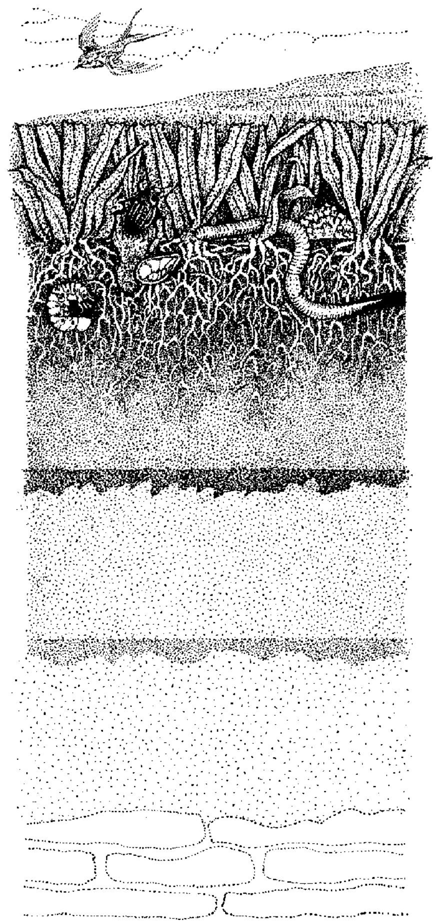
CORNELL UNIVERSITY TURFGRASS TIMES

CUTT

Spring/Summer 1996 • Volume Seven • Number One • *A Publication of Cornell Cooperative Extension*



Biorational Control Agents for Japanese Beetle Management

The development of specialty pest management products often takes a back seat to products that targeted pests of crops such as field corn, soybeans and cotton. Products that were not effective against one or more insect pests on these major commodities had little chance to be tested against insects particular to turfgrass. Although the crop protection industry has focused greater attention on so-called specialty markets such as turfgrass, funding from New York State Turfgrass Association (NYSTA), NYS IPM, and TriState Turfgrass Research Foundation was essential for providing a nonbiased evaluation of these products. Following is a brief review of some of these products together with the results of representative laboratory and field studies conducted by my research team over the past several years. It is important to remember that these studies were conducted under ideal conditions with regards to proper timing, equipment calibration, quality of control agent, and proper environmental conditions. ■

Bacillus thuringiensis

Bacillus thuringiensis (Bt) is a soil living bacterium common in nature that was first discovered in Japan in 1901. There are over 30 subspecies and varieties of Bt. This family of bacteria produces a toxic protein crystal that is active against a fairly narrow group of insect species. Certain Bt products have been used to control insects for many years. Various strains have been identified with activity against caterpillars, fly larvae, and beetle larvae. Current commercial Bt varieties include Bt *kurstaki* and Bt *aizawai* (caterpillars), Bt *israelensis* (mosquitoes), and Bt *tenbrionis* (potato beetles).

Because Bt bacteria can be produced in great quantities using artificial media, there is great interest in the commercialization of this bacteria for insect control. The bacteria normally do not reproduce in the insect host, persist

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This Times

Short Cutts

Frank Rossi,
Assistant Professor of Turfgrass Science,
Turfgrass Science Cooperative Extension Program Leader,
***Editor of* Cornell University Turfgrass Times**

Rossi Accepts Turfgrass Science Position

Dr. Frank Rossi, formerly an Assistant Professor of Environmental Management of Turfgrass at the University of Wisconsin, Madison, has accepted the position of Assistant Professor of Turfgrass Science at Cornell University.

Dr. Rossi is no stranger to New York, having grown up in Eastchester, or to Cornell University; he was a Ph.D. student under Dr. Joe Neal in 1991. He took over at Cornell on May 1, 1996. His responsibilities are in both turfgrass extension and research. His extension duties include being the Turfgrass Science Cooperative Extension Program Leader, planning the New York State Turf and Grounds Exposition educational program, editor of *Cornell University Turfgrass Times* (CUTT) and being involved with field days and short courses. We warmly welcome Frank, his wife Barbara and their two children to Ithaca.

Coinciding with Frank's arrival, we bid farewell to Scott Ebdon, who served as interim Turfgrass Extension Specialist since September, 1995. Scott has accepted a turfgrass scientist position with O. M. Scotts & Sons, Marysville, OH. He will be developing research programs pertaining to turfgrass fertilizers and new product development. We wish Scott the very best in his new position.

Joe Neal Heading Home

It is with deep regret that we announce the departure of Dr. Joe Neal to North Carolina State University. Dr. Neal has been the definitive source for turfgrass and horticultural weed control in New York State. His work, alone and in collaboration with Dr. Andy Senesac has garnered national and international respect.

Dr. Neal will be assuming his former Ph.D. advisor's duties as the horticultural weed control specialist.

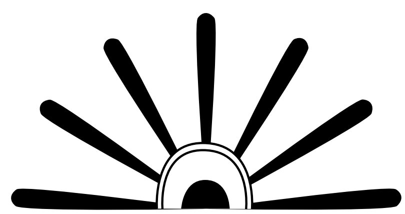
To facilitate a smooth transition for the Neal family, Joe, Brenda and the two girls will be departing in late August. While we are saddened to lose Joe and his family and his many contributions to New York State, we are thrilled to see them rejoin their close family ties in North Carolina and Georgia. We wish them all the best!

It's Our Fault, *You Win!*

As you may have noticed, the recent publication schedule of *CUTT* has been, uh, erratic. The departure of Norm Hummel, the interim period of Scott Ebdon, and the arrival of Frank Rossi, among other factors, have wreaked havoc on *CUTT's* publication. We regret that we have not been timely in delivering the latest news and information to our readers.

To try to make things up to you, our loyal readers, we have decided to extend all subscriptions by one year at no charge. We anticipate returning to a regular seasonal publication schedule and sending your full quota of four issues per year.

In addition, we intend to examine our editorial calendar to address topics that coincide with field work. We are considering some design and layout issues that will enhance the readability and appearance of *CUTT*. Finally, we are committed to providing you with the highest quality turf publication and would love your input. Call or write Frank Rossi with your comments.



CUTT, "Cornell University Turfgrass Times" is published four times per year by Cornell Cooperative Extension and the Turfgrass Science Program at Cornell University, Ithaca, New York 14853. Address correspondence to: *Cornell University Turfgrass Times*, 20 Plant Science Building, Cornell University, Ithaca, NY 14853; telephone: (607) 255-1629

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Field Diagnostic and Problem Solving Workshop for Golf Course Professionals

The Cornell Turfgrass Science Program announces a field diagnostic and problem solving workshop for golf course professionals to be held on the Cornell campus September 10-12, 1996.

Cornell Turfgrass Management specialists will use on-campus sites and the Robert Trent Jones Golf Course at Cornell to review identification techniques and control strategies for turfgrass insects, diseases and weeds in golf course situations.

The goals of the workshop are to help you to:
- improve your sampling techniques
- improve field and laboratory diagnostic techniques
- develop management programs and strategies for pest problems
- deal with different environmental situations
- implement and communicate your management program

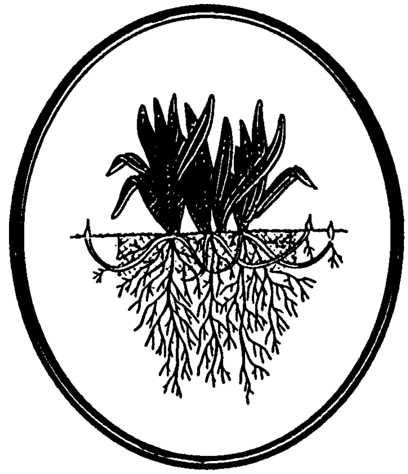
Both morning and afternoon sessions will be held. On the first day a session on IPM methods, including scouting, damage assessment, pest diagnosis, and recordkeeping will get the workshop going. It will be followed by sessions on how cultural practices impact pest pressure, and identification of key pests relating to diseases, insects and weeds.

The second day's classes will develop field diagnostic skills by focusing on how to recognize pests and the injuries they cause, how to collect samples, how to map, and how to scout. Laboratory analysis of collected samples will follow. After lunch there will be a session on developing a strategic plan and making a check list for field visits. The remainder of the afternoon will be spent at Cornell's golf course to collect samples and data.

On the last day, management practices will be the focus. Developing observation programs, assessing diagnostic tools, deciding which options to recommend, and the effect of seasonal changes will be covered in the morning. Later, management strategies for pest problems and environmental situations, covering diseases, weeds, insects, and cultural practices will be discussed. The final sessions will examine how to communicate your plan and implement your program.

The workshop fee of $275 includes all instruction; key diagnostic resources, including textbooks and guides; breaks; lunches; a BBQ dinner; and a certificate following completion of the workshop.

Enrollment is limited to 40 turfgrass managers to foster ideal learning situations. To ensure your place in the workshop, complete the registration form below (copy it so you don't have to cut up your *CUTT!)* and mail or fax it in. For more information, contact Joann Gruttadaurio at (607) 255-1792.



September 10-12, 1996 on the Cornell University campus and golf course.

Enrollment is limited so mail your registration today!

Registration Form

Please complete and mail or fax this form with your payment to Kelly Woodhouse, 20 Plant Science, Cornell University, Ithaca, NY 14853. Make your check for $275 (US) payable to Cornell University. A fee of $20 will be charged to registrants who cancel after August 15th. Please print clearly.

Name ______________________________ Social Security # ____________

Company ____

Address ____

____

Phone (daytime) ____________ Phone (home) ____________ Fax ____________

Have you attended the Cornell Turfgrass Short Course? _______ What year?_______

Years of turfgrass experience________

Education: Please describe your golf course experience:

High School ______________ ______________________________

2 yr degree in ______________ ______________________________

4 yr degree in ______________ ______________________________

Masters in ______________ ______________________________

Other ______________ ______________________________

Biorational Agents

continued from front cover

Until recently there were no Bt varieties known to cause significant mortality in scarab grubs inhabiting turfgrass. In 1991, Bt variety* japanensis *strain* BuiBui *was discovered in Japan.

Japanese beetle, Oriental beetle, northern and southern masked chafer, and green June beetle grubs have all been shown to be highly susceptible to Bt* BuiBui *in laboratory and field studies.

in the environment, or spread from the treatment site; for these reasons Bt typically has been used as a microbial insecticide for short term-control.

How Bt kills insects (mode of action) is fairly well understood. First, because it acts as a stomach poison, the toxic protein crystals must be eaten by an insect to be effective. In some cases, additional products produced by the living bacteria must be consumed for maximal activity. If the insect's gut content is of the proper acidity (pH) the crystals will dissolve in the insect's gut. Proteins released from the dissolved crystal binds to specific sites in the gut lining of susceptible insect species causing rapid paralysis of the gut. The major reasons for the lack of activity of a Bt strain against an insect species are first, improper gut pH that does not allow the toxic protein crystal to dissolve, and second, the inability of the toxic proteins to bind to the insect's gut. Almost immediately the insect stops feeding as the gut wall deteriorates. In most cases a susceptible insect will die 2-7 days after ingestion of the Bt toxin.

Although Bt products are registered for use against several turf-feeding caterpillars, including cutworms and sod webworms, these products have not been widely recommended or accepted in the turf industry, most probably due to their short residual, slow activity and inability to kill larger larvae.

Until recently there were no Bt varieties known to cause significant mortality in scarab grubs inhabiting turfgrass. In 1991, Bt variety *japanensis* strain *BuiBui* was discovered in Japan. Development and commercialization of Bt *BuiBui* has been undertaken by the biotechnology company Mycogen of San Diego CA, who expects registration of the product against certain scarab grubs in 1996, if formulation problems and consistent activity at competitive field rates can be addressed. Bt *BuiBui* has a spherical protein crystal that is toxic to certain kinds of scarab grubs. Unlike most commercial Bt products currently on the market, maximal activity of Bt *BuiBui* against scarab grubs occurs when formulations include both the toxic protein crystals and live spores produced by the bacteria. According to Mycogen, Bt *BuiBui* is nontoxic to all vertebrates, earthworms, honeybees, and plants.

Japanese beetle, Oriental beetle, northern and southern masked chafer, and green June beetle grubs have all been shown to be highly susceptible to Bt *BuiBui* in laboratory and field studies while June beetle, black turfgrass Ataenius beetle and Aphodius beetle grubs appear much less sensitive to this product. The results of four small plot field studies conducted in New York State that focused on the activity of this Bt against Japanese beetle grubs are outlined in Table 1. These results suggest a highly active

Table 1. Results of small plot field studies conducted in New York focusing on the activity of Bt against Japanese beetle grubs.

Rate (kg a. i./ha)	Mean Grubs/Ft^2	Percent Control
1993 Marcellus, NY 2nd/3rd Instar Treated		
Control	12.4	—
36.4	1.33	89.3
72.9	0.58	95.3
145.8	1.67	86.6
1994 Horseheads, NY 1st/2nd Instar Treated		
Control	28.1	—
16.2	1.40	95.0
32.3	1.20	96.0
64.6	1.50	95.0
1995 Marcellus, NY 1st/2nd Instar Treated		
Control	12.5	—
2.9	4.5	64.0
5.9	0.6	95.0
11.8	0.3	98.0
23.5	0.0	100.0
1995 Schenectady, NY 3rd Instar Treated		
Control	33.8	—
2.9	17.3	49.0
5.9	26.0	23.0
11.8	17.8	47.0

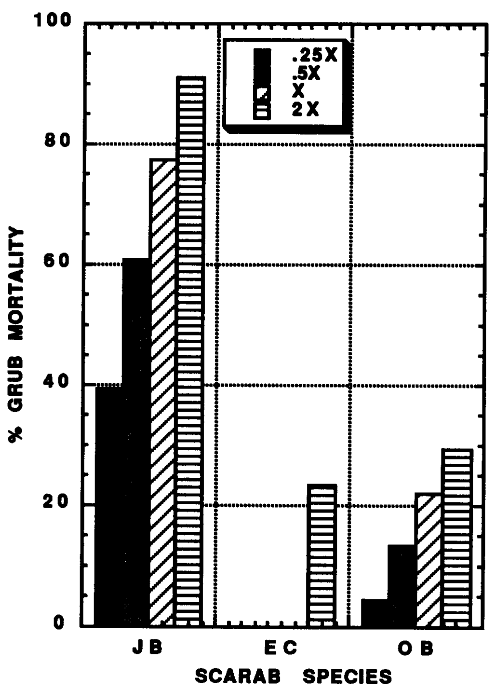
field product that appears to be more effective against earlier instars at lower field rates.

Insect Growth Regulators

Several chemical companies are developing novel classes of compounds with unique modes of action that interfere with the normal insect molting process by mimicking the action of the natural insect molting hormone ecdysone. High doses of these Insect Growth Regulator (IGR) products typically cause rapid insect mortality, while sublethal effects include rapid maturation to the adult stage, larvae showing deformities, and larvae undergoing additional larval molts instead of changing to pupa. Specific IGR products have shown activity against scarab grubs, cutworms and sod webworms.

Insect growth regulators typically require ingestion for optimum activity so it is important that the target insect is actively feeding when they are applied. The use of an IGR on scarab grub populations late in the fall as they prepare to move down into the soil for winter as well as the application to grubs in late spring as they prepare to pupate is ill advised for this reason. Laboratory and field studies indicate that early larval stages are susceptible to IGRs and also suggests that there is a fairly wide range of activity among closely related insects such as different species of scarab grubs (see Figure 1).

Figure 1. Species-Specific Activity of Insect Growth Regulator Against 3rd Instar Scarab Grubs.



Our studies have shown that one IGR shows truly impressive activity against Japanese beetle grubs but much less dramatic activity against either European chafer or Oriental beetle grubs. The specificity of these products demands that turfgrass managers determine which insect species is present, to avoid disappointing results.

The results of four small plot field studies conducted in New York State that focused on the activity of the experimental IGR, 0345, jointly developed by American Cyanamid and Rohm & Haas against Japanese beetle grubs are outlined in Table 2. These results suggest a highly active field product that appears to be more effective against earlier instars at lower field rates, as indicated in the two 1995 studies.

Our studies have shown that one IGR shows truly impressive activity against Japanese beetle grubs.

Table 2. Results of small plot field studies conducted in New York focusing on the activity of IGR 0345 against Japanese beetle grubs.

Formulation	Rate (kg a. i./ha)	Mean Grubs/Ft²	Percent Control
1994 Horseheads, NY 1st/2nd Instar Treated			
Control		28.1	—
2.5G (A)	1.5 lb AI/A	2.80	90.0
2.5G (A)	3.0 lb AI/A	0.50	98.2
2.5G (B)	1.5 lb AI/A	8.10	71.2
2.5G (B)	3.0 lb AI/A	4.40	84.3
2 (F)	1.5 lb AI/A	1.10	96.1
2 (F)	3.0 lb AI/A	0.00	100.0
1995 Marcellus, NY 1st/2nd Instar Treated			
Formulation	Rate (kg a. i./ha)	Mean Grubs/Ft²	Percent Control
Control		12.5	—
SC	1.5 lb AI/A	0.30	98.0
SC	2.0 lb AI/A	0.10	99.0
2.5 (G)	1.0 lb AI/A	0.90	93.0
2.5 (G)	1.5 lb AI/A	0.00	100.0
2.5 (G)	2.0 lb AI/A	0.50	96.0
5 (G)	1.0 lb AI/A	0.90	93.0
5 (G)	1.5 lb AI/A	2.00	84.0
5 (G)	2.0 lb AI/A	0.60	95.0
1995 Schenectady, NY 3rd Instar Treated			
Formulation	Rate (kg a. i./ha)	Mean Grubs/Ft²	Percent Control
Control		33.8	—
SC	1.5 lb AI/A	5.30	84.4
SC	2.0 lb AI/A	2.00	94.1
2.5 (G)	1.0 lb AI/A	9.30	72.6
2.5 (G)	1.5 lb AI/A	1.50	95.6
2.5 (G)	2.0 lb AI/A	1.30	96.3
5 (G)	1.0 lb AI/A	9.30	72.6
5 (G)	1.5 lb AI/A	3.30	90.4
5 (G)	2.0 lb AI/A	9.30	72.6

Entomogenous Nematodes

Entomogenous nematodes recently have received attention as alternatives to insecticides for turf insect control. There are many factors, in theory, that make nematodes the ideal microbial control agent: they have a broad host range, will not attack plants or vertebrates, are easy to mass produce, and can be applied with most standard

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Biorational Agents

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Entomogenous nematodes recently have received attention as alternatives to insecticides for turf insect control.

insecticide application equipment. Additionally, nematodes can search their hosts and kill them rapidly, multiply within the host and within several weeks release thousands of mobile progeny able to locate and infect new insect hosts. Because they are considered predators and not microbial insecticides, entomogenous nematodes are exempted from registration by the U.S. Environmental Protection Agency. This exemption from long term safety and water quality studies greatly reduced the costs and risks typically associated with bringing a new insecticide to the market .

Entomogenous nematodes enter through natural openings of the insect, most commonly the mouth or less commonly, through skin. They then move through the gut of the insect into the blood where they release a colony bacteria that lived within the nematode's body. Once inside the insect, the bacteria multiplies and produces toxins that rapidly kill the infected insect. Nematodes feed on bacteria and reproduce inside dead insects producing several thousand new nematodes. Under ideal conditions thousands of new infective nematodes will escape from the dead insect in as little as ten days and begin to search for new hosts to infect.

Table 3. Results of small plot field studies conducted in New York focusing on the activity of nematodes against white grubs.

Species	Rate	Mean Grubs/Ft²
1993 Marcellus, NY 2nd/3rd Instar Treated		
Control		12.4
S. g.	0.5 B/A	4.70
S. c.	2.0 B/A	9.10
H. b.	1.0 B/A	6.30
1994 Horseheads, NY 1st/2nd Instar Treated		
Control		28.1
H. b. (O)	0.5 B/A	19.75
H. b. (O)	1.0 B/A	6.38
1995 Marcellus, NY 1st/2nd Instar Treated		
Control		12.5
H. b. (O)	1.0 B/A	1.60
Bt	2.9 kg a.i./ha	4.50
H. b. (O) + Bt	1.0 B/A + 2.9 kg a.i./ha	0.80

KEY: S. g.=*Steinemema glaseri;* S. c.=*Steinemema carpocapsae;* H. b.=*Heterorhabditis bacteriophora; O=Oswego strain*

Although there have been many successful field applications of entomogenous nematodes for turf insect control, problems with product quality, persistence and host specificity have led to unsatisfactory results is some instances. Although entomogenous nematodes generally are considered to have fairly broad host ranges in laboratory studies, different strains and species of nematodes vary in activity against different insect species in the field. Overall, the nematodes *Heterorhabditis bacteriophora (H. b.)* and *Steinernema glaseri (S. g.)* are more effective against white grubs than the more commonly marketed *Steinernema carpocapsae*, because the former two nematode species actively move down in the soil profile and search for insects (see Table 3). Conversely, *Steinernema carpocapsae*, has been effective for control of billbugs and caterpillars such as cutworms, webworms and armyworms.

Many unsuccessful field applications of entomogenous nematodes for scarab grub control can be traced to improper environmental conditions at the time of application and for several weeks post application. Nematodes are extremely sensitive to exposure to ultraviolet light and will last only a matter of minutes when exposed to full sunlight. They are also quite prone to desiccation requiring high relative humidity and a film of moisture on leaf and soil surfaces to survive and move. For these reasons nematodes should be applied very early in the morning or late in the day and be immediately irrigated with at least one half inch of water. Nematodes searching for grubs move over soil particles on thin water films and will not search efficiently in saturated soils. The inability to provide adequate soil moisture for several weeks post application limits the utility of nematodes in many situations.

One mistake often made by turfgrass managers is to save money by applying nematodes at rates lower than recommended. Extensive field studies on New York golf courses over the past five years confirm that there is a strong positive correlation between the number of nematodes applied and grub mortality (see Table 3 for 1994 data).

Although often treated as an insecticide, entomogenous nematodes are living organisms that must be treated with care to be effective. Only nematodes in the best condition will be able to successfully search for an insect host, overcome the defenses of the insect to infect and kill it, and multiply within the dead insect producing progeny to infect new hosts. As an example, excellent field results were obtained during 1995 using Hb nematodes (Oswego strain) that were reared in my laboratory (see Table 3). To maximize the probability of applying healthy nematodes it is critical that label directions related to nematode storage, application and rates are followed carefully.

Combinations of biological control agents may impart additive or synergistic mortality on grub populations. This may occur if the two agents attack different subpopulations of the pest infestation (i.e. grubs feeding at different depths in the soil or feeding vs. nonfeeding grubs). It may also occur if the one control agent stresses or predisposes an insect to a second agent. In 1994 we reported the synergistic interactions of fungal pathogens and a synthetic insecticide. During this past year we explored the possible interaction of Bt and the Hb nematode in the lab and in the field. Laboratory bioassays showed no activity of Bt against Japanese beetle grubs at the lowest field rate tested during 1995. Hb (Oswego) applied at an equivalent of 0.5 billion nematodes/A resulted in a 43% population reduction four weeks post treatment. The combination of Bt and Hb at the stated rates resulted in increased mortality of grubs for all dates evaluated (see Figure 2).

Fungal Pathogens

Virtually every group of turfgrass insect pests, including scarab grubs, chinch bugs, billbugs, annual bluegrass weevils, sod webworms, cutworms, and mole crickets, are susceptible to endemic populations of fungal pathogens such as *Beauveria bassiana* and *Metarhizium anisopliae.* Commercial interest in fungal pathogens as biological control agents have ebbed and flowed over the last decade as the promising results seen in laboratory and greenhouse tests have collided with the hard realities of producing an effective, consistent, price competitive and safe commercial field product. At present, there are no commercial fungal products available for management of turf pests.

Fungi differ from most other microorganisms because they do not have to be ingested to be effective. Infection is initiated by the adhesion of a fungal spore to the body of an insect. If conditions are correct, the spore will germinate and a tube will grow from the spore into the insect penetrating the circulatory system. After penetration, the fungus reproduces within the insect producing toxins that quickly kill the insect. After death of the host, hyphae emerge from the insect and develop into structures that produce more infective spores. These spores can then be spread through the environment infecting additional insects. Studies 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 isolates of *Metarhizium anisopliae* 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, have generated significant interest 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 were considerable differences in how well several fungal isolates performed under a variety of environmental conditions commonly found in northeastern golf courses (see Figure 3).

Fungal pathogens may also cause mortality of adult Japanese beetles. In a laboratory bioassay mating pairs of Japanese beetles were placed in a plexiglas chamber that contained grape leaves and soil for females to lay eggs. In one third of the chambers the *Metarhizium* isolate 2547 was incorporated into the soil, in the second third of the chambers soil without fungus was used, and in the last third of the chambers beetles had the choice of treated and untreated soil. As can be seen in Figure 4, high mortality was observed in both fungus containing treatments with male mortality lagging behind females in both treatments. This occurred because males do not contact the fungus directly in the soil, but through indirect contact as they mate with infected females.

M. G. Villani
Dept. of Entomology

Combinations of biological control agents may impart additive or synergistic mortality on grub populations.

Figure 2. Interaction of Bt and Entomogenous Nematode Hb (Oswego).

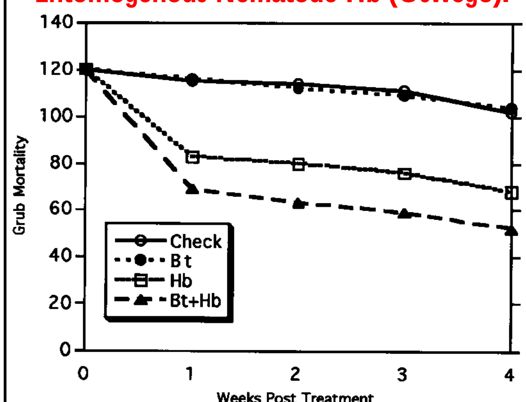


Figure 3. Comparative Activity of *Metarhizium* Isolates Against Japanese Beetle Grubs.

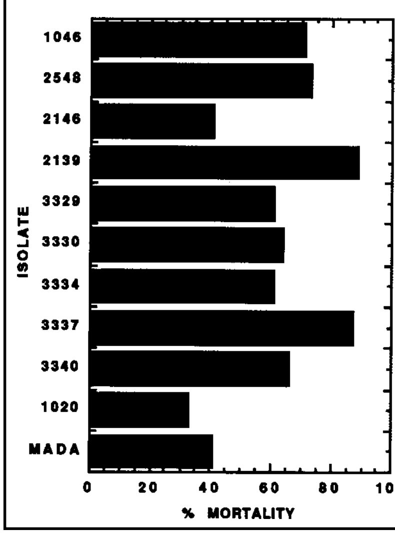
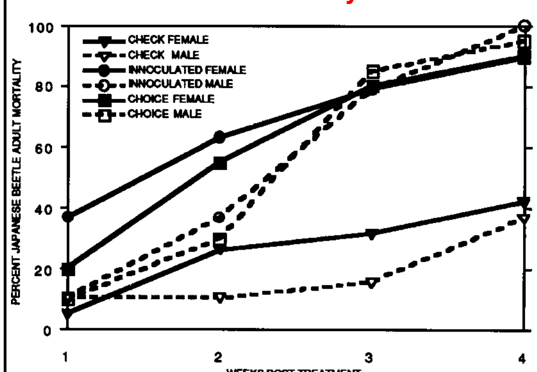


Figure 4. Japanese Beetle Oviposition Study, Adult Mortality.



Integrated Pest Management Programs in 1995

IPM Corner

As more superintendents throughout the state have been exposed to the benefits of IPM, the demand for IPM scout training for golf course employees has increased.

Once again, 1995 marked another successful year for the New York State IPM Program. Turfgrass managers, Cornell University faculty, and Cornell Cooperative Extension field staff worked together to demonstrate and implement sound research-driven pest management methods.

The New York State IPM Program provided approximately $35,000 in funds to research, develop and implement IPM methods for turfgrass professionals. These funds were provided by the State of New York through the Department of Agriculture and Markets; $17,000 of these funds were provided to the Cornell turfgrass team of Drs. Michael Villani, Eric Nelson and Joe Neal to help research alternative methods to manage turfgrass pests. The Cornell research team will present their results in future *CUTT* issues. The remaining funds were used to demonstrate and implement IPM techniques and methods. In 1995, these funds provided turfgrass managers throughout the state the opportunity to expand their knowledge and improve their pest management programs.

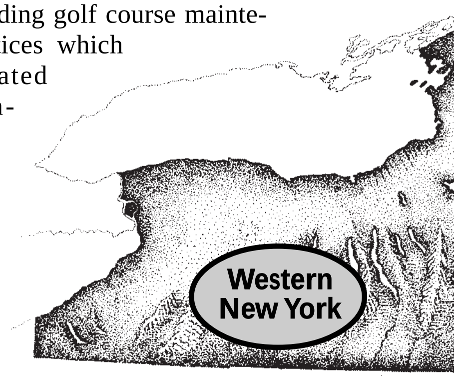
In the early 1990's, scouting demonstrations were emphasized in golf course IPM programs in New York. (One such project was conducted on two golf courses in Westchester County this year, in cooperation with Cooperative Extension of Westchester County and the NYS IPM Program.) As more superintendents throughout the state have been exposed to the benefits of IPM, the demand for IPM scout training for golf course employees has increased. In response, IPM training was offered in three areas of the state in 1995: Adirondack region, Rockland County and Western NY.

Adirondack Region

Superintendents in the Adirondack region have been interested in IPM for many years. Several of them have attended the Cornell Turfgrass Short Course, and a private turf scouting service was provided by a student in 1993. A group interested in bringing IPM to the Adirondacks began meeting in early 1995, including representatives from the Adirondack Park Agency (APA), the Adirondack Superintendents Associations, New York State Parks, and the New York State IPM Program. Two summer sessions were planned and held, with approximately 40 participants at each. The first meeting was held in Stony Creek (Warren County) and focused on IPM strategies and scouting turf. The second session in Peru (Clinton County) focused on winter diseases and the injury they cause to turf, and disease diagnosis and the use of composts in disease control.

Rockland County

A series of six hands-on IPM training sessions were conducted at Rockland county golf courses in 1995. The workshops created the forum for exchange of information related to practical application of IPM research between and among researchers and Rockland's golf course maintenance professionals. The workshops were held at a different course each month, and the educators and participants used the course as a living laboratory for learning about site assessment; water and nutrient management; pests of trees and shrubs; turf disease management; and turf insect scouting and management. Participants were able to evaluate specific problems with the educators, debate the pros and cons of some of the IPM strategies proposed, and adapt new skills and tools for pest management as the season progressed. There is a high level of concern among Rockland County environmentalists regarding golf course maintenance practices which has motivated superintendents to learn as much about IPM as possible. This training not only gave them new turf management skills, it also addressed environmental issues that are of concern to the larger community. A similar program in 1994 with state golf course personnel was used as a model.



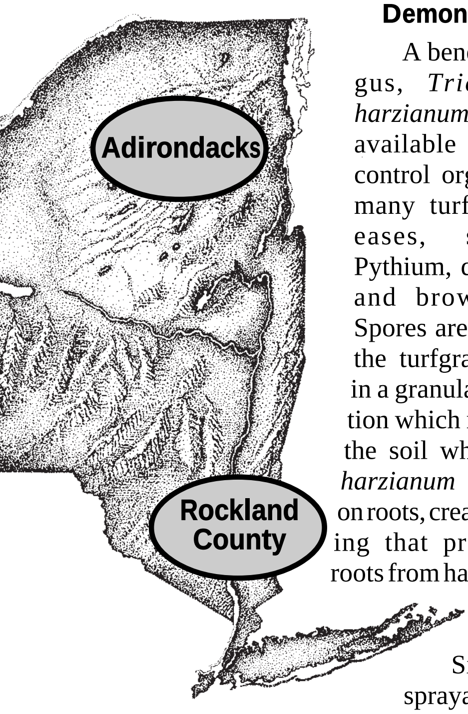
Western New York

A hands-on training series, similar to that conducted in Rockland County, was organized by Cornell Cooperative Extension in Western New York. Although these meetings were held on golf courses, general turf topics were addressed and lawn care professionals also attended. Four sessions were held, with approximately 15 participants at each. Topics included IPM scouting (general); IPM scouting and control for diseases; IPM scouting and control of insects; and IPM scouting and control for weeds.

Many superintendents prefer to hire a private, outside scout in addition to or instead of using their own employees for scouting. In 1995, a new service was offered in Central and Western New York (Syracuse to Buffalo) that provides golf course scouting and disease diagnoses of turfgrass samples. The consultant previously worked for Cornell Cooperative Extension and helped establish Cornell's turfgrass IPM scouting procedures. Approximately 20 courses were scouted and more are anticipated in 1996.

Developing, testing and demonstrating practical alternative methods to control turfgrass pests is a primary goal of the IPM Program. In 1995, two alternative products, Trichoderma, a beneficial fungus for many turfgrass diseases, and a strain of *Bacillus thuriengensis bui bui*, for controlling grubs, were tested and demonstrated. Cornell researchers have been working both in the laboratory and the field with these products for the past few seasons.

Trichoderma Demonstration



A beneficial fungus, *Trichoderma harzianum*, is a newly available biological control organism for many turfgrass diseases, such as Pythium, dollar spot, and brown patch. Spores are applied to the turfgrass surface in a granular formulation which moves into the soil where the *T. harzianum* establishes on roots, creating a coating that protects the roots from harmful root-attacking fungi. Similarly, a sprayable formulation delivers inoculum to the leaf surfaces, and a protective layer of fungus establishes on the blades. The granular product, marketed as BIO-TREK 22G by the Wilbur-Ellis company, has been approved as a pesticide by the EPA. New York State registration was also granted in 1995. The wettable powder (sprayable form) is still under development. During the 1995 season, the use of *T. harzianum* was demonstrated on four golf courses in New York (Chemung, Erie, Seneca, and Tompkins Counties).

Four golf courses, two private, and two public, were chosen as demonstrations sites. It is to early to determine the overall effect of the *Trichoderma* demonstration. A great deal was learned that should improve the prospects for these biocontrol organisms such as, application methods, soil population levels of *Trichoderma* and potential influences like thatch on the organism. An environmentally compatible disease management tool for high maintenance turfgrass is greatly needed by the industry, as was shown by the eagerness of several superintendents to participate in this demonstration. Further field studies with this organism will be pursued in order to improve its usefulness and adoption by NYS turfgrass managers.

Bt Demonstration for Grub Control

For many years, Dr. Villani at Cornell has studied the use of biorational control agents for grubs in turf (see article beginning on page 1). Dr. Villani has conducted research and reported the results in many popular turfgrass publications. In the laboratory and the field Dr. Villani has studied many biorational products such as the strains of *Bacillus thuringiensis* (Bt). Until recently there were no Bt varieties known to cause significant mortality in scarab grubs inhabiting turfgrass. In 1991, BT variety *japanensis* strain *BuiBui* (Bt *BuiBui*) was discovered in Japan. Bt *BuiBui* has a spherical protein crystal that is toxic to certain kinds of scarab grubs. Development and commercialization of Bt *BuiBui* has been undertaken by the biotechnology company Mycogen of San Diego CA. Dr. Villani's laboratory and field studies have shown promising results with Bt *BuiBui* for control of Japanese beetle, oriental beetle, northern and southern masked chafer and green beetle grubs. In 1995, this biological control product was applied on a lawn at Cornell. Populations of grubs were not significantly reduced two and four weeks after the application. The protocol for timing, rate, and application procedures were followed correctly. Therefore, reasons for this failure are not obvious. These types of results conflict with the laboratory and small plot work by Villani. Hopefully, in 1996 some of the answers learned from these demonstrations will get us closer to environmentally sound alternatives.

This article highlights only a few of the IPM program activities in 1995. Contact your local Cooperative Extension Association or the New York State IPM Program in Geneva for more information.

GERARD W. FERRENTINO
DEPT. OF FLORICULTURE AND ORNAMENTAL HORTICULTURE

Developing, testing and demonstrating practical alternative methods to control turfgrass pests is a primary goal of the IPM Program.

Laboratory and field studies have shown promising results with* Bt BuiBui *for control of Japanese beetle, oriental beetle, northern and southern masked chafer and green beetle grubs.

Enhancing Biological Disease Control in Turfgrass with Composts

Research Update

The primary aim of this research is to understand how composted amendments and the microorganisms they contain, impact soil microbial communities and how these microbial changes affect turfgrass health.

The goal of our project is to establish relationships between the composition and function of microbial communities developing in soils receiving compost amendments and the evolution of disease-suppressive soil properties. By monitoring community dynamics, in conjunction with changes in organic matter quality, we hope to identify important ecological interactions that may lead to the eventual development of methods and knowledge for predicting disease-suppressive soil properties. Monitoring selected pathogens in response to community changes may clarify their behavior and specific interaction with certain suppressive microbes. The latter may well contribute to the identification of biological indicators to soil suppressiveness/biological control of plant pests and to the understanding of the mechanisms involved. The main objective of our study is to characterize microbial communities in compost-amended and non-amended soils with respect to microbial activity, biomass, functional diversity, and species composition.

Brief Methodology

Five different composts were used in the study. They included two brewery waste composts from AllGro, Inc.; municipal biosolids compost from Schenectady NY; leaf compost from Endicott, NY; and poultry litter compost from Sustane Corporation.

The experimental site was established as a randomized complete block design on a mature stand of tall fescue/perennial ryegrass at the Cornell Turfgrass Field Research Facility in Ithaca. Each treatment consisted of 980 ft^2 plots with five replicates per treatment. Except for Sustane, which is already in a granular form, composts were screened through 1/4" mesh prior to application. The application rate was 20 lb dry weight/1000 sq ft. The composts for each replicate plot were weighed and placed in individual plastic bags. Material from the bags were applied by hand evenly over the plot area (the first application was made with a drop spreader). Five applications were made at 5 week intervals, starting May 30, 1995, with the last application on October 16, 1995.

Samples were collected immediately after the first application, and subsequently, just prior to each following application, in order to assess the effects of the preceding application on various microbial activities. Samples were analyzed for microbial populations and microbial utilization of different carbon sources. Other tests included microbial biomass, fungal biomass, and microbial community diversity.

Preliminary Results and Interpretation

Preliminary results indicate that there are some general trends in microbial properties of compost-amended soils that are worth noting. One of the most obvious properties of both amended and non-amended soils is that microbial activity increases as soil temperatures increase and as cumulative applications increase. Microbial activity (as measured by the hydrolysis of fluorescein diacetate) steadily increased from levels in May to those in August and then declined thereafter (see Figure 1). The levels of microbial activity in soil amended with composted municipal biosolids were considerably greater during July and August than those in soils treated with other amendments.

These general increases in microbial activity were not completely reflected in plate count populations of bacteria, fungi, and actinomycetes

Figure 1. Microbial activity (as determined by the hydrolysis of fluorescein diacetate (FDA)) in soils receiving different compost amendments. Increased levels of FDA hydrolysis indicate higher levels of microbial activity.

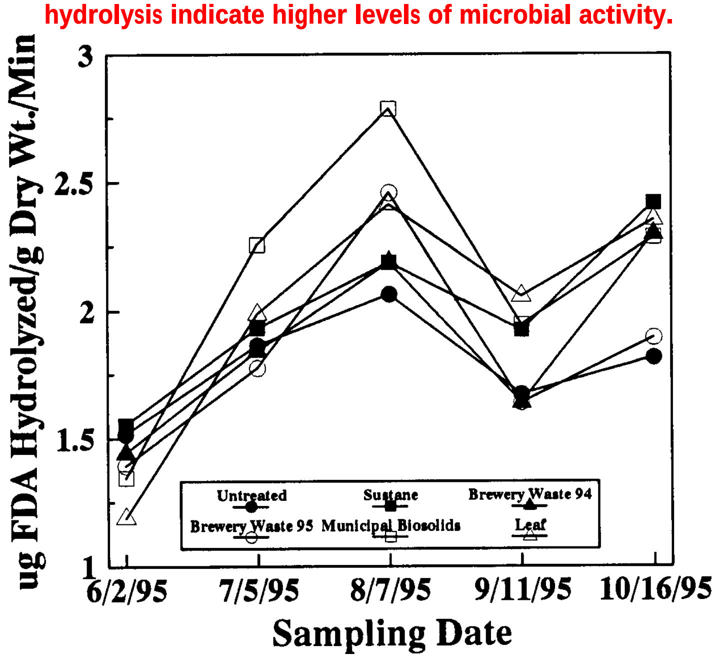
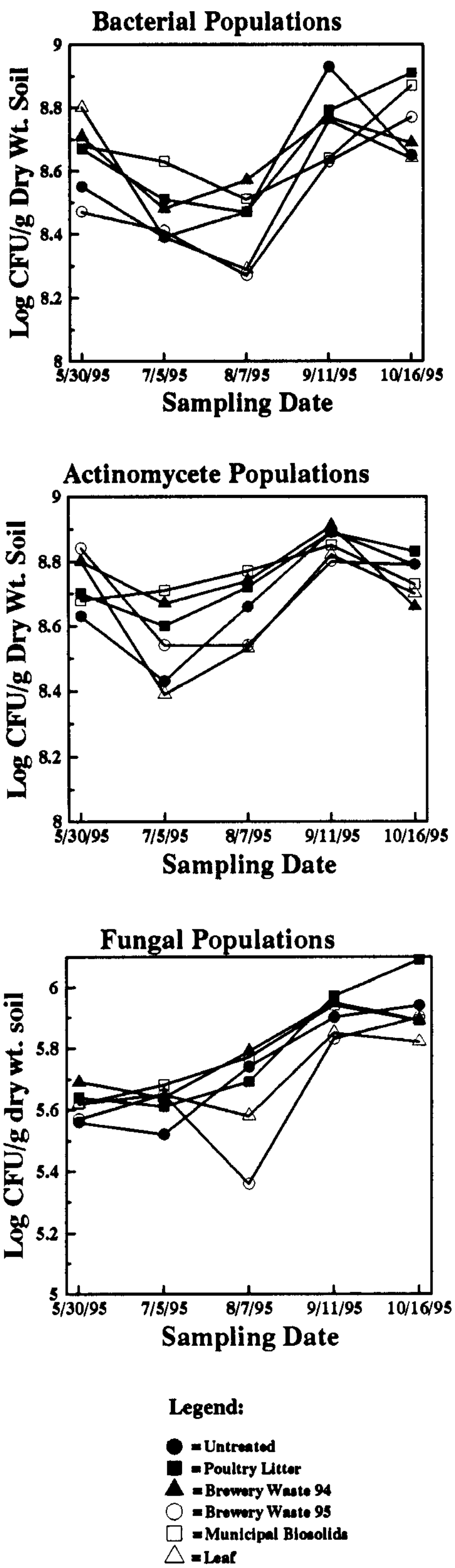


Figure 2. Populations of major microbial groups in compost-amended soils as determined by plate counting procedures.



over the course of the season (see Figure 2). The behavior of populations of each of the microbial groups differed. Populations of bacteria declined between May and August, but then increased through October. Actinomycete populations on the other hand, decreased during June and July, but steadily increased through the rest of the season. Populations of fungi increased steadily during the season, with the exception of the soil amended with the Brewery Waste 95 compost, where fungal populations took a sharp drop between the July and August sampling. This sharp drop in population corresponded to an equally sharp rise in microbial activity (see Figure 1). Other studies have shown that fungal biomass is inversely proportional to fungal plate counts. This suggests that the increase in microbial activity observed in the composted municipal biosolids treatment resulted largely from increases in fungal biomass and activity. Samples are still being analyzed for fungal biomass determinations to verify this finding.

These collective preliminary results indicate that, with the exception of the composted municipal biosolids treatment, quantitative estimates of microbial activity and biomass did not differ substantially among compost treatments. However, our results further indicate that the functional diversity of microbial communities differs with the type of compost amendment. Our evidence for this comes from results of carbon source utilization patterns of microbial communities from different compost-amended soils. Metabolic profiles of microbial communities, based on the utilization of a suite of 95 different carbon sources, revealed qualitative differences among microbial communities in soils receiving different compost treatments (see Tables 1 and 2). These profiles not only differed according to the compost amendment, but they differed temporally. Certain discriminating carbon sources could be identified that were unique to each microbial community and that could be used as signatures for each community. These results reinforce the notion that, although quantitative differences in microbial communities in compost-amended soils cannot be discerned, qualitative differences are readily apparent and are likely to be key in identifying disease-suppressive properties of certain compost-amended soils.

This study has generated a tremendous amount of data, a large part of which is still being analyzed for various microbial properties. These analyses will be completed over the remaining

continued on page 12

One of the greatest obstacles to the widespread use of composted amendments for turfgrass disease control has been the inconsistent performance from site to site, batch to batch, and year to year.

Research Update

continued from page 11

The use of organic amendments in turfgrass management is likely to increase as the emphasis on non-chemical and environmentally-friendly production practices increases.

four months of the grant period. Our current work is focussing on qualitative estimates of microbial community diversity in these compost-amended soils and on correlating these characteristics with the suppression of turfgrass diseases. Based on experiments conducted prior to the initiation of this study, soils receiving applications of Brewery Waste 94 and Poultry Litter were highly suppressive whereas those soils receiving the other amendments were not suppressive. Those soils amended with immature composted amendments (such as the Brewery Waste 95) became suppressive with time. Experiments are in progress to verify these suppressive properties. It is interesting to note further that those turfgrass plots treated with the Poultry Litter compost were of higher overall quality than were those treated with any of the other composts. The reasons for this are not entirely clear at this time but likely involve increased nitrogen nutrition as a result of this amendment.

Summary

One of the greatest obstacles to the widespread use of composted amendments for turfgrass disease control has been the inconsistent performance from site to site, batch to batch, and year to year. Much of the unpredictable nature of composted amendments has come from a lack of understanding of the microbial dynamics that determine the overall properties and behavior of amendments when incorporated into soils or when applied as topdressings. Despite the fact that some types of amendments have been shown to be highly suppressive to a number of turfgrass diseases, some composts are either not suppressive or may actually enhance disease development and pathogen persistence.

The current project was designed to address questions that will advance our understanding of how composts suppress turfgrass diseases. The primary aim of this research is to understand how composted amendments and the microorganisms they contain, impact soil microbial communities and how these microbial changes affect turfgrass health.

The use of organic amendments in turfgrass management is likely to increase as the emphasis on non-chemical and environmentally-friendly production practices increases. Furthermore, with

Table 1. Metabolic profiles of microbial communities in compost-amended tall fescue/perennial ryegrass soils. (July samples, after one application.)

Carbon Source	Untreated	Municipal Biosolids 95	Brewery Waste 94	Leaf 95	Poultry Litter	Brewery Waste 95
None	0.0936	0.1076	0.0940	0.1086	0.0998	0.0914
Bromosuccinate	0.2962	0.3492	0.3412	0.3544	0.2132	0.2923
L-histidine	0.2370	0.2184	**0.4404**	0.3710	0.3374	0.2438
Hydroxy-L-proline	0.1924	0.1946	0.3206	**0.5728**	0.3614	0.1780
Inosine	0.2554	0.2172	0.1928	0.2326	0.1530	0.2144
Dextrin	0.3762	**0.4016**	0.3914	**0.5270**	**0.4476**	0.3973
Citrate	0.2386	0.3258	0.3428	**0.4614**	0.2932	0.2568
Glycogen	0.3440	**0.4220**	**0.5156**	0.3028	0.3080	0.3320
D-galactose	0.2280	0.2488	0.2398	0.3850	0.2292	0.3187
A-ketoglutarate	0.2242	0.3712	0.3298	0.3088	0.2484	0.3007
Tween-40	0.2534	0.3284	**0.4488**	0.3444	0.3256	0.2533
Tween-80	0.2452	0.2510	**0.4392**	0.3028	0.3088	0.2197
A-D-glucose	0.3386	**0.4402**	**0.4148**	**0.5300**	0.3634	0.3804
D-galacturonate	0.3440	0.2802	0.2730	0.2270	0.2440	0.2576
Putrescine	0.2202	0.2738	0.3946	0.1914	0.2470	0.2424
Sucrose	0.3076	0.3084	0.3278	**0.4940**	**0.4730**	0.3787
D-gluconate	**0.4154**	**0.4492**	**0.6026**	**0.6030**	0.3688	**0.4309**
N-acetylglucosamine	**0.4988**	0.2976	**0.4716**	**0.5108**	0.3398	**0.4252**
D-trehalose	0.3448	0.3848	**0.4268**	0.3886	0.2616	0.3548
L-asparagine	**0.5314**	**0.5846**	**0.4926**	0.3872	0.3564	**0.4408**
Quinate	0.2462	0.3070	**0.4152**	0.3268	0.2194	0.2885
L-aspartate	0.2526	**0.4152**	0.2678	0.2898	0.2418	0.2785
Maltose	0.3440	0.3204	0.3626	0.3478	0.3910	0.2461
D-saccharate	0.2256	0.2466	0.3012	0.2284	0.2020	0.2468
L-glutamate	**0.5458**	0.3972	**0.4182**	**0.5942**	0.3196	0.3253
Glucose-1-phosphate	0.2712	**0.4174**	**0.4378**	**0.5310**	0.3080	**0.4046**
Cellobiose	0.2946	0.3318	**0.4150**	0.2976	0.3110	0.3871
D-mannose	0.3026	0.3490	0.3574	0.3724	0.2824	0.3235
Succinate	0.2452	0.2542	0.3926	0.2830	0.2788	0.2820
G-Aminobutyrate	0.2440	0.2510	**0.4040**	0.3448	0.3690	0.2914

Absorbance cutoff = 0.4

Red absorbance values indicate carbon sources utilized most rapidly (absorbance values after 24-hrs exceed absorbance cutoff value). Increases in absorbance values indicate increases in microbial activity.

the increased emphasis on biological control strategies, studies with organic amendments, particularly horticultural and industrial waste materials, will undoubtedly increase. We have chosen to center our studies strictly on composted soil amendments since composted organic substrates provide a degree of uniformity and control not achievable with uncomposted soil amendments. Additionally, composted amendments are known to be biologically diverse, supporting some of the more intense biological interactions in nature. The well-documented disease-suppressive properties of composts provide an inexpensive and effective alternative to traditional chemical fungicide treatments.

Many of the properties of the composts chosen for this study are already known. The effects of mature and immature composted sludges, turkey litter compost, and yard waste compost on soil biological processes represent relative extremes in organic matter qualities, microbial activities, and disease-suppressive properties. These attributes facilitate our comparative studies on microbiological responses and, based on our preliminary results, are increasing our understanding of why composts differ in their suppressive properties. Furthermore, we feel that the results of this study will broaden the applicability of our research as well as increase our conceptual understanding of microbial interactions in turfgrass soils that impact turfgrass health. This understanding will be essential for the effective, consistent, management of disease-suppressive properties in these types of amendments.

Eric B. Nelson and Cheryl M. Craft
Dept. of Plant Pathology

The well-documented disease-suppressive properties of composts provide an inexpensive and effective alternative to traditional chemical fungicide treatments.

Table 2. Metabolic profiles of microbial communities in compost-amended tall fescue/perennial ryegrass soils. (September samples, after three applications.)

Carbon Source	Untreated	Municipal Biosolids 95	Brewery Waste 94	Leaf 95	Poultry Litter	Brewery Waste 95
None	0.1204	0.1390	0.1455	0.1292	0.1388	0.1310
Bromosuccinate	0.3752	0.3403	0.3723	0.3864	0.3688	**0.4352**
L-histidine	0.3622	0.3887	0.3832	**0.4286**	0.3055	**0.4364**
B-methyl-d-glucoside	**0.4748**	**0.4340**	**0.4620**	0.3684	0.3208	**0.4312**
Hydroxy-L-proline	0.3740	0.3797	**0.4177**	0.3400	0.3653	**0.4430**
Inosine	**0.4062**	0.3973	0.3638	0.3242	0.3135	**0.4010**
Dextrin	**0.5974**	**0.5562**	**0.6307**	**0.4042**	**0.4153**	**0.5886**
Citrate	**0.4116**	**0.4158**	**0.5715**	**0.4400**	**0.4900**	**0.4922**
Glycogen	**0.5366**	**0.6205**	**0.6423**	0.3648	**0.4885**	**0.7084**
D-galactose	0.3974	**0.4522**	**0.4135**	0.3320	0.3110	**0.4146**
A-ketoglutarate	0.3406	0.3943	**0.4382**	0.3840	0.3953	**0.4368**
Tween-40	**0.5022**	**0.5328**	**0.5913**	**0.4474**	0.3853	**0.5850**
Tween-80	0.3756	**0.4110**	**0.4002**	**0.4048**	0.3400	0.3980
A-D-glucose	**0.5046**	**0.5227**	**0.5615**	**0.4222**	**0.4503**	**0.4596**
D-galacturonate	0.3452	0.3438	**0.4440**	0.3208	0.2925	**0.5672**
Putrescine	**0.4268**	0.3957	**0.4655**	**0.4270**	**0.4445**	**0.4844**
Sucrose	**0.4568**	**0.4262**	**0.4600**	**0.4610**	0.3683	**0.4540**
D-gluconate	0.3958	**0.5077**	**0.5145**	**0.4488**	**0.4650**	**0.5818**
N-acetylglucosamine	**0.4824**	**0.5195**	**0.4977**	0.3724	0.3583	**0.5766**
D-trehalose	**0.4110**	**0.4800**	0.3988	0.2956	0.3060	**0.4598**
L-asparagine	**0.5990**	**0.5853**	**0.6515**	**0.6446**	**0.4698**	**0.6614**
Quinate	**0.4740**	**0.5095**	**0.5760**	**0.5164**	**0.6195**	**0.6050**
L-aspartate	**0.5408**	**0.4312**	**0.5463**	**0.4320**	**0.4968**	**0.5332**
Maltose	**0.4244**	**0.4165**	**0.4193**	0.3380	0.3118	**0.4690**
D-saccharate	0.2902	0.3965	**0.4020**	**0.4004**	**0.4043**	**0.5338**
L-glutamate	**0.5106**	**0.5290**	**0.5262**	**0.5214**	**0.4653**	**0.6144**
Glucose-1-phosphate	**0.5318**	**0.5187**	**0.5603**	0.3966	0.3180	**0.6036**
Cellobiose	0.3380	**0.4162**	**0.4107**	0.3652	0.3335	**0.4616**
D-mannose	0.3746	**0.4007**	**0.4252**	0.3280	0.2988	0.3802
Succinate	0.3856	**0.4195**	**0.4047**	**0.4286**	0.3310	**0.5198**
G-aminobutyrate	**0.4046**	0.3807	0.3982	**0.4002**	0.3880	**0.4230**

Absorbance cutoff = 0.4
Red absorbance values indicate carbon sources utilized most rapidly (absorbance values after 24-hrs exceed absorbance cutoff value). Increases in absorbance values indicate increases in microbial activity.

Pest Watch

continued from back cover

In very hot, dry weather cool season turfgrasses will go dormant giving many common summer annual and perennial weeds a chance to flourish unchecked by turfgrass competition.

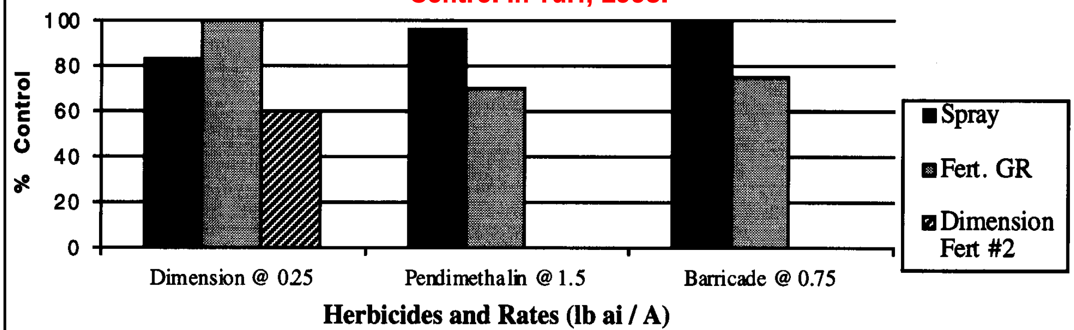
The effectiveness of both preemergent and postemergent herbicides are reduced under drought conditions.

able to tolerate insect feeding — particularly root feeding insects. Several diseases not usually considered to be major problems in our area were very damaging. For example, diagnostic labs reported receiving many samples with anthracnose. Other stress-related diseases were also prevalent. Whenever turf is thinned by disease or insect pests, weeds can take over.

Poor Herbicide Performance.

Although in upstate New York we rarely experience the kind of drought which reduces herbicide performance, our Long Island and more southerly colleagues are well used to heat and drought affecting their herbicide programs. The effectiveness of both preemergent and postemergent herbicides are reduced under drought conditions. It is easy to understand why postemergent herbicide performance is reduced — weeds have a waxy cuticle which reduces spray retention and absorption, less water in the plant results in limited translocation out of the leaves to the growing points, herbicide remaining on the surface of the leaves is degraded by sunlight, and high temperatures and humidity evaporate spray droplets and volatilize the herbicide. All of these factors result in poor postemergent herbicide performance.

Figure 1. Comparison of Spray and Fertilizer Formulations for Preemergent Crabgrass Control in Turf, 1995.



The reasons why preemergent herbicide do not perform well under drought are more complex. If the herbicide was applied very uniformly and early enough to be incorporated by the April rains, the product worked. However, if treatments were less uniform and/or were applied in mid to late April (after which rains were minimal), preemergent herbicides did not provide adequate crabgrass control. Why? In order for preemergent herbicides to work they must be uniformly incorporated into the soil surface before crabgrass seeds germinate. In a typical year, sufficient rainfall will occur in April and early May to achieve this, even when products are not applied uniformly. However, when minimal rainfall occurs (as in 1995) the herbicide is not moved laterally in the soil surface, creating non-uniform herbicide distribution and gaps in the preemergent barrier. Additionally, without adequate moisture, weed seeds will not germinate. They wait in the soil until moisture is available — often after the preemergent barrier has broken down (particularly in those gaps just mentioned).

Weed Control During Droughts

So, how do you control weeds under such a drought? There was very little any turf manager could have done to achieve acceptable levels of weed control in 1995. Extensive irrigation, enough to keep the cool season turf growing, would have improved the efficacy of postemergent herbicides. However, applications of most postemergent products would have resulted in more turf injury due to the heat stress. Where irrigation is limited, irrigate one to two days before spraying postemergent herbicides and again two days after treatment. In many respects, this season was a testimony to well timed applications of quality preemergent herbicides. In 1995 we compared spray and granular "weed & feed" formulations of pendimethalin, Barricade and Dimension (see Figure 1). All treatments were applied in late April; crabgrass control was rated in September.

The fertilizer formulations of pendimethalin and Barricade produced poor crabgrass control whereas spray applications provided essentially 100% control. This was highly unusual, as I typically see no difference between spray and granular applications with these products. An explanation of this anomaly is seen in the Dimension data where two fertilizer formulations were compared to the spray. In this case, the uniformly loaded, high quality fertilizer granule controlled crabgrass 100%; whereas, a lower quality (non-homogenous) fertilizer granule (Fert. #2) provided only about 60% control. Similarly, the Barricade and pendimethalin granules tested in 1995 were non-homogenous blends with nonuniform particle sizes and poor spreading characteristics. From these data we see that very uniform applications of high quality products produced excellent control while less uniform treatments (of lower quality and cheaper formulations) resulted in unacceptable levels of crabgrass control. Moral: you get what you pay for.

How Will The 1995 Season Affect Weeds and Weed Control in 1996?

One of the most important factors affecting annual weed populations is the number of weed seeds present. Clearly the heavy seed set in 1995 of summer annual weeds such as crabgrass, prostrate knotweed, spurge and others, virtually assures that they will be back in 1996. The perennial weeds which grew unchecked in 1995 are well established and can out-compete the recovering turfgrass.

Speaking of recovering turf, much of the turf was damaged by drought, insects and disease. These thin turf areas are an invitation to weed establishment. The turf will need all the help we can give it to become established before the summer of 1996. We must remove weed competition to allow the turf to fill in those thin areas but we need to be careful not to damage the turf with herbicides. In particular, where turf was overseeded in the fall or will be overseeded in the spring, be cautious with the use of herbicides. Much of the fall-seeded turf will not be well enough established to tolerate early spring applications of preemergent herbicides.

Of the preemergent herbicides registered for turf, only Tupersan (siduron) is safe on newly seeded turf. Dacthal (DCPA) can be applied to seedling turf after it is 2 inches tall (I suggest waiting until the seedlings have been mowed twice). While Dacthal rarely provides full season crabgrass control, it does provide better control than Tupersan. All of the other preemergent herbicides should only be applied to established turf. Postemergent crabgrass control presents special problems in seedling turf also. Both Acclaim (fenoxaprop) and MSMA will injure seedling turf. Applications should be delayed until the new turfgrass seedlings are well tillered and the lowest labeled rates should be used to improve turf tolerance.

Perennial ryegrass and fescues are more tolerant of Acclaim than is Kentucky bluegrass. Bentgrass is very sensitive to Acclaim and should only be treated if turf is well established, and then only with the special reduced rates for bentgrass turf (specified on the label). Postemergent broadleaf weed control is fairly simple even in newly seeded turf. "Three-way" herbicides (2,4-D + MCPP + dicamba) and similar products can be applied to seedling turf after the new seedlings have been mowed 3 or 4 times. To get the most out of these herbicides, treat when weeds are actively growing. Usually applications in early to mid-May are effective. Although our preferred time for postemergent broadleaf weed control is between mid-September and early October, the broadleaf weed pressure present this spring may necessitate May applications.

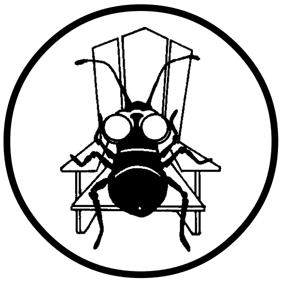
Last, but not least, let's hope we don't have a repeat of 1995 conditions!

Joseph C. Neal
Dept. of Floriculture and Ornamental Horticulture

We see that uniform applications of high quality products produced excellent control while less uniform treatments (of lower quality and cheaper formulations) resulted in unacceptable levels of crabgrass control. Moral: you get what you pay for.

One of the most important factors affecting annual weed populations is the number of weed seeds present. Clearly the heavy seed set in 1995 of summer annual weeds virtually assures that they will be back in 1996.

The Drought of 1995 and Weeds and Weed Control in 1996



Pest Watch

Weed pressure in 1995 was incredible! What happened to produce such a glorious crop of weeds? The answer: drought!

Weed pressure in 1995 was, in a word, incredible! I toured many areas — golf courses, lawns, athletic fields, and institutional grounds — that were solid crabgrass, knotweed, clover, etc. In many of these areas, if there weren't weeds, there would have been no vegetation at all. In a year like that, the weeds are probably providing a valuable service by preventing erosion and providing some ground cover; but this is small consolation for the grounds manager or superintendent trying to explain why the weed treatments apparently failed.

What happened to produce such a glorious crop of weeds? The answer: DROUGHT! The record drought in much of New York did many things which encouraged weed growth including: reduced competition from the turfgrass, increased turf damage from insect and disease pests, poor preemergent herbicide performance, poor postemergent herbicide performance, and last (but not least) heavy seed set for weeds resulting in secondary infestations and virtually ensuring weedy fields in 1996. There was little anyone could have done about the weeds, but understanding what happened and the implications on future weed management will help in developing a more effective plan for 1996.

What Happened in 1995?

Cool season turfgrass growth rates typically slow down during warm weather. In very hot, dry weather cool season turfgrasses will go dormant giving many common summer annual and perennial weeds a chance to flourish unchecked by turfgrass competition. Many of these weeds are better able to cope with heat and drought than the turfgrasses. For example, crabgrass can maintain a growth rate of up to 1 cm a day during a drought severe enough to cause Kentucky bluegrass to go dormant. Similarly, legumes like white clover, black medic and hop clover are very drought tolerant; plus these weeds are able to fix nitrogen from the air to fuel their growth (after you have stopped fertilizing the turf due to the drought). Other weeds which tolerate drought very well include the plantains, prostrate knotweed, oxalis (woodsorrel), dandelion, healall, red sorrel, oxeye daisy, and goosegrass.

As turf goes dormant we tend to reduce management inputs such as mowing and fertilization. In doing this we allow some tap-rooted biennial weeds not ordinarily seen in fine turf to become established, including wild carrot, common mullein, bull thistle, teasel, and burdock. Reduced mowing also allows many annual and perennial weeds to grow unchecked and to produce more seed. Reduced turfgrass vigor and the hot weather also produced some rather dramatic increases in insect and disease damage. In particular, white grub and chinch bug damage was extensive. In some cases the number of insects was very high (I have heard reports of as many as 200 grubs per square foot!), much of the increased damage was due to the moisture and heat stress combining to make the grass plants less

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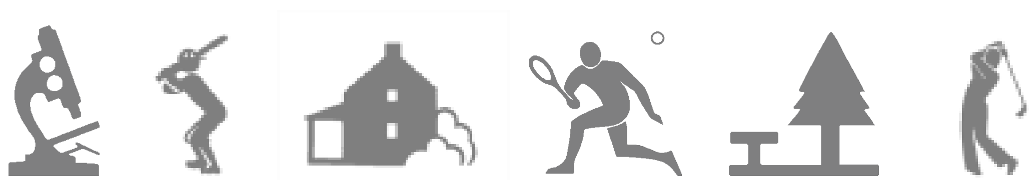

Cornell Cooperative Extension

CORNELL UNIVERSITY TURFGRASS TIMES
20 Plant Science Building
Cornell University
Ithaca, NY 14853

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