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DISCLAIMER

This publication reports pesticide use in research trials, and these uses may not conform to the pesticide label. These reported uses are not provided as recommendations. It is always the responsibility of the pesticide applicator, by law, to follow current label directions for the specific pesticide being used.

No endorsement is intended for products mentioned, nor is lack of endorsement meant for products not mentioned. The authors and the Pennsylvania State University assume no liability resulting from the use of pesticide applications detailed in this report.

I have the honor to present to you the enclosed report of the work of the Center for Turfgrass Science, Penn State University, University Park, PA for the year 2000.

Respectfully,
Deborah Holdren,
Editor

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Cultivar Development of Greens-type *Poa annua* Update

Dr. David R. Huff
Department of Agronomy

Introduction

This breeding program began in 1994 at Penn State and is focused on developing commercial cultivars of greens-type *Poa annua* for use on golf course putting greens. The purpose of this breeding program is not to replace bentgrass as a putting surface, but rather, to offer an alternative to those golf courses where *Poa annua* is simply a better choice.

Seed production

The main thrust of the project continues to be in the area of seed increase and seed production. A general observation is that strains exhibiting the best turf quality typically have the lowest seed yields. However, the program is continuing to increase a range of “high” and “low” seed yielding strains. Although the higher seed yielding types might not posses turf quality acceptable for golf greens, they may be entirely acceptable as tee or fairway turf. The seed yield of some greens-types *Poa annua* are so low that they might not be cost-effective to produce for the marketplace. Nonetheless, these strains are also being increased because currently seed costs are only a small part of the overall cost of new green construction and establishment. The project continues to experiment with different methods of seed production and harvest. We are currently harvesting seed as either mower clippings or by vacuuming seed directly off of uncut inflorescences.

The spring 2000 seed harvest produced approximately 12 pounds of seed, i.e. the combined total of all selections. This seed was earmarked for regional trial testing. However, levels of contamination from wild, weedy strains of *Poa annua* within these seed lot could not be reliably determined. Therefore, the establishment of regional trails will be postponed until fall 2001 when seed lots can be assured of being weed-free. An on-site evaluation trial was established at the Valentine Turfgrass Research Facility in fall 2000 using weed-free seed from 60 of the breeding program’s finest selections. Each of these selections has been planted into seed increase fields in fall 2000. The program should be capable of harvesting enough seed of these 60 selections in spring 2001 to establish a regional test in fall 2001. Therefore, a fall 2001 trial will contain more of the breeding program’s elite lines than a trial that would have been planted this fall.

Extreme Temperature Tolerance

The project’s experimental green for root zone examination (planted fall 1999) has become established this year and the camera inserts (two per plot) have been installed. Throughout the growing season the mowing height has been gradually lowered. At present, the height of cut of the green is 5/32 of an inch (3.9 mm) and will remain there for the duration of the rooting observations. This experimental green is the project of Eric Lyons, a NSF Graduate

Student Fellow, whose goal will be to elucidate the root biology of greens-type Poa annua under extreme temperatures (both heat and cold) throughout the growing season.

George Hamilton's Ph.D. dissertation research on the cold and ice coverage tolerance continues to detail differences between Poa annua and creeping bentgrass in terms of temperature and day length sensitivity during the hardening process.

The breeding program is continuing its long-standing collaboration with Ms. Julie Dionne (Laval University) and Yves Castonguay (Agriculture Canada). Julie's results are presently taking the form of manuscripts for scientific and popular journals. Her results are also giving us new directions to focus our future research.

Heat tolerance testing of greens-type *Poa annua* selections continues to be the weak link in the project. I am currently looking for a person to fill this position.

Germplasm Resources and Collecting

During spring 2000, samples of greens-type *Poa annua* were collected from golf greens located in the mid-Atlantic region through the organization and helpful assistance of Mr. Stan Zontek, Director, USGA Mid-Atlantic Region.

Poa Patent

A substantial portion of the year 2000 was focused on drafting a request to the US Patent and Trademark Office for a re-examine of the Minnesota Utility Patent (U.S. Patent 5,912,412) which covers perennial cultivars of *Poa annua* with restricted flowering habits for use as turf. Currently, the request is being reviewed by several independent law firms. After these reviews are completed and the document is appropriately revised, the request will be submitted to the USPTO for consideration. The resulting document is sizeable so only an abstract of the arguments contained in the request follows:

It is submitted that claims 1 through 41 of the subject patent are indistinguishable from, identical to, technically anticipated, or made obvious to any person of ordinary skill in the art, by the following newly applied non-patent prior art literature.
The following examples of non-patent prior art applicable to 35 US 102(b) and 103(a) are drawn to cultivars (i.e. cultivated and uniform varieties) of perennial Poa annua with particular flowering (i.e. "restricted flowering") and morphological characteristics for use as turf. These examples of prior art originate from two sources of non-patent literature:
<u>Literature source #1</u>: Twenty-seven newly applied, scientific papers with senior authorship other than inventor White along with 4 examples of previously applied prior art for purposes of continuity.
<u>Literature source #2</u>: Nine newly applied research reports with senior authorship by Inventor White along with 4 examples of prior art literature that demonstrate the public availability of these reports including 1 with senior authorship by Inventor White.
Lastly, in the process of applying these prior art references to U.S. Patent 5,912,412, it was discovered that Inventor White and the Assignee University of Minnesota might have been less-then-forthright or simply negligent with regards to the INDEPENDENT INVENTOR(S) form and the NONPROFIT ORGANIZATION form, contained in the file wrapper of U.S. Patent 5,912,412, by omitting a nonprofit organization under 37 C.F.R. 1.9(e) and a private business under 37 C.F.R. 1.9(d) with whom they were under contractual agreement to license certain

rights of White's claimed inventions at the time of the subject patent's application. While it is well known that patent re-examinations are based only upon examples of prior art publications, it is a civic duty to point out these four instances of incompleteness in the application of U.S. Patent 5,912,412 to the USPTO re-examination Examiner.

Performance of Kentucky Bluegrass Turfgrass Cultivars and Selections at University Park, PA 1995-1999

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Department of Agronomy, The Pennsylvania State University

Funding Sources: National Turfgrass Evaluation Program, The Pennsylvania Turfgrass Council

Introduction

Tests of commercially-available turfgrass cultivars and experimental selections are conducted annually at Penn State University to provide turfgrass managers, seed industry representatives, county extension agents, and other interested persons with information about turfgrass characteristics and performance. In September 1995, 103 Kentucky bluegrass cultivars and selections were established at the Joseph Valentine Turfgrass Research Center in University Park, PA. All entries were supplied by the National Turfgrass Evaluation Program, an organization established to coordinate the evaluation of turfgrass cultivars and experimental selections in many locations throughout the United States. The following is a report on the performance of Kentucky bluegrass cultivars and selections from 1995 to 1999.

Materials and Methods

Each entry was seeded in September, 1995 in 4 by 6 ft plots at a rate of 2.3 lb of seed per 1000 sq ft. The entire test area received full sunlight. Three replicate plots of each entry were used in this test. Plots were arranged in a randomized complete block design. Prior to seeding, starter fertilizer was applied at a rate of 1.0 lb of N, 0.75 lb of P_20_5 (phosphate), and 0.75 lb K_20 (potash) per 1000 sq ft. The test was fertilized with 2 to 3 lbs nitrogen each year and was mowed at least once a week at 2.0 inches during the test period. The test was irrigated whenever necessary to prevent wilting.

Assessments of Turfgrass Performance

All assessments of turfgrass performance were made on a visual basis. Care was taken to insure consistent and accurate evaluations. The following performance criteria were used to assess Kentucky bluegrass cultivars and selections.

Quality: Quality indicates the overall appearance of the turf and can incorporate several components including density, texture (measure of leaf width), uniformity, color, and freedom from disease and insect damage. Quality was rated using a scale of 1-9, where 9 = highest quality.

Seedling vigor: This rating is a visual estimate of percent ground cover and plant height during the early stages of seedling establishment and reflects the rate of establishment. The plots were rated shortly after seeding using a scale of 1 to 9, where 9 = most vigorous seedling growth.

Percent living ground cover: This rating is used to express the amount of living turf cover remaining after massive localized damage has occurred (such as that caused by disease, insects, weeds, and drought). Percent living ground cover was rated on a scale of 0 to 99%, where 99% = the highest obtainable living ground cover.

Spring green-up: Spring green-up provides an indication of how soon the turf breaks out of winter dormancy. The plots were rated for spring green-up using a scale of 1-9, with 9 = the most uniform green color.

Color: This rating reflects the inherent color of the entry, not yellowing or browning due to mower injury, drought stress, disease, etc. Color ratings are usually taken when grass is not under stress. Color was rated on a scale of 1-9, with 9 = the darkest green color.

Density: Density is a visual estimate of the number of plants per unit area (excluding diseased or insect-damaged patches of turf). Density was rated on a scale of 1-9, with 9 = the most dense turf.

Texture: This rating provides an indication of the relative coarseness/fineness of turf leaf width. Texture is rated on a scale of 1-9, where 9 = the finest-textured turf.

Seedheads: Seedhead production under low mowing heights is generally considered undesirable. Seedheads were visually rated on a scale of 1 to 9 with 9 = the least number of seedheads.

Disease ratings: Disease ratings provide an indication of an entry's reaction to a particular disease. Disease ratings are based on a scale of 1-9 (with 1 = extensive disease damage and 9 = no disease present). Disease ratings of leaf spot, dollar spot, and necrotic ring spot are included in this report.

Data for the above criteria are presented in Tables 1, 2, and 3. Entries are listed in order of the highest combined season average quality to lowest combined season average quality for 1996, 1997, 1998 and 1999. Due to significant contamination of creeping bentgrass in four entries (**Explorer**, **Chicago**, **Arcadia**, and J-1555), quality ratings were not taken for these entries in 1999. The combined season average quality ratings for these four entries were determined by averaging season average quality ratings for 1996, 1997, and 1998.

Differences between two entries are statistically significant only if the LSD (Least Significant Difference) value, listed at the bottom of each column in Tables 1, 2, and 3 is exceeded by the numerical difference between two entries. For example, if entry 'A' is 3.0 units higher in quality than entry 'B', then this difference is only significant if the LSD value is 3.0 or less. If the LSD is greater than 3.0, then the numerical difference between the two entries may be due to inherent variability in the test area or some other element of chance.

Summary of Results

Differences in performance criteria were found among the Kentucky bluegrass entries during 1996-99. Owing to differences in growing conditions between 1996 and 1999, the performance of some entries varied among seasons. The 11 entries showing the highest season average quality over the four-year test period were:

SR 2109
North Star
Blacksburg
Brilliant
NJ 1190
Unique
Princeton 105
PST-P46
Conni
LKB-95
Apollo

Entries that were fastest to establish (as reflected by seedling vigor ratings in 1995) were **Kenblue**, **Nimbus**, and **Baronie**. However, these three entries rated low in quality over the four year test period. Entries with the highest quality ratings generally had low seedling vigor ratings.

Entries with darkest green color over the four year test period included **Moonlight**, **Seabring**, **Total Eclipse**, and VB16015. Those with the lightest (yellow-green) color were **Compact**, BAR VB 3115B, Ba 76-197, **Classic**, **Baronie**, and **Haga**. Dark green Kentucky bluegrasses should not be included is seed mixes with light green cultivars if a uniform color is desired in the stand.

Some Kentucky bluegrasses produce seedheads during late spring and early summer. Seedheads are often considered undesirable and tend to detract from the appearance of the lawn. Entries with the greatest production of seedheads included Ba 81-113, **Dragon**, **Pepaya**, **Abbey**, and **Goldrush**.

Most Kentucky bluegrass entries exhibited high to moderate resistance to leaf spot, dollar spot, and necrotic ring spot diseases. However, some entries such as **Kenblue**, Ba 75-490, NJ-54, and **Glade** were damaged by leaf spot. Entries showing a high degree of dollar spot were BAR VB 6820, SRX 2205, **Pepaya**, BAR VB 233, and **Platini**. Necrotic ring spot severely injured **Pepaya**, HV 242, and BAR VB 6820. Disease resistance in turf may very considerably from year to year and from one location to another.

Keep in mind that the results of this test reflect cultivar performance for the management regime imposed at this site and environmental conditions in central Pennsylvania. This trial does not provide meaningful information on how these cultivars/selections will tolerate heavy traffic and extremely low mowing heights. Also, these results may not be representative of all areas of the state, especially the extreme southeast portion.

Table 1. Seasonal average quality ratings of Kentucky bluegrass entries for 1996-1999. Trial established in September, 1995 at the Joseph Valentine Research Center, University Park, PA.

	Turfgrass Quality Ratings[1]				
Entry[2]	Season Average 1996	Season Average 1997	Season Average 1998	Season Average 1999	Combined Season Ave. 1996-99
SR 2109	7.9	7.3	8.3	7.7	7.8
North Star	6.5	6.7	8.3	7.2	7.2
Blacksburg	7.5	6.9	7.2	6.7	7.1
Brilliant	6.0	7.6	7.7	6.2	6.9
NJ 1190	7.1	6.5	7.4	6.5	6.9
Unique	6.5	6.9	7.4	6.6	6.9
Princeton 105	6.9	6.9	6.9	6.7	6.9
PST-P46	7.5	6.1	7.3	6.1	6.7
Conni	7.2	5.9	7.8	5.9	6.7
LKB-95	7.1	6.1	7.1	6.3	6.6
Apollo	6.0	6.7	7.4	6.2	6.6
Wildwood	6.9	6.0	7.7	5.6	6.5
America	6.2	6.7	7.2	5.8	6.5
Showcase	6.3	6.5	6.9	6.2	6.5
NuStar	7.1	6.5	6.3	5.8	6.5
Rambo	7.3	6.3	7.1	5.2	6.5
ZPS-2183	6.7	6.3	6.6	6.3	6.5
NJ-GD	6.8	7.1	6.6	5.4	6.5
BAR VB 3115B	7.3	6.4	6.7	5.2	6.4
Jefferson	6.9	6.5	6.4	5.6	6.4
Cardiff	5.7	5.9	7.1	6.4	6.3
Eclipse	6.4	6.8	6.3	5.4	6.2
Pick-855	6.8	5.9	6.4	5.8	6.2
Glade	7.6	5.8	6.3	5.2	6.2
Pick 8	5.9	6.5	6.7	5.7	6.2
Moonlight	5.8	6.4	6.4	6.1	6.2
Explorer	6.4	5.9	5.9	-	6.1
Seabring	6.8	6.1	6.3	4.9	6.0
Limousine	6.8	6.1	6.3	4.8	6.0
Award	7.1	6.2	5.9	4.8	6.0
Bartitia	7.2	5.9	6.4	4.3	6.0
Ascot	6.1	6.6	6.3	4.8	5.9
Absolute	7.2	6.1	5.6	4.8	5.9
Odyssey	6.6	6.5	5.5	5.0	5.9

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

Table 1. Quality ratings of Kentucky bluegrass entries for 1996-1999, continued.

Entry[2]	Turfgrass Quality Ratings[1] Season Average 1996	Season Average 1997	Season Average 1998	Season Average 1999	Combined Season Ave. 1996-1999
Chicago	6.5	5.9	5.3	-	5.9
Serene	5.5	6.1	6.7	5.2	5.9
ASP200	7.1	6.3	5.5	4.8	5.9
Arcadia	6.7	6.1	5.2	-	5.9
Allure	6.6	5.9	6.0	4.9	5.9
Blackstone	6.6	5.6	6.1	5.1	5.8
Shamrock	6.3	6.1	6.1	4.8	5.8
Livingston	6.4	5.8	5.4	5.7	5.8
Coventry	6.9	5.4	6.2	4.7	5.8
Ba 81-220	6.7	5.9	5.8	4.7	5.8
Chateau	6.6	5.7	5.9	4.7	5.7
Ba 73-373	6.5	5.9	5.7	4.8	5.7
Haga	6.3	5.9	5.6	5.0	5.7
Quantum Leap	7.0	6.1	5.3	4.3	5.7
H86-690	6.3	6.3	5.9	4.1	5.7
SR 2100	6.0	5.9	5.5	5.1	5.6
NuGlade	6.9	6.6	5.1	3.9	5.6
Misty	5.5	5.9	5.7	5.3	5.6
MED-1580	7.2	5.5	5.7	3.9	5.6
Fortuna	6.2	6.3	5.7	4.1	5.6
Raven	6.7	5.6	5.5	4.5	5.6
Impact	6.2	6.3	5.4	4.3	5.6
Champagne	6.0	5.6	5.8	4.8	5.6
SRX 2205	7.5	4.7	5.8	4.2	5.5
SR 2000	5.3	6.1	5.4	5.2	5.5
Marquis	5.9	5.7	5.8	4.5	5.5
Compact	6.4	5.0	5.9	4.6	5.5
Rugby II	6.7	6.0	4.9	4.2	5.5
Ba 81-270	5.9	5.5	6.0	4.4	5.5
Liberator	6.4	6.1	5.4	3.9	5.5
Dragon	5.7	5.5	5.6	4.9	5.4
Ba 70-060	6.1	5.9	5.2	4.5	5.4
Total Eclipse	6.6	6.3	5.1	3.7	5.4
BlueChip	6.3	6.1	5.4	3.9	5.4

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

Table 1. Quality ratings of Kentucky bluegrass entries for 1996-1999, continued.

	Turfgrass Quality Ratings[1]				
	Season Average				Combined Season Ave.
Entry[2]	1996	1997	1998	1999	1996-1999
Ba 77-702	6.1	6.1	5.4	4.0	5.4
J-1555	6.0	5.4	4.8	-	5.4
Caliber	6.4	5.7	5.3	4.2	5.4
Abbey	6.3	5.7	5.2	4.2	5.4
Jewel	5.4	5.3	6.2	4.5	5.4
Classic	6.6	6.1	5.1	3.7	5.4
Midnight	6.3	6.3	5.1	3.7	5.4
Nimbus	7.0	5.8	5.3	3.2	5.3
VB 16015	5.8	5.6	5.4	4.4	5.3
Goldrush	5.5	6.2	5.2	4.3	5.3
Envicta	6.3	5.7	5.0	4.1	5.3
BAR VB 5649	7.1	5.3	5.1	3.5	5.3
Ba 75-490	5.4	5.1	5.6	4.8	5.2
Baron	5.7	5.7	5.6	3.9	5.2
Platini	7.1	5.3	5.3	3.1	5.2
PST-BO-165	5.9	5.6	5.8	3.5	5.2
Baronie	5.9	6.3	5.1	3.3	5.2
Ba 76-197	5.7	5.4	5.6	3.9	5.1
Baruzo	6.2	5.3	5.7	3.3	5.1
A88-744	4.7	5.7	5.4	4.6	5.1
Sodnet	6.1	5.1	5.0	4.0	5.1
Ba 81-058	6.5	5.0	4.5	4.1	5.0
BAR VB 233	7.2	5.4	4.5	2.9	5.0
LTP-620	4.9	5.2	5.3	4.4	5.0
Challenger	6.1	5.5	4.7	3.4	4.9
Ba 81-113	5.2	5.7	4.8	3.9	4.9
ZPS-309	6.5	5.3	4.6	2.8	4.8
NJ-54	4.7	4.7	4.8	4.2	4.6
Ba 75-163	5.6	5.2	5.2	3.6	4.5
Kenblue	4.1	3.9	4.9	4.4	4.3
BAR VB 6820	6.5	4.6	2.9	2.9	4.2
Sidekick	4.1	4.2	4.5	4.0	4.2
Lipoa	5.7	4.3	4.3	2.2	4.1
HV 242	6.7	4.6	2.7	2.2	4.1
Pepaya	5.5	4.1	3.2	2.9	3.9
LSD at 5%	0.9	0.9	0.9	1.0	-

[1] Refer to ‘Assessments of Turfgrass Performance’ for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

[3] LSD = least significant difference. The LSD values at the bottom of each column represent the minimum difference between any two entries necessary to be 95 percent confident that the difference is not attributable to chance.

Table 2. Performance of Kentucky bluegrass entries for 1995-99. Trial established in September 1995 at the Joseph Valentine Research Center, University Park, PA.

	Turfgrass Ratings[1]				
Entry[2]	Seedling Vigor 9/23/95	% Living Ground Cover 5/5/96	Spring Greenup Combined Season Ave. 1996-99	Color Combined Season Ave. 1996-99	Density Combined Season Ave. 1996-99
SR 2109	4.0	89.7	5.4	5.0	7.2
North Star	2.3	77.3	2.3	7.4	7.3
Blacksburg	3.3	90.0	4.3	7.1	6.8
Brilliant	4.0	83.7	4.1	6.1	6.4
NJ 1190	1.0	85.0	5.3	4.6	7.2
Unique	4.3	85.7	4.3	5.7	6.7
Princeton 105	2.7	86.0	4.5	6.0	6.5
PST-P46	4.3	88.3	3.6	7.2	6.5
Conni	3.0	85.7	3.8	5.2	7.2
LKB-95	5.3	90.3	5.8	4.3	6.7
Apollo	3.0	84.0	4.3	5.8	6.1
Wildwood	5.0	87.7	3.9	6.6	6.3
America	5.3	84.0	4.5	6.3	6.4
Showcase	2.7	81.7	3.7	6.0	5.8
NuStar	4.7	88.3	4.8	4.9	6.4
Rambo	3.7	87.7	5.1	5.3	7.6
ZPS-2183	2.3	87.3	5.4	6.5	5.7
NJ-GD	5.3	88.7	6.4	4.1	6.6
BAR VB 3115B	4.7	92.3	4.7	3.2	7.3
Jefferson	4.7	89.0	6.3	4.1	6.2
Cardiff	3.7	84.0	6.8	5.0	6.4
Eclipse	2.7	84.0	5.2	6.1	6.0
Pick-855	1.7	83.3	5.0	5.4	6.0
Glade	4.7	89.3	4.9	6.9	6.3
Pick 8	1.7	84.0	4.8	5.8	5.7
Moonlight	2.0	79.7	3.2	8.9	5.4
Explorer	2.3	84.3	4.4	6.2	6.2
Seabring	2.7	81.3	2.2	8.4	5.6
Limousine	4.7	92.0	4.6	4.5	8.3
Award	3.0	86.0	3.7	7.9	6.4
Bartitia	5.3	88.0	4.8	5.6	6.8
Ascot	3.7	80.3	2.3	7.4	5.6
Absolute	3.7	88.0	4.5	7.8	6.8
Odyssey	3.0	86.7	4.0	7.6	6.3

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

Table 2. Performance of Kentucky bluegrass entries for 1995-99, continued.

	Turfgrass Ratings[1]				
Entry[2]	Seedling Vigor 9/23/95	% Living Ground Cover 5/5/96	Spring Greenup Combined Season Ave. 1996-99	Color Combined Season Ave. 1996-99	Density Combined Season Ave. 1996-99
Chicago	2.0	86.3	5.5	6.3	6.2
Serene	1.0	75.3	3.8	5.6	6.3
ASP200	4.0	84.3	4.1	6.7	5.9
Arcadia	2.7	88.3	4.9	7.4	6.1
Allure	2.7	87.0	5.0	4.5	6.0
Blackstone	2.7	83.7	5.9	7.5	5.6
Shamrock	4.0	86.7	6.1	4.4	6.4
Livingston	3.3	86.3	5.6	5.0	5.3
Coventry	3.0	89.7	4.9	4.3	6.3
Ba 81-220	3.3	87.7	4.6	6.7	5.5
Chateau	3.3	86.3	4.1	4.3	6.2
Ba 73-373	3.7	87.7	4.5	6.3	5.4
Haga	6.0	89.0	5.1	3.8	6.1
Quantum Leap	3.3	87.3	4.0	7.1	6.0
H86-690	5.3	87.3	6.8	6.1	5.7
SR 2100	4.3	87.3	4.3	5.9	5.8
NuGlade	4.6	83.7	4.3	7.7	6.1
Misty	2.7	80.0	5.0	5.7	5.2
MED-1580	3.3	87.0	4.5	6.1	5.8
Fortuna	4.3	87.0	4.9	6.3	5.4
Raven	4.0	89.3	4.4	6.1	5.2
Impact	3.0	83.3	4.5	7.3	5.9
Champagne	3.3	88.7	6.4	4.8	6.0
SRX 2205	2.7	91.3	4.7	5.5	5.8
SR 2000	1.3	80.7	4.3	6.3	5.7
Marquis	5.0	86.7	4.6	6.4	5.3
Compact	3.3	84.3	4.8	2.6	5.8
Rugby II	2.7	85.7	4.3	7.7	6.2
Ba 81-270	2.3	84.7	3.3	4.4	5.8
Liberator	3.7	84.3	4.1	7.8	6.2
Dragon	3.0	83.7	4.7	5.5	4.7
Ba 70-060	2.3	85.0	4.6	6.4	4.8
Total Eclipse	3.7	86.7	4.0	8.2	6.1
BlueChip	2.3	87.3	4.4	7.2	5.3

[1] Refer to ‘Assessments of Turfgrass Performance’ for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

Table 2. Performance of Kentucky bluegrass entries for 1995-99, continued.

Entry[2]	Turfgrass Ratings[1] Seedling Vigor 9/23/95	% Living Ground Cover 5/5/96	Spring Greenup Combined Season Ave. 1996-99	Color Combined Season Ave. 1996-99	Density Combined Season Ave. 1996-99
Ba 77-702	4.0	84.0	3.8	6.2	5.1
J-1555	3.7	86.0	5.1	6.1	5.8
Caliber	3.0	85.7	5.4	4.6	5.8
Abbey	3.3	85.7	4.3	6.1	5.1
Jewel	3.0	83.0	4.8	4.3	5.7
Classic	4.0	91.7	5.8	3.6	5.7
Midnight	3.0	83.7	4.4	7.9	5.8
Nimbus	7.0	90.7	5.9	4.0	6.3
VB 16015	3.7	82.3	6.0	8.4	5.4
Goldrush	3.0	84.7	4.2	6.8	5.1
Envicta	3.7	87.3	4.1	6.5	5.2
Bariris	3.0	87.7	4.5	4.3	5.9
Ba 75-490	4.0	85.7	7.3	4.6	5.2
Baron	3.7	86.2	3.9	6.6	5.0
Platini	5.0	87.7	4.2	5.0	6.3
PST-BO-165	2.7	83.7	5.2	4.7	5.9
Baronie	6.7	88.3	5.1	3.8	5.6
Ba 76-197	3.3	86.3	4.6	3.3	5.7
Baruzo	3.3	84.0	4.9	6.8	5.9
A88-744	1.3	78.3	4.8	6.2	5.1
Sodnet	2.7	83.0	4.2	7.5	5.9
Ba 81-058	3.7	88.0	5.1	6.2	4.8
BAR VB 233	4.7	94.0	4.8	5.1	6.2
LTP-620	1.3	82.0	6.2	4.3	5.3
Challenger	3.0	83.7	5.5	5.8	5.6
Ba 81-113	2.7	84.3	4.4	6.3	4.5
ZPS-309	3.3	85.3	5.1	5.7	5.4
NJ-54	2.0	81.7	5.4	4.1	5.3
Ba 75-163	2.7	80.3	4.9	6.3	4.9
Kenblue	7.7	93.0	8.6	4.5	4.1
BAR VB 6820	2.0	79.0	3.1	6.8	5.5
Sidekick	2.7	82.3	4.8	5.3	4.3
Lipoa	5.7	82.7	4.9	5.9	5.7
HV 242	2.0	86.0	5.3	5.2	5.3
Pepaya	3.0	76.3	2.8	6.7	4.6
LSD at 5%[3]	1.5	6.1	0.9	0.7	0.7

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

[3] LSD = least significant difference. The LSD values at the bottom of each column represent the minimum difference between any two entries necessary to be 95% confident that the difference is not attributable to chance.

Table 3. Texture, seedheads, and disease ratings of Kentucky bluegrass entries from 1996-1999. Trial established in September 1995 at the Joseph Valentine Research Center, University Park, PA.

	Turfgrass Ratings[1]				
Entry[2]	Texture Combined Season Ave. 1996-98	Seedheads Combined Season Ave. 1996-1999	Leaf Spot 5/30/97	Dollar Spot 9/8/97	Necrotic Ring Spot 6/4/98
SR 2109	6.8	7.0	8.7	7.0	9.0
North Star	8.1	6.8	9.0	6.7	9.0
Blacksburg	6.6	7.0	7.3	7.0	9.0
Brilliant	6.8	5.8	8.0	9.0	9.0
NJ 1190	7.0	6.3	5.3	7.0	9.0
Unique	7.3	6.6	8.0	9.0	9.0
Princeton 105	6.4	8.0	7.3	6.7	9.0
PST-P46	6.6	6.7	8.3	7.0	9.0
Conni	7.7	7.2	9.0	5.7	8.7
LKB-95	8.2	8.1	7.7	5.0	9.0
Apollo	6.9	6.4	8.0	9.0	9.0
Wildwood	7.6	8.0	5.7	7.0	9.0
America	7.0	6.0	7.7	9.0	9.0
Showcase	6.9	6.3	8.7	9.0	9.0
NuStar	7.0	7.4	6.0	7.7	9.0
Rambo	7.2	6.7	7.3	6.3	9.0
ZPS-2183	5.8	7.3	6.7	7.3	9.0
NJ-GD	6.1	7.8	7.7	7.7	9.0
BAR VB 3115B	7.3	7.9	8.0	6.0	9.0
Jefferson	6.8	7.2	6.3	7.3	8.7
Cardiff	7.3	6.8	8.3	7.3	9.0
Eclipse	6.0	6.3	8.7	7.7	9.0
Pick-855	7.8	7.6	7.7	6.7	6.7
Glade	7.1	8.9	4.3	7.0	9.0
Pick 8	6.5	7.8	8.3	8.0	9.0
Moonlight	5.5	7.0	9.0	9.0	9.0
Explorer	6.9	7.3	8.3	7.3	9.0
Seabring	5.9	5.0	8.7	6.3	8.3
Limousine	8.3	6.9	8.3	5.7	8.7
Award	7.6	8.4	8.7	7.7	9.0
Bartitia	7.6	8.1	6.3	5.3	9.0
Ascot	5.7	4.2	9.0	8.3	9.0
Absolute	6.5	7.6	9.0	5.3	8.7
Odyssey	7.3	8.3	8.7	7.7	9.0

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

Table 3. Texture, seedheads and disease ratings of Kentucky bluegrass entries for 1996-99, continued.

Entry[2]	Turfgrass Ratings[1] Texture Combined Season Ave. 1996-98	Seedheads Combined Season Ave. 1996-1998	Leaf Spot 5/30/97	Dollar Spot 9/8/97	Necrotic Ring Spot 6/4/98
Chicago	6.7	6.1	7.7	7.3	9.0
Serene	5.8	6.1	8.3	7.6	9.0
ASP200	6.3	7.9	7.3	7.3	7.7
Arcadia	6.8	8.2	7.3	7.3	9.0
Allure	5.9	6.2	6.3	6.7	9.0
Blackstone	6.9	8.3	7.3	7.7	9.0
Shamrock	6.4	7.1	8.3	6.7	9.0
Livingston	5.0	6.6	7.0	8.3	9.0
Coventry	5.8	5.8	5.3	5.7	9.0
Ba 81-220	5.3	4.3	7.3	6.7	9.0
Chateau	5.8	5.8	6.7	5.7	9.0
Ba 73-373	5.7	4.9	8.3	6.3	9.0
Haga	6.5	6.2	6.7	7.7	9.0
Quantum Leap	7.3	7.6	9.0	8.0	9.0
H86-690	7.3	8.2	6.7	7.3	9.0
SR 2100	5.8	5.3	7.7	6.7	9.0
NuGlade	7.3	8.3	8.3	8.0	9.0
Misty	5.1	5.1	7.0	8.3	9.0
MED-1580	7.0	6.3	5.0	6.3	9.0
Fortuna	6.2	5.6	8.3	7.3	9.0
Raven	5.3	5.2	8.7	6.0	9.0
Impact	7.6	7.9	8.3	7.7	9.0
Champagne	6.5	8.2	8.3	7.0	9.0
SRX 2205	7.0	8.3	6.7	3.0	9.0
SR 2000	4.3	7.1	8.7	7.7	9.0
Marquis	5.8	6.0	8.7	7.0	9.0
Compact	6.2	6.6	8.0	5.7	9.0
Rugby II	7.2	8.3	8.7	7.0	9.0
Ba 81-270	5.6	5.4	7.3	5.0	9.0
Liberator	7.3	8.7	9.0	7.7	9.0
Dragon	5.3	2.9	7.0	7.0	9.0
Ba 70-060	5.4	4.0	7.0	7.7	9.0
Total Eclipse	7.3	8.6	9.0	7.3	9.0
BlueChip	6.3	4.9	8.7	7.0	9.0

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

Table 3. Texture, seedheads, and disease ratings of Kentucky bluegrass entries for 1996-99, continued.

Entry[2]	Turfgrass Ratings[1]: Texture Combined Season Ave. 1996-98	Seedheads Combined Season Ave. 1996-1998	Leaf Spot 5/30/97	Dollar Spot 9/8/97	Necrotic Ring Spot 6/4/98
Ba 77-702	5.4	5.2	7.3	8.0	9.0
J-1555	6.9	7.3	7.3	5.7	9.0
Caliber	6.8	6.7	9.0	5.7	8.7
Abbey	5.5	3.8	8.0	7.3	9.0
Jewel	5.3	6.3	6.7	6.3	9.0
Classic	6.2	4.8	6.3	8.0	9.0
Midnight	7.6	8.6	8.7	7.3	9.0
Nimbus	6.4	6.9	7.3	6.3	9.0
VB 16015	6.3	6.1	9.0	7.3	9.0
Goldrush	6.1	3.9	8.3	9.0	9.0
Envicta	5.3	4.4	8.0	7.0	9.0
BAR VB 5649	6.4	6.8	8.0	5.0	7.7
Ba 75-490	6.2	7.9	2.0	6.7	9.0
Baron	5.7	4.1	8.0	7.0	9.0
Platini	6.7	6.7	9.0	4.3	8.0
PST-BO-165	5.8	4.9	7.3	6.0	9.0
Baronie	6.3	4.3	7.0	8.0	8.7
Ba 76-197	6.2	4.7	6.3	7.3	9.0
Baruzo	7.3	6.6	7.0	5.0	8.7
A88-744	5.2	5.2	8.7	7.0	9.0
Sodnet	7.1	6.0	8.3	5.0	9.0
Ba 81-058	5.9	6.2	7.7	8.0	9.0
BAR VB 233	6.5	7.1	7.7	4.3	5.0
LTP-620	5.8	7.3	8.3	7.0	9.0
Challenger	5.8	5.9	8.7	6.7	9.0
Ba 81-113	5.1	2.4	8.0	8.3	9.0
ZPS-309	6.3	6.0	8.7	4.7	7.7
NJ-54	4.8	6.1	4.0	7.3	9.0
Ba 75-163	5.4	6.4	7.7	6.3	9.0
Kenblue	7.8	9.0	1.7	6.0	9.0
BAR VB 6820	7.9	6.8	8.7	3.7	4.0
Sidekick	3.4	2.9	6.7	8.0	9.0
Lipoa	8.0	5.3	7.0	9.0	9.0
HV 242	6.7	5.4	7.7	5.3	3.3
Pepaya	6.8	3.8	9.0	4.3	2.7
LSD at 5% [3]	0.5	0.8	1.5	1.3	1.0

[1] Refer to 'Assessments of Turfgrass Performance' for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially-available cultivars, those that are in plain type are experimental selections (not available to the general public).

[3] LSD = least significant difference. The LSD values at the bottom of each column represent the minimum difference between any two entries necessary to be 95 percent confident that the difference is not attributable to chance.

Performance of Fine Fescue Cultivars and Selections (1993-96)

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Funding Sources: National Turfgrass Evaluation Program, The Pennsylvania Turfgrass Council

Introduction

Tests of commercially available turfgrass cultivars and experimental selections are conducted annually in University Park, PA to provide turfgrass managers, seed industry representatives, county extension agents, and other interested persons with information about turfgrass characteristics and performance. In September 1993, sixty-six fine fescue cultivars and selections were established at the Joseph Valentine Turfgrass Research Center in University Park, PA. Entries were supplied by the National Turfgrass Evaluation Program (NTEP). The following is a report on the performance of these entries between 1993 and 1996.

Materials and Methods

Each entry was seeded in 4 by 6 ft plots at a rate of 4.4 lb of seed per 1000 sq ft. The entire test area received full sunlight. Three replicate plots of each entry were used in this test. Plots were arranged in a randomized complete block design. Prior to seeding, starter fertilizer was applied at a rate of 1.0 lb of N, 0.5 lb of P_20_5 (phosphate), and 0.5 lb K_20 (potash) per 1000 sq ft. In the spring of each year, a preemergence herbicide was applied for crabgrass control. Trimec^{TM} (2,4-D, MCPP, and dicamba) herbicide was applied in June in each year of the test at 1.5 oz per 1000 sq ft to control broadleaf weeds. The test was mowed at 2.0 inches and fertilized twice in each year (spring and fall) with 1 lb N/1000 sq ft per application. The test was irrigated whenever necessary to prevent wilting.

Assessments of Turfgrass Performance

All assessments of turfgrass performance were made on a visual basis. Care was taken to ensure consistent and accurate evaluations. The following performance criteria were used to assess fine fescue cultivars and selections.

<u>Quality</u>: Quality indicates the overall appearance of the turf and can incorporate several components including: density, texture (measure of leaf width), uniformity, and freedom from disease and insect damage. Quality is rated using a scale of 1 to 9, where 9 = highest quality.

<u>Seedling vigor</u>: This rating is a visual estimate of percent ground cover and plant height during the early stages of seedling establishment and reflects the rate of establishment. The plots were rated shortly after seeding using a scale of 1 to 9, where 9 = most vigorous seedling growth.

Spring green-up: Spring green-up provides an indication of how soon the turf breaks out of winter dormancy. The plots were rated for spring green-up using a scale of 1-9, with 9 = the most uniform green color.

Color: This rating reflects the inherent color of the entry, not yellowing or browning due to mower injury, drought stress, disease, etc. Color ratings are usually taken when grass is not under stress. Color was rated on a scale of 1-9, with 9 = the darkest green color.

Density: Density is a visual estimate of the number of plants per unit area. Density is rated on a scale of 1-9, with 9 = the most dense turf.

Disease ratings: Disease ratings provide an indication of a cultivar's reaction to a particular disease. Disease ratings are based on a scale of 1-9 (with 1 = extensive disease damage and 9 = no disease present). Disease ratings for leaf spot and red thread are included in this report.

Interpretation of Results

Data for the above criteria are presented in Tables 1 and 2. Cultivars that are commercially available are in bold type and experimental selections are in plain type. Differences between two entries are statistically significant only if the LSD (Least Significant Difference) value, listed at the bottom of each column in Tables 1 and 2 is exceeded by the numerical difference between two entries. For example, if cultivar 'A' is 3.0 units higher in quality than cultivar 'B', then this difference is only significant if the LSD value is 3.0 or less. If the LSD is greater than 3.0, then the numerical difference between the two cultivars may be due to inherent variability in the test area or some other element of chance.

Results and Discussion

Seedling vigor (Table 2) was greatest with the mixture of HF9032/**APM** at 80%/20% and 70%/30% on a weight basis. **APM** (a perennial ryegrass) germinated quicker than the fine fescue and enhanced the seedling vigor. Examining fine fescue selections only, BAR UR 204 and Flyer, both strong creeping fescues, showed the greatest seedling vigor on September 23, 1993.

Reliant II, **SR 3100**, **Discovery**, **Osprey**, HF9032/**Dover** (90%/10%), **Shadow II**, HF9032, **Nordic**, **Scaldis**, **Vernon**, **Defiant**, and **Spartan** received the highest combined seasonal quality ratings from 1994 through 1996 (Table 1). Although quality ratings take several factors into account, these entries ranked higher than other entries primarily due to their superior density, uniformity, and lack of leaf spot and red thread susceptibility. 67135 delivered the lowest combined seasonal quality rating.

Differences in leaf spot and red thread susceptibility were noticed among entries during the test period and are reported in Table 2. Ratings revealed that many entries were not severely affected by either disease. Entries that showed the most leaf spot susceptible cultivars were 67135 and BAR Frr 4ZBD. BAR UR 204, **Dawson**, **Rondo**, **Molinda**, **Shademaster II**, and **Seabreeze** exhibited the greatest red thread incidence.

Spring green-up and color ratings were taken each year between 1994 and 1996. Spring green-up was greatest with 67135, **Jasper (E)**, **Aruba**, BAR UR 204, **Eco**, **Medina**, and PST-4DT. Spring green-up was lowest with **SR 3100**, **Discovery**, **Aurora w/endo,** HF9032, **Brigade**, **Nordic**, **Vernon**, **Ecostar**, **Osprey**, and **Scaldis**. Color ratings showed BAR Frr 4ZBD and twelve other selections as the darkest green entries while **Aruba** and 67135 were the lightest green selections.

Keep in mind that the results of this test reflect cultivar performance for the management regime imposed at this site and environmental conditions in central Pennsylvania.

Table 1. Quality ratings of fine fescue cultivars and selections for 1994-96. This trial was established September 1993 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Quality Ratings[1]			
Entry[2]	Species[3]	Season Average 1994	Season Average 1995	Season Average 1996	Combined Season Ave. 1994-96
Reliant II	HRD	6.0	7.3	7.4	6.9
SR 3100	HRD	5.8	7.7	7.2	6.9
Discovery	HRD	6.1	7.6	6.9	6.9
Osprey	HRD	6.6	6.8	7.0	6.8
HF9032/**Dover**(90%/10%)	HRD/CHW	6.4	6.9	7.1	6.8
Shadow II	CHW	6.9	6.6	6.7	6.8
HF9032/**Dover**(100%/0%)	HRD/CHW	5.9	7.3	6.8	6.7
Nordic	HRD	5.3	7.1	7.2	6.6
Scaldis	HRD	5.8	6.8	6.6	6.4
Vernon	HRD	5.6	7.0	6.5	6.4
Defiant	HRD	5.3	6.8	7.0	6.4
Spartan	HRD	5.7	6.6	6.4	6.2
Ecostar	HRD	5.4	6.6	6.4	6.1
HF9032/**Dover**(80%/20%)	HRD/CHW	5.7	5.9	6.7	6.1
HF9032/**Dover**(70%/30%)	HRD/CHW	5.9	5.7	6.7	6.1
Pamela	HRD	5.4	5.9	6.8	6.1
Banner III	CHW	5.6	6.2	6.2	6.0
Aurora w/endo	HRD	5.6	6.4	5.9	5.9
Victory II	CHW	6.1	5.9	5.8	5.9
Treazure	CHW	5.9	5.7	6.1	5.9
MB 82-93	HRD	5.2	6.2	6.3	5.9
Brigade	HRD	5.1	5.8	6.7	5.9

[1] Refer to "Assessments of Turfgrass Performance" for an explanation of performance criteria ratings.
[2] Names that are in bold type are commercially available cultivars, those that are in plain type are experimental selections (not available to the general public).
[3] Fine fescue species and perennial ryegrass are designated by the following letters: CHW = chewings fescue, HRD = hard fescue, PR = perennial ryegrass, SHP = sheep fescue, SLC = slender creeping fescue, STC = strong creeping fescue

Table 1. Quality ratings of fine fescue cultivars and selections for 1994-96, continued.

		Turfgrass Quality Ratings[1]			
Entry[2]	Species[3]	Season Average 1994	Season Average 1995	Season Average 1996	Combined Season Ave. 1994-96
Bridgeport	CHW	6.0	5.6	6.0	5.9
Quarto	SHP	5.3	5.9	6.4	5.9
Culumbra	CHW	5.8	5.8	6.0	5.9
Darwin	CHW	5.7	5.7	6.2	5.9
Tiffany	CHW	5.2	5.9	6.3	5.8
Victory (E)	CHW	6.1	5.3	6.1	5.8
Jamestown II	CHW	5.6	5.8	5.9	5.8
SR 5100	CHW	5.4	5.7	6.2	5.8
TMI-3CE	CHW	5.5	5.6	6.2	5.8
WX3-FFG6	STC	5.6	5.5	6.0	5.7
Eco	CHW	5.7	5.3	5.8	5.6
Brittany	CHW	5.3	5.8	5.7	5.6
Sandpiper	CHW	5.6	5.4	5.7	5.6
MB 66-93	CHW	5.5	5.3	5.9	5.5
HF9032/**APM**(90%/10%)	HRD/PR	4.4	5.3	6.8	5.5
Shadow (E)	CHW	5.8	5.0	5.7	5.5
K-2	CHW	5.5	5.0	6.0	5.5
NJ F-93	CHW	5.7	4.9	5.7	5.4
Banner II	CHW	5.1	5.6	5.6	5.4
ISI-FC-62	CHW	5.7	5.1	5.4	5.4
Florentine	STC	5.5	5.1	5.6	5.4
PST-4ST	STC	4.7	5.9	5.6	5.4

1 Refer to "Assessments of Turfgrass Performance" for an explanation of performance criteria ratings.

2 Names that are in bold type are commercially available cultivars, those that are in plain type are experimental selections (not available to the general public).

3 Fine fescue species and perennial ryegrass are designated by the following letters: CHW = chewings fescue, HRD = hard fescue, PR = perennial ryegrass, SHP = sheep fescue, SLC = slender creeping fescue, STC = strong creeping fescue

Table 1. Quality ratings of fine fescue cultivars and selections for 1994-96, continued.

		Turfgrass Quality Ratings[1]			
Entry[2]	Species[3]	Season Average 1994	Season Average 1995	Season Average 1996	Combined Season Ave. 1994-96
WX3-FF54	CHW	4.9	5.6	5.6	5.4
Medina	CHW	4.9	4.8	6.1	5.3
Jasper (E)	STC	4.8	4.9	5.7	5.1
HF9032/**APM**(80%/20%)	HRD/PR	4.4	5.1	5.8	5.1
Flyer II	STC	5.1	4.9	5.1	5.1
Shademaster II	STC	5.5	4.3	5.2	5.1
HF9032/**APM**(70%/30%)	HRD/PR	4.7	5.1	5.3	5.0
PST-4DT	STC	5.2	4.5	5.3	5.0
Seabreeze	SLC	6.1	3.4	5.5	5.0
Jamestown	CHW	4.8	4.8	4.9	4.9
Aruba	STC	5.2	4.2	4.8	4.8
Flyer	STC	4.9	3.9	5.0	4.6
CAS-FR13	STC	4.6	4.2	4.5	4.4
Molinda	CHW	4.2	3.6	5.4	4.4
Dawson	SLC	5.5	3.3	4.2	4.3
Rondo	STC	5.0	3.4	4.4	4.3
Cascade	CHW	3.6	3.9	4.8	4.1
BAR UR 204	STC	4.5	3.2	4.4	4.1
Common Creeping	STC	4.1	3.4	3.9	3.8
BAR Frr 4ZBD	STC	3.4	3.2	4.2	3.6
Silverlawn	STC	3.7	3.2	3.6	3.5
67135	SHP	1.8	1.8	3.5	2.4
LSD at 5%[4]		1.2	0.8	0.8	0.7

[1] Refer to "Assessments of Turfgrass Performance" for an explanation of performance criteria ratings.
[2] Names that are in bold type are commercially available cultivars, those that are in plain type are experimental selections (not available to the general public).
[3] Fine fescue species and perennial ryegrass are designated by the following letters: CHW = chewings fescue, HRD = hard fescue, PR = perennial ryegrass, SHP = sheep fescue, SLC = slender creeping fescue, STC = strong creeping fescue
[4] LSD = least significant difference. The LSD values at the bottom of each column represent the minimum difference between any two entries necessary to be 95% confident that the difference is not attributable to chance.

Table 2. Performance and disease ratings of fine fescue cultivars and selections for 1993-96. This trial was established September 1993 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Ratings[1]					
Entry[2]	Species[3]	Seedling Vigor 9/24/93	Spring Greenup 1994-96	Color 1994-96	Density 1994-96	Leaf Spot 5/31/94	Red Thread 6/30/95
Reliant II	HRD	2.3	5.1	6.2	7.2	9.0	9.0
SR 3100	HRD	3.3	3.9	6.0	7.2	8.7	8.7
Discovery	HRD	2.7	3.9	5.9	7.6	9.0	9.0
Osprey	HRD	3.7	4.4	6.1	7.4	9.0	8.0
HF9032/**Dover**(90%/10%)	HRD/CHW	5.7	5.4	6.3	7.4	9.0	9.0
Shadow II	CHW	5.3	6.6	5.7	7.6	9.0	8.3
HF9032/**Dover**(100%/0%)	HRD/CHW	4.7	4.1	6.8	7.4	9.0	8.7
Nordic	HRD	4.7	4.3	6.2	7.7	8.3	9.0
Scaldis	HRD	3.7	4.7	6.8	7.0	8.0	8.7
Vernon	HRD	3.0	4.3	7.1	7.3	9.0	9.0
Defiant	HRD	3.7	5.7	6.2	6.8	8.3	8.0
Spartan	HRD	5.3	5.0	5.8	7.1	9.0	8.7
Ecostar	HRD	4.7	4.3	5.3	6.7	8.7	9.0
HF9032/**Dover**(80%/20%)	HRD/CHW	4.7	5.2	6.3	6.9	8.7	9.0
HF9032/**Dover**(70%/30%)	HRD/CHW	5.3	5.3	6.3	6.9	9.0	8.7
Pamela	HRD	3.3	5.7	5.8	6.7	7.7	8.7
Banner III	CHW	3.7	6.4	6.7	7.1	9.0	8.3
Aurora w/endo	HRD	3.7	3.9	5.8	6.9	8.3	8.7
Victory II	CHW	5.3	6.4	5.4	7.1	8.7	8.0
Treazure	CHW	5.7	6.3	5.8	6.9	8.0	7.7
MB 82-93	HRD	3.3	5.8	5.9	6.9	8.7	9.0
Brigade	HRD	4.3	4.2	6.0	6.4	8.3	7.7

[1] Refer to "Assessments of Turfgrass Performance" for an explanation of performance criteria ratings.
[2] Names that are in bold type are commercially available cultivars, those that are in plain type are experimental selections (not available to the general public).
[3] Fine fescue species and perennial ryegrass are designated by the following letters: CHW = chewings fescue, HRD = hard fescue, PR = perennial ryegrass, SHP = sheep fescue, SLC = slender creeping fescue, STC = strong creeping fescue

Table 2. Performance and disease ratings of fine fescue cultivars and selections for 1993-96, continued.

Entry[2]	Species[3]	Turfgrass Ratings[1] Seedling Vigor 9/24/93	Spring Greenup 1994-96	Color 1994-96	Density 1994-96	Leaf Spot 5/31/94	Red Thread 6/30/95
Bridgeport	CHW	5.0	6.6	6.0	7.2	8.7	7.3
Quarto	SHP	3.3	5.9	7.1	6.6	8.3	8.7
Culumbra	CHW	3.7	6.6	7.3	6.7	9.0	8.0
Darwin	CHW	5.3	5.4	7.0	7.0	9.0	8.7
Tiffany	CHW	4.3	6.1	6.3	6.8	8.0	8.3
Victory (E)	CHW	5.0	6.2	5.4	6.9	8.3	7.0
Jamestown II	CHW	5.7	6.6	5.3	6.9	8.3	8.7
SR 5100	CHW	4.3	6.0	6.0	6.8	8.3	8.7
TMI-3CE	CHW	4.7	5.9	6.0	6.6	8.7	7.3
WX3-FFG6	STC	6.0	6.4	6.1	6.9	8.7	7.7
Eco	CHW	4.3	7.1	6.7	6.6	8.3	8.0
Brittany	CHW	4.7	6.2	5.6	6.8	8.3	8.3
Sandpiper	CHW	3.3	6.2	5.8	6.7	9.0	8.7
MB 66-93	CHW	3.7	6.9	6.4	6.2	9.0	7.7
HF9032/**APM**(90%10%)	HRD/PR	6.3	5.1	6.4	6.4	9.0	8.7
Shadow (E)	CHW	4.3	6.4	5.9	6.8	9.0	7.7
K-2	CHW	4.3	6.6	6.9	6.6	9.0	8.0
NJ F-93	CHW	4.0	5.2	6.5	6.8	9.0	6.7
Banner II	CHW	5.7	6.2	5.9	6.3	8.7	9.0
ISI-FC-62	CHW	4.0	6.3	6.3	6.3	8.7	8.3
Florentine	STC	4.7	6.2	7.3	6.6	6.7	7.3
PST-4ST	STC	4.0	6.0	7.0	6.3	6.3	8.7

[1] Refer to "Assessments of Turfgrass Performance" for an explanation of performance criteria ratings.

[2] Names that are in bold type are commercially available cultivars, those that are in plain type are experimental selections (not available to the general public).

[3] Fine fescue species and perennial ryegrass are designated by the following letters: CHW = chewings fescue, HRD = hard fescue, PR = perennial ryegrass, SHP = sheep fescue, SLC = slender creeping fescue, STC = strong creeping fescue

Table 2. Performance and disease ratings of fine fescue cultivars and selections for 1993-96, continued.

		Turfgrass Ratings[1]					
Entry[2]	Species[3]	Seedling Vigor 9/24/93	Spring Greenup 1994-96	Color 1994-96	Density 1994-96	Leaf Spot 5/31/94	Red Thread 6/30/95
WX3-FF54	CHW	5.0	6.0	5.9	6.4	8.7	8.7
Medina	CHW	5.7	7.0	6.8	6.9	7.3	7.3
Jasper (E)	STC	5.7	7.2	7.0	6.2	4.7	8.3
HF9032/**APM**(80%20%)	HRD/PR	7.7	5.3	6.2	6.2	9.0	8.7
Flyer II	STC	5.7	6.1	7.5	5.8	6.3	8.3
Shademaster II	STC	5.0	5.8	7.3	6.0	5.7	5.7
HF9032/**APM**(70%30%)	HRD/PR	7.7	5.8	6.3	5.9	9.0	8.7
PST-4DT	STC	5.0	7.0	6.9	6.2	6.0	7.7
Seabreeze	SLC	4.7	5.7	5.5	5.9	8.0	6.0
Jamestown	CHW	5.3	6.6	5.6	6.2	8.3	7.7
Aruba	STC	5.7	7.1	4.1	5.3	6.3	7.7
Flyer	STC	6.7	6.7	6.8	5.6	5.3	7.0
CAS-FR13	STC	3.0	6.9	7.4	5.2	3.7	8.0
Molinda	CHW	5.0	6.7	5.4	5.4	7.0	5.3
Dawson	SLC	5.0	5.3	4.9	4.7	8.3	4.3
Rondo	STC	4.3	5.0	5.2	5.1	8.0	5.0
Cascade	CHW	5.0	6.9	5.6	5.2	6.3	8.3
BAR UR 204	STC	7.0	7.1	5.3	5.2	5.0	4.3
Common Creeping	STC	6.0	6.0	5.0	4.6	5.7	8.7
BAR Frr 4ZBD	STC	5.3	6.3	7.6	4.6	2.3	7.7
Silverlawn	STC	4.0	6.3	6.3	5.2	5.0	7.3
67135	SHP	3.3	8.0	4.7	3.1	2.0	7.7
LSD at 5%[4]		1.5	1.0	0.7	0.8	1.5	1.8

[1] Refer to "Assessments of Turfgrass Performance" for an explanation of performance criteria ratings.
[2] Names that are in bold type are commercially available cultivars, those that are in plain type are experimental selections (not available to the general public).
[3] Fine fescue species and perennial ryegrass are designated by the following letters: CHW = chewings fescue, HRD = hard fescue, PR = perennial ryegrass, SHP = sheep fescue, SLC = slender creeping fescue, STC = strong creeping fescue
[4] LSD = least significant difference. The LSD values at the bottom of each column represent the minimum difference between any two entries necessary to be 95% confident that the difference is not attributable to chance.

Creeping Bentgrass-Annual Bluegrass Competition

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Introduction

Superior greens-type annual bluegrass (*Poa annua* L. f. *reptans* [Hauskins] T.Koyama) selections offer the prospect for an alternative to creeping bentgrass (*Agrostis stolonifera* L.) for establishing golf greens with excellent putting characteristics. The superior greens-type annual bluegrasses form very dense populations that appear to resist invasion by other turfgrass populations, including other annual bluegrasses. The objective of this experiment was to assess the competitive ability of selected greens-type annual bluegrasses from Dr. David Huff's breeding program in communities with creeping bentgrasses.

Materials and Methods

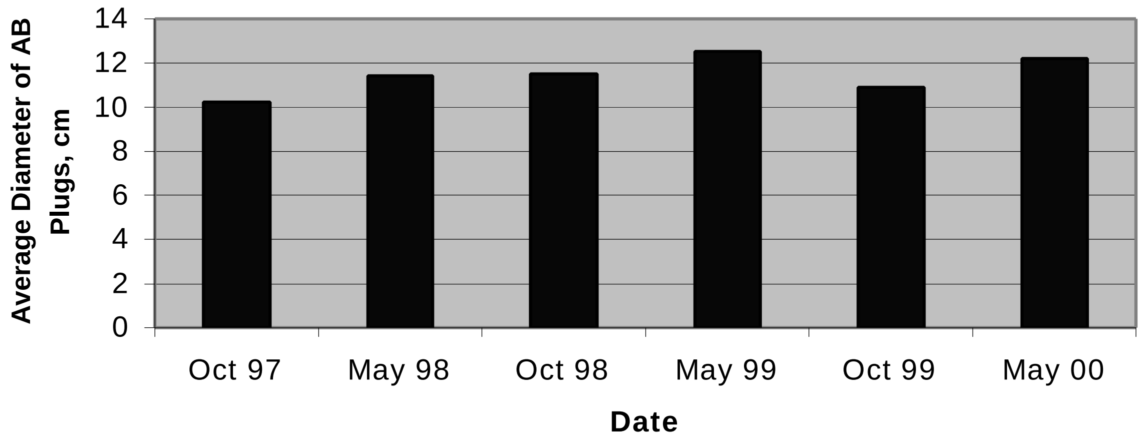
A field study was initiated in 1997 to study the competitive relationship between ten annual bluegrass selections (PA01 through PA10) and three creeping bentgrass cultivars (Penncross, Pennlinks, and Penn A-4) under two mowing heights. Replicated plots (three) of each creeping bentgrass cultivar, measuring 5 by 25 ft, were established in spring 1997. In fall 1997, three replications of each of 10 greens-type annual bluegrass selections were planted in each half of the bentgrass plots, using 4-inch-diameter plugs extracted with a cup cutter. The plots were maintained at 1/8th inch mowing height during the 1997 and 1998 growing seasons. Beginning in 1999, the bentgrass plots were divided in half, with one half mowed at 7/16th inch, simulating fairway culture, and the other at 1/8th inch, simulating greens culture.

The sizes of each annual bluegrass "plug" were measured by recording their average diameters every October and May, beginning October 1997. Descriptive data were also collected, especially when winter killing and other types of injury were evident.

Results ands Discussion

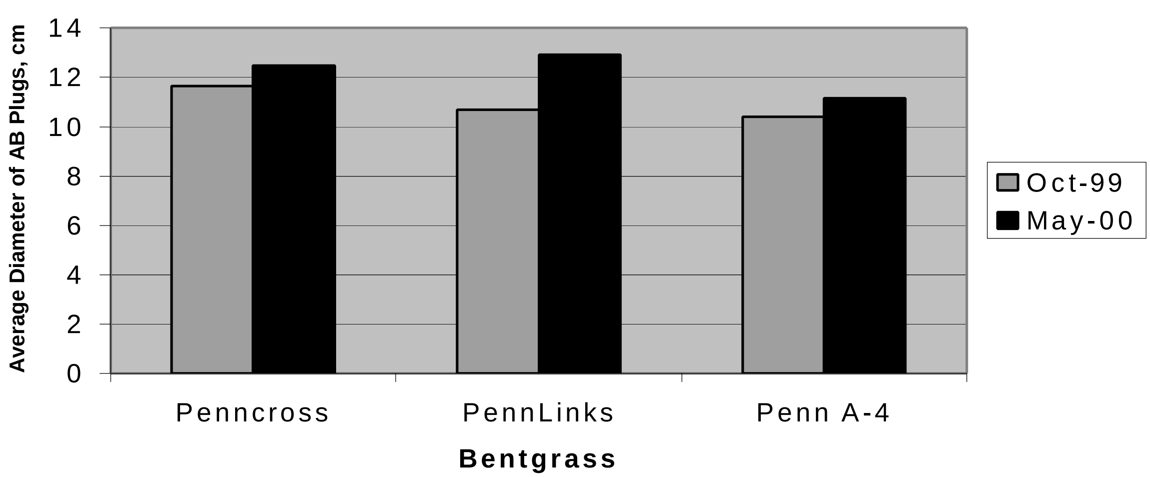
At the higher (7/16th inch) mowing height, most annual bluegrass selections essentially disappeared, reflecting the superior competitive ability of the creeping bentgrass at that height. At the lower (1/8th inch) height, the annual bluegrasses generally increased in size; however, they appeared to retreat somewhat during the summer months while expanding during the winter portion of the year (Figure 1).

Figure 1. All annual bluegrasses averaged across all creeping bentgrasses.



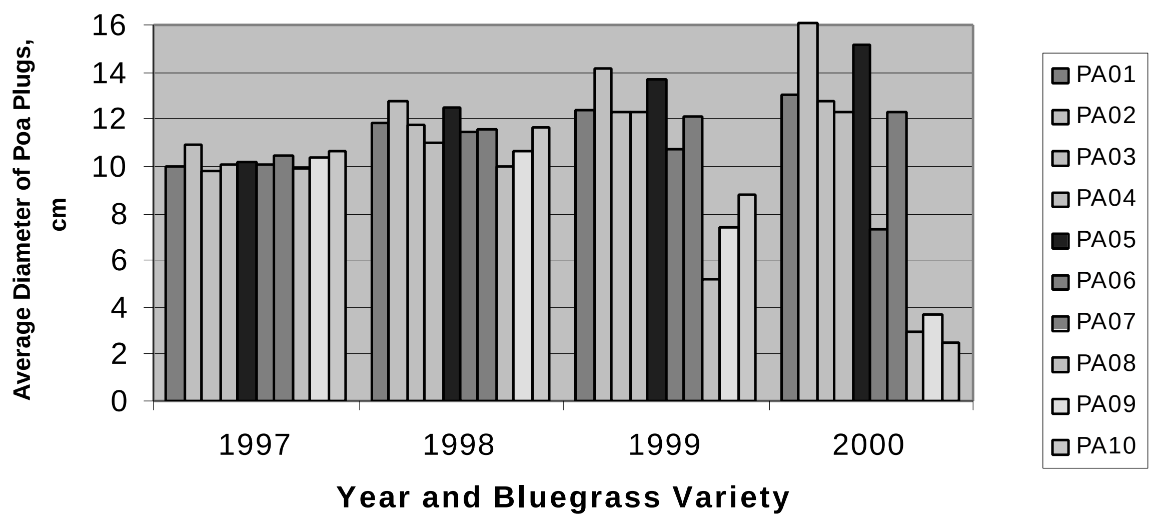
In these comparisons, the bentgrasses varied in their respective competitive abilities, with Penn A-4 appearing to be ore competitive and Pennlinks the least competitive; however, seasonal comparisons of Pennlinks and Penncross suggest that Pennlinks may be more competitive during the summer months while Penncross is more competitive during the winter portion of the year (Figure 2).

Figure 2. All annual bluegrasses averaged within each creeping bentgrass, spring and fall



Soon after establishment, some of the annual bluegrasses appeared to expand more rapidly than others; however, the most recent data show wide variation in their competitive ability, with PA02 the most competitive, averaging nearly 16 inches in diameter and PA10 the least competitive, averaging less than 3 inches in diameter (Figure 3).

Figure 3. Each annual bluegrass in all creeping bentgrasses (fall data).



Some winterkill of many of the annual bluegrass selections was observed in spring 1999. In some instances, all but a thin outer rim of the plugs appeared to be dead. Within a few weeks of favorable growing conditions, however, the plugs completely recovered. Within some of the plugs, small populations of creeping bentgrass were observed growing in the winterkilled voids; however, these largely disappeared by fall.

While most of the annual bluegrass selections are believed to be tetraploids with 28 chromosomes, at least one of them--PA02--is a dihaploid with 14 chromosomes which is sterile and thus produces no seedheads. The challenge in establishing this selection will be to either propagate it vegetatively or to develop some method by which to promote seed production without changing its performance characteristics.

Some wild populations of annual bluegrass (P. *annua* L. var. *annua* Timm) were observed in small patches following colonization of voids in the creeping bentgrass turf resulting from earlier disease incidence or mechanical injury. None of these patches occurred within any of the greens-type annual bluegrass selections, suggesting that these selections resisted their invasion more effectively than did the bentgrasses.

Evaluation of Athletic Field Soil Amendments

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Funding Sources: Pennsylvania Turfgrass Council, DuPont Nylon, Sportgrass Inc.

Introduction

Various reinforcing materials have been mixed with athletic field root-zones in attempts to increase surface stability and minimize compaction. Baker (1997) has reviewed much of the work that has been done on soil reinforcement for athletic fields. The majority of this work involved the effects of soil inclusions in non-cohesive soil (sand). Few researchers have evaluated the effects of fiber or fabric reinforcements on playing surface quality and soil physical properties of cohesive athletic field root-zones.

Researchers have found benefits to reinforcement of cohesive soil in civil engineering applications under heavy loads (confining stresses). Materials that have demonstrated reinforcement of cohesive soils include metallic and plastic grids (Jewel and Jones, 1981), spun nylon string, and polypropylene fibers (Freitag, 1987). Benefits derived from these reinforcing materials include increased soil strength in wet conditions and reduced soil deformation under loads (Freitag, 1987; Andersland and Khatak, 1979). Soil inclusions have proved beneficial in a variety of applications ranging from retaining structures and embankments to sub-grade stabilization beneath footings and pavements (Bassett and Last, 1978).

Synthetic materials mixed into soil for engineering applications are typically termed soil inclusions. Since the application of these synthetic materials to athletic field root-zones has been borrowed from the civil engineering discipline, these materials will be referred to as soil inclusions.

The majority of the athletic fields in the United States are constructed using cohesive soils. These fields, when subjected to heavy use, experience compaction, deformation, and reduced soil strength when soil moisture is high. The effects of soil inclusions on the playing surface quality of cohesive athletic field root-zones exposed to low confining stress is relatively untested. The objective of this research was to evaluate the benefits and detriments of three soil inclusion types on the soil physical properties and playing surface quality of a cohesive athletic field root-zone.

Materials and Methods

Descriptions of the Inclusions

DuPont Shredded Carpet - DuPont Shredded Carpet was obtained from DuPont Nylon (Chestnut Run Plaza, Wilmington, DE) and is the shredded remains of carpet fragments that include both pile and backing. The shredded carpet is not commercially available, but is a component of a sand-based modular turfgrass system called GrassTiles™ (Hummer SportsTurf, Lancaster, PA). DuPont Shredded Carpet is approximately 70% nylon, 12.2% calcium carbonate, 10.7% latex, and 7.1% polypropylene on a weight basis (V.J. Kumar, personal communication, 1998). Based on 100 randomly-selected carpet filaments, the average filament length was 135 mm, and the range was 20 to 610 mm. Fifteen carpet filaments were randomly selected and measured for width. The width of a carpet filament averaged 2.4 mm and ranged from 0.5 mm to 4 mm. When incorporated into soil, DuPont Shredded Carpet is randomly-oriented.

Sportgrass™ - Sportgrass is a commercially-available product manufactured by Sportgrass Inc. of McLean, VA. Sportgrass consists of a polypropylene woven backing with 24 yarn strand ends per 2.54 cm in the lineal direction and 11 yarn strand ends per 2.54 cm in width. Yarn strands are 11,000 denier (1.0 denier is equal to the fineness of a yarn weighing 1.0 g for each 9000 m). The woven backing is tufted with fibrillated polypropylene tufts. In the lineal direction there are 16 tufts per 10.2 cm. In width, the tufts are 0.95 cm apart. The pile height is 3.2 cm. The individual tufts form a net-like configuration when expanded. A fibrillated tuft is 6700 denier. (W. Cook, personal communication, 1998). Sportgrass is an oriented fabric inclusion.

Turfgrids™ - Turfgrids is a commercially-available, polypropylene fiber inclusion manufactured by Synthetic Industries, Inc. (Chattanooga, TN). It is 99.4% polypropylene and individual fibers are 38 mm long and 5 mm wide. Each individual fiber is fibrillated to form a net-like structure of fine fibers or filaments (fibrils). When mixed with soil, each fiber expands and the net-like configuration of finer fibers are randomly oriented throughout the root-zone.

<u>Plot Construction and Wear Treatments</u>

In September of 1995, a grid of 3.05 m by 3.05 m treatment plots was laid over level Hagerstown silt loam (fine, mixed Mesic Typic Hapludalf) topsoil. A 30-cm border composed of the Hagerstown soil surrounded each plot. The experimental design was a split block (blocks split by three levels of wear) with five treatments and three blocks. The five inclusion treatments for this experiment were DuPont Shredded Carpet 1% (0.01 kg kg-1 carpet and soil), DuPont Shredded Carpet 3% (0.03 kg kg-1 carpet and soil), Sportgrass, Turfgrids 1% (0.01 kg kg-1 carpet and soil), and a control with no soil inclusions. All of the treatments listed (with the exception of Sportgrass) were weighed and mixed with a screened (1.27 cm) Hagerstown silt loam topsoil using a front end loader on an asphalt mixing pad.

Wooden frames, 3.05 m by 3.05 m by 15 cm high, were installed on each of the plots and leveled using a transit. After filling the frames with the mixed root-zone treatments, the surface was leveled by raking and hand tamping. For the Sportgrass treatment, frames were installed and filled with the Hagerstown silt loam soil to within 2.54 cm of the top. The Sportgrass was then cut to fit the frames. Next, small amounts of a 90% sand: 10% sphagnum peat (m3:m3) topdressing meeting United States Golf Association specifications (Green Section Staff, 1993) was applied over the surface and worked into the pile using brooms. The plots were watered and allowed to dry, then more of the 90:10 mix was broomed into the pile. This process was repeated until approximately 3 mm of pile protruded above the settled mix. All frames were removed and the plots were seeded to 'SR 4200' perennial ryegrass (*Lolium perenne* L.) at the rate of 200 kg ha-1. Phosphorus and potassium were applied at 49 and 98 kg ha-1 to the surface as per soil test recommendations. In the fall of 1995, nitrogen was applied at the rate of 75 kg ha-1. During

1996 and 1997, nitrogen was applied in four applications of 49 kg ha-1 each. These applications occurred in early May and June, and late August and September of each year. The plot area was watered only to prevent wilting. The turf was mowed with a reel mower twice per week at a height of 3.8 cm and the clippings were returned.

Wear level treatments were applied with a Brinkman Traffic Simulator (Cockerham and Brinkman, 1989). The Brinkman Traffic Simulator weighs 410 kg and consists of a frame housing two 1.2 m long rollers. Each roller has steel dowels (12.7 mm diameter by 12.7 mm length) welded to the outside of the rollers, at an average of 150 dowels per m2. These dowels are the approximate length and width of the cleats on the shoe of an American football lineman at the collegiate level. The Brinkman Traffic Simulator produces wear, compaction, and turf/soil lateral shear. The drive thrust yielding lateral shear is produced by different sprocket sizes turning the rollers at unequal speeds. The Brinkman Traffic Simulator was pulled with a model 420 tractor (Steiner Turf Equipment Inc., Dalton, OH) equipped with a dual turf tire package. Blocks were split with three levels of wear. The wear levels were no wear, medium wear (three passes with the Brinkman Traffic Simulator three times per week), and high wear (five passes three times per week). According to Cockerham and Brinkman (1989), two passes of the Brinkman Traffic Simulator is equivalent to turfgrass wear at the 40 yard line resulting from one National Football League game. Thus, 15 passes per week is equivalent to the wear sustained from 7.5 games per week.

In 1996, wear began on 19 July and ended on 18 October. In 1997, wear began on 2 June and ended 17 October. Typically, wear was applied regardless of weather conditions. Occasionally, due to heavy precipitation or schedule conflicts, wear was not applied on the scheduled day. In these cases, wear was applied on the following day.

Data Collection

The criteria for comparing treatments were turfgrass density, soil physical properties (bulk density, water content, and infiltration rate), and playing surface quality (hardness and traction).

Turfgrass density was rated visually and served as an estimate of both turfgrass cover and tillers per unit area. Density was rated using a scale of 0 to 5 with half units. A plot with no turfgrass present is rated as 0, and 5 indicates maximum cover and tiller density.

Soil bulk density data were derived from measurements of soil total density and volumetric water content taken with a Troxler 3400-B Series Surface Moisture-Density Gauge (Troxler Electronic Laboratories Inc., Research Triangle Park, NC). The Troxler Gauge uses neutron scattering simultaneously with gamma ray attenuation to measure the volumetric water content and bulk density of the soil (Gardner, 1986).

Because some inclusions could influence water content measurements, the Troxler Gauge was calibrated using a Tektronix™ 1502B time-domain reflectometry (TDR) unit (Tektronix Inc., Beaverton, OR). To calibrate the Troxler Gauge, water contents were determined from each treatment plot, using both the TDR and the Troxler Gauge, on six different occasions to provide a range of soil water contents. Linear relationships between the two methods for each inclusion treatment were evident, with regression coefficients greater than 0.90. Regression equations were calculated for each treatment. All water content values reported in this experiment were collected using the Troxler gauge and then adjusted using the appropriate regression equation. The values represent the water content in the surface 15 cm of root-zone mix.

Water infiltration rates were measured using double-ring infiltrometers (Bertrand, 1965). Two concentrically-placed cylinders, 20.3 cm and 35.6 cm in diameter and 11.4 cm in height, were driven into the soil to a depth of approximately 2.5 cm. Three sets of cylinders were used to characterize each subplot. After an initial soaking period of 30 min, the cylinders were again filled with water and the rate of drop in the inner cylinder was measured. Because soil water infiltration rate data are not normally distributed, the statistical analysis of the data was performed after rates had been log transformed (Jury et al., 1991).

Surface hardness was measured using a Clegg Impact Tester (CIT) (Lafayette Instrument Company, Lafayette, IN) equipped with a 2.25 kg missile (Rogers and Waddington, 1989). Impact attenuation as measured by an accelerometer mounted on the missile was used to indicate surface hardness and is reported as Gmax, which is the ratio of maximum negative acceleration upon impact in units of gravities to the acceleration due to gravity. The average of six hardness measurements taken in different locations on each subplot was used to represent the hardness value of the subplot.

Linear traction measurements were taken with Pennfoot (McNitt et al., 1996, 1997) configured with a loading weight of 121.8 kg and a Nike™ high-top molded shoe. This shoe contained 18 triangular studs (12 mm long) around the perimeter of the sole and 35 smaller studs (9 mm long) in the center (Nike Inc., Beaverton, OR). The traction values reported are the average of traction measurements at three different locations on each subplot.

Rating Dates and Statistical Analysis

Turfgrass density, soil bulk density, soil water content, traction, and surface hardness data were collected on five dates. The dates were 27 August, and 19 Oct. 1996; and 18 June, 29 August, and 13 Oct. 1997. Water infiltration rates were measured from 4 October to 7 Oct. 1996 and again from 6 October to 10 Oct. 1997.

The turfgrass density rating and the means of the three soil bulk densities, three soil water contents, three traction values, six surface hardness measurements, and the log of the three water infiltration rates were analyzed as a split block design using analysis of variance and Fisher's Protected Least Significant Difference (LSD) test at the 0.05 level. A LSD was not calculated when the F ratio was not significant at the 0.05 level.

Results and Discussion

Turfgrass Density

Mean turfgrass density ratings for wear levels across all inclusion treatments are shown in Table 1. On four of the five rating dates, each increase in wear intensity resulted in a significant decrease in turfgrass density. Recovery from wear was evident between the 19 Oct. 1996 and 18 June 1997 dates and between the August and October dates in 1997. Cool, moist conditions in combination with nitrogen applications may have contributed to the recovery of turfgrass density. There was no wear by inclusion treatment interaction on any date.

When averaged over all wear levels, turfgrass density differences due to inclusion treatments were found on two rating dates (Table 2). On the 19 Oct. 1996 rating date, the Sportgrass treatment had higher turfgrass density than all other treatments except the control and DuPont Shredded Carpet 1%. On the 29 Aug. 1997 rating date, Sportgrass had higher turfgrass density than all other treatments. Sportgrass may have measured higher in turfgrass density because the polypropylene backing and the 2 cm of sand topdressing worked into the Sportgrass pile may have prevented some surface compaction and crusting, thus allowing this treatment to withstand the effects of wear to a greater degree than the other treatments.

In this study, all inclusion treatments, other than Sportgrass, measured lower in turfgrass density than the control on the 29 Aug. 1997 rating date but did not differ from the control on the other four rating dates.

Soil Bulk Density

Mean soil bulk density values for wear levels across all inclusion treatments are shown in Table 1. In 1996, there were no differences among wear levels, whereas in 1997, soil bulk density differences due to wear were found on the 29 August and 13 Oct. 1997 rating dates. The high-wear level had a higher soil bulk density than the no-wear level on the 29 August and 13 Oct. 1997 rating dates. The medium-wear level was significantly higher in bulk density than the no-wear level on the 13 Oct. 1997 rating date. There was no wear by inclusion treatment interaction on any date.

Soil bulk density values due to inclusion treatments across all wear levels are shown in Table 2. Few differences were found among treatments other than Sportgrass. On the three rating dates where differences were detected, Sportgrass had soil bulk density values higher than most treatments. The Sportgrass may have had a higher soil bulk density than other treatments because of the 2 cm of sand topdressing placed on the surface. Sand typically has a higher soil bulk density than silt loam soil and the Troxler gauge measures bulk density over the distance between the photon source and the receiver, in this case 15 cm.

Soil Water Content

Overall, few soil water content differences were measured among wear levels when averaged over all inclusion treatments (Table 1). On the 19 Oct. 1996 rating date, the no-wear level had the highest soil water content and the high-wear level had the lowest soil water content. This may be due to the medium- and high-wear plots having less turfgrass cover than the no-wear plots. Less turfgrass cover has been shown to cause an increase in soil temperatures which may result in a decrease in soil water content (Agnew, 1984). There was no wear by inclusion treatment interaction on any date.

Soil water content values due to inclusion treatments are shown in Table 2. In most cases, the addition of any of the soil inclusions to this silt loam soil reduced soil water content. The addition of 3% DuPont Shredded Carpet reduced soil water content more than the addition of Sportgrass or the DuPont Shredded Carpet 1% treatments. McNitt (2000) reported that Sportgrass consistently reduced soil water content in a sand soil. In the current experiment, Sportgrass reduced soil water content less than the other inclusions and on one rating date, Sportgrass had a soil water content higher than all other treatments. The highest soil water contents usually occurred with Sportgrass and the control.

Infiltration Rates

Significant water infiltration differences due to wear levels and inclusion treatments are shown in Tables 3 and 4, respectively. A significant wear level by inclusion treatment interaction occurred in 1996 (Table 5).

The wear level by inclusion treatment interaction data in Table 5 indicates that under the no-wear level all inclusion treatments maintained an infiltration rate above 12 cm hr-1. Compared to the no-wear level, all inclusion treatments showed a decrease in infiltration rate under medium- and high-wear; however, the decrease was most dramatic for the control plot which decreased from 12.6 to 1.9 cm hr-1. Compared to the control (1.9 cm hr-1), all inclusion treatments measured higher in infiltration (=5.8 cm hr-1) under the medium-wear level with Sportgrass having an infiltration rate higher than all other treatments (18.3 cm hr-1).

Under the high-wear level all inclusion treatments resulted in decreased infiltration compared to the medium wear-level, except Sportgrass which was unchanged (Table 5). The polypropylene backing plus the sand topdressing in the Sportgrass may have protected the underlying silt loam soil from crusting and/or compacting, thus maintaining a relatively high infiltration rate under high-wear levels.

All inclusion treatment infiltration rates increased slightly from 1996 to 1997, although no infiltration differences were found in 1997 (Table 4). These results are consistent with those reported by Canaway (1994), in which the addition of a mesh element inclusion to a fine sandy soil increased infiltration by about 1.2 cm during the first year after establishment, but did not influence infiltration during the second year after establishment.

Surface Hardness

Mean surface hardness values for wear levels across inclusion treatments are shown in Table 1. A trend is evident, with the high-wear level plots measuring highest in surface hardness, the no-wear plots measuring lowest in surface hardness, and the medium-wear plots being intermediate.

The surface hardness values for the inclusion treatment by wear level interaction were significant only on the 13 Oct. 1997 rating date (Table 6). All inclusion treatments increased in surface hardness as the wear level increased. Under no-wear, the control had a surface hardness value lower than all other treatments. Under medium- and high-wear, all treatments had similar surface hardness values except the Turfgrids 1% treatment, which had a surface hardness value higher than all other treatments. On this rating date, under somewhat dry soil conditions, the surface hardness values of all the medium- and high-wear level plots were high compared to values for heavily used fields (60-98 Gmax) reported by Rogers, et al. (1988).

Surface hardness values due to inclusion treatments are shown in Table 2. The addition of Sportgrass and Turfgrids 1% to this silt loam soil increased surface hardness, relative to the control on some rating dates under some wear levels. The addition of DuPont Shredded Carpet 1% and 3% produced no measurable change in surface hardness compared to the control. In a sand root-zone, McNitt (2000) found a significant and consistent increase in surface hardness due to the Sportgrass and Turfgrids inclusion treatments and a dramatic decrease in surface hardness with increasing rates of DuPont Shredded Carpet. Results from the present silt loam soil study show a muted response with inconsistent increases in surface hardness due to the addition of Sportgrass and Turfgrids and no change with the addition of DuPont Shredded Carpet.

The data in Tables 2 and 6 indicate that there was a larger range of hardness values from one date to another compared to the range among inclusion treatments on a single rating date. A close examination of the data in Table 2 shows that soil water content is likely a major contributing factor to the wide range in surface hardness among dates. Over the five sampling dates, average soil water contents increased from 0.20 to 0.34 m3 m-3. This increase corresponded with a decrease in average surface hardness values from 119 to 58 Gmax. While wear levels and inclusion treatments affected surface hardness, soil water content seems to have had a greater effect on surface hardness. The correlation coefficient for soil water and surface hardness (-0.77) was significant (Table 7). This relationship is consistent with the findings of other researchers (Baker and Bell, 1986; Rogers et al., 1988; Rogers and Waddington, 1990). Surface hardness had the highest correlation with soil water content, followed by soil bulk density (0.60), and turfgrass density (-0.41).

<u>Linear Traction</u>

Mean linear traction values for wear levels across all inclusion treatments are shown in Table 1. Traction differences occurred on only two rating dates with the medium-wear level plots measuring highest in traction. There were no traction differences between the no-wear and high-wear level plots. These results are consistent with those reported by McNitt (2000) where similar wear levels, on a sand root-zone, resulted in the medium-wear plots measuring highest in traction. While these differences are small, the data indicate that as wear levels increase, traction increases until the wear causes a decrease in turfgrass density at which time traction decreases. The relationship between traction and turfgrass density in this study was of minor practical importance as indicated by a correlation coefficient of –0.14 (Table 7). This result is in contrast to the findings of McNitt et al. (1997) where turfgrass density had a significant effect on traction. McNitt et al. (1997) conducted their study on silt loam soil that contained no inclusions and density differences were created by varying mowing height. No simulated traffic was applied. There was no wear level by inclusion treatment interaction for traction values on any rating date.

Mean traction differences due to treatments are listed in Table 2. While the traction values for treatments varied, Sportgrass had the highest traction on three of the five rating dates. On the 27 Aug. 1996 rating date, the Sportgrass treatment measured higher in traction than all other treatments. On the 19 Oct. 1996 rating date, the Sportgrass treatment measured higher in traction than the Turfgrids 1% treatment and on the 13 Oct. 1997 rating date, the Sportgrass treatment measured higher in traction than the Turfgrids 1% and the control.

Summary and Conclusion

The soil inclusions studied in this experiment had limited and varying effects on turfgrass density, soil physical properties, and playing surface conditions. These effects were dependent on inclusion type and wear level. Individual inclusions tended to produce both limited benefits and detriments.

Turfgrass density differences due to inclusion treatments were minor. The Sportgrass treatment resulted in turfgrass densities that were higher than all other treatments on two of five rating dates. The Sportgrass backing, pile, and sand topdressing may have protected the silt loam soil surface. Baker (1997) hypothesizes that there are four mechanisms by which synthetic inclusions may improve the wear tolerance and quality of turf, they are:

- by load-spreading, thus reducing the rate of soil compaction;
- by reduction in the effects of shearing forces which helps to preserve the continuity of large pores at the soil surface;
- by protection of the crown tissue of the grass plant;
- by increasing traction through the interaction between the fibers in the reinforcement material and the studs on the player's footwear.

The higher turfgrass density measured in the Sportgrass treatment is in contrast to results obtained by McNitt (2000) using Sportgrass on a sand root-zone. In the sand root-zone, McNitt (2000) found consistently lower turfgrass density for Sportgrass compared to sand alone, indicating that the pile and backing reduced turfgrass wear resistance. In the present silt loam soil study, Sportgrass topdressed with sand supported turf that was less susceptible to wear than turf on the silt loam soil. Future research involving Sportgrass should include a control with sand topdressing over a cohesive soil.

Soil bulk density was unaffected by the treatments with one exception. Sportgrass had a higher soil bulk density than all other treatments on three rating dates. Again, this may be due to the sand topdressing causing a higher average soil bulk density.

The soil inclusion treatments generally reduced soil water content compared to the control. The addition of 3% DuPont Shredded Carpet resulted in a soil water content lower than all other treatments on four of the five rating dates. The control measured higher in soil water than all inclusion treatments on two rating dates. The reason the soil inclusions reduced soil water content is not immediately apparent.

The addition of inclusions increased water infiltration over the control during 1996. The water infiltration values for inclusion treatments in 1997 indicted the same trend but differences between treatments and the control were not significant. The long-term effect of soil inclusions on infiltration rates of cohesive soils is impossible to predict from these data.

The addition of Sportgrass and Turfgrids 1% to this silt loam soil increased surface hardness, relative to the control, on some rating dates under some wear levels. The addition of DuPont Shredded Carpet 1% and 3% produced no measurable change in surface hardness compared to the control. The results indicate that surface hardness was influenced to a greater degree by soil water than by inclusion treatments.

Overall, few traction differences were measured, but the medium-wear level tended to have higher traction values than the high- or no-wear levels. This could be due to some firming of the surface with only minimal loss of turfgrass density.

Under high confining stress (heavy loads), certain inclusion types have improved soil physical characteristics for engineering applications. The basis for conducting this study was to determine if any benefits or detriments would occur if soil inclusions were used in a cohesive athletic field root-zone under low confining stress. Because the inclusions in this study affected little change, the use of these materials on cohesive-soil athletic fields does not seem to be cost effective. However, we do not rule out the possibility that these inclusions could provide benefits in other non-athletic field turfgrass uses.

Areas that may benefit would include turfgrass parking lots, turfgrass fire lanes and emergency access areas where a cohesive soil must support the weight of large vehicles which produce a higher confining stress than experienced on athletic fields. A study on such areas should measure soil strength, compression, rutting, and vehicular traction under varying weather, soil, and turfgrass conditions.

Table 1. Mean turfgrass density, soil bulk density, soil water content, surface hardness, and linear traction for wear level treatments averaged over soil inclusion treatments.

	1996		1997		
Wear Level	27 August	19 October	18 June	29 August	13 October
	Turfgrass Density (0-5[†])				
No wear	5.0	5.0	5.0	5.0	5.0
Medium wear	4.5	4.0	5.0	3.2	4.3
High wear	3.3	2.7	4.4	2.1	2.6
LSD (0.05)	0.2	0.1	0.2	0.2	0.4
	Soil Bulk Density ($g\ cc^{-1}$)				
No wear	1.25	1.25	1.22	1.23	1.29
Medium wear	1.26	1.27	1.22	1.23	1.32
High wear	1.27	1.28	1.22	1.26	1.33
LSD (0.05)	NS	NS	NS	0.02	0.02
	Soil Water Content ($m^3\ m^{-3}$)				
No wear	0.272	0.324	0.326	0.269	0.202
Medium wear	0.269	0.312	0.342	0.273	0.206
High wear	0.266	0.301	0.340	0.249	0.191
LSD (0.05)	NS	0.011	NS	NS	NS
	Surface Hardness (Gmax)				
No wear	59	50	52	69	95
Medium wear	71	65	58	91	125
High wear	79	74	64	105	37
LSD (0.05)	6	6	4	5	5
	Linear Traction (Newtons)				
No wear	1238	1347	1188	1175	1382
Medium wear	1302	1425	1321	1231	1400
High wear	1285	1379	1194	1190	1409
LSD (0.05)	NS	NS	43	38	NS

[†]Visual estimate turf cover and tillers per unit area, 0 represents no turfgrass present and 5 represents maximum turfgrass cover and density.

Table 2. Mean turfgrass density, soil bulk density, soil water content, surface hardness, and linear traction for soil inclusion treatments averaged over wear levels.

Treatment	1996 27 August	1996 19 October	1997 18 June	1997 29 August	1997 13 October
	Turfgrass Density (0-5†)				
Control	4.4	3.9	4.8	3.5	4.1
DuPont Shredded Carpet 1%	4.2	3.9	4.8	3.3	3.9
DuPont Shredded Carpet 3%	4.2	3.8	4.8	3.3	4.0
Sportgrass	4.4	4.1	4.9	3.8	4.0
Turfgrids 1%	4.2	3.8	4.7	3.3	3.8
LSD (0.05)	NS	0.2	NS	0.2	NS
	Soil Bulk Density ($g\ cc^{-1}$)				
Control	1.26	1.26	1.19	1.23	1.31
DuPont Shredded Carpet 1%	1.23	1.23	1.23	1.23	1.32
DuPont Shredded Carpet 3%	1.26	1.28	1.21	1.23	1.30
Sportgrass	1.28	1.30	1.25	1.27	1.31
Turfgrids 1%	1.24	1.26	1.21	1.24	1.33
LSD (0.05)	NS	0.04	0.02	0.03	NS
	Soil Water Content ($m^3\ m^{-3}$)				
Control	0.281	0.344	0.375	0.286	0.210
DuPont Shredded Carpet 1%	0.268	0.307	0.324	0.266	0.194
DuPont Shredded Carpet 3%	0.240	0.276	0.297	0.234	0.172
Sportgrass	0.284	0.324	0.341	0.274	0.244
Turfgrids 1%	0.272	0.311	0.343	0.259	0.179
LSD (0.05)	0.016	0.014	0.013	0.017	0.012
	Surface Hardness (Gmax)				
Control	71	64	54	86	114
DuPont Shredded Carpet 1%	67	61	56	88	117
DuPont Shredded Carpet 3%	66	58	52	87	117
Sportgrass	73	71	68	89	112
Turfgrids 1%	72	63	59	93	135
LSD (0.05)	NS	8	4	NS	6
	Linear Traction (Newtons)				
Control	1245	1384	1231	1207	1351
DuPont Shredded Carpet 1%	1245	1390	1251	1211	1423
DuPont Shredded Carpet 3%	1207	1377	1270	1202	1403
Sportgrass	1424	1426	1203	1185	1449
Turfgrids 1%	1255	1338	1216	1188	1359
LSD (0.05)	89	54	NS	NS	50

†Visual estimate turf cover and tillers per unit area, 0 represents no turfgrass present and 5 represents maximum turfgrass cover and density.

Table 3. Mean water infiltration rates for wear levels when averaged across all soil inclusion treatments.

Wear Level	October, 1996		October, 1997	
	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)
No wear	17.6	1.1	20.2	1.2
Medium wear	7.9	0.6	15.0	0.8
High wear	5.2	0.2	4.7	0.4
LSD (0.05)		0.2		0.2

Table 4. Water infiltration rates and mean log transformed values for soil inclusion treatments across all wear levels.

	Infiltration			
Treatment	October, 1996		October, 1997	
	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)
Control	5.2	0.3	7.6	0.9
DuPont Shredded Carpet 1%	10.0	0.7	12.1	1.2
DuPont Shredded Carpet 3%	8.0	0.5	12.3	1.2
Sportgrass	21.2	1.3	25.9	1.4
Turfgrids 1%	6.9	0.4	8.4	0.9
LSD (0.05)		0.3		NS

Table 5. Water infiltration values for the treatment by wear interaction in 1996.

Treatment	no wear		medium wear		high wear	
	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)	($cm\ hr^{-1}$)	($log\ cm\ hr^{-1}$)
Control	12.6	0.9	1.9	-0.1	1.2	-0.1
DuPont Shredded Carpet 1%	20.7	1.2	6.8	0.6	2.4	0.3
DuPont Shredded Carpet 3%	14.5	1.1	6.8	0.4	2.8	-0.1
Sportgrass	**26.9**	**1.4**	**18.3**	**1.2**	**18.4**	**1.3**
Turfgrids 1%	13.4	1.0	5.8	0.7	1.3	-0.44
LSD (0.05)	---	0.5	---	0.5	---	0.5

Table 6. Mean surface hardness values for the treatment by wear level interaction on the Oct. 13, 1997 rating date.

	Surface Hardness		
	Wear level		
Treatment	none	medium	high
	(Gmax)		
Control	87	123	134
Dupont Shredded Carpet 1%	98	122	132
Dupont Shredded Carpet 3%	97	125	129
Sportgrass	90	120	126
Turfgrids 1%	105	136	163
LSD (0.05)	11	11	11

Table 7. Correlation coefficients (n=75) between measured plot characteristics.

	Surface Hardness	Soil Water	Soil Bulk Density	Turfgrass Density
Traction	0.26**	-0.19**	0.52**	-0.14*
Surface Hardness	-	-0.77**	0.60**	-0.41**
Soil Water		-	-0.58**	0.22**
Soil Bulk Density			-	-0.27**

* = significant at 0.05 level, ** = significant at 0.01 level

REFERENCES

Agnew, M. L. 1984. Canopy/soil temperatures and acclimation responses of Kentucky bluegrass to soil compaction and moisture stress. Ph.D. diss. Kansas State Univ., Manhattan (Diss. Abstr. 84-28123).

Andersland, O.B., and A.S. Khatak, 1979. Shear strength of kaolinite/fiber soil mixtures. Proceedings, International Conference on Soil Reinforcement, Vol. 1, p. 11-16. Paris, France.

Baker, S. W. 1997. The reinforcement of turfgrass areas using plastic and other synthetic materials: A review. International Turfgrass Society Research Journal 8:3-13.

Baker, S. W., and M. J. Bell. 1986. The playing characteristics of natural turf and synthetic turf surfaces for association football. Journal of the Sports Turf Research Institute 62:9-35.

Bassett, R. H., and C. N. Last. 1978. Reinforcing earth below footings and embankments. American Society of Civil Engineers Symposium on Earth Reinforcement, p. 222-231. Pittsburgh, PA.

Betrand, A. E. 1965. Rates of water intake in the field. p. 202-204. *In* C. A. Black (ed.) Methods of Soil Analysis. Part 1-Physical and Mineralogical Methods-Agronomy Monograph #9 (1st Edition). American Society of Agronomy, Madison. WI.

Canaway, P.M. 1994. A field trial on isotropic stabilisation of sand rootzones for football using Netlon mesh elements. Journal of the Sports Turf Research Institute 70:100-109.

Cockerham, S.T., and D.J. Brinkman. 1989. A simulator for cleated-shoe sports traffic on turfgrass research plots. California Turfgrass Culture 39:9-10.

Freitag, D.R. 1987. Soil randomly reinforced with fibers. Journal of Geotechnical Engineering 112:823-826.

Gardner, W. H. 1986. Water content. p. 493-544. *In* A. Klute (ed.) Methods of Soil Analysis. Part 1-Physical and Mineralogical Methods-Agronomy Monograph #9 (2nd Edition). American Society of Agronomy, Madison. WI.

Green Section Staff. 1993. USGA recommendations for a method of putting green construction. United States Golf Association Green Section Record 31(2): 1-3.

Jewell, R.A., and C.J.F.P. Jones. 1981. Reinforcement of clay soils and waste materials using grids. Proceedings of the 10th International Conference of Soil Mechanic and Foundations Engineering, Vol. 3. P. 701-706. Stockholm, Sweden.

Jury, W.A., W.R. Gardner, and W.H. Gardner. 1991. Soil Physics. 5th ed. John Wiley and Sons, Inc. New York, NY.

McNitt, A. S. 2000. The effects of soil inclusions on soil physical properties and athletic field playing surface quality. Ph.D. diss. Pennsylvania State University, University Park, PA.

McNitt, A. S., D. V. Waddington, and R. O. Middour. 1996. Traction measurement on natural turf. p. 145-155. *In* Earl F. Hoerner (ed.) Safety in American Football. Standard Technical Publication 1305. American Society for Testing Materials. West Conshohocken, PA.

McNitt, A. S., R. O. Middour, and D. V. Waddington. 1997. Development and evaluation of a method to measure traction on turfgrass surfaces. Journal of Testing and Evaluation 25(1):99-107.

Rogers III, J.N., and D.V. Waddington. 1989. The effect of cutting height and verdure on impact absorption and traction characteristics in tall fescue turf. Journal of the Sports Turf Research Institute 65:80-90.

Rogers III, J.N., and D.V. Waddington. 1990. Effects of management practices on impact absorption and shear resistance in natural turf. p. 136-146. *In* R.C. Schmidt et al. (ed.) Natural and artificial playing fields: characteristics and safety features. Standard Technical Publication 1073. American Society for Testing Materials. Philadelphia, PA.

Rogers III, J.N., D.V. Waddington, and J.C. Harper. 1988. Relationships between athletic field hardness and traction, vegetation, soil properties, and maintenance practices. Progress Report 393. The Pennsylvania State University, College of Agriculture Experiment Station. University Park, PA. 15 pp.

The Effects of Perk on Yield and Color of Kentucky Bluegrass

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Introduction

Perk is a new ammoniacal nitrogen based fertilizer that also contains iron and manganese. Perk is designed to improve color without causing a significant increase in yield. The objective of this study was to compare the effects of Perk and ammonium sulfate on the color and yield of Kentucky bluegrass.

Materials and Methods

This experiment was conducted on Baron Kentucky bluegrass at the Landscape Management Research Center in University Park, PA. The site was mowed twice a week at 2 inches with a reel mower and clippings were returned. The site was fertilized with urea at a rate of 1 lb N/1,000 sq ft in late spring. The site was irrigated as needed to maintain adequate growth, and no fungicides or herbicides were applied to the site in 2000.

The treatments included Perk (4-0-10) and ammonium sulfate (21-0-0) at rates of 0.2 and 0.4 lbs N/1,000 sq ft (label recommended rates of Perk). The treatments also included an untreated control. Plots were 3 x 12 feet and arranged in a randomized complete block design with three replications. Individual treatments were weighed, combined with a few ounces of sand, and applied to their respective plots with a hand-held shaker jar on August 24, 2000.

Color was rated every seven days following treatment application on a scale of one to five with 1 being straw colored, 5 being dark green, and 3 and above being acceptable color. Yields representing three days of growth were removed every seven days following treatment. Clippings were dried at 60°C for a minimum of 24 hours and weighed. All data was subjected to analysis of variance and means for each rating date were separated using Duncan's New Multiple Range Test with $p = 0.05$.

Results and Discussion

There were significant differences in color between treatments 7 and 14 days after application (Table 1, Figure 1). Seven days after treatment, Perk at 0.4 lbs N/1,000 sq ft provided the best color; and Perk at 0.2 lbs N/1,000 sq ft was equivalent to ammonium sulfate at 0.4 lbs N/1,000 sq ft and significantly better than ammonium sulfate at 0.2 and the untreated control. Fourteen days after treatment, only Perk at 0.2 lbs and ammonium sulfate at 0.4 lbs were significantly better than the untreated control. There were no significant differences in color between treatments 21 days after application. There were no significant differences in yield between treatments on any of the four rating dates (Table 2, Figure 2). The lack of differences for yield may be the result of the low application rates of nitrogen (i.e., 0.2 and 0.4 lbs N/1,000 sq ft).

Table 1. Means of color* responses of Kentucky bluegrass treated with Perk and ammonium sulfate.

Treatment	Rate (lbs N/1,000 sq ft)	8/31/00	9/5/00	9/12/00
Perk	0.2	4.0 b**	4.2 a	3.7 a
Perk	0.4	4.5 a	4.0 a	3.7 a
Ammonium sulfate	0.4	3.3 c	3.8 ab	3.8 a
Ammonium sulfate	0.4	3.8 b	4.3 a	4.0 a
Untreated Control	0.0	3.0 d	3.2 b	3.2 a

*Rated on a scale of 1-5 with 5 being dark green and 3 being acceptable.

**Means followed by the same letter within a column are not statistically different according to Duncan's New Multiple Range test with p = 0.05.

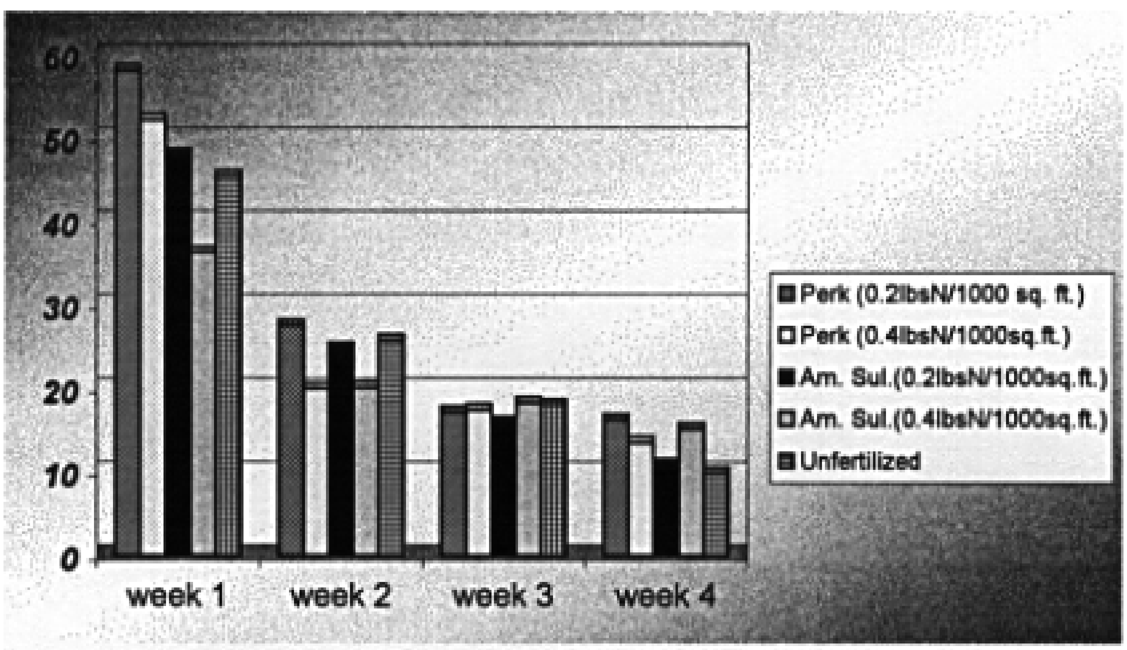

Figure 1. Clipping yields collected from Kentucky bluegrass treated with Perk or ammonium sulfate.

Evaluation of Fungicides for Control of Anthracnose on a Putting Green

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Introduction

Anthracnose *(Colletotrichum graminicola)* has become a serious disease on putting greens; particularly those comprised of high populations of annual bluegrass *(Poa annua)*. The use of fungicides plays an important role in the management of Anthracnose. The objective of this study was to evaluate the effectiveness of various fungicides, rates, and application timings in controlling Anthracnose infection.

Materials and Methods

The experiment was conducted on a mixed stand of annual bluegrass and creeping bentgrass maintained under golf course greens management conditions. The turf was mowed six times per week at 0.125 inch cutting height. The soil was a modified sandy clay loam with a soil pH of 7.0. On 27 Apr, Dimension 1EC was applied to the experiment at the rate of 1.125 fl oz per 1000 sq ft for control of crabgrass. The test area was fertilized on 9 May with 0.75 lb nitrogen (Lebanon 28-7-14) per 1000 sq ft, and 18 May with 1.0 lb nitrogen (Scotts 18-9-18) per 1000 sq ft. The experimental area was verticut 16 May and topdressed on 13 Jun. Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with three replications. Treatments were applied with a CO_2-powered boom sprayer, using TeeJet 8004 nozzles, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were initiated on 25 May, and continued on a 14-day interval through 1 Aug, except as noted in the table. The experimental turf area was inoculated on 19 Jun by applying a *C. graminicola* spore suspension, and hand-broadcasting *C. graminicola*-infested rye grains at the rate of 20-30 grains per sq ft. The inoculated turf was covered with 6-mil plastic for each of the next three nights. Plastic was removed during the daylight hours. Disease incidence was evaluated on 24 Jul. Data were subjected to analysis of variance, and the mean values were separated by the Waller-Duncan k-ratio test (P=0.05).

Results and Discussion

Disease incidence was moderate in this field study. Of the 27 treatments in the study, 14 provided control that was significantly different from the untreated check. The most effective control was provided by TADS 12529, Lynx alone or in combination with Daconil Ultrex, the two Chipco Triton 14-day treatments, Banner Maxx, Daconil Ultrex at 2.8 or 3.2 oz, both rates of Junction, and the Heritage/Daconil Ultrex combination. The high rates of TADS 12529 and

Lynx provided complete suppression of Anthracnose in this study. Phytotoxicity, in the form of a bronzed appearance, was noted in plots treated with Banner Maxx and Junction.

Table. Evaluation of Fungicides for Control of Anthracnose on a Putting Green, 2000

Treatment, formulation, and rate per 1000 sq ft	Disease Incidence[1] 24 Jul
Heritage 50WG 0.4 oz[2]	3.7a[3]
Heritage 50WG 0.3 oz[4]	3.3ab
Heritage 50WG 0.4 oz	2.7abc
Heritage 50WG 0.4 oz + LI 700 L 0.5% V/V[2]	2.7abc
Heritage 50WG 0.3 oz[5]	2.7abc
Eagle 40WP 0.6 oz	2.7abc
Untreated Check	2.7abc
Pentathlon 75DF 3.0 oz[6]	2.3bcd
Pentathlon 75DF 4.0 oz[6]	2.3bcd
Cleary 3336 50WP 2.0 oz	2.0cde
BAS 500-02 20WG 0.5 oz	1.7c-f
Daconil Ultrex 82.5WG 1.84 oz	1.7c-f
Heritage 50WG 0.2 oz	1.7c-f
Chipco Triton 1.67SC 0.5 fl oz[5]	1.7c-f
BAS 500-02 20WG 1.0 oz	1.3d-g
Chipco Triton 1.67SC 1.0 fl oz[5]	1.3d-g
Junction 61.1DF 2.0 oz[6]	1.0e-h
Heritage 50WG 0.4 oz + Daconil Ultrex 82.5WG 3.2 oz	1.0e-h
Daconil Ultrex82.5WG 3.2 oz	1.0e-h
Junction 61.1DF 4.0 oz[6]	0.7fgh
Banner Maxx 1.24MC 1.7 fl oz	0.7fgh
Chipco Triton 1.67SC 0.5 fl oz	0.7fgh
Lynx 45WP 0.556 oz + Daconil Ultrex 82.5WG 1.84 oz	0.3gh
Daconil Ultrex 82.5WG 2.8 oz	0.3gh
Chipco Triton 1.67SC 1.0 fl oz	0.3gh
TADS 12529 70WG 0.15 oz	0.3gh
Lynx 45WP 0.556 oz	0.0h
TADS 12529 70WG 0.3 oz	0.0h

[1]Disease incidence index using a 0-10 scale; 0=no disease, 1=1-10% plot infected, and 10=>90% plot infected.
[2]Treatment applied once (25 May).
[3]Mean of three replications. Means within the column followed by different letters are significantly different (P?0.05) according to the Waller-Duncan k-ratio test.
[4]Treatment applied on a 28-day interval (25 May, 22 Jun, and 20 Jul).
[5]Treatment applied on a 21-day interval (25 May, 15 Jun, and 6 and 27 Jul).
[6]Treatment applied on a 7-day interval 25 May through 1 Aug.

Evaluation of Fungicides for Control of Dollar Spot on a Putting Green

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Introduction

The use of fungicides for managing dollar spot (*Sclerotinia homoeocarpa*) on golf courses is a commonly used practice to maintain high quality playing surfaces. This study was conducted at the Valentine Turfgrass Research Center, University Park, PA, on a creeping bentgrass (*Agrostis Palustris*, 'Penncross') green. The study included various fungicides, rates, and/or application intervals to investigate control strategies and fungicide efficacy.

Materials and Methods

The experiment was conducted on creeping bentgrass maintained under golf course greens management conditions, mowed at 0.125 inch cutting height. The soil was a modified sandy clay loam with a soil pH of 7.0. The test area was fertilized on 9 May, 2000 with 0.75 lb nitrogen (Lebanon 28-7-14) per 1000 sq ft, 18 May with 1.0 lb nitrogen (Scotts 18-9-18) per 1000 sq ft, and 31 Jul with 0.5 lb nitrogen (urea 46-0-0) per 1000 sq ft. Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with three replications. Treatments were applied with a CO_2-powered boom sprayer, using TeeJet 8004 nozzles, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 14 and 28 Jun, and 12 and 26 Jul, except as noted in the table. The experimental turf area was inoculated on 21 Jun, seven days after the first treatment application, by hand-broadcasting *S. homoeocarpa*-infested ryegrains, at a density of 20-30 grains per sq ft. A mixture of five isolates of *S. homoeocarpa* was used in the inoculation. Disease incidence was evaluated on 20 and 26 Jul, and 2 and 8 Aug. Data were subjected to analysis of variance, and the mean values were separated by the Waller-Duncan k-ratio test (P?0.05).

Results and Discussion

Dollar spot incidence was very high and consistent during the study. The 8 Aug evaluation showed nine of the 34 treatments were not significantly different from the untreated check. Through the 8 Aug evaluation, however, the most effective dollar spot control was obtained from Eagle (0.6 oz or 1.2 oz [28-day interval]), Bayleton (14-day interval), and the 3.8 oz rate of Daconil Ultrex. Complete suppression of dollar spot was achieved with Lynx alone or in combination with Daconil Ultrex, Banner Maxx alone or in combination with Compass, BAS 50503 (14-day interval), and C B Maxx.

Table. Evaluation of Fungicides for Control of Dollar Spot on a Putting Green, 2000

Treatment, formulation, and rate per 1000 sq ft	Dollar Spot Incidence[1] 20 Jul	26 Jul	2 Aug	8 Aug
Heritage 50 WG 0.4 oz[2]	55.7 bcd[3]	49.3 bc[3]	119.7 abc[3]	181.0 a[3]
Fore Rainshield 80 WP 6.0 oz	61.0 bc	40.3 cd	89.3 bcd	162.7 ab
Untreated Check	91.7 a	68.3 a	132.3 a	156.3 ab
Daconil Ultrex 82.5 WG 3.8 oz[4]	93.0 a	71.7 a	122.7 ab	137.0 abc
Fore Rainshield 80 WP 8.0 oz	78.0 ab	42.0 cd	82.0 de	133.3 bcd
Heritage 50WG 0.2 oz	49.0 cde	46.0 bcd	86.3 cd	126.0 bcd
Bayleton 25DF 0.5 oz[4]	57.0 bcd	41.0 cd	82.7 de	124.3 bcd
Primo 1EC 0.125 fl oz[2]	91.0 a	62.0 ab	133.0 a	122.7 bcd
Fore 80WP 8.0 oz	63.0 bc	41.7 cd	66.7 d-g	122.3 bcd
Cleary 3336 50WP 2.0 oz[4]	43.0 c-f	35.7 cde	82.3 de	120.3 bcd
Bayleton 25DF 0.5 oz + LI 700 0.5 %V/V[4]	48.3 cde	31.7 c-f	69.0 def	108.0 cde
Daconil Ultrex 82.5WG 3.8 oz + LI 700 0.5 %V/V[4]	36.0 d-g	30.3 d-g	63.7 d-g	91.7 def
Cleary 3336 50WP 2.0 oz + LI 700 0.5 %V/V[4]	24.3 e-i	19.3 e-h	50.3 e-h	70.0 efg
Eagle 40WP 1.2 oz[4]	12.3 ghi	7.3 hi	33.7 g-j	69.7 efg
AMS 21618 2.1SC 0.288 fl oz	19.3 f-i	8.3 hi	18.3 h-k	68.3 efg
Banner Maxx 1.24MC 2.0 fl oz + LI 700 0.5 %V/V[4]	11.7 ghi	12.0 ghi	40.0 f-i	66.3 efg
AMS 21618 2.1SC 0.383 fl oz	27.3 e-h	13.0 f-i	12.3 ijk	51.0 fg
Cleary 3336 50WP 2.0 oz	18.7 f-i	16.3 f-i	29.7 h-k	46.3 gh
Eagle 40WP 1.2 oz + LI 700 0.5 %V/V[4]	4.0 hi	6.7 hi	15.3 ijk	40.3 ghi
Banner Maxx 1.24MC 2.0 fl oz[4]	9.7 hi	9.3 hi	16.3 ijk	34.7 ghi
BAS 505 03 50WG 0.2 oz[2]	5.3 hi	2.3 hi	0.0 k	30.0 ghi
Daconil Ultrex 82.5WG 1.82 oz	1.0 i	0.0 i	0.0 k	30.0 ghi
Chipco 26 GT 2.1SC 3.0 fl oz	0.0 i	0.0 i	0.3 jk	5.7 hi
Daconil Ultrex 82.5WG 3.2 oz	0.0 i	0.0 i	0.0 k	5.0 hi
Daconil Ultrex 82.5WG 3.8 oz	0.0 i	0.0 i	0.0 k	1.0 i
Eagle 40WP 0.6 oz	1.0 i	0.3 i	0.0 k	0.3 i
Bayleton 25DF 0.5 oz	0.0 i	0.0 i	0.0 k	0.3 i
C B Maxx 0.9MC 2.0 fl oz	0.0 i	0.0 i	0.0 k	0.0 i
Compass 50WG 0.15 oz + Banner Maxx 1.0 fl oz[5]	0.0 i	0.0 i	0.0 k	0.0 i
BAS 505 03 50WG 0.2 oz	0.0 i	0.0 i	0.0 k	0.0 i
Eagle 40WP 1.2 oz[2]	0.3 i	0.0 i	0.0 k	0.0 i
Banner Maxx 1.24MC 2.0 fl oz	0.0 i	0.0 i	0.0 k	0.0 i
Lynx 45WP 0.278 oz	0.0 i	0.0 i	0.0 k	0.0 i
Lynx 45WP 0.556 oz	0.0 i	0.0 i	0.0 k	0.0 i
Lynx 45WP 0.278 oz + Daconil Ult 82.5WG 1.82 oz	0.0 i	0.0 i	0.0 k	0.0 i

[1]Values represent number of infection centers per plot, mean of three of three replications.
[2]Treatment applied on a 28-day interval (14 Jun and 12 Jul).
[3]Means within each column followed by different letters are significantly different (P?0.05) according the Waller-Duncan k-ratio test.
[4]Treatment applied on 14 Jun only.
[5]Treatment applied on a 21-day interval (14 Jun, 5 and 26 Jul).

Control of Brown Patch with Fungicides

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Introduction

Brown Patch (*Rhizoctonia solani*) can be a serious disease on golf courses during warm and humid periods of summer. This study was conducted at the Valentine Turfgrass Research Center, University Park, PA, on colonial bentgrass *(Agrostis capillaris)* maintained under golf course fairway management conditions. The objective of the study was to evaluate various fungicides rates, application intervals, and tank-mixtures for effectiveness in controlling brown patch.

Materials and Methods

The experiment was conducted on colonial bentgrass (*Agrostis capillaris*, 'Bardot') mowed three times per week at 0.5 inch cutting height. The soil was Hagerstown silt loam with a soil pH of 6.4. The test area was fertilized on 18 May, 2000 with 1.0 lb nitrogen (Scotts 19-0-17) per 1000 sq ft, 19 Jun with 1.2 lb nitrogen (Nutralene 40-0-0) per 1000 sq ft, and 31 Jul with 0.5 lb nitrogen (urea 46-0-0). Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with five replications. Treatments were applied with a CO_2-powered boom sprayer, using TeeJet 8004 nozzles, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 22 Jun, 6 and 20 Jul, and 1 Aug, unless otherwise noted in the table. The experimental area was inoculated on 3 Jul (11 days after initial treatment applications) by hand-scattering *Rhizoctonia solani*-infested rye grains at a density of 20-30 grains per sq ft. From 14 Jul through 8 Aug the study was covered during the evenings and nights with a woven greens cover to reduce radiational cooling. Disease severity was assessed on 17 Jul and 8 Aug. Data were subjected to analysis of variance, and the mean values were separated by the Waller-Duncan K-ratio Test (P=0.05).

Results and Discussion

Disease severity was high in mid-July with >80% of untreated check plots infected. On 17 Jul, 17 of the 31 treatments were providing good control of brown patch. Complete suppression was observed from ProStar alone or in combination with Chipco 26 GT, Heritage alone or in combination with Daconil Ultrex, the Compass + Banner Maxx combination, and both rates of AMS 21618. By 8 Aug, disease severity was much lower, and 28 of the 31 treatments were providing good control of brown patch.

Table. Control of Brown Patch with Fungicides, 2000

Treatment, formulation, and product rate per 1000 sq ft	Disease Severity[1] 17 Jul	8 Aug
J1446 WP 32.7 oz[2]	9.8a[3]	4.6a[3]
CGA-173506 50WG 0.5 oz[4]	9.8a	0.2d
Untreated Check	8.8a	3.7ab
ProStar 70WP 2.2 oz[5]	7.8ab	2.8abc
ProStar 70WP 2.2 oz + LI 700 L 0.5% V/V[5]	7.8ab	4.6a
Eagle 40WP 1.2 oz[6]	7.6ab	1.9bcd
Daconil Ultrex 82.5WG 1.8 oz	6.0bc	0.9cd
Banner Maxx 1.24MC 2.0 fl oz	5.2c	0.6d
Fore Rainshield 80WP 6.0 oz	4.8cd	1.8bcd
Chipco 26 GT 2SC 4.0 fl oz + Chipco Signature 80WG 4.0 oz	4.2cde	0.0d
Fore Rainshield 80WP 8.0 oz	4.0cde	1.8bcd
Daconil Ultrex 82.5WG 3.2 oz	2.8def	0.0d
Chipco 26 GT 2SC 4.0 fl oz	2.8def	0.4d
Medallion 50WG 0.5 oz	2.6d-g	0.2d
Bayleton 25DF 0.5 oz	2.4efg	1.0cd
Heritage 50WG 0.4 oz[5]	2.2e-h	0.9cd
Eagle 40WP 0.6 oz	2.0e-h	1.8bcd
Fore 80WP 8.0 oz	2.0e-h	0.6d
Heritage 50WG 0.4 oz	2.0e-h	0.2d
Heritage 50WG 0.4 oz[6]	1.2fgh	0.0d
Heritage 50WG 0.4 oz + LI 700 L 0.5% V/V[5]	1.2fgh	1.0cd
Compass 0.42MC 1.5 fl oz	0.8fgh	0.8cd
C B Maxx 0.9MC 2.0 fl oz[7]	0.8fgh	0.1d
Compass 50WG 0.15 oz	0.6fgh	0.0d
ProStar 70WP 1.5 oz	0.4gh	0.1d
Heritage 50WG 0.3 oz	0.0h	0.2d
Daconil Ultrex 82.5WG 1.8 oz + Heritage 50WG 0.2 oz	0.0h	0.5d
AMS 21618 2.1SC 0.288 fl oz	0.0h	0.0d
AMS 21618 2.1SC 0.383fl oz	0.0h	0.2d
Compass 50WG 0.15 oz + Banner Maxx 1.24MC 1.0 fl oz[7]	0.0h	0.0d
ProStar 70WP 2.2 oz	0.0h	0.0d
ProStar 70WP 1.5 oz + Chipco 26 GT 2SC 4.0 fl oz	0.0h	0.0d

[1]Disease severity index (0-10); 0=no disease, 1=1-10% plot blighted, and 10=>90% plot blighted.
[2]Treatment applied with TeeJet 8008 nozzles in water equivalent to 6 gal per 1000 sq ft.
[3]Mean of five replications. Means within each column followed by different letters are significantly different (P?0.05) according the Waller-Duncan k-ratio test.
[4]Treatment was not applied until 6 Jul.
[5]Treatment applied 22 Jun only.
[6]Treatment applied on a 28-day interval (22 Jun and 20 Jul).
[7]Treatment applied on a 21-day interval (22 Jun and 13 Jul, and 1 Aug).

Control of Pythium Foliar Blight on Perennial Ryegrass

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Introduction

Pythium foliar blight can be a devastating disease on fine turf. The use of fungicides is an important means of controlling Pythium foliar blight on golf courses. The studies were conducted at the Valentine Turfgrass Research Center, University Park, PA, on perennial ryegrass (*Lolium perenne*, 'Pennfine'). The objective of the studies was to evaluate various fungicides to determine their effectiveness in disease suppression.

Materials and Methods

Two experiments were conducted on perennial ryegrass maintained under golf course fairway management conditions, and mowed three times per week at 0.5 inch cutting height. The soil was Hagerstown silt loam with a soil pH of 7.0. On 27 Apr, 2000 the test site was treated with Dimension 1EC at 1.125 fl oz per 1000 sq ft. Fertilization was done on 22 May with 1.0 lb nitrogen (Nitroform 38-0-0) per 1000 sq ft, and 26 Jun with 1.2 lb nitrogen (Nutralene 40-0-0) per 1000 sq ft. On 25 May Dyrene 4F was applied at the rate of 6.0 fl oz per 1000 sq ft for control of red thread. Lesco Benomyl 50WP (2.0 oz/1000 sq ft) was applied on 30 Jun for control of brown patch. Treatment plots, 3 ft x 7 ft, were arranged in a randomized complete block design with three replications. In both experiments, unless otherwise noted in the table, fungicides were applied on 10 Jul with a CO_2-powered boom sprayer using TeeJet 8004 nozzles. Applications were made at 40 psi in water equivalent to 2 gal per 1000 sq ft. On 11 Jul experiment 2 was irrigated with 0.4 inches of water. On 12 Jul turf in both experiments was enclosed in 30 ft x 48 ft polyethylene greenhouses to reduce radiational cooling. Experiments were inoculated with a mycelial suspension of a six-isolate pool of *Pythium aphanidermatum*. Internal intermittent misting systems provided continuous high relative humidity throughout the experiments. The greenhouses were vented during daylight hours to maintain a temperature range of 85? to 95?F. Vents were closed during the nights. Disease severity was assessed daily from 17 Jul through 21 Jul, and on 24 Jul. Data were subjected to analysis of variance, and the mean values were separated using the Waller-Duncan k-ratio Test (P=0.05). Data from 17 and 24 Jul are presented.

Results and Discussion

Environmental conditions were conducive for development of Pythium foliar blight throughout both experiments. By 24 Jul, >90% infection was noted in the untreated check plots. In Experiment 1, good control of Pythium foliar blight was obtained from Subdue Maxx alone or in combination with LI 700, the three fungicide combinations with WAC 79, Heritage alone or mixed with LI 700, and Banol. In Experiment 2, good Pythium blight control was obtained from BAS 500 02 + Subdue Maxx, the Banol + Aliette mixture, the 2.0 fl oz rate of Banol, and Subdue Maxx. AND 706-00 was ineffective in experiment 2.

Table 1. Control of Pythium Foliar Blight on Perennial Ryegrass, 2000, Experiment 1

	Disease Severity[1]	
Treatment, formulation, and rate of product/1000 sq ft	17 Jul	24 Jul[2]
Untreated Check	8.0 a[3]	10.0 a[3]
AMS 21616 0.84SC 0.958 fl oz	2.3 b	7.7 ab
AMS 21616 0.84SC 0.716 fl oz	1.7 bcd	7.3 bc
AMS 21616 0.84SC 1.44 fl oz	2.0 bc	6.7 bcd
AMS 21616 0.84SC 1.92 fl oz	1.3 cde	5.3 b-e
WAC79 L 3.0 fl oz Aliette Signature 80WG 2.0 oz	0.7 efg	5.0 c-f
Aliette Signature 80WG 4.0 oz	1.0 def	5.0 c-f
WAC79 L 5.0 fl oz	1.0 def	4.3 d-g
Banol 6SL 2.0 fl oz	0.7 efg	3.7 e-h
Heritage 50WG 0.4 oz	1.0 def	2.7 fgh
WAC79 L 3.0 fl oz +Aliette 80WG 2.0 oz +Daconil Ult. 82.5WG 3.8 oz	0.7 efg	2.3 gh
Heritage 50WG 0.4 oz + LI 700 L 0.5 % V/V	1.0 def	2.0 gh
WAC79 L 5.0 fl oz + Protect T/O 80WP 6.0 oz	0.7 efg	2.0 gh
WAC79 L 5.0 fl oz + Spectro 90WDG 5.0 oz	0.3 fg	2.0 gh
Subdue Maxx 2MC 0.5 fl oz	0.3 fg	1.7 h
Subdue Maxx 2MC 0.5 fl oz + LI 700 L 0.5 % V/V	0.0 g	1.3 h

[1]Disease severity index (0-10 scale); 0=no disease, 1=1-10% plot blighted, and 10=>90% plot blighted.
[2]Experimental area mowed prior to evaluation. (Plots had not been previously mowed since 10 Jul treatment applications.)
[3]Mean of three replications. Means within each column followed by different letters are significantly different (P?0.05) according the Waller-Duncan k-ratio test.

Table 2. Control of Pythium Foliar Blight on Perennial Ryegrass, 2000, Experiment 2

Treatment, formulation, and rate of product/1000 sq ft	Disease Severity[1] 17 Jul	24 Jul[2]
Untreated Check	6.3 a[3]	10.0 a[3]
AND 706-00 1.3GR 8.0 lb[4]	7.0 a	9.7 ab
AND 708-00 2.3GR 4.0 lb[4]	4.3 b	8.7 bc
AND 709-00 2.3GR 8.0 lb[4]	3.0 c	8.0 c
FNX-100 L 16.0 fl oz[5]	0.7 efg	6.3 d
Aliette Signature 80WG 4.0 oz	0.7 efg	6.0 de
AND 707-00 2.3GR 8.0 lb[4]	2.0 cd	5.7 de
Banol 6SL 1.0 fl oz	1.7 de	5.0 e
BAS 500 02F 20WG 0.9 oz	1.3 def	2.7 f
Subdue Maxx 2MC 1.0 fl oz	0.3 fg	1.7 fg
Banol 6SL 2.0 fl oz	0.3 fg	1.7 fg
Banol 6SL 1.0 fl oz + Aliette Signature 80WG 4.0 oz	0.0 g	1.0 g
BAS 500 02F 20WG 0.9 oz + Subdue Maxx 2MC 1.0 fl oz	0.0 g	0.7 g

[1]Disease severity index (0-10); 0=no disease, 1=1-10% plot blighted, and 10=>90% plot blighted.
[2]Experimental area mowed prior to evaluation. (Plots had not been previously mowed since 10 Jul treatment applications.)
[3]Mean of three replications. Means within each column followed by different letters are significantly different (P?0.05) according the Waller-Duncan k-ratio test.
[4]Treatment applied with a shaker jar.
[5]Treatment applied 7 Jul.

Evaluation of Fungicides for Control of Gray Leaf Spot on a Perennial Ryegrass Fairway

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Introduction

Gray leaf spot (*Pyricularia grisea*) has become an important disease on perennial ryegrass (*Lolium perenne*) golf course fairways in the Mid-Atlantic and the Mid-West regions of the United States. This study was conducted at the Willow Hollow Golf Course, Leesport (Berks County), PA, on a three-way blend of perennial ryegrass. The objective was to evaluate various fungicides and fungicide mixtures for effectiveness of suppression of gray leaf spot.

Materials and Methods

The study was conducted on number 13 fairway of the Willow Hollow Golf Course. The soil pH was 5.5. The test plots were mowed three times per week at 0.625 inch cutting height. Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with four replications. Fungicides were applied with a CO_2-powered boom sprayer using TeeJet 8004 nozzles at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Treatment applications began on 4 Jul, 2000 and continued on a 14-day interval through 11 Sep, unless otherwise noted in table. On 23 Aug the experimental area was inoculated with a spore suspension of *P. grisea*, and covered with a polyethylene sheet to maintain leaf wetness and reduce radiational-cooling during the next two nights. The test area was then allowed to grow to a two-inch height, and maintained at that height through 18 Oct. Disease severity was evaluated on 12, 20, and 27 Sep. Data were subjected to analysis of variance, and mean values were separated using the Waller-Duncan k-ratio test (P=0.05).

Results and Discussion

Gray leaf spot incidence was >50% in the untreated check plots throughout September. Of the 39 treatments in the study, 26 provided excellent control during the course of the study. Complete suppression of gray leaf spot was maintained throughout the experiment with Cleary's 3336 applied on 14 or 28-day intervals, three of the four Concorde SST treatments, C B Maxx, BAS 500 02 (0.9 oz, 28-day interval), and Daconil Ultrex applied alone or in combination with Heritage.

Table. Evaluation of Fungicides for Control of Gray Leaf Spot on a Perennial Ryegrass Fairway

	Disease Incidence[1]		
Treatment, formulation, and rate per 1000 sq ft	12 Sep	20 Sep	27 Sep
Untreated Check	5.5a[2]	5.8ab[2]	6.0a[2]
CGA 245704 50WG 0.023 oz[3]	4.8ab	6.8a	5.5a
K-61G WG 0.327 oz	4.5abc	6.3a	5.5a
CGA 245704 50WG 0.023 oz	3.0def	3.8c	3.5b
CGA 245704 50WG 0.012 oz + Compass 50WG 0.15 oz	2.8def	4.8bc	3.3b
CGA 245704 50WG 0.023 oz + Compass 50WG 0.15 oz	3.3cde	4.3c	3.3b
Junction 61.1DF 2.0 oz	3.0def	3.8c	3.0b
Junction 61.1DF 4.0 oz	3.5bcd	4.0c	2.8bc
Pentathlon 75DF 4.0 oz	1.8fgh	1.3de	1.8cd
Fore Rainshield 80WP 6.0 oz	2.0efg	1.0def	1.3de
Cleary 3336 50WP 6.0 oz + Li 700 L 0.5% V/V[4]	0.3i	0.3ef	1.3de
Heritage 50WG 0.4 oz[4]	1.8fgh	0.5def	1.0def
Concorde SST 82.5DF 5.0 oz	0.0i	0.0f	0.8def
Pentathlon 75DF 3.0 oz	1.3ghi	1.5d	0.5ef
Heritage 50WG 0.3 oz	0.8ghi	0.3ef	0.5ef
BAS 500 02F 20WG 0.9 oz	0.3i	0.3ef	0.3ef
Compass 50WG 0.15 oz + Banner Maxx 1.24MC1.0 fl oz	0.0i	0.0f	0.3ef
Heritage 50WG 0.2 oz	1.0ghi	0.3ef	0.3ef
Bayleton 25DF 2.0 oz	0.5hi	0.8def	0.0f
Heritage 50WG 0.4 oz + Potassium Silicate (0-0-2) L 2.0 fl oz[4]	0.5hi	0.5def	0.0f
Fore Rainshield 80WP 8.0 oz	0.3i	0.5def	0.0f
BAS 500 02F 20WG 0.5 oz	0.0i	0.5def	0.0f
CGA 279202 Maxx 0.42MC 1.5 fl oz	0.3i	0.5def	0.0f
Compass 50WG 0.15 oz	0.3i	0.5def	0.0f
Daconil Ultrex 82.5WG 3.7 oz	0.0i	0.0f	0.0f
Daconil Ultrex 82.5WG 3.2 oz	0.0i	0.0f	0.0f
Heritage 50WG 0.2 oz + Daconil Ultrex 82.5WG 1.83 oz	0.0i	0.0f	0.0f
BAS 500 02F 20WG 0.9 oz[4]	0.0i	0.0f	0.0f
BAS 500 00F 2.09EC 0.7 fl oz[4]	0.8ghi	0.0f	0.0f
CGA 279202 Maxx 0.42MC 2.0 fl oz	0.3i	0.0f	0.0f
C B Maxx 0.9MC 2.0 fl oz	0.0i	0.0f	0.0f
Concorde SST 82.5DF 8.8 oz	0.0i	0.0f	0.0f
Concorde SST 6F 2.125 fl oz	0.0i	0.0f	0.0f
Concorde SST 6F 3.5 fl oz	0.0i	0.0f	0.0f
Cleary 3336 50WP 6.0 oz	0.0i	0.0f	0.0f
Cleary 3336 50WP 6.0 oz[4]	0.0i	0.0f	0.0f
Heritage 50WG 0.4 oz + Daconil Ultrex82.5WG3.2 oz	0.0i	0.3ef	0.0f
Manhandle 62.25WP 10.0 oz	0.0i	0.3ef	0.0f
Compass 50WG 0.2 oz	0.3i	0.3ef	0.0f

[1]Disease severity index (0-10); 0=no disease, 1=1-10% leaves necrotic, and 10=>90% leaves necrotic.
[2]Mean of four replications. Means within each column followed by different letters are significantly different (P?0.05) according the Waller-Duncan k-ratio test.
[3]Treatment applied 4 Jul only.
[4]Treatment applied on a 28-day interval (4 and 31 Jul, and 28 Aug).

Control of Spring Leaf Spot/Melting-out on Kentucky Bluegrass

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Introduction

Leaf spot diseases caused by species of *Drechslera* and *Bipolaris* are common problems on turfgrasses. The use of fungicides is an important means of managing spring leaf spot/melting-out. This study was conducted at the Landscape Management Research Center, University Park, PA, on Kentucky bluegrass (*Poa pratensis*, 'S-21'). The objective of the study was to evaluate various treatments and application intervals to determine control of *Drechslera poae*.

Materials and Methods

The study was conducted on Kentucky bluegrass maintained under golf course fairway management conditions, and mowed three times per week at 0.75-inch cutting height. The soil was Hagerstown silt loam with a soil pH of 6.8. Urea (46-0-0) was applied to the experimental area at the rates of 1.3 and 0.7 lb nitrogen per 1000 sq ft on 16 Mar and 4 Apr, 2000 respectively. On 28 Apr, Dimension 1EC was applied at the rate of 1.125 fl oz per 1000 sq ft for control of crabgrass. Treatment plots, 3 ft by 10 ft, were arranged in a randomized complete block design with four replications. Fungicides were applied with a CO_2-powered boom sprayer, using TeeJet 8004 nozzles, at 35 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 19 Apr, and 3 and 17 May, unless otherwise indicated in the table. Data were subjected to analysis of variance, and the mean values were separated using the Waller-Duncan k-ratio Test (P?0.05).

Results and Discussion

Disease severity was high throughout mid-May. Fungicide applications were initiated as curative treatments on 19 Apr, when untreated check plots were assessed at >50% plot infected. Throughout the experiment the two Heritage treatments, Curalan, Fore Rainshield, and Chipco 26 GT provided good disease control. In the 30 May assessment, the 0.1 oz rate of Compass (14-day interval) was also providing good disease control. None of the treatments provided complete control of *Drechslera* leaf spot/melting-out in this study.

Table. Control of Spring Leaf Spot/Melting-out on Kentucky Bluegrass, 2000

Treatment, formulation, and rate per 1000 sq ft	Disease Severity[1] 2 May	16 May	30 May
Concorde SST 6F 3.5 fl oz[2]	5.1ab[3]	7.4a[3]	2.1b-e[3]
Concorde SST 82.5DF 3.2 oz[2]	5.0ab	6.8ab	2.6a-d
Untreated Check	6.2a	6.6ab	3.9a
Concorde SST 6F 2.125 fl oz[4]	4.6bcd	6.5ab	3.2ab
Daconil Ultrex 82.5WG 3.7 oz	5.2ab	6.2ab	3.4ab
Concorde SST 82.5DF 1.8 oz[4]	4.8bc	5.9abc	2.1b-e
Compass 50WG 0.1 oz	4.2b-e	5.2bcd	1.9c-f
Compass 50WG 0.1 oz[5]	4.2b-e	5.1bcd	3.1abc
Compass 50WG 0.15 oz[5]	4.8bc	4.3cde	3.8a
Heritage 50WG 0.2 oz	3.6c-f	3.5def	0.8f
Curalan 50WG 1.0 oz	3.2ef	3.0ef	1.4def
Fore RainShield 80WP 4.0 oz	3.3ef	2.9ef	1.2ef
Heritage 50WG 0.4 oz[6]	2.9f	2.8ef	0.9ef
Chipco 26GT 2SC 4.0 fl oz[6]	3.5def	2.0f	0.9ef

[1]Disease severity index (0-10); 0=no disease, 1=1-10% plot necrotic, and 10=>90% plot necrotic.
[2]Initial application made on 10 May, and applied on a 7-day interval (17, and 24 May).
[3]Mean of four replications. Means within each column followed by different letters are significantly different (P?0.05) according to the Waller-Duncan k-ratio test.
[4]Treatment applied on a 7-day interval (19 and 27 Apr, and 3, 10, 17, and 24 May).
[5]Treatment applied on 19 Apr only.
[6]Treatment applied on a 28-day interval (19 Apr and 17 May).

Seedhead Suppression of Annual Bluegrass

T. L. Watschke and J. A. Borger
Department of Agronomy

Introduction

This study was conducted on a mature stand of *Poa annua* maintained at fairway height at the Landscape Management Research Center in University Park, PA. The objective of the study was to evaluate selected herbicides and growth regulators for the seedhead suppression of *Poa annua*.

Methods and Materials

Some treatments were applied on April 4 and April 28, 2000, 21 days after treatment (DAT) using a three-foot CO_2 powered boom sprayer calibrated to deliver 40 GPA using two 6504 flat fan nozzles at 40 psi. The balance of the treatments were applied on April 21, 1999 using the same application methods and equipment. The turf was maintained using practices for irrigation, mowing and fertilization that would be typical for a golf course fairway.

Results and Discussion

Embark T&O treated *Poa annua* had a 90% seedhead suppression rating on May 17 (Table). The best seedhead suppression for *Poa annua* treated with Proxy was found when the highest application rate (10 oz/M) was used (two applications 21 days apart). Some seedhead suppression was attained via applications of Prograss at low rates, but multiple applications applications at (1.5 oz/M) appeared to be the best use of Prograss for seedhead suppression. When the rate was increased to 3 oz/M, seedhead suppression improved, but even for the single application unacceptable phytotoxicity was recorded on May 17. By making two applications at 3 oz/M, a slight increase in suppression occurred, but phytotoxicity was much more severe. Reducing the rate of the second application to 1.5 oz/M did not significantly reduce phytotoxicity and had minimal impact on seedhead suppression. It appears that the industry standard (Embark T&O) can provide excellent seedhead suppression without causing unacceptable phytotoxicity.

Table. Ratings of phytotoxicity and percent seedhead suppression of *Poa annua* (May 17, 2000).

Treatment	Form	Rate	Timing	(--------- Phytotoxicity -------) 4-13	4-20	4-28	5-5	5-17	% Suppression
PROXY	2 SL	5 OZ/M		10.0[1]	10.0	10.0	10.0	10.0	33.3 cd[2]
PROXY	2 SL	10 OZ/M		10.0	10.0	10.0	10.0	10.0	36.7 bcd
PROXY	2 SL	5 OZ/M		10.0	10.0	10.0	10.0	10.0	20.0 d
PROXY	2 SL	10 OZ/M	21DAT	10.0	10.0	10.0	10.0	10.0	36.7 bcd
PROXY	2 SL	5 OZ/M		10.0	10.0	10.0	10.0	10.0	43.3 bc
PROXY	2 SL	5 OZ/M	21DAT						
PROXY	2 SL	10 OZ/M		10.0	10.0	10.0	10.0	10.0	73.3 a
PROXY	2 SL	10 OZ/M	21DAT						
CHECK				10.0	10.0	10.0	10.0	10.0	0.0 e
PROGRASS	1.5 EC	1.5 OZ/M		10.0	10.0	10.0	8.2	10.0	55.0 b
PROGRASS	1.5 EC	1.5 OZ/M		10.0	10.0	10.0	8.3	6.3	50.0 bc
PROGRASS	1.5 EC	1.5 OZ/M	21DAT						
PROGRASS	1.5 EC	3 OZ/M		10.0	10.0	10.0	7.3	6.7	83.3 a
PROGRASS	1.5 EC	3 OZ/M		10.0	10.0	10.0	6.5	2.3	90.0 a
PROGRASS	1.5 EC	3 OZ/M	21DAT						
PROGRASS	1.5 EC	3 OZ/M		10.0	10.0	10.0	6.3	3.3	80.0 a
PROGRASS	1.5 EC	1.5 OZ/M	21DAT						
EMBARK T/O	0.2 L	80 OZ/A	21DAT	10.0	10.0	10.0	8.7	10.0	90.0 a

[1] – Rating scale of 0 = worst 7 = acceptable 10 =no phytotoxicity.

[2] - Means followed by same letter do not significantly differ (P=0.05 Duncan's New MRT)

Seedhead Suppression of Annual Bluegrass on a Putting Green

T. L. Watschke and J. A. Borger
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Introduction

This study was conducted on a mixed stand of creeping bentgrass (*Agrostis stolonifera*) and *Poa annua* at the Penn State Blue Golf Course in University Park, PA. The objective of the study was to evaluate selected growth regulators, with and without additional adjuvants, for seedhead suppression of *Poa annua*.

Methods and Materials

All of the treatments were applied on April 14, and in some cases sequential applications were made on April 28, 2000 using a three-foot CO_2 powered boom sprayer calibrated to deliver 40 GPA using two 6504 flat fan nozzles at 40 psi. The turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a green. The green did not receive any aerification/topdressing prior to or during the study.

Results and Discussion

The only treatment that caused an unacceptable phytotoxicity rating was Embark T&O at 40 oz/A (Table). However, when Ferromec was added (5 oz/M), the treatment was safened, with only a small decrease in seedhead suppression. The addition of Seaweed Cocktail (0.5 Gal/A) improved seedhead suppression without increasing phytotoxicity. Making a second application of seaweed cocktail two weeks after the first did not appear to provide substantial improvement in efficacy. Lowering the Embark T&O rate to 35 oz/A improved turf tolerance to an acceptable level, but the level of seedhead suppression dropped more than desired. By adding MacroSorb Foliar (4 oz/M) to the 35 oz/A Embark T&O rate, seedhead suppression was improved (from 78% without the addition to 92% with it). Also, Ferromec did not appear to be needed to safen the Embark T&O applied at the 35 oz/A rate. When Ferromec was added to the 35 oz/A rate of Embark T&O no appreciable change in seedhead suppression was found at the 5/8/00 rating date, but by the 5/16/00 rating date, a slight decrease in suppression was noted.

Table. Ratings of phytotoxicity (April 27, 2000) and % suppression of *Poa annua* seedheads on a *Poa annua*/creeping bentgrass putting green.

Treatment	Form	Rate (oz/A)	Phytotoxicity	(-----% Suppression-----) 5-8-00	5-16-00
Embark T/O	0.2 L	40	6.5[1]	86.7a-d[2]	83.3abc
Embark T/O	0.2 L	40	8.0	81.7bcd	83.3abc
Ferromec	L	5 oz/M			
Embark T/O	0.2 L	40	8.1	93.3ab	91.7ab
Ferromec	L	5 oz/M			
Seaweed Cocktail	L	0.5 gal/A			
Check			10.0	0.0e	0.0d
Embark T/O	0.2 L	35	7.5	91.7abc	86.7ab
Macrosorb Foliar	L	4 oz/M			
Embark T/O	0.2 L35		7.9	86.7a-d	85.0abc
Ferromec	L	5 oz/M			
Macrosorb Foliar	L	4 oz/M			
Embark T/O	0.2 L	40	8.3	95.0a	93.3a
Ferromec	L	5 oz/M			
Seaweed Cocktail	L	0.5 gal/A			
Seaweed Cocktail[3]	L	0.5 gal/A			
Embark T/O	0.2 L	35	8.3	80.0cd	75.0c
Ferromec	L	5 oz/M			
Embark T/O	0.2 L	35	7.6	78.3d	81.7bc

[1] – Rating scale of 0 = worst, 7 = acceptable, 10 = no phytotoxicity.
[2] - Means followed by same letter do not significantly differ (P=0.05 Duncan's New MRT)
[3] – Second application (two weeks after treatment).

Preemergence Control of *Poa Annua*

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Department of Agronomy

Introduction

This study is being conducted on a putting green (*Poa annua*/creeping bentgrass) at the Nittany Six Hole Golf Course, Penn State University, University Park, PA . The objective of the study is to determine the efficacy (over time) of preemergence herbicides applied in the late summer for the preemergence control of *Poa annua*.

Methods and Materials

This study is a randomized block design with three replications. All of the treatments were applied on August 26, 1998 and September 1, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two, flat fan, 6504 nozzles at 40 psi.

Results and Discussion

The green upon which the experiment is being conducted was established in 1997. Bensulide and Dimension have been applied preemergence in the late summer of 1998 and 1999 in an attempt to prevent invasion of the green by *Poa annua*. All portions of the green in the study area had one percent or less *Poa annua* invasion when the experiment was initiated. By the May 2000 rating date, the non - treated areas were becoming contaminated with *Poa annua*. Areas treated with Dimension had significantly less *Poa annua*, while those treated with bensulide were intermediate (2.7%) but tended to be less contaminated than areas not treated. The experiment will be continued.

Table. Rating of % cover of *Poa annua* in a *Poa annua*/creeping bentgrass putting green.

Treatment	Formulation	Rate (lb AI/A)	(------------%Cover------------)		
			8-26-98	5-5-99	5-17-00
Bensulide	4L	12.5	1.0a[1]	1.0a	2.7ab
Dimension	1EC	0.5	0.3a	0.3a	1.7b
Check			1.0a	1.0a	4.3a

[1] - Means followed by same letter do not significantly differ (P= 0.05 Duncan's New MRT)

Preemergence Crabgrass Control Study

Dr. T. L. Watschke and J. A. Borger
Department of Agronomy

Introduction

This study was conducted on a mature stand of Midnight Kentucky bluegrass at the Landscape Management Research Center, University Park, PA. The objective of the study was to evaluate the efficacy of herbicides for the preemergence control of smooth crabgrass.

Methods and Materials

This study was a randomized complete block design with three replications. All of the treatments were applied on April 19, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two, flat fan, 6504 nozzles at 40 psi. Some treatments were re-applied eight weeks later on June 16, 2000. Granular treatments were applied with a shaker jar. After application the entire test site received approximately 0.5 inch of water. On April 19, 2000 0.5 lb N/M was applied from urea and 0.5 lb N/M from a 24-4-12 SCU fertilizer to treatments that did not contain any nitrogen fertilizer as a carrier.
Crabgrass germination was first noted in the test site on May 5, 2000.

Results and Discussion

The following herbicides provided preemergence crabgrass control near or above the 85% level considered to be commercially acceptable: Pendulum 2G at 2 lbs ai/A, all rates of Barricade 4FL and 65WDG, Betasan at 9.2 oz/M and 5.5 oz/M followed by 3.65 oz/M eight weeks later, Ronstar 2G (fine) at 2 lbs ai/A, Dimension 1EC at 0.25 lbs ai/A, Dimension 40WP at 0.25 lbs ai/A, Dimension 2.65MEC (PE1XF00020) at 0.25 lbs ai/A, Dimension 2.65MEC (PE1XF00045) at 0.18 and 0.25 lbs ai/A, Dimension (AND442) 0.035G at 0.18 lbs ai/A (Table 1). Phytotoxicity was rated four times (4/21, 4/26, 5/3, and 5/17) and no treatment was found to cause phytotoxicity (Table 2).

Table1. Percent control of smooth crabgrass rated on Aug 11, 2000 where 85% and above was considered acceptable.

Treatment	Formulation	Rate (lbs Ai/A)	Timing	% Control
TEAM PRO	0.86G	2	PRE[1]	80
TEAM PRO	0.86G	1.5	PRE	80
TEAM PRO	0.86G	1.5	8WAT[2]	
PENDIMETHALIN	0.86G	2	PRE	75
PENDIMETHALIN	0.86G	1.5	PRE	75
PENDIMETHALIN	0.86G	1.5	8WAT	
DIMENSION	0.09G	0.25	PRE	80
BARRICADE	0.22G	0.38	PRE	65
CHECK				0
PENDULUM	3.3EC	1.5	PRE	77
PENDULUM	3.3EC	2	PRE	77
PENDULUM	60WDG	1.5	PRE	78
PENDULUM	60WDG	2	PRE	77
PENDULUM	2G	1.5	PRE	73
PENDULUM	2G	2	PRE	85
BARRICADE 4FL	4L	2.0	PRE	97
BETASAN	4EC	9.2 OZ/M	PRE	92
BETASAN	4EC	5.5 OZ/M	PRE	97
BETASAN	4EC	3.65 OZ/M	8WAT	
RONSTAR (FINE)	2G	2	PRE	83
RONSTAR	2G	3	PRE	80
BARRICADE 4FL	4L	1.0	PRE	90
DIMENSION	1EC	0.18	PRE	77
BLANK FERT	G	3.5 LB/M	PRE	
DIMENSION	1EC	0.25	PRE	82
BLANK FERT	G	3.5 LB/M	PRE	
DIMENSION	40WP	0.18	PRE	80
BLANK FERT	G	3.5 LB/M	PRE	
DIMENSION	40WP	0.25	PRE	82
BLANK FERT	G	3.5 LB/M	PRE	
PE1XF00020	2.65MEC	0.18	PRE	77
BLANK FERT	G	3.5 LB/M	PRE	
PE1XF00020	2.65MEC	0.25	PRE	85
BLANK FERT	G	3.5 LB/M	PRE	
PE2XF00045	2.43MEC	0.18	PRE	83
BLANK FERT	G	3.5 LB/M	PRE	
PE2XF00045	2.43MEC	0.25	PRE	83
BLANK FERT	G	3.5 LB/M	PRE	
DIMENSION AND 442	0.035G	0.18	PRE	97
DIMENSION AND 445	0.164G	0.25	PRE	72
BARRICADE 4FL	4L	0.75	PRE	88
BARRICADE	65WDG	0.5	PRE	83
BARRICADE	65WDG	0.75	PRE	88
BARRICADE	65WDG	1.0	PRE	90
BARRICADE	65WDG	2.0	PRE	96
BARRICADE 4FL	4L	0.5	PRE	83

[1] Preemergence application
[2] Weeks after treatment

Table 2. Phytotoxicity ratings taken in 2000 of Midnight Kentucky bluegrass where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Formulation	Rate (lbs Ai/A)	Timing	4/21	4/26	5/3	5/17
				(---------Phytotoxicity----------)			
TEAM PRO	0.86G	2	PRE[1]	10	10	10	10
TEAM PRO	0.86G	1.5	PRE	10	10	10	10
TEAM PRO	0.86G	1.5	8WAT[2]				
PENDIMETHALIN	0.86G	2	PRE	10	10	10	10
PENDIMETHALIN	0.86G	1.5	PRE	10	10	10	10
PENDIMETHALIN	0.86G	1.5	8WAT				
DIMENSION	0.09G	0.25	PRE	10	10	10	10
BARRICADE	0.22G	0.38	PRE	10	10	10	10
CHECK	10	10	10	10			
PENDULUM	3.3EC	1.5	PRE	10	10	10	10
PENDULUM	3.3EC	2	PRE	10	10	10	10
PENDULUM	60WDG	1.5	PRE	10	10	10	10
PENDULUM	60WDG	2	PRE	10	10	10	10
PENDULUM	2G	1.5	PRE	10	10	10	10
PENDULUM	2G	2	PRE	10	10	10	10
BARRICADE 4FL	4L	2.0	PRE	10	10	10	10
BETASAN	4EC	9.2 OZ/M	PRE	10	10	10	10
BETASAN	4EC	5.5 OZ/M	PRE	10	10	10	10
BETASAN	4EC	3.65 OZ/M	8WAT				
RONSTAR (FINE)	2G	2	PRE	10	10	10	10
RONSTAR	2G	3	PRE	10	10	10	10
BARRICADE 4FL	4L	1.0	PRE	10	10	10	10
DIMENSION	1EC	0.18	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
DIMENSION	1EC	0.25	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
DIMENSION	40WP	0.18	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
DIMENSION	40WP	0.25	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
PE1XF00020	2.65MEC	0.18	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
PE1XF00020	2.65MEC	0.25	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
PE2XF00045	2.43MEC	0.18	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
PE2XF00045	2.43MEC	0.25	PRE	10	10	10	10
BLANK FERT	G	3.5 LB/M	PRE				
DIMENSION AND 442	0.035G	0.18	PRE	10	10	10	10
DIMENSION AND 445	0.164G	0.25	PRE	10	10	10	10
BARRICADE 4FL	4L	0.75	PRE	10	10	10	10
BARRICADE	65WDG	0.5	PRE	10	10	10	10
BARRICADE	65WDG	0.75	PRE	10	10	10	10
BARRICADE	65WDG	1.0	PRE	10	10	10	10
BARRICADE	65WDG	2.0	PRE	10	10	10	10
BARRICADE 4FL	4L	0.5	PRE	10	10	10	10

[1] Preemergence application

[2] Weeks after treatment

Postemergence Control of Crabgrass at the Two to Three Tiller Growth Stage

Dr. T. L. Watschke and J. A. Borger
Department of Agronomy

Introduction

This study was conducted on a mature stand of perennial ryegrass at the Landscape Management Research Center, University Park, PA. The objective of the study was to evaluate the efficacy of herbicides for the postemergence control of smooth crabgrass.

Methods and Materials

This study was a randomized complete block design with three replications. All of the treatments were applied on July 2, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi.

Results and Discussion

The addition of MacroSorb Foliar to the 0.5 lb ai/A rate of Drive 75DF improved control from 68 to 78%. Drive 75DF alone at 0.75 lb ai/A provided 82% control which was close to being acceptable (Table). There is little doubt that supplementing the 0.75 lb ai/A rate of Drive 75DF with MacroSorb Foliar would have easily increased control above the acceptable level. Acclaim Extra 0.57EW provided excellent control at 20 and 28 oz/A as did Ricestar. Puma also provided excellent control at 11.4 and 16 oz/A. The addition of MacroSorb Foliar to a low rate of Acclaim Extra (10 and 15 oz/A) allowed for control that approached acceptability (83%).

Table. Percent postemergence control of smooth crabgrass rated on Aug 11, 2000 where 85% and above was considered commercially acceptable.

Treatment	Formulation	Rate (lbs Ai/A)	% Control
DRIVE	75DF	0.75	82
MSO	L	1% V/V	
DRIVE	75DF	0.5	68
MSO	L	1% V/V	
DRIVE	75DF	0.75	73
MSO	L	1% V/V	
MACROSORB FOLIAR	L	2 OZ/M	
DRIVE	75DF	0.5	78
MSO	L	1% V/V	
MACROSORB FOLIAR	L	2 OZ/M	
CHECK			0
ACCLAIM EXTRA	0.57EW	20 OZ/A	91
ACCLAIM EXTRA	0.57EW	28 OZ/A	97
RICESTAR	0.57EC	20 OZ/A	88
RICESTAR	0.57EC	28 OZ/A	95
PUMA	1EC	11.4 OZ/A	90
PUMA	1EC	16 OZ/A	94
ACCLAIM EXTRA	0.57EW	20 OZ/A	94
MACROSORB FOLIAR	L	2 OZ/M	
ACCLAIM EXTRA	0.57EW	15 OZ/A	83
MACROSORB FOLIAR	L	2 OZ/M	
ACCLAIM EXTRA	0.57EW	10 OZ/A	83
MACROSORB FOLIAR	L	2 OZ/M	
ACCLAIM EXTRA	0.57EW	28 OZ/A	97
MACROSORB FOLIAR	L	2 OZ/M	

Postemergence Control of Crabgrass at the Two to Three Leaf Growth Stage

Dr. T. L. Watschke and J. A. Borger
Department of Agronomy

Introduction

This study was conducted on a mature stand of perennial ryegrass at the Landscape Management Research Center, University Park, PA. The objective of the study was to evaluate the efficacy of pre/post emergence herbicides for the postemergence control of smooth crabgrass.

Methods and Materials

This study was a randomized complete block design with three replications. All of the treatments were applied on June 14, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi. Granular treatments were applied with a shaker jar.

Results and Discussion

Only Acclaim Extra at 0.12 lbs ai/A combined with pendimethalin at 1.5 lbs ai/A provided acceptable postemergence control of smooth crabgrass in this study (Table). The 40WP formulation of Dimension at 0.5 lbs ai/A and the 0.38 lb ai/A rate of XF00020 2.65MEC approached commercial acceptance by providing 80% control. It appears that these two formulations of Dimension have potential to be satisfactory control products, at least at the highest rates for each. It is likely that a rate of 0.5 lbs ai/A of either XF00020 or XF00045 would provide acceptable control. These rates should be evaluated in future studies.

Table. Percent postemergence control of smooth crabgrass rated on Aug 11, 2000 where 85% and above was considered commercially acceptable.

Treatment	Formulation	Rate (lb Ai/A)	% Control
DIMENSION	1EC	0.38	72
DIMENSION	1EC	0.5	73
DIMENSION	40WP	0.25	58
DIMENSION	40WP	0.38	73
DIMENSION	40WP	0.5	80
CHECK			0
DIMENSION AND 446	0.25G	0.38	65
DIMENSION AND 445	0.164G	0.25	35
XF00020	2.65MEC	0.38	80
XF00020	2.65MEC	0.25	60
XF00045	2.43MEC	0.38	77
XF00045	2.43MEC	0.25	67
XF00034	0.17G	0.25	58
XF00029	0.17G	0.25	58
SCOTTS HALTS	1.29G	1.5	38
ACCLAIM EXTRA PENDIMETHALIN	0.57EW 60WDG	0.12 1.5	98
DIMENSION	1EC	0.25	68

Postemergence Control of Crabgrass at Several Growth Stages

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Introduction

This study was conducted on a mature stand of perennial ryegrass at the Landscape Management Research Center, University Park, PA. The objective of the study was to evaluate the efficacy of herbicides for the postemergence control of smooth crabgrass.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on June 14, June 29, July 2, July 12, July 17, and Aug 1, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi.

Results and Discussion

Only Drive 75DF applied at 0.75 lbs ai/A failed to provide acceptable post emergence control of smooth crabgrass (Table). Multiple applications (even using rates lower than 0.75 lbs ai/A) improved control of smooth crabgrass substantially. It appears that by using multiple applications the historical weakness in control using Drive at certain growth stages can be overcome.

Table. Percent postemergence control of smooth crabgrass rated on Aug 11, 2000 where 85% and above was considered commercially acceptable.

Treatment	Formulation	Rate (lbs Ai/A)	Timing	% Control
DRIVE	75DF	0.75	2-3 LEAF	72
MSO	L	1% V/V	2-3 LEAF	
DRIVE	75DF	0.5	2-3 LEAF	96
MSO	L	1% V/V	2-3 LEAF	
DRIVE	75DF	0.5	2-3 TILLERS	
MSO	L	1% V/V	2-3 TILLERS	
DRIVE	75DF	0.375	2-3 LEAF	98
MSO	L	1% V/V	2-3 LEAF	
DRIVE	75DF	0.375	2 WAT[1]	
MSO	L	1% V/V	2 WAT	
DRIVE	75DF	0.375	4 WAT	
MSO	L	1% V/V	4 WAT	
DRIVE	75DF	0.25	2-3 LEAF	96
MSO	L	1% V/V	2-3 LEAF	
DRIVE	75DF	0.25	2 WAT	
MSO	L	1% V/V	2 WAT	
DRIVE	75DF	0.25	4 WAT	
MSO	L	1% V/V	4 WAT	
CHECK				0
DRIVE	75DF	0.188	2-3 LEAF	94
MSO	L	1% V/V	2-3 LEAF	
DRIVE	75DF	0.188	2 WAT	
MSO	L	1% V/V	2 WAT	
DRIVE	75DF	0.188	4 WAT	
MSO	L	1% V/V	4 WAT	
DRIVE	75DF	0.5	2-3 LEAF	98
MSO	L	1% V/V	2-3 LEAF	
DRIVE	75DF	0.5	5 + TILLERS	
MSO	L	1% V/V	5 + TILLERS	
DRIVE	75DF	0.375	2-3 TILLERS	97
MSO	L	1% V/V	2-3 TILLERS	
DRIVE	75DF	0.375	2 WAT	
MSO	L	1% V/V	2 WAT	
DRIVE	75DF	0.375	4 WAT	
MSO	L	1% V/V	4 WAT	
DRIVE	75DF	0.188	2-3 TILLERS	97
MSO	L	1% V/V	2-3 TILLERS	
DRIVE	75DF	0.188	2 WAT	
MSO	L	1% V/V	2 WAT	
DRIVE	75DF	0.188	4 WAT	
MSO	L	1% V/V	4 WAT	
DRIVE	75DF	0.75	5 + TILLERS	96
MSO	L	1% V/V	5 + TILLERS	

[1] Weeks after treatment

Postemergence Control of *Poa trivialis*

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Introduction

This study was conducted on a mature stand of *Poa trivialis* at the Landscape Management Research Center, University Park, PA. The objective of the study was to determine the efficacy and phytotoxicity of Acclaim Extra when applied in early spring for control of *Poa trivialis*. In addition, two other studies were conducted to evaluate the phytotoxicity of Acclaim Extra on creeping bentgrass and perennial ryegrass. Turf in all studies was maintained to simulate a golf course fairway.

Methods and Materials

These studies were a randomized complete block design with three replications for all turf treated. All of the treatments were applied on April 7 and April 28, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi.

Results and Discussion

The ratings for percent cover of *Poa trivialis* on May 11 (Table 1) showed a significantly reduced cover for the highest treatment rates (13 and 20 oz/A including reapplications). However, by the June 21 rating date the *Poa trivialis* had recovered to the extent that it was not distinguishable from the check. Therefore, it does not appear that early spring applications of Acclaim Extra have any lasting negative impact on *Poa trivialis*.

Phytotoxicity ratings recorded on April 13, April 20, May 11, and June 12 revealed that the applications of Acclaim Extra did not cause unacceptable phytotoxicity to any of the grasses treated. Perennial ryegrass was treated at higher rates than creeping bentgrass, but still, no phytotoxicity occurred (Tables 2, 3, and 4).

Table 1. Rating of % cover of *Poa trivialis*.

Treatment	Form	Rate (oz/A)	Timing	(-% Cover-) 5/11	6/21
ACCLAIM EXTRA	0.57 EW	3.5		90ab[1]	100a
ACCLAIM EXTRA	0.57 EW	7		92ab	100a
ACCLAIM EXTRA	0.57 EW	3.5		90ab	100a
ACCLAIM EXTRA	0.57 EW	3.5	21 DAT		
ACCLAIM EXTRA	0.57 EW	7		88ab	100a
ACCLAIM EXTRA	0.57 EW	7	21 DAT		
CHECK				93a	100a
ACCLAIM EXTRA	0.57 EW	13		87bc	100a
ACCLAIM EXTRA	0.57 EW	20		80d	100a
ACCLAIM EXTRA	0.57 EW	13		87bc	100a
ACCLAIM EXTRA	0.57 EW	13	21 DAT		
ACCLAIM EXTRA	0.57 EW	20		82cd	100a
ACCLAIM EXTRA	0.57 EW	20	21 DAT		

[1] - Means followed by the same letter do not significantly differ (P=.05 Duncan's New MRT)

Table 2. Phytotoxicity rating of *Poa trivialis* on a scale of 0-10 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	Form	Rate (oz/A)	Timing	4/13	4/20	5/11	6/21
ACCLAIM EXTRA	0.57 EW	3.5		10a[1]	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	7		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	3.5		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	3.5	21 DAT				
ACCLAIM EXTRA	0.57 EW	7		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	7	21 DAT				
CHECK				10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	13		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	20		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	13		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	13	21 DAT				
ACCLAIM EXTRA	0.57 EW	20		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	20	21 DAT				

[1] - Means followed by the same letter do not significantly differ (P=.05 Duncan's New MRT)

Table 3. Phytotoxicity rating of creeping bentgrass on a scale of 0-10 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	Form	Rate (oz/A)	Timing	4/13	4/20	5/11	6/21
ACCLAIM EXTRA	0.57 EW	3.5		10a[1]	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	7		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	3.5		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	3.5	21 DAT				
ACCLAIM EXTRA	0.57 EW	7		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	7	21 DAT				
CHECK				10a	10a	10a	10a

[1] - Means followed by the same letter do not significantly differ (P=.05 Duncan's New MRT)

Table 4. Phytotoxicity rating of perennial ryegrass on a scale of 0-10 where 0=worst, 7=acceptable and 10=no phytotoxicity.

Treatment	Form	Rate (oz/A)	Timing	4/13	4/20	5/11	6/21
ACCLAIM EXTRA	0.57 EW	13		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	20		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	13		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	13	21 DAT				
ACCLAIM EXTRA	0.57 EW	20		10a	10a	10a	10a
ACCLAIM EXTRA	0.57 EW	20	21 DAT				

[1] - Means followed by the same letter do not significantly differ (P=.05 Duncan's New MRT)

Postemergence Control of Broadleaf Weeds

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Introduction

This study was conducted on a mature stand of perennial ryegrass (*Lolium perenne* L.) at the Landscape Management Research Center, University Park, PA. The objective of the study was to determine the efficacy of broadleaf herbicides for the control of dandelion, common plantain, and white clover.

Methods and Materials

This study was a randomized complete block design with three replications. All of the treatments were applied on May 11, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi.

Results and Discussion

At no time was any phytotoxicity observed for treated turf (Table 1). On May 19 and 30 weed phytotoxicity was apparent on all treated broadleaf weeds (Table 2).

Control of dandelions was rated four times (6/11, 6/23, 7/7, 7/28) throughout the study. Three treatments XRM3972 at 0.375 lbs ai/A combined with XRM 5316 at 0.06 lbs ai/A, XRM3972 at 0.375 lbs ai/A combined with XRM 5316 at 0.25 lbs ai/A, and XRM3972 at 0.375 lbs ai/A provided control above 90 percent on all rating dates (Table 3). Two treatments, XRM3972 at 0.25 lbs ai/A combined with XRM 5316 at 0.06 lbs ai/A, and XRM3972 at 0.375 lbs ai/A combined with XRM 5316 at 0.12 lbs ai/A, controlled dandelions above the 90 percent level on the first rating date but fell below 90 percent control by the final rating date. All other treated turfgrass provided some control of dandelions on the first rating date but by the final rating date provided unacceptable control.

Control of broadleaf plantain was rated four times (6/11, 6/23, 7/7, 7/28) throughout the study. Seven treatments, XRM3972 at 0.375 lbs ai/A combined with XRM 5316 at 0.12 lbs ai/A, XRM3972 at 0.25 lbs ai/A combined with XRM 5316 at 0.25 lbs ai/A, XRM3972 at 0.25 lbs ai/A, EF1154 at 3.2 pt/A, Confront at 2 pt/A, Lontrel at 0.67 pt/A, and UHS302 at 4 pt/A provided control above 90 percent on the first rating date and above 80 percent control at the final rating date (Table 4). Four treatments, XRM3972 at 0.187 lbs ai/A combined with XRM 5316 at 0.25 lbs ai/A, Confront at 1 pt/A, UHS 302 at 3.2 pt/A and 3.6 pt/A provided control above 80 percent through the study. Turf treated with XRM3972 at 0.375 lbs ai/A combined with XRM 5316 at 0.25 lbs ai/A controlled broadleaf plantain at 77.8 percent at the first rating and 86.1 percent by the final rating date. All other treated turfgrass provided some control of broadleaf plantain on the first rating date but by the final rating date provided unacceptable control.

Only turf treated with XRM 5316 at 0.06 and 0.12 lbs ai/A failed to control white clover (Table 5).

Table 1. Turfgrass phytotoxicity ratings.

Treatment	Form	Rate (lb Ai/A)	(-----Phytotoxicity---) 5/19/00	5/30/00
XRM3972	3SL	0.187	10.00[1]	10.00
XRM5316	1.5EC	0.06		
XRM3972	3SL	0.25	10.00	10.00
XRM5316	1.5EC	0.06		
XRM3972	3SL	0.375	10.00	10.00
XRM5316	1.5EC	0.06		
XRM3972	3SL	0.187	10.00	10.00
XRM5316	1.5EC	0.12		
XRM3972	3SL	0.25	10.00	10.00
XRM5316	1.5EC	0.12		
XRM3972	3SL	0.375	10.00	10.00
XRM5316	1.5EC	0.12		
XRM3972	3SL	0.187	10.00	10.00
XRM5316	1.5EC	0.25		
XRM3972	3SL	0.25	10.00	10.00
XRM5316	1.5EC	0.25		
XRM3972	3SL	0.375	10.00	10.00
XRM5316	1.5EC	0.25		
XRM3972	3SL	0.187	10.00	10.00
XRM3972	3SL	0.25	10.00	10.00
XRM3972	3SL	0.375	10.00	10.00
CHECK			10.00	10.00
XRM5316	1.5EC	0.06	10.00	10.00
XRM5316	1.5EC	0.12	10.00	10.00
XRM5316	1.5EC	0.25	10.00	10.00
EF1154	2.17EW	3.2 PT/A	10.00	10.00
CONFRONT	3SL	1 PT/A	10.00	10.00
CONFRONT	3SL	1.5 PT/A	10.00	10.00
CONFRONT	3SL	2 PT/A	10.00	10.00
LONTREL	3SL	0.67 PT/A	10.00	10.00
TRIMEC CLASSIC	3.32L	4 PT/A	10.00	10.00
UHS 302	2.17EW	3.2 PT/A	10.00	10.00
UHS 302	2.17EW	3.6 PT/A	10.00	10.00
UHS 302	2.17EW	4.0 PT/A	10.00	10.00
CHECK			10.00	10.00
BANVEL	4L	0.5	10.00	10.00
BANVEL	4L	0.5	10.00	10.00
MACROSORB RADICULAR	L	2 OZ/M		
BANVEL	4L	0.25	10.00	10.00
BANVEL	4L	0.25	10.00	10.00
MACROSORB RADICULAR	L	2 OZ/M		

[1] – Scale of 0 – 10 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Table 2. Broadleaf weed phytotoxicity ratings.

Treatment	Form	Rate (lb Ai/A)	(-----Phytotoxicity---) 5/19/00	5/30/00
XRM3972	3SL	0.187	5.50	5.50
XRM5316	1.5EC	0.06		
XRM3972	3SL	0.25	5.17	5.17
XRM5316	1.5EC	0.06		
XRM3972	3SL	0.375	5.00	5.00
XRM5316	1.5EC	0.06		
XRM3972	3SL	0.187	5.00	5.00
XRM5316	1.5EC	0.12		
XRM3972	3SL	0.25	5.00	5.33
XRM5316	1.5EC	0.12		
XRM3972	3SL	0.375	5.33	6.17
XRM5316	1.5EC	0.12		
XRM3972	3SL	0.187	5.00	6.00
XRM5316	1.5EC	0.25		
XRM3972	3SL	0.25	5.67	5.67
XRM5316	1.5EC	0.25		
XRM3972	3SL	0.375	5.33	5.33
XRM5316	1.5EC	0.25		
XRM3972	3SL	0.187	5.00	5.00
XRM3972	3SL	0.25	5.67	5.67
XRM3972	3SL	0.375	5.17	5.67
CHECK			10.00	10.00
XRM5316	1.5EC	0.06	6.67	6.67
XRM5316	1.5EC	0.12	6.50	9.00
XRM5316	1.5EC	0.25	5.17	7.17
EF1154	2.17EW	3.2 PT/A	5.83	6.17
CONFRONT	3SL	1 PT/A	5.33	5.33
CONFRONT	3SL	1.5 PT/A	5.58	5.58
CONFRONT	3SL	2 PT/A	5.17	5.17
LONTREL	3SL	0.67 PT/A	5.08	5.08
TRIMEC CLASSIC	3.32L	4 PT/A	5.25	5.25
UHS 302	2.17EW	3.2 PT/A	5.17	5.17
UHS 302	2.17EW	3.6 PT/A	4.67	4.67
UHS 302	2.17EW	4.0 PT/A	5.17	5.17
CHECK			7.00	9.00
BANVEL	4L	0.5	6.17	7.33
BANVEL	4L	0.5	5.33	7.17
MACROSORB RADICULAR	L	2 OZ/M		
BANVEL	4L	0.25	5.00	6.33
BANVEL	4L	0.25	5.33	6.50
MACROSORB RADICULAR	L	2 OZ/M		

[1] – Scale of 0 – 10 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Table 3. Percent control of dandelion.

Treatment	Form	Rate (lb Ai/A)	(----------% Control---------) 6/11	6/23	7/7	7/28
XRM3972 XRM5316	3SL 1.5EC	0.187 0.06	82.2[1]ab	82.2ab	71.1a-d	33.3a-d
XRM3972 XRM5316	3SL 1.5EC	0.25 0.06	97.0a	90.0a	90.0ab	83.3ab
XRM3972 XRM5316	3SL 1.5EC	0.375 0.06	97.8a	95.6a	95.6a	95.6a
XRM3972 XRM5316	3SL 1.5EC	0.187 0.12	83.9ab	82.8ab	79.4abc	59.7a-d
XRM3972 XRM5316	3SL 1.5EC	0.25 0.12	62.2abc	47.8a-d	63.3a-d	48.9a-d
XRM3972 XRM5316	3SL 1.5EC	0.375 0.12	91.8ab	91.8a	91.8ab	87.8ab
XRM3972 XRM5316	3SL 1.5EC	0.187 0.25	62.8abc	56.1abc	55.0a-e	56.1a-d
XRM3972 XRM5316	3SL 1.5EC	0.25 0.25	92.2ab	61.1abc	57.8a-e	57.8a-d
XRM3972 XRM5316	3SL 1.5EC	0.375 0.25	95.6a	95.6a	94.3a	95.6a
XRM3972	3SL	0.187	69.0abc	51.7a-d	51.7a-e	28.3bcd
XRM3972	3SL	0.25	93.3a	75.6ab	72.2a-d	44.4a-d
XRM3972	3SL	0.375	98.3a	91.7a	97.2a	92.8a
CHECK			0.0d	0.0d	0.0e	0.0d
XRM5316	1.5EC	0.06	30.0cd	30.0bcd	30.0b-e	30.0bcd
XRM5316	1.5EC	0.12	48.7bc	15.0cd	15.0de	15.0cd
XRM5316	1.5EC	0.25	64.4abc	55.6abc	40.7a-e	25.9bcd
EF1154	2.17EW	3.2 PT/A	93.6a	76.9ab	72.8a-d	58.3a-d
CONFRONT	3SL	1 PT/A	56.7abc	16.7cd	0.0e	0.0d
CONFRONT	3SL	1.5 PT/A	94.4a	78.9ab	70.6a-d	52.8a-d
CONFRONT	3SL	2 PT/A	96.4a	81.2ab	69.0a-d	53.6a-d
LONTREL	3SL	0.67 PT/A	87.2ab	80.6ab	72.2a-d	52.8a-d
TRIMEC CLASSIC	3.32L	4 PT/A	92.8ab	70.2abc	74.0a-d	64.7abc
UHS 302	2.17EW	3.2 PT/A	72.8ab	62.8abc	62.8a-d	56.1a-d
UHS 302	2.17EW	3.6 PT/A	86.3ab	77.7ab	40.5a-e	42.1a-d
UHS 302	2.17EW	4.0 PT/A	84.4ab	64.4abc	53.3a-e	58.9a-d
CHECK			0.0d	30.7bcd	20.0cde	20.0cd
BANVEL	4L	0.5	73.3ab	50.0a-d	50.0a-e	41.7a-d
BANVEL MACROSORB RADICULAR	4L L	0.5 2 OZ/M	94.6a	76.9ab	61.3a-d	34.3a-d
BANVEL	4L	0.25	90.9ab	49.4a-d	39.7a-e	35.6a-d
BANVEL MACROSORB RADICULAR	4L L	0.25 2 OZ/M	82.0ab	69.5abc	65.3a-d	65.3abc

[1] - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT)

Table 4. Percent control of broadleaf plantain.

Treatment	Form	Rate (lb Ai/A)	(----------% Control---------) 6/11	6/23	7/7	7/28
XRM3972 XRM5316	3SL 1.5EC	0.187 0.06	70.5[1]abc	83.8a	75.7ab	75.7abc
XRM3972 XRM5316	3SL 1.5EC	0.25 0.06	83.9a	85.6a	83.9a	61.7a-e
XRM3972 XRM5316	3SL 1.5EC	0.375 0.06	81.1a	93.8a	81.1a	64.4a-e
XRM3972 XRM5316	3SL 1.5EC	0.187 0.12	83.3a	86.7a	88.9a	56.7a-e
XRM3972 XRM5316	3SL 1.5EC	0.25 0.12	90.7a	87.3a	87.3a	57.3a-e
XRM3972 XRM5316	3SL 1.5EC	0.375 0.12	98.3a	97.0a	93.7a	93.7a
XRM3972 XRM5316	3SL 1.5EC	0.187 0.25	84.4a	91.1a	91.1a	91.1a
XRM3972 XRM5316	3SL 1.5EC	0.25 0.25	90.0a	93.3a	83.3a	83.3ab
XRM3972 XRM5316	3SL 1.5EC	0.375 0.25	77.8ab	81.1a	81.1a	86.1a
XRM3972	3SL	0.187	48.3bcd	51.7b	51.7bc	51.7a-e
XRM3972	3SL	0.25	91.7a	95.0a	91.7a	88.3a
XRM3972	3SL	0.375	75.0ab	80.6a	80.6a	57.2a-e
CHECK			0.0e	0.0d	0.0e	0.0f
XRM5316	1.5EC	0.06	26.7de	26.7bcd	26.7cde	30.0c-f
XRM5316	1.5EC	0.12	8.3e	23.3cd	16.7de	16.7ef
XRM5316	1.5EC	0.25	83.3a	83.3a	76.7ab	70.0a-d
EF1154	2.17EW	3.2 PT/A	92.8a	96.1a	94.4a	94.4a
CONFRONT	3SL	1 PT/A	85.0a	95.0a	95.0a	88.3a
CONFRONT	3SL	1.5 PT/A	96.7a	96.7a	95.0a	61.7a-e
CONFRONT	3SL	2 PT/A	93.9a	96.1a	93.9a	91.7a
LONTREL	3SL	0.67 PT/A	92.2a	92.2a	88.9a	83.9a
TRIMEC CLASSIC	3.32L	4 PT/A	95.0a	95.0a	91.7a	61.7a-e
UHS 302	2.17EW	3.2 PT/A	89.4a	98.3a	92.8a	92.8a
UHS 302	2.17EW	3.6 PT/A	83.3a	86.7a	81.7a	81.7ab
UHS 302	2.17EW	4.0 PT/A	90.7a	94.1a	92.4a	83.5ab
CHECK			0.0e	0.0d	0.0e	0.0f
BANVEL	4L	0.5	73.3ab	76.7a	70.0ab	60.0a-e
BANVEL MACROSORB RADICULAR	4L L	0.5 2 OZ/M	43.3cd	43.3bc	36.7cd	33.3b-f
BANVEL	4L	0.25	8.3e	8.3d	21.7de	21.7def
BANVEL MACROSORB RADICULAR	4L L	0.25 2 OZ/M	40.0d	48.3bc	41.7cd	25.0def

[1] - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT)

Table 5. Percent control of white clover.

Treatment	Form	Rate (lb Ai/A)	(----------% Control---------) 6/11	6/23	7/7	7/28
XRM3972	3SL	0.187	100.0a[1]	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.06				
XRM3972	3SL	0.25	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.06				
XRM3972	3SL	0.375	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.06				
XRM3972	3SL	0.187	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.12				
XRM3972	3SL	0.25	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.12				
XRM3972	3SL	0.375	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.12				
XRM3972	3SL	0.187	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.25				
XRM3972	3SL	0.25	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.25				
XRM3972	3SL	0.375	100.0a	100.0a	100.0a	100.0a
XRM5316	1.5EC	0.25				
XRM3972	3SL	0.187	100.0a	100.0a	100.0a	100.0a
XRM3972	3SL	0.25	100.0a	100.0a	100.0a	100.0a
XRM3972	3SL	0.375	100.0a	100.0a	100.0a	100.0a
CHECK		33.3c	33.3b	33.3b	33.3c	
XRM5316	1.5EC	0.06	50.0bc	33.3b	50.0b	50.0bc
XRM5316	1.5EC	0.12	66.7ab	66.7a	86.7a	86.7a
XRM5316	1.5EC	0.25	100.0a	100.0a	93.3a	93.3a
EF1154	2.17EW	3.2 PT/A	100.0a	100.0a	100.0a	100.0a
CONFRONT	3SL	1 PT/A	100.0a	100.0a	100.0a	100.0a
CONFRONT	3SL	1.5 PT/A	100.0a	100.0a	100.0a	100.0a
CONFRONT	3SL	2 PT/A	100.0a	100.0a	100.0a	100.0a
LONTREL	3SL	0.67 PT/A	100.0a	100.0a	100.0a	100.0a
TRIMEC CLASSIC	3.32L	4 PT/A	100.0a	100.0a	100.0a	100.0a
UHS 302	2.17EW	3.2 PT/A	100.0a	100.0a	100.0a	100.0a
UHS 302	2.17EW	3.6 PT/A	100.0a	100.0a	100.0a	100.0a
UHS 302	2.17EW	4.0 PT/A	100.0a	100.0a	100.0a	66.7ab
CHECK			0.0d	0.0c	0.0c	0.0d
BANVEL	4L	0.5	100.0a	100.0a	100.0a	100.0a
BANVEL	4L	0.5	100.0a	100.0a	100.0a	100.0a
MACROSORB RADICULAR	L	2 OZ/M				
BANVEL	4L	0.25	100.0a	100.0a	100.0a	100.0a
BANVEL	4L	0.25	100.0a	100.0a	100.0a	100.0a
MACROSORB RADICULAR	L	2 OZ/M				

[1] - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT)

Phytotoxicity Evaluations of Creeping Bentgrass

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Department of Agronomy

Introduction

This study was conducted on a mixed stand of creeping bentgrass and *Poa annua* at the Valentine Turfgrass Research Center, University Park, PA. The objective of the study was to evaluate the phytotoxicity of postemergence crabgrass herbicides.

Methods and Materials

This study was a randomized complete block design with three replications. All of the treatments were applied on July 2, 2000 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi. The study area was maintained to simulate a golf course fairway.

Results and Discussion

At no time, at any rate, did any of the treatments cause phytotoxicity to the creeping bentgrass (Table).

Table. Phytotoxicity ratings of creeping bentgrass on a scale of 0-10 where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Formulation	Rate	(----Phytotoxicity----)		
			7/10	7/17	7/31
CHECK			10.0	10.0	10.0
ACCLAIM EXTRA	0.57EW	3.5 oz /A	10.0	10.0	10.0
ACCLAIM EXTRA	0.57EW	7 oz /A	10.0	10.0	10.0
RICESTAR	0.57EW	3.5 oz /A	10.0	10.0	10.0
RICESTAR	0.57EW	7 oz /A	10.0	10.0	10.0
PUMA	1EC	2 oz /A	10.0	10.0	10.0
PUMA	1EC	4 oz /A	10.0	10.0	10.0
ACCLAIM EXTRA MACROSORB FOLIAR	0.57EW L	7 oz /A 2 oz /M	10.0	10.0	10.0
ACCLAIM EXTRA MACROSORB FOLIAR	0.57EW L	3.5 oz /A 2 oz /A	10.0	10.0	10.0

This publication is available in alternative media on request.

Front cover

Top photo: A conference group visits the turfgrass plots in the 1930s, soon after H. B. Musser began his famed turf research program.
Photo reproduced from The College of Agriculture at Penn State: A Tradition of Excellence. Penn State Press.

Bottom photo: Turfgrass field days attendees, 1998 Penn State Turfgrass Field Days. File photo.

Back cover

Top left inset: Conceptual drawing of the Agricultural Experiment station, circa 1888.

Top right inset: The Agricultural Experiment station.
Photo and drawing reproduced from the Report of the Pennsylvania State College for the Year 1888. Edwin K. Meyers, State Printer.

Main photo: Conceptual drawing of the future Center for Turfgrass Science.

Editors note: The following excerpt was taken from the address of Professor I. P. Roberts, Director of Cornell University Experiment Station, at the cornerstone laying ceremony for the Pennsylvania State College Ag Experimental Station on June 27, 1888:

Then the work of the stations devoted to searching out knowledge is to be good. It is not quantity, but quality that we want. This station is to guard the people against fraud, adulteration, and false balances as well as to search out improved methods and new principles.

This station is not to perform miracles, but it is to do a greater work - reveal truth. It cannot make the careless read or heed, but it can help the man who is searching for the truth as for "hid" treasure. It cannot reveal all the secrets of the earth and air, but can give help and guidance to the inquiring mind.