OFFICIAL

MULTI-STATE HATCH PROJECT

PROJECT NUMBER: NE-187

TITLE: Best Management Practices for Turf Systems in the East

DURATION: October 1, 1999 through September 30, 2004

STATEMENT OF PROBLEM:

Turfgrass areas are perceived to contribute significantly to the pollution of surface water (phosphorus, nitrates and pesticides) and groundwater (nitrate and pesticides). Management strategies that integrate pest resistant germplasm, cultural practices, biological agents, biorational compounds and the judicious use of pesticides constitute best management practices (BMPs). A better understanding of the fate of fertilizers and pesticides in turfgrass systems is needed to evaluate and develop BMPs that minimize any potentially adverse effects on humans and the environment.

JUSTIFICATION:

Advances in BMP strategies, and our understanding of nutrient and pesticide transport in turf systems, will require the expertise of scientists working in many disciplines (e.g., agronomists, engineers, breeders, chemists, entomologists, pathologists, and weed scientists) across various environmental, climatic, and political zones. Individual state experiment stations do not have adequate expertise and resources to address all environmental concerns associated with the management of turfgrasses. Therefore, a multi-state interdependent research collaboration is required to develop BMPs for turf systems and to evaluate nutrient and pesticide fate and transport. Specific portions of projects designated for one or more locations are determined based on project priority and personnel expertise, site and equipment capabilities to complete those projects. Creeping bentgrass is the most important species grown on golf courses in the Eastern U.S., and will serve initially as the model turfgrass system for this project. The single species of grass with one or two representatives of each pest group is chosen as a manageable starting point for this project. Additionally, the number of pesticides for intensive study is also limited initially. A search of all current CRIS projects indicates that this project is unique in its scope.

RELATED CURRENT AND PREVIOUS WORK:

Dramatic progress in the genetic improvement of a number of cool-season grass species has resulted in the development of durable turfs with improved pest resistance (Meyer and Funk, 1989). The identification of better adapted bentgrasses that have the ability to dominate in mixed stands with annual bluegrass will likely lead to the development of turfs which require fewer management resources. Previous work has primarily focused on cultural and chemical approaches to affecting species dominance in a mixed stand (Eggens et al., 1989; Eggens and Wright, 1985; Gaul and Christians, 1988; Gaussion and Branham, 1989) while chemical inputs remain at a high level, deployment of improved genetics may reduce use rate and/or frequency.

The development of biocontrol agents for turfgrass disease control has been largely unsuccessful (Watschke et al., 1995). One of the major obstacles in achieving effective disease control with agents such as TX-1(*Pseudomonas aureofaciens*) and BL915 has been the inability to deliver and maintain high enough population densities in the field. TX-1 injection has been shown to suppress the growth of numerous turfgrass pathogens in vitro, but there is no published scientific evidence that it reduces the severity of diseases in the field. There is also no information regarding how long TX-1, BL915, or other biocontrol agents survive in the injector fermenter-irrigation lines or soil, or whether these organisms have potential to reduce fungicide inputs in a turf management program.

Black cutworm (*Agrostis ipsilon* [Hufnagel]) is a serious pests of bentgrass (Niemczyk 1981, Tashiro 1987, Williamson and Potter 1997). Black cutworm feeding causes dead patches in turf, so several insecticide applications may be directed each year to prevent injury to putting greens. Black cutworm lays most of its eggs on the tips of leaf blades, leading to high mortality on putting greens from their removal during frequent mowing. The most damaging, late-instar larvae may travel several meters at night, and so much of the injury to greens may result from larvae developing in surrounding turf and moving onto greens (Williamson and Potter 1997). New insecticides being investigated for the management of cutworms include insect growth regulators, insect pathogenic nematodes, and microbially-derived products like spinosad (Heller and Walker 1998, Shetlar and Niemczyk 1998, Swier et al. 1998).

Studies have evaluated the success of the following biorational formulations for suppression of turfgrass insect pests: *Bacillus thuringiensis japonensis* Buibui, *Bacillus thuringiensis, Beauveria bassiana* strain JW-1, insect parasitic nematodes, halofenozide, and spinosad. Black cutworm larvae were significantly reduced with formulations of *Beauveria bassiana*, insect parasitic nematodes, halofenozide, and spinosad (Heller and Walker, 1996; Heller and Walker, 1997a; Heller and Walker, 1997b; Heller and Walker, 1997c). Entomopathogenic nematodes are well adapted to infecting larval insect pests living in soil, and have the potential to be important biological control agents in a variety of ornamental and crop production systems. The impact of the agronomic environment on nematode ecology must be better understood before nematodes can be a reliable pest management alternative for insect pest control.

During the past decade, there has been considerable knowledge generated about the fate of fertilizers and pesticides in the turfgrass ecosystem. On a highly pervious lawn-type turf site, natural precipitation did not produce detectable levels of runoff (>0.6 mm/hr) (Harrison et al., 1993). When irrigated at a rate of 150 mm/hr for 1 hr., runoff did occur and ranged from 0.8% to 11.6% of the total irrigation applied. Additional experiments are needed to answer questions that remain in this area, further contributing to the knowledge base of fertilizer and pesticide fates in turfgrass ecosystems.

Lawn clippings, if allowed to remain onsite, provide a biodegradable source of organic N to the soil/plant ecosystem. Studies by Heckman et al. (1997) and Beard (1973) indicate that leaving grass clippings onsite reduces the need for fertilization. More research is needed to quantify the rate of turfgrass clipping decomposition and the amount of N that is provided by returning lawn clippings to the turf. The amount of N that is needed to maintain turfgrass quality without excess leaching of NO_3, has not been extensively evaluated for turfgrass. To do so, requires the ability to determine the portion of available N mineralized from decaying grass clippings and other organic-N sources in the turfgrass system.

Several organophosphate insecticides (trichlorfon and isazofos) when applied to turfgrass resulted in dermal and inhalation exposure that could not be deemed as completely safe using the USEPA Hazard Quotient (HQ) determination (Murphy et al., 1996). Because the HQ is a conservative estimate of hazard including worst case scenarios of exposure, more realistic exposure estimates are necessary to predict the health implications of pesticide exposure to the public (e.g., golfers).

Comparison of simulation model predictions for solute flux (leaching) with actual values collected from field studies indicate that convection/dispersion models such as PRZM and LEACHM can over-predict solute fluxes from turfgrass rootzones by as much as 300% (Petrovic, 1993; Petrovic et al., 1990). Using two years of pesticide runoff data from turfed slopes at Penn State University, Haith (1998) observed that the runoff model PESTRUN predicted annual pesticide runoff losses of from 27% to 180% of the observed values. These models in general do not account for the unique layered profile that exists below the turfgrass canopy. Dell et al. (1994) found that the pesticide absorption potential per unit weight of the thatch is lower than soil. Thus, accurate pesticide absorption coefficients cannot be obtained for a combined thatch-soil surface layer by simply re-scaling the soil pesticide absorption value using the combined organic carbon contents of the thatch and soil layers.

OBJECTIVES:

1. In coordinated trials, evaluate germplasm in numerous environments of the eastern region for compatibility with best management practices to reduce the environmental impact of pesticides and nutrients.

2. Assess the environmental fate of pesticides and nutrients associated with conventional and best management practices used in typical eastern turf management systems.

PROCEDURES:

Researchers will focus on parts of the first or second objective, or both, depending on individual expertise.

Objective 1: Creeping bentgrass (*Agrostis palustris* Huds.) germplasm developed by traditional breeding or molecular techniques from NJ, PA and RI will be assessed by all stations for overall quality and durability, as well as tolerance of additional stresses (biotic and/or abiotic) specifically noted in the remainder of this section. BMPs will be developed for three major bentgrass pests, including dollar spot disease (*Sclerotinia homoeocarpa* F.T. Bennett), annual bluegrass (*Poa annua* L.), and cutworms (*Nephelodes minions* Guenee and *Agrotis ipsilon* Hufnagel). ME, MA, MD, NJ, NY, PA, RI and FL have excellent field research facilities representing different climatic zones that provide suitable environmental conditions for consistent occurrence of dollar spot, annual bluegrass, and/or cutworms.

The growth, survivability, and disease suppressive efficacy of biological agents and biorational compounds will be assessed at the aforementioned stations. MD, NJ, and RI will determine the dollar spot suppressiveness of *Pseudomonas* spp., Bacillus spp., *Burkholderia* spp., *Trichoderma harzianium* and other commercial and pre-commercial microbes. The growth, survivability and dollar spot suppressive efficacy of the agent *Pseudomonas aureofaciens* TX-1, produced onsite in the Bioject fermentation system, will be evaluated in MD, NJ and RI. MD will survey the influence of TX-1 on the microbial communities in a bentgrass ecosystem for all participating states and determine the mechanism(s) of dollar spot suppression. MD also will evaluate the influence of bioorganic fertilizers on dollar spot suppression and microbial communities. Soluble silica, biorational materials, and antifungal compounds produced conventionally or naturally by microbes will be evaluated as a means of dollar suppression in MD, NJ, and PA. NJ will assess the response of improved bentgrass germplasm to dollar spot using different nitrogen sources and mowing height regimes. The FL site introduces heat tolerance evaluation, considered important as the usage of new cultivars is extended southward in the United States.

NJ will evaluate additional creeping bentgrass germplasm, representing a broad range of genetic diversity, for their ability to dominate annual bluegrass in bentgrass maintained as putting green and fairway turf. The NJ trials will be conducted to also determine the effects of traffic related stress such as wear, compaction and wear plus compaction as separate treatments. Annual bluegrass will be introduced using shredded soil cores from old golf course greens containing annual bluegrass. Annual bluegrass control using the biological agent *Xanthomonas campestris* will be assessed by MD and NJ. The agent will be produced on site by fermentation using the Bioject System. The bacteria will be applied in multiple spring and fall applications using various protocols and bentgrass cultivars developed by NJ, PA or RI. MD will monitor annual bluegrass seedling emergence to determine optimum application timing of reduced herbicide rates. NJ and PA will evaluate the influence of plant growth regulators (PGR's) and herbicides on the competitive and seed production capabilities of annual bluegrass in bentgrass swards. The germination of bentgrass seed and stand development as influenced by PGR's and herbicides that target annual bluegrass will be assessed in MD.

CT, NY, PA and RI will evaluate biorational strategies as replacements for organophosphate and carbamate insecticides for suppressing cutworm populations. In PA, bentgrass will be aerified and cutworm larvae will be distributed. Populations will be sampled to determine economic thresholds and pest distribution. NJ will investigate methods of transforming bentgrass using the Bt gene. The Bt gene will stimulate plants to produce proteins that are toxic to cutworms. NJ also will investigate techniques for incorporating endophytic fungi (e.g. *Balansia* sp.) in creeping bentgrass germplasm, which would discourage cutworms feeding and reduce survival. Bt-transformed and endophytic bentgrasses will be evaluated for regional adaptability at most stations. Irritant soap drenches will be used in non-treated bentgrass plots of these cultivars to assess differences among cultivars in susceptibility to cutworms. Entomopathogenic nematodes that are well adapted to infecting larval stages of cutworms will be assessed by RI and NY. NY will use bentgrass/soil microcosms to evaluate biorationals for managing cutworms, including entomopathogenic nematodes, Bt, fungal pathogens, and insect growth regulators.

Objective 2: Two types of investigations are planned: experimental studies to fill gaps in our knowledge of chemical behaviors in turf systems, and refinement and testing of fate and transport models for estimating chemical losses. The experimental results will be used to either determine fate and transport model parameters or to test model predictions. As with the first objective, management practices used to control the primary pests of creeping bentgrass will serve as a prototype system to demonstrate the research results. Other turf species will be considered, however, since significant data from previous and on-going experiments involving other species will be used for models testing.

Experiments to evaluate the mechanisms of nitrogen transfer in turf will be performed at CT. A particular focus will be the role of grass clippings and testing of pre-treated anion exchange membranes for measurement of soil nitrate. Soil column experiments will examine the leaching potential of a stratified drift soil established and maintained as a bentgrass fairway. RI will study nitrate leaching and soil microbial activity following the death of established turf utilizing glyphosate. These experiments, which involve a common practice for turfgrass establishment, will contribute to our knowledge of organic N dynamics. NY and PA will study the extent of N and P runoff from turf.

MD will complete a series of laboratory studies evaluating the effect of thatch on pesticide (dicamba, 2,4-D, triclopyr, and carbaryl) transport. NY will determine the amount of leaching from sand based turfed sites for: 1) the reduced risk fungicides mefenoxam and azoxystrobin, 2) seed treatment verses surface application of metalaxyl and mefenoxam and 3) clinoptilolite zeolite amendments in putting green profiles.

Personal air samplers will be used by MA to determine pesticide vapor concentrations above 0.2-ha plots of creeping bentgrass. Concentrations will be measured for a variety of chemicals and environmental conditions. MA will also investigate pesticide exposure through direct contact using gauze patches attached to clothing to determine potential exposure to external body parts, and hand rinses to determine the amount of pesticide absorbed via the hands. In both cases, investigations will focus on a relatively small set of chemicals representative of commonly used turf pesticides.

Three modeling approaches will be evaluated. The pesticide runoff model PESTRUN will be evaluated by NY for its applicability to turfgrass using experimental data from PA and NY as well as comparable related data from Oklahoma and Georgia field studies. The abilities of linear equilibrium, one-site kinetic non-equilibrium, and two-site kinetic non-equilibrium solute transport models to predict the movement of pesticides in turf that contains thatch will be assessed by MD. Simple modeling approaches for pesticide volatilization based on regression regressions will be developed and tested by NY and MA. The comprehensive pesticide model PRZM will be studied by NY for its ability to simultaneously estimate leaching, runoff and volatilization of pesticides and nitrates applied to turf. Since no site contains instrumentation to provide all data needed for PRZM testing, model components will be evaluated with data from three sites: volatilization (MA), runoff (PA), and leaching (NY). PRZM will also be used to systematically evaluate the potential chemical losses of the most efficacious BMPs identified by research conducted under objective one of this project . The Environmental Fate and Effects division of the USEPA Office of Pesticide Programs will participate in the modeling efforts by providing access to fate and transport data and assistance in the development of model parameters for turf systems.

EXPECTED OUTCOMES:

Objective 1: The deliverables of this objective will be the development of creeping bentgrass cultivars having lower requirements for fertilizers and pesticides. The outcome will be a quantification of the effect of biological agents and biorational products for dollar spot, annual bluegrass, and cutworm suppression. Improved or genetically transformed germplasm, biological agents, and biorational products identified by Eastern turfgrass scientists could reduce pesticide usage or pesticide active ingredient outputs by 40 to 50%.

Objective 2: This research will ultimately provide the means to quantify the fates of chemicals applied using conventional approaches, or by using established or newly developed best management practices. This, in turn, will permit direct assessment of the environmental benefits that will be realized by adopting specific BMPs.

ORGANIZATION:

A Technical Committee, comprised of scientific expertise in agronomy, plant breeding, pesticide fate and transport, and plant protection will direct the project and project-related activities. Each participating agency will have one official voting member of the Technical Committee. A major committee function will be the coordination of contributing projects to ensure adherence to regional project objectives. The yearly meetings will include evaluation of the project's progress, to determine if enough research has been done with the core group of plant materials and pesticides, and to determine if the following year's focus should be changed to increase investigation of species and pesticides.

An Executive Committee composed of the Administrative Advisor, the Chair, the Past Chair and the Secretary will conduct the activities of the regional project between the annual Technical Committee meeting. Elections of a Chair and Secretary of the Executive Committee will take place every two years at the annual meeting. The Technical Committee will meet annually at either a participating institution or at a conference site that focuses on turfgrass science and management. The Technical Committee will participate in seminars and workshops as appropriate to increase the awareness of the subject matter.

This project will involve the active participation of at least seven Eastern States, plus one additional state. Communication and coordination will be facilitated by the establishment of a listserve and web page for both participants and others wishing to communicate on turf BMPs. In addition, a yearly meting will communicate previous results and plan upcoming studies, minutes, and results of this meeting and the associated trials will be available at the website. Portions of this meeting will be set aside to develop teams competitive for EPA, USDA, foundation, or other funding.

SIGNATURES:

Regional Project Title: Development and Evaluation of Best Management Practices for Turf Systems in the East

Paul A. Backman — 8/2/99

Administrative Advisor — Date

David R. MacKenzie for NERA — Aug 16, 1999

Chairman, Regional Association of Directors — Date

George Cooper — 8/26/99

Administrator, Cooperative State Research, Education and Extension Service — Date

REFERENCES:

Beard, J.B. 1973. Turfgrass: Science and culture. Regents/Prentice Hall. Englewood Cliffs, NJ..

Dell, C. J., C. S. Throssell, M. Bischoff and R. F. Turco. 1994. Estimation of sorption coefficients for fungicides in soil and turfgrass thatch. J. Environ. Qual. 23:92-96.

Eggens, J. L., and C. P. M. Wright. 1985. Nitrogen effects on monostands and poly stands of annual bluegrass and creeping bentgrass. HortSci. 20:109-110.

Eggens, J. L., C. P. M. Wright, and K. Carey. 1989. Nitrate and ammonium nitrogen effects on growth of creeping bentgrass and annual bluegrass. HortSci. 24:952-954.

Gaul, M. C., and N. E. Christians. 1988. Selective control of annual bluegrass in cool-season turfs with fenarimol and chlorsulfuron. Agron. J. 80:120-125.

Gaussoin, R. E., and B. E. Branham. 1989. Influence of cultural factors on species dominance in a mixed stand of annual bluegrass/creeping bentgrass. Crop Sci. 29:480-484.

Haith, D. A. 1998. Final report on Regional Hatch Project NE-181.

Harrison, S. A., T. L. Watschke, R. O. Mumma, A. R. Jarett and G. W. Hamilton. 1993. Nutrient and pesticide concentrations in water from chemically treated turfgrass. P.191-207. In K.D. Racke and A.R. Leslie (ed.) Pesticides in urban environments: Fate and significance. ACS Symp. Ser. 522.

Heckman, J.R., J. Liu, and W.J. Hill. 1997. Turfgrass quality response to mowing and nitrogen fertility management. p. 125. In Agronomy Abstracts. ASA, Madison, WI.

Heller, P.R. and R. Walker. 1996. Evaluation of Talstar, Dursban and experimental formulations to manage black cutworm on creeping bentgrass at the Valentine Turfgrass Research Center. AMT, V. 21: 4G.

Heller, P. R. and R. Walker. 1997a. Evaluation of NAF formulations, Dursban Pro, Scimitar CS for management of black cutworm on creeping bentgrass. AMT, V. 22: 14G.

Heller, P. R. and R. Walker. 1997b. Evaluation of Rohmid's RH0345, Scimitar CS, Cruiser, Crymax, and Naturalis-T for management of black cutworm. AMT, V. 22: 18G.

Heller, P.R. and R. Walker. 1997c. Timing effect on performance of RH0345, Merit 75WSP, Tempo 2, and Dursban Pro for management of black cutworm on creeping bentgrass. AMT, V. 22., 17G.

Heller, P. R. and R. Walker. 1998. Evaluations of spinosad, bifenthrin, chlorpyrifos and experimental formulations for management of black cutworm on creeping bentgrass, 1997. Arthropod Mngt. Tests 23: 313.

Meyer, W. A. and C. R. Funk. 1989. Progress and benefits to humanity from breeding cool-season turf grasses. p. 31-48. In Sleper et al. (eds.) Contributions from breeding cool-season grasses for forage and turf grasses. CSSA Spec. Publ. 15. CSSA, Madison WI.

Murphy, K. C., R. J. Cooper, and J. M. Clark. 1996. Volatile and dislodgeable residues following trichlorfon and isazofos application to turfgrass and implications for human exposure. Crop Sci. 36:1446-1454.

Niemczyk, H. D. 1981. Destructive turf insects. HDN Books, Wooster, OH.

Petrovic, A. M. 1993. Leaching: current status of research. Intern. Turfgrass Res. J. 139-147.

Petrovic, A. M., N.C. Roth, D. Lisk and D.A. Haith. 1990. Evaluation of pesticide leaching models for turfgrass. Am. Soc. Agron. Abs. pp180.

Shetlar, D. J. and H. D. Niemczyk. 1998. Control of black cutworm and sod webworm after timed applications, 1997. Arthropod Mngt. Tests 23: 316.

Swier, S. R., A. Rawlins, and R. Lamarche. 1998. Comparison of Mach-2 and Tempo on late larval instars of black cutworm, 1997. Arthropod Mngt. Tests 23: 313.

Tashiro, H. 1987. Turfgrass insects of the United States and Canada. Cornell University Press, Ithaca, NY.

Watschke, T. L., P. H. Dernoeden and D. J. Shetlar. 1995. Managing Turfgrass Pests. Lewis Publishers. Roca Raton, FL.

Williamson, R. C. and D. A. Potter. 1997. Nocturnal activity and movement of black cutworms (*Lepidoptera: Noctuidae*) and response to cultural manipulations on golf course putting greens. J. Econ. Entomol. 90: 1283-1289.

ATTACHMENT A: PROJECT LEADERS

Agricultural Experiment Stations:
Connecticut/New Haven (CT)
Leader: Dr. Richard S. Cowles*, Department of Entomology
Specialization: Entomology

Connecticut/Storrs (CT)
Leader: Dr. Karl Guillard*, Department of Plant Science
Specialization: Turfgrass Management

Florida (FL)
Leader: Dr. Brian Scully*, Everglades Research and Education Center
Specialization: Turfgrass Breeding

Maine (ME)
Leader: Dr. Alan R. Langille*, Department of Agronomy
Specialization: Turfgrass Management

Maryland (MD)
Leader: Dr. Mark J. Carroll*, Department of Natural Resources and Land. Arch.
Specialization: Turfgrass Management

Leader: Dr. Peter H. Dernoeden, Department of Natural Resources and Land. Arch.
Specialization: Turfgrass Pathology and Weed Science

Massachusetts (MA)
Leader: Dr. J. Scott Ebdon*, Department of Plant and Soil Science
Specialization: Turfgrass Management

Leader: Dr. Prasanta C. Bhowmik, Department of Plant and Soil Science
Specialization: Weed Science

Leader: Dr. J. Marshall Clark, Department of Entomology
Specialization: Pesticide and Environmental Toxicology

Leader: Dr. Patricia J. Vittum, Department of Entomology
Specialization: Entomology

Leader: Dr. Gail L. Schuman, Department of Microbiology
Specialization: Pathology

Leader: Dr. Robert L. Wick, Department of Microbiology
Specialization: Nematology

New Jersey (NJ)

Leader: Dr. James A. Murphy*, Department of Plant Science
Specialization: Turfgrass Management

Leader: Dr. Faith C. Belanger, Department of Plant Pathology
Specialization: Turfgrass Transformation

Leader: Dr. Bruce B. Clarke, Department of Plant Pathology
Specialization: Turfgrass Pathology

Leader: Dr. C. Reed Funk Jr., Department of Plant Science
Specialization: Plant Breeding

Leader: Stephen E. Hart, Department of Plant Science
Specialization: Weed Management in Turfgrass and Ornamentals

Leader: Dr. William A. Meyer, Department of Plant Science
Specialization: Turfgrass Breeding

Leader: Dr. James White, Department of Plant Science
Specialization: Endophytic Turfgrasses

New York/Cornell/Geneva (NY)

Leader: Dr. Mike G. Villani*, Department of Entomology
Specialization: Soil Insect Ecology/Turf Insect Pest Management

Leader: Dr. Inga-Mai (Pim) Larsson-Kovach, Department of Food Science and Technology
Specialization: Analytical Chemistry

New York/Cornell/Ithaca (NY)

Leader: Dr. A. Martin Petrovic*, Department of Floriculture and Ornamental Horticulture
Specialization: Turfgrass Water Quality and Management

Leader: Dr. Joseph Esnard, Department of Plant Pathology
Specialization: Nematology (Biocontrol/Soil Health)

Leader: Dr. Douglas A. Haith, Department of Agricultural and Biological Engineering
Specialization: Environmental Systems Analysis

Leader: Dr. Andrew J. Landers, Department of Agricultural and Biological Engineering
Specialization: Pesticide Application Technology

Leader: Dr. Donald J. Lisk, Department of Fruit and Vegetable Science
Specialization: Environmental Toxicologist

Leader: Dr. Eric B. Nelson, Department of Plant Pathology
Specialization: Turfgrass Pathology

Leader: Dr. Tammo S. Steenhuis, Department of Agricultural and Biological Engineering
Specialization: Hydrology, Non-Point Source Pollution

Leader: Dr. Leslie A. Weston, Department of Floriculture and Ornamental Horticulture
Specialization: Weed Science

Leader: Dr. Frank S. Rossi, Department of Floriculture and Ornamental Horticulture
Specialization: Turfgrass and Environmental Management

Pennsylvania (PA)

Leader: Dr. Thomas L. Watschke*, Department of Agronomy
Specialization: Turfgrass and Weed Science

Leader: Dr. Peter J. Landschoot, Department of Agronomy
Specialization: Turfgrass Science

Leader: Dr. Paul R. Heller, Department of Entomology
Specialization: Turfgrass Entomology

Leader: Dr. Wakar Uddin, Department of Plant Pathology
Specialization: Plant Pathology

Rhode Island (RI)

Leader: Dr. Bridget Ruemmele*, Department of Plant Sciences
Specialization: Turfgrass Breeding

Leader: Dr. Steve Alm, Department of Entomology
Specialization: Turfgrass Entomology

Leader: Dr. Richard Hull, Department of Plant Sciences
Specialization: Turfgrass Physiology

Leader: Dr. W. Michael Sullivan, Department of Plant Sciences
Specialization: Turfgrass Agronomy

Other Cooperators:

USDA - National Turfgrass Evaluation Program

Cooperator: Mr. Kevin Morris, National Turfgrass Evaluation Program
Specialization: Turfgrass Evaluation

USEPA Office of Pesticide Programs - Environmental Fate and Effects division

*Voting Member

ATTACHMENT B: RESOURCES

	SYs	PYs	TYs
Agricultural Experiment Stations:			
Connecticut/New Haven (CT-NH)	0.60	0.00	0.40
Connecticut/Storrs (CT-S)	0.20	0.25	0.45
Florida (FL)	0.50	0.00	1.00
Maine (ME)	0.30	0.00	0.00
Maryland (MD)	1.00	1.00	1.00
Massachusetts (MA)	1.05	1.00	1.75
New Jersey (NJ)	1.80	0.70	1.25
New York/Cornell/Geneva (NY)	0.25	0.10	0.10
New York/Cornell/Ithaca (NY)	1.64	0.47	2.52
Pennsylvania (PA)	0.75	0.00	0.00
Rhode Island (RI)	0.60	0.90	1.00
Other Cooperators:			
USDA - National Turfgrass Evaluation Program	0.00	1.00	0.00
TOTAL	**8.69 SYs**	**5.42 PYs**	**9.47 TYs**