2006 Wisconsin Turfgrass Research Reports

Volume XXIV

TABLE OF CONTENTS

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Editor's Note

We are sincerely grateful for the tremendous industry support for the UW Turfgrass Program provided by the above sponsors. Without your help, our turfgrass research and educational program would be unable to function at anywhere near its current and targeted level. While we strive for perfection and attempt to list all our supporters, if we accidentally missed you then you have our sincere apology; please let us know so we may correct the situation in the future. If you have any comment or suggestions for next year's program, please contact John Stier at 608-262-1624 or jstier@.wisc.edu. References to pesticide products in this booklet are intended to convey objective, unbiased information and are not an endorsement of one product over similar products with similar results.

Yours truly,

Dr. John C. Stier

Horticulture Department

Introduction to the Turf Program at the University of Wisconsin

Thanks in part to tremendous support by you, the turf industry, the turf program at the University of Wisconsin has expanded its commitment to turf research, extension, and instruction tremendously in the past several years. In 2006 we lost one faculty member, Dr. Geunhwa Jung (Plant Pathology) due to a non-tenure decision but gained a new faculty member, Dr. Doug Soldat (Soil Sciences). One Ph.D. graduate student, Dr. Kurt Steinke, graduated from the program and became an assistant professor of turfgrass ecology at Texas A & M university. Two other Ph.D. students graduated and began post-docs at the University of Illinois. Please take a moment to read about the faculty, staff, and graduate students and their exciting and diverse research and extension programs. The university exists ultimately to serve the public good, and so though it may not be evident at first glance, all of the projects have the final goal of enhancing our understanding of turf management to help you become more successful and aid in sound decision-making at both the managerial and legislative levels.

The Faculty

Mike Casler (USDA and Adjunct Professor-Agronomy) 70% research, 30% instruction
Mike's program emphasis is in breeding better grasses for forage and turf. His turf projects include development of bentgrasses (creeping, colonial, and velvet) that are adapted to Wisconsin conditions (especially snow mold and *Poa annua* resistance). He also assists faculty and graduate students with statistical analysis.

Geunhwa Jung (former Assistant Professor-Plant Pathology) 60% research, 40% extension
Geunhwa was the molecular biologist of the turf group. He made many contributions to the UW-Madison turf program and really helped put the program "on the map". He made significant advancements in understanding the genetic basis of dollar spot infection and relatedness in bentgrasses, perennial ryegrass, and Kentucky bluegrass. For sod growers, his development of molecular markers to identify varieties in sod blends was beginning to develop an understanding of how various blends could become monopolized by a single variety. His ground-breaking investigations into the genetics of Typhula spp. helped explain why turf managers in Wisconsin do not have consistent results with fungicides.

Wayne Kussow (Professor Emeritus-Soil Science) 50% research, 50% instruction
Wayne has been the core of the turf program since the mid 1980s. His many research projects in understanding turf fertility and runoff have contributed greatly to our understanding of the environmental fate of nutrients and development of best management practices. Though he officially retired in 2005, Dr. Kussow continues to conduct applied research and help with the turf program.

Doug Soldat (Assistant Professor-Soil Science) 60% extension, 25% research, 15% instruction
Doug joined the turf program in December 2006 as he finished his Ph.D. at Cornell University where he studied the dynamics of nutrient runoff in turf systems. He will begin teaching a turf

nutrient and water management course in 2007 and conduct nutrient and soils-related investigations in turf science. We are glad to have Doug on board!

John Stier (Associate Professor-Horticulture) 70% extension, 30% instruction
John's research interests lie in athletic field management, cold and shade stress physiology, and turf's impact on the environment. Ancillary research projects include sod production, herbicide efficacy, establishment practices and cultivar evaluations. He also coordinates the UW portion of Wisconsin's School IPM program.

Chris Williamson (Assistant Professor-Entomology) 70% extension, 30% research
Chris has responsibilities for turf and ornamental entomology. His turf research program is diverse with projects involving black cutworm resistance, aetenius beetle, and Japanese beetle. In 2006 he has spent a tremendous amount of time conducting research and educating the public about the emerald ash borer.

Dick Wolkowski (Researcher-Soil Science) UW-Madison and UW-Extension
Dick began working at the O.J. Noer this year as he led a project to evaluate the utility of composted sewage sludge from Madison Metropolitan Sewage District commission. Dick has a long history of conducting a wide variety of nutrient and soils-related projects in the Department of Soil Science at the University of Wisconsin-Madison.

The Staff

A number of part-time students and non-students are hired to work at the O.J. Noer facility throughout the year. These personnel are integral to the functioning of the program. In addition, several permanent staff provide the continuity and in-depth service needed to help make the Wisconsin turf program one of the best in the nation.

Audra Anderson (ARS/WTA secretary)
Audra keeps the WTA program running smoothly and serves as a receptionist at the O.J. Noer turfgrass facility. She takes a primary role in coordinating the details of the WTA projects, including Turf Expo and the summer field days. Without her, the turf program would fail to function as smoothly as it does.

Paul Koch (Plant Pathology)
Paul is the diagnostician of the Turf Diagnostic Lab (TDL) and diagnoses commercial turf samples for golf courses, lawn care companies, schools, parks, and sod producers. In addition, he is completing his M.S. degree by investigating the dynamics of fungicide resistance as a function of the type and frequency of various fungicide programs on Wisconsin golf courses. Paul also conducts the day-to-day fungicide trials and interacts with cooperators.

Eric Koeritz (Horticulture)
Eric has worked as a research assistant with John Stier since he began his B.S. degree program over six years ago. He will finish his M.S. degree in 2007. Eric is in charge of the daily activities for all of the Horticulture field research projects at the O.J. Noer facility as well as several off-site trials, particularly herbicide investigations.

Tom Schwab (ARS-O.J. Noer manager)
As manager of the O.J. Noer facility Tom's responsibilities include procuring equipment and product donations from many turf companies, most of which is donated. His other responsibilities include building and grounds maintenance, including fixing irrigation. He also assists faculty and students with their projects when necessary.

Graduate Students

Nanda Chakraborty (Ph.D.-Plant Pathology)
Nanda concluded her graduate degree in 2006 with investigations into the genetic basis of dollar spot susceptibility and genetic relatedness of creeping bentgrass with wheat and rice. She is now doing a post-doc at the University of Illinois.

Joe Curley (Ph.D.-Plant Pathology)
Joe finished his Ph.D. program in 2006. His dissertation topic focused on mapping and identifying the genes in perennial ryegrass that provide resistance to gray leaf spot, a disease which can devastate perennial ryegrass turf and which has caused the conversion of many golf course fairways across the country to another turf species. He is now doing a post-doc at the University of Illinois.

Mark Garrison (M.S. student-Horticulture)
Mark is a native of Michigan and began his M.S. degree in autumn 2006 after graduating from the turf program at Michigan State University. His thesis topic is Invasiveness of Turfgrasses in Prairie Environments. He has already established plots on golf courses in Wausau, WI and Monroe, WI and will be collecting data from these sites as well as natural areas around sod farms. He is funded by a federal Hatch grant which is part of a multi-state effort to determine the invasiveness potential of turfgrasses.

Steven Hong (Ph.D.-Entomology)
Steven is nearing completion of his Ph.D. on black cutworm ecology. His advisor is Dr. Chris Williamson.

Eric Koeritz (M.S. student-Horticulture)
Eric's M.S. thesis topic is Development of an Environmentally Sustainable Golf Course. His two major projects have been 1) fine fescue and colonial bentgrass fairways and 2) velvet bentgrass management for putting greens. He is concluding data collection and will graduate in 2007. He divides his time in graduate studies with his position as a research assistant in the Horticulture department for John Stier.

Paul Koch (M.S. student-Plant Pathology)
Paul is finishing his M.S. degree on explaining the background of fungicide use and development of fungicide resistance in Sclerotinia homeocarpa, the causal agent of dollar spot disease. He splits his graduate program efforts with his primary duties as the turf diagnostician and fungicide evaluator for the program.

Jake Schneider (M.S. student-Horticulture)
Jake is supported by the Terry and Kathleen Kurth Wisconsin Distinguished Fellowship. His primary M.S. topic is Rain Garden Efficacy for Controlling Stormwater Runoff which compares rain gardens to lawn turf to control runoff from rooftops and improve groundwater replenishment. A second project has been focused on shade tolerance of velvet and creeping bentgrasses. Jake will finish his degree in December 2007 and plans to work as a golf course superintendent.

Kurt Steinke (Ph.D. student-Horticulture)
Kurt finished his Ph.D. under John Stier in May 2006 and is now an assistant professor of turfgrass ecology at Texas A & M university. His dissertation focused on understanding nutrient runoff and leaching from turf and prairie systems with a view towards developing sound environmental strategies for vegetative buffer strips in urban environments.

Ana Tapasieva (M.S. student-Soil Science)
Ana hails from Russia and is working towards a master of science degree in soil science. Her thesis topic is utilization of composted sewage sludge as a soil amendment for horticultural crops, including turfgrass. Research includes both Kentucky bluegrass lawn and creeping bentgrass fairway evaluations.

Cultivar Evaluations

2003 NTEP Bentgrass Putting Green Test

John Stier and Eric J Koeritz
Department of Horticulture

INTRODUCTION

Twenty-six cultivars of bentgrass representing creeping (*Agrostis stolonifera*) and velvet (*Agrostis canina*) species are being evaluated for putting green quality.

MATERIALS AND METHODS

Plots were seeded September 23, 2003 into a native soil push-up green (silt loam). The plot was fertilized with Spring Valley 15-24-8 at a rate of 1# P_20_5 at the time of establishment. The plot was covered with a greens cover to promote germination and to discourage seed movement. The cover was removed approximately two weeks following seeding. The plot size is 4 x 6 ft (24 ft^2). The experimental design was a randomized complete block with three replications.

The putting green was grown in during the spring of 2004. Mowing was initiated at 11/16" and gradually worked down to 5/32" using a regular topdressing program. The green is now topdressed monthly and it receives ½ lb N/1000 ft^2 per growing month. No core aerations have been conducted. Irrigation is supplied 3 times weekly to replenish 100% ET.

In October 2003 an application of Subdue Maxx (mefenoxam) was made to control an infection of pythium root rot on the velvet bentgrasses. In June 2004, an application of Lontrel was made at .25 oz/M to control broadleaf weeds. Velocity was applied at 30 g ai/Acre in October 2004 to control *Poa annua*. In 2006 no pesticides were applied.

Turfgrass quality will be rated monthly during the growing season. Spring green-up, genetic color and density ratings are taken annually.

RESULTS AND DISCUSSION

Poa annua infestation was markedly reduced from previous years, no more than 1-2%. Several varieties of both creeping and velvet bentgrass have provided high quality turf despite the lack of fungicide applications. Some of these velvet bentgrasses have greatly improved their turf quality since the first two years of the test. Full results will be published early in 2007 at www.ntep.org. Results from previous years are already available.

Table 1. Entries in 2003 National Turfgrass Evaluation Program putting green test.

Entry	Name	Species	Sponsor
1	LS-44	Creeping	Links Seed, LLC
2	Penn A-1	Creeping	Standard Entry
3	Benchmark DSR	Creeping	Turf Merchants, Inc.
4	Penncross	Creeping	Standard Entry
5	CY-2	Creeping	Snow Brand Seed Co.
6	Alpha	Creeping	Simplot/Jacklin Seed
7	T-1	Creeping	Simplot/Jacklin Seed
8	SR 7200	Velvet	Standard Entry
9	13-M	Creeping	Pennington Seed
10	Declaration	Creeping	Lebanon Turf Products
11	Independence	Creeping	Lebanon Turf Products
12	Legendary	Velvet	Lebanon Turf Products
13	235050	Creeping	LESCO, Inc.
14	Bengal	Creeping	Barenbrug USA
15	9200	Creeping	ProSeeds Marketing
16	IS-AC 1	velvet	DLF International Seeds
17	IS-AP 9	Creeping	DLF International Seeds
18	EFD	Velvet	ProSeeds Marketing
19	Vesper	Velvet	Standard Entry
20	A03-EDI	Creeping	The Scotts Company
21	DSB	Creeping	R. H. Hurley, LLC
22	Greenwich	Velvet	Turf-Seed, Inc.
23	23R	Creeping	Mountain View Seeds, Ltd.
24	SRX 1GPD	Creeping	Seed Research of Oregon
25	SRX 1GD	Creeping	Seed Research of Oregon
26	Pennlinks II	Creeping	Tee-2-Green Corp.

2003 Bentgrass Fairway NTEP Test

John Stier and Eric Koeritz
Departments of Horticulture

OBJECTIVE

The purpose of the test is to compare experimental and commercially available lines of bentgrasses for fairway use in Wisconsin (Table 1).

MATERIALS AND METHODS

Plots were seeded 9 September 2003 on a Troxel silt loam soil following application of a starter fertilizer. Futerra® erosion control blankets were used to cover the plots to prevent potential washouts and provide a favorable environment for germination. Plots were topdressed once in spring 2004 using an 80:20 sand:peat mixture to assist grow-in. Plots are mowed 3 times weekly at 0.375 inch, and fertilized twice yearly with a total of 1.5 – 2 lb N per thousand square feet.

Data collected include:

- Establishment rate (% ground cover 4-6 weeks after seeding)
- Percent living ground cover at the end of each spring, summer, and autumn season
- Quality ratings (monthly)

Simulated golf cart traffic will begin 3 times weekly in spring 2005 and continue through the end of the test in 2007. A golf cart traffic simulator developed by the UW Biological Systems Engineering department will be used. The traffic simulator equals the weight of a conventional golf cart with 2 golfers and golf bags.

RESULTS

Most cultivars did not provide high quality turf though several creeping bentgrass varieties provided acceptable quality turf. The colonial bentgrass varieties tended to perform poorly and most suffered from moderate to severe Poa annua invasion. Full data will be published early in 2007 at www.ntep.org; data from previous years are already posted.

Table 1. Entries in the 2003 National Bentgrass Test for Fairways.

Name	Species	Name	Species
LS-44	Creeping	9200	Creeping
L-93	Creeping	IS-AT 7	Colonial
Bardot	Creeping	IS-AP 14	Creeping
Penncross	Creeping	23R	Creeping
EWTR	Colonial	Sr 7150	Colonial
Alpha	Creeping	SRX 1GPD	Creeping
T-1	Creeping	SR 1119	Creeping
cPrinceville	Creeping	SRX 1PDH	Creeping
13-M	Creeping	Pennlinks II	Creeping
Declaration	Creeping	Penneagle II	Creeping
Independence	Creeping	PST-OEB	Creeping
Tiger II	Colonial	PST-9NBC	Colonial
235050	Creeping	PST-9VN	Colonial
Bengal	Creeping	Seaside	Creeping

2003 Fine Fescue NTEP Fairway

John Stier and Eric J Koeritz
Department of Horticulture

OBJECTIVE

Evaluate commercial and experimental varieties of fine fescue species for fairway use.

MATERIALS AND METHODS

Fifty-three varieties of fine fescue representing strong creeping red, chewings, hard, and sheep fescue were seeded on silt loam on September 17, 2003. Plots were fertilized with 1 lb P_20_5 at the time of seeding and covered with Futerra erosion blankets. The trial is conducted under the following management:

Mowing height: 11/16", 3 times weekly
Nitrogen rate: 1 lb N/1000ft^2 in May and September
Irrigation: 75% ET 1X/week
Pesticide use: Mec-Amine-D 3-way June 2004 for broadleaves, Vantage .5 oz/M 8/25/04 for annual grasses, Velocity 30 g ai/acre for Poa annua, 10/15/04 Lontrel .5oz/M 10/25/04 for broadleaves
Plot Size: 5 x 5 ft (25ft^2)
Experimental design: Randomized complete block, 3 replications

Traffic treatments will be applied to the trial using a golf cart traffic simulator beginning in spring of 2005. Treatments will be applied 3 X per week, twice each time, for a total of 6 golf cart passes per week.

RESULTS AND DISCUSSION

Unlike in the previous (1998) trial when only one variety consistently provided acceptable quality under traffic, a number of varieties have provided acceptable quality under traffic in this test. Most tend to be Chewings fescues though some of the creeping reds are performing fairly well. Full data are published at www.ntep.org and are free for viewing.

Table 1. Entries in the 2003 Fine Fescue Test.

Name	Species	Name	Species
Razor	Strong creeping	Quatro	Sheep
Predator	Hard	IS-FRR 30	Strong creeping
7 Seas	Chewings	IS-FL 28	Hard
Seabreeze	Slender creeping	TL1	Strong creeping
Shademaster	Strong creeping	Pick CRF 1-03	Strong creeping
TL 53	Strong creeping	BMXC-S02	Strong creeping
Celestial	Strong creeping	Boreal	Strong creeping
SPM	Hard	SR 3000	Hard
Oracle	Strong creeping	Dawson E	Slender creeping
A01630Rel	Hard	Scaldis	Hard
ACF 174	Chewings	BUR 4601	Chewings
ASC 245	Strong creeping	SRX 51G	Chewings
5001	Strong creeping	SRX 3K	Hard
Audobon	Strong creeping	SRX 55R	Slender creeping
Jamestown 5	Chewings	Ambassador	Chewings
C-SMX	Strong creeping	Oxford	Hard
Jasper II	Strong creeping	Pathfinder	Strong creeping
Pick HF #2	Hard	DP 77-9885	Chewings
ACF 188	Chewings	DP 77-9886	Chewings
C03-RCE	Strong creeping	DP 77-9578	Strong creeping
C03-4676	Strong creeping	DP 77-9360	Strong creeping
Berkshire	Hard	DP 77-9579	Strong creeping
IS-FRR 23	Strong creeping	PST-4TZ	Chewings
IS-FRR 29	Strong creeping	PST-8000	Strong creeping
DLF-RCM	Strong creeping	Musica	Strong creeping
Longfellow II	Chewings	Cascade	chewings
IS-FRC 17	Chewings		

2004 NTEP Perennial Ryegrass Test

John Stier, Kevin Schneider, and Eric Koeritz
Department of Horticulture

INTRODUCTION

The purpose of this trial is to evaluate commercial and experimental cultivars of perennial ryegrass.

MATERIALS AND METHODS

This study is conducted at the O.J. Noer Turfgrass Facility in Verona, WI and is maintained as an athletic field at 1.5-inch mowing height. Plots were seeded 14 September, 2004 as a randomized complete block with 25 ft^2 individual plots. The study receives 0.5 lb N/growing month. Irrigation is applied to prevent dormancy. No pesticides were applied in 2006.

Turf Quality is rated monthly. Spring green-up, color, and density data are collected seasonally. Disease and weed ratings are taken when pests are present.

RESULTS

Some winterkill occurred throughout the plot during 2004-05 although ice was not present for extended periods. Much of the damage appeared to be varietally-related. Overall quality has markedly improved for most of these plots during 2006. Data will be collected on this study until the summer of 2010. Additional information for Wisconsin and other state evaluations is available at www.ntep.org.

Table 1. Perennial ryegrass entry numbers, varieties, and sponsors for 2004 NTEP test.

Entry	Sponsor	Entry	Sponsor
1 LPR02203	Deutsche Saatveredulung	61 PST-2AG4	Pure-Seed Testing, Inc.
2 Panther	Standard Entry	62 PST-2GSM	Pure-Seed Testing, Inc.
3 Manhattan II	Standard Entry	63 PST-2LAN	Pure-Seed Testing, Inc.
4 Pizaazz	Turf Merchants, Inc.	64 04-BEN	Oregro Seed, Inc.
5 Affinity	Turf Merchants, Inc.	65 05-BRE	Oregro Seed, Inc.
6 Paragon	Turf Merchants, Inc.	66 Sunshine 2	Pickseed West
7 Protege	Turf Merchants, Inc.	67 Pick F4	Pickseed West
8 LTP-611-GLR	Lebanon Seaboard Corp.	68 Pick 02-R	Pickseed West
9 ES45	Bailey Seeds	69 PRG HS-01-09	Pickseed West
10 TR47	Bailey Seeds	70 PM 101	Pickseed West
11 CNV	Columbia Seeds	71 APR 1663	Mountain View Seeds
12 GPR	Grasslands Oregon	72 AAZ-B104	Z Seeds
13 KN42	Kanako Seeds, Inc.	73 RG3P	Mountain View Seeds
14 VB99	Landmark Seed Company	74 DCM	LESCO, Inc.
15 VB77	Landmark Seed Company	75 AF	LESCO, Inc.
16 L44	LESCO, Inc.	76 PS-2	LESCO, Inc.
17 TRS	McCarthy Research Farm	77 Palmer III	Standard Entry
18 BPR	McCarthy Research Farm	78 RAD-PR8	Radix Research, Inc.
19 AJM	McCarthy Research Farm	79 Brightstar SLT	Turf-Seed, Inc.
20 LPFG	McCarthy Research Farm	80 Citation Fore	Turf-Seed, Inc.
21 EXS54	McCarthy Research Farm	81 $ilver Dollar	Turf-Seed, Inc.
22 RTS	McCarthy Research Farm	82 PST-2LGL	Turf-Seed, Inc.
23 PWDR	Pennington Seed Company	83 Quicksilver	Turf-Seed, Inc.
24 SP4	Smith Seed Company	84 Premier II	Barenbrug USA
25 SNR	Smith Seed Company	85 Pinnacle II	Barenbrug USA
26 APR 1660	Ampac Seed Company	86 Barlennium	Barenbrug USA
27 Pick 01-2	Ampac Seed Company	87 BAR Lp 4317	Barenbrug USA
28 JR-119	Jacklin Seed/Simplot	88 BAR Lp 4420	Barenbrug USA
29 JR-324	Jacklin Seed/Simplot	89 BAR Lp 4920	Barenbrug USA
30 JR-348	Jacklin Seed/Simplot	90 SRX 4682	Seed Research of Oregon
31 JR-408	Jacklin Seed/Simplot	91 SRX 4692	Seed Research of Oregon
32 DP1	Pennington Seed Company	92 SRX 4SP	Seed Research of Oregon
33 MMW	Pennington Seed Company	93 SRX 4UP3	Seed Research of Oregon
34 ARR 1664	Pennington Seed Company	94 PM 102	Pickseed West
35 Mach I	Standard Entry	95 Headstart 2	Turf-One
36 Pick RB-1	Pickseed West	96 MS2	Pickseed West
37 LCK	Rutgers University	97 Repell GLS	ProSeeds Marketing
38 IS-PR 271	DLF International Seed Inc.	98 Panther GLS	ProSeeds Marketing
39 IS-PR 273	Columbia Seeds	99 GL-2	ProSeeds Marketing
40 IS-PR 270	LESCO, Inc.	100 RNS	ProSeeds Marketing
41 IS-PR 274	DLF International Seeds	101 Palmer IV	ProSeeds Marketing
42 IS-PR 276	DLF International Seeds	102 APR 1797	ProSeeds Marketing
43 IS-PR 312	DLF International Seeds	103 AC2	Pickseed West
44 IS-PR 269	Columbia Seeds	104 PM 103	Pickseed West
45 IS-PR 268	DLF International Seeds	105 E-99	Ultra-Turf
46 IS-PR 236	Mountain View Seeds	106 D04-LP05	The Scotts Company
47 IS-PR 233	Grasslands Oregon	107 D04-UP	The Scotts Company
48 IS-PR 235	Grasslands Oregon	108 D04-11T	The Scotts Company
49 Buena Vista	Burlingham Seeds, LLC	109 D04-1667	The Scotts Company
50 Fusion	Burlingham Seeds, LLC	110 Inspire	The Scotts Company
51 LTP-PG-GLR	Lebanon Seaboard Corp.	111 Pentium	The Scotts Company
52 LTP-101-GLR	Lebanon Seaborad Corp.	112 APR 1648	Ultra-Turf
53 JR-163	Jacklin Seed/Simplot	113 APR 1670	Lewis Seed Co.
54 JR-114	Jacklin Seed/Simplot	114 Premier	Standard Entry
55 JR-255	Jacklin Seed/Simplot	115 Pinnacle	Standard Entry
56 Overdrive	Burlingham Seeds, LLC	116 Linn	Standard Entry
57 PST-217	Pure-Seed Testing, Inc.	117 DP 17-9499	DLF-Trifolium A/S
58 PST-2AM	Pure-Seed Testing, Inc.	118 DP 17-9502	DLF-Trifolium A/S
59 PST-2BLK	Pure-Seed Testing, Inc.	119 DP 17-9505	DLF-Trifolium A/S
60 PST-2MNG	Pure-Seed Testing, Inc.	120 DP 17-9788	DLF-Trifolium A/S

2005 NTEP Kentucky Bluegrass Test

John Stier, Kevin Schneider, David Anderson and Eric Koeritz
Department of Horticulture

INTRODUCTION

The purpose of the trial is to evaluate commercial and experimental cultivars of Kentucky bluegrass under golf course fairway conditions.

MATERIAL AND METHODS

Plots were seeded in September 2005 on a silt loam soil. Starter fertilizer (1 lb P2O5/1000ft2) was applied at time of establishment. Futerra covers were used to prevent wash out or cross contamination. Plots are irrigated to prevent visual drought stress. The study receives 3-4 lbs N/M/year. Mowing height is 0.5 inches. Beginning in 2007, ½ of each plot will receive simulated golf cart traffic using a traffic simulator developed by the Biological Systems Engineering Department at UW-Madison. Turf quality is rated on a monthly basis. Spring green up, color, and density are collected seasonally. Disease ratings are taken when diseases are present. An application of Confront was made 22, May 2006 to control broadleaf weeds.

RESULTS

Plots will be grown in during the 2006 growing season. Traffic treatments will begin in 2007. Data for 2006 will be posted by mid-2007 at www.ntep.org for free viewing.

Table 1. 2005 Kentucky bluegrass NTEP cultivar entries.

Entry #	Cultivar	Sponsor	Entry #	Cultivar	Sponsor
#1	SW AG 514	Burlingham Seeds, LLC	#56	A00-1254	Mountain View Seed, Ltd.
#2	Shamrock	Standard Entry	#57	Bluestone	Mountain View Seed, Ltd.
#3	A97-890	Blue Mountain Seed, Inc.	#58	A98-999	Mountain View Seed, Ltd.
#4	Midnight	Standard Entry	#59	A95-410	Seeds, Inc.
#5	A98-689	Columbia River Seed	#60	RAD-343	Seeds, Inc.
#6	NA-3261	Columbia River Seed	#61	RAD-762	Seeds, Inc.
#7	Kenblue	Standard Entry	#62	Washington	Seeds, Inc.
#8	NA-3249	Columbia River Seed	#63	RAD-0AN64	Seeds, Inc.
#9	NA-3271	Columbia River Seed	#64	A99-3119	DLF International Seeds
#10	Bd 98-2108	The Scotts Company	#65	A99-2559	DLF International Seeds
#11	Bd 95-1930	The Scotts Company	#66	Harmonie	DLF International Seeds
#12	Bd 98-1358	The Scotts Company	#67	A97-1287	DLF International Seeds
#13	Bd 03-84	The Scotts Company	#68	Rhythm	DLF International Seeds
#14	Bd 99-2103	The Scotts Company	#69	Dynamo	Burlingham Seeds, LLC
#15	Bd 03-159	The Scotts Company	#70	Avid	Burlingham Seeds, LLC
#16	MSP 3722	University of Minnesota	#71	A01-299	Burlingham Seeds, LLC
#17	MSP 3723	University of Minnesota	#72	Reveille	Standard Entry
#18	MSP 3724	University of Minnesota	#73	Belissimo	Turf Merchants, Inc.
#19	Blueberry	Turf Merchants, Inc.	#74	Skye	Grassland Oregon
#20	Bewitched	Turf Merchants, Inc.	#75	RAD-504	Columbia River Seed
#21	Julia	Standard Entry	#76	SPTR 2LM95	Seed Research/Pickseed
#22	CPP 817	DLF International Seeds	#77	STR 2553	Seed Research of Oregon
#23	CPP 822	Cebeco Seeds	#78	STR 2703	Seed Research of Oregon
#24	CPP 821	Cebeco	#79	STR 23180	Seed Research of Oregon
#25	DP 76-9066	DLF Trifolium A/S	#80	SPTR 2959	Seed Research/Pickseed
#26	DP 76-9081	DLF Trifolium A/S	#81	STR 2485	Seed Research of Oregon
#27	DLF 76-9075	DLF International Seeds	#82	1QG-38	Columbia River Seed
#28	CP 76-9068	DLF Trifolium A/S	#83	PST-109-752	Pure-Seed Testing, Inc.
#29	A98-948	Pennington Seed, Inc.	#84	PST-101-390	Pure-Seed Testing, Inc.
#30	Argos	TurfOne	#85	PST-101-73	Pure-Seed Testing, Inc.
#31	PSG 366	Pickseed West, Inc.	#86	PST-Y2K-169	Seed Research of Oregon
#32	J-1326	Jacklin Seed by Simplot	#87	Prosperity	Turf-Seed, Inc.
#33	J-1334	Jacklin Seed by Simplot	#88	PST-1A1-899	Pure-Seed Testing, Inc.
#34	J-1466	Jacklin Seed by Simplot	#89	NA-3248	Columbia River Seed
#35	J-2024	Jacklin Seed by Simplot	#90	NA-3259	Columbia River Seed
#36	J-2399	Jacklin Seed by Simplot	#91	H98-701	Grassland Oregon
#37	J-2404	Jacklin Seed by Simplot	#92	LTP 2949	Lebanon Seaboard Corp.
#38	J-2502	Jacklin Seed by Simplot	#93	PSG 711	Pickseed West, Inc.
#39	J-2791	Jacklin Seed by Simplot	#94	America	Standard Entry
#40	J-2870	Jacklin Seed by Simplot	#95	Barrister	Barenbrug USA
#41	J-3429	Jacklin Seed by Simplot	#96	Bariris	Barenbrug USA
#42	Everglade	Jacklin Seed by Simplot	#97	Baron	Standard Entry
#43	Everest	Jacklin Seed by Simplot	#98	BAR VV 9634	Barenbrug USA
#44	Rugby II	Jacklin Seed by Simplot	#99	BAR VV 9630	Barenbrug USA
#45	Nu Destiny	Standard Entry	#100	BAR VV 0665	Barenbrug USA
#46	Award	Jacklin Seed by Simplot	#101	BAR VV 8536	Barenbrug USA
#47	NuGlade	Jacklin Seed by Simplot	#102	BAR VV 0709	Barenbrug USA
#48	Impact	Jacklin Seed by Simplot	#103	BAR VK 0710	Barenbrug USA
#49	Beyond	Jacklin Seed by Simplot	#104	LTP-73	Lebanon Seaboard Corp.
#50	A00-1400	Pennington Seed, Inc.	#105	LTP-149	Lebanon Seaboard Corp.
#51	Excursion	LESCO, Inc.	#106	H94-305	ProSeeds Marketing, Inc.
#52	NA-3257	LESCO, Inc.	#107	Mystere	ProSeeds Marketing, Inc.
#53	Glenmont	LESCO, Inc.	#108	AKB449	ProSeeds Marketing, Inc.
#54	A00-247	LESCO, Inc.	#109	Diva	ProSeeds Marketing, Inc.
#55	A01-349	Mountain View Seed, Ltd.	#110	POPR 04594	Euro Grass Breeding

2006 Tall Fescue NTEP Test

John Stier and Eric Koeritz
Department of Horticulture

OBJECTIVE

Evaluate new and existing tall fescue varieties for low maintenance turf use.

MATERIALS AND METHODS

Plots were seeded and established in September 2006. A prolonged period of subfreezing temperatures in October squelched development of the young swards, resulting in incomplete coverage before the end of the growing season. The amount of turf cover was rated 4 weeks after seeding and ranged from approximately 25-85%. Data to be collected over the next few years will include quality, winterkill, disease susceptibility, color and leaf texture.

Entomology Research

Effect of leaf toughness of selected turfgrasses on black cutworm development

S.C. Hong and R.C. Williamson
Department of Entomology

INTRODUCTION

The objective of this study was to investigate the leaf toughness among turfgrasses with different planting dates (i.e., young and old). Toughness of stems (leaf sheath), foliage, and pods of various crops have been reported to be correlated with resistance to insect pests, toughness adversely affects penetration and feeding by insects. Although adverse effects of leaf toughness on feeding activities of leaf-feeding insects have been investigated, no information associated with black cutworm and turfgrass is known.

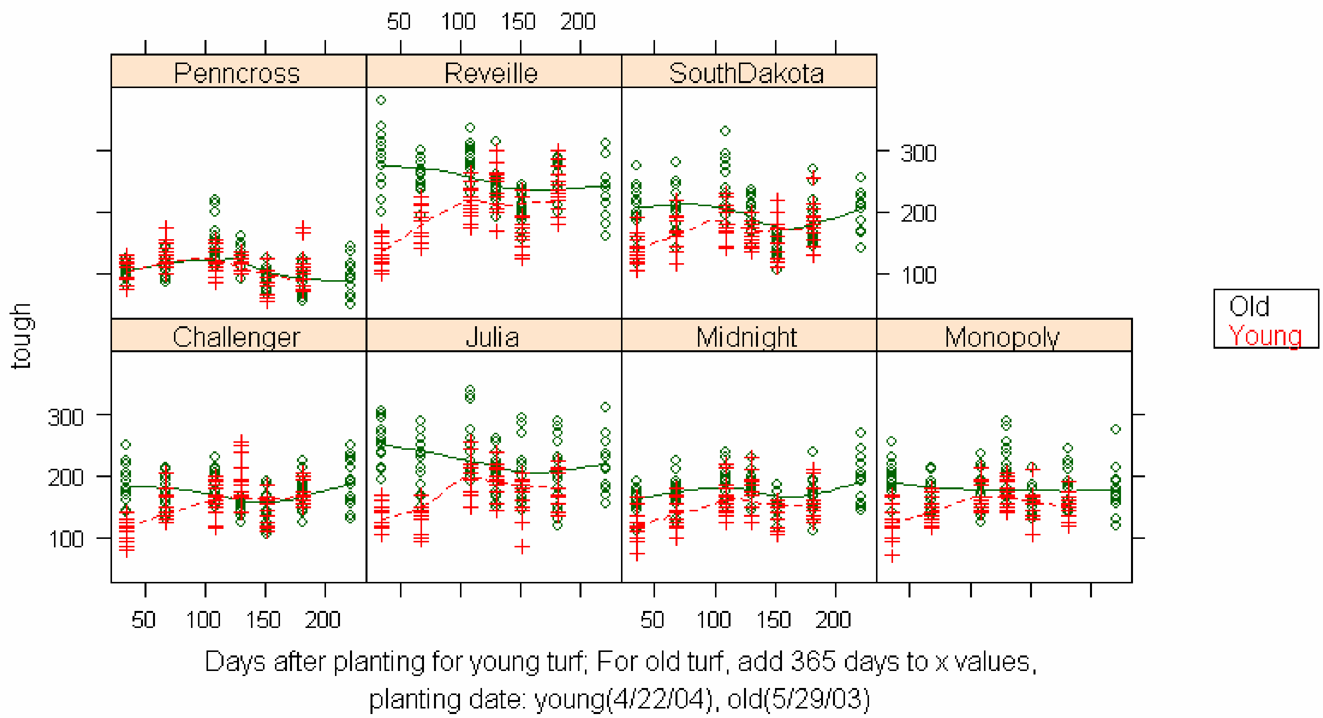
MATERIALS AND METHODS

Leaf tissue toughness was measured with a penetrometer. This device (photo) measures the weight required to force solid probes through leaf tissue. The thong is used to hold leaf tissues and the needle attached to the device is inserted into the hole and penetrated the tissue to measure the toughness. Turfgrasses used for toughness test were: creeping bentgrass ‘Penncross’, Kentucky bluegrass cultivars (‘Challenger’, ‘Julia’, ‘Midnight’, ‘Monopoly’, and ‘South Dakota’), and F1-hybrid ‘Reveille’ of Kentucky bluegrass and Texas bluegrass.

RESULTS AND DISCUSSIONS

Leaf toughness for old plant tissues was relatively consistent during the sampling period compared young plant tissues (Figure 1). The most obvious difference in leaf toughness between young and old tissues occurred when young plant tissues were less than 50 d old, leaves become tougher over times. Beyond about 100—150d, no difference in leaf toughness between young and old occurred. However, leaf toughness of creeping bentgrass (CBE) did not differ with plant age and was lower than other turfgrasses (Figure 1). Generally, leaf of all Kentucky bluegrass cultivars and ‘Reveille’ were tougher than that of creeping bentgrass ‘Penncross’.

Figure 1. Change of leaf toughness of turfgrasses



Evaluation of Arena (clothianidin) for Corrective Control of Japanese Beetle Larvae in Turf

Dr. R. Chris Williamson
Department of Entomology

INTRODUCTION

The larvae (white grubs) of Scarab beetles including the Japanese beetle, May/June beetle, and black turfgrass ataenius (BTA) can be highly problematic (damaging) in turfgrass. Although several effective preventative insecticides exist (e.g., chlothianidin, imidacloprid, and thiamthoxam), few insecticides provide effective corrective (curative) control. The objective of this study was to investigate the performance of several

MATERIALS and METHODS

Four insecticides (Arena 50WG, TM90701, Dylox 420 SL, and DPX-E2Y45) including different rates and formulations were evaluated to determine corrective performance against Japanese beetle larvae.

Turfgrass Site: Bridges Golf Course (Madison, WI), Irrigated Kentucky Bluegrass maintained @ 2 ½- 2 ¾”
Design: RCB, 4 replications
Insecticide Application Date: October 1, 2006
Application Method: CO_2 backpack sprayer, 8004 flat fan nozzles, post-treatment irrigation (about 0.20 inches) was applied immediately following treatment application

Spray Volume: 2 gallons water per 1000 ft^2
Data Collection Dates: October 6 (5 DAT) and October 15 (14 DAT)
Data Collection: Number of Japanese beetle larvae (grubs) alive and moribund (sick and/or not feeding) per one square foot.

RESULTS

Table 1. Number of Japanese beetle larvae alive and moribund at 5 and 14 day after treatment (DAT).

TRT	Mean # Grubs: 5 DAT	% CNT	Mean # Grubs: 14 DAT	%CNT
1	24 (18.25)	17.9	14.2 (3.5)	48.6
2	22.5 (17.5)	23.0	9.5 (2.75)	65.8
3	24.25 (18.5)	17.1	14.0 (3.5)	49.5
4	31.5 (25.25)	0	20.25 (3.25)	27.0
5	22.0 (17.0)	24.8	18.0 (3.0)	35.1
6	2.0 (0)	93.2	2.75 (0)	90.1
7	29.25	---	27.75	---
8	13.75 (11.75)	52.9	14.5 (10.5)	47.7

Number of alive larvae are presented. Mean number of moribund larvae are in parenthesis ( ).
Moribund larvae= larvae that are sick and/or not feeding.

CONCLUSION

Other than the Dylox treatment, no one corrective insecticide treatment provided 70% (acceptable) mortality (death) at 5 and 14 DAT. However, excluding the Dylox treatment, > 75% of larvae were moribund (sick and/or not feeding) at 5 DAT while between 16-72% of larvae were moribund at 14 DAT. A significantly greater proportion of larvae were moribund in the DPX-E2Y45 (DuPont experimental) treatment compared to all other treatments except the Dylox treatment. Since this study was terminated at 14 DAT, it is difficult to extrapolate the results of this study beyond the parameters tested. The results of this study do suggest that the treatments tested exhibited optimistic corrective insecticide properties since moribund larvae are not actively feeding and not likely to cause root-feeding damage. However, it must be noted that moribund larvae may attract vertebrate pests such as skunks and raccoons that may result in turf damage.

Evaluation of Meridian 25WG and 0.33G for preventative control of Japanese beetle larvae in turf

R. Chris Williamson
Department of Entomology

INTRODUCTION

The larvae (white grubs) of Scarab beetles including the Japanese beetle, May/June beetle, and black turfgrass ataenius (BTA) can be highly problematic (damaging) in turfgrass. The objective of this study was to investigate the performance of thiamethoxam (Meridian), a new insecticide, for preventative control of Japanese beetle larvae in turf.

MATERIALS and METHODS

Arena 50WG, Meridian 25 WG, and Meridian 0.33G were evaluated to determine preventative performance against Japanese beetle larvae.

Turfgrass Site: Bridges Golf Course (Madison, WI), Irrigated Kentucky Bluegrass maintained @ 2 ½- 2 ¾"
Design: RCB, 4 replications
Insecticide Application Date: June 29, 2006
Application Method: CO_2 backpack sprayer, 8004 flat fan nozzles and granular shaker-jar applicator, post-treatment irrigation (about 0.20 inches) was applied immediately following treatment application
Spray Volume: 2 gallons water per 1000 ft^2
Data Collection Dates: October 5, 2006
Data Collection: Number of Japanese beetle larvae (grubs) alive per one square foot.

RESULTS

TRT	Rate	No. grubs alive/ft^2	Mean # Grubs/ft^2	% Control
Arena 50WG	0.3 lb ai/A	0/0/0/0	0	100
Meridian 25WG	0.2 lb ai/A	0/0/0/0	0	100
Meridian 0.33	0.26 lb ai/A	0/0/0/0	0	100
Untreated	---	12/14/7/10	10.75	---

CONCLUSION

All treatments provided 100% control. The results of this study suggest that Arena 50 WG, Meridian 25 WG and Meridian 0.33G are all excellent preventative Japanese beetle control products.

Evaluation of Tempo Ultra and Dylox 420 SL for control of Surface Feeding Insects (Sod Webworm) in Low-cut Creeping Bentgrass

R. Chris Williamson
Department of Entomology

INTRODUCTION

Several species of sod webworm larvae can be problematic (damaging) on low-cut golf course turf including putting green, tee boxes, and fairways. The objective of this study was to investigate the performance (efficacy) of several insecticides.

MATERIALS and METHODS

Turfgrass Site: O.J. Noer Turfgras Research and Education Facility (Verona, WI) Irrigated creeping bentgrass maintained at fairway height (3/8 inch)
Design: RCB, 4 replications
Insecticide Application Date: August 16, 2006
Application Method: 10 sod webworm larvae were artificially infested into 8" PVC cylinders, after an acclimation period of 48 hours, insecticide treatments were made immediately thereafter with a hand-held, pump spray-bottle applicator at a spray volume equivalent to 2 gallons water per 1000 ft^2
Data Collection Dates: August 23 (7 DAT) and August 30, 2006 (14 DAT)
Data Collection: Number of sod webworm larvae alive per cylinder (n = 10).
Treatments:

TRT	Rate (grams ai/ha)
1= Tempo WP	108
2= Tempo Ultra	52.6
3= DeltaGard 5	33.6
4= Dylox 80 T&O	9100
5 = Dylox 420 SL	9100
6= DPX-E2Y45	224
7= Arena	280
8= UNT	---

RESULTS

7 DAT

TRT	Mean Number Larvae/Cylinder	% Control
1= Tempo WP	0	100
2= Tempo Ultra	0	100
3= DeltaGard 5	0	100
4= Dylox 80 T&O	0	100
5 = Dylox 420 SL	0	100
6= DPX-E2Y45	0	100
7= Arena	0.25	97.2
8= UNT	9.0	---

14 DAT

TRT	Mean Number Larvae/Cylinder	% Control
1= Tempo WP	0	100
2= Tempo Ultra	0	100
3= DeltaGard 5	0	100
4= Dylox 80 T&O	0	100
5 = Dylox 420 SL	0	100
6= DPX-E2Y45	0	100
7= Arena	1.75	78.1
8= UNT	8	---

CONCLUSION

With the exception of the Arena treatment, all other insecticide treatments tested provided 100% control of sod webworm at 7 and 14 DAT. The Area treatment did provide excellent control at 7 DAT and acceptable control at 14 DAT. The results of this study suggest all of the insecticide treatments tested are effective sod webworm control products.

Environmental Research

INVASIVE POTENTIAL OF COOL-SEASON TURFGRASSES

Mark A. Garrison and Dr. John C. Stier
Department of Horticulture

INTRODUCTION

Executive Order 13122 was enacted on February 3, 1999. The order is intended to prevent the introduction of, provide for the control of, and to minimize the economic, ecological, and human health impacts that invasive species cause (E.O. 13122). The turf industry has become a stakeholder of such legislation due to the species of economically important turfgrasses which have been added to Wisconsin Dep. of Natural Resources (WDNR) and national invasive species lists including Kentucky bluegrass and creeping bentgrass (USDA-NCRS, 2002; WDNR, 2003).

There is a lack of scientific data on the invasiveness of turfgrasses. Listings often are developed based on casual observation of a species occurrence at a site. The Nature Conservancy, for example, lists numerous sites where Kentucky bluegrass and bentgrasses (*Agrostis* spp.) exist as proof of their invasiveness. It is unclear whether the occurrence of turfgrasses at these sites is due to an ancient planting or self-establishment and elimination of and/or cause economic and/or environmental harm. For example, the Plant Conservation Alliance (PCA, 2003) lists red fescue (*Festuca rubra*) as an invasive species while the USDA lists it as native (USDA-NRCS, 2002). Determining the invasive potential of turfgrasses is important to protecting sensitive natural areas and determining if transgenic turfgrasses should be approved for commercial use.

OBJECTIVES

The results of this research will help regulatory agencies to make decisions regarding policies on transgenic turfgrasses. The objectives of this study are to clarify and document the invasiveness of commercially produced turf species/varieties in anthropogenic prairie environments. The null hypothesis is that no turfgrass species observed is invasive. The prediction is that some turfgrasses will have the ability to become established in the native areas. Anecdotal evidence suggests that certain species may indeed be invasive depending on the environmental setting and management. The study will be in three parts. These parts are to include; 1) collecting grass samples and identifying through molecular markers technology, 2) Burying and exhuming turfgrass seeds, stolons, and rhizomes to study the length of survival in soil, and 3) Measuring the survivability and spread of live turfgrass plants in a constructed prairie setting.

MATERIALS AND METHODS

Part 1of this investigation will identify grass samples collected from areas bordering sod farms using genetic marker technology. The goal is to identify the samples as elite or common varieties in order to determine if spread has occurred from the desired or planted areas. Data collection for this part of the study will start in the spring of 2007.

Part 2 will measure the spread of turfgrass plants in a native prairie setting. This study will take place at two locations; Monroe Country Club (Monroe, WI) and Greenwood Hills Country Club (Wausau, WI). The locations selected are areas which have been established to a prairie setting a minimum of 5 years prior to the establishment of the research plots. The variation in latitude, climate, and soil should provide a favorable contrast for observation of different environments. Each location will consist of 5 replications in a randomized complete block design on 8' centers. Each replication consists of individual monostand plugs of 11 separate turfgrass species/varieties. Turf plugs were germinated and initially grown under greenhouse conditions at the University of Wisconsin-Madison West Madison Agricultural Research Station. Turf plugs were raised by applying seed at the species recommended rate in 1 ½" x 5" conetainers filled with sterilized field soil and mulched with Metro Mix. Growth was encouraged in the conetainers, fertilizer and pesticides were applied as necessary. Turf plugs were trimmed to an average height of 2" to promote lateral growth. To better acclimate to outdoor climate turf plugs were moved outdoors in mid-August, 45 days prior to establishment in the field. Plugs were planted in small holes of a proper depth and a slightly larger diameter. The holes were made with a custom designed and fabricated soil probe constructed from a piece of 1 ½" metal electrical conduit cut approximately 2 ½' long with a ½" x 14" piece of rebar handle. After planting small metal cages and irrigation flags were placed over the plants and next to the plants to mark their location and help to protect them from predators during their initial establishment (all of the original plantings at the first site established were eaten to the soil level by animals within the first week). The cages will be removed in 2007. Measurements will be collected on a monthly basis, unless snow cover is present. The observations will include three measurements; two measuring diameter of spread and another measurement of the plants' vertical growth. Data on seedhead development and seed viability will also be collected.

Part 3a will determine the longevity of Kentucky bluegrass and creeping bentgrass seeds to survive in the soil seed-bank. For comparison, two Kentucky bluegrass seed varieties and one creeping bentgrass variety will be used along will several other non-native and native grasses. Non-native grasses are Canada bluegrass (*Poa compressa*), rough bluegrass (*Poa trivialis*), and tall fescue (*Festuca arundinacea*). Native grasses are Virginia wild rye (*Elymus virginicus*), local ecotype switchgrass, and a local ecotype big bluestem (*Andropogon gerardi*). This study is occurring at two locations: Monroe Country Club (Monroe, WI) and Greenwood Hills Country Club (Wausau, WI). Each location consists of 5 replications in a randomized complete block design. Each replication will observe eight time periods; 0, 1, 3, 4, 6, 12, 24, and 36 month(s). Each seed sample contains 100 seeds combined with autoclaved soil contained in a bag made from 440 count silk screeners mesh material. The mesh bag was composed of a polyester nylon blended fabric cut into squares ranging from 3.5" x 3.5" - 5" x 5". The fabric was folded and closed with 4" plastic cable ties. The bags were identified by writing on corrosion resistant 3" aluminum plant marker tags, cut to a more appropriate size determined by the amount of writing on tag. Seeds were hand counted and mixed at a seed/soil ratio of 25:1 (by volume). Bags were buried at a depth of approximately 2" (5 cm) in holes cut by a 4" diameter putting green cup cutter. Three bags were placed per hole spaced in a triangular pattern. Therefore, each time period will require three holes to contain the 9 seed types. To prevent light from reaching the seeds, initiating germination, an opaque plastic cover was placed above the bags in the soil profile and the existing ground cover (plug previously removed) was replaced. The locations of individual time periods were marked by placing colored road marking flags in a triangular pattern around the seed bags (i.e. one flag on the perimeter of each hole cut). A soil water and temperature monitoring station was placed at both the Monroe CC and Greenwood Hills CC sites to monitor soil conditions. The data will be retrieved monthly. To aid in the exhumation, assorted colors of flags will be used to indicate each time designation. Germination tests will then be used to determine seed viability. These tests will follow the ASOA seed vigor testing handbook procedures and a tetrazolium staining process will be used on non germinated seed to determine if dormancy exists.

Part 3b will determine the longevity of Kentucky bluegrass rhizomes and creeping bluegrass stolons. This study will take place at two locations; Monroe Country Club (Monroe, WI) and Greenwood Hills Country Club (Wausau, WI) and will be established in the spring of 2007. Each location will consist of 5 replications in a randomized complete block design. Each replication will observe seven time periods; 1, 3, 4, 6, 12, 24, and 36 month(s). Four stolons or rhizomes will be mixed with autoclaved soil obtained previously from the site and placed in mesh bags. Each stolon will be composed of one node approximately 2 cm in total length and an individual rhizome will be composed of a node and approximately 3 cm in length. The mesh bag will be composed of a polyester nylon blended fabric of 240 count and that is cut into squares of an appropriate size to accommodate the stolons/rhizomes and soil. The fabric will be folded and closed with 4" plastic cable ties. The bags will be identified by writing on corrosion resistant 3" aluminum plant marker tags, cut to a more appropriate size determined by the amount of writing on tag. Stolons and rhizomes shall be hand counted and mixed at an appropriate seed/soil ratio (by volume). Bags will be buried at a depth of approximately 2" (5 cm) in holes cut by a 4" diameter putting green cup cutter. To prevent light from reaching the stolons/rhizomes a non transparent plastic cover will be placed above the bags in the soil profile and the existing ground cover (plug previously removed) will be replaced. The locations of individual time periods will be marked by placing assorted colors of road marking flags. A soil water and temperature monitoring station was placed at both the Monroe CC and Greenwood Hills CC sites to monitor soil conditions. The data will be retrieved monthly. To aid in the exhumation assorted colors of flags will be used to indicate each time designation. Immediately following exhumation the stolons/rhizomes will be placed in soil and given optimum conditions to check for viability.

DISCUSSION

Establishment is complete and data collection has started for parts "2 and 3a" and will conclude the spring of 2009 when the last of the stolon/rhizomes will be exhumed for survival analysis. Each project is designed to produce at least one manuscript. Appropriate audiences for the invasiveness research include the USDA and Wisconsin DNR. Results will be submitted to the peer-reviewed Journal of Environmental Quality, Ecology, Oecelogia or other journal and presented at the National Extension Natural Resources conference in 2008 and/or other appropriate venues. Results will be presented to state and national regulatory groups and the turf and seed industries through trade show conferences and publications in trade journals Golf Course Management, Grounds Management, Grounds Maintenance, and The Grass Roots.

Low Input Sustainable Turfgrass Trial

John Stier, Eric Koeritz and Mark Garrison
Department of Horticulture

OBJECTIVE

The objective of this study is to identify alternative grass species adapted to this region with minimum input and obtain information on best management practices for each species. Information obtained will be used for future breeding efforts.

MATERIAL AND METHODS

A total of 13 species were planted for this trial (see Table 1.). Individual plots measure 3' x 5'. Plots were dormant-seeded 11/12/2004 and covered in Futerra erosion control blankets. No starter fertilizer was applied at the time of seeding or at any time during the study. Plots are maintained without irrigation. Three mowing heights, no mow, 2" and 4" are stripped across each replication with each of the 13 grass species arranged randomly within each mowing height. Clippings are returned to the mowed plots and a 3 ft alley, mowed at 2-4" height, is maintained between the replications and around the plot area. There are a total of 3 replications. Plots are mowed once per month with the exception of the no mow treatment. Mec Amine-D herbicide was applied on 21 June, 2005 to control broadleaf weeds which were outcompeting the grasses. Quality was rated monthly. Density, percent coverage and percent of other species data was collected in May, July and September of each year. Data were first analyzed as a 12 x 3 factorial treatment arrangement using ANOVA (Crested dogstail failed to germinate and was consequently dropped from statistical analysis). The extensive interactions between mowing heights and grasses stimulated analysis as a two-way ANOVA (replication and grass type) to better observe trends within each mowing height, of which the data are presented here. The study is being repeated in 9 other locations throughout the middle of the United States as part of the NCERA-192 regional project.

Table 1. Grass type and seeding rate for low input sustainable turfgrass trial.

Code	Cultivar	Species	Seeding Rate (lbs/M
A	RoadCrest	Crested Wheatgrass	5
B	LMC-1122	Meadow Fescue	7
C	Spike	Tufted Hairgrass	1
D	Blacksheep	Sheep Fescue	7
E	Berkshire	Hard Fescue	6
F	LMC-5000	Praire Junegrass	2
G	Fults	Alkaligrass	1.5
H	HB 342	Hybrid Bluegrass	2
I	Dura Blue	Hybrid Bluegrass	2
J	Shade Star	Crested Dogs Tail	1
K	Bad River	Blue Grama	3
L	SR 7150	Colonial Bentgrass	1
M	Grande II	Tall Fescue	7

RESULTS AND DISCUSSION

First year establishment was slowed by dry weather conditions and abundant annual broadleaf weeds which had to be treated with herbicide to enable grass establishment. Grass cover and quality changed throughout the study depending on individual grasses reacted to mowing and fluctuating environmental conditions.

Desirable grass cover

Crested wheatgrass and alkaligrass started out with relatively moderate cover but declined over time: alkaligrass virtually disappeared regardless of mowing while crested wheatgrass cover increased only when left unmowed (Fig. 1). Few other plants grew in the umowed crested wheatgrass plots (data not shown) despite about 20% lack of wheatgrass cover; it is unknown if wheatgrass may produce allelotoxins. Tufted hairgrass along with the hard, sheeps, and meadow fescues had moderate establishment rates and increased in ground cover over time regardless of mowing heights. Hard fescue and sheep fescue developed the greatest cover of all grasses, about 90% ground cover by late summer 2006 regardless of mowing height. Tall fescue maintained its best cover (about 75%) when mowed at 2" height. At 4" height and in unmowed situations, tall fescue cover greatly declined over time to approximately 40% by autumn 2006, belying its reputation as an invasive species in natural areas.

Neither of the hybrid bluegrasses maintained sufficient cover to be useful as a turf without irrigation and/or fertilizer. Previous studies have shown the hybrid bluegrasses to be able to provide moderate to high quality lawn turfs when mowed, fertilized, and irrigated (Bremer et al., 2006; Stier et al., 2005).

Blue grama, a native grass, never developed more than 50% cover but interestingly, cover was best when it was mowed (approximately 40-50% cover). In unmowed conditions, cover gradually increased over time but by the end of the 2006 growing season it was still less than 30%. Ecological research on blue grama indicates it is a late-successional species, having very low nitrogen requirements, so it may increase its cover over time (Tilman and Wedin, 1991).

Prairie Junegrass, another native grass, had moderate establishment in 2005 though populations crashed regardless of mowing height in 2006. Weather was fairly wet and relatively higher-than-normal temperatures in 2006 compared to 2005 which had milder temperatures and much drier conditions.

Turf quality

None of the unmowed vegetation grew more than 1-2 ft., in fact many of the conventional turfgrasses such as the fescues, bentgrass, and bluegrasses grew less than 6 inches in height. In most grass stands, annual weeds such as ragweed grew taller than the grasses and greatly disrupted the uniformity of the stand which severely reduced turf quality.

From a lawn-type turf standpoint where uniformity and a vegetative height conducive to most recreational activities (picnicking, sports, etc.), mowing was always required: no unmowed grass plots provided usable turf with acceptable quality (≥ 6.0 on a 9 point scale). Unmowed hard fescue occasionally was close to providing acceptable turf quality though tall (>6”) weeds often disrupted the turf uniformity (Fig. 2). Hard fescue and sheep fescue provided the most consistently acceptable turf quality at 2” height though only sheep fescue consistently provided acceptable turf quality at 4” height. Colonial bentgrass occasionally provided acceptable quality turf when maintained at 2” height though puffiness became increasingly evident during 2006 and led to areas prone to scalping which resulted in large brown patches as chlorophyll-containing leaves were removed and the underlying brown shoots and stolons were exposed. Tufted hairgrass showed some promise over time, especially at the 4” mowing height, of providing an acceptable turf.

Meadow fescue provided relatively good ground cover and moderate quality (Fig. 2), though the wide leaf blades and light green color are generally not considered desirable for aesthetic purposes: it may be suitable for areas where aesthetics are of little concern (e.g., roadside but not a lawn turf). Tufted hairgrass had a more pleasing appearance than meadow fescue.

Crested wheatgrass provided an aesthetically-pleasing sward when it wasn’t mowed: vegetation was brown much of the year but the golden color and seedheads were attractive and the lack of other species allowed a uniform grass stand to develop. The height of the sward, about 1.5-2 ft, precludes unmowed crested wheatgrass from being a turf people can use for picnicking or most other recreational activities. The height would also be undesirable near a building as it would provide habitat for rodents, snakes, and other creatures which might periodically move into the building.

None of the hybrid bluegrasses, tall fescue, blue grama, alkaligrass or prairie Junegrass provided acceptable quality turf regardless of mowing height. Dr. Eric Watkins at the University of Minnesota has indicated better varieties of some of the native grasses exist and should be assessed for low input sustainable turf (personal communication, June 2006).

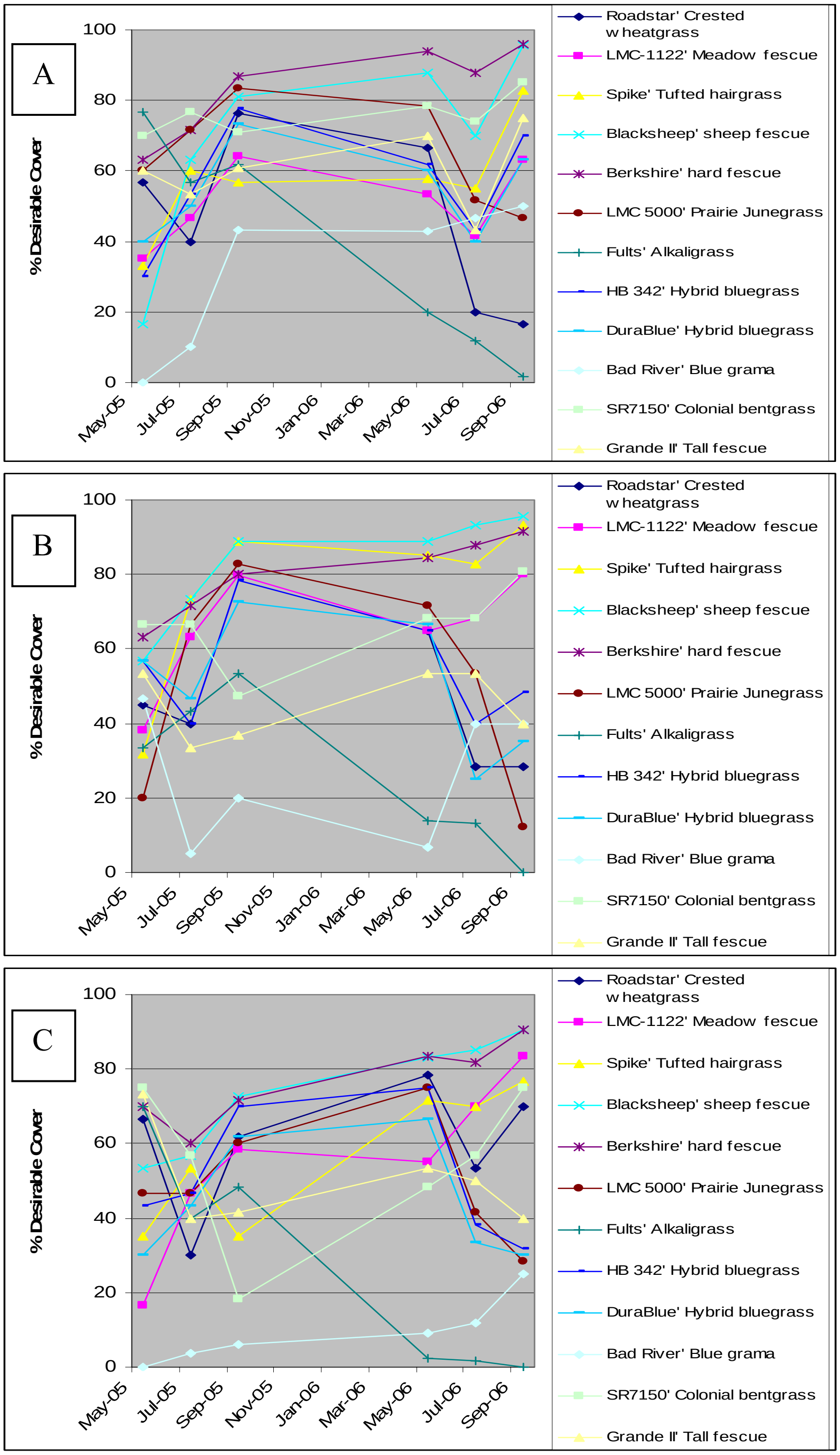


Fig. 1. Vegetative ground cover of desired (planted) species which were dormant-seeded in November 2004 and maintained at 2” height (A), 4” height (B), or unmowed (C) and without fertilizer or irrigation; a broadleaf herbicide (2,4-D, dicamba, MCPP) was applied in June 2005 to remove broadleaf weeds which were preventing grass establishment.

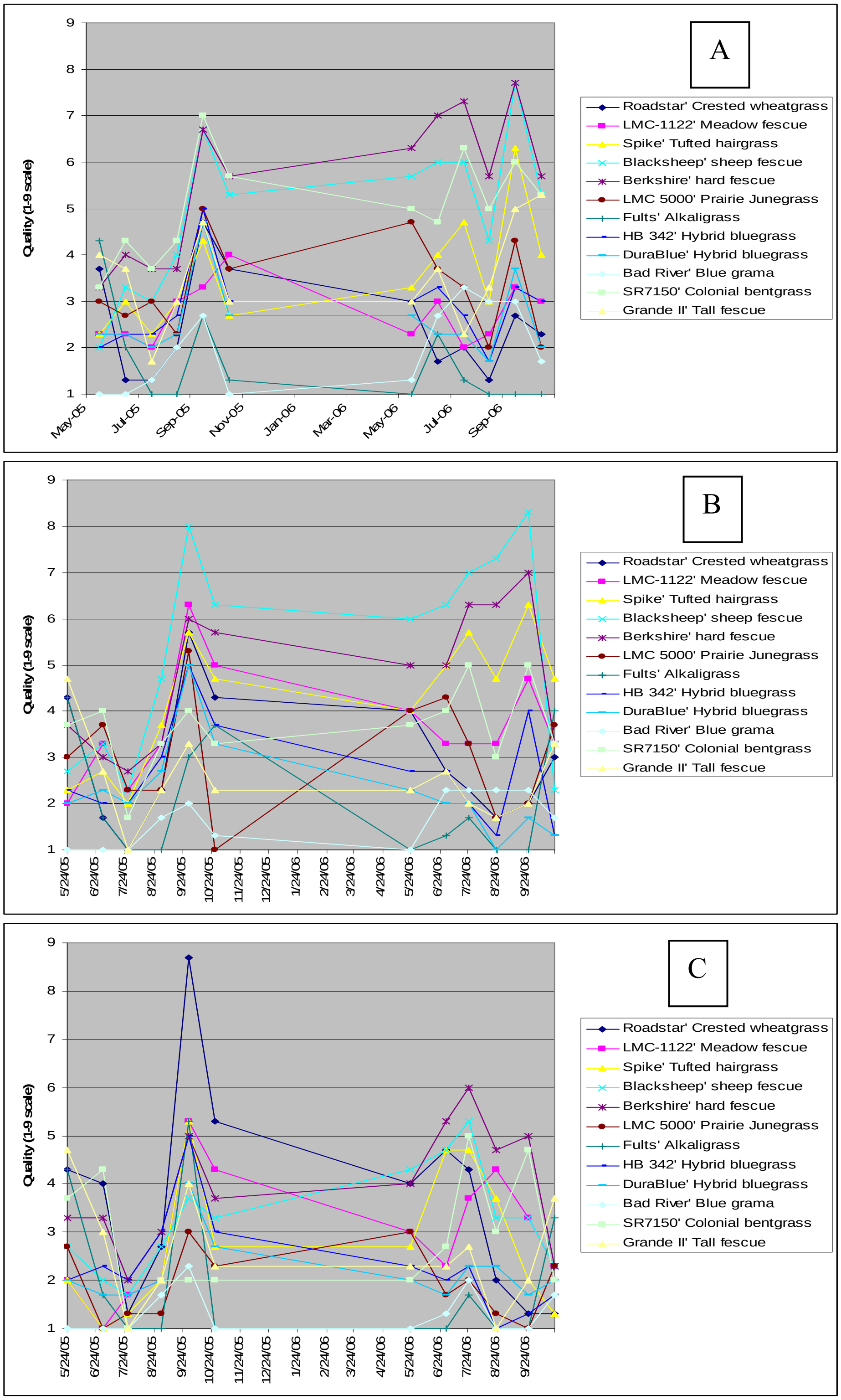


Fig. 2. Turf quality of various native and non-native grasses which were dormant-seeded in November 2004 and maintained at 2" height (A), 4" height (B), or unmowed (C) and without fertilizer or irrigation; a broadleaf herbicide (2,4-D, dicamba, MCPP) was applied in June 2005 to remove broadleaf weeds which were preventing grass establishment.

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Rain Gardens for Urban Water Quality Improvement

Jacob L. Schneider[1], Dr. John Stier[1], and Dr. Doug Soldat[2]
[1]Department of Horticulture and [2]Department of Soil Sciences

INTRODUCTION

Rain gardens are bermed areas that are designed to trap water coming from rooftop downspouts and allow this water to filter through the soil. They potentially offer one solution in the battle against urban water-quality issues. Rain gardens may decrease contaminant-laden surface runoff while increasing the quantity and quality of aquifer recharge. The objectives of this project are to determine the controlling factor(s) behind rain garden effectiveness. This investigation will attempt to determine if the vegetation in rain gardens, if proper rain garden construction and sizing, or if a combination of these factors are most influential in predicting their effectiveness. With water quality issues becoming more and more prevalent in urban settings, the need for such a study has never been greater, and its results have the potential to positively affect our urban surface- and ground waters.

MATERIALS AND METHODS

This study is a randomized, complete block design with four treatments replicated four times. The four treatments are 1) bermed Kentucky bluegrass (KBG), 2) unbermed KBG, 3) bermed native plants, and 4) unbermed native plants. The KBG sod and native plugs were installed in October 2005. All berms are approximately 6" high and surround the appropriate treatments on four sides. Treatment plot sizes are 8' x 8.75'. Each treatment is associated with an 8' x 25' rooftop that is sloped at 10% and an 8' x 10' KBG area. Downspouts traverse the KBG area and connect the treatment areas to their respective rooftops. With the exception of the f lat-bottomed bermed areas, the entire plot area has a 5% slope from rooftop to weir. Each treatment has a PVC weir system to collect runoff water and a buried lysimeter to collect leached water. Treatments are separated by a 2' buffer strip and by in-ground root barriers.

All KBG areas were fertilized with three pounds of nitrogen per 1000 ft2, using three one-pound applications. No irrigation or any other supplemental input was provided to the KBG. The plots were mown at 3" approximately one time per week with clippings returned.

The data that was collected for each treatment area was: runoff volume per runoff event, leachate volume as needed, monthly visual percent ground cover, monthly chlorophyll readings, yearly soil infiltration rates, and yearly estimated biomass. Sensors in each treatment area also collect soil moisture readings and soil temperature readings. An on-site weather station collects data on air temperature, relative humidity, and rainfall.

RESULTS AND DISCUSSION

The following figure (Figure 1) illustrates the treatment means of the runoff volumes per event. Due to lack of data, one of the unbermed turfgrass replications was omitted.

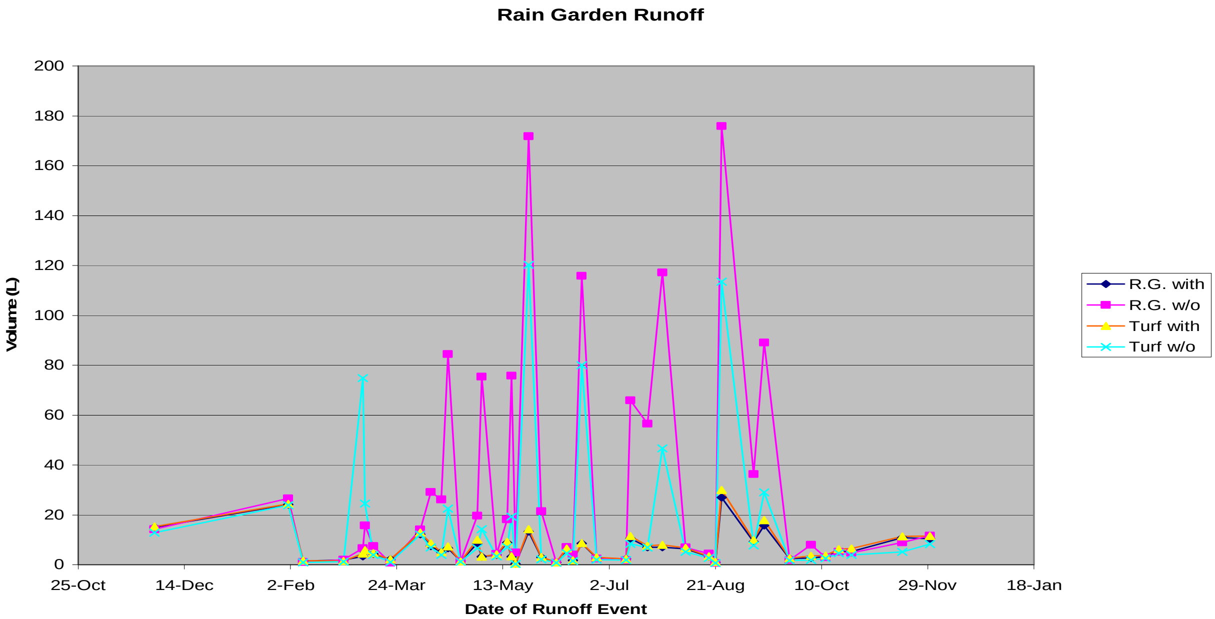

Figure 1: Mean runoff volume per treatment per event

From this (Figure 1), it is apparent that there is no difference between either of the bermed treatments. Both have very little associated runoff. Regarding the unbermed treatments, the rain garden vegetation treatments had substantially higher runoff volumes than the KBG treatments for all major runoff events except on March 8. Slower soil-warming rates in turfed areas which kept the ground frozen longer may explain this aberration; soil temperature data collected the winter of 2006-2007 will determine if a soil warming difference exists.

The next figure (Figure 2) illustrates the treatment means of leachate volume collected by date. No leachate was collected from one of the unbermed rain garden replications and so data were omitted; the collection device appears to be malfunctioning and will be fixed spring 2007.

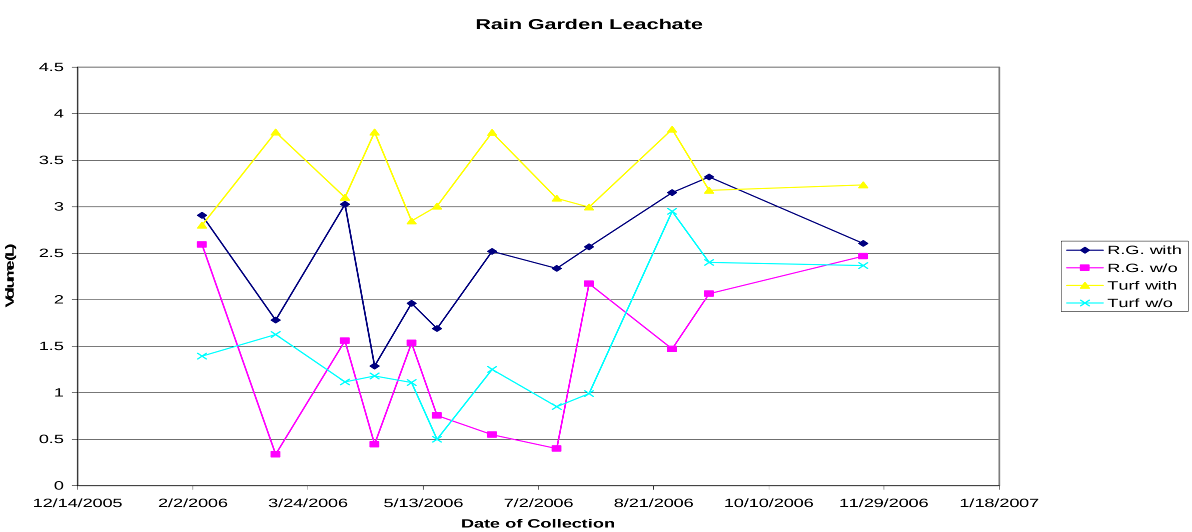

Figure 2: Mean leachate volume per treatment per collection

Throughout the first year, the bermed turfgrass treatment had the most collected leachate. The bermed native treatment was a distinguishable second, and the unbermed treatments were sporadic but consistently lower than the bermed treatments. Concerning water quality, all runoff and leachate samples will be analyzed for NO3, NH4, soluble reactive P, total-P, and total suspended solids. These analyses will begin in winter 2007.

A chlorophyll meter was used periodically to assess the relative amount of green (living) vegetation as data from other studies indicate P and other nutrients may be more likely to leach from dead vegetation than from living vegetation, contributing to nutrient loading in runoff. The following figure (Figure 3) illustrates the treatment means of the monthly chlorophyll meter readings. The greater the score, the more green vegetation existed.

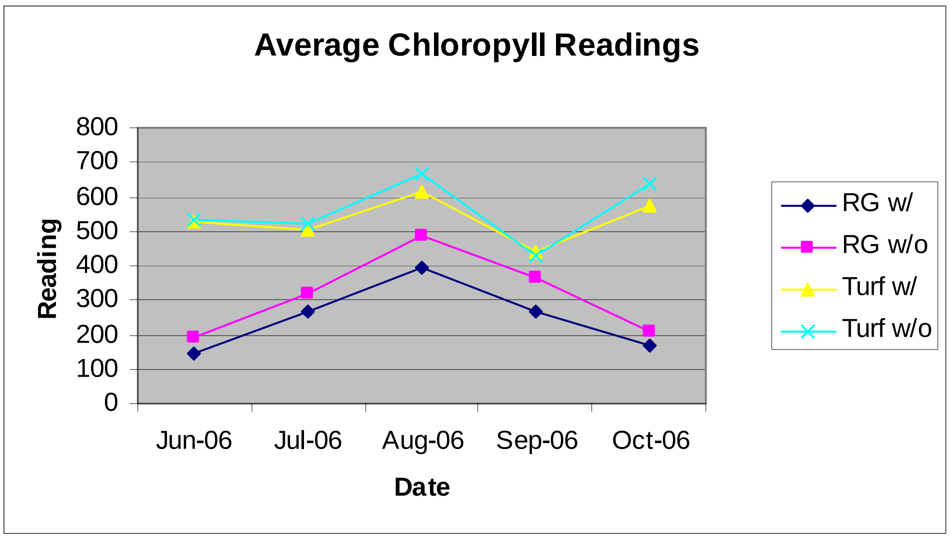

Figure 3: Mean chlorophyll reading per treatment per month

The KBG treatments had fairly consistent readings throughout the growing season that were substantially higher than the rain garden vegetation. The rain garden vegetation data show a curve that correlates with the growing season. In other words, because of their immaturity and plant-growth characteristics, these plots were slower to green-up in spring and entered dormancy earlier in the fall. Compared to the bermed native treatment, the unbermed rain garden treatment had a greater population of Pennsylvania smartweed, common ragweed, and curly dock. This may explain the difference in chlorophyll readings between these two treatments as these weeds contributed to "green index". The annual weed presence also resulted in the unbermed native treatment having higher estimated biomass and higher percent groundcover than the bermed native treatment.

CONCLUSION

Although the water samples have yet to be analyzed, it appears that turfgrass offers a suitable, less costly alternative to native plants in a properly-constructed rain garden. With proper sizing, both turfgrass and the native plants have the potential to increase the amount of water infiltrating our soils and decrease the amount of runoff.

Golf, Lawn, and Sports Turf Management

Management of Velvet Bentgrass Putting Greens

Eric J. Koeritz
Department of Horticulture

INTRODUCTION

In the mid 1900's velvet bentgrass was known to provide an excellent putting surface but there was a misconception that velvet bentgrass was a high maintenance turfgrass that formed excessive thatch and was only adapted to temperate oceanic climates. This misconception along with the lack of a quality, reliable seed supply led to the infrequent utilization of velvets on golf courses. The excessive thatch, disease, and *Poa annua* invasion associated with velvets was likely due to excessive irrigation and fertilization. Proper management and increased breeding efforts have reduced the problems formerly associated with velvets (Brilman, 2003).

Interest in velvet bentgrass, *Agrostis canina* (L.), has increased in recent years because of its excellent playability characteristics and environmental stress tolerances. Velvet bentgrass is the finest textured and densest of all bentgrass species. Velvets can tolerate close mowing, heat, cold, and drought. In addition they are the most shade tolerant of all of the bentgrass species (Brilman, 2003) (Plumly et al., 2001). Research recently conducted at Rutgers University showed that velvet bentgrass requires less water to maintain quality turf than creeping bentgrass (DaCosta and Huang, 2006). Velvets may be a good option for turf managers who are trying to reduce inputs and create an environmentally sustainable golf course because of their environmental stress tolerances and ability to thrive under low input conditions.

Currently there is little information on the performance of velvet bentgrass under reduced input conditions. The previous research done on velvets has compared velvets to other bentgrasses but has not compared the effects of multiple management strategies on the performance of velvets under trafficked and low input conditions in the Midwest. The ideal mowing height and fertilizer rate is not known for velvet bentgrasses.

OBJECTIVES

The two objectives of this research are to 1) Compare commonly available velvet bentgrass cultivars to commonly available creeping bentgrass cultivars, 2) Determine the effect of mowing height, and 3) Determine the effect of fertilizer rate.

MATERIALS AND METHODS

A field trial was conducted at the O.J. Noer Turfgrass Research and Educational Facility in Verona, WI. Plots were established in June 2004 on USGA specification greens constructed with an 80:20 sand:peat mix. Treatments were initiated in the spring of 2005. The experimental design was a randomized strip block-split plot with 4 replications. Grass type is the main plot. Three mowing heights were stripped across each block. Two nitrogen rates were used as sub-plots within each grass type and mowing height.

Treatments:

Grass type: SR7200, MVB (Vesper), L-93, Penncross
Mowing heights: .1", .156", .25"
Fertilizer rates: 1lb N/M/Yr, 3lb N/M/Yr

Data Collection:

Quality
Color
Shoot density
Disease
Green speed
Poa annua invasion
Thatch/Organic matter
Spring green up
Clipping yield
P and K content of clippings

Other Maintenance:

Traffic: Simulates 21,000 rounds annually
Topdress monthly using 80:20 sand:peat 0.54 kg m^{-2}
Irrigation- 5X/week 75%ET
Fungicides: applied curatively only to prevent significant turfgrass loss

RESULTS

It is important to consider that this study took place under reduced irrigation, reduced fungicide and trafficked conditions. Results would likely vary if the study was conducted under high input conditions.

Table 1 shows the effect of grass type and nitrogen rate on shoot density in June and August of 2006. The data show that both velvet bentgrass cultivars had better shoot density than the creeping bentgrass cultivars. Also, Vesper velvet bentgrass was the only grass type to have a positive shoot density response to the higher nitrogen rate. Vesper velvet bentgrass generally had greater shoot density than SR7200 velvet bentgrass.

Table 2 shows the effect of grass type and mowing height on dollar spot incidence. The data presented in table 2 was collected on 28 August 2006 immediately following a severe outbreak of dollar spot. The data show that in general the higher mowing heights had more dollar spot infection centers per square meter. However, the velvet bentgrasses had significantly less dollar spot at the .156" and .250" mowing heights than the creeping bentgrasses. Vesper at the .100" mowing height had virtually no damage from dollar spot.

Figure 1 shows the effect of grass type and nitrogen rate on average turf quality from May through September in 2006. The velvet bentgrasses performed reasonably at the low nitrogen rate but Vesper responded dramatically to added nitrogen. Vesper velvet bentgrass at the high nitrogen rate was the only grass type to maintain acceptable levels of quality throughout the growing season. The quality of Penncross creeping bentgrass was also improved by applying more nitrogen but quality ratings were always less than that of Vesper at the high nitrogen rate. Quality of SR7200 and L-93 remained the same regardless of the nitrogen rate.

Ball roll distance (green speed) was evaluated monthly using a modified (shortened) stimpmeter and the data is reported in figure 2 as an average of all of the rating dates in 2006. The graph shows interactions between grass type and nitrogen rate. The data show that applying less nitrogen to Vesper and Penncross increased ball roll distance. Ball roll on SR 7200 and L-93 was unaffected by varying the nitrogen rate.

Table 1. Shoot density as affected by grass type and nitrogen rate, Verona, WI, 2006.

	27 June 2006		10 Aug. 2006	
	--------N rate (lb N/M)--------		--------N rate (lb N/M)--------	
Grass	1	3	1	3
	------------------------------shoots/dm^2------------------------------			
Vesper (MVB)	2040 b†	2582 a	2145 b	2804 a
SR 7200	1710 c	1619 cd	1943 b	2127 b
Penncross	1055 f	1240 ef	1237 c	1430 c
L-93	1300 e	1432 de	1465 c	1461 c

† Values followed by the same letter within a rating date are not significantly different at P ≤ 0.05.

Table 2. Effect of grass type and mowing height on dollar spot incidence on 28 August, 2006 in Verona, WI.

	Mowing Height		
Grass Type	.100”	.156”	.250”
	-----------------infection centers/m^2-----------------		
Vesper	9.4 f	290.6 d	568.8 c
SR 7200	62.5 ef	237.5 de	534.4 c
Penncross	246.9 de	678.1 c	1365.6 a
L-93	115.6 def	628.1 c	1150.0 b

† Values followed by the same letter within a column are not significantly different at P ≤ 0.05

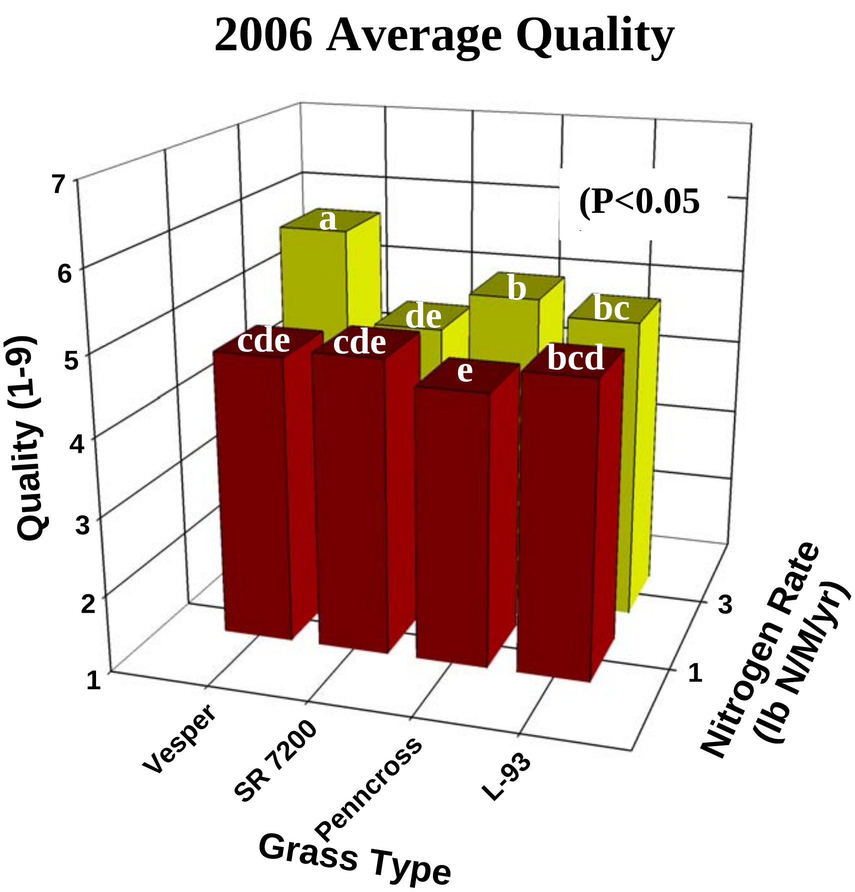

Figure 1. Effect of grass type and nitrogen rate on average turf quality from May through September 2006, Verona, WI.

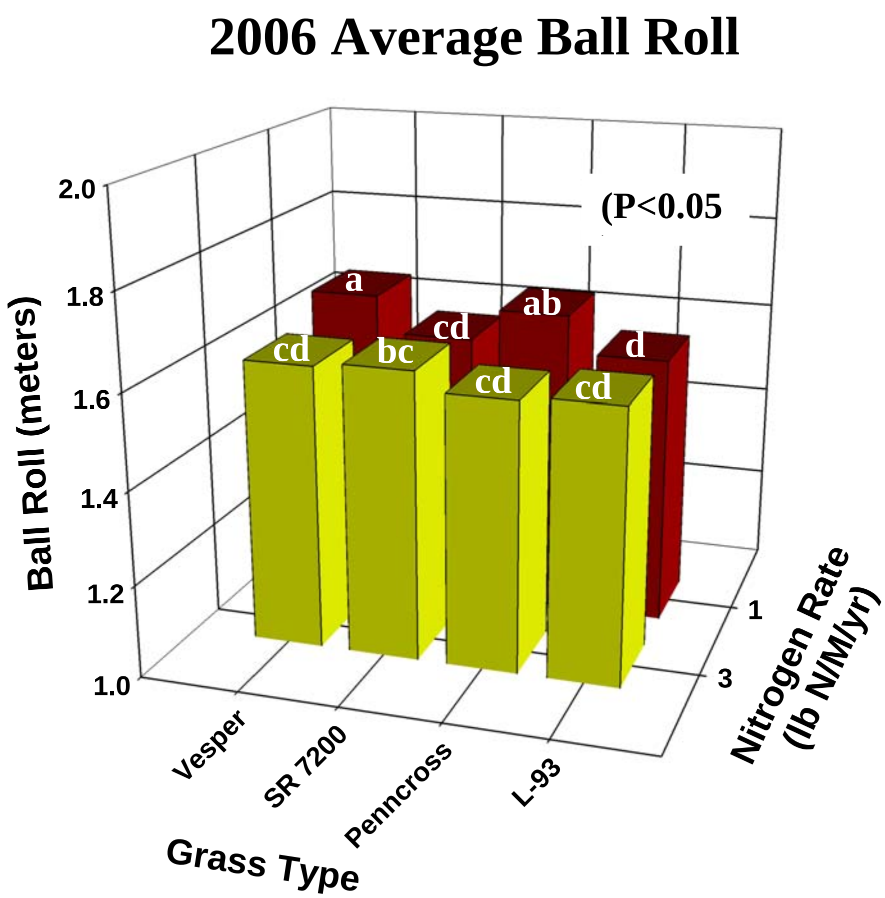

Figure 2. Effect of grass type and nitrogen rate on ball roll distance during the 2006 growing season, Verona, WI.

Figure 3. Vesper (left) has more shoots per plant than L-93 (right).

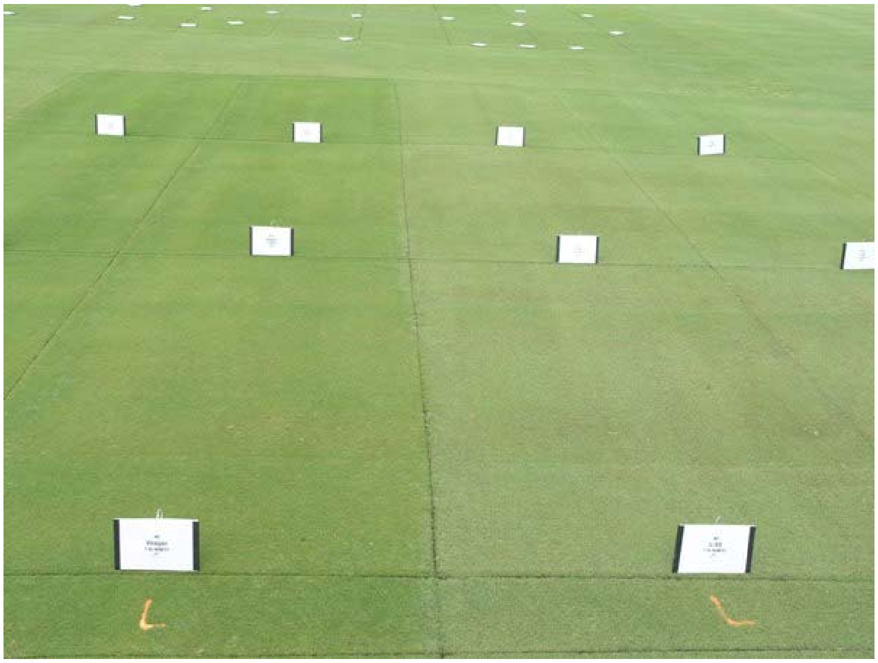

Figure 4. Vesper (left) and L-93 (right) fertilized with 1 lb N/M/yr in July 2005, Verona, WI.

Figure 5. Vesper (left) has fewer dollar spot infection centers than Penncross (right).

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EVALUATION OF METROMIX FOR HORTICULTURAL USE

Richard Wolkowski and Ana Tapsieva
Department of Soil Science

INTRODUCTION

The Madison Metropolitan Sewerage District (MMSD) treats approximately 40 million gallons of wastewater daily from the City of Madison and surrounding communities. As a result of treatment, biosolids are generated and applied yearly to about 4,500 – 5,000 acres of agricultural cropland through its MetroGro landspreading program. The program has been extremely successful, but with urban pressure consuming cropland and phosphorus management issues potentially limiting application sites, the MMSD has decided to pursue other alternatives for the management of its solids. The creation of an exceptional quality Class A biosolid for use in the horticultural and nursery industry, turf uses such as golf course topdressing and turfgrass establishment, and home horticultural applications has been successfully developed by cities such as Tacoma, Washington. Their material "TAGRO" is a 2:1:1 by dry weight blend of biosolid, sawdust, and sand. Research is proposed to examine the development of a similar, soil-like material with MMSD solids and locally derived sand, sawdust, yardwaste compost, etc., which will then be tested in various applications. This material has been given the name MetroMix by MMSD.

This report describes preliminary experiments that were performed to learn more about the potential use of MetroMix as a soil amendment for turfgrass establishment. The objectives of the experiments were to compare rates of two different MetroMix blends with commercial fertilization for the establishment and growth of bluegrass (home lawns) and creeping bentgrass (golf course fairways). The effect of treatment on growth, nutrient uptake, verdure, and selected soil physical properties are all being evaluated. This report will focus on the growth and verdure measurements.

METHODS AND MATERIALS

MetroMix materials were constructed at the Madison Metropolitan Sewerage District facility in the spring of 2006. Biosolid material that had been dewatered to about 23 % solids were blended by volume with mason sand and hardwood sawdust in proportions of either 2:1:1 or 4:1:2 parts biosolid:sand:sawdust using a front-end loader. These were turned several time with this loader and then further mixed with an auger-type mixer mounted on a skid-steer. These materials were similar to those prepared the previous fall with the analysis shown in Table 1.

Two sites were selected at the Noer Turfgrass Research Facility on silt loam soils. The turf on these areas was fall killed with Roundup and the sites were roto-tilled in the spring prior to treatment. Measured amounts of both blends of MetroMix were hand-applied in early June 2006 at rates to provide 1 or 3 lb N/M, assuming 25 % availability of the organic N = [TKN – (NH_4 + NO_3)], and 20 and 40 % of the soil volume. The soil was excavated to accommodate the application of the higher rates. Nitrogen fertilizer was topdressed to separate plots at rates of 0, 40, 80, and 120 % of the recommended rate of 3 lb N/M. The N fertilizer treatments were split three times with applications 23 May, 4 August, and 29 September. The materials were incorporated and the two sites were planted to the appropriate grass variety. The bluegrass was seeded 8 June and the bentgrass was seeded 12 June 2006. Treatments were replicated four times in a split-plot treatment arrangement. Each site was watered as needed by the staff at the Noer Center.

Grass was cut as needed with a rotary mower (bluegrass) or reel mower (bentgrass). Clippings were collected weekly from the middle portion of each plot for the determination of dry matter accumulation and nutrient uptake. The remaining clippings were not removed from the plots and were thus returned to the soil when cut. The harvested clippings were dried at 60 C and ground for future nutrient analysis. Chlorophyll meter readings (verdure) were taken prior to clipping. Five measurements were averaged from each plot.

Data were subjected to a one-way analysis of variance. Where significance was found at the p=0.05 level a Fisher's LSD was calculated. The term "NS" implies the response was not significant at the 0.05 level.

RESULTS AND DISCUSSION

The analyses of the MetroMix materials constructed in the fall of 2005, which are expected to be similar to those used in the 2006 study, are shown in Table 1. The materials had a total N content ranging between 0.7 and 1.2 % and were also found to have a relatively high P content. Small amounts of other plant nutrients were present. The levels of heavy metals were well below the ceiling concentrations for biosolids established by the US EPA. While this material does not have the Class A biosolid designation at this time it would appear to be a reasonable soil amendment.

The effect of treatment application on the chlorophyll meter readings and dry matter production for the bentgrass are shown in Tables 2 and 3. The actual dates of the measurements are shown in Table 6. These parameters can be considered indices of plant health and growth, both of which would reflect adequate nutrient supply and favorable soil physical properties. Nitrogen fertilization did not generally influence the chlorophyll reading, whereas the MetroMix treatments, even at the lower rate of application increased the chlorophyll content of the grass. Dry matter content appeared to be more responsive to treatment. As the season progressed and additional N fertilizer was applied a response was apparent. The 4:1:2 blend tended to produce greater dry matter, although the responses were not consistent at all clippings.

The effect of treatment application on the chlorophyll meter readings and dry matter production for the bentgrass are shown in Tables 4 and 5. The actual dates of the measurements are shown in Table 7. Fewer clippings were taken from the bluegrass due to a severe infestation of crabgrass, which was removed by two applications of Drive herbicide. The greenness of the bluegrass was much more visible compared to the bentgrass. The 20 % and 40 % treatments of both biosolids blends stood out throughout the season and were often 2-3 times greater than the recommended fertilizer treatment. Generally the 4:1:2 blend had higher readings, which was a reflection of the increased amount of applied N with that material. The bluegrass clipping weights were essentially non-responsive to N fertilizer, but responded well to either MetroMix blend. These effects lasted throughout the season.

SUMMARY

The use of MetroMix was examined on both bentgrass and bluegrass and was compared to commercial fertilizer. Materials were applied and incorporated prior to seeding at rates of 1 or 3 lb N/M or 20 or 40 % of the soil volume. These treatments and rates simulate application that would occur by professional landscapers or homeowners should the material be released for public distribution. Preliminary results showed that MetroMix did not cause any detrimental effects on growth, although it is obvious that high rates of application will supply more nutrients than the turfgrass needs in the year of application. It will also load soils with a substantial amount of P. Soil test P should be monitored to ensure levels do not become excessive. MetroMix outperformed commercial fertilizer with respect to greenness and growth of the turfgrasses and thereby shows promise as a soil amendment for turf establishment. This study will be repeated in 2008 to examine residual effects of the treatments.

Table 1. Nutrient and metal content of several blend ratios of MetroMix materials created in the fall of 2005.

MetroMix Blend	Solids	TKN	NH_4-N	NO_3-N	P	WEP	K	Ca	Mg	S	B	Na	Al	pH	Org. C	Sol. Salts
	------------- % ------------			ppm	--------------------- % --------------------						-- ppm --		%		%	mmhos x 10^{-5} cm^{-1}
2:1:1	69.2	0.70	0.16	37	0.59	0.10	0.10	4.2	2.3	0.08	1.0	219	0.18	5.9	4.35	1673
4:1:1	44.7	1.10	0.28	237	0.86	0.13	0.13	4.1	2.2	0.22	5.5	380	0.28	5.8	7.29	470
4:2:1	55.1	1.10	0.25	96	0.86	0.11	0.11	4.4	2.3	0.15	6.1	341	0.26	5.9	7.53	196
4:1:2	48.7	1.20	0.26	209	0.91	0.14	0.13	3.9	2.0	0.25	4.8	421	0.26	6.0	11.25	253

	Cd	Cr	Cu	Mn	Hg	Mo	Ni	Pb	Zn	Fe
	---------------------------------- ppm ----------------------------------									%
2:1:1	0.4	11.5	141	148	0.28	8.4	7.1	11.9	171	0.66
4:1:1	1.0	23.7	311	216	0.64	20.5	13.9	22.4	380	1.23
4:2:1	0.7	18.9	243	180	0.71	15.4	11.9	18.3	294	0.98
4:1:2	0.8	17.4	230	218	0.64	15.1	11.0	17.3	287	0.96

MetroMix Blends are proportion by volume of dewatered biosolid:mason sand:hardwood sawdust.
WEP = Water Extractable P

Table 2. Bentgrass Chlorophyll Readings as Affected by N fertilization and MetroMix Treatments, Noer Turfgrass Center, 2006.

Treatment	Reading Date												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	---------- Relative Reading ----------												
Control (no fert)	162	297	342	306	373	352	384	423	208	216	245	298	292
Control (40% fert)	161	300	355	320	358	361	408	446	220	240	255	355	366
Control (80% fert)	164	302	362	320	308	378	410	451	205	231	270	391	425
Control (120% fert)	149	300	364	324	297	383	424	439	194	224	244	357	436
MM 2-1-1 @1 lb N/M	177	336	356	301	287	353	409	450	223	243	268	313	310
MM 2-1-1 @3 lb N/M	227	349	374	335	355	373	440	464	191	226	263	342	348
MM 2-1-1 @20%	333	311	338	321	323	371	454	493	225	237	291	396	428
MM 2-1-1 @40%	301	334	307	328	279	335	437	464	273	285	309	438	472
MM 4-1-2 @1 lb N/M	177	325	357	299	312	365	416	493	236	256	273	304	311
MM 4-1-2 @3 lb N/M	255	372	394	328	333	379	441	464	222	235	262	329	333
MM 4-1-2 @20%	383	323	341	308	337	383	460	453	224	245	294	381	436
MM 4-1-2 @40%	365	320	332	273	233	349	455	490	287	299	305	394	468
Pr>F	<0.01	0.01	<0.01	<0.01	0.03	0.13	<0.01	0.18	<0.01	0.02	<0.01	<0.01	<0.01
LSD	53	40	36	27	74	NS	28	NS	44	45	28	37	31

Table 3. Bentgrass Dry Matter Production as Affected by N fertilization and MetroMix Treatments, Noer Turfgrass Center, 2006.

Treatment	Clipping Date										
	1	2	3	4	5	6	7	8	9	10	11
	------------ g/m^2 ------------										
Control (no fert)	1.6	5.8	12.7	5.4	8.9	7.5	7.3	6.9	2.6	1.1	5.0
Control (40% fert)	1.1	4.0	6.8	6.0	6.8	8.3	9.0	7.9	0.6	1.4	9.3
Control (80% fert)	2.2	3.3	8.8	6.2	7.7	8.2	10.0	5.7	2.6	2.2	12.7
Control (120% fert)	1.1	5.6	11.7	5.7	6.5	10.3	10.2	5.9	2.3	2.9	14.1
MM 2-1-1 @1 lb N/M	2.1	6.8	11.4	5.3	6.7	7.0	8.5	6.0	1.3	1.6	5.7
MM 2-1-1 @3 lb N/M	3.4	12.1	12.5	9.3	9.2	8.3	11.1	5.2	1.2	1.6	6.5
MM 2-1-1 @20%	4.1	8.8	6.5	8.2	9.3	8.2	10.9	5.6	1.5	4.2	10.7
MM 2-1-1 @40%	3.8	13.0	6.0	6.9	6.8	6.3	9.1	8.3	1.2	4.0	17.7
MM 4-1-2 @1 lb N/M	2.4	8.7	7.1	7.4	8.6	7.2	7.8	10.3	2.1	0.9	7.2
MM 4-1-2 @3 lb N/M	4.5	8.4	13.7	7.9	7.8	7.0	10.1	9.7	1.8	1.2	5.9
MM 4-1-2 @20%	3.6	8.9	18.6	8.1	5.8	8.5	11.1	7.3	2.9	1.7	11.0
MM 4-1-2 @40%	4.1	13.5	24.7	8.6	4.2	8.4	14.4	10.1	3.5	4.6	15.0
Pr>F	0.03	<0.01	0.02	0.06	0.24	0.44	<0.01	0.62	0.17	0.04	<0.01
LSD	2.3	4.2	10.2	2.7	NS	NS	2.6	NS	NS	2.6	4.5

Table 4. Bluegrass Chlorophyll Readings as Affected by N fertilization and MetroMix Treatments, Noer Turfgrass Center, 2006.

Treatment	Reading Date											
	1	2	3	4	5	6	7	8	9	10	11	12
	---------- Relative Reading ----------											
Control (no fert)	104	379	340	264	254	175	281	276	259	221	201	155
Control (40% fert)	105	439	349	255	257	189	294	309	287	228	239	210
Control (80% fert)	109	485	387	266	281	180	284	265	257	242	267	228
Control (120% fert)	124	410	359	252	242	174	281	308	281	234	277	285
MM 2-1-1 @1 lb N/M	116	449	335	270	250	201	310	299	289	243	218	161
MM 2-1-1 @3 lb N/M	161	514	309	232	222	219	341	342	328	262	229	168
MM 2-1-1 @20%	210	549	263	230	195	294	443	505	437	326	311	224
MM 2-1-1 @40%	203	601	334	309	254	360	551	717	559	536	588	415
MM 4-1-2 @1 lb N/M	150	524	363	261	258	220	338	324	306	250	225	170
MM 4-1-2 @3 lb N/M	146	543	330	270	267	242	382	407	354	292	264	189
MM 4-1-2 @20%	280	516	272	243	276	344	509	585	481	408	419	274
MM 4-1-2 @40%	232	608	368	389	395	526	720	877	590	523	658	430
Pr>F	<0.01	<0.01	0.12	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
LSD	48	117	NS	72	80	77	89	106	64	52	60	38

Table 5. Bluegrass Dry Matter Production as Affected by N fertilization and MetroMix Treatments, Noer Turfgrass Center, 2006.

Treatment	Clipping Date						
	1	2	3	4	5	6	7
	---------- g/m^2 ----------						
Control (no fert)	42.5	4.6	6.3	4.1	0.5	2.3	2.1
Control (40% fert)	30.8	4.3	7.5	4.3	0.5	3.3	2.1
Control (80% fert)	28.7	4.0	6.7	5.0	1.2	4.4	3.1
Control (120% fert)	16.2	3.1	6.5	3.3	0.6	3.0	2.9
MM 2-1-1 @1 lb N/M	23.6	5.8	11.2	5.0	1.3	5.4	2.5
MM 2-1-1 @3 lb N/M	10.9	4.6	12.1	6.6	1.4	6.1	2.5
MM 2-1-1 @20%	25.5	12.5	29.3	17.6	6.3	14.4	5.4
MM 2-1-1 @40%	20.6	38.6	63.3	34.0	21.7	49.6	21.9
MM 4-1-2 @1 lb N/M	29.3	10.6	17.4	9.0	3.3	8.9	3.1
MM 4-1-2 @3 lb N/M	23.6	10.7	16.1	9.1	2.5	9.3	3.8
MM 4-1-2 @20%	18.0	24.3	40.8	25.8	11.6	26.3	9.4
MM 4-1-2 @40%	23.2	75.5	99.1	62.9	27.5	61.9	30.7
Pr>F	0.38	<0.01	<0.01	<0.01	<0.01	<0. 01	<0. 01
LSD	NS	12.9	15.2	7.9	4.3	7.5	5.7

Table 6. Dates of Dry Matter Clipping Collection and Chlorophyll Readings in the Bentgrass Study, Noer Turfgrass Center, 2006.

Clipping	Date	Chlorophyll reading	Date
1	07/07/06	1	06/29/06
2	07/14/06	2	07/14/06
3	07/24/06	3	07/21/06
4	07/28/06	4	07/28/06
5	08/04/06	5	08/04/06
6	08/11/06	6	08/11/06
7	08/18/06	7	08/18/06
8	09/15/06	8	08/29/06
9	09/29/06	9	09/07/06
10	10/06/06	10	09/15/06
11	10/20/06	11	09/29/06
		12	10/06/06
		13	10/20/06

Table 6. Dates of Dry Matter Clipping Collection and Chlorophyll Readings in the Bluegrass Study, Noer Turfgrass Center, 2006.

Clipping	Date	Chlorophyll reading	Date
1	08/04/06	1	06/29/06
2	08/29/06	2	07/14/06
3	09/08/06	3	07/21/06
4	09/15/06	4	07/28/06
5	09/29/06	5	08/04/06
6	09/06/06	6	08/18/06
7	10/20/06	7	08/29/06
		8	09/08/06
		9	09/15/06
		10	09/29/06
		11	10/06/06
		12	10/20/06

Midwestern Bio Ag Fertilizer Evaluation

John Stier and Eric Koeritz
Horticulture Department

OBJECTIVE

The objective of this study was to compare an organic-based fertilizer regime to a conventional synthetic fertilizer regime at various input levels on putting green turf based on agronomic and playability characteristics.

MATERIALS AND METHODS

The study was conducted on a USGA-specified putting green with an 80:20 sand:peat root zone. Turf was mowed daily at .156" and clippings were removed. Turf was irrigated three times weekly at 100% of estimated evapotranspiration. The typical five times weekly irrigation regime for putting greens was replaced with three times weekly to enhance the effects of calcium-modulated stress tolerance. The reduced irrigation regime also mimics anticipated changes in future turf management practices as water resources become more regulated. The turf was core aerated in early May and was topdressed monthly with an 80:20 sand:peat mix.

Data collected

- Turf quality ratings (1-9 on visual scale) at 2 week intervals.
- Turf color ratings (1-9 on visual scale) at 2 week intervals.
- Disease ratings (% area infected) at 2 week intervals or when disease occurred.
- Stimpmeter (green speed) readings collected monthly.

Treatments

All treatments were replicated 4 times and the experimental design was a randomized complete block. The experiment was designed as a loose 4x2 factorial treatment arrangement with a total of 8 treatments. The factorial arrangement allowed for separation of the effects of the input program (input level of fertilizer and fungicides) from the two fertilizer types (regime) (HealthyGro + organic calcium fertilizer vs. conventional) and to determine any potential interactions. Factor 1 (main plots) consisted of 4 input programs: high, medium, moderate, and low input (3 lb N/1000 ft ^{2} + full fungicide rate, 2.25 lb N plus ¾ of the full fungicide rate, 1.5 lb N plus ½ of the full fungicide rate, and 1.5 lb N with no fungicides. Factor 2 (sub plots) consisted of two fertilizer regimes: HealthyGro + organic calcium fertilizer vs. a conventional synthetic fertilizer with a 4:1:4 ratio. The conventional fertilizer was custom blended using 60% 21-3-12, 10% 0-0-50, and 30% 18-9-18 to give an analysis of 18-4.5-17.6 with mostly slow release and some fast release nitrogen. Individual plots measured 3x14 ft. Fertilizer was watered in following application.

As a modification to the protocol used in 2005, the following treatments were added to the study for the 2006 growing season: 1) After dormancy, 50 lbs/M HealthyGrow 2-5-4 and 20 lbs/M

HumaCal was be applied on all organic based fertility plots and 1 lb N/M using conventional fertilizer on the conventional based fertility plots. At this time iprodione was applied to plots according to the input level originally specified to control snow mold. 2) In late March, 6.25 lbs/M of HealthyGrow 8-3-8 and 6 lbs/M of HumaCal was applied to the organic Bio Ag fertilizer regime plots. No conventional fertilizer was applied at this time.

The idea behind the modifications to the protocol was to compare an organic-based regime specified by Midwestern Bio Ag to what is typically done on a golf course using conventional fertilizer. As a result of these modifications, the fertilizer types used as sub-plots are now referred to as fertilizer regime.

Table 1. Treatment schedule for Midwestern Bio Ag Fertilizer Evaluation, Verona, WI, 2006.

-----------------Treatment Schedule-----------------		
Date	Application	Fungicide Rates
22 Nov 2005	Sprayed Chipco 26 GT for snow mold	4, 3, and 2 oz/M†
28 Nov 2005	Made dormant fertilizer applications	
7 April 2006	Made organic fertilizer regime applications	
26 May 2006	Made fertilizer treatments to all plots	
1 June 2006	Chipco 26 GT (iprodione) fungicide treatment	4, 3, and 2 oz/M
14 June 2006	Emerald (boscolid) fungicide treatment	0.18, 0.14, and 0.09 oz/M
6 July 2006	Made fertilizer treatments to all plots	
17 July 2006	Chipco 26 GT (iprodione) fungicide treatment	4, 3, and 2 oz/M†
2 August 2006	Emerald (boscolid) fungicide treatment	0.18, 0.14, and 0.09 oz/M
10 August 2006	Made fertilizer treatments to all plots	
5 December 2006	Made dormant fertilizer applications	

† M is the symbol for $1000ft^2$.

RESULTS

Spring green-up was evaluated in April of 2006 as turf grew out of winter dormancy which caused much of the turf to appear brown. Fertilizer type was the only variable to affect green-up in this study (Table 2). Plots treated with the organic fertilizer regime received higher green-up ratings than plots treated with the conventional fertilizer regime on all three rating dates between 7 to 28 April.

Table 2. Effect of fertilizer regime on putting green spring greenup, Verona, WI 2006.

	------Spring Greenup------		
Fertilizer Regime	7 April	17 April	28 April
1. Conventional Fertilizer	3.2	4.6	6.1
2. Bio Ag Program	4.4	6.6	7.0
LSD (0.05)	0.2	0.1	0.1

Spring Greenup rating scale: 1-9, 1=totally brown, optimal dark green, 6=acceptable

Turf input programs affected turf quality throughout most of the growing season (Table 3). There were no significant differences between input programs on 25 May perhaps because all plots had received approximately equal levels of nitrogen in November of 2005, although the organic Bio Ag fertilizer plots received equivalent applications of fertilizer in April (see materials and methods). There was also no disease pressure at this time. Input programs 1, 2, and 3 provided acceptable levels of quality or better throughout the growing season. Program 4, which consisted of the half nutrient rate and no fungicide, provided well below acceptable levels of quality for the entire growing season. Quality ratings declined significantly for input program 4 throughout the season.

Fertilizer type also had an effect on turfgrass quality early in the growing season (Table 3). The organic Bio Ag fertilizer regime provided better quality in May and June. The increased quality may have been a result of an additional fertilizer application in April that was part of the Bio Ag program and not the conventional fertilizer program.

There were significant interactions between input program and fertilizer type on 9 June and 23 June. The difference in turf quality between the conventional fertilizer plots and the Bio Ag fertilizer plots was much greater for the high input programs than the low input programs (Table 4). In general, Bio Ag treatments provided better turf quality than conventional turf in June and turf treated with the Bio Ag approach responded more positively to fungicides than turf receiving conventional fertilizers.

Table 3. Effect of program and fertilizer regime on putting green turf quality, Verona, WI 2006.

	--------------Turfgrass Quality--------------						
Factor	25 May	9 June	23 June	6 July	26 July	9 Aug	1 Sept
Program							
1. 3 lb N + fungicide	5.6	6.1 a	6.9 a	7.9 a	7.8 a	7.2 a	7.0 a
2. 2.25 lb N + ¾ fungicide	5.5	5.9 ab	6.5 b	7.2 b	7.5 b	6.8 ab	6.5 ab
3. 1.5 lb N + ½ fungicide	5.6	5.8 b	6.4 b	6.8 c	7.2 c	6.4 b	5.8 b
4. 1.5 lb N + no fungicide	5.7	5.3 c	5.2 c	4.8 d	4.0 d	3.4 c	2.5 c
LSD (0.05)	ns	0.3	0.4	0.4	0.3	0.4	1.0
Fertilizer Regime							
1. Conventional Fertilizer	5.2 b	5.1 b	5.9 b	6.6	6.7	6.0	5.4
2. Bio Ag Program	6.0 a	6.4 a	6.6 a	6.7	6.6	5.9	5.5
LSD (0.05)	0.1	0.1	0.1	ns	ns	ns	ns

Quality rating scale: 1-9, 1=dead turf, 9=best quality, 6=acceptable
Means followed by the same letter are not significantly different at $P \leq 0.05$.

Input program affected turfgrass color periodically during the growing season (Table 5). Input programs 1, 2, and 3 always provided better than acceptable levels of color, with treatments 1 and 2 often providing the best color. Input program 4 generally received the lowest color ratings out of the four programs, however, program 4 did provide acceptable color up to 9 August when turf began to appear chlorotic (yellowish).

The Bio Ag fertilizer regime provided better turfgrass color than the conventional fertilizer regime early in the growing season. In July there were no differences between the two fertilizer regimes in terms of color. In August and September the conventional fertilizer regime provided better turf color.

Table 4. Interaction of program and fertilizer regime and its effect on putting green turf quality, Verona, WI 2006.

		------Turfgrass Quality------	
Program	Fertilizer	9 June	23 June
1. 3 lb N + fungicide	Bio Ag	7.0 a	7.5 a
2. 2.25 lb N + ¾ fung.	Bio Ag	6.6 b	7.0 b
3. 1.5 lb N + ½ fung.	Bio Ag	6.4 b	6.6 c
4. 1.5 lb N + no fung.	Bio Ag	5.6 c	5.4 f
1. 3 lb N + fung.	Conventional	5.3 d	6.4 cd
2. 2.25 lb N + ¾ fung.	Conventional	5.1 d	6.0 e
3. 1.5 lb N + ½ fung.	Conventional	5.1 d	6.1 de
4. 1.5 lb N + no fung.	Conventional	5.0 d	5.0 g
LSD (0.05)		0.3	0.3

Quality rating scale: 1-9, 1=dead turf, 9=best quality, 6=acceptable
Means followed by the same letter are not significantly different at P ≤ 0.05.

Table 5. Effect of program and fertilizer regime on putting green turf color, Verona, WI 2006.

			-------------Turfgrass Color-------------				
Factor	25 May	9 June	23 June	6 July	26 July	9 Aug	1 Sept
Program							
1. 3 lb N + fungicide	6.2	7.0 a	7.5 a	7.9	8.4 a	7.1 a	6.9 a
2. 2.25 lb N + ¾ fungicide	6.1	6.8 ab	7.2 b	7.8	8.3 a	6.9 a	6.9 a
3. 1.5 lb N + ½ fungicide	6.3	6.7 ab	7.1 bc	7.8	7.8 b	6.7 a	6.6 b
4. 1.5 lb N + no fungicide	6.1	6.5 b	6.9 c	7.5	6.2 c	5.5 b	5.1 c
LSD (0.05)	ns	0.3	0.3	ns	0.3	0.4	0.3
Fertilizer Regime							
1. Conventional Fertilizer	5.5 b	6.0 b	6.7 b	7.7	7.8	6.8 a	6.5 a
2. Bio Ag Program	6.8 a	7.5 a	7.6 a	7.8	7.6	6.2 b	6.3 b
LSD (0.05)	0.2	0.2	0.2	ns	ns	0.2	0.1

Color rating scale: 1-9, 1=totally brown, 9=dark green, 6=acceptable
Means followed by the same letter are not significantly different at P ≤ 0.05.

There was a great deal of dollar spot pressure in 2006 due to the warm weather which made it easy to detect treatment differences (Table 6). Input program 4 provided the worst dollar spot control and programs 1 and 2 generally provided the best dollar spot control. There are no universally-accepted levels of dollar spot disease: at most golf courses, the desirable level is zero. Input program 3 which was the half nutrient rate with a half rate of fungicide usually provided equal or slightly worse dollar spot control compared to input programs 1 and 2. Turf without fungicide had two times as much disease as treated turf by late spring, and over 20 fold more disease than turf treated with the full fungicide rate by mid-summer.

The organic Bio Ag fertilizer regime provided better control of dollar spot in May and June (Table 6). No differences between fertilizer types in terms of dollar spot control were seen later in the growing season.

Half-rate and no fungicide treatments slightly enhanced ball roll distance (green speed) as turf density and lushness declined compared to turf receiving ¾ or full fungicide rates. The Bio Ag program slightly reduced ball roll distance compared to turf receiving conventional fertilizer. While the differences were statistically significant, they were likely not significant from a practical sense as golf courses measure ball roll in feet (e.g., 11 ft superior to 10 ft) and these differences were a matter of a couple inches which may be a trade-off for superior turf density.

Table 6. Effect of program and fertilizer regime on dollar spot occurrence, Verona, WI 2006.

			-------------number of infection centers--------------					
Factor	25 May	2 June	9 June	23 June	6 July	26 July	9 Aug	1 Sept†
Program								
1. 3 lb N + fungicide	28.8	166.3	82.6 b	19.9 c	11.9 c	8.9 c	6.75 c	4.0 b
2. 2.25 lb N + ¾ fungicide	22.8	145.3	82.5 b	29.6 bc	17.4 c	25.1 c	25.5 c	9.4 b
3. 1.5 lb N + ½ fungicide	18.9	152.5	93.3 b	44.6 b	50.1 b	52.6 b	54.1 b	13.8 b
4. 1.5 lb N + no fungicide	16.9	140.6	150.6 a	173.5 a	256.0 a	183.0 a	220.8 a	63.8 a
LSD (0.05)	ns	ns	34.6	20.9	29.5	18.6	22.9	13.7
Fertilizer Regime								
1. Conventional Fertilizer	24.7 a	159.9	128.8 a	78.6 a	76.8	69.8	78.5	22.6
2. Bio Ag Program	18.9 b	142.4	75.7 b	55.2 b	90.8	64.9	75.1	22.9
LSD (0.05)	4.7	ns	16.4	11.5	ns	ns	ns	ns

†Data reported as the number of dollar spot infection centers per plot except for 1 Sept data which was reported as percent dollar spot incidence.
Means followed by the same letter are not significantly different at P ≤ 0.05.

In May and August of 2006 ball roll distance was greatest for input program 4 (Table 7). Ball roll distance for input program 3 was statistically the same as programs 1,2, and 4. Ball roll distance was lowest for input programs 1 and 2 which receive the highest nitrogen rates.
In May, June, and August, measured ball roll distances were greater in plots treated with conventional fertilizer than in plots treated with the organic Bio Ag fertilizer regime. These results were consistent with those seen in the 2005 study.

Table 7. Effect of program and fertilizer regime on ball roll using a full length stimpmeter, Verona, WI, 2006.

		------Ball Roll (inches)------		
Factor	28 May	20 June	20 July	15 Aug
Program				
1. 3 lb N + fungicide	82.8 b	91.9	91.8	100.9 b
2. 2.25 lb N + ¾ fungicide	82.1 b	93.4	90.5	100.5 b
3. 1.5 lb N + ½ fungicide	83.9 ab	95.0	94.8	106.3 ab
4. 1.5 lb N + no fungicide	85.0 a	93.3	98.8	114.9 a
LSD (0.05)	2.0	ns	ns	10.0
Fertilizer Regime				
1. Conventional Fertilizer	85.6 a	96.6	95.7	108.3
2. Bio Ag Program	81.3 b	90.2	92.2	103.0
LSD (0.05)	1.8	3.2	ns	2.5

Means followed by the same letter are not significantly different at P ≤ 0.05.

DISCUSSION

In addition to evaluating multiple input levels in this study, we compared an organic-based fertility regime to a conventional fertility regime. Plots treated with the organic based fertility regime exhibited faster spring green-up, better early season turf quality, and better early season turf color. A color rating of 6.0 on a 1 to 9 scale was considered acceptable for golf course play, meaning plots receiving the Bio-Ag program may have been able to open a couple weeks sooner. The improved qualities may have been at least partly due to the fast release nitrogen source in the HealthyGro fertilizer and the addition of nitrogen to only the organic Bio Ag program plots in April. The effects of this extra boost of nitrogen were seen through the month of June.

Quality and color were influenced heavily by the input program applied especially under severe disease pressure. Programs 1, 2, and 3 provided acceptable levels of quality and color throughout the growing season. It is important to note that program 3 was performing well despite having half the nutrient and fungicide rate of input program 1. This shows that, on a putting green, under the conditions of this study, inputs can be dramatically reduced while maintaining a good putting surface. However, when fungicides were completely removed, as in treatment 4, turfgrass performance was drastically compromised (Table 3). Disease pressure was one of the main factors that influenced the agronomic and playability characteristics of the putting green turf. Input programs 1-3, which all received at least a half rate of fungicide, all had good to excellent control of dollar spot.

Results showed that it is possible to reduce disease occurrence by varying the fertilizer regime. Early in the growing season plots treated with the organic Bio Ag fertilizer regime had less dollar spot than the plots treated with the conventional fertilizer regime. However it is not possible to determine from the results of this study if the reduced dollar spot was due to the composition of the fertilizers or due to the effect of the increased overall nitrogen rate in the organic Bio Ag fertilizer regime.

Slightly greater ball roll distances seen for input levels 3 and 4 were likely due to less lush green growth and a more horizontal leaf orientation. In addition the slightly reduced ball roll distances seen for the organic Bio Ag fertilizer regime (Table 9) were probably due to very lush, green, and vertically oriented leaves. It is common for high nitrogen rates or fast release nitrogen sources such as HealthyGro to cause lush green growth which can slow green speeds. Given the rather minor differences in ball roll between the two fertilizer regimes, this is not seen as an impediment to use of the Bio Ag program.

Though hard to document as data, application rates of the Healthy-Gro product should be minimized to prevent excessive materials from remaining on the turf surface after application. Because of the rather low nitrogen content (8-3-8), applications to provide 1 lb N/M resulted in excessive fertilizer material remaining on the surface even after irrigation which was unsightly, could interfere with play, and could be picked up and removed by mowing, reducing the potential nutrient additions for turf uptake. Healthy-Gro should be applied at low but more frequent amounts than the ones used in the 2006 study.

In conclusion, the organic based fertility regime, specified by Midwestern Bio Ag, is an effective fertility regime compared to a conventional fertility regime at all input levels. The agronomic characteristics of the putting green turf when the organic Bio Ag fertilizer regime is applied are equal to or better than that of the conventional fertilizer regime. The additional application to the Bio Ag fertilizer regime in April seemed to have positive effects on green-up, color, quality and disease control for a couple months of the growing season. Public antipathy towards synthetic chemicals along with increased oil and gas costs make it likely that natural organic-based products will become more important in the near future. The results of this study show promise for the Bio-Ag products tested.

Germination of Blue Yellow Turf Systems in Cool Temperatures

Eric Koeritz and Dr. John Stier
Department of Horticulture

INTRODUCTION

Blue Yellow turf systems simplify turf establishment because they incorporate seed, fertilizer and mulch into one roll-out unit. The pre-packaged turf systems save time and eliminate the possibility of miscalculating seed or fertilizer rates. Blue Yellow mats are composed of a fine white cellulose material capable of retaining moisture as well as holding seed and fertilizer in place. Casual observations have led to the idea that the highly reflective properties of the white color of the cellulose may delay germination when soil temperatures are low by reflecting too much solar radiation. Previous research evaluating Blue Yellow performance at the University of Wisconsin has shown that Blue Yellow mats do indeed exhibit delayed germination when compared to conventional seeding practices. In addition, research showed that plots seeded by conventional means had warmer surface and sub-surface temperatures than plots seeded using the Blue Yellow turf systems. The surface and sub-surface temperature of the Blue Yellow turf system could be increased by adding green dye or Milorganite but these amendments did not improve germination. Following research done in 2005 it was still unclear as to what was causing the delayed germination in the Blue Yellow turf systems. Tests were started earlier in the spring of this year (first week of May vs. last week in May last year) when soil and air temperatures are a more limiting factor in germination and establishment.

OBJECTIVES

The objectives of this study were to 1) verify the results of the 2005 germination and establishment study while adding elements that may help develop a better understanding of Blue Yellow Turf System (BY) performance, and 2) utilize freshly made and aged inventory to determine if longer term storage of BY affects turf establishment rates.

MATERIALS AND METHODS

This study was conducted at the O.J. Noer Turfgrass Research and Educational Facility in Verona, WI. Plots were established/seeded May 4, 2006 on a silt loam soil. The experimental design was a randomized complete block with four replications. Experimental units measured 6' by 10'. There were a total of seven treatments per replication including five variations of Blue Yellow Turf System treatments and two standard seeding treatments for comparison (Table 1). Standard seeding treatments were conventional straw mulch and Futerra® blanket. The two standard treatments were seeded with the same tall fescue seed mix (Triplet Tall Fescue Blend) and at the same rate (10 lbs/1000ft^2) as in the BY treatments. Standard seeded treatments received starter fertilizer with a phosphorous rate equivalent to that in the BY treatments. BY treatments included both new BY material and BY material that had been stored for several months. There were both un-amended BY treatments and BY treatments amended with Milorganite or Futerra®. Milorganite topdressing and Futerra® mulch was added to the top of

BY treatments after they had been wetted down. The Milorganite topdressing was applied by hand using shaker jars (Table 1). The BY plus Futerra® treatment was included to determine if increasing the insulating properties of the BY product would improve germination. Plots were kept moist by irrigating three times daily until germination occurred. Once all plots had germinated irrigation was supplied one time daily to replace 100% of the daily evapotranspiration rate until completion of the study. Turf was mowed once weekly beginning when it reached a height of 2".

Data collected included surface and sub-surface (1cm) soil temperatures twice daily (6 a.m. and 3 p.m.) from seeding until approximately 1 week after all plots germinated. Sub-surface temperatures were measured by inserting a probe 1cm beneath the soil surface and allowing it to equilibrate for three minutes using a Barnant Dual LogR thermocouple. Surface temperatures were measured at a height of three feet using a Raytek Ranger ST infrared thermometer. The average of five readings was recorded. Morning temperature measurements were made just prior to sunrise when the soil had re-radiated as much heat has possible in an effort to determine how much heat energy was retained in the soil overnight by each seeding treatment. The number of days between seeding and germination was recorded for each treatment. Seedling density was recorded two times per week by counting the number of seedlings in a 40 square inch area using a 1 inch square grid. Percent cover (0-100%) was determined visually weekly until all plots had equal ground cover.

Table 1. Treatment list for Germination of Blue Yellow Turf Systems in Cool Temperatures. Verona, WI 2006.

Treatment	Notes
1. New[1] BY + Milorganite[2]	25 lbs Milorganite/1000 ft^2 (M)
2. Aged BY + Milorganite	25 lbs Milorganite/M
3. New BY alone	
4. Aged BY alone	
5. Seed + Straw: 50% cover	Applied 2 lb P_2O_5/M w/ starter at trial start
6. Seed + Futerra	Applied 2 lb P_2O_5/M w/ starter at trial start
7. BY + Futerra	

[1]New refers to Blue Yellow product which has been produced within the past few months vs. Aged Blue Yellow product which has been stored for an extended period of time.
[2]Use greens grade Milorganite, sufficient to cover surface.

RESULTS

Treatments had a statistically significant effect on surface temperatures in both the morning and afternoon particularly prior to germination (Table 2). Differences in surface temperature were greater in the afternoon as a result of solar energy being absorbed for longer period of time. In general the two standard seeding treatments and the BY+Futerra treatment had the warmest surface temperatures, approximately, approximately 1-3 °F greater than the lowest morning temperature and 2-7 °F greater than the lowest afternoon temperature which was usually the un-amended BY treatment (Table 3 and 4). The BY + Milorganite treatments had slightly greater (1-2 °F) surface temperatures than the un-amended BY treatments. The age of the BY roll did not affect surface temperature.

Table 2. Analysis of variance for effect of seeding method on surface temperatures, Verona, WI, 2006.

	------Morning Surface Temperatures------									
Source	5/5	5/7	5/8	5/10	5/13	5/16	5/17	5/20	5/25	Average
Rep	**	**	**	**	**	**	**	**	**	**
Treatment	**	**	**	ns	ns	ns	*	**	ns	**

	------Afternoon Surface Temperatures------					
Source	5/5	5/7	5/10	5/13	5/17	Average
Rep	**	*	ns	**	ns	ns
Treatment	**	**	**	**	ns	**

* Significant at P ≤ 0.05, ** significant at P ≤ 0.01.

Table 3. Effect of seeding method on morning surface temperatures, Verona, WI, 2006.

	-------Morning Surface Temperatures (˚F)-------									
Seeding Method	5/5	5/7	5/8	5/10	5/13	5/16	5/17	5/20	5/25	Average†
1. New BY+Milorg.	48.8	40.8	44.2	54.4	45.4	47.6	50.4	46.6	62.5	46.7
2. Aged BY+Milorg.	48.9	40.7	43.9	54.4	45.2	47.5	50.4	46.8	62.6	46.6
3. New BY alone	48.4	40.4	42.5	53.9	45.1	47.8	50.5	46.8	62.5	46.1
4. Aged BY alone	48.5	40.2	42.5	53.9	44.9	47.3	49.9	46.9	62.2	46.0
5. Seed+Straw	48.9	43.1	46.8	54.7	45.8	48.3	49.6	48.1	62.3	47.9
6. Seed+Futerra®	49.1	41.8	44.8	54.3	45.7	47.8	50.2	48.0	62.4	47.1
7. BY+Futerra®	49.1	42.2	44.8	54.1	45.4	47.7	49.5	48.1	62.9	47.1
LSD (0.05)	0.4	1.5	1.0	ns	ns	ns	0.6	0.9	ns	0.5

† Average column shows average between 5 May and 15 May 2006.

Table 4. Effect of seeding method on afternoon surface temperatures, Verona, WI, 2006.

	-------Afternoon Surface Temperatures (˚F)-------					
Seeding Method	5/5	5/7	5/10	5/13	5/17	Average
1. New BY+Milorg.	51.5	61.9	68.2	53.8	68.1	58.8
2. Aged BY+Milorg.	51.0	62.9	68.6	54.1	67.1	59.1
3. New BY alone	50.1	58.2	66.0	53.2	68.4	56.9
4. Aged BY alone	50.2	58.4	66.4	53.2	66.0	57.0
5. Seed+Straw	52.9	64.8	71.2	52.1	71.1	60.2
6. Seed+Futerra®	52.5	65.5	68.5	52.9	70.4	59.9
7. BY+Futerra®	52.0	65.0	69.7	52.5	72.7	59.8
LSD (0.05)	1.0	1.8	1.6	0.5	ns	0.8

† Average column shows average between 5 May and 15 May 2006.

Seeding method had a highly statistically significant effect on morning and afternoon sub-surface (1cm) soil temperatures throughout the study (Table 5). Morning sub-surface temperatures, which represent the amount of heat energy retained in the soil overnight, were warmest in the BY + Futerra treatment followed by the Seed + Straw and Seed + Futerra treatments (Table 6 and Figure 1). The BY + Milorganite and un-amended BY treatments had the lowest sub-surface soil temperatures (Table 6 and Figure 1). Afternoon sub-surface temperatures were generally highest for the standard seed + Futerra treatment. The BY + Futerra, seed + straw, and BY + Milorganite treatments had significantly warmer afternoon sub-surface temperatures than the un-amended BY treatments (Table 7).

Table 5. Analysis of variance for effect of seeding method on sub-surface temperatures, Verona, WI, 2006.

	------Morning Sub-Surface Temperatures------									
Source	5/5	5/7	5/8	5/10	5/13	5/16	5/17	5/20	5/25	Average
Rep	ns	**	**	**	**	**	**	**	*	**
Treatment	**	**	**	**	**	**	*	**	ns	**

	------Afternoon Sub-Surface Temperatures------					
Source	5/5	5/7	5/10	5/13	5/17	Average
Rep	**	ns	**	ns	**	**
Treatment	**	**	*	**	**	**

* Significant at P ≤ 0.05, ** significant at P ≤ 0.01.

Table 6. Effect of seeding method on morning sub-surface temperature (1cm depth), Verona, WI, 2006.

	-------Morning Sub-Surface Temperatures (˚F)-------									
Seeding Method	5/5	5/7	5/8	5/10	5/13	5/16	5/17	5/20	5/25	Average
1. New BY+Milorg.	49.2	43.5	45.4	55.8	44.0	49.0	51.8	47.4	62.2	47.6
2. Aged BY+Milorg.	49.3	43.7	45.5	55.5	44.3	48.6	51.8	46.8	63.5	47.7
3. New BY alone	49.1	43.1	44.9	55.6	44.2	48.5	51.7	47.1	61.9	47.4
4. Aged BY alone	49.1	42.6	44.9	55.4	43.9	48.8	51.1	46.6	62.1	47.2
5. Seed+Straw	50.4	46.4	48.4	56.1	44.6	49.9	52.0	48.4	61.8	49.2
6. Seed+Futerra®	50.3	45.2	47.8	56.0	44.9	49.5	52.8	48.3	62.3	48.4
7. BY+Futerra®	51.1	46.7	48.7	55.9	45.4	49.5	52.2	47.7	62.2	49.6
LSD (0.05)	0.5	1.1	0.7	0.3	0.5	0.4	0.8	0.8	ns	0.7

† Average column shows average between 5 May and 15 May 2006.

Table 7. Effect of seeding method on afternoon sub-surface temperature (1cm depth), Verona, WI, 2006.

	-------Afternoon Sub-Surface Temperatures (˚F)-------					
Seeding Method	5/5	5/7	5/10	5/13	5/17	Average
1. New BY+Milorg.	52.7	63.3	68.8	53.9	67.8	59.7
2. Aged BY+Milorg.	52.8	63.3	68.8	54.2	67.8	59.8
3. New BY alone	51.7	61.5	67.3	53.7	66.7	58.5
4. Aged BY alone	51.7	61.9	66.9	53.6	66.8	58.5
5. Seed+Straw	53.3	64.2	68.3	53.4	65.2	59.8
6. Seed+Futerra®	54.5	66.4	69.3	54.5	68.9	61.1
7. BY+Futerra®	51.1	64.9	67.6	54.2	66.9	60.2
LSD (0.05)	0.5	1.5	1.4	0.5	1.5	0.6

† Average column shows average between 5 May and 15 May 2006.

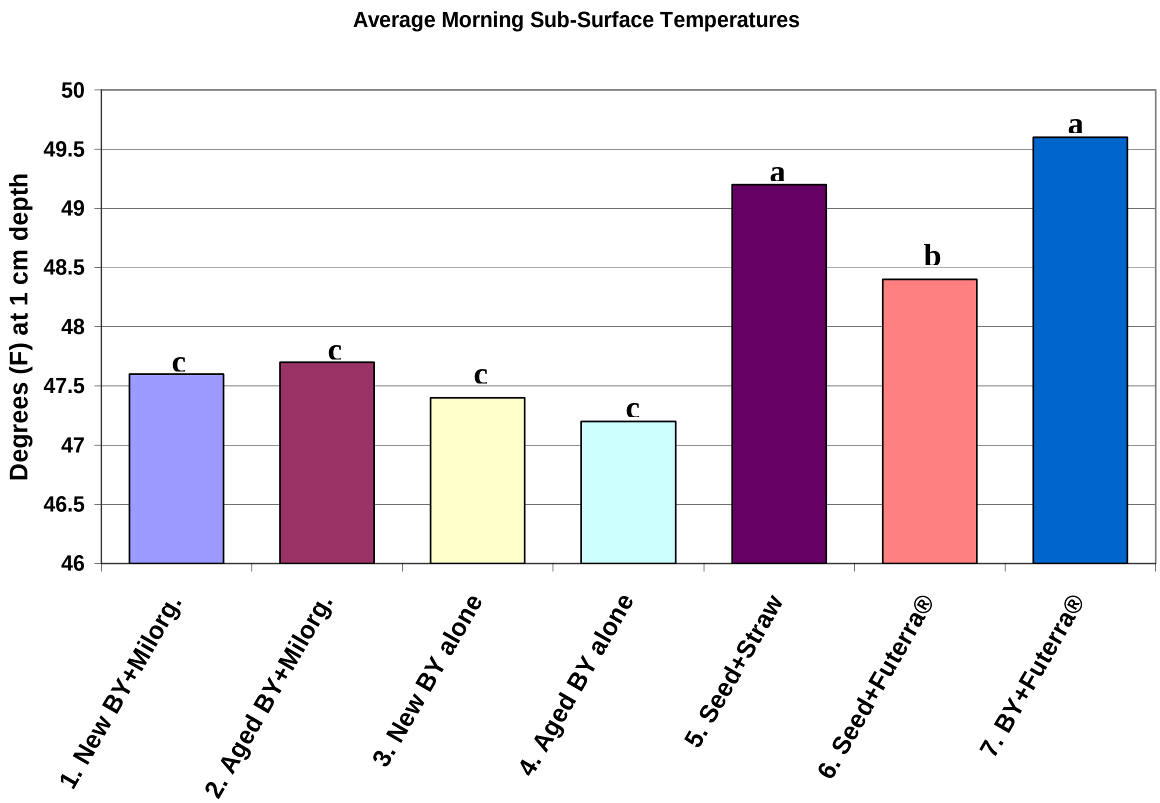

Figure 1. Average sub-surface soil temperature at a depth of 1 cm for 5 May through 15 May, 2006 inVerona, WI. Bars with the same letter are not significantly different at P ≤ 0.05.

Seeding method had a significant effect on the seedling density (Table 8). On 22 May, approximately 7 days after initial germination the BY + Futerra had approximately twice the seedling stand as other BY treatments while the two standard seeding methods had statistically similar seedling density. The BY + Futerra treatment had as equal or better seedling density compared to the other BY treatments throughout the study, though density was only 25% greater by mid-June. The un-ammended BY and BY + Milorganite had the poorest seedling density throughout the study. The age of the BY roll did not seem to affect seedling density.

Table 8. Effect of seeding method on seedling counts, Verona, WI, 2006.

	Seedling Count				
	---------------(Seedlings/40 in^2)----------------				
Seeding Method	22 May	26 May	30 May	5 June	12 June
1. New BY+Milorg.	135.5 c	198.5 c	289.8 c	383.3 bc	436.8 bc
2. Aged BY+Milorg.	161.3 bc	224.3 bc	298.3 bc	321.8 c	433.8 bc
3. New BY alone	129.5 c	223.0 bc	286.3 c	325.3 c	432.5 bc
4. Aged BY alone	155.8 bc	185.5 c	276.0 c	327.8 c	388.8 c
5. Seed+Straw	225.8 ab	290.5 ab	395.3 ab	460.8 ab	483.5 ab
6. Seed+Futerra®	281.3 a	344.8 a	411.5 a	431.3 ab	492.0 ab
7. BY+Futerra®	305.5 a	353.5 a	432.5 a	511.5 a	544.0 a
LSD (0.05)	83.6	74.3	99.9	81.7	69.9

Means followed by the same on letter within columns are not significantly different at P ≤ 0.05.

The standard seeding methods and the BY + Futerra seeding method had more ground cover than the un-amended and Milorganite-amended BY treatments until 47 days after seeding (Table 9). In fact the BY + Futerra treatment often had the most turf cover out of all the treatments. After 6 June the un-amended and Milorganite-amended BY treatments began catching up to the other treatments and by 20 June, all treatments had equal ground cover (Figure 2).

Table 9. Effect of seeding method on percent living turf cover, Verona, WI, 2006.

	Turf Cover (0-100%)					
Seeding Method	May 25	May 30	June 6	June 12	June 20	June 26
1. New BY+Milorg.	4.5	26.3	46.3	71.3	91.8	92.0
2. Aged BY+Milorg.	5.0	26.3	47.5	78.8	93.3	95.8
3. New BY alone	4.0	23.8	46.3	72.5	89.3	90.8
4. Aged BY alone	4.5	26.3	48.8	75.0	92.3	92.5
5. Seed+Straw	28.8	48.8	70.0	81.3	91.0	92.0
6. Seed+Futerra®	31.3	50.0	70.0	82.5	93.3	94.0
7. BY+Futerra®	25.0	50.0	75.0	87.5	97.3	97.5
LSD (0.05)	4.2	4.1	3.9	8.6	ns	ns

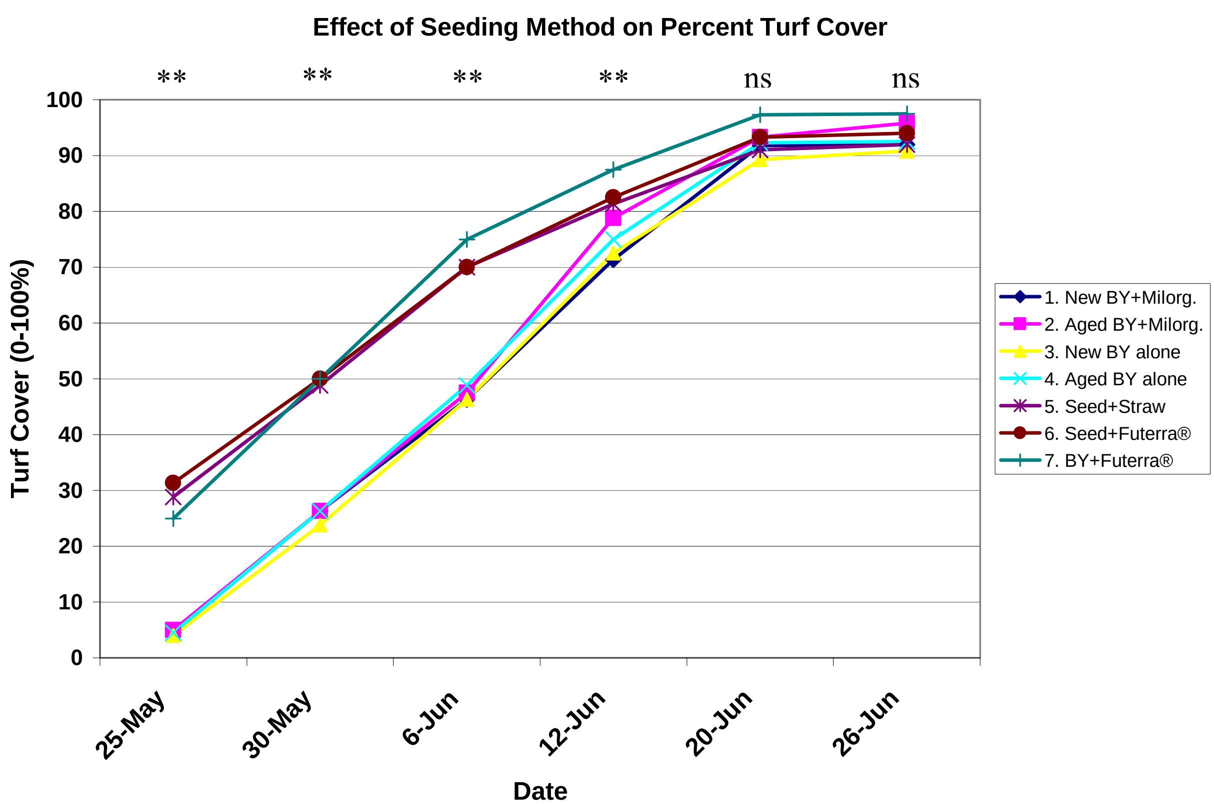

Figure 2. Effect of seeding method on percent turf cover. Verona, WI 2006.
* Significant at $P \leq 0.05$, ** significant at $P \leq 0.01$.

The two standard seeding treatments were the fastest to germinate closely followed by the BY + Futerra treatment. The un-amended and Milorganite-amended BY treatments were the slowest to germinate. The addition of Milorganite to BY or the age of BY rolls did not affect seed germination.

Table 10. Number of days to germination for seven different seeding methods, Verona, WI, 2006.

Seeding Method	Days to Germination
1. New BY+Milorg.	15.5 a
2. Aged BY+Milorg.	14.5 a
3. New BY alone	14.5 a
4. Aged BY alone	14.5 a
5. Seed+Straw	11.0 c
6. Seed+Futerra®	11.0 c
7. BY+Futerra®	12.5 b
LSD (0.05)	1.1

Means followed by the same on letter within columns are not significantly different at $P \leq 0.05$.

DISCUSSION

It is important to note that the weather conditions during this study were much different than for the study done in 2005. May of 2006 was very wet and rainy. In addition May temperatures were much cooler than in 2005. The mean morning surface temperatures for the various treatments ranged from 46.0 to 47.9 °F while the afternoon mean temperatures ranged from 57.0 to 60.2 °F. All the temperatures in this study were below the optimum for cool-season turfgrass germination. The optimum temperature for tall fescue seed germination is 68-86 °F (AOSA, 1960). Air temperature optima for shoot growth are somewhat lower (approximately 60-75 °F) and soil temperature optima for root growth are even lower (approximately 50-65 °F) (Beard, 1973).

It has been suggested that the reflective properties of the BY system are responsible for inhibiting warming of the underlying soil thus slowing seed germination. The results of this and previous studies show that the daytime surface and sub-surface temperatures in the BY treatments can be increased by amending with Milorganite, however, the addition of Milorganite did not improve germination rate.

Data obtained from this study suggest that <u>surface</u> temperature differences are not critical since surface temperature of the BY+Futerra treatment was statistically similar to the other BY treatments yet BY + Futerra, as well as seeded plots covered with straw or Futerra, had the most rapid turf cover. Instead, differences in sub-surface temperatures may be important. Sub-surface soil temperature measurements were taken just prior to sunrise to address this issue. Our data showed the sub-soil temperatures were near to or within the range of optimal temperatures for cool-season turf seed germination (Beard, 1973).

The inherent insulating properties of straw and Futerra increased sub-soil temperature retention during the evening as morning temperatures with these treatments were greater than the other treatments (Fig. 1). The cellulose fibers of the BY mats adhere to the soil in a dense thin layer after water is applied which reduces insulating capabilities. The thin BY treatments were essentially wet soil in contact with the atmosphere and wet soil has a heat conductivity value of 0.0050 Cal/sec*cm*°C. The straw and Futerra mats have "still air" pockets between the wet soil and atmosphere which only have a heat conductivity value of 0.0000614 Cal/sec*cm*°C.

It is also possible that the Futerra and straw mulches enhanced moisture holding capacity compared to the other BY treatments, though the daily irrigation combined with the relatively low evapotranspiration rates during May make this an unlikely source of variation.

In 2005 we saw no difference between the treatments in terms of seedling density. In 2006 we did see differences in terms of seedling density and this may have been a result of much cooler temperatures and/or using tall fescue seed instead of Kentucky bluegrass. The standard seeding methods and the BY + Futerra treatment generally had more seedlings per unit area than the un-amended and Milorganite-amended BY treatments. The increased seedling density is most likely due to higher soil temperatures in the corresponding plots resulting in faster seed germination. After 12 June, seedling density was too high to reasonably count but it is likely that all plots had equal seedling density on later rating dates based on the 20 June and 26 June % turf cover ratings.

Although establishment rates were slower for the BY treatments all seeding treatments resulted in a uniform, dense and good quality turf by around 47 days after seeding. Germination in the standard treatments occurred 3-4 days before germination in the BY treatments with the exception of the BY + Futerra treatment. Covering the BY treatments with a Futerra blanket dramatically reduced time to germination, percent cover, and seedling density.

CONCLUSION

Subsurface temperatures appeared to be more important than surface temperatures for seed germination. Retention of subsurface heat from Futerra or straw mulches during the evening appeared related to more rapid seed germination; even though temperatures were only a few degrees Fahrenheit greater than unmulched plots, germination could have been improved because the mean temperature was close to the minimum optimal temperature for seed germination. Germination differences might not have existed if sub-surface temperatures were well below or much higher in the optimum range. Multiple data sets encompassing a range of sub-surface temperature effects with BY might enhance the understanding of the importance of sub-surface temperatures for germination. The initial delay in germination of even the BY + Futerra (Table 9) indicates there may be a chemical or other physical impediment to germination which is not present with bare seed covered with either straw or Futerra mulch. In addition the results of this study show that longer term storage of BY does not affect turf establishment rates. Ultimately, the Blue Yellow seeding blanket provides turf cover equivalent to using bare seed plus a straw or Futerra mulch without the additional step of adding a mulch.

Timing Requirements for Establishing Athletic Fields from Seed

John Stier and Eric Koeritz
Department of Horticulture

RATIONALE AND OBJECTIVES

Sports fields are often constructed under short time lines. Ideally, many consultants like to have a full year of growing conditions between seeding and when play begins. In most cases this time line is not feasible. Indeed, there is no documented information to show such a timeline is needed, and it may even vary with the grass species used.

We know from previous research that a 95:5 Kentucky bluegrass:perennial ryegrass mixture is needed to achieve approximately 50% of each species within 12 months after seeding. Unfortunately such a seed mix is slow to establish due to the large amount of Kentucky bluegrass. In some cases a ryegrass-dominated stand may be necessary and practical, particularly if play will be heavy and turf cover will depend to a large degree on the amount of overseeding (which is usually all or largely perennial ryegrass).

The objective of the proposed project is to evaluate the length of time needed for turf to establish before athletic field-type play is imposed. Other variables include the type of seed mixture used and the amount of traffic: for example, a 3 month-old seeded perennial ryegrass field may stand up to 1 football game a week but not to 4 games.

MATERIALS AND METHODS

Two adjacent experiments were established to evaluate the effects of 3 seed mixes planted at three different times. The experimental design was a split-plot, randomized complete block with four replications. Planting dates (main plots) were late summer (1 September), dormant (29 November), and spring (27 April). The soil type was a Troxel silt loam soil with pH approximately 7.4, 85 ppm P, 160 ppm K, and 3.9% organic matter.

Seed mixes were 95:5 Kentucky bluegrass:perennial ryegrass (w:w), 80:20, 70:30, and 0:100. Seed mixtures were prepared and donated by L.L. Olds Seed Co. of Madison, WI. The rates were based on information from a previous study and represent the range of mixtures commonly used for athletic fields in the Upper Midwest (Stier et al., 2005). Kentucky bluegrass cultivars used in the mixtures were Touchdown, Odyssey, and Fairfax with the PRG cultivars Manhattan 4, SR4500, and Fiesta 3. Varieties within a species were blended in equal proportions. Plots were seeded using 13 pure live seed (PLS) per square inch. Actual seeding rates were developed by multiplying the germination % by seed purity % to determine PLS, then calculating the density of each seed species in a mixture using a 1000 seed sample and adjusting the seed weight accordingly for the seeding of each treatment.

Starter fertilizer (13-25-12) was applied at time of seeding to provide 1 lb P_2O_5/1000 ft^2 and biodegradable Futerra erosion/mulch covers were placed over new seedings to enhance germination and prevent erosion. Irrigation was supplied to summer and spring-planted plots daily until two to three weeks after germination occurred. For summer-seeded plots, irrigation continued once weekly for an additional four weeks; for spring-seeded plots, irrigation continued until the third week in October. Weekly irrigation was supplied to replenish 100% of the estimated evapotranspiration as determined using a weather station and a modified Penman equation.

Mowing began at the time when irrigation was reduced to once weekly. Turf was mowed at 3.8 cm height using a reel mower with clippings returned. A broadleaf herbicide (Mec-amine D at 1.1 oz/1000 ft^2) was applied 29 June 2006 to control broadleaf weeds. Plots were fertilized with 25-2-4 (donated by Spring Valley) on 6 October 2005, 26 May 2006, September, and October to supply 1 lb N/1000 ft^2.

One experiment was subjected to one simulated football game weekly from mid-August to mid-November using a Brinkman Traffic Simulator for a total of 14 games, the other experiment received four simulated football games weekly during the same period of time for a total of 56 games. Each treatment was replicated four times. Plots were seeded beginning in August, 2005 and traffic treatments began August 2006. This study was a repetition of a prior study conducted at a different location at the O.J. Noer Facility beginning August 2004 and ending November 2005.

Turf quality was rated monthly on a 1 to 9 scale before and during the traffic period. Turf cover was evaluated visually monthly on a 1 to 9 scale and also a percent cover basis. Turf cover and composition (Kentucky bluegrass, perennial ryegrass, annual bluegrass (*Poa annua*), broadleaf weeds, other weeds (e.g., crabgrass), and bare soil were quantitatively determined using an optical point quadrat twice during 2005 and monthly in August through November in 2006. The quadrat measured 0.6 m by 1.2 m with 5 x 10 cm grids and data were collected by determining the plant type or lack of a plant directly underneath 100 intersections of the grid.

RESULTS AND DISCUSSION

Seed mixture consistently affected the amount of Kentucky bluegrass, perennial ryegrass, and *Poa annua* throughout the simulated trafficking period (Table 1). Timing of seeding affected perennial ryegrass especially when subjected to heavy traffic. The amount of annual bluegrass was occasionally affected by seeding timing and/or seed mixture at both levels of traffic (Table 1).

Without traffic, all three mixtures containing KBG yielded similar proportions of KBG (approximately 50% of ground cover). As time and traffic progressed through the autumn, the 95:5 KBG:PRG mixture retained significantly more KBG than the 80:20 and 70:30 mixtures (Table 2). Although Kentucky bluegrass has a greater germination time requirement than perennial ryegrass and is more temperature sensitive (Larsen et al., 2004), the time of seeding did not have any long-lasting influence on the amount of KBG in the swards (Table 1). Our results likely differed from those of Larsen et al. (2004) because traffic was applied in our study. Kentucky bluegrass has less wear tolerance than perennial ryegrass (Shearman and Beard, 1975). In the short-term of our study, loss of Kentucky bluegrass leaf tissue occurred without a concomitant loss of perennial ryegrass (Tables 3a and 3b). Information is needed on long-term recovery and sustainability of Kentucky bluegrass:perennial ryegrass mixtures with and without overseeding.

Unlike in our previous study (Stier et al., 2005), annual bluegrass contamination was moderately severe even though irrigation regimes between the two studies were similar (Tables 4a and 4b). Contamination tended to be significantly less in plots seeded to 100% perennial ryegrass compared to plots seeded with mixtures containing Kentucky bluegrass. The rapid germination of perennial ryegrass and subsequent turf cover squelched annual bluegrass seed germination. One reason more annual bluegrass contamination occurred in the current study may be due to the enhanced longevity of the turf site by 2005: when the study reported by Stier et al. (2005) was planted in the late 1990s, the site had only been in turf for about five years. By 2005, the site had been in turf approximately 12 years.

In many contracts a 50:50 sward of KBG and PRG is desired. Reasons include better disease resistance and overall turf performance. In the current study, turf quality was inversely proportional to the amount of Kentucky bluegrass during most of the spring and summer likely due to the slower establishment rate of Kentucky bluegrass (Figs. 2a and 2b; Fig. 3). By early September the plots with Kentucky bluegrass were as good as the 100% perennial ryegrass turf. However, by the end of the traffic “season”, plots seeded to 95:5 mixture had significantly lower turf quality than plots seeded to greater amounts of ryegrass or to straight ryegrass.

We expected to see perennial ryegrass seedings outperform Kentucky bluegrass mixtures only when seeded in the spring. The fact that perennial ryegrass turf provided as good or better turf quality and cover compared to more expensive Kentucky bluegrass mixtures provides tempting evidence to jettison Kentucky bluegrass:perennial ryegrass mixtures for sports turf in Wisconsin. However, perennial ryegrass is much more susceptible to winterkill than Kentucky bluegrass. In 2004-05, significant winterkill was observed on the perennial ryegrass and tall fescue National Turfgrass Evaluation Program variety trials in Wisconsin while Kentucky bluegrass suffered no noticeable injury. In addition, rust disease can be severe on perennial ryegrass in Wisconsin much more commonly than on Kentucky bluegrass. In the absence of certain biotic and abiotic stresses (e.g., winterkill), the data suggest the amount of Kentucky bluegrass in a cool-season athletic field in the Upper Midwest may not be critical to success of the field.

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Table 1. Analysis of variance tables for main effects and interaction of seeding timing and seed mixture on turf composition subjected to either one or four simulated football games weekly, Verona, WI, 2006.

	1 Game Weekly											
	Kentucky bluegrass				Perennial ryegrass				*Poa annua*			
Source	8/17	9/23	10/27	11/20	8/17	9/23	10/27	11/20	8/17	9/23	10/27	11/20
Timing	ns	ns	ns	ns	ns	ns	*	**	**	ns	ns	ns
Mix	**	**	**	**	**	**	**	**	**	ns	ns	*
TimingxMix	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	4 Games Weekly											
	Kentucky bluegrass				Perennial ryegrass				*Poa annua*			
Source	8/17	9/23	10/27	11/20	8/17	9/23	10/27	11/20	8/17	9/23	10/27	11/20
Timing	ns	ns	ns	ns	*	*	*	**	ns	*	**	ns
Mix	**	**	**	**	**	**	**	**	ns	*	ns	*
TimingxMix	ns	ns	ns	ns	ns	ns	ns	**	ns	ns	ns	ns

Table 2. Main effects of seeding mixture on amount of Kentucky bluegrass in turf prior to and during one simulated football game weekly from mid-August to mid-November, Verona, WI, 2006. An optical point quadrat was used to determine the presence of various types of vegetation or bare soil at 50 or 100 grid intersections.

Mixture (KBG:PRG)†	**17 Aug**	**23 Sept**	**27 Oct**	**20 Nov**
	--------------------------1 simulated game per week-----------------------			
95:5	48.4 a	72.8 a	65.1 a	60.8 a
80:20	42.8 a	63.5 ab	58.2 ab	47.3 b
70:30	50.2 a	52.8 b	50.5 b	43.2 b
0:100	0.0 b	7.2 c	0.0 c	0.0 c
Tukey's HSD (0.05)	12.7	17.1	14.0	4.7
	-------------------------4 simulated games per week-----------------------			
95:5	49.0 a	74.5 a	61.0 a	47.0 a
80:20	55.4 a	60.5 ab	52.1 a	36.0 b
70:30	46.0 a	53.6 b	45.2 a	34.5 b
0:100	5.8 b	6.4 c	5.8 b	0.0 c
Tukey's HSD (0.05)	20.0	20.4	18.7	8.9

† Equal proportions of the following KBG cultivars were used: Touchdown, Odyssey, and Fairfax along with the following PRG cultivars: Manhattan 4, SR4500, and Fiesta 3.

Table 3a. Main effects of timing seeding and seeding mixture on amount of perennial ryegrass in turf prior to and during one simulated football game weekly from mid-August to mid-November, Verona, WI, 2006. An optical point quadrat was used to determine the presence of various types of vegetation or bare soil at 50 or 100 grid intersections.

Seeding Timing†	**17 Aug**	**23 Sept**	**27 Oct**	**20 Nov**
Summer	29.8	20.6	27.4 b	29.2 c
Dormant	30.4	28.3	34.8 ab	36.0 b
Spring	40.2	34.3	37.5 a	44.2 a
Tukey's HSD (0.05)	ns	ns	7.9	5.7
Mixture (KBG:PRG)‡				
95:5	9.5 c	5.8 b	11.2 b	14.3 c
80:20	18.1 bc	10.9 b	20.0 b	26.0 b
70:30	25.0 b	19.5 b	24.2 b	28.2 b
0:100	81.3 a	74.7 a	77.4 a	77.5 a
Tukey's HSD (0.05)	10.2	15.1	14.3	8.2

† Summer seeding = 1 September 2005, dormant = 29 November 2005, spring = 27 April 2006.
‡ Equal proportions of the following KBG cultivars were used: Touchdown, Odyssey, and Fairfax along with the following PRG cultivars: Manhattan 4, SR4500, and Fiesta 3.

Table 3b. Main effects of timing seeding and seeding mixture on amount of perennial ryegrass in turf prior to and during 4 simulated football games weekly from mid-August to mid-November, Verona, WI, 2006. An optical point quadrat was used to determine the presence of various types of vegetation or bare soil at 50 or 100 grid intersections.

Seeding Timing†	**17 Aug**	**23 Sept**	**27 Oct**	**20 Nov**
Summer	25.6 ab	22.9 b	24.5 b	25.6 b
Dormant	22.5 b	34.9 a	34.7 ab	35.0 ab
Spring	41.5 a	39.1 a	42.0 a	42.5 a
Tukey's HSD (0.05)	16.4	11.8	13.1	9.5
Mixture (KBG:PRG)‡				
95:5	13.1 b	6.6 b	12.8 b	13.7 c
80:20	16.9 b	22.1 b	23.3 b	27.8 b
70:30	16.8 b	18.9 b	27.6 b	29.5 b
0:100	72.8 a	81.6 a	71.2 a	66.5 a
Tukey's HSD (0.05)	17.5	16.0	17.3	7.1

† Summer seeding = 1 September 2005, dormant = 29 November 2005, spring = 27 April 2006.
‡ Equal proportions of the following KBG cultivars were used: Touchdown, Odyssey, and Fairfax along with the following PRG cultivars: Manhattan 4, SR4500, and Fiesta 3.

Table 4a. Main effects of timing seeding and seeding mixture on amount of *Poa annua* in turf prior to and during one simulated football game weekly from mid-August to mid-November, Verona, WI, 2006. An optical point quadrat was used to determine the presence of various types of vegetation or bare soil at 50 or 100 grid intersections.

Seeding Timing†	**17 Aug**	**23 Sept**	**27 Oct**	**20 Nov**
Summer	31.1 a	25.6	25.4	27.0
Dormant	16.9 b	22.1	18.7	22.5
Spring	12.3 b	15.9	18.2	17.8
Tukey's HSD (0.05)	10.5	ns	ns	ns
Mixture (KBG:PRG)‡				
95:5	24.6 ab	18.0	20.9	20.8 a
80:20	26.8 a	24.7	20.2	24.7 ab
70:30	17.2 bc	26.6	22.8	26.7 ab
0:100	11.9 c	15.5	19.1	17.2 b
Tukey's HSD (0.05)	8.9	ns	ns	8.9

† Summer seeding = 1 September 2005, dormant = 29 November 2005, spring = 27 April 2006.
‡ Equal proportions of the following KBG cultivars were used: Touchdown, Odyssey, and Fairfax along with the following PRG cultivars: Manhattan 4, SR4500, and Fiesta 3.

Table 4b. Main effects of timing seeding and seeding mixture on amount of *Poa annua* in turf prior to and during four simulated football games weekly from mid-August to mid-November, Verona, WI, 2006. An optical point quadrat was used to determine the presence of various types of vegetation or bare soil at 50 or 100 grid intersections.

Seeding Timing†	**17 Aug**	**23 Sept**	**27 Oct**	**20 Nov**
Summer	27.4	22.4 a	18.9 a	15.9
Dormant	17.1	9.8 b	9.2 b	8.2
Spring	14.1	9.9 b	7.3 b	7.5
Tukey's HSD (0.05)	ns	10.3	7.2	ns
Mixture (KBG:PRG)‡				
95:5	25.2	16.9 ab	13.5 ab	14.2 a
80:20	24.4	13.9 ab	11.7 ab	10.5 ab
70:30	15.8	19.5 a	15.2 a	13.2 a
0:100	12.5	5.9 b	7.0 b	4.3 b
Tukey's HSD (0.05)	ns	12.4	8.1	8.2

† Summer seeding = 1 September 2005, dormant = 29 November 2005, spring = 27 April 2006.
‡ Equal proportions of the following KBG cultivars were used: Touchdown, Odyssey, and Fairfax along with the following PRG cultivars: Manhattan 4, SR4500, and Fiesta 3.

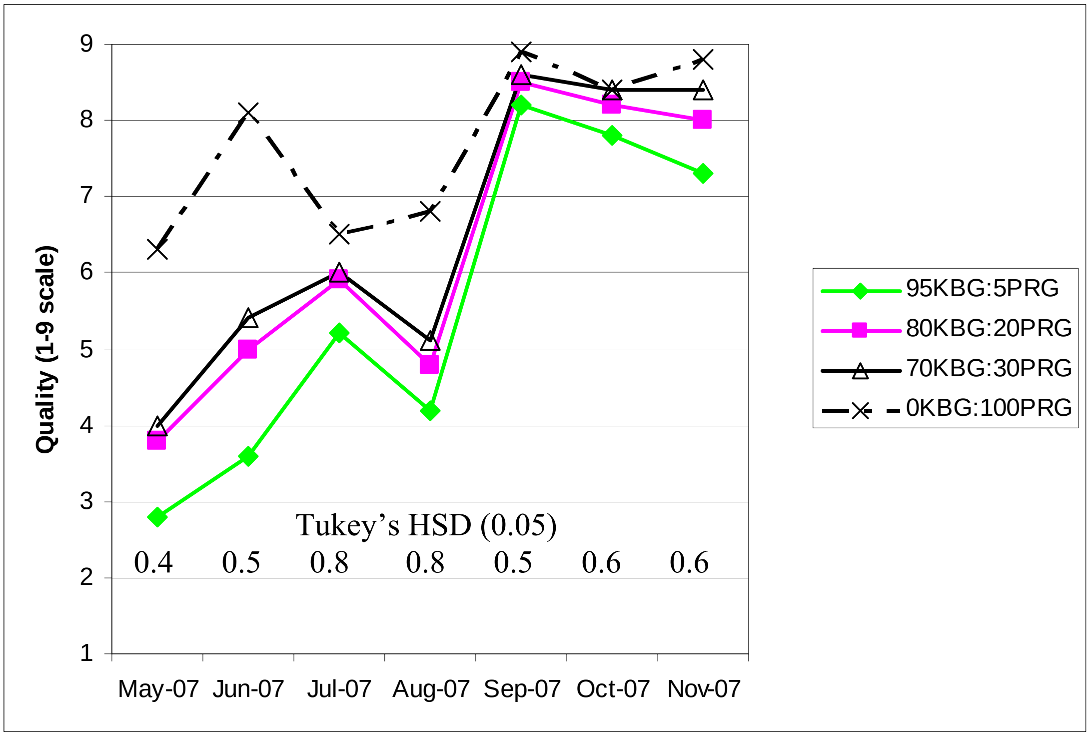

Fig. 2a. Quality of KBG:PRG mixtures subjected to 1 simulated football game per week from mid-August to mid-November, 2006, Verona, WI.

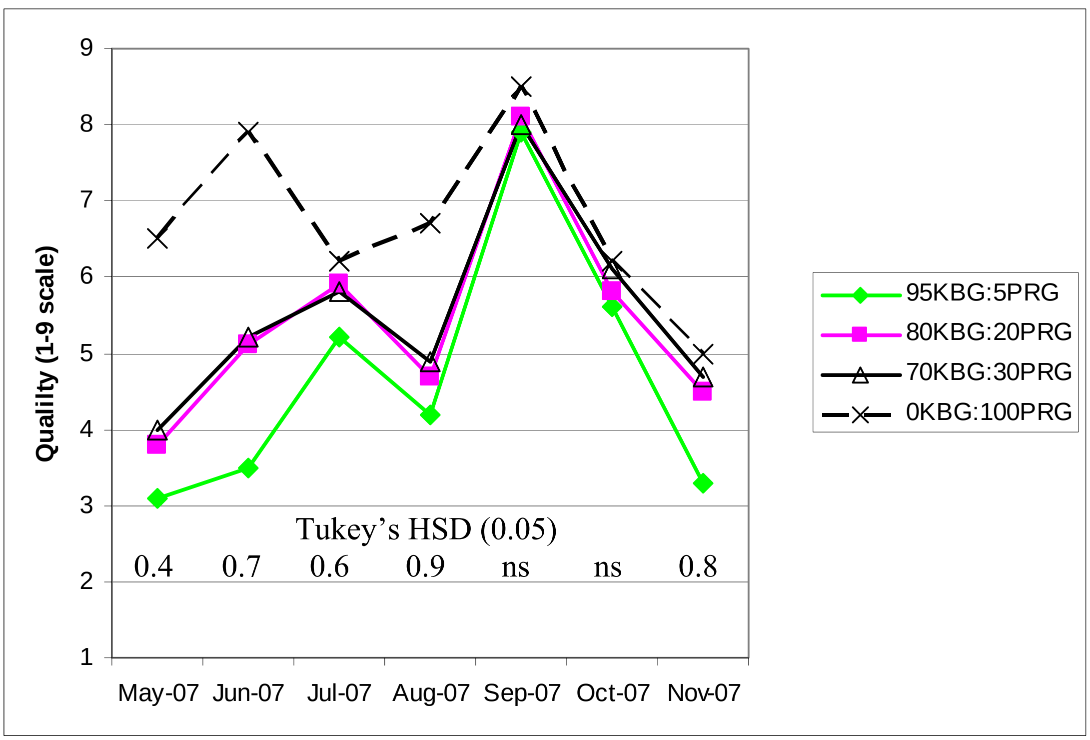

Fig. 2b. Quality of KBG:PRG mixtures subjected to 4 simulated football games per week from mid-August to mid-November, 2006, Verona, WI.

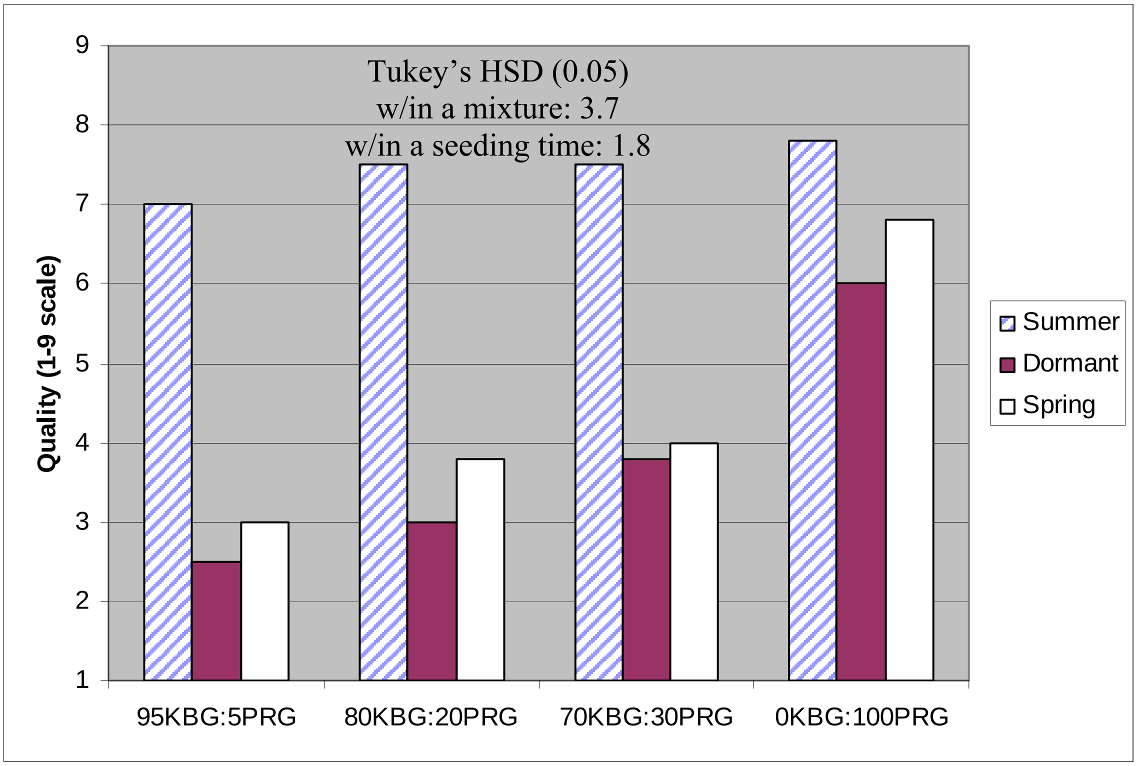

Fig. 3. Interaction of KBG:PRG mixtures and time of seeding on turf quality on August 11, 2006 (designated for 1 weekly football game traffic treatment).

Comparison of Corn Gluten Meal, Integrated Pest Management, and Conventional Approaches to Maintaining Landscape and Athletic Field Turf at Wisconsin Schools K-12

Dr. John Stier[1] and Patricia Kandziora[2]
[1]Department of Horticulture, Univ. of Wisconsin-Madison, and [2]Wisconsin Dept. of Agriculture, Trade and Consumer Protection

Introduction

Integrated pest management (IPM) has been encouraged in Wisconsin as a means to reduce reliance on pesticides at schools K-12 for turf maintenance while providing acceptable turf quality. Corn gluten meal is a natural by-product of the wet milling process of corn. Corn gluten meal acts as both a natural fertilizer and a pre-emergent herbicide in turf. Our objective was to determine relative cost inputs and effect on turf quality when both landscape turf and high quality athletic field turf was maintained with either an IPM, corn gluten-meal only, or conventional low-input approach.

Methodology

Six public school systems in Wisconsin volunteered to participate in a study to evaluate costs and effectiveness of IPM and corn gluten meal-only turf management strategies. Field plots were established in summer 2004 as randomized block designs with four replications. Experimental units (e.g., a single treatment replicate) were large, measuring 15 ft width by 65 ft length. School personnel were provided with data collection sheets, point quadrats, and training to assess turf quality, turf density, weed cover, and bare soil. Training was conducted at the O.J. Noer Turfgrass Research and Educational Facility during summer 2004 where participants could see and use a range of turf and weed plots to develop their assessment skills. School personnel collected made field assessments monthly during the growing season. Treatments were applied using an IPM program as described in the Wisconsin School IPM manual (Stier et al., 1999; Stier et al., 2002), two annual applications of corn gluten meal at 20 lb/1000 ft^2 for each application, or the school's conventional program of fertilizer and pesticide.

Results and Discussion

<u>School Participation</u>

Participation at all but one of the schools faltered and eventually collapsed. At D.C. Everest, the superintendent was not able to start the project as other priorities developed. At Neenah School, changes in administration and budget priorities caused treatments and data collection to cease after the first year. At the Appleton School, employees inadvertently fertilized and aerated all the treatments uniformly on multiple occasions, and no data were collected as the superintendent felt there were no differences among treatments. A visit by our program in autumn 2005 concurred that no differences existed among treatments.

DeForest High School continued their involvement closest to the level desired. Treatments were applied on time to the correct plots and data were recorded monthly during the growing season. Sufficient turf assessments were collected to allow treatment comparisons of turf quality, turf cover, weed cover, and exposed soil for both Level B Landscape Area and Level A Athletic Field area. Some data related to treatment costs were collected but were insufficient to accurately compare treatments.

Soil test results

Soil samples were collected from the Deforest School sites at the beginning of the study. Soil type was a silt loam at both sites. At the landscape level B site, soil pH was 6.1, phosphorus was 41 ppm, potassium 135 ppm, and organic matter was 4.8%. These conditions are ideal for maintaining cool-season turf. At the athletic field site, soil pH was 5.4, phosphorus was 26 ppm, potassium 132 ppm, and organic matter was 4.0%. The pH is somewhat low as a minimum of 6.0 is generally deemed sufficient, though by no means is limiting for Kentucky bluegrass/perennial ryegrass turf. Phosphorus was still sufficient to maintain an established turf.

Data from Landscape Area B

Turf quality in the Level B Landscape Area improved from unacceptable quality (< 6.0 rating on a 1 to 9 scale) to acceptable quality over the course of the project. However, all turf quality improved without regard to the three treatments except for one rating date at which the corn gluten meal treatment was superior to the untreated area; the IPM treatment was statistically similar to both the corn gluten and untreated treatments (Fig. 1).

Turf ground cover improved dramatically during the course of the project from approximately 40% to over 70%. Significant treatment differences ($P \leq 0.05$) began to appear by October 2005. Both corn gluten meal and IPM treatments increased the amount of desirable turf cover compared to the low input/conventional treatment. By the end of the study, the conventional treatment program resulted in just over 70% turf cover while the IPM and corn gluten meal treatments resulted in 80 to 90% turf cover (Fig. 2).

Weed cover as a percentage of ground cover declined from 50-60% to 10-30% during the trial (Fig. 3). By summer 2006, both the IPM and the corn gluten meal-only treatments resulted in similar levels of weed control, both of which were better than the low input/conventional program. The amount of bare soil was relatively low throughout the trial (usually less than 5%) and was usually similar among the treatments (Fig. 4).

Data from Athletic Field Level A (baseball out field)

Athletic field turf responded quite differently to treatments compared to landscape level B where turf quality was less important, traffic amount and/or type was different, and fertility and irrigation inputs were different. In high quality athletic fields, data indicate an Integrated Pest Management program which included several applications of fertilizer containing at least some water-soluble nitrogen provided significantly better turf quality and cover than turf treated with corn gluten meal only (Figs. 5 and 6). However, corn gluten meal treatments provided better turf quality than where no or little fertilizer was applied.

Weeds were reduced from approximately 20% of the ground cover to about 15% in the conventional/less treated turf, about 10% in the corn gluten-treated plots, and about 2% in the IPM-treated plots (Fig. 7). There was usually very little (<3%) bare soil except for autumn 2005 in the corn gluten and conventional/less treated turf plots when approximately 5-10% bare soil was exposed, though full turf recovery occurred by spring 2006 (Fig. 8).

Conclusion

In medium level landscape areas (no irrigation), management programs relying on either IPM or corn gluten meal provided better quality turf than a conventional approach where fertilizer and other inputs were not routinely applied. In Level A athletic fields, an IPM approach was clearly superior to using only corn gluten meal as both a fertilizer and herbicide, though a corn-gluten meal only approach was still better than an irregular program of fertilizer and other inputs.

An IPM approach to turf management has hidden, indirect costs such as scouting time and training for personnel, though these costs may be at least partially offset by more efficient and perhaps fewer applications of pesticides along with providing better quality turf. Costs of a corn gluten meal-only approach depends largely on the source of corn gluten meal. Feed mills sell corn gluten cheaply, which is where it was obtained for our study. Granulated corn gluten meal costs considerably more than synthetic fertilizer (cost varies depending on the retailer) but is easier to handle and apply. It is unknown how the increasing demand for corn to be used for ethanol production will affect corn gluten meal rates and availability. Corn prices have risen 50% in the past year and may rise exponentially in the next several years as ethanol plants are built in the Midwest.

References

Wisconsin's School IPM Manual. 1999. Stier, J.C., K.A. Delahaut, P.J. Pellitteri, and B.A. Becker. 250 pgs. http://ipcm.wisc.edu/programs/school.

Stier, J. C., K. A. Delahaut, P.J. Pellitteri, R. C. Williamson, and B.P. Becker. 2002. Extension Assistance for Integrated Pest Management Programs in K-12 Schools. J. of Extension 40(1) [Online]. Available at http://www.joe.org/joe/2002february/iw3.html (verified 19 January 2003).

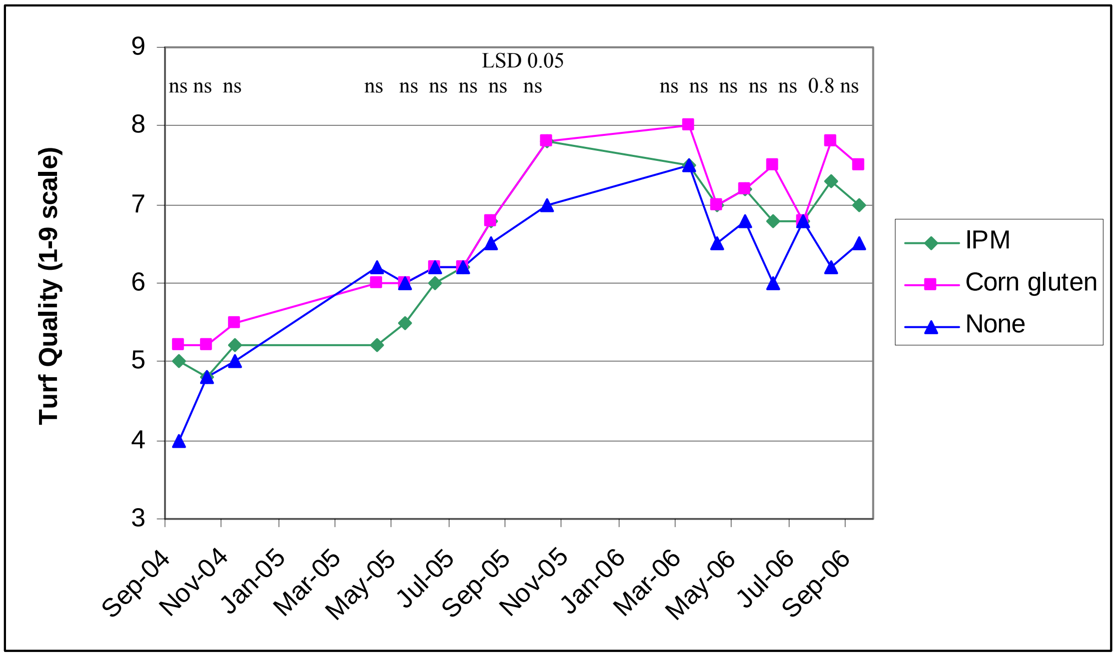

Fig. 1. Turf quality of Landscape B area at DeForest High School, WI, resulting from three management programs.

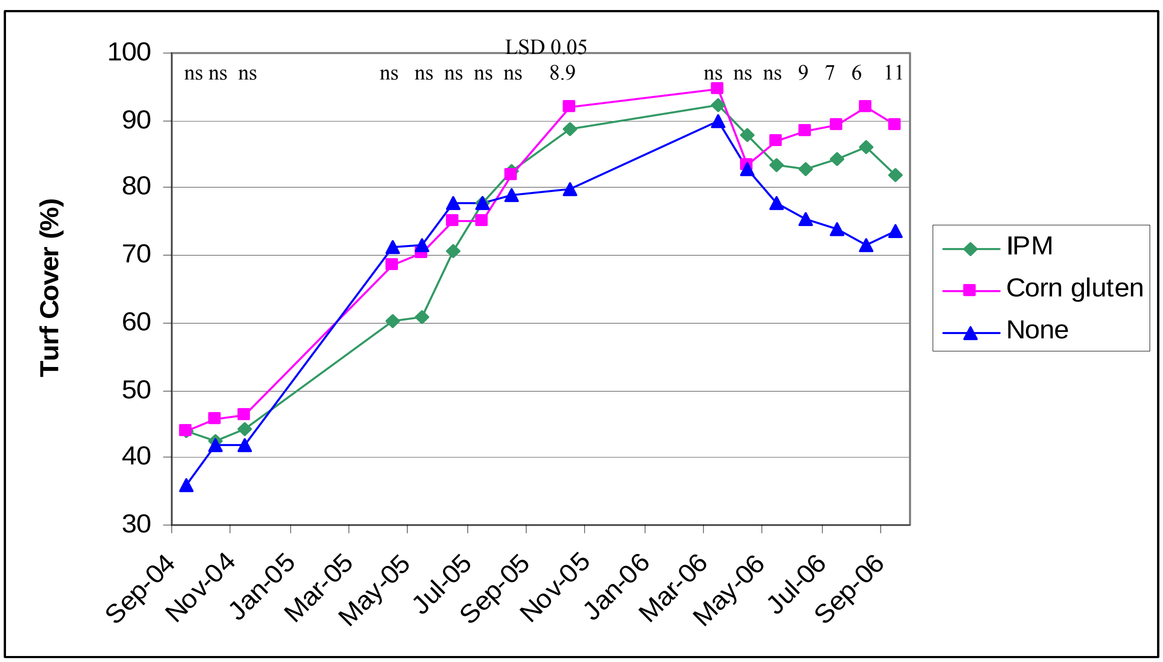

Fig. 2. Percent ground covered by desirable turf in Landscape B area at DeForest High School, WI, resulting from three management programs.

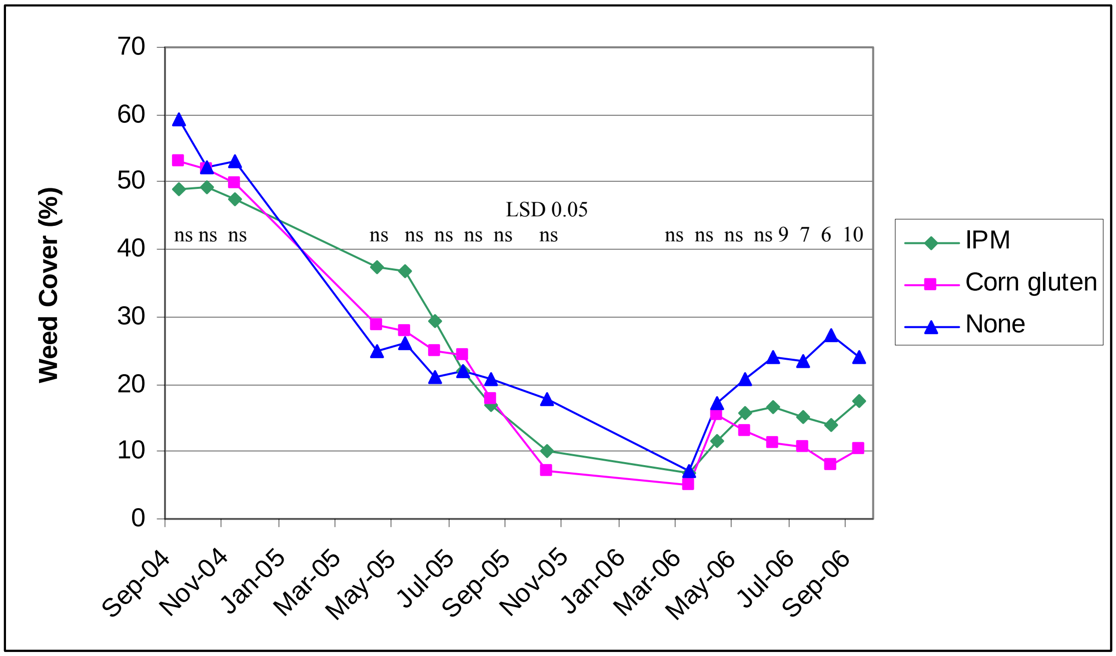

Fig. 3. Percent ground covered by weeds in Landscape B area at DeForest High School, WI, as a function of three management programs.

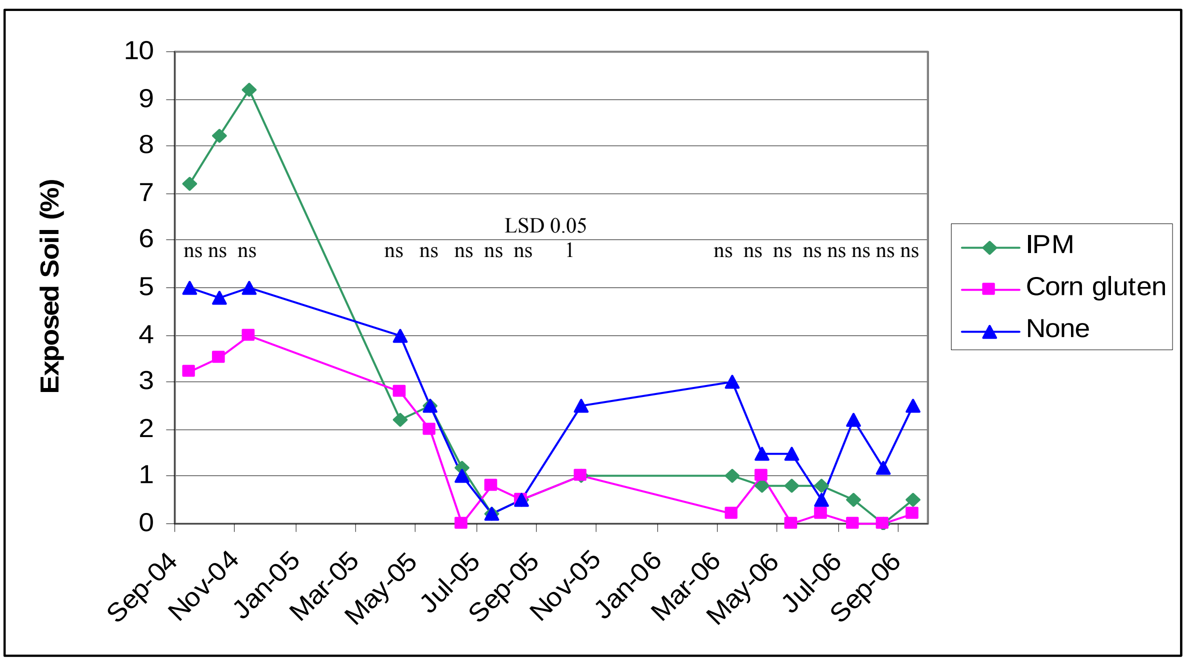

Fig. 4. Percent of exposed soil in Landscape B area at DeForest High School, WI, resulting from three management programs.

Athletic Field (Baseball outfield)

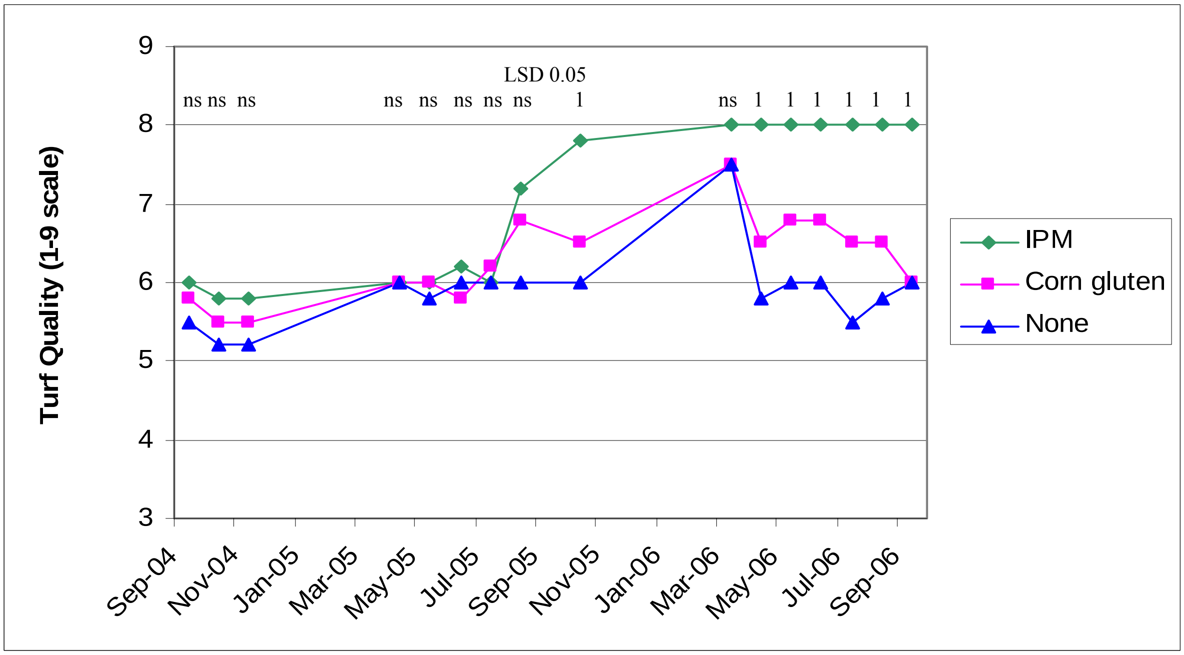

Fig. 5. Turf quality of Level A athletic turf at DeForest High School, WI, resulting from three management programs.

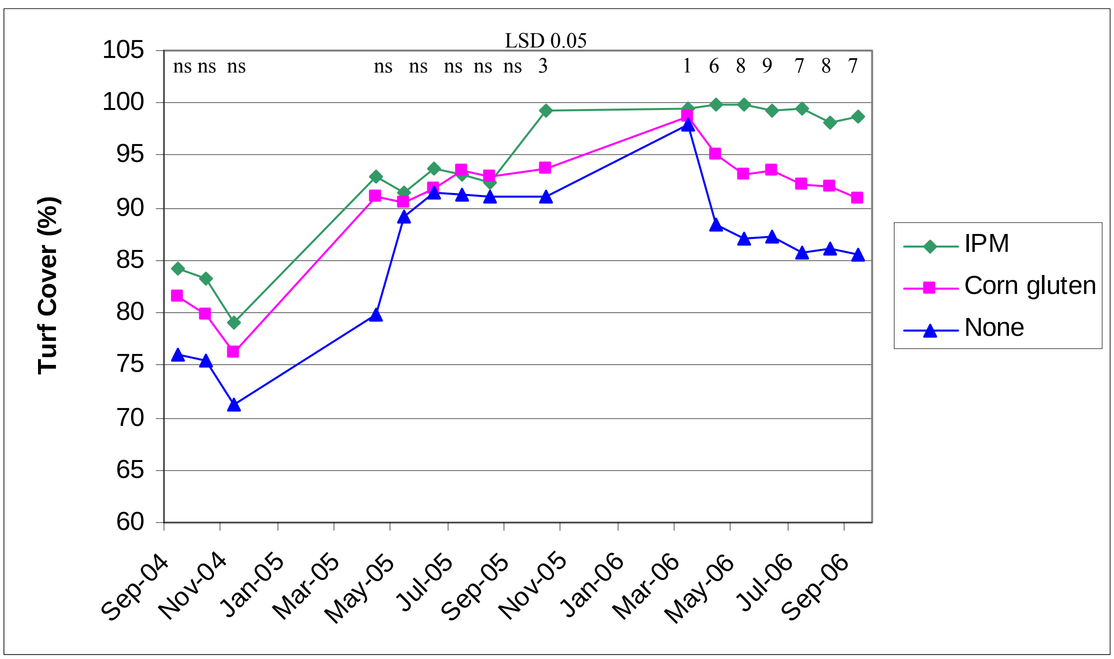

Fig. 6. Percent ground covered by desirable turf in Level A Athletic Field area at DeForest High School, WI, resulting from three management programs.

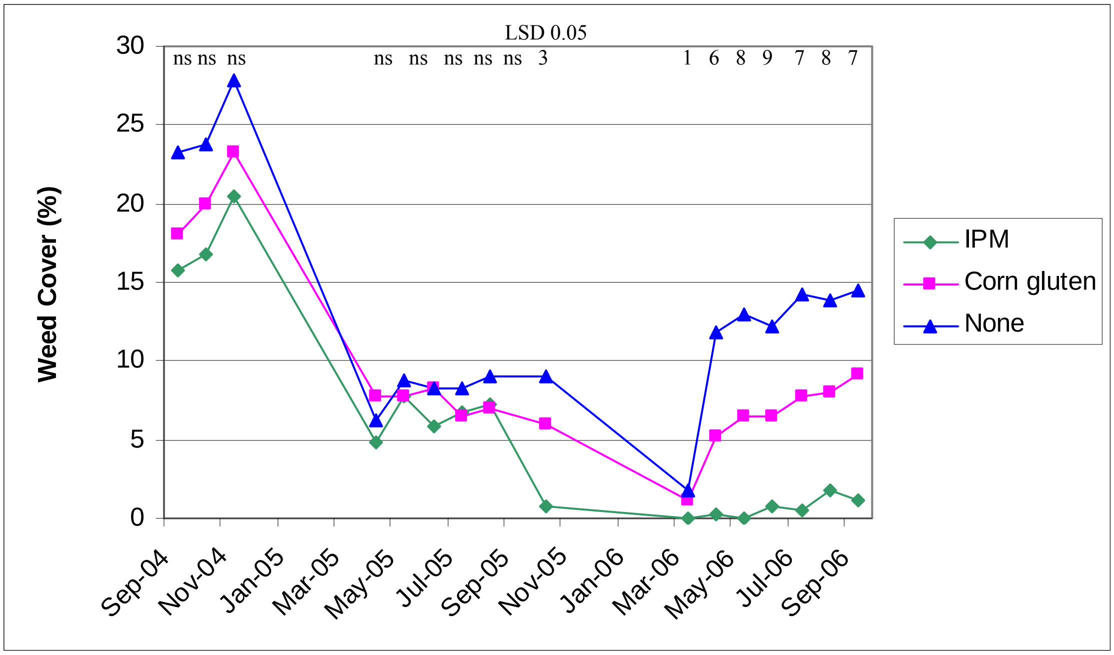

Fig. 7. Percent ground covered by weeds in Level A Athletic Field at DeForest High School, WI, as a function of three management programs.

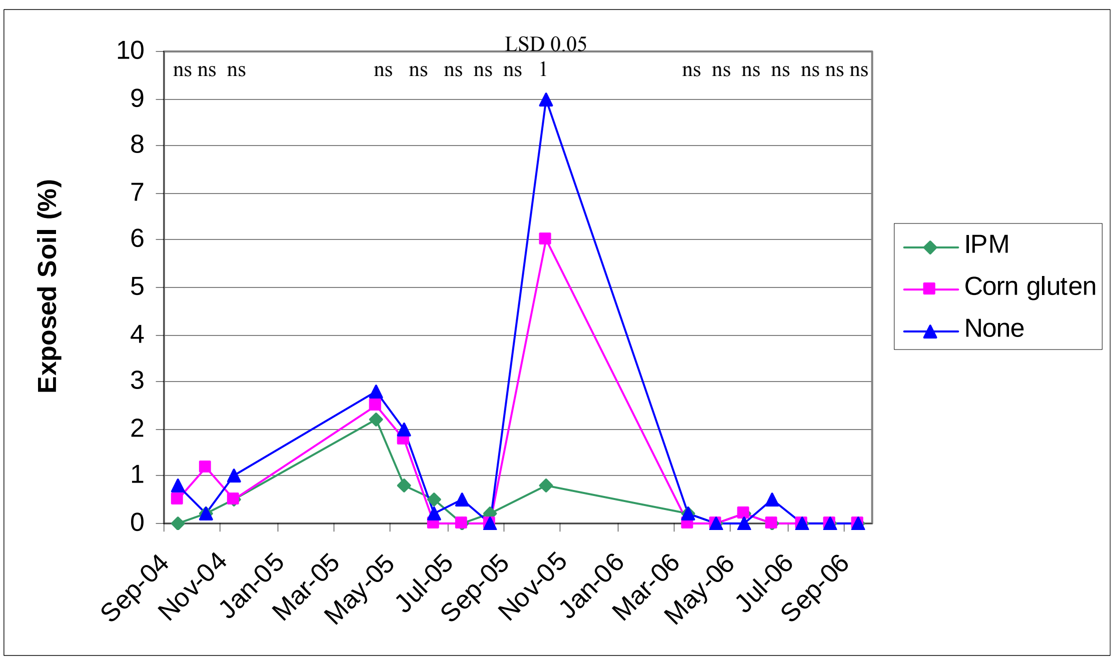

Fig. 8. Percent of exposed soil in Level A Athletic Field at DeForest High School, WI, resulting from three management programs.

Herbicide Trials

Pre-emergent Crabgrass Control with Dimension EW Herbicide

Dr. John Stier, Associate Professor, and Mr. Eric Koeritz, Research Assistant
Department of Horticulture
University of Wisconsin-Madison

OBJECTIVE

Determine if Dimension EW herbicide performs as well as the present dithiopyr formulations for pre-emergent crabgrass control in university demonstration trials in cool season turf.

MATERIALS AND METHODS

Field trials were conducted at the O.J. Noer Turfgrass Research and Educational Facility, Madison, WI, in both lawn and fairway height turf, though only a lawn turf study was requested. The soil type was a silt loam soil, pH approximately 7.8. The experimental design was a randomized complete block with four replications. Each experimental unit (individual plot) measured 3 x 5 ft (15 ft^2) in the lawn site and 3 x 10 ft (30 ft^2) in the fairway site. An on-site weather station and data logger (Campbell Scientific) were used to record weather data which are available upon request.

The lawn turf has been maintained as a low maintenance lawn turf composed of Kentucky bluegrass and perennial ryegrass since the area was converted from corn production 16 years ago. Mowing height is 2 inches once weekly with clippings returned. The area receives 1 lb N/1000 ft^2 each October using sulfur-coated urea (32-0-0) but no routine irrigation. The creeping bentgrass fairway area was planted to Penncross creeping bentgrass about six years ago and is mowed three days weekly at 0.5 inch height with clippings returned. Small amounts of Kentucky bluegrass and fine fescue exist in the fairway site. It receives two annual fertilizer applications, 1 lb N/1000 ft^2 in spring and fall though no fertilizer was applied in 2006. No irrigation was used this year other than to water in the treatments.

In mid-April the lawn turf was mowed at 1" height to "scalp" the turf. Both turf sites were then power raked to encourage crabgrass establishment. Though both sites have had a history of crabgrass infestation, additional crabgrass was seeded at 1.1 lbs/1000 ft^2 on 22 April using a drop spreader.

Liquid herbicide treatments were applied using a CO_2-powered backpack sprayer with XR TeeJet 8004 VS nozzles at 40 psi with 2.6 gal H_2O/1000 ft^2 as carrier (Table 1). Granular treatments were applied using a shaker jar. All treatments were applied 26 April and irrigated with ½ inch of water using an in-ground automated irrigation system. This was the only irrigation supplied to the sites.

Crabgrass plants were counted in each plot to determine treatment efficacy. Counts were made at 4, 8, 12, and 16 WAT. Percent control was calculated by dividing the number of crabgrass plants by those in the untreated control for each replication, multiplying the dividend by 100, and subtracting the product from 100. Color and phytotoxicity ratings were collected 3, 7, 14, and 28 DAT. Color was evaluated visually on a 1 to 9 scale (similar to ratings we conduct for the National Turfgrass Evaluation Program) with 1 = brown turf, 9 = dark green, and a minimum of 6 considered desirable for high quality (5 is considered acceptable for low to moderate quality/maintenance lawn turf). Phytotoxicity to lawn turf was noted as failure to greenup while phytotoxicity to fairway turf was noted as brown color and rated on a scale of 0 to 10, with 0 = no damage and 10 = dead turf; a rating of 3 or greater was considered to be unacceptable.

Table 1. Treatment names and application rates for lawn height and fairway trial.

Trt. #	**Trt. Name**	**Formulation**	**Rate**	**Timing**
1	Dimension Ultra	2 EW	0.5 lb ai/A	Pre
2	Dimension	1 EC	0.5 lb ai/A	Pre
3	Dimension Ultra	40 WP	0.5 lb ai/A	Pre
8	Untreated Control			

*M is symbol for 1000 square feet.

RESULTS AND DISCUSSION

Lawn turf

No treatments caused any phytotoxicity or change in turf color (Tables 2, 3). Crabgrass emergence began by early to mid June and was in the 1-2 leaf stage by 23 June. Consequently, no data were available at the 4 WAT date. The number of crabgrass plants in control plots averaged 5.5 in June, 31.5 in July, and 35 in August. All three formulations provided excellent (100%) control in June and July (Table 4). By August, continued crabgrass germination was starting to overcome turf treated with the 1 EC formulation, though control was still good (about 89%). The Ultra WSP formulation had the best control in August (96.5%). The EW formulation provided control statistically similar to both the WSP and EC formulations.

Fairway turf

No treatments caused any phytotoxicity or change in turf color (Tables 5, 6). Crabgrass emergence began by early to mid June and was in the 1-2 leaf stage by 23 June. Consequently, no data were available at the 4 WAT date. Crabgrass infestation was good much sooner than in the lawn turf where shading of the soil by the taller grass likely delayed the onset of soil temperatures favorable for crabgrass germination and growth. The number of crabgrass plants in control plots averaged 44.2 in June, 79.0 in July, and 58.5 in August. All three formulations provided good to excellent control by June and through August. As seen in the lawn turf study though, the 1EC formulation was less effective by August compared to the Ultra WSP formulation, which continued to provide over 90% control (Table 7). The EW formulation provided control statistically similar to both the WSP and EC formulations.

Table 2. Effect of Dimension formulations (0.5 lb ai/A) on Kentucky bluegrass/perennial ryegrass lawn turf color. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
Dimension Ultra 2EW	6.2	6.5	6.5	6.8
Dimension 1 EC	5.8	6.4	6.0	6.5
Dimension Ultra WSP	5.5	5.8	6.0	6.2
Untreated control	5.8	6.0	6.2	6.8
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 3. Phytotoxicity of Dimension formulations on Kentucky bluegrass/perennial ryegrass lawn turf. Phytotoxicity ranked on 0 to 10 scale, 0 = no injury, > 3 was unacceptable, and 10 = dead turf. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
Dimension Ultra 2EW	0.5	0.2	0.5	0.5
Dimension 1 EC	0.7	0.5	0.5	0.2
Dimension Ultra WSP	0.7	0.7	0.7	1.0
Untreated control	0.5	0.5	0.2	0.5
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 4. Crabgrass control (%) in Kentucky bluegrass/perennial ryegrass lawn turf using three Dimension formulations. Products were applied 26 April 2006, Madison, WI. Percent control was calculated by dividing the number of crabgrass plants in treated plots by those in the control plot for that replication, multiplying the dividend by 100, and subtracting the product by 100. Values followed by the same letter were not statistically different at $P \leq 0.05$.

Product	24 May	23 June†	26 July	21 August
Dimension Ultra 2EW	---‡	100.0 a§	100.0 a	93.6 ab
Dimension 1 EC	---	100.0 a	100.0 a	88.7 b
Dimension Ultra WSP	---	100.0 a	100.0 a	96.5 a
Untreated control	---	0.0 b	0.0 b	0.0 c

† Number of crabgrass plants per 15 ft^2 control plots averaged 5.5 in June, 31.5 in July, and 35.0 in August.
‡ Crabgrass was not visible in plots until the June rating.
§ Values followed by the same letter were not significantly different at $P \leq 0.05$.

Table 5. Effect of Dimension formulations (0.5 lb ai/A) on color of creeping bentgrass fairway turf. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
Dimension Ultra 2EW	7.0	6.8	7.0	7.0
Dimension 1 EC	7.0	7.0	7.2	7.0
Dimension Ultra WSP	7.0	7.0	7.0	7.0
Untreated control	7.0	6.8	7.2	7.0
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 6. Phytotoxicity of Dimension formulations on creeping bentgrass fairway turf. Phytotoxicity ranked on 0 to 10 scale, 0 = no injury, > 3 was unacceptable, and 10 = dead turf. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
Dimension Ultra 2EW	0.0	0.0	0.0	0.0
Dimension 1 EC	0.0	0.0	0.0	0.0
Dimension Ultra WSP	0.0	0.0	0.0	0.0
Untreated control	0.0	0.0	0.0	0.0
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 7. Crabgrass control (%) in creeping bentgrass fairway turf using three Dimension formulations. Products were applied 26 April 2006, Madison, WI. Percent control was calculated by dividing the number of crabgrass plants in treated plots by those in the control plot for that replication, multiplying the dividend by 100, and subtracting the product by 100. Values followed by the same letter were not statistically different at $P \leq 0.05$.

Product	24 May	23 June†	26 July	21 August
Dimension Ultra 2EW	---‡	100.0 a§	76.4 a	85.7 ab
Dimension 1 EC	---	100.0 a	100.0 a	84.2 b
Dimension Ultra WSP	---	100.0 a	99.7 a	92.4 a
Untreated control	---	0.0 b	0.0 b	0.0 c

† Number of crabgrass plants per 30 ft^2 control plots averaged 44.2 in June, 79.0 in July, and 58.5 in August.

‡ Crabgrass was not visible in plots until the June rating.

§ Values followed by the same letter were not significantly different at $P \leq 0.05$.

Granular Dithiopyr Combinations for Pre-Emergent Crabgrass and Broadleaf Weed Control

Dr. John Stier, Associate Professor, and Mr. Eric Koeritz, Research Assistant
Department of Horticulture
University of Wisconsin-Madison

OBJECTIVES

1) Determine efficacy of granular dithiopyr with tank mixtures of isoxaben and experimental products on crabgrass (Digitaria spp.), white clover (Trifolium repens), and dandelion (Taraxacum officinale) in Kentucky bluegrass/perennial ryegrass turf maintained at lawn height.
2) Determine phytotoxicity and turf color effects of the same products/combinations for cool-season lawn turf.

MATERIALS AND METHODS

The field study was conducted at the O.J. Noer Turfgrass Research and Educational Facility in Madison, WI on a silt loam soil, pH approximately 7.8. The experimental design was a randomized complete block with four replications. Each experimental unit (individual plot) measured 3 x 7 ft (21 ft^2). An on-site weather station and data logger (Campbell Scientific) were used to record weather data which are available upon request.

The turf has been maintained as a low maintenance lawn turf composed of Kentucky bluegrass and perennial ryegrass since the area was converted from corn production 16 years ago. Mowing height is 2 inches with clippings returned. The area receives 1 lb N/1000 ft^2 each October using sulfur-coated urea (32-0-0).

In mid-April the turf was mowed at 1” height to “scalp” the turf then power raked to encourage crabgrass establishment. The site has had a history of crabgrass infestation. In addition, crabgrass was seeded at 1.1 lbs/1000 ft2 on 21 April using a drop spreader.

Liquid herbicide treatments were applied using a CO_2-powered backpack sprayer with XR TeeJet 8004 VS nozzles at 40 psi with 2 gal H_2O/1000 ft^2 as carrier (Table 1). Granular treatments were applied using a shaker jar. All treatments were applied 24 April and irrigated with ½ inch of water using an in-ground automated irrigation system. This was the only irrigation supplied to the site.

Crabgrass and broadleaf ratings were conducted on 23 May, 20 June, 25 July, and 21 August (4, 8, 12, and 16 WAT). Crabgrass and dandelion plants were counted in each plot. Clover infestation was estimated as percent ground cover. Percent control was calculated by dividing the number/percentage of plants/plant cover by the untreated control for each replication, multiplying the dividend by 100, and subtracting the product from 100. Color and phytotoxicity ratings were made on 28 April, 2 May, 10 May, 23 May, and 20 June 2006. Color was evaluated visually on a 1 to 9 scale (similar to ratings we conduct for the National Turfgrass Evaluation Program) with 1 = brown turf, 9 = dark green, and a minimum of 6 considered desirable for high quality (5 is considered acceptable for low to moderate quality/maintenance lawn turf). Phytotoxicity was evaluated on a 0 to 10 scale, with 0 = no injury, 10 = dead turf, and 3 or higher considered unacceptable damage.

RESULTS AND DISCUSSION

None of the treatments caused any significant phytotoxicity. Slight discoloration of treated turf occurred from all treatments but had completely disappeared by 23 May. Compared to the untreated control, turf color was significantly decreased by only two treatments on 28 April, L-0517 at 0.25% ai and L-0516 + L-0517 (0.25% ai each). Turf color was statistically similar to the untreated control plots at all other dates for all treatments.

Crabgrass emergence started in mid-June and continued through early July. Both large (*Digitaria sanguinalis*) and smooth crabgrass (*D. ischaemum*) were present. Data from the 20 June rating (8 WAT) did not provide a good analysis of treatment effects due to insufficient crabgrass emergence (control plots averaged only 1.5 plants per plot). Consequently, we collected an additional data set at 16 WAT (August 21) as crabgrass infestation had increased to an average of 44 to 95 plants per plot for the untreated and some treated plots by August. Data from July and August (12 and 16 WAT, respectively) showed excellent control (at or near 100%) with any treatment that contained dithiopyr. Treatments containing only Gallery (isoxaben) or oxyfluorfen had marginal efficacy on crabgrass control which was usually not statistically different from the untreated plots and certainly would not be considered acceptable control.

Clover pressure was good throughout the study: in untreated plots clover covered 10, 50, 70, and 70% in the four replicates by August. Clover was partially controlled by all treatments though none provided 90% or better control. The best treatment was the combination of L-0516+Gallery+L-0517 at 0.5 lb ai/A of each product, resulting in approximately 80-88% control. In all cases, clover control in May was not statistically different from the untreated plots. Control increased from May to June then either remained steady or shifted slightly during July to August.

Dandelion pressure was excellent in replicates 1, 2, and 3 (77, 166, and 114 plants per plot) but poor in the 4th replicate (18 plants per plot). On 2 May 2006 dandelions which were present in the plot before treatment applications were turning red in treated plots, especially those treated with oxyfluorfen, while no discoloration occurred in control plots. On 23 May the control plots had more young emerging dandelions than treated plots. Existing dandelions in control plots also looked healthier (green) than existing dandelions in treated plots (dandelions had more of a purplish brown color). In any case, dandelion control was never more than fair for any treatment, generally being between about 15 to 60% control. The L-0516+Gallery+L-0517 treatment controlled dandelions significantly better than the untreated control (about 65% control) in May and June but continued dandelion emergence coupled with recovery of some dandelions from herbicide damage eventually negated the effect, at least statistically, of all treatments compared to the untreated control by the final rating in August (16 WAT). Consequently, none of the treatments could be considered sufficiently effective for dandelion control in a home lawn situation as they were used in our study.

Table 1. Treatment list for dithiopyr combinations study.

Trt.	Product	Conc.	Rate	Timing
1	L-0516 (Dithiopyr)	.25 %ai w/w	.5 lb ai/A	Pre Crab
2	Gallery 75 DF	75 %ai w/w	.25 lb ai/A	Pre Crab
3	Gallery 75 DF	75 %ai w/w	.5 lb ai/A	Pre Crab
4	L-0517 (Oxyfluorfen)	.25 %ai w/w	.25 lb ai/A	Pre Crab
5	L-0517 (Oxyfluorfen)	.25 %ai w/w	.5 lb ai/A	Pre Crab
6	L-0516 (Dithiopyr)	.25 % ai w/w	.5 lb ai/A	Pre Crab
7	L-0516 (Dithiopyr)	.25 %ai w/w	.5 lb ai/A	Pre Crab
	L-0517 (Oxyfluorfen)	.25 %ai w/w	.25 lb ai/A	
8	L-0516 (Dithiopyr)	.25 %ai w/w	.5 lb ai/A	Pre Crab
	Gallery 75 DF	75 %ai w/w	.25 lb ai/A	
	L-0517 (Oxyfluorfen)	.25 %ai w/w	.25 lb ai/A	
9	L-0516 (Dithiopyr)	.25 %ai w/w	.5 lb ai/A	Pre Crab
	Gallery 75 DF	75 %ai w/w	.5 lb ai/A	
10	L-0516 (Dithiopyr)	.25 %ai w/w	.5 lb ai/A	Pre Crab
	L-0517 (Oxyfluorfen)	.25 %ai w/w	.5 lb ai/A	
11	L-0516 (Dithiopyr)	.25 %ai w/w	.5 lb ai/A	Pre Crab
	Gallery 75 DF	75 %ai w/w	.5 lb ai/A	
	L-0517 (Oxyfluorfen)	.25 %ai w/w	.5 lb ai/A	
12	Untreated control			Pre Crab

NORTH

3	8	4	1	12	9	2	7	11	6	5	10	Rep 1
2	3	9	11	7	4	5	8	6	1	10	12	Rep 2
10	8	4	7	2	1	9	12	11	6	5	3	Rep 3
1	2	3	4	5	6	7	8	9	10	11	12	Rep 4

Fig. 1. Plot diagram for granular dithiopyr combination evaluations at the O.J. Noer Turfgrass Research and Educational Facility, Madison, WI, 2006.

Table 2. Phytotoxicity of Dithiopyr, Gallery, and experimental products and combinations to Kentucky bluegrass/perennial ryegrass lawn turf when treated on 24 April, 2006 in Madison, WI, prior to crabgrass emergence. Phytotoxicity was rated on a 0 to 10 scale, 0= no injury, 10=dead turf, >3 unacceptable.

Product	Concentration	Rate	28 Apr	2 May	10 May	23 May	20 Jun
L-0516 (Dith.)	0.25% ai w/w	.5 lb ai/A	2.0	2.0	1.0	0.0	0.0
Gallery 75 DF	75% ai w/w	.25 lb ai/A	1.8	1.8	0.8	0.0	0.0
Gallery 75 DF	75% ai w/w	.5 lb ai/A	1.5	1.5	0.8	0.0	0.0
L-0517 (Oxyfl.)	.25% ai w/w	.25 lb ai/A	2.2	2.2	1.2	0.0	0.0
L-0517 (Oxyfl.)	.25% ai w/w	.5 lb ai/A	1.5	1.5	0.5	0.0	0.0
L-0516 (Dith.)	.25% ai w/w	.5 lb ai/A	0.5	0.5	0.0	0.0	0.0
L-0516 + L-0517	.25% + .25% ai w/w	.5 lb + .25 lb ai/A	1.8	1.8	0.2	0.0	0.0
L-0516 + Gallery + L-0517	.25% + 75% +.25% ai w/w	.5 lb + .25 lb + .25 lb ai/A	2.2	2.2	0.2	0.0	0.0
L-0516 + Gallery	.25% +75%	.5 lb ai/A + .5 lb ai/A	1.2	1.2	0.5	0.0	0.0
L-0516 +L-0517	.25% + .25%	.5 lb + .5 lb ai/A	1.8	1.8	0.5	0.2	0.0
L-0516+Gallery+L-0517	.25% + 75% + .25%	.5 lb + .5 lb + .5 lb ai/A	1.5	1.5	0.5	0.0	0.0
Untreated control	---	---	0.8	0.8	0.0	0.0	0.0
Tukey's HSD (0.05)			ns†	ns	ns	ns	ns

† Not statistically significant at P ≤ 0.05. In other columns, values followed by the same letter were not statistically different from each other.

Table 3. Color of Kentucky bluegrass/perennial ryegrass lawn turf following treatment with dithiopyr, Gallery, and experimental products and combinations on 24 April, 2006 in Madison, WI, prior to crabgrass emergence. Color was rated on a 1 to 9 scale, 1=brown turf and 9 = dark green; 6 = acceptable.

Product	Concentration	Rate	28 Apr	2 May	10 May	23 May	20 Jun
L-0516 (Dith.)	0.25% ai w/w	.5 lb ai/A	5.2 bc	5.5 ab	6.5 a	6.8 a	5.0 a
Gallery 75 DF	75% ai w/w	.25 lb ai/A	5.5 abc	5.8 ab	6.8 a	6.8 a	5.0 a
Gallery 75 DF	75% ai w/w	.5 lb ai/A	5.5 abc	5.8 ab	6.5 a	6.8 a	5.4 a
L-0517 (Oxyfl.)	.25% ai w/w	.25 lb ai/A	5.0 c	5.0 b	6.2 a	6.8 a	5.0 a
L-0517 (Oxyfl.)	.25% ai w/w	.5 lb ai/A	5.5 abc	5.2 b	6.8 a	7.0 a	5.2 a
L-0516 (Dith.)	.25% ai w/w	.5 lb ai/A	6.5 a	6.8 a	7.2 a	7.0 a	5.4 a
L-0516 + L-0517	.25% + .25% ai w/w	.5 lb + .25 lb ai/A	5.0 c	5.2 b	7.0 a	7.0 a	5.0 a
L-0516 + Gallery + L-0517	.25% ai w/w + 75% +.25%	.5 + .25 + .25 lb ai/A	5.2 bc	5.5 ab	6.5 a	6.8 a	5.1 a
L-0516 + Gallery	.25% +75%	.5 lb + .5 lb ai/A	5.2 bc	5.8 ab	6.8 a	6.8 a	5.1 a
L-0516 +L-0517	.25% + .25% ai w/w	.5 lb + .5 lb ai/A	5.5 abc	5.5 ab	6.8 a	7.0 a	5.4 a
L-516+Gallery +L-0517	.25% + 75% + .25% ai w/w	.5 lb + .5 lb + .5 lb ai/A	5.5 abc	5.5 ab	6.5 a	7.0 a	5.4 a
Untreated control	---	---	6.2 ab	6.2 ab	7.2 a	6.8 a	5.2 a
Tukey's HSD (0.05)			1.2	1.4	ns	ns	ns

† Not statistically significant at P ≤ 0.05. In other columns, values followed by the same letter were not statistically different from each other.

Table 3. Crabgrass (large and smooth) control (%) in Kentucky bluegrass/perennial ryegrass lawn height turf with combinations of Dithiopyr, Gallery, and experimental compounds applied 24 April, 2006, Madison, WI.

Product	Concentration	Rate	23 May†	20 June‡	25 July	21 Aug
L-0516 (Dith.)	0.25% ai w/w	.5 lb ai/A	---	50.0	100.0 a	97.0 a
Gallery 75 DF	75% ai w/w	.25 lb ai/A	---	8.3	8.2 bc	0.5 b
Gallery 75 DF	75% ai w/w	.5 lb ai/A	---	0.0	2.9 bc	0.0 b
L-0517 (Oxyfl.)	.25% ai w/w	.25 lb ai/A	---	25.0	13.1 bc	10.5 b
L-0517 (Oxyfl.)	.25% ai w/w	.5 lb ai/A	---	8.3	37.9 b	13.3 b
L-0516 (Dith.)	.25% ai w/w	.5 lb ai/A	---	50.0	95.8 a	94.9 a
L-0516 + L-0517	.25% + .25% ai w/w	.5 lb + .25 lb ai/A	---	50.0	100.0 a	98.5 a
L-0516 + Gallery + L-0517	.25% + 75% +.25% ai w/w	.5 lb + .25 lb + .25 lb ai/A	---	50.0	98.3 a	95.6 a
L-0516 + Gallery	.25% +75%	.5 lb ai/A + .5 lb ai/A	---	25.0	100.0 a	92.5 a
L-0516 +L-0517	.25% + .25%	.5 lb + .5 lb ai/A	---	50.0	100.0 a	94.6 a
L-0516+Gallery+L-0517	.25% + 75% + .25%	.5 lb + .5 lb + .5 lb ai/A	---	50.0	100.0 a	89.3 a
Untreated control	---	---	---	0.0	0.0 c	0.0 b
Tukey's HSD (0.05)			---	ns§	42.2	26.0

† No crabgrass plants had yet emerged.
‡ Crabgrass plants were just beginning to emerge, many plots still had little or no crabgrass.
§ Not statistically significant at $P \leq 0.05$. In other columns, values followed by the same letter were not statistically different from each other.

Table 4. Clover control (%) in Kentucky bluegrass/perennial ryegrass lawn height turf with combinations of Dithiopyr, Gallery, and experimental compounds applied 24 April, 2006, Madison, WI.

Product	Concentration	Rate	23 May	20 June	25 July	21 Aug
L-0516 (Dith.)	0.25% ai w/w	.5 lb ai/A	38.8	42.5 ab	55.4 ab	68.9 a
Gallery 75 DF	75% ai w/w	.25 lb ai/A	45.6	57.5 a	61.1 ab	56.4 a
Gallery 75 DF	75% ai w/w	.5 lb ai/A	20.6	54.2 a	55.8 ab	67.9 a
L-0517 (Oxyfl.)	.25% ai w/w	.25 lb ai/A	38.8	62.5 a	66.3 a	51.6 ab
L-0517 (Oxyfl.)	.25% ai w/w	.5 lb ai/A	48.5	77.1 a	84.6 a	69.7 a
L-0516 (Dith.)	.25% ai w/w	.5 lb ai/A	44.1	54.6 a	70.5 a	82.9 a
L-0516 + L-0517	.25% + .25% ai w/w	.5 lb + .25 lb ai/A	48.5	75.0 a	71.2 a	72.4 a
L-0516 + Gallery + L-0517	.25%+ 75% +.25% ai w/w	.5 lb + .25 lb + .25 lb ai/A	27.0	56.7 a	42.6 ab	66.2 a
L-0516 + Gallery	.25% +75%	.5 lb ai/A + .5 lb ai/A	25.0	70.8 a	55.7 ab	60.0 a
L-0516 +L-0517	.25% + .25%	.5 lb + .5 lb ai/A	27.0	85.0 a	75.1 a	69.7 a
L-0516+Gallery+L-0517	.25% + 75% + .25%	.5 lb + .5 lb + .5 lb ai/A	42.6	70.0 a	87.8 a	83.4 a
Untreated control	---	---	0.0	0.0 b	0.0 b b	0.0 b
Tukey's HSD (0.05)			ns†	49.3	65.7	52.8

† Not statistically significant at P ≤ 0.05. In other columns, values followed by the same letter were not statistically different from each other.

Table 5. Dandelion control (%) in Kentucky bluegrass/perennial ryegrass lawn height turf with combinations of Dithiopyr, Gallery, and experimental compounds applied 24 April, 2006, Madison, WI.

Product	Concentration	Rate	23 May	20 June	25 July	21 Aug
L-0516 (Dith.)	0.25% ai w/w	.5 lb ai/A	23.2 abc	37.8 ab	7.2 ab	13.4
Gallery 75 DF	75% ai w/w	.25 lb ai/A	22.9 abc	27.3 ab	9.9 ab	13.4
Gallery 75 DF	75% ai w/w	.5 lb ai/A	11.7 abc	35.3 ab	10.6 ab	13.4
L-0517 (Oxyfl.)	.25% ai w/w	.25 lb ai/A	34.5 abc	34.6 ab	9.0 ab	11.0
L-0517 (Oxyfl.)	.25% ai w/w	.5 lb ai/A	49.2 ab	53.3 a	31.4 ab	16.1
L-0516 (Dith.)	.25% ai w/w	.5 lb ai/A	48.8 ab	60.2 a	37.3 ab	33.6
L-0516 + L-0517	.25% + .25% ai w/w	.5 lb + .25 lb ai/A	34.9 abc	50.7 a	19.0 ab	16.4
L-0516 + Gallery + L-0517	.25%+ 75% +.25% ai w/w	.5 lb + .25 lb + .25 lb ai/A	34.5 abc	52.0 a	46.2 a	18.4
L-0516 + Gallery	.25% +75%	.5 lb ai/A + .5 lb ai/A	27.7 abc	46.5 a	21.8 ab	20.5
L-0516 +L-0517	.25% + .25%	.5 lb + .5 lb ai/A	40.3 abc	45.8 a	27.9 ab	20.5
L-0516+Gallery+L-0517	.25% + 75% + .25%	.5 lb + .5 lb + .5 lb ai/A	63.5 a	66.5 a	39.2 ab	33.7
Untreated control	---	---	0.0 c	0.0 b	0.0 b	0.0
Tukey's HSD (0.05)			41.1	44.8	45.0	ns†

† Not statistically significant at $P \leq 0.05$. In other columns, values followed by the same letter were not statistically different from each other.

Evaluation of *Poa Annua* Control with Velocity Herbicide

Eric Koeritz and Dr. John Stier
Department of Horticulture

OBJECTIVE

The objective of this study is to evaluate multiple applications of Velocity herbicide (bispyribac-sodium) for control of annual bluegrass on bentgrass fairways.

MATERIALS AND METHODS

The study took place at the O.J. Noer Turfgrass Research and Education Facility in Verona, Wisconsin on a mixed stand of creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass (*Poa annua*). The soil type was a silt loam. Established about 1997, the turf has been mown at ½" three times per week, receives 3 lbs N/M/year and is not treated with additional fungicide. Irrigation was applied to prevent drought stress. Six treatments were arranged in a randomized complete block design with four replications. Treatments were applied beginning on 8 June, 2006 with a CO_2 –powered backpack sprayer, using XR TeeJet 8004 VS nozzles, at 38 PSI, in water carrier to provide 1.5 gallons spray volume/1000 square feet. Bentgrass tolerance, percent *Poa annua* control, and dollar spot control were evaluated at approximately 3, 7, 14, 21, 28, 42, and 56 days after initial treatments began. In addition bentgrass quality was rated multiple times throughout the growing season on a scale from 1-9, where 1=dead turf, 9=best quality turf, and 6=acceptable turf quality. Percent *Poa annua* control was determined by visually rating the percentage of living *Poa annua* in the plot on a given rating date then using the number in the following equation: 100*[1-(%poa on rating date/initial %poa)]. Bentgrass tolerance was rated on a scale from 1-9, where 1=no injury, 9=dead turf, and 3 or greater = unacceptable injury. Dollar spot control was determined by counting the number of dollar spots on a given plot and comparing to the control plot in the same replication using the following equation: 100*[1-(# spots on trt. X / #spots on control plot)]. Soil (2" depth) and air temperatures were recorded at each application date.

Table 1. Treatment list for Evaluation of *Poa annua* Control with Velocity Herbicide trial at the O.J. Noer Turfgrass Research and Education Facility in Verona, WI, 2006.

Trt. #	Product	Rate/Application	Timing	Total Rate
1	Velocity 17.6 SG	10 g ai/A	6 apps 2 day interval	60 g ai/A
2	Velocity 17.6 SG	10 g ai/A	6 apps 7 day interval	60 g ai/A
3	Velocity 17.6 SG	30 g ai/A	2 apps 2 day interval	60 g ai/A
4	Velocity 17.6 SG	30 g ai/A	2 apps 7 day interval	60 g ai/A
5	Velocity 17.6 SG	30 g ai/A	2 apps 14 day interval	60 g ai/A
6	Untreated Control			

Table 2. Treatment application log, Verona, WI, 2006.

Date	Treatment	Soil Temperature (˚C)	Air Temperature (˚C)
8 June	1-6, Initial Application	26.3	29.6
10 June	1 and 3	20.5	20.6
12 June	1	20.1	24.0
14 June	1	-	-
15 June	2 and 4	20.6	-
16 June	1	24.4	30.4
19 June	1	25.2	25.8
23 June	2 and 5	23.1	23.8
29 June	2	20.7	31.1
5 July	2	26.2	27.1
11 July	2	-	-

RESULTS AND DISCUSSION

Percent *Poa annua* control for each treatment is presented in Table 3. In this study all of the treatments received the same overall rate of Velocity, however, treatments were split into two or six applications at various timings (Table 1 and 2). Air temperatures ranged from ideal (20.6 C = 69 F) to supraoptimal (30 C = 86 F) for turf growth during the treatment period (Table 2). Some research suggests that *P. annua* control may be improved when Velocity is applied at slightly above optimal temperatures because *P. annua* is less heat-tolerant than creeping bentgrass and control will therefore be improved. While temperature at time of application is important to maximize product absorption, the effect of temperatures in the days following application are unknown. Soil temperatures were above the optimum for cool-season turf growth during the treatment period (ideally 10-18 C = 50-60 F). By eight days after the initial treatment (DAIT) all treatments were providing some control of *P. annua*. At 14 DAIT treatments 3 and 4, which were 2 applications on a 2 and 7 day interval respectively, were providing over 20% *Poa annua* control which was greater than all other treatments. At around 21 DAIT, treatment 1, which consisted of 6 applications on a two day interval, had caught up to treatments 3 and 4 in terms of *Poa annua* control. On 11 July (42 DAIT), the last of the treatment applications had been made and treatments 1 and 5 were showing the greatest *Poa annua* control. The rating taken on 26 July showed that all Velocity treatments were providing statistically equal control of *Poa annua* and all treatments were significantly better than the control. Control of *Poa annua* in treatment 6 (the untreated control) was due to severe dollar spot infection. The *Poa annua* control ratings between 26 July and 9 September were probably the most meaningful because at this point all treatments had been made and had been given time to take effect. Ultimately, multiple applications of 10 g ai/A at 2 and 7 day intervals and two applications of 30 g ai/A at 14 day intervals gave the best control, approximately 80%. *P. annua* populations partially recovered later in the summer when 30 g ai/A treatments were made at 2 and 7 day intervals. The multiple lower rates probably gave better control than higher rates with fewer applications because the higher rates killed more of the leaf tissue quickly, probably reducing the total amount of product to enter the plant over the course of the study. The 30 g ai/A rate was most successful when applied at a 14 day intervals, likely because new leaf growth occurred during the interval which was able to absorb more of the product at the second application. The overall control of P. annua

(80%) was similar to our previous work and mirrors what many other tests have found. We need to determine if the remaining 20% of the P. annua population is resistant to the bispyribac-sodium or if these merely represent “escapes” which received insufficient chemical because they were growing under an existing turf canopy, had large enough crowns that effectively diluted the chemical and allowed some buds to survive, or represent newly germinated seedlings. Another aspect which deserves more attention is information on the conversion process from a mixed *Poa*/bent stand using Velocity: information is needed to show how interseeding or cultivation may be used in conjunction with Velocity to encourage bentgrass competition over *P. annua*.

Table 4 and Figure 1 show data regarding dollar spot control as a result of Velocity application at various timings and application rates. Beginning June 23, dollar spot pressure was uniform enough to detect differences in terms of dollar spot control between the treatments. All treatments provided some dollar spot control, ranging from approximately 60 to 90%. There may be an interaction between application rate, frequency, and dollar spot pressure though our test was not designed to provide this information. Dollar spot control decreased within 3-4 weeks after the final application when disease pressure was moderate (June and July). Dollar spot control decreased within one week after the final application of 10 g ai/A (Trt 2) when dollar spot pressure became severe in August (Table 4). Treatment 2, 10 g ai/A applied at 7 day intervals for a 42 day period, provided excellent control (>90%) beginning two to three weeks after the initial treatment and which lasted until 8 August, about 1 week after the final treatment. These data suggest that 10 g ai/A of bispyribac-sodium may substitute for conventional dollar spot fungicides, though control may need to be supplemented with fungicides early in the season if dollar spot pressure is severe. Given the public pressure to reduce pesticide use, information on dollar spot management with reduced fungicide input during a Velocity-treatment program would be beneficial to golf course superintendents.

Bentgrass tolerance data are presented in Table 5. A rating of 3 or above was given if there was unacceptable phytotoxicity to the creeping bentgrass present in a given treatment. All Velocity treatments received a mean rating of 3 or above on at least one rating date with the exception of treatment 2. The highest mean rating given to treatment 2 was a rating of 2.5 which is still acceptable. The worst phytotoxicity was seen on treatments 1 and 3 around 7 DAIT. Information is needed on the nature and causes of phytotoxicity to bentgrass, particularly since injury did not occur after June 29 though Trt 2 still received two additional treatments of 10 g ai/A.

Bentgrass quality ratings were taken to help determine the best timing of application. In July and August treatment 2 provided the best turf quality out of the 6 treatments. The increased quality in treatment 2 was largely due to the control of dollar spot.

CONCLUSION

The objective of this study was to evaluate multiple applications of Velocity for control of annual bluegrass on bentgrass fairways. Treatment 2, which was 6 applications of 10 g ai/A on a 7 day interval, provided the best overall *Poa annua* control with minimal bentgrass injury and the longest-term dollar spot control. Treatment 1 also performed well suggesting that splitting the total rate up into 6 applications at low rates provides better control of *Poa annua* than making

2 applications at higher rates. Treatment 5, which was 2 applications of 30 g ai/A on a 14 day interval also provided good control of *Poa annua* showing that making the applications of the high rate at longer intervals improves efficacy.

Table 3. Percent *Poa annua* control, Verona, WI, 2006.

Treatment	Jun 11	Jun 16	Jun 23	Jun 29	Jul 11	Jul 26	Aug 8	Sep 9
1	0	3.8	8.8 b	52.5 a	89.3a	86.3 a	90.3 a	77.1 ab
2	0	17.7	3.1 b	11.5 b	50.4 b	77.9 a	94.6 a	87.3 a
3	0	15.8	23.3 a	44.2 a	57.5 b	68.3 a	72.5 bc	58.3 b
4	0	10.8	20.0 a	37.1 a	65.4 b	61.3 a	67.9 c	56.7 bc
5	0	17.3	4.2 b	7.3 b	67.1 ab	67.1 a	83.4 ab	79.4 ab
6	0	0.0	0.0 b	0.0 b	0.0 c	21.9 b	42.7 d	32.3 c
LSD (0.05)	ns	ns	10.1	20.7	23.8	25.9	13.8	24.4

Percent *P. annua* control is presented here as the percentage of the initial *P. annua* in each treatment that was controlled by the treatment application. Means followed by the same on letter within columns are not significantly different at $P \leq 0.05$. Green shading emphasizes the best treatments for *P. annua* control.

Table 4. Percent dollar spot control, Verona, WI, 2006.

Treatment	Jun 11	Jun 16	Jun 23	Jun 29	Jul 11	Jul 26	Aug 8	Ave 6/23-7/26
1	33.3 a	42.6 a	87.1 a	97.0 a	96.4 a	53.4 ab	0	83.5 ab
2	30.0 a	51.7 a	76.2 ab	92.0 a	99.1 a	93.8 a	30.0	90.2 a
3	29.9 a	34.5 a	88.4 a	89.2 a	35.7 a	27.5 bc	20.0	60.2 b
4	4.9 a	44.5 a	57.6 b	99.2 a	59.9 a	32.1 bc	0	62.2 b
5	24.7 a	33.8 a	65.0 ab	68.2 a	93.6 a	58.9 ab	0	71.4 ab
6	0.0 a	0.0 a	0.0 c	0.0 b	0.0 b	0.0 c	0	0.0 c
LSD (0.05)	ns	ns	27.5	32.4	30.2	41.1	ns	23.8

Percent dollar spot control is presented her as percent control in comparison to the level of disease pressure present in the control plot of each replication. Means followed by the same on letter within columns are not significantly different at $P \leq 0.05$. Green shading emphasizes the best treatment for dollar spot control.

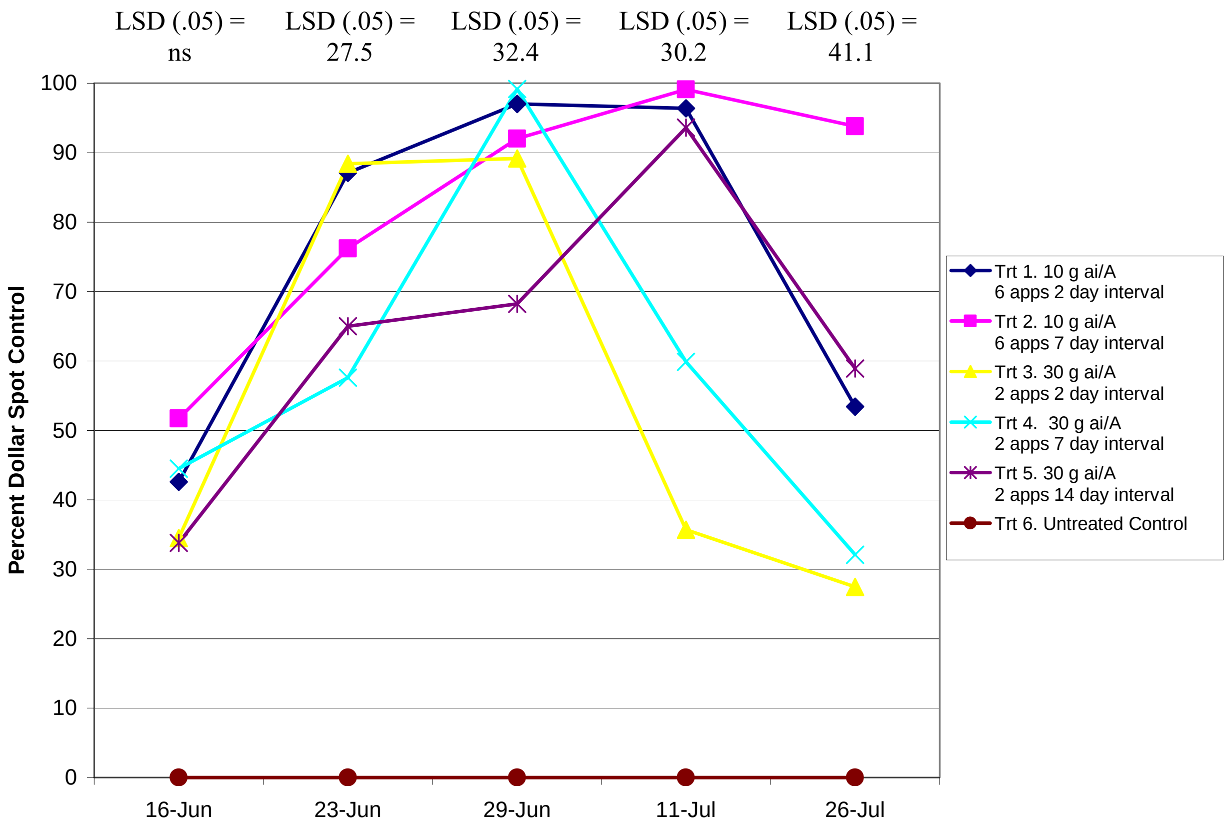

Figure 2. Dollar spot control between 16 June and 26 July, Verona, WI, 2006. (Scale: 0-100%).

Table 5. Phytotoxicity of Velocity herbicide to bentgrass fairway turf, Verona, WI, 2006.

Treatment	Jun 11	Jun 16	Jun 23	Jun 29	Jul 5	Jul 11	Jul 26	Aug 8
1	1.5 a	4.0 a	4.0 a	2.3 a	1.0 b	1.0	1.0	1.0
2	1.5 a	2.5 b	1.0 c	1.5 b	1.5 a	1.0	1.0	1.0
3	2.3 a	3.8 a	1.5 c	1.3 b	1.0 b	1.0	1.0	1.0
4	1.5 a	3.0 ab	2.3 b	1.3 b	1.0 b	1.0	1.0	1.0
5	1.8 a	3.0 ab	1.0 c	2.8 a	1.0 b	1.0	1.0	1.0
6	1.3 a	1.0 c	1.0 c	1.0 b	1.0 b	1.0	1.0	1.0
LSD (0.05)	ns	1.1	0.7	0.6	0.4	ns	ns	ns

Means followed by the same on letter within columns are not significantly different at $P \leq 0.05$. (Scale: 1-9, 1 = no phytotoxicity, 9 = totally dead, 3 = unacceptable.)

Table 6. Quality of creeping bentgrass fairway turf treated with Velocity herbicide, Verona, WI, 2006.

Treatment	July 5	July 26	Aug 8	Sep 9
1	6.9 a	5.5 b	4.9 bc	6.5 a
2	7.0 a	6.5 a	5.9 a	6.4 a
3	6.1 b	5.3 bc	5.3 b	6.3 a
4	7.0 a	4.8 c	4.6 c	6.3 a
5	7.0 a	5.3 bc	5.0 bc	6.4 a
6	5.9 b	4.9 bc	4.9 bc	6.5 a
LSD (0.05)	0.4	0.7	0.6	ns

Means followed by the same on letter within columns are not significantly different at $P \leq 0.05$. (Scale: 1-9, 1 = dead turf, 9 = perfect turf quality, 6 = acceptable turf quality)

Evaluation of High Rates of Mesotrione for Turf Safety

Dr. John Stier and Mr. Eric Koeritz
Department of Horticulture
University of Wisconsin-Madison

OBJECTIVES

The objectives of this study were 1) determine relative turf safety of mesotrione granular treatments for cool-season lawns and 2) determine relative turf safety of mesotrione rates in granular form (Table 1).

MATERIALS AND METHODS

This study was conducted at the O.J. Noer Turfgrass Research Center in Verona, WI during the spring of 2006. The soil type was a silt loam, pH approximately 7.5. The turf was a mixed stand of Kentucky bluegrass and perennial ryegrass maintained at a 2.25" mowing height with clippings returned. The study was mowed two times weekly and irrigated one time per week at 100% of the estimated evapotranspiration rate. Individual plots measured 6 x13 feet and were arranged in a randomized complete block design with four replications. Each replication was watered using a hand-held hose prior to treatment application to simulate the presence of dew. All treatments were initiated on 23 May 2006 at 10:00 a.m. Treatments were applied using hand-held shaker jars making two passes over in two directions. The study area had been fertilized on 20 April 2006 with a 25-2-4 fertilizer at a rate of 1 lb N/1000 square feet but did not receive any additional fertilizer during the course of the study.

Phytotoxicity and color ratings were taken at 7, 14, 21, 28 and 42 days after treatment. Turf color was evaluated visually on a 1 to 9 scale (similar to ratings we conduct for the National Turfgrass Evaluation Program) with 1 = brown turf, 9 = dark green, and a minimum of 6 considered desirable for high quality (5 is considered acceptable for low to moderate quality/maintenance lawn turf). Percent turf bleaching, the percentage of the plot area that had turned white, was also rated as a measure of phytotoxicity to turf at 7, 14, 21, 28, and 42 days after treatment. Dandelion counts were made at 28 days after treatment.

Table 1. Treatment list and rates for mesotrione safety evaluation, Verona, WI 2006.

Trt #	Trt Name	Rate (g ai/ha)	Product Rate (lb product/acre)
1	EXC851 0.12 GR (29-3-4)	168.0	125
2	EXC853 0.20 GR (29-3-4)	280.0	125
3	EXC854 0.40 GR (29-3-4)	560.0	125
4	EXC855 0.60 GR (29-3-4)	840.0	125
5	EXC856 0.60 GR (29-3-4)*	840.0	125
6	EXC876 0.087 GR	175.0	173
7	EXC878 0.144 GR	271.0	173
8	EXC879 0.289 GR	560.0	173
9	EXC880 0.433 GR	830.0	173

10	EXC881 0.433 GR**	830.0	173
11	Untreated Control		

*Treatment contains mesotrione + prodiamine (33.33 + 66.67%)
** Treatment contains mesotrione + prodiamine (32.56 + 67.44%)

RESULTS AND DISCUSSION

Three treatments (# 3, 4, and 9) caused moderate phytotoxicity beginning 1 week after treatment (WAT) on 30 May, 6 June, and 13 June 2006 (Table 2). All treatments causing phytotoxicity were at the higher rate of 560 or 840 g ai/ha. Phytotoxicity appeared as bleached turf combined with some slight stunting of vertical growth. Treatment 4, which was EXC855 0.60 GR (29-3-4) at 840.0 g ai/ha, caused the most phytotoxicity through the June 13 rating date (Table 2). Phytotoxicity from treatment 4 was considered to be at unacceptable levels on 30 May and 6 June. By 13 June the phytotoxicity from treatment 4 had diminished to acceptable levels as new, unaffected turf growth appeared and older, damaged leaves senesced and were removed or masked by new growth. Treatments 3 and 9 also caused some phytotoxicity but damage was less than that from treatment 4 and was considered acceptable. Treatments 5 and 10, which contained prodiamine along with mesotrione, caused little to no phytotoxicity despite the high rate of active ingredient applied per hectare.

Percent bleaching of the turf stand was rated as another measure of phytotoxicity (Table 3). Treatments 3 and 4 caused bleaching on 30 May and 6 June. Treatment 4 caused significantly more bleaching (47.5% and 30.0%) than treatment 3 (17.5% and 4.8%) on both rating dates. The damage was temporary, though, and new growth had full green color. Digital photographs showing whole plots as well as individual plants were taken and will be sent separate from this report.

Turf color was slightly enhanced by most treatments when rated on 6 June and 13 June (Tables 4, 5). While all treatments exhibited good turf color, treatments 1 through 5 and 10 were significantly darker than the control 2 WAT on 6 June 2006. On 13 June only treatments 1 through 3 and 5 were still significantly darker than the control. The nitrogen fertilizer used as a carrier in treatments 1-5 likely cause the darker green color seen on the two rating dates.

Although not required, dandelions were counted on 20 June 2006. All mesotrione treatments had significantly fewer dandelions than the control and results were statistically equivalent to each other (Table 6).

Twenty-four to 48 hours of “dry time” were requested after treatment application. On the 24th May, 20 hours after application, the O.J. Noer Turf Research Center received .15 inches of rainfall. That afternoon, .approximatley 29 hours after application, 0.3 inches of water were applied through the irrigation system and later that evening another .42 inches of rain fell.

CONCLUSION

In general phytotoxicity issues were minimal. Treatment 4 was the only one that resulted in obviously unacceptable damage, albeit short-term. In reality, from a home-consumer/professional lawn care perspective, treatments 3 and 9 might also be considered unacceptable as slight turf bleaching did occur, though again it was temporary. Treatments 8 and 10 stand out as providing the best dandelion control without any phytotoxicity, while treatment 10 maintained as good or better turf color than any other treatment or the control.

Table 2. Phytotoxicity on Kentucky bluegrass and perennial ryegrass turf, Verona, WI, 2006.

Trt #	**Trt Name**	**Rate (g ai/ha)**	**5/30**	**6/6**	**6/13**	**6/20**	**7/6**
1	EXC851 0.12 GR (29-3-4)	168.0	1.0 d	1.0 c	1.0 b	1.0 a	1.0 a
2	EXC853 0.20 GR (29-3-4)	280.0	1.1 d	1.0 c	1.0 b	1.0 a	1.0 a
3	EXC854 0.40 GR (29-3-4)	560.0	2.5 b	1.6 b	1.0 b	1.0 a	1.0 a
4	EXC855 0.60 GR (29-3-4)	840.0	3.0 a	3.4 a	1.5 a	1.0 a	1.0 a
5	EXC856 0.60 GR (29-3-4)*	840.0	1.1 d	1.0 c	1.0 b	1.0 a	1.0 a
6	EXC876 0.087 GR	175.0	1.0 d	1.0 c	1.0 b	1.0 a	1.0 a
7	EXC878 0.144 GR	271.0	1.0 d	1.0 c	1.0 b	1.0 a	1.0 a
8	EXC879 0.289 GR	560.0	1.0 d	1.0 c	1.0 b	1.0 a	1.0 a
9	EXC880 0.433 GR	830.0	1.5 c	1.5 b	1.0 b	1.0 a	1.0 a
10	EXC881 0.433 GR**	830.0	1.0 d	1.0 c	1.0 b	1.0 a	1.0 a
11	Untreated Control	0.0	1.0 d	1.0 c	1.0 b	1.0 a	1.0 a
	LSD (0.05)		0.4	0.4	0.25	ns	ns

Phytotoxicity was rated on a scale from 1-9 where 1=no injury, 9=totally dead, and 3=unacceptable.
Means followed by the same on letter within columns are not significantly different at P ≤ 0.05.
*Treatment contains mesotrione + prodiamine (33.33 + 66.67%)
** Treatment contains mesotrione + prodiamine (32.56 + 67.44%)

Table 3. Percent bleaching of Kentucky bluegrass and perennial ryegrass turf following mesotrione application, Verona, WI, 2006.

Trt #	**Trt Name**	**Rate (g ai/ha)**	**5/30**	**6/6**	**6/13**	**6/20**	**7/6**
1	EXC851 0.12 GR (29-3-4)	168.0	0.0 c	0.3 c	0.0 a	0.0 a	0.0 a
2	EXC853 0.20 GR (29-3-4)	280.0	0.5 c	0.0 c	0.0 a	0.0 a	0.0 a
3	EXC854 0.40 GR (29-3-4)	560.0	17.5 b	4.8 b	0.0 a	0.0 a	0.0 a
4	EXC855 0.60 GR (29-3-4)	840.0	47.5 a	30.0 a	6.3 a	0.0 a	0.0 a
5	EXC856 0.60 GR (29-3-4)*	840.0	1.0 c	0.0 c	0.0 a	0.0 a	0.0 a
6	EXC876 0.087 GR	175.0	0.0 c	0.0 c	0.0 a	0.0 a	0.0 a
7	EXC878 0.144 GR	271.0	0.0 c	0.0 c	0.0 a	0.0 a	0.0 a
8	EXC879 0.289 GR	560.0	0.0 c	0.0 c	0.0 a	0.0 a	0.0 a
9	EXC880 0.433 GR	830.0	0.5 c	1.5 c	0.0 a	0.0 a	0.0 a
10	EXC881 0.433 GR**	830.0	0.0 c	0.0 c	0.0 a	0.0 a	0.0 a
11	Untreated Control	0.0	0.0 c	0.0 c	0.0 a	0.0 a	0.0 a
	LSD (0.05)		8.0	3.2	ns	ns	ns

Turf bleaching was rated on a scale from 0-100% where 0=no visible bleached turf and 100=all plants are bleached.
Means followed by the same on letter within columns are not significantly different at P ≤ 0.05.

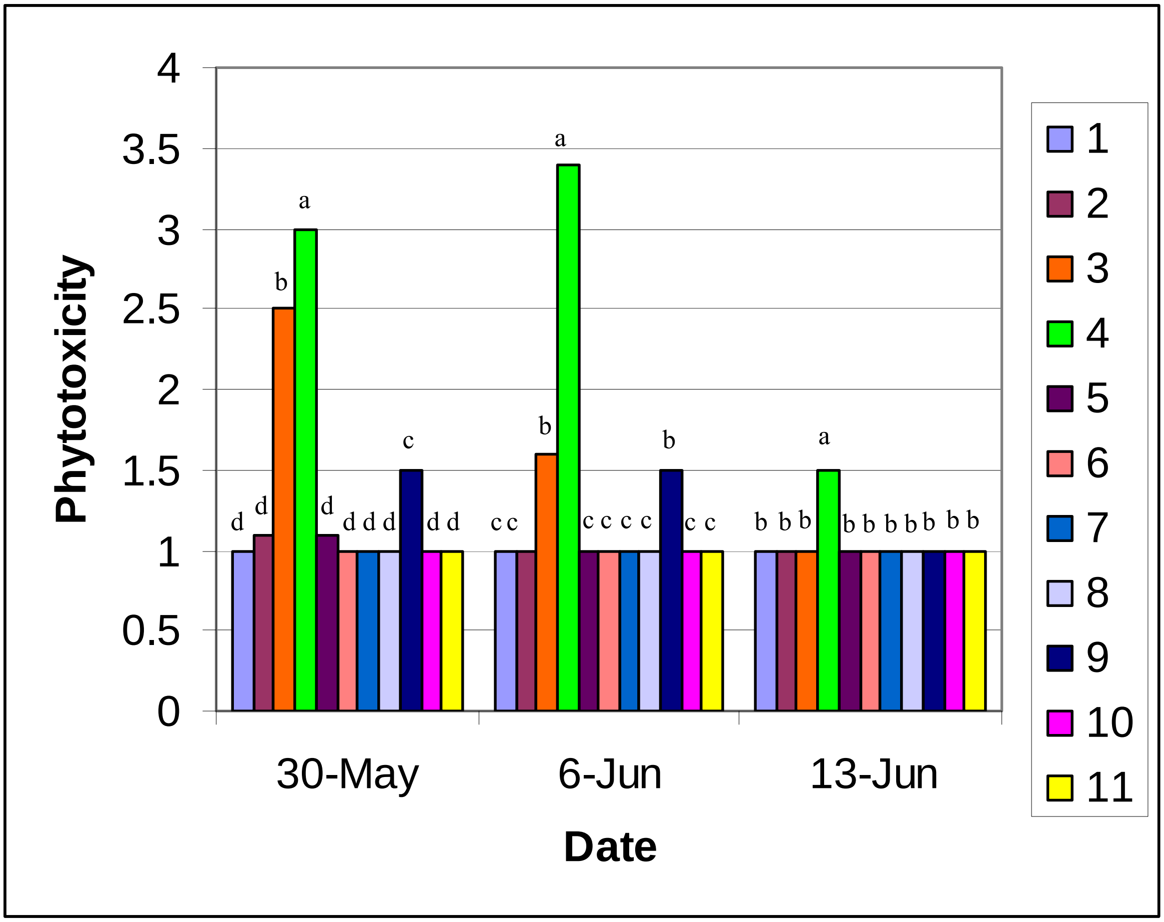

Figure 1. Phytotoxicity on Kentucky bluegrass and perennial ryegrass turf following mesotrione application. Rating scale = 1-9, 1 = no phyto, 9=totally dead, 3 = unacceptable. Bars with the same letter are statistically the same within a rating date. Verona, WI, 2006.

*Treatment contains mesotrione + prodiamine (33.33 + 66.67%)
** Treatment contains mesotrione + prodiamine (32.56 + 67.44%)

Table 4. Analysis of variance for turf color following mesotrione application, Verona, WI, 2006..

Source	May 30	June 6	June 13	June 20	July 6
Rep	ns	ns	**	ns	**
Treatment	ns	**	*	ns	ns

* Significant at $P \leq 0.05$, ** significant at $P \leq 0.01$.

Table 5. Green color of Kentucky bluegrass and perennial ryegrass turf following mesotrione application, Verona, WI, 2006.

Trt #	Trt Name	Rate (g ai/ha)	5/30	6/6	6/13	6/20	7/6
1	EXC851 0.12 GR (29-3-4)	168.0	7.8 a	8.0 a	7.5 ab	7.0 a	6.8 a
2	EXC853 0.20 GR (29-3-4)	280.0	7.8 a	8.0 a	7.8 a	7.0 a	6.8 a
3	EXC854 0.40 GR (29-3-4)	560.0	8.0 a	8.0 a	7.8 a	7.0 a	6.8 a
4	EXC855 0.60 GR (29-3-4)	840.0	8.0 a	8.0 a	7.0 abc	7.3 a	6.8 a
5	EXC856 0.60 GR (29-3-4)*	840.0	7.8 a	8.0 a	7.5 ab	7.0 a	6.8 a
6	EXC876 0.087 GR	175.0	7.5 a	7.5 ab	6.5 c	7.0 a	6.6 a
7	EXC878 0.144 GR	271.0	7.8 a	7.5 ab	6.8 bc	7.0 a	6.8 a
8	EXC879 0.289 GR	560.0	7.3 a	7.3 b	6.5 c	7.0 a	6.8 a
9	EXC880 0.433 GR	830.0	7.5 a	7.8 ab	6.8 bc	7.3 a	6.8 a
10	EXC881 0.433 GR**	830.0	7.8 a	8.0 a	7.0 abc	7.3 a	6.8 a
11	Untreated Control	0.0	7.0 a	7.3 b	6.6 c	7.3 a	6.8 a
	LSD (0.05)		ns	0.5	0.9	ns	ns

Turf color was rated on a scale from 1-9 where 1=brown turf, 9=optimum dark green, and 6=acceptable turf color.
Means followed by the same on letter within columns are not significantly different at P ≤ 0.05.

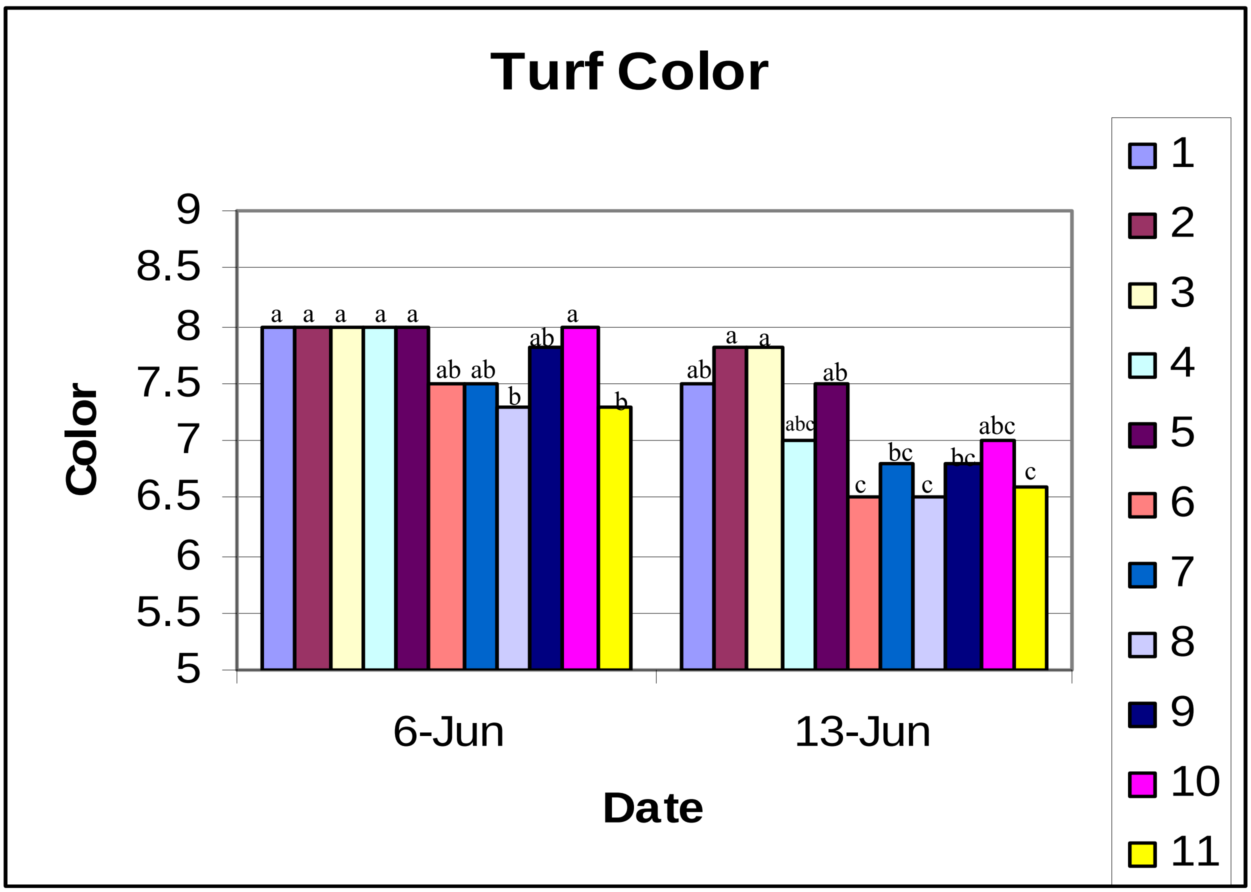

Figure 2. Turf color following application of mesotrione treatments. Color is rated on a scale from 1-9, 1 = brown, 9 = optimum dark green, 6 = acceptable turf color. Bars labeled with the same letter are statistically the same within rating dates.

Table 6. Number of dandelions present following application of mesotrione to Kentucky bluegrass and perennial ryegrass turf, Verona, WI, 2006.

Trt #	Trt Name	Rate (g ai/ha)	June20
1	EXC851 0.12 GR (29-3-4)	168.0	3.3 b
2	EXC853 0.20 GR (29-3-4)	280.0	3.3 b
3	EXC854 0.40 GR (29-3-4)	560.0	0.5 b
4	EXC855 0.60 GR (29-3-4)	840.0	0.0 b
5	EXC856 0.60 GR (29-3-4)*	840.0	1.5 b
6	EXC876 0.087 GR	175.0	1.8 b
7	EXC878 0.144 GR	271.0	1.5 b
8	EXC879 0.289 GR	560.0	0.5 b
9	EXC880 0.433 GR	830.0	0.8 b
10	EXC881 0.433 GR**	830.0	0.5 b
11	Untreated Control	0.0	14.0 a
	LSD (0.05)		6.2

Means followed by the same on letter within columns are not significantly different at $P \leq 0.05$.

Pre-emergent Crabgrass Control with Pendulum®

Dr. John Stier, Associate Professor, and Mr. Eric Koeritz, Research Assistant
Department of Horticulture
University of Wisconsin-Madison

OBJECTIVE

The purpose of the study was to evaluate the level of crabgrass control with several Pendulum® formulations and to determine if single or split applications are most effective. Pendulum® was also compared to other pre-emergence products.

MATERIALS AND METHODS

Field trials were conducted at the O.J. Noer Turfgrass Research and Educational Facility, Madison, WI, in both lawn and fairway height turf, though only a lawn turf study was requested. The soil type was a silt loam soil, pH approximately 7.8. The experimental design was a randomized complete block with four replications. Each experimental unit (individual plot) measured 3 x 5 ft (15 ft^2) in the lawn site and 3 x 10 ft (30 ft^2) in the fairway site. An on-site weather station and data logger (Campbell Scientific) were used to record weather data which are available upon request.

The turf has been maintained as a low maintenance lawn composed of Kentucky bluegrass and perennial ryegrass since the area was converted from corn production 16 years ago. Mowing height is 2 inches once weekly with clippings returned. The area receives 1 lb N/1000 ft^2 each October using sulfur-coated urea (32-0-0) but no routine irrigation. The fairway area consists of Kentucky bluegrass seeded six years ago into which creeping bentgrass has integrated along with a small amount of fine fescue. The turf is mowed three days weekly at 0.5 inch height with clippings returned. The plot normally receives two annual fertilizer applications, 1 lb N/1000 ft^2 in spring and fall though only 1/2 lb N/1000 ft^2 from Milorganie (6-2-0) was applied in spring 2006. No irrigation was used this year other than to water in the treatments. There was sufficient rainfall this year to maintain good turf health without supplemental irrigation.

In mid-April the lawn turf was mowed at 1" height to "scalp" the turf. Both turf sites were then power raked to encourage crabgrass establishment. Though both sites have had a history of crabgrass infestation, additional crabgrass was seeded at 1.1 lbs/1000 ft^2 on 22 April using a drop spreader. Milorganite was used as a carrier for the seed and was applied at a rate of .5 lbs N/1000 ft^2.

Liquid herbicide treatments were applied using a CO_2-powered backpack sprayer with XR TeeJet 8004 VS nozzles at 40 psi with 2.6 gal H_2O/1000 ft^2 as carrier (Table 1). All treatments were applied 26 April and irrigated with ½ inch of water using an in-ground automated irrigation system. This was the only irrigation supplied to the sites.

Crabgrass plants were counted in each plot to determine treatment efficacy. Counts were made at 4, 8, 12, and 16 weeks after initial treatment (WAIT). Percent control was calculated by dividing the number of crabgrass plants by those in the untreated control for each replication, multiplying the dividend by 100, and subtracting the product from 100. Color and phytotoxicity ratings were collected 3, 7, 14, and 28 DAIT. Color was evaluated visually on a 1 to 9 scale (similar to ratings we conduct for the National Turfgrass Evaluation Program) with 1 = brown turf, 9 = dark green, and a minimum of 6 considered desirable for high quality (5 is considered acceptable for low to moderate quality/maintenance lawn turf). Phytotoxicity to lawn turf was noted as failure to greenup while phytotoxicity to fairway turf was noted as brown color and rated on a scale of 0 to 10, with 0 = no damage and 10 = dead turf; a rating of 3 or greater was considered to be unacceptable.

Table 1. Treatment names and application rates for lawn height and fairway trial.

Trt. #	Trt. Name	Formulation	Rate	Timing
1	Dimension Ultra	2 EW	0.5 lb ai/A	Pre
2	Dimension	1 EC	0.5 lb ai/A	Pre
3	Dimension Ultra	40 WP	0.5 lb ai/A	Pre
4	Pendulum	3.3 EC	2.0 oz/M	Pre
5	Pendulum	3.3 EC	1.0+1.0 oz/M	Pre and 6 WAIT
6	Pendulum	3.8 CS	2.0 oz/M	Pre
7	Pendulum	3.8 CS	1.0+1.0 oz/M	Pre and 6 WAIT
8	Untreated Control			

*M is symbol for 1000 square feet.

RESULTS AND DISCUSSION

Lawn turf

None of the treatments caused significant phytotoxicity or changes in turf color (Tables 2, 3). Crabgrass emergence began by early to mid June and plants were in the 1-2 leaf stage by 23 June. Consequently, no data were available at the 4 WAIT date. The number of crabgrass plants in control plots averaged 5.5 in June, 31.5 in July, and 35 in August. All treatments provided excellent (near 100%) control in June and July except for the one time application of Pendulum 3.3 EC which only provided 92% control in July (Table 4). 2006 was the most severe year for crabgrass in Wisconsin in the past 9 years, with nearly 100% cover in other research plots seeded during spring 2006 (data not shown). By August crabgrass germination began to overcome control by several products. Dimension Ultra 2 EW, Dimension Ultra WSP and both Pendulum 3.8 CS treatments were still providing greater than 90% crabgrass control but the Pendulum 3.3 EC treatments were only providing poor to marginal control. The split application of Pendulum 3.3 EC performed better than the single application. The single and split applications of Pendulum 3.8 CS performed the same. Season long control provided by Pendulum 3.8 CS was equal to or better than control provided by the Dimension treatments in a lawn situation.

Fairway turf

None of the treatments caused significant phytotoxicity or changes in turf color (Tables 5, 6). Crabgrass emergence began around early to mid June and plants were in the 1-2 leaf stage by 23 June. Consequently, no data were available at the 4 WAIT date. Crabgrass infestation occurred much sooner than in the lawn turf where shading of the soil by the taller grass likely delayed the onset of soil temperatures favorable for crabgrass germination and growth. The number of crabgrass plants in control plots averaged 44.2 in June, 79.0 in July, and 58.5 in August. All treatments performed well in June and July except for the Dimension Ultra 2 EW treatments which provided only 76% control in July (Table 7). In August crabgrass germination began to overcome control provided by Pendulum 3.3 EC and the single application of Pendulum 3.8 CS. The Dimension treatments and the split application of Pendulum 3.8 CS were still providing good control at this time. Pendulum 3.8 CS was better at controlling crabgrass than Pendulum 3.3 EC. Making a split application of both Pendulum products also controlled crabgrass better than the single application. Season long control provided by Pendulum 3.8 CS was equivalent to control provided by the Dimension treatments at fairway height.

Table 2. Effect of pre-emergent crabgrass herbicides on Kentucky bluegrass/perennial ryegrass lawn turf color. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
1 Dimension Ultra 2EW	6.3	6.5	6.5	6.8
2 Dimension 1 EC	5.8	6.4	6.0	6.5
3 Dimension Ultra WSP	5.5	5.8	6.0	6.2
4 Pendulum 3.3 EC	6.3	6.3	6.3	6.3
5 Pendulum 3.3 EC	6.0	6.6	7.0	6.5
6 Pendulum 3.8 CS	5.8	6.3	6.5	6.5
7 Pendulum 3.8 CS	6.0	6.3	6.5	6.8
8 Untreated control	5.8	6.0	6.2	6.8
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 3. Phytotoxicity of pre-emergent crabgrass herbicides on Kentucky bluegrass/perennial ryegrass lawn turf. Phytotoxicity ranked on 0 to 10 scale, 0 = no injury, > 3 was unacceptable, and 10 = dead turf. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
1 Dimension Ultra 2EW	0.5	0.3	0.5	0.5
2 Dimension 1 EC	0.8	0.5	0.3	0.5
3 Dimension Ultra WSP	0.8	0.8	1.0	0.8
4 Pendulum 3.3 EC	0.8	0.5	0.5	0.8
5 Pendulum 3.3 EC	0.3	0.3	0.3	0.3
6 Pendulum 3.8 CS	0.8	0.5	0.8	0.3
7 Pendulum 3.8 CS	0.5	0.3	0.8	0.3
8 Untreated control	0.5	0.5	0.2	0.3
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$

Table 4. Crabgrass control (%) in Kentucky bluegrass/perennial ryegrass lawn turf using several pre-emergence crabgrass herbicides. Products were applied 26 April 2006, Madison, WI. Percent control was calculated by dividing the number of crabgrass plants in treated plots by those in the control plot for that replication, multiplying the dividend by 100, and subtracting the product by 100. Values followed by the same letter were not statistically different at $P \leq 0.05$.

Product	24 May	23 June†	26 July	21 August
1 Dimension Ultra 2EW	---‡	100.0 a§	100.0 a	93.6 ab
2 Dimension 1 EC	---	100.0 a	100.0 a	88.7 b
3 Dimension Ultra WSP	---	100.0 a	100.0 a	96.5 a
4 Pendulum 3.3 EC	---	100.0 a	92.1 b	31.5 c
5 Pendulum 3.3 EC	---	100.0 a	99.5 a	63.3 b
6 Pendulum 3.8 CS	---	100.0 a	100.0 a	93.7 a
7 Pendulum 3.8 CS	---	100.0 a	100.0 a	94.7 a
8 Untreated control	---	0.0 b	0.0 c	0.0 c

† Number of crabgrass plants per 15 ft^2 control plots averaged 5.5 in June, 31.5 in July, and 35.0 in August.
‡ Crabgrass was not visible in plots until the June rating.
§ Values followed by the same letter were not significantly different at $P \leq 0.05$.

Table 5. Effect of pre-emergent crabgrass herbicides (0.5 lb ai/A) on color of creeping bentgrass fairway turf. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
1 Dimension Ultra 2EW	7.0	6.8	7.0	7.0
2 Dimension 1 EC	7.0	7.0	7.3	7.0
3 Dimension Ultra WSP	7.0	7.0	7.0	7.0
4 Pendulum 3.3 EC	7.0	6.8	7.0	7.0
5 Pendulum 3.3 EC	7.0	7.0	7.3	7.0
6 Pendulum 3.8 CS	7.0	6.8	7.5	7.0
7 Pendulum 3.8 CS	7.0	7.0	7.3	7.0
8 Untreated control	7.0	6.8	7.3	7.0
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 6. Phytotoxicity of pre-emergent crabgrass herbicides on creeping bentgrass fairway turf. Phytotoxicity ranked on 0 to 10 scale, 0 = no injury, > 3 was unacceptable, and 10 = dead turf. Products were applied 26 April 2006, Madison, WI.

Product	29 April	2 May	10 May	24 May
1 Dimension Ultra 2EW	0.0	0.3	0.0	0.0
2 Dimension 1 EC	0.0	0.0	0.0	0.0
3 Dimension Ultra WSP	0.0	0.0	0.0	0.0
4 Pendulum 3.3 EC	0.0	0.3	0.0	0.0
5 Pendulum 3.3 EC	0.3	0.0	0.0	0.0
6 Pendulum 3.8 CS	0	0.0	0.0	0.0
Pendulum 3.8 CS	0.0	0.0	0.0	0.0
Untreated control	0.0	0.0	0.0	0.0
LSD (0.05)	ns†	ns	ns	ns

† not significant at $P \leq 0.05$.

Table 7. Crabgrass control (%) in creeping bentgrass fairway turf using several pre-emergence crabgrass herbicides. Products were applied 26 April 2006, Madison, WI. Percent control was calculated by dividing the number of crabgrass plants in treated plots by those in the control plot for that replication, multiplying the dividend by 100, and subtracting the product by 100. Values followed by the same letter were not statistically different at $P \leq 0.05$.

Product	24 May	23 June†	26 July	21 August
Dimension Ultra 2EW	---‡	100.0 a§	76.4 b	85.7 a
Dimension 1 EC	---	100.0 a	100.0 a	84.2 a
Dimension Ultra WSP	---	100.0 a	99.7 a	92.5 a
Pendulum 3.3 EC	---	100.0 a	91.5 ab	20.1 d
Pendulum 3.3 EC	---	100.0 a	98.8 ab	41.5 c
Pendulum 3.8 CS	---	100.0 a	98.9 ab	61.5 b
Pendulum 3.8 CS	---	100.0 a	100.0 a	83.3 a
Untreated control	---	0.0 b	0.0 c	0.0 e

† Number of crabgrass plants per 30 ft^2 control plots averaged 44.2 in June, 79.0 in July, and 58.5 in August.
‡ Crabgrass was not visible in plots until the June rating.
§ Values followed by the same letter were not significantly different at $P \leq 0.05$.

Fertility Trials

Field Evaluation of Experimental Nitrogen Sources

Dr. Wayne R. Kussow
Department of Soil Science, Univ. of Wisconsin-Madison

INTRODUCTION

The Floratine Products Group (FPG) relies upon a liquid organic N to formulate many of its products. There are concerns regarding the supply and agronomic performance of the organic N source currently being used. The purpose of this research was to identify an organic N product that would better serve the needs of FPG.

MATERIALS AND METHODS

Several experimental liquid organic N sources were compared to Carbon Power (CP) 20-0-4 applied as part of a complete fertility program and to straight urea. The complete program consisted of recommended rates of Maxiplex and CalpHlex as soil-applied products and foliarly applied Astron, ProteSyn and CP20-0-4. All N source treatments were applied at the common rate of 0.1 lb N/M every 2 weeks. Applications were to a push-up 'L-93' creeping bentgrass golf putting green established in 2002 at the University of Wisconsin O.J. Noer Turfgrass Research and Education Facility located near Verona, Wisconsin.

The N source treatments were applied to 5 x 12 foot plots replicated four times in a randomized complete block experimental design. Each plot was split for application of 0.125 oz/M of Primo to one-half of each plot every 2 weeks. All materials were applied with a CO_2-powered back-pack sprayer. Applications began on June 14 and ended in October, the result being a total of nine applications providing 0.9 lb N/M over the 18-week trial period.

To assess bentgrass response to the N source treatments, chlorophyll indices were measured three to four times per month with a Spectrum CM1000 chlorophyll meter. Clippings were collected in July, August, and September, their oven-dry weights recorded, and the samples ground and analyzed for nutrient content.

Composite soil samples were taken to a 4-inch depth from al plots and submitted to the University of Wisconsin Soil and Plant Analysis Laboratory (SPAL) for analysis via the Mehlich-3 method. Statistical analysis of the soil test data showed no significant plot-to-plot differences. This observation led to compositing of the four replicates of each treatment before submitting the samples to the MDS Harris Lab for analysis for exchangeable and extractable nutrient concentrations.

RESULTS AND DISCUSSION

Soil Characteristics

The soil cores collected consisted of approximately 1 inch of calcareous topdressing sand and 3 inches of silt loam soil. Depending on lab and method of analysis, soil pH was either 7.6 or 7.1 (Table 1). According to SPAL interpretations, all nutrient concentrations measured by way of the Mehlich-3 method were adequate to high for a push-up putting green. The Mehlich-3 method and the methods used by MDS Harris for exchangeable nutrients gave very comparable results for all but Fe and Mn. Levels of all MDS Harris extractable nutrients shown in Table 1 were interpreted as being insufficient .

Table 1. Research site soil characteristics.

Analysis *	UW SPAL Mehlich-3 #	MDS Harris exchangeable	MDS Harris extractable**
pH	7.6	7.1	—
Organic matter, %	2.2	2.1	—
Estimated CEC, meq/100 g	9.6	8.6	—
N ($NH_4^+ + NO_3^-$)	—	20	2.0
P ($PO_4^=$)	40	44	0.2
K	74	75	0.3
Ca	1309	1187	3.9
Mg	336	248	3.1
S ($SO_4^=$)	8.5	14	1.5
B	0.9	0.7	0.1
Cu	1.8	1.0	0.1
Fe	178	43.3	6.4
Mn	156	17.5	0.4
Zn	3.0	1.6	0.1

* All data on elemental basis except for MDS Harris extractable, where the basis for N, P, and S is as shown in parentheses.
\# Unless otherwise indicated, units are ppm (mg/kg soil).
**Units are meq/L.

Chlorophyll Indices

Readings taken with the Spectrum CM1000 chlorophyll meter are termed “indices” because the values reflect both turfgrass chlorophyll concentrations and the amount of biomass present. Hence, the indices are integrated measures of turfgrass chlorophyll concentration and stand density.

During June, when the first two N source applications were made, the FPG 6005, 6013, and 6008 treatments produced lower chlorophyll indices (CI) than did the other N sources (Table 2). These N source differences disappeared in July and August and all produced comparable CI's. In October, the FPG 6005 stood out with a mean CI of 318. Hence, this N source had superior cool weather performance, possibly because of relatively high residual turfgrass response.

Table 2. Nitrogen N source influences on monthly means of bentgrass putting green chlorophyll indices.

	Mean chlorophyll indices				
Nitrogen source(s)	June	July	August	September	October
CP20-0-4 + ProteSyn *	258	295	284	291	296
CP20-0-4 + FPG 6008 #	256	295	283	292	300
FPG 6005	236	274	268	268	318
FPG 6013	242	283	282	278	298
FPG 6008	243	285	277	285	290
FPG 6009	262	299	286	292	304
FPG 6010	252	288	269	276	272
Urea	262	299	283	286	288
Duncan's LSD, p=0.05	12	13	NS**	NS	18

* 96% of N from CP20-0-4.
\# 50% of N from CP20-0-4.
**NS, not significant.

Clipping Weights

In fertilizer trials, high clipping weights are indicative of undesirable short duration surges in turfgrass shoot growth. To detect this undesirable characteristic among the various N sources, clippings were collected 5 to 7 days after applications of the N sources.

Statistically significant differences in N source influences on bentgrass clipping weights were observed in August, but not in July or September (Table 3). The FPG 6005, 6013, 6008, and 6010 produced less clippings in August than did urea and FPG 6009, suggesting more uniform N release from the FPG 6005, 6013, 008, and 6010 and significant slow N release properties.

Summing clipping weights over the three samplings revealed that only FPG 6005 and 6008 produced less clipping than did urea over the July through September growth period. Thus, the FPG 6005 and 6008 had the characteristic of inducing the same CI's as urea (Table 2) without causing a corresponding increase in shoot growth (Table 3).

Bentgrass Nutrient Status

According to published sufficiency ranges, rarely did application of any of the N sources at the rate of 0.1 lb N/M/2 weeks provide the bentgrass with adequate N (Table 4). This signifies that in this trial bentgrass demand for all other nutrients was relatively low and in any future research the N rate should be increased, more so on any sand putting green than the push-up green used in this study.

Table 3. Nitrogen source influences on bentgrass putting green clipping weights.

	Clipping weight			
Nitrogen source(s)	July 5	August 4	September 14	Sum
CP20-0-4 + Protesyn *	1.36	1.52	1.33	4.21
CP20-0-4 + FPG 6008 #	1.40	1.62	1.27	4.29
FPG 6005	1.37	1.44	1.29	4.10
FPG 6013	1.39	1.46	1.38	4.23
FPG 6008	1.47	1.48	1.16	4.11
FPG 6009	1.31	1.76	1.33	4.40
FPG 6010	1.40	1.43	1.38	4.21
Urea	1.43	1.79	1.42	4.64
Duncan's LSD, p=0.05	NS**	0.26	NS	0.44

* 96% of N from CP20-0-4.
\# 50% of N from CP20-0-4.
**NS, not significant.

Table 4. Bentgrass clipping nutrient concentrations compared to published sufficiency ranges.

Nutrient	Range observed	Sufficiency range *
N	3.6 to 4.7%	4.5 to 6.0%
P	0.59 to 0.80%	0.3 to 0.6%
K	1.86 to 2.18%	2.2 to 2.6%
Ca	0.43 to 0.68%	0.5 to 0.75%
Mg	0.26 to 0.36%	0.25 to 0.30%
S	0.46 to 0.55%	0.3 to 0.7%
Zn	43 to 65 ppm	25 to 75 ppm
B	3.4 to 8.7 ppm	8 to 20 ppm
Fe	114 to 192 ppm	100 to 300 ppm
Cu	19 to 49 ppm	8 to 30 ppm

* McCarty, L. B. 2001. Best golf course management practice. Prentice-Hall, Inc., Upper Saddle River, NJ. 243 p.

Clippings from the FPG 6005 treatment collected on July 5 had significantly less N than did the CP 20-0-4 and urea treatment (Table 4). This difference disappeared in September and is consistent with what was observed for the CI readings (Table 2). Amending the FPG 6006 with some soluble N would likely overcome the relatively slow initial response observed.

Bentgrass clipping P concentrations were consistently within or above sufficiency levels (Table 4). Highest clipping P concentrations were consistently associated with application of FPG 6005 as the N source (Table 5). In many instances the PTG 6005 clipping P levels were significantly greater than for the other N sources. The increased clipping P concentrations resulting from application of FPG 6005 were not associated with increased clipping weights (Table 3) or tissue N levels (Table 6). Thus, these elevated clipping P concentrations did not result from differences in N source influences on plant P demand. A more logical explanation is that FPG 6005 has the capacity to solubilize soil P. This is feasible given that other research has shown that carboxylic acids possibly present in FPG 6005 have the capacity to solubilize soil P.

Table 5. Nitrogen source influences on bentgrass clipping P concentrations.

	Clipping phosphorus		
Nitrogen source(s)	June 5	August 4	September 14
	----------------------- % ---------------------------		
CP20-0-4 + Protesyn *	0.64	0.72	0.65
CP20-0-4 + FPG 6008 #	0.64	0.75	0.64
FPG 6005	0.68	0.79	0.75
FPG 6013	0.66	0.77	0.69
FPG 6008	0.62	0.75	0.68
FPG 6009	0.62	0.70	0.70
FPG 6010	0.65	0.74	0.67
Urea	0.64	0.72	0.70
Duncan's LSD, p=0.05	0.03	0.05	0.05

* 96% of N from CP20-0-4.
# 50% of N from CP20-0-4.

Table 6. Nitrogen source influences on bentgrass clipping N percentages.

	Clipping nitrogen		
Nitrogen source(s)	June 5	August 4	September 14
	----------------------- % ---------------------------		
CP20-0-4 + Protesyn *	4.38	4.65	3.80
CP20-0-4 + FPG 6008 #	4.21	4.56	3.71
FPG 6005	4.04	4.61	3.76
FPG 6013	4.19	4.65	3.73
FPG 6008	4.16	4.46	3.66
FPG 6009	4.29	4.67	3.62
FPG 6010	4.09	4.44	3.66
Urea	4.40	4.63	3.86
Duncan's LSD	0.28	NS**	NS
p=0.05			

* 96% of N from CP20-0-4.
# 50% of N from CP20-0-4.
**NS, not significant.

Clipping K levels were generally below the sufficiency range (Table 4) even though Mehlich-3 extractable K was high (Table 1). The fact that the clippings also had low N levels suggests that the low K concentrations resulted from low plant demand for the nutrient.

The N sources had no readily apparent influences on clipping concentrations of all other nutrients and, with the exception of B, virtually all concentrations were in the sufficiency range (Table 4). My research has identified 3 to 5 ppm as being the sufficiency range for B in bentgrass. In this case, all B concentrations were sufficient.

CONCLUSIONS

Among the five nitrogen sources tested, the FPG 6005 stood out as having some unique and desirable characteristics. The rate of N release appears to be more uniform over time as compared to some of the other N carriers evaluated. Its residual N value likewise ranks very high. Perhaps most notable of all is its implied capacity to solubilize soil P.

2006 Honeywell Coated Ammonium Sulfate Fertilizer Trials

Dr. Wayne R. Kussow
Department of Soil Science, University of Wisconsin-Madison

INTRODUCTTION

The purpose of this research was to quantify the agronomic performances of Honeywell experimental ammonium sulfate fertilizers and their burn potential when applied to creeping bentgrass maintained under golf fairway conditions. The products tested are identified in the tables that follow.

MATERIALS AND METHODS

The trials were conducted at the Univ. of Wisconsin O.J. Noer Turfgrass Research and Education Facility near Verona, WI. Site of the trial was a 3-year-old stand of 'L-93' creeping bentgrass established on a USGA specification root zone mix containing 94% sand. Previously managed as a putting green, mowing height was increased to 0.375 inch for these trials after core aeration and sand topdressing on April 17.

With a single exception, the fertilizers tested were those listed on Attachments #1 and #2. The exception was addition of a 4.0 lb N/M urea treatment in the field tolerance trial. Protocols followed for trial establishment and data collection were those given in the two above-referenced attachments. The agronomic performance trial was begun on May 22. Start of the burn tolerance trial was delayed until July 27, when air temperatures were more conducive to fertilizer burn.

Routine plot maintenance consisting of mowing twice a week, daily irrigation at 70% of estimated ET in lieu of 0.25 inch or more of precipitation, and application of Daconil whenever dollar spot infection occurred. Subdue was applied once in August when there was a threat of brown patch.

Soil tests performed in April revealed Bray #1 extractable P levels of 18 ppm at the 0- to 3-inch and 3- to 6-inch soil depths. Corresponding K levels were 43 and 36 ppm. These are considered to be marginally adequate, which prompted application of an 18-9-18 fertilizer at the rate of 0.5 lb N/M at the time of aerification.

RESULTS AND DISCUSSION

Agronomic Performance

Color ratings, chlorophyll indices, and clipping weights were recorded every Monday and Friday. Intervals of re-growth therefore differed between sampling dates. It was for this reason that color ratings and chlorophyll indices were averaged over the two weekly observations and clipping weights totaled. This results in all observations being reported on a weekly basis.

With but few exceptions, visual color ratings were highly correlated ($r > 0.92$) with the chlorophyll indices. The exceptions were associated with infections by dollar spot and late in the trial when the high rates of N applied induced turf puffiness and scalping occurred. Because of the generally strong correspondence between color ratings (Table 1) and chlorophyll indices (Table 2), only the visual color ratings are being reviewed and discussed.

Significant differences were observed in the initial greening responses to the fertilizers (Table 1). By the third day after fertilizer application of the HON-AS at both rates, ASN, SCU, and urea treatments color ratings were already elevated nearly one unit and were above the minimally acceptable rating of 6.0. Four days later, all treatments except the control (no N) and the HON-204D at the 1.0 lb N rate had color ratings in excess of 7.0. At that time color ratings for the HON-AS and ASN at the 2 lb N/M rate were in excess of 8.0. These fertilizers induced the two most intense color developments by 7 DAT and were significantly superior to urea in this regard.

Times to peak color response varied from 7 days for ASN to 35 days for SCU (Table 1). Among the experimental ammonium sulfates, the time to maximum color development ranged from 14 days for HON-AS, HON-204A, and HON-204D to 21 days for HON-203D. Thus, the polymer coating on the HON-203D slowed N release but not to the same extent as the 9% by weight coating on the SCU.

Maximum intensities in bentgrass color observed at the 2 lb N/M rate followed the sequence HON-AS > ASN > HON-204A > HON-203D > HON-204D > urea > SCU (Table 1). Although maximum color intensities did not all occur on the same date, the magnitudes of the LSD values in Table 1 provide justification for separating the fertilizers into distinctive groups. The HON-AS and ASN comprise the group producing the most intense color. Intermediate were the HON-204A and HON-203D. Least intense color development occurred when HON-204D, urea, and SCU were applied. The appearance of urea in this group might be viewed as an anomaly unless one assumes that volatilization loss of N occurred as the urea hydrolyzed.

As time progressed, significant differences in color ratings among treatments at compare-able N rates became fewer and fewer in number (Table 1). Consequently, there were few notable differences in greening longevity. Twelve weeks after fertilization all treatments other than HON-204D were still maintaining bentgrass color at or above the minimally acceptable level of 6.0. At that time, only the HON-203D was maintaining color that was not significantly less than SCU.

Splitting the applications of HON-AS and HON-204D into two 1.0 lb N/M applications understandably dampened surges in bentgrass color and resulted in significantly better color by the end of 12 weeks (Table 1). Interestingly, with the second N application, the HON-204D quite consistently produced better color than did the HON-AS. The reverse was true for the single 2.0 lb N/M rate or for the first 1.0 lb N/M application. This suggests that in future studies, multiple repetitive applications at rate of 1.0 lb N/M or less of the experimental ammonium sulfates might yield responses quite different from those observed with a single, high rate of application.

Bentgrass clipping weights (Table 3) were generally highly correlated (r >0.9) with color ratings (Table 1). This is to be expected given that rates of N normally applied to turf-grasses are typically about one-fourth to one-third those required for maximum biomass production. Hence, N supply is the primary regulator of both color and growth rate under most circumstances. There were, however, two times when the correlation coefficients for the relationship between clipping production and color were in the range of 0.80 to 0.85. These two times were 42 and 63 DAT. Clipping weights subsequently increased. A plausible reason is growth restricting moisture supply during periods of very low precipitation (Attachment #3) when irrigating at only 70% of estimated ET.

With the single 2.0 lb N/M application, total clipping weights ranged from 26.47 to 34.41 lb/M (Table 3). Among the polymer-coated ammonium sulfates, only HON-203D yielded significantly less clippings than did the un-coated AS. Total clipping production for the coated AS products did not differ from that for SCU, which produced significantly less clippings than did urea.

Applying HON-AS and HON-204D applications two 1.0 lb N/M applications rather than a single 2.0 lb N/M application not only lent more stability to color ratings (Table 1), but significantly reduced clipping production as well (Table 3). Under this circumstance, clipping production with HON-AS was not different from that for a single 2.0 lb N/M application of SCU.

The highest total clipping production was achieved with 2.0 lb N/M applied as ASN (Table 3). This was followed by urea and HON-AS. The common denominator among these three fertilizers is the fact that they are all 100% water soluble. Contrasting ASN with SCU shows a 17% difference in clipping weights.

Quality of the bentgrass fairway was rated at 0, 7, 19, 40, and 84 DAT (Table 4). These visual assessments focused on turf density and uniformity. The 0 DAT quality ratings reflect the fact that the fairway was not entirely healed from the 17 April core aeration. Thus, the 7 DAT quality ratings provide an assessment of the abilities of the fertilizers applied to stimulate growth into the aeration holes backfilled with sand. This is when the HON-AS and ASN had distinctive advantages over the other fertilizers. Among the coated ammonium sulfates, the HON-204D generally provided turf quality that was inferior to that of HON-204A or HON-203D. Except at 40 DAT, SCU produced lower turf quality than any other fertilizer. Thus, when the issue is that of turf recovery from mechanical or disease injury, a slow N release rate is not a desirable fertilizer characteristic.

Per project protocol (Attachment #1), the plots were rated at 1, 2, and 3 DAT for fertilizer residues. We also measured mower pickup of granules during the first two mowings. Fertilizer residue ratings were understandably highest for SCU and zero for the water-soluble fertilizers (Table 5). In going from 1 to 3 DAT, residue ratings declined 19 to 48% for the coated ammonium sulfates and 12% for the SCU. Quantities of fertilizers isolated in the 7 DAT clippings were very small (<0.05 g/7.44 ft^2), which represents less than 2% of the fertilizer applied.

Table 1. Creeping bentgrass fairway color responses to Honeywell fertilizers; UW-Madison, 2004.

		Visual color rating												
	N	3	7	14	21	28	35	42	49	56	63	70	77	84
Fertilizers	rate	DAT*	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT
	lb/M	---------- Scale 1 to 9 ----------												
HON-AS	2	6.32	8.45	8.90	8.58	8.35	8.18	8.05	7.70	7.45	7.22	6.98	6.65	6.12
HON-204A	2	5.55	7.18	8.65	8.45	8.18	7.90	7.90	7.42	7.15	6.92	6.65	6.42	6.00
HON-204D	2	5.58	7.42	8.25	8.18	7.98	7.92	7.75	7.42	7.15	6.98	6.72	6.42	5.95
HON-203D	2	5.82	7.60	8.42	8.52	8.48	8.22	8.12	7.80	7.52	7.35	7.08	6.75	6.15
ASN	2	6.42	8.82	8.62	8.48	7.98	8.00	8.05	7.40	7.32	7.38	6.98	6.42	6.05
SCU	2	6.15	7.15	7.80	7.75	7.98	8.10	8.10	7.88	7.60	7.92	7.28	6.72	6.32
Urea	2	6.38	7.82	8.82	7.95	7.78	7.78	7.70	7.30	7.35	7.32	6.98	6.50	6.18
HON-AS	1x2#	6.20	7.30	7.38	7.42	7.30	7.18	6.98	7.78	8.20	7.80	7.35	6.72	6.42
HON-204D	1x2	5.75	6.38	6.90	7.15	7.08	6.85	6.82	7.38	8.25	8.42	7.58	7.10	6.65
None	0	5.30	4.70	4.58	4.90	5.08	5.22	5.22	5.18	5.28	5.72	5.78	6.02	5.70
Duncan's LSD		0.34	0.26	0.26	0.24	0.23	0.31	0.28	0.22	0.27	0.38	0.36	0.24	0.22
p = 0.05														

* DAT = days after treatment (fertilizer application).

#1.0 lb N/M at 0 and 42 DAT.

Table 2. Creeping bentgrass fairway chlorophyll indices for Honeywell fertilizer applications; UW-Madison, 2006.

		Chlorophyll indices												
	N	3	7	14	21	28	35	42	49	56	63	70	77	84
Fertilizers	rate	DAT*	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT
	lb/M													
HON-AS	2	315	546	528	487	519	472	459	432	387	440	405	375	371
HON-204A	2	269	449	505	485	505	449	448	421	383	425	384	359	364
HON-204D	2	275	474	480	459	475	456	440	424	378	433	392	361	368
HON-203D	2	281	482	484	481	518	467	468	441	408	449	413	384	379
ASN	2	335	552	517	484	494	465	463	430	394	441	405	372	363
SCU	2	301	458	460	442	484	457	469	449	420	446	435	390	391
Urea	2	315	506	475	451	480	442	454	421	393	439	480	370	380
HON-AS	1x2#	300	473	432	417	441	408	385	456	460	491	440	381	381
HON-204D	1x2	267	395	401	398	390	387	385	412	458	502	428	399	406
None	0	261	271	271	275	300	291	292	298	305	361	350	346	346
Duncan's LSD		26	26	24	19	24	20	22	24	16	27	79	22	15
p = 0.05														

* DAT = days after treatment (fertilizer application).

#1.0 lb N/M at 0 and 42 DAT.

Table 3. Creeping bentgrass growth responses to Honeywell fertilizers; UW-Madison, 2006.

		Clipping weight												
	N	7	14	21	28	35	42	49	56	63	70	77	84	
Fertilizers	rate	DAT*	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	Total
	lb/M	---------- lb/M ----------												
HON-AS	2	3.27	5.54	2.56	3.04	2.42	1.58	2.53	2.40	1.57	2.89	1.83	1.60	31.25
HON-204A	2	2.57	5.84	2.77	2.97	2.45	1.82	2.60	1.92	1.49	2.31	1.97	1.85	30.48
HON-204D	2	2.89	5.42	2.51	2.90	2.27	1.78	2.32	1.97	1.54	2.47	2.16	1.44	29.85
HON-203D	2	2.47	4.13	2.19	2.40	2.06	1.55	2.25	2.04	1.59	2.60	1.80	1.61	26.47
ASN	2	4.07	5.45	2.43	2.80	2.27	1.85	2.52	2.46	1.43	4.06	2.62	2.12	34.41
SCU	2	2.73	3.41	1.56	2.15	1.95	1.99	2.54	2.52	2.03	3.72	2.79	1.57	28.48
Urea	2	3.91	4.85	2.20	2.48	2.10	1.74	2.48	2.14	1.70	3.67	2.14	1.95	31.39
HON-AS	1x2#	2.26	2.96	1.22	1.29	1.18	2.08	1.38	4.89	2.87	4.10	2.02	2.00	28.27
HON-204D	1x2	1.95	2.27	0.99	1.00	0.88	1.48	1.16	3.87	3.05	4.68	2.15	1.71	25.20
None	0	1.28	0.74	0.38	0.37	0.31	0.56	0.60	0.67	0.90	1.36	1.31	1.25	9.95
Duncan's LSD		0.20	0.41	0.20	0.19	0.23	0.35	0.12	0.25	0.32	1.10	0.48	0.31	2.48
p = 0.05														

* DAT = days after treatment (fertilizer application).

1.0 lb N/M at 0 and 42 DAT.

Table 4. Creeping bentgrass fairway quality ratings for a 2.0 lb N/M Honeywell fertilizer application; Uw-Madison, 2006.

	Quality rating on a scale of 1 to 9 *				
Fertilizer	0 DAT	7 DAT	19 DAT	40 DAT	84 DAT
HON-AS	5.12	8.35	8.78	8.95	7.82
HON-204A	5.08	7.80	8.62	8.60	6.92
HON-204D	4.70	6.75	7.95	8.45	6.75
HON-203A	4.90	7.40	8.10	8.70	7.50
ASN	5.25	8.22	8.45	8.88	6.88
SCU	5.08	5.62	7.52	8.90	5.95
Urea	5.15	6.82	8.18	8.78	6.65
None	4.88	4.25	5.00	5.35	5.60
Duncan's LSD	NS #	0.68	0.40	0.42	0.38
p = 0.05					

* A 9 rating signifies a dense, perfectly uniform turf.

NS, not significant.

Table 5. Honeywell fertilizer residue granules.

		Residue rating			Mower pick-up
Fertilizer	N rate	1 DAT	2 DAT	3 DAT	7 DAT
	lb/M	------------ Scale 0 to 5 ------------			g/plot
HON-AS	2	0	0	0	0
HON-204A	2	2.1	2.1	1.7	0.05
HON-204D	2	3.5	3.4	2.6	0.01
HON-203A	2	3.2	2.9	1.5	0.01
ASN	2	0	0	0	0
SCU	2	5.0	5.0	4.4	0.02
Urea	2	0	0	0	0
HON-AS	1x2	0	0	0	0
HON-203D	1x2	3.1	2.1	0.9	0.01
Duncan's LSD		0.2	0.3	0.2	0.02
p = 0.05					

Per project protocol (Attachment #1), the plots were rated at 1, 2, and 3 DAT for fertilizer residues. We also measured mower pickup of granules during the first two mowings. Fertilizer residue ratings were understandably highest for SCU and zero for the water-soluble fertilizers (Table 5). In going from 1 to 3 DAT, residue ratings declined 19 to 48% for the coated ammonium sulfates and 12% for the SCU. Quantities of fertilizers isolated in the 7 DAT clippings were very small (<0.05 g/7.44 ft^2), which represents less than 2% of the fertilizer applied.

Clippings collected at 14 DAT contained no detectable fertilizer residues. Thus, mower pickup of the coated ammonium sulfates does not appear to be a real concern when the fertilizers are applied to a dense stand of creeping bentgrass mowed at 0.375 inch.

Tolerance Evaluation

Bentgrass tolerance of the fertilizers applied was assessed in terms of the percent of the plot areas displaying burn symptoms. As expected, burn from HON-AS and urea was almost immediate and severe (Table 6). Not until 2 and 3 DAT did burn become extensive where the coated ammonium sulfates were applied. At the 1.5 lb N/M rate, the coated AS fertilizers produced significantly less burn than the uncoated AS. This was not the case at the 4.0 lb N/M rate. Burn was as great or greater for the coated AS fertilizers than for uncoated AS.

At the 1.5 lb N/M rate, recovery from the HON-AS induced burn began 5 DAT and was 100% by 21 DAT. In the case of the coated AS fertilizers, significant turfgrass recovery from burn was delayed until some time between 7 and 14 DAT, but recovery was complete by 21 DAT.

Increasing the N rate from 1.5 to 4.0 lb/M understandably increased bentgrass burn and led to longer recovery times (Table 6). At this N rate HON-2063 generally produced less burn than did HON-204A, HON-204D, and HON-203D.

At both N rates, SCU produced less burn than any of the AS fertilizers (Table 6). Unlike in 2005, recovery from SCU burn was complete at 21 DAT.

The extent of burn by urea was often comparable to that resulting from application of the AS fertilizers (Table 6). However, as noted in 2005, the burn resulting from urea application is fundamentally different from AS burn. In the case of AS, burn results from plasmolysis of leaf tissue, an injury from which turfgrass recovers by leaf re-growth. Urea burn extends into the crowns of turfgrass, resulting in plant death. Recovery requires stolen growth into the area from surrounding healthy turfgrass.

Table 6. Creeping bentgrass fairway injury by Honeywell fertilizers; UW-Madison, 2006.

		Percent of plot injured (%)						
	N	1	2	3	5	7	14	21
Fertilizer	rate	DAT	DAT	DAT	DAT	DAT	DAT	DAT
	lb/M							
HON-AS	1.5	78	83	82	62	53	14	0
HON-204A	1.5	5	57	68	57	67	21	0
HON-204D	1.5	7	53	65	45	48	18	0
HON-203D	1.5	10	53	58	47	42	18	0
HON-2063	1.5	12	40	67	45	42	11	0
SCU	1.5	7	12	8	5	17	16	0
Urea	1.5	52	63	50	41	35	19	2
HON-204A	4.0	2	65	73	75	72	43	0.7
HON-204D	4.0	8	82	83	75	78	42	1.0
HON-203D	4.0	15	82	82	85	78	48	0
HON-2063	4.0	10	67	68	75	67	33	0
SCU	4.0	7	12	13	42	42	12	0
Urea	4.0	65	87	82	80	78	73	53
None		0	0	0	0	0	0	0
Duncan's LSD		3	3	3	12	12	23	5
p = 0.05								

SUMMARY

Agronomic Performance

Compared to HON-AS and urea, the three polymer-coated AS fertilizers tested displayed some control of N release. All delayed the initial 3-day color response of a bentgrass fairway, but this delay lasted 14 days or less in the case of HON-204A and 203D. Control of N release from HON-204D was of much longer duration – in the range of 30 to 40 days.

Unlike in 2005, none of the coated AS fertilizers had N release characteristics that closely paralleled those of SCU or the longevity of color response. In 2005, HON-106 had an N release pattern similar to that of SCU.

In this study, bentgrass quality was largely dependent on speed of recovery from mechanical and disease (dollar spot) injury. Speed of recovery is a function of grass growth rate, which is favored by high N supply. This being the case, all AS fertilizers generally produced superior quality turf compared to SCU.

The particle sizes of the experimental AS fertilizers would normally be judged too large for a turf mown at 0.375 inch to avoid extensive mower pickup. This proved not to be the case, most likely because the high densities of the fertilizer particles favored penetration into the turf canopy.

Fertilizer Tolerance

Compared to uncoated AS, the coatings on the experimental AS fertilizers reduced the extent of fertilizer burn by about 30%, but only during the first 3 days after application. All AS fertilizers produced four to eight times more burn than did SCU. Among the four coated AS products tested, none had superior fertilizer tolerance.

Even at the excessive application rates of 1.5 and 4.0 lb N/M, bentgrass recovery from AS burn was rapid. Complete recovery occurred somewhere between 14 and 21 days after fertilizer application. Damage caused by urea persisted well beyond 21 days after application.

Weather Data: UW Turfgrass Research Facility, 2006

		Solar	Mean	Soil temp.				Solar	Mean	Soil temp.	
Date	Precip	rad.	air T	1 in.	4 in.	Date	Precip	rad.	air T	1 in.	4 in.
	inch	W/m^2	------- °C ----------				inch	W/m^2	-------- °C ---------		
May						**July**					
22	0	315	14.2	19.4	16.5	5	0	308	19.8	26.2	23.2
23	0.99	224	18.0	19.4	16.9	6	0	292	18.8	25.7	23.0
24	0.77	125	17.9	19.6	17.2	7	0.01	256	19.7	25.2	22.5
25	0	270	20.4	22.8	19.6	8	0.24	235	23.4	26.9	23.8
26	0	192	21.9	21.0	18.9	9	0	265	19.3	26.0	23.4
27	0	310	25.6	24.1	21.0	10	1.43	40	17.2	23.3	22.2
28	0	285	25.5	24.6	21.7	11	0	256	22.2	25.4	23.1
29	0.16	154	21.3	23.1	20.9	12	0	252	22.1	25.6	28.3
30	0.29	282	20.0	24.1	21.2	13	0.01	245	24.5	26.6	24.1
31	0	310	20.7	25.6	22.4	14	0	317	26.9	28.7	25.6
June						15	0	305	26.4	28.8	25.8
1	0	309	19.6	25.0	21.9	16	0	275	27.5	28.4	25.8
2	0	306	17.4	24.3	21.4	17	0	305	23.3	28.2	25.5
3	0	334	17.1	25.3	22.0	18	0.45	118	20.1	24.5	23.8
4	0	276	17.9	25.1	21.4	19	0.79	141	21.9	25.8	23.7
5	0.12	85	17.4	21.4	20.6	20	0.04	85	18.6	24.2	23.1
6	0	298	21.2	23.0	20.6	21	0.03	178	18.5	24.8	22.7
7	0	294	20.5	23.9	21.2	22	0.01	297	20.0	27.2	24.3
8	0.01	89	15.2	20.8	19.9	23	0	284	24.0	26.7	24.3
9	0.81	205	12.4	20.3	18.3	24	0.01	259	24.6	27.0	24.8
10	0.05	208	12.6	20.1	18.2	25	0.11	254	23.9	27.7	25.4
11	0	332	14.9	23.3	23.2	26	0.86	135	22.2	26.2	24.4
12	0	313	17.0	24.3	21.2	27	0.01	294	24.6	28.6	26.1
13	0.20	146	17.1	21.6	20.0	28	0	247	26.2	28.6	26.2
14	0.01	192	20.4	22.3	20.0	29	0	218	25.4	27.8	25.7
15	0	255	25.0	21.2	21.4	30	0	288	21.4	29.4	26.7
16	0.02	266	25.1	24.5	21.8	31	0.01	243	27.8	29.8	27.1
17	1.00	150	21.7	23.9	21.6	**Aug.**					
18	0	282	20.0	24.2	21.8	1	0.01	211	26.7	29.2	26.8
19	0	181	18.5	22.2	21.0	2	0.01	280	22.2	28.3	26.0
20	0.04	136	21.9	22.9	20.9	3	0	294	23.5	28.9	26.3
21	0	227	20.2	24.3	21.7	4	0	158	20.8	25.8	24.8
22	0	323	17.7	25.0	22.3	5	0.77	105	21.7	25.0	23.4
23	0.06	171	17.5	22.4	21.2	6	0	266	21.3	27.6	25.1
24	0.07	176	17.4	23.9	21.4	7	0	255	20.1	27.5	24.9
25	0.24	199	16.6	22.8	20.8	8	0	220	20.2	26.8	24.4
26	0	298	18.6	23.8	21.4	9	0	126	22.4	25.2	23.7
27	0	271	16.7	22.9	20.8	10	0	170	20.0	25.3	23.4
28	0	313	17.7	24.5	21.8	11	0	274	19.3	26.8	24.2
29	0	299	20.7	24.1	22.1	12	0	211	19.6	25.2	23.2
30	0.02	253	23.7	24.3	22.0	13	0	273	21.1	21.9	23.8
July						14	0	282	19.0	26.4	24.0
1	0	212	22.8	25.2	22.5	15	0	267	19.8	26.8	24.2
2	0.1	198	22.5	24.8	22.5	16	0.38	62	17.5	23.5	22.5
3	0	304	21.0	25.6	23.0	17	0.13	93	20.6	24.1	22.3
4	0	295	18.4	25.1	22.6	18	0	158	20.3	25.0	23.0

2006 Influences of Growth Promoters on Turfgrass Establishment and Growth

Dr. Wayne R. Kussow
Department of Soil Science, Univ. of Wisconsin-Madison

INTRODUCTION

Growth promoters supplied by Nitragin, Inc. were screened to determine their influences on turfgrass establishment and post-establishment on shoot and root growth. This research was carried out at the University of Wisconsin O.J. Noer Turfgrass Research and Education Facility located 3 miles north of Verona, Wisconsin.

MATERIALS AND METHODS

Preparation of the research sites began with application of Roundup in early May to kill existing turfgrass. Kill was complete in 3 weeks, after which the two sites — a pre-existing 50 x 100 ft lawn and a 44 x 68 ft golf putting green — were rototilled. Turf clods were hand raked from the sites, the sites rototilled a second time, and the clods once again removed. Both sites were then leveled via hand raking to prepare seedbeds.

The pre-existing lawn site was split into two 48x48 foot blocks, a 13-23-10 starter fertilizer applied at the rate of 1.0 lb N/M (M = 1000 ft^2), and the area lightly rototilled and raked. The two areas were then staked out in four blocks, each consisting of twelve 4 x 8 ft plots.

The growth promoters were then applied according to Nitragin protocol to weighed quantities of an elite blend of Kentucky bluegrass cultivars and Grande II turf-type tall fescue. Seed weights were such that the seeding rates would be 3 lb/M for the Kentucky bluegrass and 6 lb/M for the tall fescue when seeded into the 4 x 8 ft plots.

The plots were seeded with the Kentucky bluegrass and tall fescue on May 13 employing the shaker jar method. The seed was slightly covered with soil via hand-raking. The area was then covered with a porous golf putting green cover to prevent seed washing and help maintain a moist soil surface during a grow-in irrigation regime of 2-minute irrigations five times per day. Tall fescue began to emerge 5 days after seeding, at which time the greens cover was removed from the site. The Kentucky bluegrass began to emerge 8 days after seeding.

The creeping bentgrass plots were seeded May 30, covered, and irrigation for 2 minutes five times per day begun. Emergence began May 26, at which time the green cover was removed.

Two sets of measurements were employed to establish growth promoter influences on turfgrass establishment. One, a standard technique in turfgrass research, was visual rating of the plot for grass stand density. This technique employs a rating scale of 1 to 9, where 1 is bare soil and 9 is 100% ground cover. Such ratings are obviously subjective, which prompted employment of a second technique, that of measurement of chlorophyll indices. The instrument employed was a Spectrum CM1000 chlorophyll meter. The meter sensed light at wavelengths of 700 and 840 nm. Light reflected at 700 nm corresponds to the amount of chlorophyll present. Reflection at 840 nm is not influenced by plant chlorophyll content. It serves to indicate how much light is reflected due to plant physical characteristics and serves to correct the 700 nm reflectance for these physical characteristics. The amount of chlorophyll detected is a function of the concentration of chlorophyll in the plants and the quantity of vegetation. Thus, the chlorophyll meter readings objectively indicate the extent of plant cover when tissue chlorophyll concentrations are constant over time.

The visual stand density ratings and measures of chlorophyll indices were recorded periodically until values between successive dates showed little or no change. The turfgrasses were then fertilized and maintained until the stands were uniform enough to begin foliar application of three growth promoters. Infestation of the Kentucky bluegrass by crabgrass was too extensive to provide meaningful responses to the foliarly applied growth promoters. Hence, the growth promoters were foliarly applied only to the fall fescue and creeping bentgrass.

The growth promoters applied and the suggested rates are given in Attachment #2. With only three products and a control, each applied to four replicates, the experimental error term degrees of freedom would have been only 9, which are considered to be the minimum for field studies. Therefore, the number of treatments was increased to eight by applying the three growth promoters at both the recommended and twice the recommended rates and adding a foliar application of Primo, turfgrass growth regulator. The foliar treatments were applied to 6 x 8 ft plots of tall fescue and creeping bentgrass. Treatments were arrayed in a randomized complete block experimental design with four replications.

Turfgrass responses to the growth promoter treatments were determined by measuring clipping production and chlorophyll indices. Clippings were periodically collected from a 9.94 ft^2 area in the tall fescue plots and a 10.85 ft^2 area in the creeping bentgrass plots. The clipping samples were dried at 70^oC and weighed. Measurements of clipping weights and chlorophyll indices were periodically made until changes between successive dates were largely insignificant.

All data collected were subjected to an analysis of variance and least significant differences (LSD's) computed. The LSD's were computed at the two probability levels of 5 and 10%. Researchers typically only compute and apply LSD's at the 5% probability. The 10% level was included because this is accepted by the Wisconsin Department of Agriculture, Trade and Consumer Protection when reviewing research data that become the basis for product registration for sale in the state.

RESULTS AND DISCUSSION

Seed Applications of Growth Promoters

The focus of these trials was on the positive influences of the growth promoters on turfgrass establishment. Hence, the comparisons made are those between the control treatment where no growth promoter was applied and the growth promoter treatments. Tall fescue — Visual stand ratings for this fast-germinating turfgrass did not identify any posi-tive growth promoter effects on rate of establishment at 8, 10, or 14 days after seeding (DAS) (Table 1). Stand density appeared to be improved at 17 DAS by the NI-70-1 and NI-50c-8/ NI-656C-1 seed treatments. At 24 DAS, only the NI-50c-2 was found to have improved tall fescue stand density. None of the growth promoter treatments adversely influenced tall fescue establishment.

Chlorophyll indices measured at 15, 20, and 24 DAS (Table 2) gave no indication that any of the growth promoters favored tall fescue establishment. The chlorophyll indices did suggest that NI-70-2 was slowing establishment at 15 DAS, NI-50c-6/NI-70-1 performed likewise at 20 and 24 DAS, and NI-70-2 was adversely influencing the tall fescue establishment at 24 DAS.

Kentucky bluegrass — In comparison to tall fescue, Kentucky bluegrass is slow to germinate, often requiring up to 14 days for 100% germination. For this turfgrass, the seed-applied growth regulators had no significant influences on stand ratings at 10 and 14 DAS. Positive responses (10% probability) were seen for NI-655c-1 at 17 DAS and for NI-50c-6 and NI-50c-8/NI-65b-1 at 24 DAS.

Chlorophyll indices (Table 3) gave no indication that any of the growth promoters significantly increased Kentucky bluegrass establishment at 15, 20, or 24 DAS. The NI-50c-8/NI-65b-1 seed treatment came close to enhancing establishment at 24 DAS at the 10% probability levels. This provides some supporting evidence for the positive influences of this treatment on the Kentucky bluegrass stand rating at 24 DAS (Table 4).

Creeping bentgrass — Creeping bentgrass is intermediate to tall fescue and Kentucky bluegrass as far as germination rate is concerned, and, by far, has the smallest seed size. Perhaps this is why the creeping bentgrass had the highest frequency of responses to the seed-applied growth promoters.

Creeping bentgrass stand ratings were increased at the 10% probability level for the NI-50c-6/ NI-70-2 combination of growth promoters at 7 and 17 DAS, but not at 10 DAS (Table 5). Negative influences on creeping bentgrass were indicated by stand ratings for the NI-50c-6 and NI-50c-6/NI-70-1 treatments on 17 DAS.

Chlorophyll indices identified a positive response to NI-50c-8 at 8 DAS (Table 6). No responses, positive or negative, were indicated at 13, 17, 28, or 30 DAS.

Foliar Applications of Growth Promoters

Tall fescue — No significant influences of the growth promoters on tall fescue clipping weights were noted at 7 days after treatment (DAT) (Table 7). Clipping weights were increased at 9 DAT by applications of NI-70-1 at the 2X rate and by NI-50c-2 and NI-65b-1 at the 2X rate. These significant influences were not evident at 15 DAT. By 23 DAT, only the NI-65b-1 at the 2X rate and NI-70-1 at the 2X rate were positively influencing tall fescue growth rates.

Table 1. Influences of seed-applied Nitragin growth promoters on tall fescue stand ratings.

	Stand ratings				
Growth promoter	8 DAS *	10 DAS	14 DAS	17 DAS	24 DAS
	----------------------------- Scale 1 to 9 # -------------------------------				
None	6.0	7.0	7.2	7.2	8.6
NI-50c-2	6.0	7.4	7.5	7.8	8.6
NI-50c-6	5.5	7.1	7.2	7.6	8.8
NI-70-1	6.2	7.2	7.4	7.8	8.6
NI-70-2	5.8	6.9	6.9	7.2	8.4
NI-65b-1	6.8	7.1	7.4	7.6	8.5
NI-65b-2	6.2	7.1	7.4	7.6	8.4
NI-655c-1	5.5	7.0	7.5	7.6	8.6
NI-50c-6/NI-70-1	5.8	6.5	7.1	7.2	8.4
NI-50c-6/NI-70-2	5.8	6.9	7.4	7.5	8.5
NI-50c-8/NI-65b-1	6.2	7.2	7.5	7.9	8.7
NI-50c-8/NI-655c-1	6.8	7.1	7.6	7.8	8.4
LSD 0.05	1.2	0.8	0.6	0.8	0.3
LSD 0.10	1.0	0.7	0.5	0.6	0.2

* DAS = days after seeding. # 0 = bare soil; 9 = 100% ground cover.

Table 2. Influence of seed-applied Nitragin growth promoters on tall fescue chlorophyll indices.

	Chlorophyll indices		
Growth promoter	15 DAS *	20 DAS	24 DAS
None	175	266	283
NI-50c-2	152	251	251
NI-50c-6	174	272	296
NI-70-1	174	245	275
NI-70-2	146	208	222
NI-65b-1	167	243	254
NI-65b-2	176	241	245
NI-655c-1	164	252	254
NI-50c-6/NI-70-1	149	193	219
NI-50c-6/NI-70-2	181	262	265
NI-50c-8/NI-65b-1	170	259	275
NI-50c-8/NI-655c-1	180	252	271
LSD 0.05	28	58	57
LSD 0.10	23	48	48

* DAS = days after seeding.

Table 3. Influence of seed-applied Nitragin growth promoters on Kentucky bluegrass chlorophyll indices.

	Chlorophyll indices		
Growth promoter	15 DAS *	20 DAS	24 DAS
None	94	123	128
NI-50c-2	96	116	120
NI-50c-6	95	125	136
NI-70-1	101	118	126
NI-70-2	83	106	110
NI-65b-1	92	131	133
NI-65b-2	88	127	140
NI-655c-1	105	152	152
NI-50c-6/NI-70-1	87	102	109
NI-50c-6/NI-70-2	98	116	121
NI-50c-8/NI-65b-1	102	146	156
NI-50c-8/NI-655c-1	94	115	130
LSD 0.05	14	30	36
LSD 0.10	12	25	30

* DAS = days after seeding.

Table 4. Influences of seed-applied Nitragin growth promoters on Kentucky bluegrass stand ratings.

	Stand ratings			
Growth promoter	10 DAS *	14 DAS	17 DAS	24 DAS
	------------------------ Scale 0 to 9 # ---------------------------			
None	5.5	6.8	7.6	8.1
NI-50c-2	5.1	6.1	7.5	8.4
NI-50c-6	5.9	6.5	7.8	8.5
NI-70-1	5.5	6.5	8.0	8.4
NI-70-2	4.5	5.6	6.8	8.1
NI-65b-1	4.9	6.1	7.6	8.0
NI-65b-2	6.0	6.8	7.6	8.4
NI-655c-1	5.9	7.1	8.2	8.5
NI-50c-6/NI-70-1	5.1	6.2	7.5	8.4
NI-50c-6/NI-70-2	6.1	7.0	7.6	8.1
NI-50c-8/NI-65b-1	5.4	6.9	8.0	8.5
NI-50c-8/NI-655c-1	5.4	6.2	7.5	8.2
LSD 0.05	1.4	1.4	0.8	0.5
LSD 0.10	1.2	1.2	0.6	0.4

* DAS = days after seeding. # 0 = bare soil; 9 = 100% ground cover.

Table 5. Influence of seed-applied Nitragin growth promoters on creeping bentgrass stand ratings.

	Stand ratings		
Growth promoter	7 DAS *	10 DAS	17 DAS
	----------------- Scale 0 to 9 # -----------------		
None	4.8	7.5	7.8
NI-50c-2	4.9	7.6	7.8
NI-50c-6	4.9	7.4	7.4
NI-70-1	4.9	7.6	7.8
NI-70-2	5.6	7.6	7.9
NI-65b-1	4.9	7.4	7.5
NI-65b-2	4.5	7.6	7.6
NI-655c-1	5.0	7.7	7.9
NI-50c-6/NI-70-1	5.1	7.6	7.8
NI-50c-6/NI-70-2	5.8	7.8	8.1
NI-50c-8/NI-65b-1	5.4	7.6	7.7
NI-50c-8/NI-655c-1	5.0	7.3	7.6
LSD 0.05	1.1	0.5	0.4
LSD 0.10	0.9	0.4	0.3

* DAS = days after seeding. # 0 = bare soil; 9 = 100% ground cover.

Table 6. Influences of seed-applied Nitragin growth promoters on creeping bentgrass chlorophyll indices.

	Chlorophyll indices				
Growth promoter	8 DAS *	13 DAS	17 DAS	28 DAS	30 DAS
None	62	77	83	201	208
NI-50c-2	62	76	84	198	210
NI-50c-6	65	76	80	190	200
NI-70-1	63	76	80	190	215
NI-70-2	64	75	86	192	200
NI-65b-1	64	73	82	198	222
NI-65b-2	62	74	83	191	209
NI-655c-1	64	78	82	183	204
NI-50c-6/NI-70-1	63	74	82	188	206
NI-50c-6/NI-70-2	64	76	85	198	211
NI-50c-8/NI-65b-1	63	78	88	218	232
NI-50c-8/NI-655c-1	63	74	81	176	200
LSD 0.05	4	5	8	29	31
LSD 0.10	3	4	8	24	26

* DAS = days after seeding.

Table 7. Influences of foliar-applied Nitragin growth promoters on tall fescue clipping weights.

		Clipping weight			
Growth promoters	Rate	7 DAT *	9 DAT	15 DAT	18 DAT
		-------------------------- g/plot ---------------------------------			
None	—	10.61	3.90	19.65	5.66
NI-50c-2	1X	9.90	4.45	17.30	5.95
NI-70-1	1X	9.36	5.92	20.59	6.30
NI-65b-1	1X	8.85	4.68	21.87	5.40
NI-50c-2	2X	9.82	5.27	18.45	5.96
NI-70-1	2X	11.10	4.28	19.71	5.55
NI-65b-1	2X	9.84	5.00	16.56	5.70
Primo	—	9.33	4.37	16.61	4.91
LSD 0.05		0.80	0.79	1.51	0.53
LSD 0.10		0.66	0.65	1.25	0.44

* DAT = days after treatment.

Chlorophyll indices failed to corroborate significant treatment effects on tall fescue clipping weights (Table 8). Because the NI-65b-1 at 1X improved chlorophyll indices but reduced the indices at the 2X rate, the difference between the two treatments was significant.

Creeping bentgrass — Foliar applications of all growth promoters except NI-50c-2 at the 2X rate increased clippings weights at 7 DAT (Table 9). These positive influences persisted at 9 DAT for NI-70-1 and NI-50c-2 at the 1X rate and for NI-70-1 and NI-65b-1 at the 2X rate. No significant effects on clipping weights were noted at 15 DAT.

Chlorophyll indices provided no evidence that the foliarly applied growth promoters influenced creeping bentgrass growth at 7, 9, and 15 DAT regardless of rate of applications (Table 10).

The creeping bentgrass putting green with its root zone mix containing more than 94% sand lends itself to investigation of the influences of the foliar-applied growth promoters on root mass. Oven-dried root weights showed a positive response to NI-65b-1 at the 1X rate at the 5% probability level and to NI-70-1 at the 2X rate at the 10% probability level (Table 9).

SUMMARY

In the seed treatment trials, the combination of turfgrasses x treatments x observations totaled 253. Positive responses to the growth promoters numbered 9, an overall response rate of 3.6%. These positive responses were nearly off-set by a negative response rate of 2.4%. The growth promoter seed treatment having the greatest number of positive responses was NI-50c-6/ NI65b-1 combination. Next in terms of positive responses were NI-50c-6 and the NI-50c-8/NI-70-2 combination.

Table 8. Influences of foliar-applied Nitragin growth promoters on tall fescue chlorophyll indices.

		Chlorophyll indices			
Growth promoters	Rate	0 DAT *	7 DAT	9 DAT	15 DAT
None	—	383	413	391	459
NI-50c-2	1X	410	412	404	459
NI-70-1	1X	393	409	396	470
NI-65b-1	1X	389	410	389	478
NI-50c-2	2X	399	404	413	480
NI-70-1	2X	408	393	403	461
NI-65b-1	2X	384	414	382	448
Primo	—	389	405	405	450
LSD 0.05		NS #	NS	NS	28
LSD 0.10		NS	NS	NS	23

* DAT = days after treatment. # NS = not significant.

Table 9. Influences of foliar-applied Nitragin growth promoters on tall fescue clipping weights.

		Clipping weight			Root weight
Growth promoters	Rate	7 DAT *	9 DAT	15 DAT	23 DAT
		-------------------------- g/plot ---------------------------------			
None	—	12.30	4.68	12.02	1.32
NI-50c-2	1X	14.30	4.83	13.15	1.38
NI-70-1	1X	14.07	5.70	12.81	1.40
NI-65b-1	1X	14.00	4.56	13.09	1.59
NI-50c-2	2X	11.87	5.11	11.95	1.26
NI-70-1	2X	13.63	5.38	12.31	1.52
NI-65b-1	2X	13.95	5.37	12.51	1.43
Primo	—	13.64	5.86	11.88	1.45
LSD 0.05		1.06	0.46	1.15	0.24
LSD 0.10		0.87	0.38	0.95	0.20

* DAT = days after treatment.

Table 10. Influences of foliar applied Nitragin growth promoters on creeping bentgrass chlorophyll indices.

		Chlorophyll indices			
Growth promoters	Rate	0 DAT *	7 DAT	9 DAT	15 DAT
None	—	338	343	343	321
NI-50c-2	1X	343	350	352	316
NI-70-1	1X	352	356	350	332
NI-65b-1	1X	347	346	341	322
NI-50c-2	2X	346	344	350	328
NI-70-1	2X	351	356	353	329
NI-65b-1	2X	356	361	355	336
Primo	—	354	360	352	324
LSD 0.05		NS #	NS	NS	NS
LSD 0.10		NS	NS	NS	NS

* DAT = days after treatment. # NS = not significant.

The response rate for foliar applications of the growth promoters was 13.4% considerably higher than for the seed treatments. Three treatments showed the highest and same response rates. These treatments were NI-70-1 and NI-65b-1 at the 1X rate, and NI-70-1 at the 2X rate.

In the realm of turfgrass management, the growth promoters tested here would be broadly classified as biostimulants. Over several years of conducting biostimulant efficacy trials, the positive response rate I've experienced has never exceeded 20% in a given year. Efforts to identify combinations of weather and turf cultural practices where the probability of positive responses to biostimulants is on the order of 5% or more have not been successful. Regardless, many golf course superintendents are willing to try the products. Of particular interest are products that might enhance turfgrass root growth on golf putting greens. Therefore, should EMD Crop Bioscience, Inc. elect to continue testing of growth promoters on turfgrass, emphasis should be on repetitive foliar applications on golf putting greens. Besides type of growth regulators, treatment variables should include application rate and frequency and explore possible combinations of growth regulators-nutrients and growth regulators-fungicides.

Fungicide Trials

Control of Sclerotinia Dollar Spot (Fairway)

Paul Koch, Dan Goeser, Jeremy Nacewicz, Jennifer Koch, and Dr. Geunhwa Jung
Department of Plant Pathology

OBJECTIVE

To determine the efficacy of standard and experimental fungicides for controlling dollar spot caused by the fungus *Sclerotinia homoeocarpa*.

MATERIALS AND METHODS

The study was conducted at the O. J. Noer Turfgrass Research and Education Facility on a stand of creeping bentgrass (Agrostis stolonifera 'Penneagle') maintained at 0.5 inches. The individual plots measured 3 feet by 5 feet and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000 ft^2. All treatments were initiated June 5th, and subsequent applications were made at either 14 or 21 day intervals until the final application on August 15th. The number of dollar spot patches per plot and quality (1-9, 9 being excellent and 6 acceptable) were visually assessed and the data was subjected to an analysis of variance to determine statistical differences between treatments.

RESULTS AND DISCUSSION

Dollar spot pressure has been variable this summer, but an extended period of high pressure immediately preceded the rating on July 13th and continued through the August 7th rating. In regards to the August 7th rating, only treatments 3 and 20 did not significantly reduce dollar spot when compared to the control, but it should be noted treatment 20 (Daconil Ultrex) was put down at a low rate on a 21 day interval and that is not recommended on the label. The poor control by treatment 3 (3336 Plus) appears to be a product of resistance by the pathogen. Treatments 4, 6, 13, and 16 provided exceptional control of dollar spot with an average of less than 10 dollar spots per 3 X 5 foot plot. Only treatements 3 and 20 failed to improve the quality when compared to the control. Most other treatments were similar in their quality, except treatments 13 and 19 provided slightly higher quality on the August 15th rating. It should also be noted that treatments 4, 5, 6, and 7 were the only treatments to provide acceptable quality two weeks after the final treatment applications. No phytotoxicity was observed with any of the treatments applied.

Mean number of dollar spots per plot at the O. J. Noer Turfgrass Center in Verona, WI

	Treatment	Rate		Interval	Rating Date			
					July 13*	July 25*	Aug 7*	Aug 23*
1	Non-treated control				102.5ab	138a	160.3a	200.8a
2	26/36	4	FL OZ/M	21 Days	2.8d	4.5d	51.3b-e	11.5g
3	3336 Plus	4	FL OZ/M	21 Days	118.5a	117.8a	159.3a	171.8b
4	3336 Plus CLEX-08	4 8	FL OZ/M OZ/M	21 Days	0d	2.3d	4.3e	0.3g
5	3336 Plus CLEX-08	4 4	FL OZ/M OZ/M	21 Days	4.8d	0.8d	21.5cde	0.5g
6	CLEX-08	8	OZ/M	21 Days	0.5d	0.3d	7de	1.3g
7	CLEX-08	4	OZ/M	21 Days	0d	0.5d	18cde	0.8g
8	CLEX-09	1.2	OZ/M	21 Days	16.8cd	15d	64.3bcd	71ef
9	CLEX-09	0.6	OZ/M	21 Days	31.8cd	66.5bc	99.3b	124cd
10	Banner MAXX	1	FL OZ/M	21 Days	54.8bcd	41.3cd	103.8b	95.8de
11	Headway	0.75	FL OZ/M	14 Days	29.3cd	28.3cd	12.5cde	23.3g
12	Headway	1.5	FL OZ/M	21 Days	23cd	30.5cd	70.5bc	74.8ef
13	Tartan	1	FL OZ/M	14 Days	0.5d	2.8d	3e	2.8g
14	Tartan	2	FL OZ/M	21 Days	9.8d	1.5d	24.8cde	13.8g
15	Insignia	0.9	OZ/M	14 Days	7.5d	9.8d	10.8de	43fg
16	Insignia PX056	0.9 0.125	OZ/M % V/V	14 Days	8d	4.8d	3e	31.3g
17	Bayleton	1	OZ/M	21 Days	20.5cd	18d	43.3cde	46fg
18	Bayleton SC	1	FL OZ/M	21 Days	16.8cd	18d	65.3bcd	73.3ef
19	Lynx	2	FL OZ/M	21 Days	7d	4.3d	56.3b-e	10.3g
20	Daconil Ultrex	1.8	OZ/M	21 Days	81.3abc	80.3b	144.3a	147.8bc
		LSD			**41.01**	**31.31**	**35.2**	**28.5**

***Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)**

Quality Ratings for Dollar Spot Fairway Trial at the O. J. Noer Turfgrass Research and Education Center in Verona, WI

	Treatment	Rate		Interval	Rating Date	
					Aug 15*	**Aug 31***
1	Non-treated control				2.5d	1.5i
2	26/36	4	FL OZ/M	21 Days	7.3ab	5.5bcd
3	3336 Plus	4	FL OZ/M	21 Days	3.3d	2hi
4	3336 Plus CLEX-08	4 8	FL OZ/M OZ/M	21 Days	7.5ab	8.8a
5	3336 Plus CLEX-08	4 4	FL OZ/M OZ/M	21 Days	7.5ab	7.8a
6	CLEX-08	8	OZ/M	21 Days	7.8ab	8.3a
7	CLEX-08	4	OZ/M	21 Days	7.8ab	6.5b
8	CLEX-09	1.2	OZ/M	21 Days	6.5abc	4d-g
9	CLEX-09	0.6	OZ/M	21 Days	5c	3.3fgh
10	Banner MAXX	1	FL OZ/M	21 Days	5.8bc	3.8efg
11	Headway	0.75	FL OZ/M	14 Days	6bc	4.3c-f
12	Headway	1.5	FL OZ/M	21 Days	7.5ab	3.3fgh
13	Tartan	1	FL OZ/M	14 Days	8.3a	5.8bc
14	Tartan	2	FL OZ/M	21 Days	7.5ab	4.8c-f
15	Insignia	0.9	OZ/M	14 Days	5.3c	3.8efg
16	Insignia PX056	0.9 0.125	OZ/M % V/V	14 Days	6bc	4.5c-f
17	Bayleton	1	OZ/M	21 Days	7abc	4.5c-f
18	Bayleton SC	1	FL OZ/M	21 Days	7abc	4d-g
19	Lynx	2	FL OZ/M	21 Days	8.5a	5cde
20	Daconil Ultrex	1.8	OZ/M	21 Days	5c	2.5ghi
		LSD			**1.26**	**1**

***Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)**

Control of Sclerotinia Dollar Spot (Putting Green)

Paul Koch, Dan Goeser, Jeremy Nacewicz, Jennifer Koch, and Dr. Geunhwa Jung
Department of Plant Pathology

OBJECTIVE

To determine the efficacy of standard and experimental fungicides for controlling dollar spot caused by the fungus *Sclerotinia homoeocarpa*.

MATERIALS AND METHODS

The study was conducted at the O. J. Noer Turfgrass Research and Education Facility on a stand of creeping bentgrass (Agrostis stolonifera 'Penncross') maintained at 0.156 inches. The individual plots measured 3 feet by 5 feet and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000 ft^2. All treatments were initiated June 1st, and subsequent applications were made at 7, 14 or 21 day intervals until the last application was made on August 18th. The number of dollar spot patches per plot was visually assessed and quality rated on a 1-9 scale (9 being excellent, 6 being acceptable) and the data was subjected to an analysis of variance to determine statistical differences between treatments.

RESULTS AND DISCUSSION

Conditions have been optimum for dollar spot disease development throughout much of the season, but pressure on the putting green trial has been lower when compared to the trial maintained at fairway height. Because of this, all treatments significantly reduced dollar spot symptoms when compared to the untreated control. Treatments 7, 8, 11, 15, 19, 20, 21, and 22 all provided exceptional control of dollar spot with a mean of less than or equal to one dollar spot per 3 X 5 plot. All treatments provided increased quality over the untreated control, but treatments 19 and 20 provided superior quality throughout the summer with average quality ratings higher than 8. No phytotoxicity was observed with any treatments.

Mean number of dollar spots per plot at the O. J. Noer Turfgrass Research and Education Center in Verona, WI

	Treatment	Rate		Interval	Rating Date			
					July 13*	**July 25***	**Aug 8***	**Aug 23***
1	Non-treated control				19.8a	56a	72.5a	90.8a
2	Spectator Ultra	1	FL OZ/M	14 Days	4.5b	1.5b	2.3b	1.5b
3	Spectator Ultra	2	FL OZ/M	21 Days	3.5b	2b	2.8b	5b
4	Manicure Ultra	1.82	OZ/M	7 Days	2.5b	1.8b	3.5b	3b
5	Manicure Ultra	3.25	OZ/M	14 Days	2.3b	7.8b	6.5b	12b
6	Manicure 6FL	3.6	FL OZ/M	14 Days	3b	9.3b	4.8b	8.3b
7	Spectator Ultra Manicure Ultra	2 3.25	FL OZ/M OZ/M	14 Days	2.5b	1.3b	0.5b	0.3b
8	Spectator Ultra Manicure Ultra	1 1.82	FL OZ/M OZ/M	7 Days	4b	1b	0.5b	0.3b
9	Instrata	3	FL OZ/M	14 Days	4.5b	0.5b	2.3b	0.3b
10	Instrata	6	FL OZ/M	28 Days	5.5b	7.3b	6.5b	2.8b
11	Headway	1.5	FL OZ/M	14 Days	4b	3.5b	1b	0.5b
12	Tartan	1	FL OZ/M	14 Days	4b	7b	3.5b	6.8b
13	Tartan	2	FL OZ/M	21 Days	3.5b	6b	3.8b	4.8b
14	Emerald	0.13	OZ/M	14 Days	3.3b	2b	1.8b	0.8b
15	Emerald	0.18	OZ/M	14 Days	5.5b	1.8b	0.3b	1.3b
16	Bayleton	1	OZ/M	14 Days	2.8b	1.8b	3b	3.8b
17	Bayleton SC	1	FL OZ/M	14 Days	4.5b	3.8b	4b	3.8b
18	Lynx	1	OZ/M	14 Days	3.5b	4b	3.5b	1.3b
19	Lynx	1.5	FL OZ/M	14 Days	2b	0.3b	1b	0b
20	Lynx Chipco AL Signature	1.5 4	FL OZ/M OZ/M	14 Days	2.3b	0.8b	0b	0b
21	Bayer-EXP	1.5	FL OZ/M	14 Days	5.3b	1.3b	0.3b	0.5b
22	Banner MAXX	2	FL OZ/M	14 Days	4.5b	0.8b	0.5b	1.5b
	LSD				**5.48**	**15.56**	**15.53**	**18.8**

***Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)**

Quality Ratings taken from the O. J. Noer Turfgrass Research and Education Center in Verona, WI

	Treatment	Rate		Interval	Rating Date		
					Aug 15*	Aug 21*	Aug 31*
1	Non-treated control				4.8c	3.3d	3.5d
2	Spectator Ultra	1	FL OZ/M	14 Days	6.5b	6.5bc	6.8abc
3	Spectator Ultra	2	FL OZ/M	21 Days	6.5b	7bc	6.5bc
4	Manicure Ultra	1.82	OZ/M	7 Days	7.5b	7bc	6.8abc
5	Manicure Ultra	3.25	OZ/M	14 Days	7b	6.3bc	7abc
6	Manicure 6FL	3.6	FL OZ/M	14 Days	6.8b	6.5bc	5.8c
7	Spectator Ultra Manicure Ultra	2 3.25	FL OZ/M OZ/M	14 Days	6.3b	6.8bc	6.8abc
8	Spectator Ultra Manicure Ultra	1 1.82	FL OZ/M OZ/M	7 Days	6.8b	6.5bc	6.8abc
9	Instrata	3	FL OZ/M	14 Days	6.8b	6.8bc	7abc
10	Instrata	6	FL OZ/M	28 Days	6.5b	6.5bc	7abc
11	Headway	1.5	FL OZ/M	14 Days	7b	6.5bc	6.8abc
12	Tartan	1	FL OZ/M	14 Days	7.3b	6.5bc	6c
13	Tartan	2	FL OZ/M	21 Days	7.3b	6.5bc	6c
14	Emerald	0.13	OZ/M	14 Days	7b	7bc	7abc
15	Emerald	0.18	OZ/M	14 Days	7b	7.5abc	7.5abc
16	Bayleton	1	OZ/M	14 Days	6b	6c	6c
17	Bayleton SC	1	FL OZ/M	14 Days	6b	6c	6c
18	Lynx	1	OZ/M	14 Days	7.8b	7.8ab	7.3abc
19	Lynx	1.5	FL OZ/M	14 Days	8.8a	8.5a	8.5ab
20	Lynx Chipco AL Signature	1.5 4	FL OZ/M OZ/M	14 Days	9a	8.5a	8.8a
21	EXP	1.5	FL OZ/M	14 Days	7b	6.8bc	8.3ab
22	Banner MAXX	2	FL OZ/M	14 Days	6.3b	6.3bc	7abc
	LSD				**0.96**	**0.84**	**1.14**

***Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)**

Preventative Application of Fungicides for the Control of Dollar Spot

Paul Koch[1], Pat Sisk[2], and Dr. Geunhwa Jung[1]
[1]Department of Plant Pathology, University of Wisconsin-Madison
[2]Milwaukee Country Club, River Hills, WI

OBJECTIVE

To determine length and degree of efficacy of different fungicides and fungicide combinations in preventing dollar spot caused by the fungus *Sclerotinia homoeocarpa*.

MATERIALS AND METHODS

This study was performed at Milwaukee Country Club located in River Hills, WI on a creeping bentgrass nursery maintained at 0.5 inches. The individual plots measured 3 x 5 ft and were arranged in a randomized complete block design with four replications. All 26 treatments were applied on May 3rd, 2006. Fungicide treatments were applied at a rate of 2 gallons per 1000 ft2 using a CO2 pressurized boom sprayer (40 psi) equipped with XR Teejet 8005 VS nozzles. Ratings of quality (1-9 with 9 being excellent) and the amount of disease present (% cover per plot) were taken weekly at both experimental locations. The results of the weekly ratings were then analyzed for their statistical significance via analysis of variance.

RESULTS AND DISCUSSION

Dollar spot disease pressure was relatively high this year in the Milwaukee area, with disease pressure becoming extremely high near the end of July. Despite this pressure, only the low rate of Daconil Ultrex failed to provide less than 10% control through 6 weeks after the initial application. The rating taken on July 25th (in bold on table) is nearly 12 weeks after the initial application, and most treatments are still providing statistically significant reductions in dollar spot when compared to the control. Treatments 15 (Lynx) and 24 (high rate of Banner MAXX and Bayleton) provided exceptional dollar spot control on this rating date with means of 6.3% and 5% dollar spot, respectively. There were no statistically significant differences in the next rating taken on July 31st, suggesting all the treatment were no longer effective. No significant differences in quality were recorded.

Table 1: Efficacy of fungicides and tank mixtures for pushing the initial outbreak of dollar spot or reducing the disease severity by knocking down the initial disease at Milwaukee Country Club in 2006.

	Treatment	Rate		Disease Rating (mean percent diseased area per plot)					
				June 13*	June 19*	July 4*	July 21*	**July 25***	July 31*
1	Non-treated control			6.5a	5ab	31.3ab	31.3abc	**40a**	38.8a
2	Chipco 26GT	4	FL OZ/M	0b	0b	1.5bc	12.8bcd	**10bc**	10a
3	Chipco 26GT	2	FL OZ/M	0b	0.5b	4.3bc	12.5bcd	**16.3abc**	8.8a
4	Emerald	0.18	OZ/M	0b	0.3b	2.3bc	13.8bcd	**13.8bc**	11.3a
5	Banner Maxx	2	FL OZ/M	0b	0b	1.5bc	12.5bcd	**11.3bc**	10a
6	Banner Maxx	0.5	FL OZ/M	1.5b	0b	3bc	15bcd	**11.3bc**	11.3a
7	Spotrete	5	OZ/M	8.8a	6ab	31.3ab	27.5bcd	**31.3abc**	37.5a
8	3336 Plus	4	FL OZ/M	2.5b	1.5b	10.5bc	16.3bcd	**13.8bc**	13.8a
9	Curalan EG	1	OZ/M	0b	1.3b	6bc	10bcd	**8.8bc**	18a
10	Tartan	2	FL OZ/M	0b	0b	4.5bc	8.8bcd	**11.3bc**	8.8a
11	Daconil Ultrex	5	OZ/M	0b	0.3b	8.8bc	22.5a-d	**22.5abc**	18.8a
12	Daconil Ultrex	1.8	OZ/M	1.3b	10.3b	41.3a	40.5a	**36.3ab**	37.5a
13	Rubigan AS	1.5	FL OZ/M	0b	0.3b	6.5bc	17.5bcd	**28.8abc**	31.8a
14	Eagle	2.4	FL OZ/M	1.3b	0.5b	1.3bc	7.5cd	**8.8bc**	4a
15	Lynx	2	FL OZ/M	0b	0b	1bc	8.8bcd	**6.3c**	3.3a
16	Bayleton	1	OZ/M	0b	0b	12.8bc	18.8bcd	**8.8bc**	5.5a
17	Bayleton	0.25	OZ/M	0.5b	0.5b	5.3bc	17.5bcd	**15abc**	11.3a
18	Banner MAXX Chipco 26GT	2 4	FL OZ/M FL OZ/M	1.5b	0b	0.5bc	6.3d	**11.3bc**	8a
19	Banner MAXX Chipco 26GT	0.5 2	FL OZ/M FL OZ/M	0b	0b	0.8bc	17.5bcd	**10bc**	11.3a
20	Banner MAXX Curalan EG	2 1	FL OZ/M OZ/M	0b	0b	0.3c	8.8bcd	**7.5bc**	6a
21	Banner MAXX Curalan EG	0.5 1	FL OZ/M OZ/M	0b	0b	1.8bc	10bcd	**8.8bc**	6.8a
22	Banner MAXX Daconil Ultrex	2 5	FL OZ/M OZ/M	0b	0b	1bc	11.3bcd	**11.3bc**	7.5a
23	Banner MAXX Daconil Ultrex	0.5 1.8	FL OZ/M OZ/M	0b	0.3b	2.8bc	11.3bcd	**11.3bc**	5.3a
24	Banner MAXX Bayleton	2 1	FL OZ/M OZ/M	0b	0b	0.5bc	7.5cd	**5c**	4.3a
25	Banner MAXX Bayleton	0.5 0.25	FL OZ/M OZ/M	1.5b	0b	3.3bc	16.3bcd	**15abc**	8a
	LSD			3.05	4.57	16.73	13.06	**15.73**	20.55

Column in bold contains the most statistically significant differences.
*Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Curative Fungicide Applications for Dollar Spot Control

Paul Koch[1], Dan Goeser[1], Jeremy Nacewicz[1], Jennifer Koch[1], Jim Knulty[2], and Geunhwa Jung[1]
[1]Department of Plant Pathology, University of Wisconsin - Madison
[2]Big Foot Country Club in Fontana, WI

INTRODUCTION

Dollar spot, caused by the fungus *Sclerotinia homoeocarpa*, is an important disease of intensively managed cool-season turfgrass. Fungicides are necessary to provide complete control of the disease throughout the growing season, but decreasing budgets can make it impossible to spray all susceptible turfgrass preventatively. Therefore, it is important to know which fungicides and which fungicide combinations provide the best curative control of dollar spot. The objective of this study was to determine the efficacy of fungicide combinations to curatively control dollar spot caused by the fungus *Sclerotinia homeocarpa*.

MATERIALS AND METHODS

The field trials were conducted at the following two locations: a creeping bentgrass fairway at Big Foot Country Club in Fontana, WI and a creeping bentgrass green at the OJ Noer Turfgrass Research and Education Facility in Verona, WI. Individual plots measured 3 x 5 ft, and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 psi using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were shaken by hand and applied in the equivalent of 2 gallons of water per 1000 ft^2. The rating of dollar spot severity was measured by counting dollar spot infection centers (DSIC's; approximate 2-inch diameter) per each plot at the OJ Noer center, and by percent damage at Big Foot CC. A total of 26 fungicide treatments (either single or mixtures of two) were evaluated for their curative efficacy of dollar spot control. Each treatment was applied twice to the plots. The first treatment was initiated when there was greater than an average of 30 DSIC's per plot at the OJ Noer and greater than 25% damage per plot at Big Foot. The second treatment followed two weeks later. The treatment dates can be seen in Table 1.

Table 1. Dates of applications and ratings for dollar spot curative study conducted at OJ Noer and Big Foot CC in 2006.

Location	Application dates		Rating dates		
OJ Noer	29-June	13-July	28-June	12-July	26-July
Big Foot CC	6-June	20-June	6-June	20-June	5-July

RESULTS AND DISCUSSION

Dollar spot pressure was quite high at both sites this year. The onset of dollar spot was earlier at Big Foot CC, which is why that location was sprayed earlier. Statistically, though, the better data came from the trial at the OJ Noer Turfgrass Research and Education Facility. Treatments 2, 4, 5, 19, 20, 21, and 23 all provided exceptional curative control in the OJ Noer study by allowing less than 5 dollar spots per 3 X 5 foot plot. The lower rates of many treatments provided poor curative control, most likely because of the higher disease pressure found in a curative control situation. Treatments that included thiophanate-methyl (3336 Plus and 3336F) also performed poorly, most likely due to fungicide resistance issues.

Table 2. Efficacy of fungicides and tank mixtures for reducing dollar spot severity at Big Foot CC in 2006.

	Treatment	Rate		Big Foot CC*			OJ Noer*		
				Jun 6	Jun 20	**Jul 5**	Jun 28	Jul 12	**Jul 26**
1	Non-treated control			36a	55abc	**69abc**	39a	61a	**168b**
2	Chipco 26GT	4	FL OZ/M	35a	2c	**6ef**	59a	4b	**1f**
3	Chipco 26GT	2	FL OZ/M	41a	21bc	**29c-f**	56a	18b	**50def**
4	Emerald	0.13	OZ/M	33a	19bc	**14def**	34a	4b	**1f**
5	Emerald PX056	0.13 0.125	FL OZ/M % V/V	20a	11bc	**25c-f**	29a	5b	**1f**
6	Banner MAXX	2	FL OZ/M	53a	54abc	**51a-e**	37a	11b	**10f**
7	Banner MAXX	0.5	FL OZ/M	49a	65ab	**74abc**	36a	12b	**53def**
8	Spotrete	5	FL OZ/M	50a	57abc	**68abc**	27a	28b	**90cde**
9	3336F	4	FL OZ/M	36a	47abc	**85ab**	56a	79a	**223a**
10	Curalan EG	1	OZ/M	51a	4c	**5.5ef**	45a	6b	**13ef**
11	3336 Plus Protect	4 8	FL OZ/M OZ/M	43a	53abc	**85ab**	61a	30b	**95cd**
12	3336 Plus Spotrete	4 7	FL OZ/M FL OZ/M	53a	79a	**91a**	43a	28b	**88cde**
13	Daconil Ultrex	5	OZ/M	45a	1c	**4ef**	61a	6b	**35def**
14	Daconil Ultrex	1.8	OZ/M	26a	6	**29c-f**	51a	26b	**134bc**
15	Eagle	2.4	FL OZ/M	25a	40abc	**54a-d**	36a	23b	**52def**
16	Lynx Flo	1	FL OZ/M	56a	56abc	**68abc**	72a	26b	**42def**
17	Bayleton	1	OZ/M	31a	30abc	**41b-f**	33a	13b	**53def**
18	Bayleton	0.25	OZ/M	35a	58abc	**65abc**	40a	22b	**88cde**
19	Banner MAXX Chipco 26GT	2 4	FL OZ/M FL OZ/M	35a	3c	**2f**	36a	7b	**0.3f**
20	Banner MAXX Chipco 26GT	0.5 2	FL OZ/M FL OZ/M	23a	14bc	**25c-f**	34a	6b	**2f**
21	Banner MAXX Curalan EG	2 1	FL OZ/M OZ/M	18a	1c	**1f**	38a	3b	**0.3f**
22	Banner MAXX Curalan EG	0.5 1	FL OZ/M OZ/M	49a	11bc	**3ef**	37a	8b	**6f**
23	Banner MAXX Daconil Ultrex	2 5	FL OZ/M OZ/M	43a	1c	**1f**	48a	8b	**0f**
24	Banner MAXX Daconil Ultrex	0.5 1.8	FL OZ/M OZ/M	61a	67ab	**58a-d**	61a	13b	**52def**
25	Banner MAXX Bayleton	2 1	FL OZ/M OZ/M	65a	17bc	**6ef**	41a	6b	**12ef**
26	Banner MAXX Bayleton	0.5 0.25	FL OZ/M OZ/M	37a	41abc	**50a-e**	27a	10b	**19def**
	LSD			37.52	32.71	28.12	26.81	18.42	45.45

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)
Bold column is final rating 2 weeks after 2nd application
***Big Foot rated as % dollar spot, OJ Noer rated as # dollar spots per plot**

Appropriate Spatial Sampling Scale for Determining *In Vitro* Fungicide Sensitivity of a Dollar Spot Population

Young-Ki Jo[1,2], Jessica Rees[1], and Geunhwa Jung[1,2]
[1]Department of Plant Pathology, University of Wisconsin-Madison and [2]Current Address: Department of Plant, Soil & Insect Sciences, University of Massachusetts-Amherst

INTRODUCTION

Dollar spot caused by *Sclerotinia homoeocarpa* F. T. Bennett is one of the most important and chronic diseases on turfgrass in North America. On the intensively-cared-for turf such as golf course fairways and putting greens, multiple applications of different fungicides are usually required for managing dollar spot throughout the growing season. The rapid development and prevalent distribution of fungicide resistance by *S. homoeocarpa* has been known in the US for various classes of fungicides, particularly benzimidazole fungicide thiophanate-methyl and demethylation inhibitor fungicide propiconazole.

Despite significant interest in dollar spot fungicide resistance, proper sampling methods including sample numbers and plot size to provide the representative of fungicide sensitivity of the dollar spot population at a given location have been overlooked. The objective of this study is to determine the proper spatial scale of sampling to properly evaluate the *in vitro* sensitivity of a dollar spot population for thiophanate-methyl and propiconazole.

MATERIALS AND METHODS

Dollar spot isolates were collected from a creeping bentgrass (*Agrostis stolonifera* L.) fairway and a creeping bentgrass putting green at the O.J. Noer Research and Education Facility in Verona, WI in September, 2005, using the hierarchical sampling scheme. Samples were drawn from hierarchically-sized plots at five different spatial scales: 15.00×15.00 m, 3.75×3.75 m, 0.94×0.94 m, 0.23×0.23 m, and 0.06×0.06 m.

In vitro sensitivities of sampled dollar spot isolates for thiophanate-methyl and propiconazole were determined through laboratory petri dish assays. For testing thiophanate-methyl *in vitro* sensitivity, each dollar spot isolate was grown at the same time on a non-amended potato dextrose agar (PDA) and a PDA amended with thiophanate-methyl (Cleary's 3336) at the concentration of 1,000 μg a.i./ml. More than 90% of mycelial growth on the fungicide-amended media compared with the control media indicated insensitivity to thiophanate-methyl, while no growth on the fungicide-amended media indicated that the isolate was sensitive to the fungicide.

For propiconazole *in vitro* sensitivity, each isolate was grown on a non-amended PDA and a propiconazole (Banner MAXX)-amended PDA at the concentration of 0.1 μg a.i./ml. More than 30% of relative mycelial growth on the fungicide-amended media compared with the non-amended control was considered as an insensitive isolate to propiconazole.

RESULTS AND DISCUSSION

There was remarkable consistency of *in vitro* fungicide sensitivity throughout different spatial sampling scales on the fairway and green, but *in vitro* sensitivities to thiophanate-methyl and propiconazole were significantly different between the fairway and putting green (Table 1). The frequencies of insensitive isolates to thiophanate-methyl and propiconazole were 53-92% and 40-73%, respectively, throughout different sizes of sampling scales on the fairway. On the green, the frequencies of insensitive isolates were consistent throughout spatial scale of the plot but significantly less as 13-25% for thiophanate-methyl and 0-24% for propiconazole.

This data suggests that dollar spot fungus seems to distribute uniformly throughout the field of the fairway or green where similar management practices are applied. This finding is beneficial for future dollar spot sampling and for *in vitro* fungicide sensitivity assays. Turfgrass pathologists can select only a small part of a fairway or a green for sampling dollar spot, which still represents the dollar spot population in the whole fairway or green without any significant bias. Another finding is that the mowing height seems to affect the dollar spot population and consequently contributes to the difference of fungicide sensitivities. Further researches need to be done to investigate this interesting phenomenon.

Table 1. Percentage of *in vitro* insensitive isolates to thiophanate-methyl and propiconazole that were collected from the creeping bentgrass fairway and putting green at the O.J. Noer Turfgrass and Education Facility, Verona, WI in September 2005

Plot size (m)	Fairway		Green	
	Thiophanate-methyl insensitivity[1]	Propiconazole insensitivity[2]	Thiophanate-methyl insensitivity	Propiconazole insensitivity
15.00 × 15.00	92.0%	73.9%	21.1%	23.5%
3.75 × 3.75	79.2%	65.2%	15.8%	12.5%
0.94 × 0.94	52.6%	40.0%	25.0%	23.1%
0.23 × 0.23	71.4%	52.4%	13.4%	9.1%
0.06 × 0.06	70.0%	66.7%	14.3%	0.0%

[1]Insensitive isolates growing ≥90% on potato dextrose agar media (PDA) amended with thiophanate-methyl at the concentration of 1,000 µg a.i./ml compared with the mycelial growth on non-amended PDA.
[2]Insensitive isolates growing >30% on PDA amended with propiconazole at the concentration of 0.1 µg a.i./ml compared with the mycelial growth on non-amended PDA.

Dollar Spot Population Dynamics in Response to Fungicides

Young-Ki Jo[1,2], Jessica Rees[1], Ryan Escalante[1], Paul Koch[1], and Geunhwa Jung[1,2]
[1]Department of Plant Pathology, University of Wisconsin-Madison and [2]Current Address:
Department of Plant, Soil & Insect Sciences, University of Massachusetts-Amherst

INTRODUCTION

Dollar spot caused by *Sclerotinia homoeocarpa* F. T. Bennett is the most important disease on intensively managed turf such as golf course putting greens and fairways in the North America. Most golf course superintendents highly rely on fungicides for dollar spot management to meet the desirable aesthetic turf quality. Multiple applications of different fungicides are often required to manage dollar spot throughout the growing season, although various cultural practices such as reduction of the prolonged period of leaf wetness and adequate fertility programs are recommended.

A side effect from the heavy dependence on fungicides is the development of fungicide resistance by *S. homoeocarpa*. Learned from other crop systems, we hypothesize that the frequent and continuous use of fungicides selects insensitive *S. homoeocarpa* isolates in the population, and thus fungicide efficacy decreases. In a worse case scenario, the population is completely dominated by insensitive isolates, causing the failure of fungicides. The main objective of this project is to determine how fast and how much insensitive and sensitive isolates shift in the dollar spot population in response to fungicide applications.

MATERIALS AND METHODS

Field plots were established at the O.J. Noer Turfgrass Research and Education Facility on the creeping bentgrass (*Agrostis stolonifera* L.) fairway and putting green. The individual plots measured 6 × 9 ft and were arranged in a randomized complete block design (n = 4) with 3 ft buffer zones between plots.

The fungicide application began in June, 2006 when disease symptoms became apparent and was conducted in a 21-day interval until September. Rating and sampling of dollar spot were performed before each fungicide application. Fungicide treatments (Table 1) were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressured boom sprayer equipped with two XR Teejet 8005 VS nozzles, and in the equivalent of 2 gallons of water per 1000 ft^2. Percent diseased area and/or number of dollar spot infection centers per plot were subjected to analysis of variance to determine differences between treatments.

Laboratory petri dish assays were run in the lab to evaluate *in vitro* fungicide sensitivity of dollar spot isolates for propiconazole and thiophanate-methyl. Relative mycelial growth of each isolate on fungicide-amended media compared with its growth on non-amended media was indicative of *in vitro* fungicide sensitivity. The change of the composition of sensitive and insensitive isolates in the population was determined.

RESULTS AND DISCUSSION

Dollar spot severity was significantly reduced after the first application of Banner MAXX and CLEX-08 but not Cleary's 3336 on both fairway and green (Table 2). Percentage of insensitive isolates to thiophanate and/or propiconazole significantly increased after fungicide applications as we expected. Interestingly, on the putting green, insensitive isolates to propiconazole significantly increased at the propiconazole-treated plots but not at the plots treated with either thiophanate-methyl or CLEX-08. The time-course monitoring of dollar spot population dynamics showed the negative correlation between the percentage of insensitive isolates and fungicide efficacy in the field. This will provide a fundamental understanding of the mechanisms of fungicide resistance development by *S. homoeocarpa*.

Table 1. Treatments used in this study

Treatment	Product	Active ingredient	Rate (oz/1000 ft^2)
1	Non-treated control		
2	Banner MAXX	Propiconazole	1
3	Cleary's 3336	Thiophanate-methyl	4
4	CLEX-08	Confidential	4

Table 2. The frequency of insensitive isolates to thiophanate-methyl and propiconazole in the dollar spot population and disease severity on a fairway and a putting green before and after fungicide applications

Location	Treatment	Before fungicide applications[1]			After fungicide applications[2]		
		% insensitive isolates to		% disease	% insensitive isolates to		% disease
		Thiophanate -methyl[3]	Propic-onazole[4]		Thiophanate-methyl	Propic-onazole	
Fairway	1	96.3	29.6	0.3	84.2	27.0	25.2
	2	75.0	33.3	0.2	97.5	97.5	15.5
	3	73.5	41.2	0.2	97.2	44.4	32.0
	4	57.5	35.0	0.1	94.4	30.6	6.3
Green	1	63.2	76.3	1.2	68.4	65.8	28.6
	2	77.8	92.6	0.9	97.5	100	6.7
	3	45.5	72.7	1.4	100	100	28.2
	4	60.7	67.9	1.0	100	97.2	0.2

[1]Initial sampling and rating of disease severity were conducted for the fairway on June 23 and for the green on June 6, 2006.
[2]Thiophanate-methyl and propiconazole were applied three times and CLEX-08 was applied twice with a 21-day interval on the fairway. Thiophanate-methyl and propiconazole were applied four times and CLEX-08 was applied three times with a 21-day interval on the green. The last sampling and rating were conducted on September 1, 2006 and presented here.
[3]Percentage of insensitive isolates growing on thiophanate-methyl (1,000 μg a.i./ml)-amended media more than 90% of their growth on non-amended media.
[4]Percentage of insensitive isolates growing on propiconazole (0.1 μg a.i./ml)-amended media more than 30% of their growth on non-amended media.

Control of Anthracnose

Paul Koch, Dan Goeser, Jeremy Nacewicz, Jennifer Koch, and Dr. Geunhwa Jung
Department of Plant Pathology
University of Wisconsin

OBJECTIVE

To determine the efficacy of standard fungicides for preventing anthracnose caused by the fungus *Colletotrichum cereale*.

MATERIALS AND METHODS

The study was conducted on an annual bluegrass and creeping bentgrass fairway at Blackhawk Country Club in Madison, WI. The individual plots measured 3 X 10 feet and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000 ft^2. Treatments were initiated on June 27th and subsequent applications were made at 7, 14, 21, or 28 day intervals as instructed for each treatment (see table). Visual ratings of percent anthracnose were recorded and the data was subjected to an analysis of variance to determine statistical differences between treatments.

RESULTS AND DISCUSSION

Anthracnose disease pressure was light to moderate this year at Blackhawk Country Club, with most treatments providing acceptable control throughout the entire growing season. The first rating on August 8th provided the only statistically significant data of the trial, but clear differences in percent anthracnose can still be seen in the ratings on August 16th and August 31st. Treatments 5, 6, 7, and 8 were the only treatments to allow less than one percent anthracnose at all three rating dates. No phytotoxicity was observed with any treatments.

Percent Anthracnose Recorded at Blackhawk Country Club in Madison, WI

	Treatment	Rate		Interval	Rating Date		
					Aug 8*	Aug 16*	Aug 31*
1	Non-treated control				13.8a	12.5a	8a
2	Spectator Ultra	1	FL OZ/M	14 Days	0b	1.3a	0.5a
3	Spectator Ultra	2	FL OZ/M	28 Days	2.5b	10a	6.8a
4	Manicure Ultra	3.25	OZ/M	7 Days	0b	1.3a	0a
5	Manicure Ultra	5	OZ/M	14 Days	0b	0a	0.5a
6	Manicure 6FL	5.5	FL OZ/M	14 Days	0b	0.5a	0.5a
7	Spectator Ultra Manicure Ultra	2 5	FL OZ/M OZ/M	21 Days	0b	0a	0.5a
8	Spectator Ultra Manicure Ultra	1 3.25	FL OZ/M OZ/M	14 Days	0b	0a	0a
9	Insignia	0.9	OZ/M	14 Days	0b	2.5a	1.3a
10	Insignia Propiconazole Pro	0.9 1	OZ/M FL OZ/M	14 Days	1.3b	2.5a	1.3a
11	Insignia Revolution	0.9 6	OZ/M FL OZ/M	14 Days	6.3ab	10a	6.3a
12	Insignia Cascade Plus	0.9 8	OZ/M FL OZ/M	14 Days	6.3ab	5a	1a
13	Insignia Aqueduct	0.9 8	OZ/M FL OZ/M	14 Days	7.5ab	12.5a	8.3a
		LSD			**5.89**	**8.54**	**5.21**

***Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)**

Control of Rhizoctonia Brown Patch

Paul Koch, Dan Goeser, Jeremy Nacewicz, Jennifer Koch, and Dr. Geunhwa Jung
Department of Plant Pathology
University of Wisconsin

OBJECTIVE

To determine the efficacy of fungicides for the control of Rhizcotonia blight (brown patch) caused by the fungus *Rhizoctonia solani*.

MATERIALS AND METHODS

The study was conducted at the O. J. Noer Turfgrass Research and Education Facility on a mixed stand of colonial bentgrass (*Agrostis capillaries* 'SR7150') and annual bluegrass (*Poa annua*) maintained at 0.5 inch cutting height. The individual plots measured 3 ft X 10 ft and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000 ft^2. All treatments were initiated on June 15th and subsequent applications were made until August 4th depending on the instructed spray interval (see interval in table). Plots were not inoculated, however, plots received extra irrigation (200% evapotranspiration) and biweekly applications of 0.5 lb N/1000 ft^2 when conditions were conducive for disease development. Visual ratings of percent brown patch per plot were recorded on July 20th, July 31st, and August 3rd. The data was then subjected to an analysis of variance to determine statistically significant differences between the treatments.

RESULTS AND DISCUSSION

Brown patch disease pressure was extremely high for a two week period beginning near the end of July and running through the first few days of August. All treatments statistically reduced the percent brown patch damage in comparison with the untreated control. Treatments 9, 10, 11, 12, and 13 all provided exceptional control with damage of less than 2%. All treatments applied at two different rates and intervals provided statistically equal control when applied at lower rates and shorter intervals or higher rates and longer intervals. Insignia provided exceptional control with a spray interval of 28 days. No phytotoxicity was observed with any treatments applied.

Percent Brown Patch Ratings from the O. J. Noer Turfgrass Research and Education Facility in Verona, WI

	Treatment	Rate		Interval	Rating Date		
					July 20*	July 31*	Aug 3*
1	Non-treated control				25a	65a	73.8a
2	Spectator Ultra	1	FL OZ/M	14 Days	0b	20bcd	42.5b
3	Spectator Ultra	2	FL OZ/M	21 Days	2.5b	25bc	41.3b
4	Manicure Ultra	1.82	OZ/M	7 Days	2.5b	8cd	30bcd
5	Manicure Ultra	3.25	OZ/M	14 Days	3.8b	28.8b	33.8bc
6	Manicure 6FL	3.6	FL OZ/M	14 Days	2.5b	9.3cd	27.5bcd
7	Spectator Ultra Manicure Ultra	2 3.25	FL OZ/M OZ/M	21 Days	2.5b	8.5cd	13.8de
8	Spectator Ultra Manicure Ultra	1 1.82	FL OZ/M OZ/M	14 Days	1.3b	7.5cd	21.3cd
9	Headway	0.75	FL OZ/M	14 Days	0b	1.3d	0e
10	Headway	1.5	FL OZ/M	21 Days	0b	0.5d	1.3e
11	Tartan	1	FL OZ/M	14 Days	0b	0.5d	0e
12	Tartan	2	FL OZ/M	21 Days	0b	0d	0e
13	Insignia	0.9	OZM	28 Days	6.3b	0.5d	0e
	LSD				**7.56**	**12.8**	**13.4**

***Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)**

Control of Pythium Blight – 0.5 Inch Cutting Height

Paul Koch, Dan Goeser, Jeremy Nacewicz, Jennifer Koch, and Dr. Geunhwa Jung
Department of Plant Pathology
University of Wisconsin

OBJECTIVE

To determine the efficacy of standard and experimental fungicides for preventing Pythium blight caused by several species of fungi from the *Pythium* genus.

MATERIALS AND METHODS

The study was conducted at the O.J. Noer Turfgrass Research and Education Facility in Verona, WI on a stand of perennial ryegrass (Lolium perenne) seeded on June 1st and maintained at a 0.5 inch cutting height. The individual plots measured 3 feet by 10 feet and were arranged in a randomized complete block design with four replications. Individual treatments were applied on July 18th at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000 ft^2. On July 20th, the trial was covered with an Evergreen® growth blanket which increases the turfgrass canopy temperature and humidity and makes the environment more conducive for Pythium blight infection. The plots were visually rated for percent Pythium blight on July 24th, the plots covered again for two more days, and another rating taken on July 26th. The data was subjected to an analysis of variance to determine statistically significant differences between individual treatments.

RESULTS AND DISCUSSION

Results of this year's Pythium blight trial were affected when the treatment plots were mowed too short and scalped, thinning out much of the trial shortly before onset of optimum Pythium blight conditions. No statistically significant observations were observed with the first rating, but the second rating showed treatments 2, 3, and 5 provided excellent protections against Pythiuim blight.

Percent Pythium Blight Ratings Recorded at the O. J. Noer Turfgrass Facility in Verona, WI

Treatment		Rate		Rating Date	
				July 24*	**July 26***
1	Non-treated control			9.5a	38.8a
2	Subdue MAXX Heritage TL	0.5 1	FL OZ/1000 ft2 FL OZ/1000 ft2	0a	1.3b
3	Heritage TL	2	FL OZ/1000 ft2	0a	0b
4	Subdue MAXX	1	FL OZ/1000 ft2	5.5a	27.5ab
5	Insignia	0.9	OZ/1000 ft2	0a	0b
6	Cyazofamid	0.45	FL OZ/1000 ft2	5a	22.5ab
7	Cyazofamid	0.9	FL OZ/1000 ft2	6.8a	30ab
8	Cyazofamid Alude	0.45 5	FL OZ/1000 ft2 FL OZ/Acre	1.3a	20ab
9	Cyazofamid Alude	0.45 10	FL OZ/1000 ft2 FL OZ/Acre	4.3a	15ab
10	Cyazofamid Alude	0.9 5	FL OZ/1000 ft2 FL OZ/Acre	6.8a	25ab
LSD				**6.96**	**20.06**

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

2005-2006 Snow Mold Control Evaluation - Sentryworld Golf Course, Stevens Point, WI

P. Koch, S. Abler, M. Manemann, Y. Jo, S. Chang, and G. Jung
Department of Plant Pathology
University of Wisconsin-Madison

OBJECTIVE

To evaluate fungicides for the control of Typhula blight (caused by *Typhula ishikariensis* and *T. incarnata*) and pink snow mold (caused by *Microdochium nivale*).

MATERIALS AND METHODS

This evaluation was conducted at Sentryworld Golf Course in Stevens Point, WI on a Penneagle creeping bentgrass (*Agrostis stolonifera*) fairway nursery maintained at 0.5-inch cutting height. Individual plots measured 3 ft x 10 ft (30 ft^2), and were arranged in a randomized complete block design with three replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000ft^2. Granular applications were applied using a shaker jar. Early applications were applied on October 16, 2005, and late applications were applied on November 5, 2005. The experimental plot area was not inoculated. There was continuous snow cover on the plots from mid-January to mid-March 2005, a total of approximately 60 days. The number of Typhula blight patches (approximately 1.5 inch in diameter) and phytotoxicity were recorded on March 30, 2006. Data obtained was subjected to an analysis of variance to determine significant differences between treatments. The mean number of Typhula blight patches and mean phytotoxicity rating for each individual treatment are located in the table below.

RESULTS AND DISCUSSION

Disease pressure was moderate at this site this year with untreated checks averaging 28 snow mold patches (equivalent to 40% diseased area). The dominant pathogens causing damage were *Typhula ishikariensis,* and to a lesser degree, *Typhula incarnata*. All treatments gave significant reduction of snow mold compared with non-treated controls. Many treatments provided 100% control of snow mold. Differences in plot color were observed, but most treatments were statistically equal to the color of the untreated check plots.

Snow Mold and Phytotoxicity Ratings Recorded on March 30, 2006 at Sentryworld, WI

Treatment	Rate	Timing[a]	# Typhula Patches[b]	Phytotoxicity[c]
1 Untreated Control			27.7 a	6.3 a-e
2 18 Plus	4 FL OZ/M	Early	0 c	5 de
Manicure Ultra	5 OZ/M	Early		
Revere 4000	12 FL OZ/M	Late		
3 18 Plus	4 FL OZ/M	Late	0 c	5.3 de
Manicure Ultra	5 OZ/M	Late		
Revere 4000	12 FL OZ/M	Late		
4 Spectator Ultra	4 FL OZ/M	Early	0 c	5 de
Revere 4000	12 FL OZ/M	Late		
5 AMVAC Par-Flo	12 FL OZ/M	Late	0.7 c	6 b-e
6 Revere 4000	12 FL OZ/M	Late	0.7 c	5.7 cde
7 Insignia	0.7 OZ/M	Early	0.3 c	6.3 a-e
18 Plus	4 FL OZ/M	Late		
Manicure Ultra	5 OZ/M	Late		
8 Spectator Ultra	4 FL OZ/M	Early	0 c	6 b-e
Insignia	0.7 OZ/M	Early		
Manicure Ultra	5 OZ/M	Late		
9 Insignia	0.7 OZ/M	Early	0 c	5 de
Manicure Ultra	5 OZ/M	Late		
Revere 4000	12 FL OZ/M	Late		
10 Armada	1.2 OZ/M	Early	0 c	5 de
Revere 4000	12 FL OZ/M	Late		
11 Manicure Ultra	5 OZ/M	Early	0.7 c	8 a
PCNB 12.5% plus 10-3-23E	6 LB/M	Late		
12 Headway	3 FL OZ/M	Early/Late	0 c	6 b-e
13 Headway	5.25 FL OZ/M	Late	1 c	6 b-e
14 Headway	5.25 FL OZ/M	Late	0 c	6 b-e
Daconil WeatherStik	5.5 FL OZ/M	Late		
15 Headway	5.25 FL OZ/M	Late	0 c	6.3 a-e
Medallion	0.5 OZ/M	Late		
16 Banner MAXX	4 FL OZ/M	Early/Late	0 c	5.7 cde
Medallion	0.5 OZ/M	Late		
17 Banner MAXX	4 FL OZ/M	Late	0 c	6 b-e
Medallion	0.5 OZ/M	Late		
18 Daconil WeatherStik	5.5 FL OZ/M	Late	0 c	6 b-e
Medallion	0.5 OZ/M	Late		
19 Instrata	5.5 FL OZ/M	Early/Late	0 c	6 b-e
20 Instrata	4.7 FL OZ/M	Late	0.3 c	6.7 a-d
21 Instrata	6 FL OZ/M	Late	0 c	6.3 a-e
22 Instrata	9.3 FL OZ/M	Late	0 c	6 b-e
23 Instrata	11 FL OZ/M	Late	0 c	6 b-e
24 Medallion	0.14 OZ/M	Late	0.3 c	6.7 a-d
Daconil WeatherStik	2.36 FL OZ/M	Late		
Banner MAXX	1.7 FL OZ/M	Late		

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 16, 2005 and Nov. 5, 2005, respectively

[b]Mean # Typhula blight patches

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 6 = acceptable, 9 = dark green

Snow Mold and Phytotoxicity Ratings Recorded on March 30, 2006 at Sentryworld, WI

	Treatment	Rate	Timing[a]	# Typhula Patches[b]	Phytotoxicity[c]
25	Banner MAXX	2 FL OZ/M	Late	0 c	6.3 a-e
	Daconil WeatherStik	5.5 FL OZ/M	Late		
26	Banner MAXX	2 FL OZ/M	Late	0.3 c	5.7 cde
	Turfcide 400	6 FL OZ/M	Late		
27	Turfcide 400	12 FL OZ/M	Late	2 c	5 de
28	Insignia	0.7 OZ/M	Late	0 c	4.7 e
	Manicure Ultra	3.2 OZ/M	Late		
	Iprodione Pro	4 FL OZ/M	Late		
	Revere 4000	8 FL OZ/M	Late		
29	Heritage TL	2 FL OZ/M	Late	0 c	6 b-e
	Medallion	0.5 OZ/M	Late		
30	Heritage TL	2 FL OZ/M	Late	0 c	6 b-e
	Medallion	0.5 OZ/M	Late		
	Daconil WeatherStik	5.5 FL OZ/M	Late		
31	Heritage TL	3.5 FL OZ/M	Late	0.3 c	6.7 a-d
	Daconil WeatherStik	5.5 FL OZ/M	Late		
32	26 GT	4 FL OZ/M	Late	0 c	6 b-e
	Daconil WeatherStik	5.5 FL OZ/M	Late		
	Turfcide	4 FL OZ/M	Late		
33	Tartan	2 FL OZ/M	Late	1.7 c	8 a
34	Tartan	2 FL OZ/M	Late	0.3 c	7.7 ab
	26 GT	4 FL OZ/M	Late		
35	Tartan	2 FL OZ/M	Late	0 c	7.3 abc
	Turfcide	4 FL OZ/M	Late		
36	26 GT	4 FL OZ/M	Late	2 c	6 b-e
	Compass	0.25 OZ/M	Late		
37	Lynx Flo	1 FL OZ/M	Late	0 c	6 b-e
	Compass	0.25 OZ/M	Late		
38	Lynx Flo	1 FL OZ/M	Late	0 c	6.3 a-e
	Compass	0.25 OZ/M	Late		
	26 GT	4 FL OZ/M	Late		
39	Insignia	0.9 OZ/M	Late	0 c	5.3 de
	Iprodione Pro	4 FL OZ/M	Late		
	Revere	8 FL OZ/M	Late		
40	Insignia	0.9 OZ/M	Late	1.3 c	6 b-e
	Iprodione Pro	4 FL OZ/M	Late		
	Manicure Ultra	3.2 OZ/M	Late		
41	Insignia	0.7 OZ/M	Early/Late	0 c	7.3 abc
	Iprodione Pro	4 FL OZ/M	Early/Late		
	Manicure Ultra	3.2 OZ/M	Early/Late		
42	Turfcide 400	12 FL OZ/M	Late	0 c	5.3 de
43	Turfcide 400	9 FL OZ/M	Late	0 c	5.7 cde
	Daconil Ultrex	3.7 OZ/M	Late		

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 16, 2005 and Nov. 5, 2005, respectively

[b]Mean # Typhula blight patches

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 6 = acceptable, 9 = dark green

Snow Mold and Phytotoxicity Ratings Recorded on March 30, 2006 at Sentryworld, WI

Treatment	Rate	Timing[a]	# Typhula Patches[b]	Phytotoxicity[c]
44 AND5017	6.66 LB/M	Late	0.3 c	8 a
45 AND5174	6.66 LB/M	Late	0 c	8 a
46 AND4334	9 LB/M	Late	1.7 c	5.7 cde
47 AND4333	9 LB/M	Late	0.3 c	6 b-e
48 AND5176	6.36 LB/M	Late	4.3 c	8 a
49 AND5177	6.36 LB/M	Late	1 c	8 a
50 AND5173	10 LB/M	Late	0 c	6.7 a-d
51 AND3224	6.35 LB/M	Late	1 c	8 a
52 26/36	4 FL OZ/M	Late	23.7 ab	6.3 a-e
Endorse	4 OZ/M	Late		
53 26/36	4 FL OZ/M	Late	1 c	6 b-e
Daconil WeatherStik	5.5 FL OZ/M	Late		
54 26/36	4 FL OZ/M	Late	0.7 c	6.7 a-d
Daconil WeatherStik	5.5 FL OZ/M	Late		
Alude	5.5 FL OZ/M	Late		
55 Endorse	4 OZ/M	Late	18.7 b	6 b-e
56 Endorse	4 OZ/M	Late	7 c	6.3 a-e
Spectro	5.75 OZ/M	Late		
57 Spectro	4 OZ/M	Early	1 c	6.3 a-e
Endorse	4 OZ/M	Late		
Spectro	4 OZ/M	Late		
58 CL-EXP-4	1 FL OZ/M	Late	27.3 a	6.3 a-e
59 CL-EXP-4	1 FL OZ/M	Late	4.7 c	6.3 a-e
Spectro	5.75 OZ/M	Late		
60 Spectro	4 OZ/M	Early	7.3 c	6.3 a-e
CL-EXP-4	1 FL OZ/M	Late		
Spectro	4 OZ/M	Late		

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 16, 2005 and Nov. 5, 2005, respectively

[b]Mean # Typhula blight patches

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 6 = acceptable, 9 = dark green

GCSAA and WGCSA-Funded Research: Evaluation of Fungicides to Determine the Minimum Rate of Product Required for Acceptable Species-Specific Snow Mold Control

S. Chang, P. Koch, S. Abler, M. Manemann, Y. Jo, and G. Jung
Department of Plant Pathology, University of Wisconsin-Madison

OBJECTIVES

The objectives are to 1) determine the lowest application rate threshold for acceptable disease control with five fungicides previously selected for their high efficacy to snow mold specific pathogens and 2) convey information about proper threshold application rates of fungicides to fungicide manufacturers as guidelines for labeling their products for specific snow mold fungi.

MATERIALS AND METHODS

Two field trials were conducted, one at Sentryworld Golf Course in Stevens Point, WI and a second study at Gateway Golf Club in Land O' Lakes, WI. Plots at Sentryworld and Gateway Golf Clubs were established in the summer of 2005 as Penncross creeping bentgrass maintained at 0.5 inches. Prior to establishment both areas were fumigated with dazomet (Basimid®) to eliminate snow mold populations that may be present at the site. The plots were seeded at 1#/1000 sq ft. The experimental design is a split plot, randomized complete block with four replications. The fungicides were the main plot with the snow molds being the sub-plot. Treatments were arranged to determine efficacy of five fungicides for four snow mold fungi (*Typhula. incarnata, T. ishikariensis, T. phacorrhiza,* and *Microdochium nivale*). Individual plots were 2 ft X 2 ft. The plots at both locations were inoculated with 12 different isolates of snow mold (2 x *T. incarnata,* 2 x *T. ishikariensis* var. *ishikariensis,* 2 x *T. ishikariensis* var. *canadensis,* 2 x *T. ishikariensis* var. *idahoensis,* 2 x *T. phacorrhiza,* and 2 x *M. nivale*) in November 2005 (Table 1). Each snow mold fungal isolate was prepared as a form of grain inoculum, where each fungus was colonized on sterilized Kentucky bluegrass seeds which served as a medium for growth. One plot was left un-inoculated to serve as an untreated control. The five best-performing fungicides (Table 2) selected from the previous two years' field experiments were applied at three different rates (high-label, intermediate-label, and low-label rates) on November 5th, 2005 at both locations. Individual plots at Sentryworld were rated on March 30th, 2006 and April 7th, 2006 at Gateway to determine percent damage caused by each pathogen.

Table 1. Snow mold isolates used for fungicide sensitivity screening

Isolate ID	Species	**Isolate ID**	Species
NW 3.16.2	*T. ishikariensis* var. *ishikariensis* #1	SW 5.4.5	***T. incarnata* #1**
NW 69.8.5	*T. ishikariensis var. ishikariensis* #2	NE 108.8.3	*T. incarnata* #2
NW 39.3.3	*T. ishikariensis* var. *canadensis* #1	SW 2.13.2	*T. phacorrhiza* #1
NW 10.6.5	*T. ishikariensis* var. *canadensis* #2	NW 3.2.3	*T. phacorrhiza* #2

SW 63.2.4	*T. ishikariensis* var. *idahoensis* #1	NW 48.7.1	*Microdochium nivale* #1
NW 39.5.5	*T. ishikariensis* var. *idahoensis* #2	NE 90.11.1	*Microdochium nivale* #2

Table 2. Fungicides evaluated for efficacy of snow mold control

Chemical	Trade Name	Formulation	Rate (oz/M)
Chloroneb	Terramec SP	65 WP	9, 7.5, 6
Chlorothalonil	Daconil WeatherStik	6 F	5.5, 3.6, 2
PCNB	Revere 4000	4 F	16, 12, 8
Propiconazole	Banner MAXX	1.3 EC	4, 3, 2
Trifloxystrobin	Compass	50 WG	0.25, 0.2, 0.15

RESULTS AND DISCUSSION

Significant differences of fungicides efficacy between snow mold species and among the rates of the fungicides were observed at both sites in Table 3. In addition, there were significant differences between isolates of each snow mold species tested at both sites. Interestingly, significant interaction between snow mold isolates and efficacy of different rates of fungicides was detected at both sites. The identification of *Typhula* species was visually confirmed by sclerotial color and morphology. Overall, PCNB performed very well for the control of the snow mold species at both locations.

Table 3. Analysis of variance for testing effects of fungicide and snow mold isolate on the mean percent snow mold disease at Sentryworld Golf Course (A) and Gateway Golf Course (B)

A.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F	Prob(F)	LSD (.05)
Total	831	305330.2776				
Replication	3	2754.715144	918.238381	5.467	0.001	2.5
Rates of Fungicides	15	26517.41226	1767.827484	10.526	0.0001	5
Isolates	12	103190.7933	8599.232772	51.199	0.0001	4.5
Fungicides x Isolates	180	68566.32212	380.924012	2.268	0.0001	18
ERROR	621	104301.0349	167.956578			

B.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F	Prob(F)	LSD (.05)
Total	831	873676.7692				
Replication	3	10339.70192	3446.567308	10.527	0.0001	3.5
Rates of Fungicides	15	126281.9615	8418.797436	25.713	0.0001	7
Isolates	12	260226.3317	21685.52764	66.233	0.0001	6.3
Fungicides x Isolates	180	273505.976	1519.477644	4.641	0.0001	25.1
ERROR	621	203322.7981	327.411913			

2005-2006 Snow Mold Control Evaluation - The Legend at Giants Ridge: Biwabik, MN

P. Koch, S. Abler, M. Manemann, Y. Jo, S. Chang, and G. Jung
Department of Plant Pathology, University of Wisconsin-Madison
Brian Horgan
Department of Horticultural Science, University of Minnesota

OBJECTIVE

To evaluate fungicide efficacy for the control of Typhula blight (caused by *Typhula ishikariensis* and *Typhula incarnata*), and pink snow mold (caused by *Microdochium nivale*).

MATERIALS AND METHODS

This evaluation was conducted at Giants Ridge Golf Resort, Biwabik, MN on creeping bentgrass (*Agrostis stolonifera*) golf course fairway maintained at a height of 0.5 inch. Individual plots measured 3 ft x 10 ft (30 ft^2), and were arranged in a randomized complete block design with three replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000ft^2. Granular applications were applied using a shaker jar. Early treatments were applied on October 15, 2005, and late treatments were applied on November 6, 2005. There was continuous snow cover on the plots for approximately 120 days. Percent snow mold damage was recorded on April 8th, 2006. Data obtained were subjected to an analysis of variance to determine significant differences between treatment means.

RESULTS AND DISCUSSION

The disease pressure at the experimental site was moderate this year, with snow mold damage approximately 58% on the check plots. The predominant snow mold species that caused damage was *Typhula ishikariensis*, however, *Microdochium nivale* was also present in moderate levels. Heavy ice damage occurred, causing difficulty in disease evaluation on 30% of our plots. Most treatments significantly reduced snow mold damage to less than 10%, but several treatments did not, having above 30% of snow mold damage. Fungicide efficacy of each individual treatment is presented in the table below.

Snow Mold Ratings Recorded on April 8, 2006 at The Legend at Giants Ridge, MN

Treatment	Rate	Timing[a]	% Snow mold
1 Untreated Control			58.3 a
2 18 Plus	4 FL OZ/M	Early	18.3 b
Manicure Ultra	5 OZ/M	Early	
Revere 4000	12 FL OZ/M	Late	
3 18 Plus	4 FL OZ/M	Late	6.7 b
Manicure Ultra	5 OZ/M	Late	
Revere 4000	12 FL OZ/M	Late	
4 Spectator Ultra	4 FL OZ/M	Early	5 b
Revere 4000	12 FL OZ/M	Late	
5 AMVAC Par-Flo	12 FL OZ/M	Late	38.3 ab
6 Revere 4000	12 FL OZ/M	Late	30 ab
7 Insignia	0.7 OZ/M	Early	15 b
18 Plus	4 FL OZ/M	Late	
Manicure Ultra	5 OZ/M	Late	
8 Spectator Ultra	4 FL OZ/M	Early	5 b
Insignia	0.7 OZ/M	Early	
Manicure Ultra	5 OZ/M	Late	
9 Insignia	0.7 OZ/M	Early	0 b
Manicure Ultra	5 OZ/M	Late	
Revere 4000	12 FL OZ/M	Late	
10 Armada	1.2 OZ/M	Early	1.7 b
Revere 4000	12 FL OZ/M	Late	
11 Manicure Ultra	5 OZ/M	Early	30 ab
PCNB 12.5% plus 10-3-23E	6 LB/M	Late	
12 Headway	3 FL OZ/M	Early/Late	5 b
13 Headway	5.25 FL OZ/M	Late	10 b
14 Headway	5.25 FL OZ/M	Late	1.7 b
Daconil WeatherStik	5.5 FL OZ/M	Late	
15 Headway	5.25 FL OZ/M	Late	0.7 b
Medallion	0.5 OZ/M	Late	
16 Banner MAXX	4 FL OZ/M	Early/Late	0 b
Medallion	0.5 OZ/M	Late	
17 Banner MAXX	4 FL OZ/M	Late	4 b
Medallion	0.5 OZ/M	Late	
18 Daconil WeatherStik	5.5 FL OZ/M	Late	0 b
Medallion	0.5 OZ/M	Late	
19 Instrata	5.5 FL OZ/M	Early/Late	5 b
20 Instrata	4.7 FL OZ/M	Late	10 b
21 Instrata	6 FL OZ/M	Late	6.7 b
22 Instrata	9.3 FL OZ/M	Late	0.7 b
23 Instrata	11 FL OZ/M	Late	1.7 b
24 Medallion	0.14 OZ/M	Late	2.3 b
Daconil WeatherStik	2.36 FL OZ/M	Late	
Banner MAXX	1.7 FL OZ/M	Late	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 6, 2005, respectively

[b]Mean percent diseased area

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 7 = acceptable, 9 = dark green

Snow Mold Ratings Recorded on April 8, 2006 at The Legend at Giants Ridge, MN

	Treatment	Rate	Timing[a]	% Snow mold[b]
25	Banner MAXX	2 FL OZ/M	Late	0.3 b
	Daconil WeatherStik	5.5 FL OZ/M	Late	
26	Banner MAXX	2 FL OZ/M	Late	11.3 b
	Turfcide 400	6 FL OZ/M	Late	
27	Turfcide 400	12 FL OZ/M	Late	11.7 b
28	Insignia	0.7 OZ/M	Late	0 b
	Manicure Ultra	3.2 OZ/M	Late	
	Iprodione Pro	4 FL OZ/M	Late	
	Revere 4000	8 FL OZ/M	Late	
29	Heritage TL	2 FL OZ/M	Late	10.3 b
	Medallion	0.5 OZ/M	Late	
30	Heritage TL	2 FL OZ/M	Late	0.3 b
	Medallion	0.5 OZ/M	Late	
	Daconil WeatherStik	5.5 FL OZ/M	Late	
31	Heritage TL	3.5 FL OZ/M	Late	2.3 b
	Daconil WeatherStik	5.5 FL OZ/M	Late	
32	26 GT	4 FL OZ/M	Late	0.7 b
	Daconil WeatherStik	5.5 FL OZ/M	Late	
	Turfcide	4 FL OZ/M	Late	
33	Turfcide 400	12 FL OZ/M	Late	10 b
34	Turfcide 400	9 FL OZ/M	Late	6.7 b
	Daconil Ultrex	3.7 OZ/M	Late	
35	26/36	4 FL OZ/M	Late	13.3 b
	Endorse	4 OZ/M	Late	
36	26/36	4 FL OZ/M	Late	28.3 ab
	Daconil WeatherStik	5.5 FL OZ/M	Late	
37	Endorse	4 OZ/M	Late	11.7 b
	Spectro	5.75 OZ/M	Late	
38	Spectro	4 OZ/M	Early	21.7 ab
	Endorse	4 OZ/M	Late	
	Spectro	4 OZ/M	Late	
39	CL-EXP-4	1 FL OZ/M	Late	5 b
	Spectro	5.75 OZ/M	Late	
40	Spectro	4 OZ/M	Early	6.7 b
	CL-EXP-4	1 FL OZ/M	Late	
	Spectro	4 OZ/M	Late	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 6, 2005, respectively

[b]Mean percent diseased area

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 7 = acceptable, 9 = dark green

2005-2006 Snow Mold Control Evaluation- The Quarry at Giants Ridge

P. Koch, S. Abler, M. Manemann, Y. Jo, S. Chang, and G. Jung
Department of Plant Pathology, University of Wisconsin-Madison
Brian Horgan
Department of Horticultural Science, University of Minnesota

OBJECTIVES

The primary objective is to evaluate fungicide efficacy for the control of snow scald, an outbreak of which has observed in 2005 when PCNB fungicides are switched with other contact and systemic fungicides. Also, fungicide efficacy for the control of Typhula blight (caused by *Typhula ishikariensis* and *Typhula incarnata*), and pink snow mold (caused by *Microdochium nivale*) is evaluated.

MATERIALS AND METHODS

This evaluation was conducted at Giants Ridge Golf Resort, Biwabik, MN on a creeping bentgrass (*Agrostis stolonifera*) golf course fairway maintained at a height of 0.5 inch. Individual plots measured 3 ft x 10 ft (30 ft^2), and were arranged in a randomized complete block design with three replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per $1000ft^2$. Granular applications were applied using a shaker jar. Early treatments were applied on October 15^{th}, 2005, and late treatments were applied on November 6^{th}, 2005. There was continuous snow cover on the plots for approximately 120 days. Percent snow mold, phytotoxicity, and snow scald occurrence were all recorded on April 8th, 2006. Data obtained were subjected to an analysis of variance to determine significant differences between treatment means. The mean percent snow mold damage, mean phytotoxicity, and occurrence of snow scald for each individual treatment is located in the table below.

RESULTS AND DISCUSSION

The disease pressure at the experimental site was moderate this year, with damage approximately 67% in the check plots at The Quarry. The predominant snow mold species that caused damage was *Typhula ishikariensis*. Snow scald damage was also found at non-treated check plots and several non-PCNB treatment plots. Compared with the non-treated controls, most treatments significantly reduced snow mold damage of less than 5%, though some treatments did have damage approaching 10%. A few treatments did cause slight phytotoxic chlorosis, but the majority of treatments had little or no discoloration.

Snow Mold and Phytotoxicity Ratings Recorded on April 8, 2006 at The Quarry, MN

	Treatment	Rate	Timing[a]	Snow scald[b]	% Snow mold[c]	Phytotoxicity[d]
1	Untreated Control			XX	66.7 a	7.3 ab
2	18 Plus	4 FL OZ/M	Early		0.3 c	6 c
	Manicure Ultra	5 OZ/M	Early			
	Revere 4000	12 FL OZ/M	Late			
3	18 Plus	4 FL OZ/M	Late		1.7 c	6 c
	Manicure Ultra	5 OZ/M	Late			
	Revere 4000	12 FL OZ/M	Late			
4	Spectator Ultra	4 FL OZ/M	Early		0.7 c	5.7 c
	Revere 4000	12 FL OZ/M	Late			
5	AMVAC Par-Flo	12 FL OZ/M	Late		0 c	6 c
6	Revere 4000	12 FL OZ/M	Late		1 c	5.7 c
7	Insignia	0.7 OZ/M	Early		0 c	7 b
	18 Plus	4 FL OZ/M	Late			
	Manicure Ultra	5 OZ/M	Late			
8	Spectator Ultra	4 FL OZ/M	Early		0 c	7 b
	Insignia	0.7 OZ/M	Early			
	Manicure Ultra	5 OZ/M	Late			
9	Insignia	0.7 OZ/M	Early		0 c	6 c
	Manicure Ultra	5 OZ/M	Late			
	Revere 4000	12 FL OZ/M	Late			
10	Armada	1.2 OZ/M	Early		0 c	5.3 c
	Revere 4000	12 FL OZ/M	Late			
11	Manicure Ultra	5 OZ/M	Early		1.7 c	7.7 ab
	PCNB 12.5% plus 10-3-23E	6 LB/M	Late			
12	Headway	3 FL OZ/M	Early/Late	X	2 c	7 b
13	Headway	5.25 FL OZ/M	Late	X	1 c	7 b
14	Headway	5.25 FL OZ/M	Late	X	0.3 c	7 b
	Daconil WeatherStik	5.5 FL OZ/M	Late			
15	Headway	5.25 FL OZ/M	Late	X	0.3 c	7 b
	Medallion	0.5 OZ/M	Late			
16	Banner MAXX	4 FL OZ/M	Early/Late		0 c	7 b
	Medallion	0.5 OZ/M	Late			
17	Banner MAXX	4 FL OZ/M	Late		0 c	7.3 ab
	Medallion	0.5 OZ/M	Late			
18	Daconil WeatherStik	5.5 FL OZ/M	Late		0.7 c	7.3 ab
	Medallion	0.5 OZ/M	Late			
19	Instrata	5.5 FL OZ/M	Early/Late		0.3 c	7.3 ab
20	Instrata	4.7 FL OZ/M	Late	X	1.7 c	7.3 ab
21	Instrata	6 FL OZ/M	Late	X	2.7 c	7 b
22	Instrata	9.3 FL OZ/M	Late	X	1 c	7 b
23	Instrata	11 FL OZ/M	Late		1 c	7 b
24	Medallion	0.14 OZ/M	Late	XX	2.7 c	7 b
	Daconil WeatherStik	2.36 FL OZ/M	Late			
	Banner MAXX	1.7 FL OZ/M	Late			

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)
[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 6, 2005, respectively
[b]Occurrence of snow scald at one plot (X) or two plots (XX).
[c]Mean percent diseased area
[d]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 7 = acceptable, 9 = dark green

Snow Mold and Phytotoxicity Ratings Recorded on April 8, 2006 at The Quarry, MN

Treatment	Rate	Timing[a]	Snow scald[b]	% Snow mold[c]	Phytotoxicity[d]
25 Banner MAXX	2 FL OZ/M	Late		2.3 c	7 b
Daconil WeatherStik	5.5 FL OZ/M	Late			
26 Banner MAXX	2 FL OZ/M	Late		0.3 c	6 c
Turfcide 400	6 FL OZ/M	Late			
27 Turfcide 400	12 FL OZ/M	Late		2.3 c	5.3 c
28 Insignia	0.7 OZ/M	Late		0.3 c	5.7 c
Manicure Ultra	3.2 OZ/M	Late			
Iprodione Pro	4 FL OZ/M	Late			
Revere 4000	8 FL OZ/M	Late			
29 Heritage TL	2 FL OZ/M	Late	XX	5 c	7 b
Medallion	0.5 OZ/M	Late			
30 Heritage TL	2 FL OZ/M	Late		0.3 c	7 b
Medallion	0.5 OZ/M	Late			
Daconil WeatherStik	5.5 FL OZ/M	Late			
31 Heritage TL	3.5 FL OZ/M	Late		1 c	7 b
Daconil WeatherStik	5.5 FL OZ/M	Late			
32 26 GT	4 FL OZ/M	Late		0.3 c	7 b
Daconil WeatherStik	5.5 FL OZ/M	Late			
Turfcide	4 FL OZ/M	Late			
33 Turfcide 400	12 FL OZ/M	Late		0.7 c	5.7 c
34 Turfcide 400	9 FL OZ/M	Late		0 c	6 c
Daconil Ultrex	3.7 OZ/M	Late			
35 26/36	4 FL OZ/M	Late		15.3 bc	7 b
Endorse	4 OZ/M	Late			
36 26/36	4 FL OZ/M	Late		6.7 c	7.7 ab
Daconil WeatherStik	5.5 FL OZ/M	Late			
37 Endorse	4 OZ/M	Late		23.3 b	7 b
Spectro	5.75 OZ/M	Late			
38 Spectro	4 OZ/M	Early		1 c	8 a
Endorse	4 OZ/M	Late			
Spectro	4 OZ/M	Late			
39 CL-EXP-4	1 FL OZ/M	Late	X	10.3 bc	7.3 ab
Spectro	5.75 OZ/M	Late			
40 Spectro	4 OZ/M	Early		9.7 bc	7.3 ab
CL-EXP-4	1 FL OZ/M	Late			
Spectro	4 OZ/M	Late			

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 6, 2005, respectively

[b]Occurrence of snow scald at one plot (X) and two plots (XX).

[c]Mean percent diseased area

[d]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 7 = acceptable, 9 = dark green

2005-06 Snow Mold Control Evaluation - Gateway Golf Club, Land O' Lakes, WI

P. Koch, S. Abler, M. Manemann, Y. Jo, S. Chang, and G. Jung
Department of Plant Pathology
University of Wisconsin-Madison

OBJECTIVE

To evaluate fungicides for the control of Typhula blight (caused by *Typhula ishikariensis* and *Typhula incarnata*) and pink snow mold (caused by *Microdochium nivale*).

MATERIALS AND METHODS

This evaluation was conducted at Gateway Golf Club in Land O' Lakes, WI on a creeping bentgrass (*Agrostis stolonifera*) fairway nursery managed at a height of 0.5 inch. Individual plots measured 3 ft x 10 ft (30 ft^2), and were arranged in a randomized complete block design with three replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i using a CO_2 pressurized boom sprayer equipped with two XR Teejet 8005 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 2 gallons of water per 1000ft^2. Granular applications were applied using a shaker jar. Early treatments were applied on October 15, 2005, and late applications were applied on November 5, 2005. There was continuous snow cover on the plots from November 27, 2005 to April 7, 2005 (132 days). Percent snow mold damage were recorded on April 14, 2005. Data obtained were subjected to an analysis of variance to determine significant differences between treatment means.

RESULTS AND DISCUSSION

Disease pressure from *Typhula ishikariensis* was extremely high this season, with untreated control plots averaging 100% disease damage. None of the treatments tested completely controlled disease symptoms, however, twelve treatments had 5% or less damage in this severe year. Most of these treatments are mixtures of two or more fungicides, including treatments 3, 8, 9, 14, 15, 19, 22, 23, 28, 32, 37, and 38. The mean percent snow mold per plot for each individual treatment is presented in the table below.

Snow Mold and Phytotoxicity Ratings Recorded on April 14, 2006 at Gateway Golf Club, WI

Treatment	Rate	Timing[a]	% Snow mold[b]
1 Untreated Control			100 a
2 18 Plus	4 FL OZ/M	Early	22 g-l
Manicure Ultra	5 OZ/M	Early	
Revere 4000	12 FL OZ/M	Late	
3 18 Plus	4 FL OZ/M	Late	5 kl
Manicure Ultra	5 OZ/M	Late	
Revere 4000	12 FL OZ/M	Late	
4 Spectator Ultra	4 FL OZ/M	Early	8.7 jkl
Revere 4000	12 FL OZ/M	Late	
5 AMVAC Par-Flo	12 FL OZ/M	Late	63.3 a-k
6 Revere 4000	12 FL OZ/M	Late	85 a-e
7 Insignia	0.7 OZ/M	Early	25.3 e-l
18 Plus	4 FL OZ/M	Late	
Manicure Ultra	5 OZ/M	Late	
8 Spectator Ultra	4 FL OZ/M	Early	3.3 kl
Insignia	0.7 OZ/M	Early	
Manicure Ultra	5 OZ/M	Late	
9 Insignia	0.7 OZ/M	Early	1.7 l
Manicure Ultra	5 OZ/M	Late	
Revere 4000	12 FL OZ/M	Late	
10 Armada	1.2 OZ/M	Early	49 a-l
Revere 4000	12 FL OZ/M	Late	
11 Manicure Ultra	5 OZ/M	Early	43.3 a-l
PCNB 12.5% plus 10-3-23E	6 LB/M	Late	
12 Headway	3 FL OZ/M	Early/Late	60 a-l
13 Headway	5.25 FL OZ/M	Late	33.3 d-l
14 Headway	5.25 FL OZ/M	Late	4 kl
Daconil WeatherStik	5.5 FL OZ/M	Late	
15 Headway	5.25 FL OZ/M	Late	1.3 l
Medallion	0.5 OZ/M	Late	
16 Banner MAXX	4 FL OZ/M	Early/Late	17.7 h-l
Medallion	0.5 OZ/M	Late	
17 Banner MAXX	4 FL OZ/M	Late	12.3 h-l
Medallion	0.5 OZ/M	Late	
18 Daconil WeatherStik	5.5 FL OZ/M	Late	13.3 h-l
Medallion	0.5 OZ/M	Late	
19 Instrata	5.5 FL OZ/M	Early/Late	3.3 kl
20 Instrata	4.7 FL OZ/M	Late	33.3 d-l
21 Instrata	6 FL OZ/M	Late	24.7 e-l
22 Instrata	9.3 FL OZ/M	Late	1 l
23 Instrata	11 FL OZ/M	Late	1.3 l
24 Medallion	0.14 OZ/M	Late	26 e-l
Daconil WeatherStik	2.36 FL OZ/M	Late	
Banner MAXX	1.7 FL OZ/M	Late	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 5, 2005, respectively

Snow Mold and Phytotoxicity Ratings Recorded on April 14, 2006 at Gateway Golf Club

Treatment	Rate	Timing[a]	% Snow mold[b]
25 Banner MAXX	2 FL OZ/M	Late	61.7 a-l
Daconil WeatherStik	5.5 FL OZ/M	Late	
26 Banner MAXX	2 FL OZ/M	Late	27.7 e-l
Turfcide 400	6 FL OZ/M	Late	
27 Turfcide 400	12 FL OZ/M	Late	63.3 a-k
28 Insignia	0.7 OZ/M	Late	1 l
Manicure Ultra	3.2 OZ/M	Late	
Iprodione Pro	4 FL OZ/M	Late	
Revere 4000	8 FL OZ/M	Late	
29 Heritage TL	2 FL OZ/M	Late	35 c-l
Medallion	0.5 OZ/M	Late	
30 Heritage TL	2 FL OZ/M	Late	10.7 i-l
Medallion	0.5 OZ/M	Late	
Daconil WeatherStik	5.5 FL OZ/M	Late	
31 Heritage TL	3.5 FL OZ/M	Late	56.7 a-l
Daconil WeatherStik	5.5 FL OZ/M	Late	
32 26 GT	4 FL OZ/M	Late	3.3 kl
Daconil WeatherStik	5.5 FL OZ/M	Late	
Turfcide	4 FL OZ/M	Late	
33 Tartan	2 FL OZ/M	Late	81.7 a-g
34 Tartan	2 FL OZ/M	Late	73.3 a-h
26 GT	4 FL OZ/M	Late	
35 Tartan	2 FL OZ/M	Late	25 e-l
Turfcide	4 FL OZ/M	Late	
36 26 GT	4 FL OZ/M	Late	58.3 a-l
Compass	0.25 OZ/M	Late	
37 Lynx Flo	1 FL OZ/M	Late	2.3 kl
Compass	0.25 OZ/M	Late	
38 Lynx Flo	1 FL OZ/M	Late	4.3 kl
Compass	0.25 OZ/M	Late	
26 GT	4 FL OZ/M	Late	
39 Insignia	0.9 OZ/M	Late	23.7 f-l
Iprodione Pro	4 FL OZ/M	Late	
Revere	8 FL OZ/M	Late	
40 Insignia	0.9 OZ/M	Late	25.7 e-l
Iprodione Pro	4 FL OZ/M	Late	
Manicure Ultra	3.2 OZ/M	Late	
41 Insignia	0.7 OZ/M	Early/Late	23.3 f-l
Iprodione Pro	4 FL OZ/M	Early/Late	
Manicure Ultra	3.2 OZ/M	Early/Late	
42 Turfcide 400	12 FL OZ/M	Late	71.7 a-i
43 Turfcide 400	9 FL OZ/M	Late	25.7 e-l
Daconil Ultrex	3.7 OZ/M	Late	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 5, 2005, respectively

[b]Mean % diseased area

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 6 = acceptable, 9 = dark green

Snow Mold and Phytotoxicity Ratings Recorded on April 14, 2006 at Gateway Golf Club

Treatment	Rate	Timing[a]	% Snow mold[b]
44 AND5017	6.66 LB/M	Late	50 a-l
45 AND5174	6.66 LB/M	Late	13.3 h-l
46 AND4334	9 LB/M	Late	53.3 a-l
47 AND4333	9 LB/M	Late	38.3 b-l
48 AND5176	6.36 LB/M	Late	70 a-i
49 AND5177	6.36 LB/M	Late	68.3 a-j
50 AND5173	10 LB/M	Late	15 h-l
51 AND3224	6.35 LB/M	Late	95 abc
52 26/36	4 FL OZ/M	Late	90 a-d
Endorse	4 OZ/M	Late	
53 26/36	4 FL OZ/M	Late	83.3 a-f
Daconil WeatherStik	5.5 FL OZ/M	Late	
54 26/36	4 FL OZ/M	Late	96.7 ab
Daconil WeatherStik	5.5 FL OZ/M	Late	
Alude	5.5 FL OZ/M	Late	
55 Endorse	4 OZ/M	Late	100 a
56 Endorse	4 OZ/M	Late	96.7 ab
Spectro	5.75 OZ/M	Late	
57 Spectro	4 OZ/M	Early	90 a-d
Endorse	4 OZ/M	Late	
Spectro	4 OZ/M	Late	
58 CL-EXP-4	1 FL OZ/M	Late	95 abc
59 CL-EXP-4	1 FL OZ/M	Late	91.7 a-d
Spectro	5.75 OZ/M	Late	
60 Spectro	4 OZ/M	Early	93.3 a-d
CL-EXP-4	1 FL OZ/M	Late	
Spectro	4 OZ/M	Late	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

[a]Early and late fungicide treatments were applied on Oct. 15, 2005 and Nov. 5, 2005, respectively

[b]Mean % diseased area

[c]Phytotoxicity was rated on a scale of 1-9 where 1 = straw colored, 6 = acceptable, 9 = dark green