducted in growth chambers and in the field to evaluate several bentgrasses for resistance to brown patch, dollar spot, and Pythium root rot. Twenty two bentgrass from the National Turfgrass Evaluation Program were grown in the growth chamber and/or at the Turfgrass Research Laboratory in Ithaca. Varieties grown in the growth chamber were inoculated with *Rhizoctonia solani* and *Sclerotinia homeocarpa* in two separate studies. Observations on mortality were taken on several dates after inoculation. Natural infestations occurred in the field studies, except for the Pythium root rot, which was inoculated.

Differences in cultivar resistance to brown patch and dollar spot occurred in both field and growth chamber studies. In the field, the colonial bentgrasses, such as Allure, Tracenta, and Bardot showed the greatest resistance to dollar spot. Egmont browntop bentgrass and BR-1518 also showed some resistance relative to the creeping bentgrasses. None of the creeping bentgrasses showed observable resistance, although Emerald, SR-1020, and Forbes 89-12 exhibited the most severe disease injury.

Greatest resistance to brownpatch in the field trial was observed on Lopez creeping bentgrass, followed closely by WVPB 89-D-15, Forbes 89-12, and Penncross. BR 1518, Bardot, and Allure were most susceptible, with most of the other creeping bentgrasses intermediate in resistance.

There were few differences in cultivar resistance to Pythium root rot, all the bentgrasses succumbing to the disease within one month after inoculation.

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