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2003
Turfgrass Research Report

In Cooperation With The

Pennsylvania Turfgrass Council

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INSECTICIDE EVALUATIONS

FERTILIZER and ROOT ZONE DEPTH EVALUATIONS

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 2003.

Respectfully,
Aaron Lathrop,
Editor

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Evaluation of Colored Sands as a Material to Enhance Putting Green Turf Spring Green-Up

George Hamilton

Objective

The objective of this research was to evaluate colored sands as a topdressing material and to determine their affect on causing golf course putting green turf to break dormancy and grow earlier than normal in the spring.

Materials and Methods

Two experiments were conducted on a "push-up" style putting green at the Valentine Turfgrass Research Center in University Park, PA. The turf was a 60-40 mixture of creeping bentgrass and annual bluegrass, respectively, and maintained at 0.125 inches. In one experiment, sand treatments were applied in late fall of 2001 and in the other experiment, sand treatments were applied in early spring 2002. Ratings for both experiments were completed in the spring of 2002.

The topdressing sands used in the experiments met United States Golf Association (USGA) specifications for putting green construction. The sands were supplied and treated by D.M. Boyd Company of New Wilmington, PA.

In both experiments, plots were 3 by 3 feet and treatments were arranged in a randomized complete block design with three replications. Treatments were applied with a hand-held shaker jar on December 19, 2001 and February 18, 2002 for the fall and spring experiments, respectively. Black sand was used in both experiments at rates of 400 and 800 lbs/1000 sq ft and dark green sand was also used in the spring experiment at 800 lbs/1000 sq ft. An untreated control and non-colored white sand (the same sand that was dyed black or green) were included as treatments in both experiments.

Turf color was rated on a scale of 1 to 5 with 1 being brown and 5 being dark green, and 3 being acceptable color. Color was rated on February 18th and April 10th for the fall experiment and on April 10th for the spring experiment. Surface temperatures of plots were recorded on April 8th, 10th, and 11th with a Licor infrared meter. Five temperature readings were recorded for each plot and averaged.

Results and Discussion

Fall Experiment

Color was rated on February 18th and April 10th. In February, black sand at 400 and 800 lbs/1000 sq ft provided the best turf green-up with above acceptable ratings of 3.5 and 3.8, respectively (fig.1). White sand at 400 lbs/1000 sq ft had the same unacceptable color rating (2.8) as the untreated control. Even at this late winter rating, the black sand at both application rates was able to improve color to an acceptable level. The heavy rate of white sand slightly improved color (3.0) and the low rate of white sand had no effect.

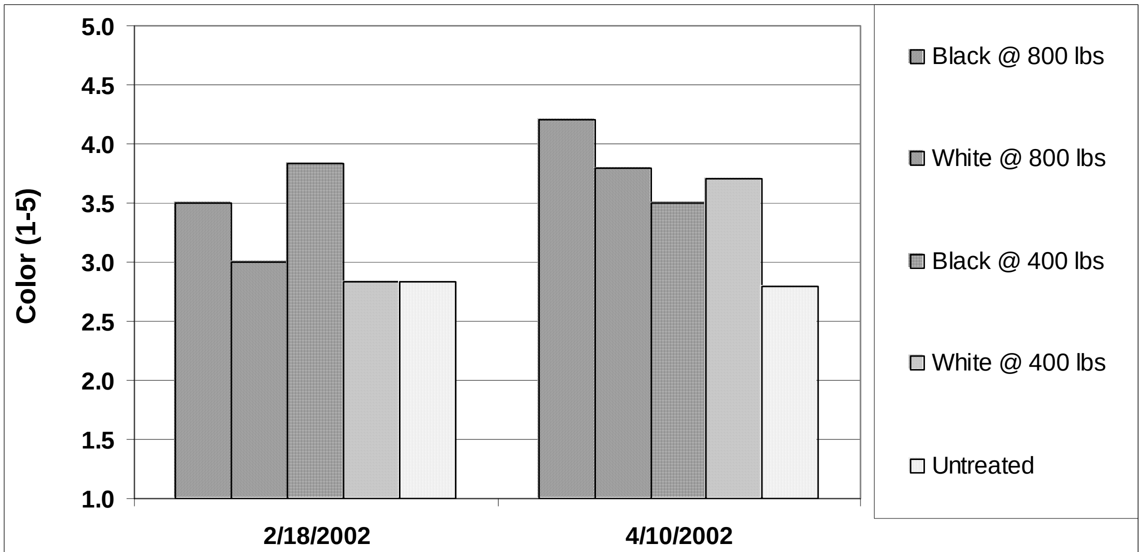

Figure 1. Color ratings for fall experiment

All sand treatments had improved color ratings for the April rating. Black sand at 800 lbs/1000 sq ft had the highest rating (4.3) followed by white sand at 800 lbs/1000 sq ft (3.8). At the low application rate, white sand provided slightly better color than black sand with ratings of 3.7 and 3.5, respectively. The untreated control color rating (2.7) remained unacceptable and practically unchanged from the February rating. Even though growth had started well before the April rating and the turf was beginning to cover the topdressing, the dyed sand was still effective at improving color. This was probably due to increased soil and turf temperatures resulting from improved absorption of radiant energy caused by the black color. The sand topdressing probably also retained the radiant energy at times of little to no sunlight.

Spring Experiment

Black and green sand at 800 lbs/1000 sq ft provided the highest color ratings (4.8) and black sand at 400 lbs/1000 sq ft (4.3) provided a higher color rating than white sand at 800 lbs/1000 sq ft (4.0)(fig 2). The untreated control had unacceptable color (2.8) on this rating date. Most of the sand treatments of this experiment had higher color ratings than fall experiment, so the topdressing in the fall experiment plots probably became grown-over and the effectiveness of the colored sand was decreased.

The black and green sand also provided the highest surface temperatures (fig. 3) on all the rating dates. Black sand at both 400 and 800 lbs/1000 sq ft and green sand at 800 lbs/1000 sq ft had temperatures a degree or two higher than both white sand treatments and the untreated control. A few degree increase in average daily temperature would mimic a multiple week advance of spring time temperatures.

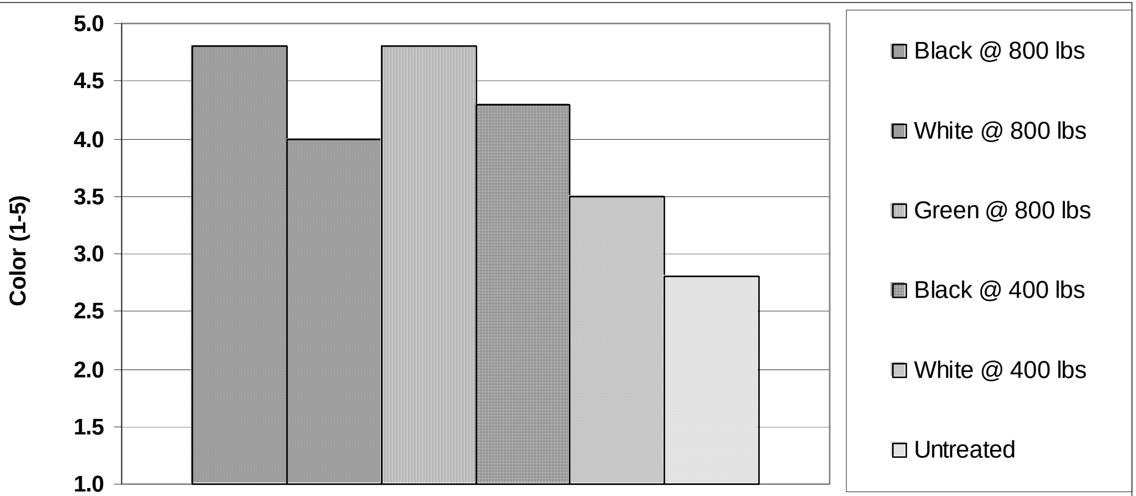

Fig. 2 Color ratings for spring experiment

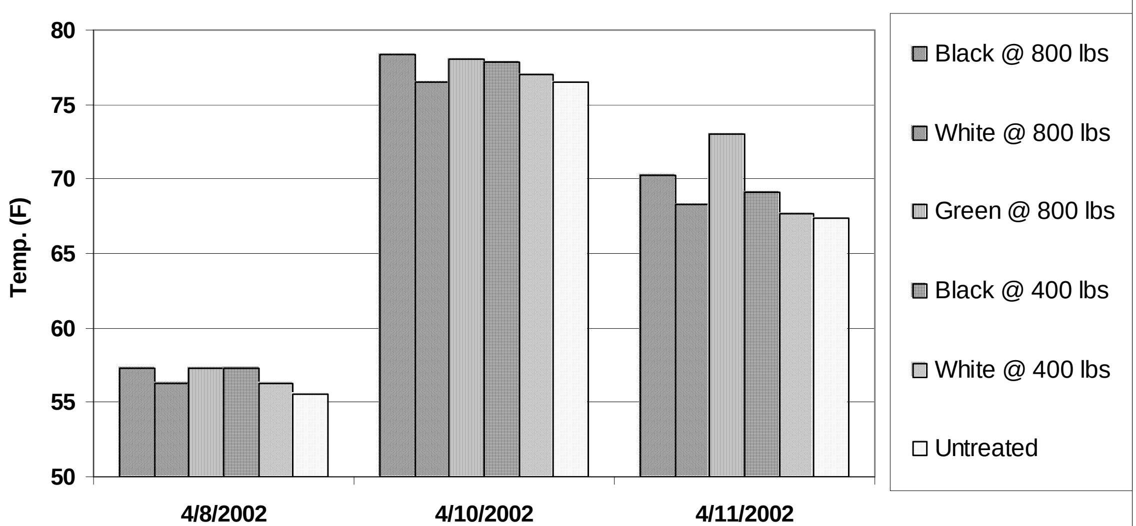

Fig. 3 Average surface temperatures

Conclusions

Dark colored topdressing sands increased surface temperatures of putting green turfgrass as compared to white topdressing and an untreated control. The dark colored topdressings also cause the turf to have improved spring green-up regardless if it was applied in the fall or spring. The material application rate did affect topdressing performance.

Performance of Bentgrass Cultivars and Selections under Fairway Conditions (1998-2002)

P.J. Landschoot, B.S. Park, and D. Livingston

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 1998, 26 bentgrass 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 from 1998 through 2002.

Materials and Methods

Entries were seeded on September 14, 1998 in 5 by 9 ft plots at a rate of 1.1 lbs seed/1000 ft^2. The entire test site received full sunlight. Three replicate plots of each entry were used in this test and plots were arranged in a randomized complete block design. Prior to seeding, the test area received starter fertilizer (10-13-3) at a rate of 1.0 lb N/1000 ft^2. The test was mowed at 0.5 inch in height. To ensure aggressive establishment, three fertilizer applications were made between seeding and December 2, 1998, in which a total of 3.0 lbs N/1000 ft^2 was delivered.

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 bentgrass 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.

<u>Spring green-up</u>: 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.

<u>Leaf texture</u>: 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 leaves.

Color: Color ratings reflect the inherent color of the entry, not yellowing or browning due to mower injury, drought stress, disease, etc. Color ratings are taken when grass is not under stress. Color is 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 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). Multiple disease ratings of dollar spot and brown patch are included in this report. All disease infestations occurred naturally.

Results and Discussion

Interpretation of Results

Data for the above criteria are presented in Tables 1, 2, and 3. 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, 2, and 3 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.

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.

Summary of Results

The entries with the highest average seasonal quality (Table 1) for 1999-2002 were **L-93**, SRX 1BPAA, **SR 1119**, ISI At-5, **Seaside II**, **Imperial**, **Trueline**, **Penn G-6**, and **Grand Prix**. These entries showed excellent color, density, uniformity, and disease resistance throughout the test. The entry that ranked lowest in turf quality during the test period was **Seaside**.

Seedling vigor (Table 2) was greatest with **Penncross**, **Tiger**, **Princeville**, **GolfStar**, **Providence**, **SR 7100**, **Seaside II**, and **Backspin**. The selections that were slowest to establish included, PST-9PM, SRX 7MODD, SRX 7MOBB, SRX 1BPAA, and **Brighton**.

Six colonial bentgrasses showed the finest leaf texture in 2001 including, SRX 7MODD, SRX 7MOBB, **SR 7100**, ABT-Col-2, ISI At-5, and **Tiger (Table 2)**. The coarsest leaf texture was displayed by **Seaside**.

Spring green-up ratings from 1999 through 2002 revealed that PST-9PM, **Glory**, **SR 7100**, **Tiger**, and ISI At-5 broke winter dormancy sooner than all other selections and varieties (Table 2). **Seaside II**, **Seaside**, **Penneagle**, **Princeville, Penncross**, **Penn G-6**, and **SR 1119** showed the slowest combined spring green-up.

Although cultivar color is usually not considered an important criterion in terms of playability, it can be a consideration when trying to achieve a uniform-appearing stand with a blend of several cultivars. **GolfStar**, an Idaho bentgrass, showed the darkest blue/green color, followed by PST-0VN, SRX 7MODD, and SRX 1BPAA (Table 2). **Seaside** was the lightest green (yellow/green) entry.

The following bentgrasses, ISI At-5, SRX 7MOBB, SRX 7MODD, **Imperial**, **Seaside II**, **Grand Prix**, and **Century** received the highest combined density rating for 1999-2002. **Seaside** showed the lowest combined density rating (Table 2).

Differences in disease susceptibility were noticed among entries and are reported in Table 3. Colonial bentgrasses and the Idaho bentgrass generally showed excellent resistance to dollar spot. Some creeping bentgrasses showed good resistance to dollar spot (**L-93**, **Seaside II**, and **Seaside**) while others (**Backspin** and **Century)** were relatively susceptible. Colonial bentgrasses were highly susceptible to brown patch, whereas the creeping bentgrasses were generally more resistant.

Table 1. Quality ratings of bentgrass cultivars and selections for 1999-2002. This trial was established in September, 1998 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Quality Ratings[1]				
		Combined Season Averages				Combined Average
Entry[2]	Species[3]	1999	2000	2001	2002	1999-02
L-93	CRB	7.5	7.8	7.5	7.8	7.6
SRX 1BPAA	CRB	7.9	7.9	7.3	7.3	7.6
SR 1119	CRB	7.8	7.7	7.3	7.5	7.6
ISI At-5	COL	7.8	7.8	7.0	7.4	7.5
Seaside II	CRB	7.1	7.8	6.8	7.5	7.3
Imperial	CRB	7.1	7.6	7.1	7.5	7.3
Trueline	CRB	7.2	7.3	7.1	7.4	7.3
Penn G-6	CRB	7.2	7.6	6.9	7.2	7.2
Grand Prix	CRB	7.3	7.4	7.0	7.1	7.2
PST-0VN	CRB	7.3	7.2	6.5	6.8	7.0
Brighton (SRX 1120)	CRB	7.1	7.2	6.3	7.0	6.9
Providence	CRB	7.0	7.6	5.9	7.1	6.9
Century	CRB	6.8	6.6	6.3	7.3	6.8
Backspin	CRB	6.6	7.1	6.1	7.2	6.8
Glory (PST-9HG)	COL	6.9	7.3	5.7	6.9	6.7
SRX 7MODD	COL	6.8	7.2	5.7	6.4	6.5
Princeville	CRB	6.2	6.8	6.2	6.5	6.5
SRX 7MOBB	COL	6.7	6.9	5.7	6.3	6.4
Penncross	CRB	5.9	6.3	6.0	6.4	6.2
SR 7100	COL	6.5	6.9	5.1	5.7	6.0
Penneagle	CRB	5.4	5.9	6.2	6.3	6.0
ABT-Col-2	COL	6.5	6.5	4.9	5.9	5.9
GolfStar	IDH	6.7	6.2	4.9	5.0	5.7
Tiger	COL	6.1	6.4	4.5	5.2	5.6
PST-9PM	COL	6.2	6.1	3.9	4.6	5.2
Seaside	CRB	4.0	3.6	3.7	3.3	3.6
LSD at 5% level[4]		0.7	0.8	0.7	0.7	0.5

[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] Bentgrass species designated by the following letters: CRB = creeping bentgrass, COL = colonial bentgrass. IDH = Idaho bentgrass
[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 of bentgrass cultivars and selections for 1998-02. This trial was established in September, 1998 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Ratings[1]				
Entry[2]	Species[3]	Seedling Vigor 9/20/98	Leaf Texture 2001	Combined Spring Greenup 2000-02	Combined Color 1999-00, 02	Combined Density 1999-00
L-93	CRB	6.0	7.0	5.6	6.3	7.8
SRX 1BPAA	CRB	1.7	7.0	5.8	7.4	7.4
SR 1119	CRB	4.7	6.7	5.4	6.4	7.6
ISI At-5	COL	4.7	8.7	7.2	5.4	8.3
Seaside II	CRB	6.3	7.7	4.7	5.1	8.0
Imperial	CRB	5.3	7.3	6.2	5.4	8.1
Trueline	CRB	5.7	7.0	5.7	6.8	7.3
Penn G-6	CRB	6.0	7.0	5.4	5.9	7.2
Grand Prix	CRB	5.7	7.7	5.7	5.3	7.9
PST-0VN	CRB	5.0	6.7	5.6	7.9	7.1
Brighton (SRX 1120)	CRB	2.0	7.0	5.8	5.9	7.4
Providence	CRB	6.7	7.3	5.8	5.8	7.4
Century	CRB	5.0	8.0	5.9	5.2	7.9
Backspin	CRB	6.3	8.0	6.1	4.8	7.7
Glory (PST-9HG)	COL	2.7	8.0	7.8	5.9	7.7
SRX 7MODD	COL	1.0	9.0	7.0	7.8	8.2
Princeville	CRB	7.7	7.3	5.2	4.9	6.5
SRX 7MOBB	COL	1.7	9.0	6.9	6.6	8.2
Penncross	CRB	7.7	5.0	5.3	6.2	6.2
SR 7100	COL	6.7	9.0	7.8	4.4	7.6
Penneagle	CRB	4.3	6.0	5.0	5.3	6.0
ABT-Col-2	COL	2.7	9.0	6.3	4.6	7.8
GolfStar	IDH	7.0	7.3	6.7	8.6	6.8
Tiger	COL	7.7	8.3	7.2	5.2	7.2
PST-9PM	COL	1.0	8.0	7.9	6.8	6.6
Seaside	CRB	5.3	3.3	4.9	3.2	3.7
LSD at 5% level[4]		1.5	0.7	0.7	0.7	0.4

[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] Bentgrass species designated by the following letters: CRB = creeping bentgrass, COL = colonial bentgrass. IDH = Idaho bentgrass

[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 3. Disease ratings of bentgrass cultivars and selections for 1999-02. This trial was established in September, 1998 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Disease Ratings[1]						
		Dollar Spot				Brown patch		
Entry[2]	Species[3]	8/23/99	9/21/00	8/6/01	7/5/02	7/22/99	9/7/00	7/2/01
L-93	CRB	6.7	8.0	8.0	7.7	7.3	9.0	9.0
SRX 1BPAA	CRB	7.0	7.3	8.0	6.7	8.3	9.0	9.0
SR 1119	CRB	7.0	6.3	6.7	5.7	7.7	9.0	9.0
ISI At-5	COL	8.3	8.7	8.3	8.7	6.3	7.7	8.3
Seaside II	CRB	7.3	8.3	8.0	7.0	7.3	9.0	9.0
Imperial	CRB	5.3	6.0	5.7	5.3	8.0	9.0	9.0
Trueline	CRB	7.0	7.3	7.7	7.3	8.0	9.0	9.0
Penn G-6	CRB	6.7	7.0	6.3	7.7	7.7	9.0	9.0
Grand Prix	CRB	6.3	6.7	6.0	5.7	7.7	9.0	9.0
PST-0VN	CRB	7.0	8.3	7.3	8.7	8.0	8.7	9.0
Brighton (SRX 1120)	CRB	5.3	6.0	5.7	6.0	7.7	9.0	9.0
Providence	CRB	6.3	6.3	4.7	6.0	8.0	9.0	9.0
Century	CRB	5.3	4.3	4.3	4.7	7.7	9.0	9.0
Backspin	CRB	4.7	5.3	4.3	6.3	7.7	9.0	9.0
Glory (PST-9HG)	COL	8.0	8.7	8.3	8.0	5.7	4.0	7.7
SRX 7MODD	COL	8.0	8.7	8.0	8.3	5.3	4.0	7.7
Princeville	CRB	5.3	6.7	5.7	6.0	7.0	8.7	9.0
SRX 7MOBB	COL	7.7	9.0	8.3	8.3	5.7	3.7	7.3
Penncross	CRB	4.3	7.0	6.7	7.0	8.3	9.0	9.0
SR 7100	COL	8.0	9.0	8.0	8.3	5.3	4.7	7.3
Penneagle	CRB	6.7	7.3	6.3	7.0	7.0	9.0	9.0
ABT-Col-2	COL	8.0	8.7	7.7	8.7	4.7	3.0	6.7
GolfStar	IDH	8.7	9.0	8.7	9.0	6.7	6.3	8.0
Tiger	COL	7.7	8.7	8.0	8.7	5.7	4.3	7.3
PST-9PM	COL	8.3	9.0	7.7	9.0	5.3	4.3	7.3
Seaside	CRB	7.0	9.0	8.0	7.7	6.3	7.0	9.0
LSD at 5% level[4]		1.1	1.0	1.2	1.6	1.4	0.9	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] Bentgrass species designated by the following letters: CRB = creeping bentgrass, COL = colonial bentgrass. IDH = Idaho bentgrass

[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.

Performance of Bentgrass Cultivars and Selections under Putting Green Conditions (1998-2002)

P.J. Landschoot, B.S. Park, and D. Livingston

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 1998, twenty-nine bentgrass 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 from 1998 through 2002.

Materials and Methods

Entries were seeded on September 26, 1998 in 5 by 9 foot plots at a rate of 1.1 lbs seed/1000 ft^2. The soil was a mix of 80% sand : 20% peat and the entire test site received full sunlight. Three replicate plots of each entry were used in this test and plots were arranged in a randomized complete block design. Prior to seeding, the test area received starter fertilizer (10-13-3) at 1.0 lb N/1000 ft^2. The test was mowed at 0.25 inch during 1998. In 1999, the mowing height was gradually lowered from 0.25 to 0.125 inch. To promote rapid establishment, 5.0 lbs N/1000 ft^2 was applied between the date of seeding and December 2, 1998 using five individual applications at 1.0 lb N/1000 ft^2.

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 bentgrass 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.

<u>Spring green-up</u>: 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.

<u>Color:</u> Color ratings reflect the inherent color of the entry, not yellowing or browning due to mower injury, drought stress, disease, etc. Color ratings are taken when grass is not under stress. Color is rated on a scale of 1-9, with 9 = the darkest green color.

<u>Leaf texture</u>: 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 leaves.

<u>Density</u>: 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.

<u>Disease ratings</u>: 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). Multiple disease ratings of dollar spot and brown patch (warm and cool temperature) are included in this report. A rating for red leaf spot was taken in May 2000. All disease infestations occurred naturally.

Results and Discussion

Interpretation of Results

Data for the above criteria are presented in Tables 1, 2, and 3. 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 1-3, 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.

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.

Summary of Results

Syn 96-1, Syn 96-3, Pick Syn 96-2, **Penn A-4**, and **Penn A-1** received the highest combined quality ratings from 1999-2002 (Table 1). Although quality ratings take several factors into account, these cultivars and selections ranked higher than other entries primarily due to their superior density, uniformity, and lack of severe disease susceptibility. Two velvet bentgrasses, **Bavaria** and **SR 7200** performed poorly over the duration of the test

Seedling vigor (Table 2) was greatest with **Penn G-1** and **Penncross**, however, sixteen other selections and cultivars did not differ from these cultivars. The selection that was slowest to establish was PST-A2E. By the summer of 1999, all plots in this test showed complete turf cover and were able to tolerate daily mowing.

Spring green-up ratings from 2000 and 2001 revealed that **Backspin**, **Century,** the three velvet bentgrasses (**SR 7200**, **Bavaria**, and **Vesper**) along with seven other cultivars and selections broke winter dormancy sooner than all other selections and cultivars (Table 2). While Pick CB 13-94 showed the slowest combined spring green-up, fifteen other varieties and selections did not differ statistically from this entry.

Turfgrass color ratings in 2000 and 2002 show that **Vesper** and 10 other cultivars and selections were the darkest bentgrasses (Table 2). **Bavaria** exhibited the lightest shade of green.

Leaf texture was rated in 2001 (Table 2). **Vesper**, **SR 7200**, and Pick Syn 96-2 showed the finest leaf texture. **Penncross** followed by SRX 1BPAA, **Brighton**, and **Pennlinks** displayed the coarsest leaf texture.

Turfgrass density ratings for all cultivars and selections are listed in Table 2. Due to extremely poor turfgrass quality, density could not be accurately measured for **SR 7200** and **Bavaria** in 2002. Therefore, density ratings for all other cultivars and selections were analyzed separately in 2002. **Vesper**, **SR 7200,** Pick Syn 96-2, and Syn 96-3, provided the highest density values from 1999-2001 (Table 2). **Bavaria** showed the lowest density rating from 1999-2001 and **Penncross** and **Pennlinks** showed low density ratings for all four years of the test. Examining combined average quality data in Table 1 and density values in Table 2, in general, selections displaying greater density also showed greater quality values.

Differences in disease susceptibility were noticed among entries during the test period and are reported in Table 3. An infestation of cool temperature brown patch was evident in the test area in May 1999. Disease ratings revealed that most entries were not severely affected by this disease. Entries that were most severely affected included Syn 96-3 and Pick Syn 96-2. Although warm temperature brown patch was not a significant problem in 1999 or 2000, a moderate infestation was noted in 2002. **Bengal**, **L-93**, and twelve other varieties and selections displayed the highest degree of susceptibility to warm temperature brown patch in 2002.

The velvet bentgrasses showed very good resistance to dollar spot in 2000 and 2002 (Table 3). Creeping bentgrass cultivars and selections with the least susceptibility to dollar spot included: **Penn A-1**, **Penn G-1**, **Penn A-2**, **Bengal**, **L-93**, ISI Ap-5, PST-A2E, SRX 1NJH, and **Penncross**. **Crenshaw** showed the greatest degree of dollar spot susceptibility on all three rating dates.

Table 1. Quality ratings of bentgrass cultivars and selections for 1999-2002. This trial was established in September, 1998 at the Joseph Valentine Research Center, University Park, PA.

	Turfgrass Quality Ratings[1]	
	Combined Season Averages	Combined Ave.

Entry[2]	Species[3]	1999	2000	2001	2002	1999-02
Syn 96-1	CRB	7.9	7.3	8.2	7.8	7.8
Syn 96-3	CRB	7.9	7.4	7.9	7.9	7.8
Pick Syn 96-2	CRB	7.8	7.1	8.1	7.7	7.7
Penn A-4	CRB	8.0	7.2	7.3	7.1	7.4
Penn A-1	CRB	7.7	6.6	7.4	7.8	7.4
Penn G-6	CRB	7.1	7.2	7.6	6.9	7.2
Penn G-1	CRB	7.3	6.8	7.0	7.4	7.1
Penn A-2	CRB	7.4	6.7	6.8	7.3	7.0
Century	CRB	7.5	7.3	6.6	6.7	7.0
Bengal (BAR AS 8FUS2)	CRB	7.1	7.1	7.0	6.7	7.0
ABT-CRB-1	CRB	8.3	6.3	6.6	6.5	6.9
L-93	CRB	7.3	6.9	6.8	6.6	6.9
ISI Ap-5	CRB	6.8	6.9	6.9	6.8	6.9
PST-A2E	CRB	7.7	6.8	6.1	6.6	6.8
Imperial	CRB	7.1	6.7	6.7	6.5	6.8
SRX 1NJH	CRB	6.7	6.7	6.7	6.3	6.6
SR 1119	CRB	6.9	6.9	6.2	5.9	6.5
BAR CB 8US3	CRB	6.9	6.2	6.4	6.2	6.5
Backspin	CRB	6.9	6.2	6.3	6.2	6.4
Pick CB 13-94	CRB	5.9	6.2	6.8	6.7	6.4
Providence	CRB	6.8	6.2	6.0	6.1	6.3
Brighton (SRX 1120)	CRB	6.6	6.4	5.8	6.0	6.2
Crenshaw	CRB	7.1	5.5	6.6	5.7	6.2
SRX 1BPAA	CRB	6.3	6.3	5.9	5.9	6.1
Vesper (Pick MVB)	VLT	8.4	4.5	4.2	5.7	5.7
Pennlinks	CRB	5.4	5.5	5.6	5.1	5.4
Penncross	CRB	5.4	5.4	4.9	5.0	5.2
SR 7200	VLT	7.2	4.1	4.5	1.5	4.3
Bavaria	VLT	4.0	1.4	1.0	1.0	1.9
LSD at 5% level[4]		0.5	0.9	0.8	0.6	0.5

[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] Bentgrass species designated by the following letters: CRB = creeping bentgrass, VLT = velvet bentgrass.

[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. Ratings of bentgrass cultivars and selections for 1998-2002. This trial was established in September, 1998 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Ratings[1]					
		Seedling Vigor	Spring Green-up	Combined Color	Leaf Texture	Combined Density	
Entry[2]	Species[3]	10/13/98	2000-01	2000, 2002	2001	1999-01	2002
Syn 96-1	CRB	7.3	6.8	6.0	7.3	8.2	8.3
Syn 96-3	CRB	5.7	7.2	6.5	7.7	8.3	7.8
Pick Syn 96-2	CRB	6.3	6.3	7.2	8.0	8.3	8.2
Penn A-4	CRB	6.3	7.0	6.0	6.7	8.0	7.0
Penn A-1	CRB	7.0	6.7	6.3	7.7	8.1	7.5
Penn G-6	CRB	6.7	7.0	6.8	7.0	7.5	7.2
Penn G-1	CRB	7.7	6.0	6.5	7.0	7.4	7.7
Penn A-2	CRB	7.3	6.3	6.8	6.7	7.6	7.5
Century	CRB	7.0	7.5	5.8	6.7	7.5	7.0
Bengal (BAR AS 8FUS2)	CRB	6.3	6.8	6.2	6.7	7.4	6.8
ABT-CRB-1	CRB	6.0	6.0	5.8	7.0	8.0	6.7
L-93	CRB	7.3	6.2	6.0	6.0	7.0	6.3
ISI Ap-5	CRB	6.7	5.7	6.8	6.0	6.9	6.8
PST-A2E	CRB	4.0	6.8	6.8	6.7	7.7	6.7
Imperial	CRB	6.7	7.0	5.2	6.3	7.3	6.7
SRX 1NJH	CRB	5.3	6.0	7.0	5.7	6.9	6.5
SR 1119	CRB	6.7	6.3	6.5	6.0	6.8	6.3
BAR CB 8US3	CRB	6.0	6.3	5.8	6.7	7.0	6.0
Backspin	CRB	7.0	7.7	5.2	6.7	7.4	6.5
Pick CB 13-94	CRB	6.7	5.5	6.3	5.7	6.3	6.8
Providence	CRB	7.3	6.2	5.2	5.7	6.8	6.3
Brighton (SRX 1120)	CRB	5.0	5.7	5.7	5.0	6.6	5.7
Crenshaw	CRB	7.0	6.0	6.0	6.0	6.9	6.0
SRX 1BPAA	CRB	6.7	5.8	6.2	4.7	6.0	5.3
Vesper (Pick MVB)	VLT	6.0	7.2	7.3	9.0	8.9	8.8
Pennlinks	CRB	7.3	5.8	4.8	5.0	5.3	4.7
Penncross	CRB	7.7	5.8	5.3	4.0	5.2	4.8
SR 7200	VLT	6.3	7.5	6.5	9.0	8.4	--
Bavaria	VLT	7.0	7.2	3.0	5.3	2.3	--
LSD at 5% level[4]		1.1	0.9	0.8	1.0	0.6	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] Bentgrass species designated by the following letters: CRB = creeping bentgrass, VLT = velvet bentgrass.

[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 3. Disease ratings of bentgrass cultivars and selections for 1999, 2000 and 2002. This trial was established in September, 1998 at the Joseph Valentine Research Center, University Park, PA.

		Turfgrass Disease Ratings[1]							
		Brown Patch				Red Leaf Spot	Dollar Spot		
Entry[2]	Species[3]	5/99[4]	7/99[5]	8/00[5]	8/02[5]	5/00	5/00	8/00	7/02
Syn 96-1	CRB	9.0	8.7	9.0	6.7	5.3	6.7	7.7	6.0
Syn 96-3	CRB	6.7	8.3	8.7	7.3	6.7	7.3	6.7	6.0
Pick Syn 96-2	CRB	7.7	8.0	9.0	7.0	6.0	6.3	6.3	5.7
Penn A-4	CRB	9.0	7.7	6.3	5.7	5.7	6.7	8.0	7.0
Penn A-1	CRB	9.0	8.0	8.0	6.7	5.0	8.0	8.3	8.0
Penn G-6	CRB	8.3	8.0	8.0	5.7	5.7	7.0	8.0	7.3
Penn G-1	CRB	9.0	8.3	7.7	5.3	4.0	8.0	8.0	7.7
Penn A-2	CRB	8.0	8.3	8.3	6.7	5.0	8.7	8.7	8.0
Century	CRB	9.0	8.0	8.7	6.0	3.7	6.7	7.0	5.3
Bengal (BAR AS 8FUS2)	CRB	8.3	8.7	7.0	5.0	5.7	8.0	8.0	7.3
ABT-CRB-1	CRB	8.7	8.7	8.7	7.0	2.3	7.7	7.3	6.7
L-93	CRB	8.7	8.0	8.0	5.0	6.0	9.0	8.7	8.0
ISI Ap-5	CRB	9.0	8.0	7.3	5.7	8.0	8.3	8.0	7.7
PST-A2E	CRB	9.0	8.0	8.0	7.0	4.7	9.0	8.7	7.7
Imperial	CRB	9.0	8.0	8.3	6.0	4.3	6.7	7.7	6.7
SRX 1NJH	CRB	9.0	8.7	9.0	7.3	7.0	8.0	8.0	7.0
SR 1119	CRB	9.0	8.3	8.7	6.0	7.7	8.3	7.7	5.5
BAR CB 8US3	CRB	8.3	8.3	7.7	5.7	3.7	6.7	7.7	7.0
Backspin	CRB	9.0	8.0	8.0	6.0	7.0	6.7	7.0	6.0
Pick CB 13-94	CRB	8.3	8.7	9.0	6.7	6.0	7.7	8.0	7.0
Providence	CRB	8.7	7.7	7.0	5.0	4.0	6.3	7.0	6.7
Brighton (SRX 1120)	CRB	9.0	8.0	8.0	5.3	6.0	7.7	8.0	6.3
Crenshaw	CRB	8.0	8.7	8.3	5.3	3.7	3.7	5.0	4.0
SRX 1BPAA	CRB	8.7	7.7	9.0	7.0	8.0	8.3	8.3	7.3
Vesper (Pick MVB)	VLT	9.0	9.0	9.0	8.0	3.7	9.0	8.3	8.7
Pennlinks	CRB	8.3	9.0	7.7	6.0	6.3	7.7	8.0	7.7
Penncross	CRB	8.3	8.3	8.7	5.7	7.3	8.3	8.0	7.5
SR 7200	VLT	9.0	9.0	9.0	--	4.0	9.0	9.0	--
Bavaria	VLT	9.0	9.0	9.0	--	9.0	9.0	8.7	--
LSD at 5% level[6]		1.0	0.8	1.3	1.6	1.8	1.1	1.1	1.1

[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] Bentgrass species designated by the following letters: CRB = creeping bentgrass, VLT = velvet bentgrass.
[4] Cool temperature brown patch.
[5] Warm temperature brown patch
[6] 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 Nutrient Uptake on Sand Root Zones Amended with 'HYDRAZONE^{TM}' Acrylamide/Acrylate Copolymer.

Maxim J. Schlossberg, K. Shankaran, and P.J. Cook

Introduction
Polyacrylamide amendments (water absorbing polymers/gels) have been shown to enhance physical properties of plant growth media. Recent studies report acrylamide copolymer (polyacrylamide) amendment of coarse-textured soil to increase plant available water, yet effects on nutrient availability have not been examined as thoroughly.

Coarse-textured sands have notoriously-low cation exchange capacities, and are often amended to improve this important soil property. A favorable soil amendment possesses one or more of the following attributes:

- Improves porosity of fine-textured soils
- Improves plant available water holding capacity of coarse-textured soils
- Enhances nutrient retention (cation exchange capacity)
- Is easily incorporated into the turfgrass root zone (plow depth)
- Resists compaction and degradation over time

Objective
To evaluate growth and fertilizer use efficiency of creeping bentgrass (*Agrostis palustris* L. 'A4') established to golf course putting green root mixes amended with polyacrylamide at recommended rates and depths of incorporation.

Materials and Methods
This experiment was initiated in February, 2003, at the Penn State Greenhouse Complex, University Park, PA. Twenty PVC columns (18" x 3" ID) were constructed to USGA putting green specifications using a Mapleton fine sand. The columns were complete with gravel layer and Tygon tube drainage port (Fig. 1). Of the 12" root zone, the upper 4 or 6" of each column was filled with an homogenous root mix amended at an equivalent rate of 0, 2.2, or 4.4 lbs of Hydrazone^{TM} copolymer (1000 ft^{2})$^{-1}$. Penn A4 creeping bentgrass sod, previously established on Mapleton sand, was installed and the column length adjusted to ensure all columns possessed an equal head spacing. Columns were fertilized with 1 lb P & K (1000 ft^{-2}).

All columns were equally fertilized throughout the experimental period using a nutrient solution, every 8-20 days (Fig. 2). Columns were mowed 3(±1) times per week at 1/5" using a modified electric clipper. Clippings were collected on 6 occasions throughout the 100-d study, oven-dried, and their mass determined. Columns were leached with DI H_2O, 20, 54, and 63 days after sodding (DAS). Water holding capacity of the columns varied. Thus, requisite H_2O volume to leach ~50 mL was recorded, and solute concentration multiplied by the leaching fraction to compute solute concentration per volume infiltrated H_2O (henceforth adjusted NO_3 and K).

Figure 1. Amended sand root zones, following installation of Penn A4 creeping bentgrass, yet prior to column length adjustment

Leachate K, NO_3, pH, and EC were measured by standard methods. Following 100-d of establishment-data collection, the columns were sectioned at the 4, 6, and 9" depths using an industrial band saw. All PVC filings were painstakingly removed from each column segment by hand.

Amended root mixes in the upper 4" of each column were subsampled (2g) for subsequent cation exchange capacity (CEC) measurement. Unamended root mix segments, from the 6-9" soil depth, were gently sieved and roots collected in a porcelain crucible. Root carbon content was inferred following combustion at 550°C, then related to A4 root mass by a least squares estimator (Schlossberg, unpublished data).

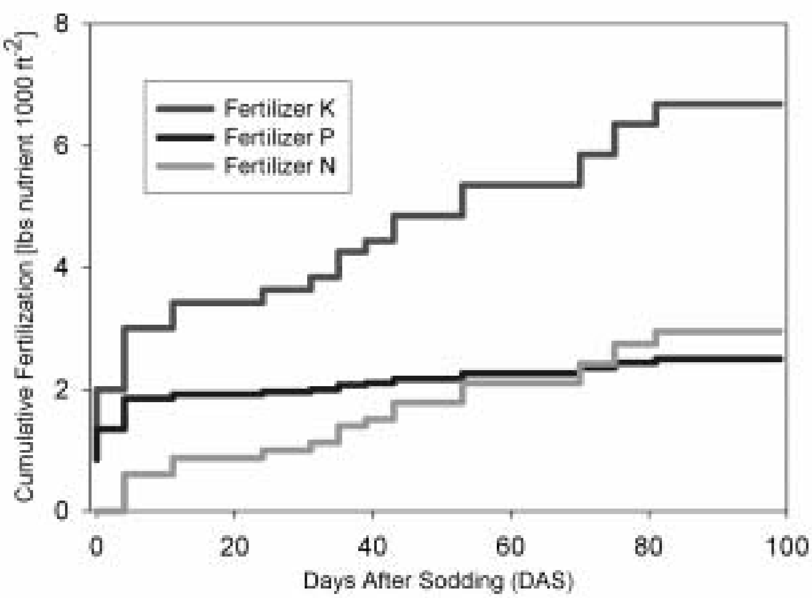

Figure 2. Fertilization timing and rates during the experimental period.

The experimental design was completely randomized with repeated measures (sans CEC and deep root density). In the analysis, repeated measures were treated as split-plots in time. Treatment (main) effects were tested using the appropriate error term. Prearranged contrasts were used to test effects of amendment rate at any application depth, and vice-versa. The GLM procedure of SAS/STAT 8.0 (SAS Institute, Cary, NC) facilitated analysis of all data.

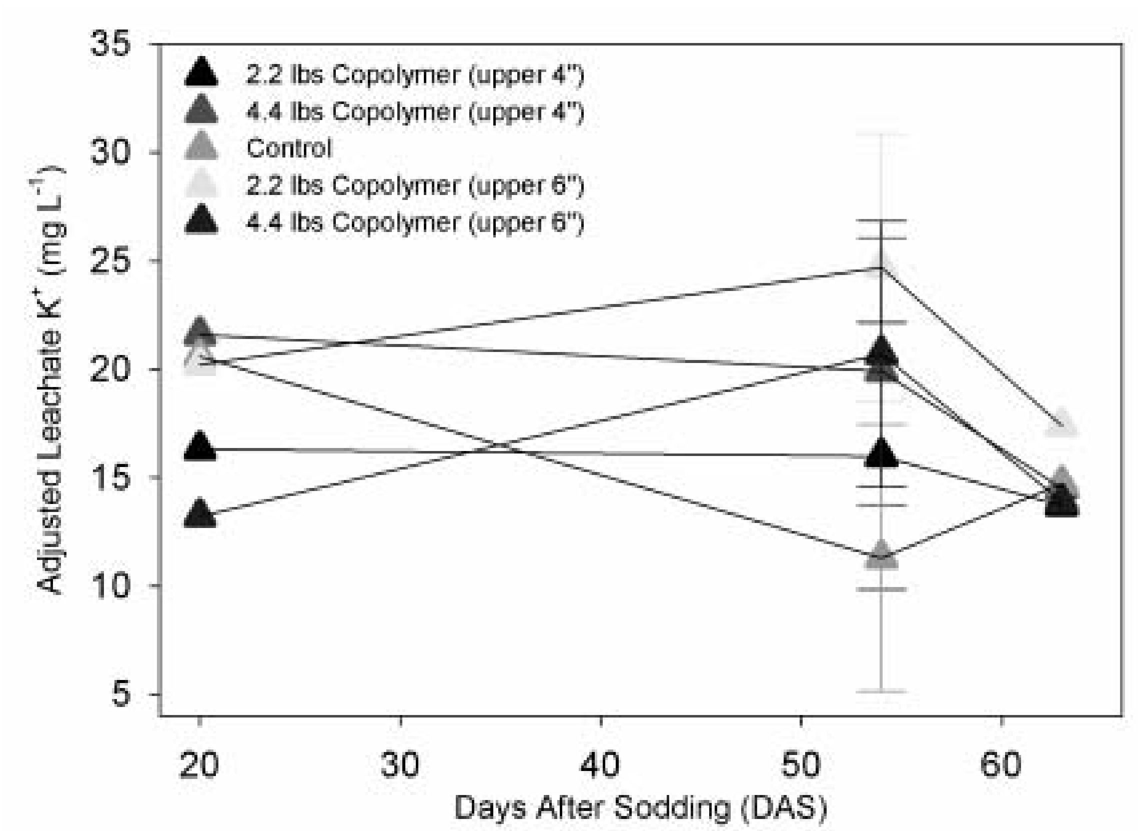

Figure 3. Potassium concentration in leachate per mL precipitation/irrigation infiltrated (error bars signify statistical differences at the 0.05 alpha level).

Conclusions

- Hydrazone™ copolymer amendment did not significantly affect root mix CEC [0.56 meq (100 g root mix)$^{-1}$], soil pH, or soil EC (data not shown) over the 100 day experimental period.
- 54 DAS, root mixes amended with 2.2 lbs copolymer in the upper 6" released significantly greater concentrations of potassium in leachate than the unamended root mixes, per infiltrated volume.
- Throughout the experimental period, higher rates of copolymer amendment and/or deeper incorporation depths resulted in higher concentrations of nitrate in leachate, per infiltrated volume.
- Root density in the 6-9" soil depth was significantly greater in amended root mixes than the unamended mix.

- Clipping yield was unaffected by copolymer amendment, uptake results are pending (tissue analysis incomplete).
- The authors believe comprehensive and sophisticated measurements of macropore connectivity, preferential flow-path development/conductivity, and the shrinking/swelling tendencies of copolymer-amended sands will be needed before the above-reported results may be unequivocally explained and related to creeping bentgrass nutritional parameters.

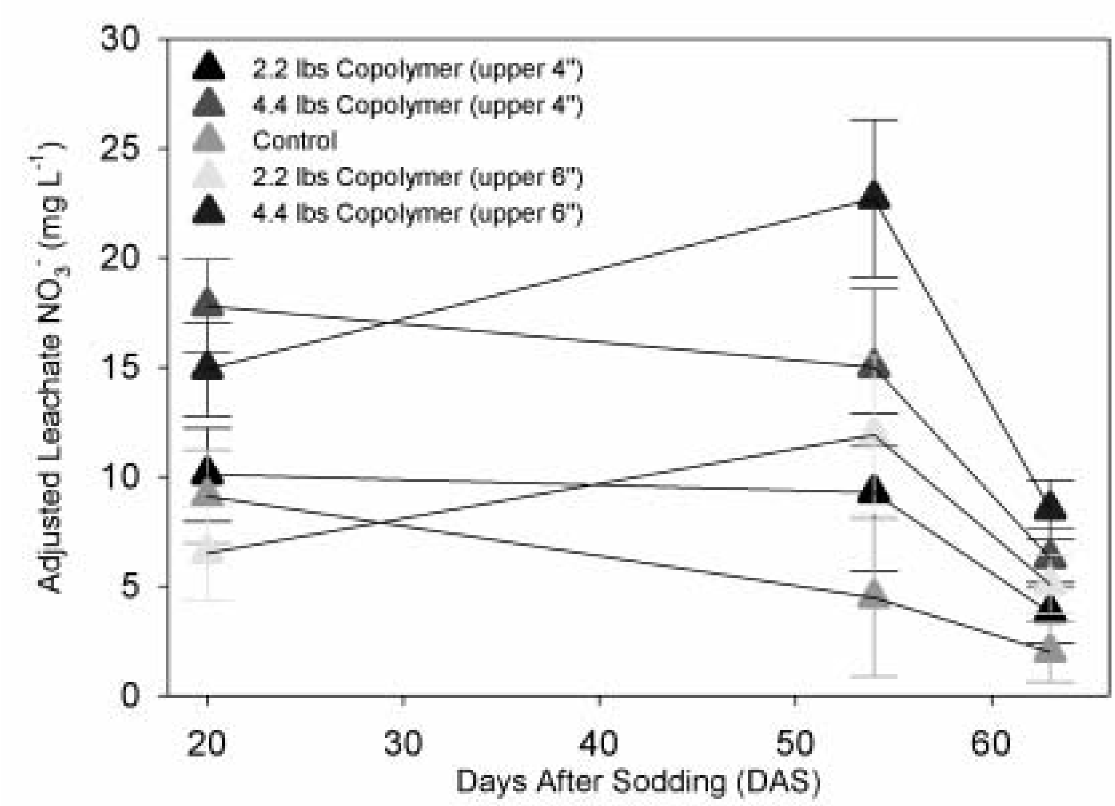

Figure 4. Nitrate concentration in leachate per mL precipitation/irrigation infiltrated (error bars signify statistical differences at the 0.05 alpha level).

Management of Basal-rot Anthracnose on a Putting Green, 2003

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Introduction

Anthracnose *(Colletotrichum graminicola)* can cause serious injury on putting greens; particularly those comprised of high populations of annual bluegrass *(Poa annua)*. The use of fungicides is a significant part of a turf manager's strategy in the management of basal-rot anthracnose. This study assessed the effects of various products, rates, and application timings for controlling Anthracnose infection on *Poa annua*.

Materials and Methods

The experiment was carried out on a mixed-stand of annual bluegrass and creeping bentgrass maintained under golf course greens-management conditions, mowed at 0.125-inch cutting height six times per week. The soil was a modified sandy clay loam with a soil pH of 7.0. The test area was fertilized on 17 Apr with 0.5 lb nitrogen (Lebanon 28-7-14) per 1000 sq ft, 20 May with 0.5 lb nitrogen (Lebanon 10-18-18) per 1000 sq ft, and on 11 Jul with 0.2 lb nitrogen (Lebanon 28-7-14) 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 sprayer, equipped with a TeeJet 11008E nozzle, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 28 Apr, 14 and 27 May, 9 and 23 Jun, 8 and 21 Jul, and 4 Aug, unless otherwise noted in the table. Disease severity was evaluated on 31 Jul, and 15 and 19 Aug. Only the annual bluegrass was evaluated, as the creeping bentgrass was not symptomatic. Data were subjected to analysis of variance, and the mean values were separated using the Waller-Duncan k-ratio test ($P \leq 0.05$).

Results and Discussion

Temperatures were moderate, but rainfall was abnormally high throughout the growing season; and the turfgrass was not under any prolonged period of stress. Disease severity was light and variable in this study. On 4 Jun, phytotoxicity, appearing as dark green to bronze colored turfgrass, was observed in the following treatments: Insignia + Propiconazole Pro, A13705H, A14035A, A14036A, A13817A, A14167A, Banner MAXX at 1.0 and 2.0 fl oz, Daconil Ultrex + Banner MAXX, Banner MAXX + Medallion, Banner MAXX + Primo MAXX, and Syngenta Solution. Phytotoxicity was increasingly severe as the study progressed, with the exception of the Syngenta Solution treatment, in which the phytotoxic effects were undetectable by the end of Jun. In the 19 Aug evaluation, 37 of the 47 treatments were providing excellent control of basal-rot anthracnose. The two Insignia treatments and the Compass + Bayleton mixture had significantly more disease symptoms than the untreated check. Fifteen treatments provided complete control of anthracnose throughout the study.

Table 1. Management of basal-rot anthracnose on a putting green, 2003.

	Disease Severity[z]		
Treatment, formulation, and rate per 1000 sq ft	31 Jul	15 Aug	19 Aug
Compass 50WG 0.25 oz + Bayleton 50DF 0.5 oz	1.13 b[y]	2.31 a[y]	3.93 a[y]
Insignia 20WG 0.5 oz	0.47 c-f	2.32 a	3.70 a
Insignia 20WG 0.9 oz[x]	0.83 bc	1.95 ab	3.57 a
Compass 50WG 0.25 oz	1.87 a	2.52 a	3.17 ab
3336 50WP 4.0 oz	0.70 bcd	1.65 abc	3.07 abc
Untreated Check	0.73 bc	1.60 a-d	2.27 bcd
A-13666B 5.5SC 1.66 fl oz	0.13 ef	0.78 b-f	2.23 cd
Heritage 50WG 0.4 oz	1.07 b	0.77 b-f	1.77 d
Heritage 50WG 0.2 oz	0.73 bc	0.74 c-f	1.43 de
Heritage MAXX 9.5ME 1.04 fl oz	0.50 cde	0.42 def	0.83 ef
Banner MAXX 1.3ME 1.0 fl oz	0.00 f	0.19 f	0.37 f
Heritage MAXX 9.5ME 4.16 fl oz	0.03 ef	0.32 ef	0.30 f
Medallion 50WP 0.25 oz	0.00 f	0.00 f	0.28 f
Signature 80WG 4.0 oz + Compass 50WG 0.25 oz	0.00 f	0.09 f	0.23 f
A-13817A 4.33SE 4.2 fl oz	0.00 f	0.00 f	0.20 f
Endorse 2.5WP 4.0 oz	0.20 ef	0.19 f	0.20 f
A-14167A 1.67ME 1.33 fl oz	0.00 f	0.04 f	0.08 f
Heritage MAXX 9.5ME 2.08 fl oz	0.23 def	0.20 f	0.07 f
Medallion 50WP 0.33 oz	0.00 f	0.00 f	0.07 f
Signature 80WG 4.0 oz	0.00 f	0.14 f	0.03 f
Bayleton 50DF 0.5 oz + Signature 80WG 4.0 oz	0.00 f	0.00 f	0.03 f
Endorse 2.5WP 6.0 oz	0.20 ef	0.04 f	0.03 f
Spectro 90WG 4.0 oz + Alude 5.17L 5.5 fl oz	0.00 f	0.04 f	0.03 f
Insignia 20WG 0.5 oz + Concorde 82.5DF 1.6 oz	0.00 f	0.00 f	0.03 f
Syngenta Solution[w]	0.00 f	0.09 f	0.03 f
1. Banner MAXX 2.0 fl oz + Daconil Ultrex 1.8 oz			
2. Banner MAXX 1.0 fl oz + Daconil Ultrex 82.5WG 1.8 oz			
3. Medallion 50WP 0.25 oz + Daconil Ultrex 82.5WG 1.8 oz			
4. 3336 50WP 4.0 oz + Daconil Ultrex 82.5WG 1.8 oz			
5. Heritage 50WG 0.4 oz + Daconil Ultrex 82.5WG 3.2 oz			
6. Medallion 50WP 0.25 oz + Daconil Ultrex 82.5WG 3.2 oz			
7. Heritage 50WG 0.4 oz + Banner MAXX 1.3ME 1.0 fl oz			
8. Subdue MAXX 0.5 fl oz + 3336 4.0 oz + Daconil Ultrex 3.2 oz			
Insignia 20WG 0.5 oz + Concorde 82.5DF 3.2 oz	0.00 f	0.07 f	0.00 f
Insignia 20WG 0.5 oz + Propiconazole Pro 1.0 fl oz	0.00 f	0.00 f	0.00 f
Signature 80WG 4.0 oz + Chipco 26 GT 2SC 4.0 fl oz	0.00 f	0.00 f	0.00 f
Signature 80WG 4.0 oz + Daconil Ultrex 3.2 oz	0.00 f	0.00 f	0.00 f

Table 2. Management of basal-rot anthracnose on a putting green, 2003.

Treatment, formulation, and rate per 1000 sq ft	Disease Severity[z] 31 Jul	15 Aug	19 Aug
Triton 70WG 0.298 oz	0.00 f	0.00 f	0.00 f
Triton 70WG 0.298 oz + Signature 80WG 4.0 oz	0.00 f	0.00 f	0.00 f
Lynx 45WP 0.6 oz	0.00 f	0.00 f	0.00 f
Lynx 45WP 0.6 oz + Signature 80WG 4.0 oz	0.00 f	0.04 f	0.00 f
A-13705H 1.67SC 1.33 fl oz	0.00 f	0.00 f	0.00 f
A-14035A 3.67SE 9.33 fl oz	0.00 f	0.00 f	0.00 f
A-14036A 3.61SE 9.33 fl oz	0.00 f	0.00 f	0.00 f
Banner MAXX 1.0 fl oz + Heritage 0.2 oz	0.00 f	0.05 f	0.00 f
Medallion 50WP 0.5 oz	0.00 f	0.00 f	0.00 f
Daconil Ultrex 82.5WG 3.2 oz	0.00 f	0.00 f	0.00 f
Daconil Ultrex 3.2 oz + Banner MAXX 1.0 fl oz	0.00 f	0.00 f	0.00 f
Banner MAXX 1.0 fl oz + Medallion 50WP 0.25 oz	0.00 f	0.00 f	0.00 f
Banner MAXX 1.3ME 2.0 fl oz	0.00 f	0.03 f	0.00 f
Endorse 2.5WP 4.0 oz + Alude 5.17L 5.5 fl oz	0.00 f	0.04 f	0.00 f
Spectro 90WG 4.0 oz	0.00 f	0.05 f	0.00 f
Daconil Ultrex 3.2 oz + Primo MAXX 0.125 fl oz	0.00 f	0.00 f	0.00 f
Banner MAXX 1.0 fl oz + Primo MAXX 0.125 fl oz	0.00 f	0.00 f	0.00 f
3336 50WP 2.0 oz + Endorse 2.5WP 3.0 oz	0.00 f	0.04 f	0.00 f

[z]Disease severity index 0-10; 0=asymptomatic, and 10=>90% annual bluegrass symptomatic, mean of three replications.
[y]Means within column followed by different letters are significantly different (P≤0.05) according to the Waller-Duncan k-ratio test.
[x]Treatment applied on a 28-day interval (28 Apr, 27 May, 23 Jun, 21 Jul).
[w]Treatments were applied on 14-day intervals in the order indicated in the table.

Control of Brown Patch with Fungicides, 2003

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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 6.5. The test area was fertilized on 15 May with 0.8 lb nitrogen (Lebanon 21-3-18) per 1000 sq ft, 7 Jun with 1.0 lb nitrogen (IBDU 31-0-0) per 1000 sq ft, and 15 Jun with 1.0 lb nitrogen (Scotts 22-0-16). Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with four 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 20 Jun, 3, 17, and 31 Jul, unless otherwise noted in the table. The experimental area was inoculated on 18 Jul by hand-scattering *Rhizoctonia solani*-infested rye grains at a density of 15-20 grains per sq ft. From 18 Jul through 4 Aug the study was lightly irrigated and covered during the nights with a 6-mil plastic cover to reduce radiational cooling. Disease severity was assessed on 2, 25, and 31 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 this experiment. Excellent control of brown patch was obtained throughout the study with Compass, Lynx, combinations of Compass + Lynx, and Compass + Bayleton (0.5 oz + 0.15 oz). Additionally, Heritage, the high rate of Endorse, XF-00044, and Eminent provided excellent control. The chlorothalonil treatments, Echo 720 and Daconil Weatherstik, also provided good control, except for the 31 Jul assessment.

Table. Control of brown patch with fungicides, 2001.

Treatment, formulation, and rate per 1000 sq ft	Disease Severity[a] 2 Jul	25 Jul	31 Jul	8 Aug
Bayleton 50WP 0.5 oz[b]	1.0 def[c]	4.3 b[c]	6.8 a[c]	9.5 a[c]
Rubigan 1AS 1.5 fl oz[b]	2.3 b	7.0 a	7.3 a	8.0 ab
Untreated Check	4.0 a	6.5 a	7.8 a	8.0 ab
Bayleton 50WP 0.5 oz[d]	1.8 bcd	2.8 bcd	6.5 a	7.5 bc
TD-2389 WG 6.0 oz	2.5 b	4.3 b	7.8 a	6.3 bcd
Banner MAXX 1.3MC 2.0 fl oz[b]	1.0 def	2.8 bcd	6.3 a	5.8 cd
Chipco 26GT 2SC 4.0 fl oz[d]	0.5 efg	0.8 efg	3.5 b	5.5 de
Bayleton 50WP 0.5 oz	2.0 bc	2.5 b-e	3.5 b	5.0 def
TD-2390 WG 6.0 oz	2.3 b	3.8 bc	7.0 a	4.8 def
Eagle 40WP 1.2 oz[d]	1.3 cde	2.3 c-f	1.8 b-e	4.5 d-g
Eagle 40WP 0.6 oz	2.3 b	1.3 d-g	1.3 b-e	3.8 e-h
Fore Rainshield 80WP 8.0 oz	0.3 fg	2.0 c-g	2.3 b-e	3.3 f-i
Fore Rainshield 80WP 6.0 oz	2.0 bc	1.8 d-g	3.5 b	2.8 g-j
Cleary's 3336 50WP 2.0oz	0.0 g	1.0 d-g	3.0 bc	2.8 g-j
Bayleton 50WP 0.5 oz + Compass 50WG 0.15 oz[b]	0.3 fg	0.8 efg	1.0 b-e	2.5 h-k
ProStar 70WP 2.2 oz[b]	0.5 efg	2.0 c-g	3.5 b	2.5 h-k
Bayleton 50WP 0.5 oz + Compass 50WG 0.15 oz	0.5 efg	0.3 g	1.0 b-e	2.3 h-l
Heritage 50WG 0.2 oz[b]	0.3 fg	0.5 fg	1.3 b-e	2.3 h-l
Compass 50WG 0.15 oz[b]	0.3 fg	0.5 fg	1.8 b-e	1.8 i-l
Eminent 1SL 4.0 fl oz	0.3 fg	0.8 efg	1.0 b-e	1.5 i-l
Heritage 50WG 0.2 oz	0.0 g	0.8 efg	0.8 cde	1.3 jkl
Heritage 50WG 0.4 oz[d]	0.0 g	0.3 g	0.5 cde	1.3 jkl
Lynx 45WP 0.556 oz + Compass 50WG 0.15 oz	0.0 g	0.3 g	0.0 e	1.0 jkl
Lynx 45WP 0.556 oz[b]	0.0 g	0.5 fg	1.3 b-e	0.8 kl
Lynx 45WP 0.556 oz + Compass 50WG 0.15 oz[b]	0.0 g	0.3 g	0.3 de	0.8 kl
Endorse 2.5WP 4.0 oz	0.5 efg	0.5 fg	2.8 bcd	0.8 kl
XF-00044 WP 3.5 oz	0.0 g	0.3 g	0.8 cde	0.8 kl
Daconil Weatherstik 6F 3.6 fl oz	0.3 fg	0.5 fg	3.5 b	0.8 kl
Echo 720 6F 3.6 fl oz	0.3 fg	1.0 d-g	6.5 a	0.5 l
Endorse 2.5WP 6.0 oz	0.5 efg	0.8 efg	0.8 cde	0.5 l
Compass 50WG 0.15 oz	0.3 fg	0.5 fg	0.3 de	0.5 l
Lynx 45WP 0.556 oz	0.3 fg	0.3 g	0.3 de	0.5 l

[a]Disease severity index 0-10; 0=asymptomatic, and 10=>90% turf area symptomatic; means of four replications.
[b]Treatment applied on a 21-day interval (20 Jun, 10 and 31 Jul).
[c]Means within a column followed by different letters are significantly different ($P \leq 0.05$) according to the Waller-Duncan k-ratio test.
[d]Treatment applied on a 28-day interval (20 Jun and 17 Jul).

Effects of Fungicides on Control of Dollar Spot on a Putting Green, 2003

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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 Joseph Valentine Turfgrass Research Center, University Park, PA, on a mixed stand of creeping bentgrass (*Agrostis Palustris*, 'Penncross') and annual bluegrass (*Poa annua*). The study included various fungicides, rates, mixtures, and/or application intervals to investigate control strategies and fungicide efficacy.

Materials and Methods

The experiment was carried out on a mixed-stand of creeping bentgrass and annual bluegrass maintained under golf course greens-management conditions, mowed at 0.125-inch cutting height six times per week. The soil was a modified sandy clay loam with a soil pH of 7.0. The experiment was fertilized on 17 Apr and 20 May with 0.5 lb nitrogen (Lebanon 28-7-14) respectively per 1000 sq ft, and on 21 May with 0.5 lb nitrogen (31-0-0) 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 sprayer, equipped with a TeeJet 11008E nozzle, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 2 and 17 Jun, and 1, 15, and 29 Jul, except as otherwise noted in the table. The experimental turf area was inoculated on 10 Jun by hand-broadcasting *S. homoeocarpa*-infested ryegrains, at a density of 20-30 grains per sq ft. A pool of five isolates of *S. homoeocarpa* was used in the inoculation. Disease incidence was evaluated once per week from 17 Jun through 13 Aug. Data were subjected to analysis of variance, and the mean values were separated by the Waller-Duncan k-ratio test ($P \leq 0.05$). Data from 11 and 22 Jul, and 13 Aug are presented.

Results and Discussion

Dollar spot severity was high during the experiment. At the 13 Aug evaluation, 12 of the 26 treatments were providing excellent control of dollar spot. Banner MAXX, Propiconazole Pro, and Emerald provided complete suppression of dollar spot from 1 Jul through the remainder of the study.

Table. Effects of fungicides on control of dollar spot on a putting green, 2003.

Treatment, formulation, and rate per 1000 sq ft	Infection centers per sq ft[z] 22 Jul		29 Jul		5 Aug		13 Aug	
Untreated Check	8.3	a[y]	9.3	a[y]	15.9	a[y]	25.3	a[y]
Heritage 50WG 0.4 oz	6.7	b	5.8	b	11.4	b	18.6	b
Compass 50WG 0.25 oz	4.3	c	3.8	c	6.6	c	11.4	c
TM85 85WG 1.0 oz	1.2	def	1.3	de	4.8	cd	9.3	cd
Daconil Ultrex 82.5WG 3.7 oz + LI-700 L 0.5% v/v[x]	0.2	ef	0.6	ef	3.4	de	8.9	cde
Topsin-M 70WP 1.43 oz	1.8	d	1.6	de	3.0	def	6.9	def
Topsin-M 4.5F 1.8 fl oz	1.1	def	1.6	de	4.3	cd	6.6	def
Daconil Ultrex 82.5WG 3.7 oz[x]	0.1	f	0.4	ef	4.3	cd	6.3	efg
Equus 82.5DF 2.0 oz	1.4	de	3.7	c	3.2	def	6.1	efg
Daconil Ultrex 82.5WG 2.0 oz	0.6	def	2.1	d	1.4	efg	6.1	efg
Insignia 20WG 0.9 oz	0.0	f	0.7	ef	2.4	d-g	5.7	fg
3336 50WP 2.0 oz	0.8	def	1.6	de	2.8	def	5.2	fg
Chipco 26GT 2SC 4.0 fl oz	0.0	f	0.7	ef	0.1	g	4.9	fgh
Equus 82.5DF 2.0 oz + Farmsaver.com Phosphorous Acid L 4.0 fl oz	0.2	ef	0.9	ef	0.7	fg	3.6	ghi
Equus 82.5DF 3.2 oz	0.0	f	0.0	f	0.0	g	2.0	hij
Daconil Ultrex 82.5WG 3.2 oz	0.0	f	0.0	f	0.0	g	1.3	ij
Emerald 70WG 0.18 oz[x]	0.0	f	0.1	f	0.0	g	1.1	ij
Bayleton 50WP 0.5 oz[w]	0.2	ef	0.4	ef	0.1	g	1.0	ij
Equus 82.5DF 2.0 oz + TM85 85WG 1.0 oz	0.0	f	0.1	f	0.0	g	0.8	ij
Emerald 70WG 0.18 oz[w]	0.0	f	0.1	f	0.0	g	0.7	ij
Emerald 70WG 0.13 oz **alternate** Insignia 20WG 0.9 oz[v]	0.0	f	0.0	f	0.0	g	0.6	j
Eagle 40WP 0.5 oz	0.0	f	0.0	f	0.1	g	0.4	j
Spectro 90WG 4.0 oz	0.0	f	0.0	f	0.0	g	0.3	j
Emerald 70WG 0.13 oz	0.0	f	0.0	f	0.0	g	0.0	j
Propiconazole Pro 1.3ME 1.0 fl oz	0.0	f	0.0	f	0.0	g	0.0	j
Banner MAXX 1.3ME 1.0 fl oz	0.0	f	0.0	f	0.0	g	0.0	j

[z]Number of infection centers per sq ft, three subsamples per plot, mean of three replications.
[y]Means within a column followed by different letters are significantly different ($P \leq 0.05$) according to the Waller-Duncan k-ratio test.
[x]Treatment applied on a 21-day interval (2 and 24 Jun, 15 Jul).
[w]Treatment applied on a 28-day interval (2 Jun, 1 and 29 Jul).
[v]Treatment applications alternated on a 14-day interval (Emerald applied 2 Jun, 1 and 29 Jul; Insignia applied 17 Jun and 15 Jul).

Evaluation of Fungicides for Control of Gray Leaf Spot on Perennial Ryegrass, 2003

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Introduction

Gray leaf spot (*Pyricularia grisea*) is an important disease on perennial ryegrass (*Lolium perenne*) golf course fairways in the Mid-Atlantic, Mid-West, and New England regions of the United States. This study was located at the Pennsylvania State University on perennial ryegrass. The objective was to evaluate various fungicides, rates, and fungicide combinations for their effectiveness in suppressing gray leaf spot.

Materials and Methods

The study was conducted on 'Legacy II' perennial ryegrass at the Valentine Turfgrass Research Center. The site was maintained under golf course fairway management conditions; mowed three times per week at 1.0-inch cutting height. The soil was a Hagerstown silt loam with a pH of 6.8. The test site was fertilized with 0.36 lb nitrogen (28-7-14), 1.0 lb nitrogen (31-0-0), and 0.8 lb nitrogen (10-18-18) per 1000 sq ft on 1 and 20 May, and 12 Jun respectively. On 10 Jun Chipco 26GT was applied at 4.0 fl oz per 1000 sq ft for control of brown patch. Subdue MAXX and ProStar were applied at 1.0 fl oz + 1.5 oz respectively on 27 Jun and 4 Aug for control of Pythium foliar blight and brown patch. Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with four replications. Treatments were applied with a CO_2-powered sprayer equipped with a TeeJet 11008E nozzle, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Treatments were applied on 2, 17, and 31 Jul, and 14 Aug. The experiment was inoculated on 21 and 28 Jul by spraying spore suspensions of *P. grisea* over the experimental site. The experiment was lightly irrigated and covered during the night (21-24 Jul, and 28 Jul) with a 6-mil polyethylene sheet to maintain leaf wetness and reduce radiational cooling. The cover was removed between 10:00 a.m. and 4:00 p.m. daily during this period. The experiment was not mowed between 21 and 28 Jul, or between 28 Jul and 4 Aug. From 4 Aug through the remainder of the study the experiment was mowed once per week. Disease severity was evaluated on 18 and 25 Aug, and 2 Sep. Data were subjected to analysis of variance, and mean values were separated using the Waller-Duncan k-ratio test ($P \leq 0.05$).

Results and Discussion

Temperatures in central Pennsylvania were lower than normal during the experiment, while rainfall was abnormally high. On 18 Aug, 20 of the 24 treatments were offering excellent control of gray leaf spot. By 2 Sep, 16 treatments were still effectively suppressing the disease. The Equus + TM85 tank mixture provided complete suppression of gray leaf spot throughout the study.

Table. Evaluation of fungicides for control of gray leaf spot on perennial ryegrass, 2003.

Treatment, formulation, and rate per 1000 sq ft	Gray leaf spot severity* 18 Aug		25 Aug		2 Sep	
Untreated Check	5.8	a**	7.5	a**	7.5	a**
Echo 720 6F 2.0 fl oz + Propiconazole EC 0.36 fl oz	0.0	d	2.0	b	1.8	b
Echo 720 6F 3.6 fl oz	0.0	d	2.3	b	1.3	bc
Equus 82.5DF 2.0 oz + Farmsaver Phosphorous Acid L 4.0 fl oz	0.0	d	1.5	bc	1.3	bc
Bayleton 50DF 0.5 oz + Daconil Ultrex 82.5WG 3.2 oz	0.0	d	0.5	de	1.0	bcd
Banner MAXX 1.3ME 1.0 fl oz + Daconil Ultrex 82.5WG 3.2 oz	0.1	d	1.0	cd	1.0	bcd
TM85 85WG 1.25 oz	1.3	b	0.5	de	1.0	bcd
Fore 80WP 8.0 oz	0.3	d	0.8	cde	1.0	bcd
3336 50WP 4.0 oz	1.3	b	1.0	cd	0.8	cde
Equus 82.5DF 2.0 oz	0.0	d	0.8	cde	0.8	cde
Daconil Ultrex 82.5WG 2.0 oz	0.1	d	0.5	de	0.8	cde
Daconil Ultrex 82.5WG 3.2 oz	0.0	d	0.3	de	0.8	cde
Insignia 20WG 0.5 oz + T-Storm Flowable 4.5SC 3.5 fl oz	0.0	d	0.5	de	0.5	cde
Topsin-M 70WP 2.86 oz	0.9	bc	0.3	de	0.5	cde
Daconil Ultrex 82.5WG 3.6 oz	0.0	d	0.0	e	0.5	cde
Insignia 20WG 0.9 oz	0.0	d	0.5	de	0.3	de
Insignia 20WG 0.5 oz + Concorde 82.5DF 3.2 oz	0.0	d	0.0	e	0.3	de
Compass 50WG 0.2 oz	0.0	d	0.3	de	0.3	de
Heritage 50WG 0.2 oz	0.1	d	0.0	e	0.3	de
Spectro 90WG 5.0 oz	0.0	d	0.0	e	0.3	de
Topsin-M 4.5F 3.6 fl oz	0.3	d	0.5	de	0.3	de
Equus 82.5DF 3.2 oz	0.4	cd	0.3	de	0.3	de
Insignia 20WG 0.5 oz + Pentathlon 75WG 8.0 oz	0.1	d	0.0	e	0.0	e
Equus 82.5DF 2.0 oz + TM85 85WG 1.25 oz	0.0	d	0.0	e	0.0	e

*Disease severity index 0-10; 0=asymptomatic, and 10=>90% turf area symptomatic, mean of four replications.
**Means within a column followed by different letters are significantly different ($P \leq 0.05$) according to the Waller-Duncan k-ratio test.

Control of Pythium Foliar Blight on Perennial Ryegrass, 2003

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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 study was conducted at the Valentine Turfgrass Research Center, University Park, PA, on perennial ryegrass (*Lolium perenne*, 'Legacy II'). The objective of the study was to evaluate various fungicides, rates, and mixtures to determine their effectiveness in suppressing the disease.

Materials and Methods

The experiment was conducted on perennial ryegrass maintained under golf course fairway management conditions, and mowed three times per week at 1.0-inch cutting height. The soil was Hagerstown silt loam with a soil pH of 6.8. Fertilizer was applied on 1 May with 0.36 lb nitrogen (Lebanon 28-7-14) per 1000 sq ft, 20 May with 1.0 lb nitrogen (31-0-0) per 1000 sq ft, and 12 Jun with 0.8 lb nitrogen (10-18-18) per 1000 sq ft. Chipco 26GT (4.0 fl oz/1000 sq ft) and Farmsaver.com TM85 (1.2 oz per 1000 sq ft) were applied on 10 and 26 Jun respectively for control of brown patch. Treatment plots, 3 ft x 3 ft, were arranged in a randomized complete block design with three replications. Treatments were applied on 7 Jul with a CO_2-powered sprayer using a TeeJet 11008E nozzle. Applications were made at 40 psi in water equivalent to 2 gal per 1000 sq ft. On 9 Jul the experiment was enclosed in 30 ft x 48 ft polyethylene greenhouse to reduce radiational cooling; and was inoculated with a mycelial suspension of a six-isolate pool of *Pythium aphanidermatum.* An internal intermittent misting system provided continuous high relative humidity throughout the experiment. The greenhouse was vented during daylight hours to maintain a temperature range of 85° to 95°F. Vents were closed during the evenings and nights. Disease severity was assessed from 15 through 18 Jul. Data were subjected to analysis of variance, and the mean values were compared using the Waller-Duncan k-ratio Test ($P \leq 0.05$).

Results and Discussion

Severity of Pythium foliar blight was high in the experiment. Through 18 Jul (11 days after treatment), all treatments with Ranman (alone or in combination with other fungicides), Subdue MAXX (1.0 fl oz), Banol, and the combination of Farmsaver.com Mefenoxam + Farmsaver.com phosphorous acid provided excellent control of the disease.

Table. Control of Pythium foliar blight on perennial ryegrass, 2003.

Treatment, formulation, and rate per 1000 sq ft	Disease Severity* 15 Jul		16 Jul		17 Jul		18 Jul	
Untreated Check	8.0	a**	9.0	a**	9.7	a**	9.8	a**
FNX-101 WP 7.04 oz	4.3	bc	7.3	ab	8.7	ab	9.5	ab
Biophos L 12.0 fl oz	4.7	b	7.7	ab	8.3	abc	9.3	ab
Vital Sign 4.2L 6.0 fl oz + Junction 61.1WG 2.0 oz	3.0	cde	6.0	bc	8.0	a-d	8.8	abc
Chipco Signature 80WG 4.0 oz	3.7	bcd	6.0	bc	8.3	abc	8.7	abc
Biophos L 15.0 fl oz	2.0	e-h	4.0	cde	6.3	c-f	8.0	a-d
Spectro 90WG 5.0 oz + Alude 5.17L 5.5 fl oz	2.3	d-g	4.7	cd	6.7	b-e	7.8	b-e
Alude 5.17L 5.5 fl oz	2.7	def	3.3	def	6.0	d-g	7.7	b-e
Vital 4.2L 6.0 fl oz	2.0	e-h	1.7	fgh	4.3	fgh	7.3	cde
Farmsaver.com Phosphorous Acid L 4.0 fl oz	2.0	e-h	3.3	def	5.3	efg	7.3	cde
Insignia 20WG 0.9 oz	2.3	d-g	3.3	def	4.7	e-h	7.0	cde
Vital Sign 4.2L 6.0 fl oz	1.0	ghi	3.0	d-g	4.4	fgh	6.7	de
Alude 5.17L 7.5 fl oz	1.3	f-i	2.0	e-h	5.0	e-h	6.5	def
Protect 80WG 4.0 oz + Alude 5.17L 5.5 fl oz	1.3	f-i	2.0	e-h	4.0	ghi	6.3	def
Farmsaver.com Mefenoxam 2ME 0.5 fl oz	0.0	i	0.7	h	3.0	hij	6.0	ef
Chipco Signature 80WG 8.0 oz	0.3	i	0.7	h	2.1	ijk	4.7	fg
Farmsaver.com Mefenoxam 2ME 1.0 fl oz	0.0	i	0.7	h	1.3	jk	4.0	g
Subdue MAXX 2ME 0.5 fl oz	0.3	i	0.7	h	3.0	hij	4.0	g
Insignia 20WG 0.9 oz + Chipco Signature 80WG 4.0 oz	0.7	hi	1.3	fgh	2.0	ijk	3.3	gh
Banol 6SL 3.0 fl oz	0.3	i	0.0	h	0.3	k	1.7	hi
Ranman 3.34SC 0.225 fl oz + Insignia 20WG 0.45 oz	1.0	ghi	0.3	h	1.0	jk	1.7	hi
Ranman 3.34SC 0.225 fl oz	0.7	hi	1.0	gh	0.7	k	1.0	i
Subdue MAXX 2ME 1.0 fl oz	0.0	i	0.0	h	0.1	k	1.0	i
Farmsaver.com Mefenoxam 2ME 0.5 fl oz + Farmsaver.com Phosphorous Acid L 4.0 fl oz	0.0	i	0.0	h	0.1	k	0.8	i
Ranman 3.34SC 0.45 fl oz	0.3	i	0.3	h	0.4	k	0.7	i
Ranman 3.34SC 0.225 fl oz + Heritage 50WG 0.45 oz	0.3	i	0.0	h	0.1	k	0.5	i
Ranman 3.34SC 0.225 fl oz + Banol 6SL 1.3 fl oz	0.0	i	0.0	h	0.0	k	0.3	i
Ranman 3.34SC 0.9 fl oz	0.0	i	0.0	h	0.1	k	0.1	i

*Disease severity index 0-10; 0=asymptomatic, and 10=>90% turf area symptomatic, mean of three replications.
**Means within column followed by different letters are significantly different ($P \leq 0.05$) according to the Waller-Duncan k-ratio test.

Post Emergence Control of Broadleaf Weeds and Phytotoxicity Evaluations

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

Broadleaf weed control and phytotoxicity evaluations were conducted on a stand of mature perennial ryegrass (*Lolium perenne* L.) at the Valentine Turfgrass Research Center, Penn State University, University Park, PA. The objectives of the study were to determine the efficacy of broadleaf weed herbicides for the control of dandelion (*Taraxacum officinale*), buckhorn plantain (*Plantago lanceolata*), and white clover (*Trifolium repens*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

The study was a randomized complete block design with three replications. All of the treatments were applied on June 5, 2003 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi.

The perennial ryegrass was mowed at 1.5 inches twice weekly with a rotary mower with clippings returned to the site. All individual plots were rated for weed encroachment prior to treatment application.

Results and Discussion

The only phytotoxicity observed on perennial ryegrass occurred from applications of V-10029 and V-10029 plus Drive 75DF plus MSO at 1.0% v/v (Table 1). Control of individual weed species was rated on August 4. The best control of dandelion occurred as a result of applications of V-10029, V-10029 and Drive 75 DF plus MSO at 1.0% v/v, and Drive 75DF plus MSO at 1.0% v/v with 2,4-D (3.8L) at 1.0 lb ai/A (Table 2). Most treatments provided good control to excellent control of white clover, the exception being Quicksilver T&O (1.9EW) at 0.019 lbs ai/A, Chaser 2, and Quicksilver T&O (1.9EW) and MacroSorb Foliar at 2 oz/M. Although the addition of 2 oz/M of MacroSorb Foliar tended to improve the control from Quicksilver T&O. Quicksilver T&O and Drive 75DF did not provide good control of buckhorn plantain. However, when Drive 75DF plus MSO at 1.0% v/v was combined with V-10029, the control of buckhorn plantain was complete. As an aside to the broadleaf weed control evaluations, the reduction of annual bluegrass (Poa annua) in the plots was recorded (Table 3). V-10029 alone provided excellent annual bluegrass control which was maintained when it was combined with Drive 75DF, however Drive 75DF plus MSO at 1.0% v/v had modest annual bluegrass control.

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Table 1. Evaluations of perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate	(--------------Phytotoxicity----------)					
		Lbs ai/A	6-6	6-9	6-11	6-17	7-2	7-29
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
TRIMEC CLASSIC	L	3.0 PT/A						
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
TRIMEC CLASSIC	L	3.0 PT/A						
MSO	L	0.25 % V/V						
CHECK			10.0	10.0	10.0	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	2.0 PT/A						
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
CHASER 2	L	2.5 PT/A						
TRIMEC CLASSIC	L	3.0 PT/A	10.0	10.0	10.0	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	2.0 PT/A	10.0	10.0	10.0	10.0	10.0	10.0
CHASER 2	L	2.5 PT/A	10.0	10.0	10.0	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
CHASER 2	L	2.5 PT/A						
MACROSORB FOLIAR	L	2.0 OZ/M						
QUICKSILVER T&O	1.9EW	0.019	10.0	10.0	10.0	10.0	10.0	10.0
MACROSORB FOLIAR	L	2.0 OZ/M						
V-10029	81.6WP	2.0 OZ/A	10.0	8.0	6.5	5.3	10.0	10.0
V-10029	81.6WP	2.0 OZ/A	10.0	8.0	6.5	5.3	10.0	10.0
DRIVE	75DF	0.75						
MSO	L	1.0 % V/V						
DRIVE	75DF	0.75	10.0	10.0	10.0	10.0	10.0	10.0
2,4-D	3.8L	1.0						
MSO	L	1.0 % V/V						

Table 2. Rating of percent control of dandelion, white clover and buckhorn plantain population. Ratings taken on August 4, 2003.

Treatment	Form	Rate Lbs ai/A	Dand	Clover	Plantain
QUICKSILVER T&O	1.9EW	0.019	6.7e[1]	33.3b	49.4ab
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.019 3.0 PT/A	16.7de	96.7a	93.3a
QUICKSILVER T&O TRIMEC CLASSIC MSO	1.9EW L L	0.019 3.0 PT/A 0.25 % V/V	22.2de	98.3a	99.4a
CHECK			5.6e	0.0c	0.0c
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.019 2.0 PT/A	34.3cde	100.0a	100.0a
QUICKSILVER T&O CHASER 2	1.9EW L	0.019 2.5 PT/A	45.0cd	98.3a	100.0a
TRIMEC CLASSIC	L	3.0 PT/A	66.7bc	85.6a	100.0a
HORSEPOWER/ELIMINATE	L	2.0 PT/A	56.0bc	96.7a	100.0a
CHASER 2	L	2.5 PT/A	55.6bc	55.6b	100.0a
QUICKSILVER T&O CHASER 2 MACROSORB FOLIAR	1.9EW L L	0.019 2.5 PT/A 2.0 OZ/M	39.3cde	87.2a	100.0a
QUICKSILVER T&O MACROSORB FOLIAR	1.9EW L	0.019 2.0 OZ/M	5.6e	47.2b	33.3bc
V-10029	81.6WP	2.0 OZ/A	100.0a	100.0a	100.0a
V-10029 DRIVE MSO	81.6WP 75DF L	2.0 OZ/A 0.75 1.0 % V/V	100.0a	100.0a	100.0a
DRIVE 2,4-D MSO	75DF 3.8L L	0.75 1.0 1.0 % V/V	84.0ab	100.0a	46.7b

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

Table 3. Ratings of the percent reduction of the annual bluegrass population for selected treatments. Ratings taken on August 4, 2003.

Treatment	Form	Rate lbs ai/A	% Change
CHECK			27.8c[1]
V-10029	81.6WP	2.0 OZ/A	94.5a
V-10029 DRIVE MSO	81.6WP 75DF L	2.0 OZ/A 0.75 1.0 % V/V	86.5a
DRIVE 2,4-D MSO	75DF 3.8L L	0.75 1.0 1.0 % V/V	51.4b

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

Seedhead Suppression of Annual Bluegrass on a Putting Green

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

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

Methods and Materials

Treatments were applied on April 23, 2003 (BOOT) and for the Proxy/Primo combination again on May 13, 2003 (3 WAT) using a three-foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two 11004 flat fan nozzles at 40 psi. The turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a putting green. Ratings were taken on May 2 for phytotoxicity and on May 20 for turf quality and seedhead suppression. The turf quality ratings were an amalgamation of color, density, texture, and seedhead suppression.

Results and Discussion

Phytotoxicity was rated nine days after the April 23 application date, which was considered to be when the annual bluegrass seedheads were in the "BOOT" stage of development. Phytotoxicity ratings below 7 were considered to be unacceptable. Turf treated with Embark alone at 40 oz/A and in combination with MacroSorb Foliar at 4 and 8 oz/M, MacroSorb Foliar with and without Minors at 1.5 oz/M, and GBJ1 at 4 oz/M, was rated as having unacceptable phytotoxicity (Table 1). On May 20, the lowest quality rating was observed for untreated turf, primarily because of emerged seedheads. Turf having the best combination of quality and seedhead suppression was treated with Primo MAXX (0.125 oz/M) plus Proxy (3 oz/M) applied twice, Primo MAXX (0.125 oz/M) plus Proxy (5 oz/M) plus MacroSorb Foliar (4 and 8 oz/M) applied once, and Primo Maxx (0.125 oz/M) plus Proxy (5 oz/M) applied once. When the Primo MAXX rate was reduced to 0.06 oz/M in combination with Proxy (3 oz/M) and MacroSorb Foliar (8 oz/M), quality was very good (8.5), as was seedhead suppression (82%). It appears that the addition of MacroSorb Foliar at 8 oz/M to lower the rates of both Primo MAXX and Proxy enhanced quality without causing a significant loss of seedhead suppression (Table 1).

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Table 1. Ratings of chemical phytotoxicity, turf quality, and percent seedhead suppression of an annual bluegrass/creeping bentgrass putting green.

Treatment	Form	Rate oz/M	Timing	5/2/03 Phyto	5/20/03 Quality	5/20/03 Suppression
PROXY	2SL	5	BOOT	9.7[1]	7.7[2]	83.3abc[3]
PROXY	2SL	3	BOOT	9.7	7.2	78.3a-d
PROXY	2SL	5	BOOT	8.7	8.2	88.3ab
PRIMO MAXX	1MEC	0.125	BOOT			
PROXY	2SL	3	BOOT	8.7	6.7	73.3bcd
PRIMO MAXX	1MEC	0.125	BOOT			
PROXY	2SL	3	BOOT/3WAT	8.7	9.2	93.3a
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
EMPARK T/O	0.2L	40 OZ/A	BOOT	5.3	6.3	85.0ab
EMPARK T/O	0.2L	40 OZ/A	BOOT	8.3	7.2	73.3bcd
FEROMEC	L	5	BOOT			
CHECK				10.0	5.7	0.0f
PROXY	2SL	5	BOOT	9.0	7.2	78.3a-d
CUTLESS	50WP	0.25 LB/A	BOOT			
PROXY	2SL	5	BOOT	7.3	7.5	75.0bcd
TRIMMIT	2SC	6 OZ/A	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	8.7	6.3	58.3e
FERROMEC	L	5	BOOT			
SEAWEED COCKTAIL	L	0.25 GAL/A	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	6.0	6.3	68.3cde
MACROSORB FOLIAR	L	8	BOOT			
EMBARK T/O 0.2	L	40 OZ/A	BOOT	5.3	6.3	75.0bcd
MACROSORB FOLIAR	L	4	BOOT			
EMBARK T/O 0.2	L	40 OZ/A	BOOT	7.0	7.3	68.3cde
FERROMEC	L	5	BOOT			
MACROSORB FOLIAR	L	4	BOOT			
PROXY	2SL	5	BOOT	7.7	8.2	88.3ab
PRIMO MAXX	1MEC	0.125	BOOT			
MACROSORB FOLIAR	L	4	BOOT			
PROXY	2SL	5	BOOT	9.0	8.5	86.7ab
PRIMO MAXX	1MEC	0.125	BOOT			
MACROSORB FOLIAR	L	8	BOOT			
PROXY	2SL	3	BOOT	9.3	8.5	81.7a-d
PRIMO MAXX	1MEC	0.06	BOOT			
MACROSORB FOLIAR	L	8	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	6.0	6.7	73.3bcd
GBJ1	L	4	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	6.7	6.3	68.3cde
MINORS	L	1.5	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	6.3	6.3	66.7de
MINORS	L	1.5	BOOT			
MACROSORB FOLIAR	L	4	BOOT			

1 – Rating scale: 0 = complete phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.
2 – Rating scale: 0 = worst quality, 7 = acceptable, and 10 = best quality.
3 - Means followed by same letter do not significantly differ (P = 0.05 Duncan's New MRT)

Post Emergence Control of Broadleaf Weeds and Annual Bluegrass in the Fall

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

Broadleaf weed and annual bluegrass (*Poa annua*) control evaluations were conducted on a stand of mature "Jet Elite" perennial ryegrass (*Lolium perenne* L.) at the Valentine Turfgrass Research Center, Penn State University, University Park, PA. The objectives of the study were to determine the efficacy of broadleaf weed herbicides for the control of dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and annual bluegrass in perennial ryegrass.

Methods and Materials

The study was a randomized complete block design with three replications. All of the treatments were applied on September 16, 2003 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi.

The perennial ryegrass was mowed at 1.5 inches twice weekly with a rotary mower with clippings returned to the site. All individual plots were rated for weed encroachment prior to treatment application.

Results and Discussion

Most of the herbicides tested provided good to excellent dandelion control by the November 11th rating date (Tables 1 and 2). Although, Quick Silver T&O at 1.3 oz/A was the only treatment where dandelions were observed to recover by the November 11th rating date. Similar ratings were recorded for white clover control, however, in this case, the control from Quick Silver T & O improved from the October 13 h to the November 11 h rating date (Tables 1 and 2). None of the treatments provided a meaningful decrease in the annual bluegrass population (Table 3).

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Table 1. Ratings of percent change of the dandelion and white clover population. Ratings taken on October 13, 2003.

Treatment	Form	Rate Pt/A	(-------% Change----------) Dand	Clover
VELOCITY	81.6WP	2.0 OZ/A	72.2 c [1,2]	25.0 c
VELOCITY DRIVE MSO	81.6WP 75DF L	2.0 OZ/A 0.75 LB AI/A 1.0 % V/V	88.2 ab	63.9 b
SPEED ZONE	L	5.0	100.0 a	100.0 a
POWER ZONE	L	6.0	100.0 a	100.0 a
CHECK			4.8 d	0.0 c
CONFRONT	L	2.0	94.4 ab	91.7 ab
TRIMEC CLASSIC	L	4.0	100.0 a	88.3 ab
QUICK SILVER	L	1.3 OZ/A	81.7 bc	23.3 c
QUICK SILVER CONFRONT	L L	1.3 OZ/A 1.0	100.0 a	100.0 a
QUICK SILVER TRIMEC CLASSIC	L L	1.3 OZ/A 2.0	100.0 a	100.0 a

1 - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT).
2 – Negative numbers represent an increase in population and positive numbers a decrease in population.

Table 2. Ratings of percent change of the dandelion and white clover population. Ratings taken on November 11, 2003.

Treatment	Form	Rate Pt/A	(-------% Change----------) Dand	Clover
VELOCITY	81.6WP	2.0 OZ/A	100.0 a [1,2]	98.3 a
VELOCITY DRIVE MSO	81.6WP 75DF L	2.0 OZ/A 0.75 LB AI/A 1.0 % V/V	100.0 a	100.0 a
SPEED ZONE	L	5.0	99.4 a	100.0 a
POWER ZONE	L	6.0	100.0 a	100.0 a
CHECK			-6.4 c	8.3 c
CONFRONT	L	2.0	100.0 a	100.0 a
TRIMEC CLASSIC	L	4.0	100.0 a	100.0 a
QUICK SILVER	L	1.3 OZ/A	56.7 b	68.3 b
QUICK SILVER CONFRONT	L L	1.3 OZ/A 1.0	98.2 a	100.0 a
QUICK SILVER TRIMEC CLASSIC	L L	1.3 OZ/A 2.0	98.6 a	100.0 a

1 - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT).
2 – Negative numbers represent an increase in population and positive numbers a decrease in population.

Table 3. Ratings of percent change of the annual bluegrass population. Ratings taken on November 11, 2003.

Treatment	Form	Rate Pt/A	% Change Annual Bluegrass
VELOCITY	81.6WP	2.0 OZ/A	0.0 ab [1,2]
VELOCITY DRIVE MSO	81.6WP 75DF L	2.0 OZ/A 0.75 LB AI/A 1.0 % V/V	4.2 a
SPEED ZONE	L	5.0	-33.4 ab
POWER ZONE	L	6.0	0.0 ab
CHECK			-11.1 ab
CONFRONT	L	2.0	-22.2 ab
TRIMEC CLASSIC	L	4.0	-17.8 ab
QUICK SILVER	L	1.3 OZ/A	-11.1 ab
QUICK SILVER CONFRONT	L L	1.3 OZ/A 1.0	-22.2 ab
QUICK SILVER TRIMEC CLASSIC	L L	1.3 OZ/A 2.0	-55.6 b

1 - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT).
2 – Negative numbers represent an increase in population and positive numbers a decrease in population.

Seedhead Suppression of Fairway Height Annual Bluegrass (Demonstration Study)

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

This study was conducted on a mature annual bluegrass (*Poa annua*) stand at the Valentine Research Center, University Park, PA. The objective of the study was to evaluate selected growth regulators, with and without adjuvants, for the seedhead suppression of annual bluegrass maintained at a fairway height of cut.

Methods and Materials

Treatments were applied on April 23, 2003 (BOOT STAGE) using a three-foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two 11004 flat fan nozzles at 40 psi. The turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a golf course fairway.

Results and Discussion

Phytotoxicity rated on May, 2, 2003 revealed that turf treated with Cutless plus Primo at 0.25 lb ai/A and 0.25 oz/M respectively, Cutless plus Primo at the same rates, but with the addition of MacroSorb Foliar at 2 oz/M, and Cutless plus Primo at the same rates but with the addition of GBJ1 at 2 oz/M had unacceptable ratings (below 7.0) (Table 1). These same treatments provided excellent seedhead suppression (90%) on this rating date, but by the second rating date (May 19) these treatments provided the poorest suppression of seedheads (Table 1). The best treatments, when both injury and degree of suppression were considered were Embark T/O at 60 oz/A plus GBJ1 at 2 oz/M and 4 oz/M, Embark at 60 oz/M , plus Coron at 0.2 lbs N/M and Embark at 60 oz/A, plus Coron at 0.2 lbs N/M plus MacroSorb Foliar at 2 oz/M.

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Table 1. Ratings of phytotoxicity, and percent suppression of annual bluegrass seedhead formation.

Treatment	Form	Rate oz/m	Timing	5/2/03 Phyto	5/2/03 (%Suppression)	5/19/03
PROXY	2SL	5	BOOT	10[1]	80	45
PRIMO MAXX	1MEC	0.25	BOOT			
PROXY	2SL	5	BOOT	10	80	65
PRIMO MAXX	1MEC	0.25	BOOT			
MACROSORB FOLIAR	L	2	BOOT			
CUTLESS	50WP	0.25 LB AI/A	BOOT	6	90	15
PRIMO MAXX	1MEC	0.25	BOOT			
CUTLESS	50WP	0.25 LB AI/A	BOOT	5	90	35
PRIMO MAXX	1MEC	0.25	BOOT			
MACROSORB FOLIAR	L	2	BOOT			
CUTLESS	50WP	0.25 LB AI/A	BOOT	6	90	20
PRIMO MAXX	1MEC	0.25	BOOT			
GBJ1	L	2	BOOT			
EMPARK T/O	0.2L	60 OZ/A	BOOT	7	90	95
EMBARK T/O	0.2L	60 OZ/A	BOOT	10	70	80
MACROSORB FOLIAR	L	2	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10	70	90
GBJ1	L	2	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10	70	70
MACROSORB FOLIAR	L	4	BOOT			
EMBARK T/O 0.2	L	60 OZ/A	BOOT	10	70	95
GBJ1	L	4	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10	50	85
CORON	2.9L	0.2 LB N/M	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	9	70	95
CORON	2.9L	0.2 LB N/M	BOOT			
MACROSORB FOLIAR	L	2	BOOT			
CHECK				10	0	0

1 – Rating scale: 0 = complete phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Post Emergence Control of Ground Ivy and Broadleaf Weeds

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

This study was conducted on a mature mixed stand of perennial ryegrass, Kentucky bluegrass, and fine fescue on a home lawn in Julian, PA. The objective of the study was to determine the efficacy of broadleaf weed herbicides for the control of ground ivy. Although there were many types of broadleaf weeds in the stand they were not uniform enough to evaluate control on a species by species basis. The term "other weed" (used in this report) thus refers to buckhorn plantain, common plantain, dog fennel, slender speedwell, wild violet, wild strawberry, oxalis, white clover, dandelion, hawkweed, mouse ear chickweed, thyme-leaf speedwell, heal-all, wild carrot, and yarrow that were present at the time of the herbicide application.

Methods and Materials

The study was a randomized complete block design with three replications. All of the treatments were applied on June 10, 2002 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi. Ratings were taken on June 10, July 8, and Aug 5, 2002. Each plot was rated for ground ivy cover and other weed cover prior to treatment.

The site was mowed at two inches with a rotary mower with clippings returned. The site was not irrigated.

Results and Discussion

Ground ivy control was highly variable from treatment to treatment (Table 1). Sprayed formulations provided better control than granular materials. Speed Zone, Drive plus 2,4-D and MSO, Confront and Trimec Classic tended to provide the best and most lasting control of ground ivy (Table 1).

On June 16, 2003 Lebanon Turf Herbicide 0.68G at 157 lbs/A, Speed Zone at 3 pt/A, and Power Zone at 3.5 pt/A provided less than 45 percent control of ground ivy (Table 1).

Control of the other weeds on the site was also variable, but the sprayed formulations again were typically more efficacious than the granular formulations (Table 2).

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Table1. Rating of percent change of ground ivy population.

Treatment	Form	Rate	7-8-02	8-5-02	6-16-03
LEBANON TURF HERBICIDE	0.68G	157 LB/A	8.9c[1]	22.2b	-8.9c
CHECK			-6.7c	-13.3b	-13.8c
DRIVE	75DF	0.75 LB A/A	100.0a	100.0a	98.9a
2,4-D	3.8L	1.0 LB A/A			
MSO	L	1 % V/V			
SPEED ZONE	L	3 PT/A	84.3ab	85.0a	18.3c
POWER ZONE	L	3.5 PT/A	94.5a	75.8a	40.8bc
CONFRONT	3SL	0.75 LB A/A	97.2a	100.0a	90.8ab
TRIMEC CLASSIC	L	4 PT/A	100.0a	100.0a	89.6ab

1 - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT). Positive numbers are a decrease in population and negative numbers are an increase in population.

Table 2. Rating of percent change of other weed populations.

Treatment	Form	Rate	7-8-02	8-5-02
LEBANON TURF HERBICIDE	0.68G	157 LB/A	22.2cd[1]	35.5b
CHECK			0.0d	-4.2c
DRIVE	75DF	0.75 LB A/A	66.5ab	71.4a
2,4-D	3.8L	1.0 LB A/A		
MSO	L	1 % V/V		
SPEED ZONE	L	3 PT/A	75.2a	82.9a
POWER ZONE	L	3.5 PT/A	73.1ab	78.7a
CONFRONT	3SL	0.75 LB A/A	72.3ab	81.2a
TRIMEC CLASSIC	L	4 PT/A	66.7ab	80.4a

1 - Means followed by same letter do not significantly differ (P=.05 Duncan's New MRT). Positive numbers are a decrease in population and negative numbers are an increase in population.

Micro and Macro Nutrient Evaluations on a Putting Green

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

Foliar tissue evaluations of macro and micro nutrient concentrations were conducted on a mature mixed stand of “Penn A4” creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass (*Poa annua*) at the Valentine Turfgrass Research Center, Penn State University, University Park, PA. The objective of the study was to determine if selected micronutrient containing materials could increase the macro and micro nutrient levels in foliar tissue of the turfgrass plant, effect color, and increase growth.

Methods and Materials

This study was a randomized complete block design with three replications. All treatments were applied on June 17, 31, and August 14, 2003 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi. The test site was maintained similar to that of a golf course green with respect to irrigation and mowing. Fertilization was limited to those applications pertaining to the experimental treatments. Tissue analyses were conducted at the Penn State Analytical Laboratories.

Results and Discussion

None of the treatments significantly increased the growth (weight) of the turfgrass compared to untreated. However, turf treated with the Minors material had significantly more growth than turf treated with Minors plus Coron at 1.5 oz/M and 0.2 lbs N/M respectively (Table 1). Color was rated on four dates and all the treatments tended to improve color compared to the untreated (Table 1). The most consistent color response across all rating dates was found for turf treated with Minors alone at 1.5 oz/M or with the Minors plus Coron at 0.2 lbs N/M. Tissue and soil samples were taken and analyzed prior to the application of any treatments to establish a baseline for comparison after the treatments were initiated (Table 2). Tissue analyses for samples taken on July 23 revealed that no significant differences were found between treated and untreated turf with the following exceptions; turf treated with the Minors plus Coron and Foliar plus Radicular plus Minors, had higher percent sulfur, turf treated with Minors plus Coron had higher ppm Mn, and turf treated with Minors, Minors plus Coron, Foliar plus Radicular plus Minors and GBJ1 plus Minors had higher ppm of Zn (Tables 3 and 4).

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Tissue harvested on August 6 revealed the following tissue results; turf treated with Minors plus Coron, Coron, Foliar plus Radicular plus Minors, and Quelant K had higher percent nitrogen than untreated, turf treated with Minors plus Coron had higher percent phosphorous than untreated, turf treated with Foliar plus Minors had higher percent potassium than untreated, turf treated with Foliar plus Radicular, plus Minors had higher percent sulfur than untreated, turf treated with Minors had higher ppm of copper than untreated, turf treated with Minors had higher boron than untreated, turf treated with Minors, Minors plus Coron, Foliar plus Radicular plus Minors, GBJ1 plus Minors, Foliar plus Minors, and Quelant K plus Minors had higher ppm zinc than untreated (Tables 5 and 6). Tissue harvested on August 21 revealed the following tissue results; turf treated with Coron had higher percent nitrogen than untreated, turf treated with Coron had higher percent potassium than untreated, turf treated with Minors plus Coron, Coron, and Foliar plus Radicular, plus Minors had higher percent sulfur than untreated, turf treated with GBJ1 plus Minors had higher ppm iron than untreated, and turf treated with Minors, Minors plus Coron, Foliar plus Radicular plus Minors, GBJ1 plus Minors, Foliar plus Minors, and Quelant K plus Minors has higher ppm zinc than untreated (Tables 7 and 8). It appears that turf treated with the Minors alone or often in combination with Coron and other materials had significantly elevated levels of some micronutrients (especially zinc) and had more consistent and better color and growth than untreated turf.

Table 1. Evaluations of color where 0= brown, 7= acceptable, and 10= dark green and fresh weights (grams) taken in 2003.

Treatment	**Form**	**Rate Oz/M**	**(------Color------) 7-31**	**8-7**	**8-14**	**8-21**	**Weight 8-21**
MINORS	L	1.5	8.8	9.3	9.3	9.5	43.8a[1]
MINORS	L	1.5	8.8	9.5	9.2	9.3	32.4b
CORON	2.9L	0.2 lb ai/M					
CORON	2.9L	0.2 lb ai/M	8.5	9.2	9.0	9.3	39.4ab
FOLIAR	L	2	9.0	9.3	8.5	9.0	33.8ab
RADICULAR	L	2					
MINORS	L	1.5					
CHECK			8.2	8.8	8.0	8.5	33.4ab
SCOTTS FLUID MINORS	L	1.47	8.7	9.5	9.0	9.2	40.2ab
GBJ1	L	2	9.0	9.5	9.0	9.2	37.0ab
MINORS	L	1.5					
FOLIAR	L	2	9.0	9.5	9.0	9.3	40.4ab
MINORS	L	1.5					
QUELANT K	L	2	8.8	9.5	8.2	9.3	39.0ab
MINORS	L	1.5					
QUELANT K	L	2	8.3	9.0	8.5	8.3	34.6ab

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

Table 2. Evaluations of macro and micro nutrients on a putting green in the plant tissue and soil (composite of the entire test site). Samples were collected prior to any treatment applications.

N %	P %	K %	Ca %	Mg %	S %	Mn ppm	Fe ppm	Cu ppm	B ppm	Al ppm	Zn ppm
Plant Tissue											
3.17	0.35	2.14	0.44	0.20	0.34	77.20	183.73	12.45	4.13	29.51	46.52
Soil (Plant Available)											
X	3.87	3.13	2.70	0.42	X	7.82	20.28	15.09	X	12.56	11.96

Table3. Evaluations of macro and micro nutrients on a putting green. Samples were collected on July 23, 2003.

Treatment	Form	Rate Oz/M	N %	P %	K %	Ca %	Mg %	S %
MINORS	L	1.5	3.25ab[1]	0.34a	1.99a	0.41b	0.20ab	0.28abc
MINORS	L	1.5	3.25ab	0.34a	1.93a	0.42ab	0.21ab	0.30ab
CORON	2.9L	0.2 lb ai/M						
CORON	2.9L	0.2 lb ai/M	3.28ab	0.34a	1.93a	0.40b	0.20ab	0.28abc
FOLIAR	L	2	3.30a	0.34a	1.93a	0.44a	0.21a	0.30a
RADICULAR	L	2						
MINORS	L	1.5						
CHECK			3.20ab	0.33a	1.91a	0.40b	0.20ab	0.27c
SCOTTS FLUID MINORS	L	1.47	3.25ab	0.33a	1.92a	0.41b	0.20ab	0.28bc
GBJ1	L	2	3.27ab	0.33a	1.93a	0.40b	0.20ab	0.28abc
MINORS	L	1.5						
FOLIAR	L	2	3.25ab	0.33a	1.97a	0.42ab	0.20ab	0.28bc
MINORS	L	1.5						
QUELANT K	L	2	3.13ab	0.33a	1.91a	0.40b	0.19b	0.27c
MINORS	L	1.5						
QUELANT K	L	2	3.11b	0.34a	1.89a	0.41b	0.20ab	0.28abc

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

Table 4. Evaluations of macro and micro nutrients on a putting green. Samples were collected on July 23, 2003.

Treatment	**Form**	**Rate Oz/M**	**Mn ppm**	**Fe ppm**	**Cu ppm**	**B ppm**	**Al ppm**	**Zn ppm**
MINORS	L	1.5	67.51ab[1]	407.39a	12.07a	4.18a	62.08b	50.40a
MINORS	L	1.5	77.44a	730.76a	12.43a	4.19a 1	62.01ab	52.10a
CORON	2.9L	0.2 lb ai/M						
CORON	2.9L	0.2 lb ai/M	65.14b	497.12a	12.49a	3.81ab	75.64b	41.97c
FOLIAR	L	2	71.88ab	586.89a	14.41a	4.00ab	199.44a	49.56a
RADICULAR	L	2						
MINORS	L	1.5						
CHECK			64.98b	585.49a	16.91a	3.71ab	102.57ab	41.34c
SCOTTS FLUID MINORS	L	1.47	70.86ab	644.18a	11.79a	3.90ab	116.91ab	42.83bc
GBJ1	L	2	68.53ab	536.51a	12.02a	3.97ab	99.19ab	49.81a
MINORS	L	1.5						
FOLIAR	L	2	71.01ab	583.02a	12.08a	4.13ab	106.49ab	47.71abc
MINORS	L	1.5						
QUELANT K	L	2	70.79ab	726.90a	11.85a	3.80ab	116.82ab	48.60ab
MINORS	L	1.5						
QUELANT K	L	2	66.99ab	504.73a	12.26a	3.64b	109.91ab	41.36c

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

Table 5. Evaluations of macro and micro nutrients on a putting green. Samples were collected on August 6, 2003.

Treatment	**Form**	**Rate Oz/M**	**N %**	**P %**	**K %**	**Ca %**	**Mg %**	**S %**
MINORS	L	1.5	2.98de[1]	0.34de	1.84a-d	0.38ab	0.19a	0.28abc
MINORS	L	1.5	3.20a	0.39a	1.89ab	0.38ab	0.20a	0.31ab
CORON	2.9L	0.2 lb ai/M						
CORON	2.9L	0.2 lb ai/M	3.12ab	0.37abc	1.85a-d	0.38ab	0.19a	0.29abc
FOLIAR	L	2	3.11abc	0.37ab	1.88abc	0.39ab	0.20a	0.31a
RADICULAR	L	2						
MINORS	L	1.5						
CHECK			2.89ef	0.35b-e	1.81bcd	0.38ab	0.19a	0.28bc
SCOTTS FLUID MINORS	L	1.47	2.92def	0.35b-e	1.82a-d	0.38ab	0.19a	0.28bc
GBJ1	L	2	2.83f	0.34cde	1.80cd	0.44a	0.19a	0.28bc
MINORS	L	1.5						
FOLIAR	L	2	3.00cde	0.36b-e	1.90a	0.38ab	0.19a	0.30abc
MINORS	L	1.5						
QUELANT K	L	2	2.88ef	0.34e	1.77d	0.36b	0.18a	0.27c
MINORS	L	1.5						
QUELANT K	L	2	3.01bcd	0.37a-d	1.87abc	0.38ab	0.20a	0.30abc

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

Table 6. Evaluations of macro and micro nutrients on a putting green. Samples were collected on August 6, 2003.

Treatment	Form	Rate Oz/M	Mn ppm	Fe ppm	Cu ppm	B ppm	Al ppm	Zn ppm
MINORS	L	1.5	84.65b[1]	374.24a	16.97a	3.40a	123.69ab	43.54a
MINORS	L	1.5	99.20a	823.10a	12.68a	3.05b	135.50ab	46.04a
CORON	2.9L	0.2 lb ai/M						
CORON	2.9L	0.2 lb ai/M	88.57ab	353.01a	11.84a	3.14ab	105.33ab	38.04b
FOLIAR	L	2	93.46ab	561.58a	12.61a	3.31ab	162.85ab	45.61a
RADICULAR	L	2						
MINORS	L	1.5						
CHECK			90.60ab	681.43a	11.34a	3.08b	195.00a	37.37b
SCOTTS FLUID MINORS	L	1.47	81.58b	349.46a	11.68a	3.20ab	103.25ab	37.48b
GBJ1	L	2	84.74b	370.56a	11.91a	3.18ab	118.48ab	42.87a
MINORS	L	1.5						
FOLIAR	L	2	87.10ab	404.15a	12.32a	3.13ab	75.80b	45.25a
MINORS	L	1.5						
QUELANT K	L	2	87.25ab	648.60a	11.86a	3.05b	114.83ab	42.29a
MINORS	L	1.5						
QUELANT K	L	2	85.44b	446.93a	12.21a	3.07b	128.40ab	37.45b

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

Table 7. Evaluations of macro and micro nutrients on a putting green. Samples were collected on August 21, 2003.

Treatment	**Form**	**Rate Oz/M**	**N %**	**P %**	**K %**	**Ca %**	**Mg %**	**S %**
MINORS	L	1.5	2.86bcd[1]	0.36c	1.80bc	0.44a	0.21a	0.30cd
MINORS	L	1.5	3.02ab	0.39abc	1.88ab	0.47a	0.23a	0.34a
CORON	2.9L	0.2 lb ai/M						
CORON	2.9L	0.2 lb ai/M	3.09a	0.40a	1.90a	0.46a	0.23a	0.34ab
FOLIAR	L	2	2.96abc	0.39abc	1.86abc	0.44a	0.23a	0.33abc
RADICULAR	L	2						
MINORS	L	1.5						
CHECK			2.86bcd	0.37abc	1.81bc	0.44a	0.21a	0.30d
SCOTTS FLUID MINORS	L	1.47	2.81cd	0.38abc	1.78c	0.44a	0.21a	0.30d
GBJ1	L	2	2.78d	0.37abc	1.80bc	0.44a	0.21a	0.30d
MINORS	L	1.5						
FOLIAR	L	2	2.93a-d	0.38abc	1.83abc	0.45a	0.22a	0.31bcd
MINORS	L	1.5						
QUELANT K	L	2	2.80cd	0.37bc	1.78c	0.47a	0.21a	0.30d
MINORS	L	1.5						
QUELANT K	L	2	3.00ab	0.40ab	1.84abc	0.46a	0.23a	0.32a-d

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

Table 8. Evaluations of macro and micro nutrients on a putting green. Samples were collected on August 21, 2003.

Treatment	Form	Rate Oz/M	Mn ppm	Fe ppm	Cu ppm	B ppm	Al ppm	Zn ppm
MINORS	L	1.5	100.43a[1]	320.03b	11.79b	3.74a	80.40a	55.39a
MINORS	L	1.5	119.57a	452.07b	12.64ab	3.33a	122.93a	57.09a
CORON	2.9L	0.2 lb ai/M						
CORON	2.9L	0.2 lb ai/M	96.36a	181.65b	12.35ab	3.32a	61.46a	39.92b
FOLIAR	L	2	150.18a	632.43ab	13.13a	3.72a	151.35a	56.81a
RADICULAR	L	2						
MINORS	L	1.5						
CHECK			94.58a	294.89b	11.57b	3.45a	79.48a	37.86b
SCOTTS FLUID MINORS	L	1.47	95.02a	509.02b	11.60b	3.70a	130.72a	38.74b
GBJ1	L	2	119.84a	1037.28a	12.31ab	3.82a	209.16a	54.67a
MINORS	L	1.5						
FOLIAR	L	2	109.10a	333.66b	12.51ab	3.95a	87.16a	57.73a
MINORS	L	1.5						
QUELANT K	L	2	117.98a	407.95b	11.89b	3.80a	142.91a	53.80a
MINORS	L	1.5						
QUELANT K	L	2	95.11a	270.57b	12.19ab	3.55a	65.46a	40.47b

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

Phytotoxicity Evaluations of Selected Preemergence Herbicides

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

This study was conducted on a simulated putting green (*Poa annua*/A4 creeping bentgrass) at the Valentine Turfgrass Research Center, Penn State University, University Park, PA. The objective of the study is to determine the phytotoxicity on creeping bentgrass of selected herbicides applied in the late summer for the preemergence control of *Poa annua*.

Methods and Materials

This study was a randomized complete block design with three replications. All of the treatments were applied on Sept 10, 2003 using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two, flat fan, 11004 nozzles at 40 psi.

Results and Discussion

Ratings taken on April 4, 2003 revealed that no phytotoxicity was evident (Table 1).

Table 1. Rating of phytotoxicity of a simulated *Poa annua*/A4 creeping bentgrass putting green on 4/4/03.

Treatment	Form	Rate (lb ai/A)	Phyto 4/4/03
DIMENSION	40WP	0.125	10.0[1]
DIMENSION	40WP	0.25	10.0
DIMENSION	40WP	0.5	10.0
CHECK			10.0
DIMENSION	1EC	0.125	10.0
DIMENSION	1EC	0.25	10.0
DIMENSION	1EC	0.5	10.0
BETASAN	4EC	12.5	10.0

1 - 0 = worst, 7 = acceptable, and 10 = no phytotoxicity

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Phytotoxicity Evaluation of Selected Herbicides on Creeping Bentgrass, Kentucky Bluegrass, and Perennial Ryegrass

Dr. T. L. Watschke and J. A. Borger[1]

Introduction

Three different studies to evaluate phytotoxicity were conducted on stands of mature fairway height "Seaside II" creeping bentgrass (*Agrostis stolonifera*), a mixed home lawn stand of 33.3% "Touchdown", 33.3% "Washington", and 33.3% "Liberator" Kentucky Bluegrass (*Poa prantensis*), and a home lawn stand of perennial ryegrass (*Lolium perenne*) (variety unknown) at the Valentine Turfgrass Research Center, Penn State University, University Park, PA. The objective of the study was to determine the phytotoxicity of selected herbicides on these turfgrasses.

Methods and Materials

The studies were a randomized complete block design with three replications. All of the treatments were applied on June 5, July 10, and September 4, 2003 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi.

The creeping bentgrass was mowed with a reel mower at one half inch with clippings removed and the Kentucky bluegrass and perennial ryegrass were mowed at two inches with a rotary and clippings returned to the site.

Results and Discussion

An array of chemical treatments were evaluated for their phytotoxicity on three turfgrass species (Kentucky bluegrass, perennial ryegrass, and creeping bentgrass). Three applications dates were used (6/5, 7/10, and 9/4) and phytotoxicity was rated 17 times during the course of the experiment. Unacceptable phytotoxicity was found for application of Quick Silver T & O at 0.062 lbs ai/A with and without MSO on June 6, 9, and 12 (Table 1). Quicksilver T & O at 0.031 lbs ai/A plus either Horsepower/Eliminate at 3 pt/A or Chaser 2 at 3.5 pt/A caused unacceptable phytotoxicity on June 9, 12, 19, and 26. In fact, Quick Silver T & O alone at 0.031 lbs ai/A was the only treatment rated on 6/12 that did not cause unacceptable phytotoxicity on creeping bentgrass. As the season progressed, the injury to creeping bentgrass, overall, was less severe, however, some treatments applied even in the fall were rated as unacceptable (including the bentgrass formulation of Trimec on September 8, 11, 18, and October 1). The only treatment that did not cause unacceptable phytotoxicity on any rating date was Quick Silver T & O applied at 0.031 lbs ai/A. Therefore, use of the tested products for broadleaf weed control in creeping bentgrass should only be done using extreme caution or not at all. Applications of the herbicides to Kentucky bluegrass resulted in improved safety compared to creeping bentgrass (Table 2). Only Quick Silver T & O plus MSO caused unacceptable phytotoxicity (Table 2). However, this injury was not found for applications made in September. Perennial ryegrass exhibited tolerance of the tested herbicides similar to Kentucky bluegrass (Table 3). Again, none of the applications in September caused phytotoxicity to perennial ryegrass.

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Table 1. Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**		**(-----------Phytotoxicity------)**		
		Rate (pt/A)	**06-06**	**06-09**	**06-12**
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	6.0	5.0	6.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	5.3	3.7	5.3
MSO	L	0.25 % V/V			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.7	6.7	6.0
TRIMEC BENTGRASS	L	4			
CHECK			10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	8.3	5.7	4.3
HORSEPOWER/ELIMINATE	L	3 PT/A			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	7.3	6.0	4.7
CHASER 2	L	3.5			
TRIMEC BENTGRASS	L	4	10.0	6.7	6.7
HORSEPOWER/ELIMINATE	L	3	9.7	7.3	5.3
CHASER 2	L	3.5	8.7	7.0	5.7

Table 1 (continued). Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**		**(-----------Phytotoxicity------)**		
		Rate (pt/A)	**06-19**	**06-26**	**07-02**
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	9.7	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	7.0	9.7	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	6.0	7.7	9.3
MSO	L	0.25 % V/V			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	6.0	9.3	9.3
TRIMEC BENTGRASS	L	4			
CHECK			10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	5.0	6.0	8.7
HORSEPOWER/ELIMINATE	L	3 PT/A			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	4.3	6.0	9.0
CHASER 2	L	3.5			
TRIMEC BENTGRASS	L	4	7.0	8.7	10.0
HORSEPOWER/ELIMINATE	L	3	5.3	7.7	9.0
CHASER 2	L	3.5	5.3	9.0	9.7

Table 1 (continued). Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 07-11	07-14	07-17
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.7	9.3	9.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	8.3	6.0	8.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	7.7	5.0	6.0
QUICKSILVER T&O TRIMEC BENTGRASS	1.9EW L	0.031 lb ai/A 4	9.7	8.0	9.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	9.0	7.7	8.3
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	8.3	7.3	6.0
TRIMEC BENTGRASS	L	4	9.0	8.3	9.0
HORSEPOWER/ELIMINATE	L	3	9.3	8.0	8.0
CHASER 2	L	3.5	9.3	8.0	7.7

Table 1 (continued). Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 7-31	9-5	9-8
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0	10.0	9.3
QUICKSILVER T&O TRIMEC BENTGRASS	1.9EW L	0.031 lb ai/A 4	10.0	10.0	5.7
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	10.0	10.0	6.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0	10.0	5.3
TRIMEC BENTGRASS	L	4	10.0	10.0	5.7
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	6.0
CHASER 2	L	3.5	10.0	10.0	5.0

Table 1 (continued). Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**	**Rate (pt/A)**	**(-----------Phytotoxicity------)** 9-11	9-18	10-1
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	9.7	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	9.3	10.0	10.0
QUICKSILVER T&O TRIMEC BENTGRASS	1.9EW L	0.031 lb ai/A 4	4.7	5.0	6.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	6.0	6.0	7.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	4.0	4.7	5.3
TRIMEC BENTGRASS	L	4	5.3	5.7	6.3
HORSEPOWER/ELIMINATE	L	3	6.0	6.0	7.0
CHASER 2	L	3.5	4.0	4.0	5.7

Table 1 (continued). Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**	**Rate (pt/A)**	**(--Phytotoxicity-)** 10-10	10-17
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	9.3	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	9.0	10.0
QUICKSILVER T&O TRIMEC BENTGRASS	1.9EW L	0.031 lb ai/A 4	7.3	10.0
CHECK			10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	7.0	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	6.3	10.0
TRIMEC BENTGRASS	L	4	7.7	10.0
HORSEPOWER/ELIMINATE	L	3	7.0	10.0
CHASER 2	L	3.5	6.0	10.0

Table 2. Evaluations of home lawn height Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**	**Rate (pt/A)**	**(-----------Phytotoxicity------)** 06-06	06-09	06-12
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	9.3	9.7
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	9.3	9.3
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0	6.0	6.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	10.0	9.7	9.3
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	10.0	9.3	9.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0	9.0	8.0
TRIMEC CLASSIC	L	4	10.0	9.7	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	9.7	9.3
CHASER 2	L	3.5	10.0	9.7	9.3

Table 2 (continued). Evaluations of home lawn height Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**	**Rate (pt/A)**	**(-----------Phytotoxicity------)** 06-19	07-02	07-11
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.3	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	8.7	10.0	9.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	7.3	10.0	8.3
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	9.0	10.0	9.7
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	8.3	10.0	9.7
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	7.3	10.0	9.7
TRIMEC CLASSIC	L	4	8.7	10.0	9.7
HORSEPOWER/ELIMINATE	L	3	9.3	10.0	10.0
CHASER 2	L	3.5	9.0	10.0	9.3

Table 2 (continued). Evaluations of home lawn height Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form		(-----------Phytotoxicity------)		
		Rate (pt/A)	07-14	07-17	7-31
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.0	9.7	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	6.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	5.0	8.3	10.0
MSO	L	0.25 % V/V			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.3	10.0	10.0
TRIMEC CLASSIC	L	4			
CHECK			10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.3	9.3	10.0
HORSEPOWER/ELIMINATE	L	3 PT/A			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.0	9.7	10.0
CHASER 2	L	3.5			
TRIMEC CLASSIC	L	4	9.7	9.7	10.0
HORSEPOWER/ELIMINATE	L	3	9.7	10.0	10.0
CHASER 2	L	3.5	9.3	8.7	10.0

Table 2 (continued). Evaluations of home lawn height Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form		(-----------Phytotoxicity------)		
		Rate (pt/A)	9-5	9-8	9-11
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	9.0	10.0
MSO	L	0.25 % V/V			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
TRIMEC CLASSIC	L	4			
CHECK			10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3 PT/A			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
CHASER 2	L	3.5			
TRIMEC CLASSIC	L	4	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	10.0
CHASER 2	L	3.5	10.0	10.0	10.0

Table 2 (continued). Evaluations of home lawn height Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 9-18	10-1	10-10
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0	10.0	10.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	10.0	10.0	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0	10.0	10.0
TRIMEC CLASSIC	L	4	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	10.0
CHASER 2	L	3.5	10.0	10.0	10.0

Table 2 (continued). Evaluations of home lawn height Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	Phytotoxicity 10-17
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	10.0
CHECK			10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0
TRIMEC CLASSIC	L	4	10.0
HORSEPOWER/ELIMINATE	L	3	10.0
CHASER 2	L	3.5	10.0

Table 3. Evaluations of home lawn height perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 06-06	06-09	06-12
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0	10.0	10.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	10.0	10.0	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0	10.0	10.0
TRIMEC CLASSIC	L	4	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	10.0
CHASER 2	L	3.5	10.0	10.0	10.0

Table 3 (continued). Evaluations of home lawn height perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 06-19	07-02	07-11
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.3	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	9.7	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0	10.0	10.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	8.7	10.0	10.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	6.3	10.0	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	9.3	10.0	10.0
TRIMEC CLASSIC	L	4	9.3	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	8.3	10.0	10.0
CHASER 2	L	3.5	8.7	10.0	10.0

Table 3 (continued). Evaluations of home lawn height perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 07-14	07-17	7-31
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	9.7	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	7.3	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	6.0	10.0	10.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	9.7	10.0	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0	10.0	10.0
TRIMEC CLASSIC	L	4	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	10.0
CHASER 2	L	3.5	9.7	10.0	10.0

Table 3 (continued). Evaluations of home lawn height perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	Form	Rate (pt/A)	(-----------Phytotoxicity------) 9-5	9-8	9-11
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O MSO	1.9EW L	0.062 lb ai/A 0.25 % V/V	10.0	10.0	10.0
QUICKSILVER T&O TRIMEC CLASSIC	1.9EW L	0.031 lb ai/A 4	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
QUICKSILVER T&O HORSEPOWER/ELIMINATE	1.9EW L	0.031 lb ai/A 3 PT/A	10.0	10.0	10.0
QUICKSILVER T&O CHASER 2	1.9EW L	0.031 lb ai/A 3.5	10.0	10.0	10.0
TRIMEC CLASSIC	L	4	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	10.0
CHASER 2	L	3.5	10.0	10.0	10.0

Table 3 (continued). Evaluations of home lawn height perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**	**Rate (pt/A)**	**(-----------Phytotoxicity------)** 9-18	10-1	0-10
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0	10.0	10.0
MSO	L	0.25 % V/V			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
TRIMEC CLASSIC	L	4			
CHECK			10.0	10.0	10.0
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3 PT/A			
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0	10.0	10.0
CHASER 2	L	3.5			
TRIMEC CLASSIC	L	4	10.0	10.0	10.0
HORSEPOWER/ELIMINATE	L	3	10.0	10.0	10.0
CHASER 2	L	3.5	10.0	10.0	10.0

Table 3 (continued). Evaluations of home lawn height perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best.

Treatment	**Form**	**Rate (pt/A)**	**Phytotoxicity** 10-17
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0
QUICKSILVER T&O	1.9EW	0.062 lb ai/A	10.0
MSO	L	0.25 % V/V	
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0
TRIMEC CLASSIC	L	4	
CHECK			10.0
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0
HORSEPOWER/ELIMINATE	L	3 PT/A	
QUICKSILVER T&O	1.9EW	0.031 lb ai/A	10.0
CHASER 2	L	3.5	
TRIMEC CLASSIC	L	4	10.0
HORSEPOWER/ELIMINATE	L	3	10.0
CHASER 2	L	3.5	10.0

Preemergence Control of Smooth Crabgrass

Dr. T. L. Watschke and J. A. Borger [1]

Introduction

Preemergence control of smooth crabgrass (*Digitaria ischaemum*) was evaluated on a mature stand of “Midnight” Kentucky bluegrass (*Poa pratensis*), at the Valentine Turfgrass Research Center, Penn State University, University Park, PA. The objective of the study was to determine the efficacy of selected preemergence herbicides for the control of smooth crabgrass.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on April 29, 2003 (PRE) and some treatments were applied on June 10, 2003 (6WAT) using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two, flat fan, 11004 nozzles at 40 psi. After application the entire test site received approximately 0.5 inch of water. On May 20, 2003, 0.5 lb N/M was applied from urea and 0.5 lb N/M from a 31-0-0 IBDU fertilizer was applied to the test site. The site was mowed two times per week with a rotary mower at one inch with clippings returned to the site.

Smooth crabgrass germination was first noted in the test site on May 1, 2003. Control was rated on August 5, 2003.

Results and Discussion

No phytotoxicity was noted from the application of any of the treatments. Acceptable control (85% or above) was determined for the following treatments; Dimension Ultra 40WP at 0.25 lbs ai/A followed by another 0.25 lbs ai/A six weeks later, Dimension Ultra 40WP at 0.5 lbs ai/A, Pendulum 3.8CS at 1.5 lbs ai/A followed by another 1.5 lbs ai/A six weeks later, Barricade 65WDG at 0.325 lbs ai/A followed by another 0.325 lbs ai/A six weeks later, Barricade 65WDG at 0.65 lbs ai/A, Barricade 4FL at 0.325 lbs ai/A followed by another 0.325 lbs ai/A six weeks later, and Barricade 65WDG and 4FL at 0.5 lbs ai/A followed six weeks later with 0.25 lbs ai/A (Table 1).

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Table 1. Evaluations of the percent control of smooth crabgrass taken on Aug 15, 2003. Commercially acceptable control was considered to be 85% and above.

Treatment	**Form**	**Rate (lbs ai/A)**	**Timing**	**% Control**
DIMENSION ULTRA	40WP	0.25	PRE/6WAT	96.0
DIMENSION ULTRA	40WP	0.5	PRE	90.0
PENDULUM	3.3EC	3	PRE	68.3
PENDULUM	3.3EC	1.5	PRE/6WAT	76.7
PENDULUM	3.8CS	3	PRE	75.0
PENDULUM	3.8CS	1.5	PRE/6WAT	95.0
BARRICADE	4FL	0.75	PRE	83.3
CHECK				0.0
BARRICADE	4FL	0.65	PRE	80.0
BARRICADE	4FL	0.325	PRE/6WAT	88.3
BARRICADE	65WDG	0.75	PRE	83.3
BARRICADE	65WDG	0.65	PRE	88.3
BARRICADE	65WDG	0.325	PRE/6WAT	96.0
BARRICADE	65WDG	0.5/0.25	PRE/6WAT	95.0
BARRICADE	4FL	0.5/0.25	PRE/6WAT	94.3
BETASAN	4EC	9.4 OZ/M	PRE	68.3
BETASAN	4EC	7.3 OZ/M	PRE	53.3
BETASAN	4EC	4.4/2.9 OZ/M	PRE/6WAT	65.0

Plant Growth Regulator Assessment of Macro-Sorb Foliar and Its Impact on the Photosynthetic Efficiency of Perennial Ryegrass (*Lolium perenne* L.) Exposed to Heat Stress

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Funding Sources: Bioiberica Corporation (Barcelona, Spain), Nutramax Labs, and the Pennsylvania Turfgrass Council.

Introduction

Applications of biostimulant products such as Macro-Sorb Foliar are fairly common throughout the golf course industry. The value and use of these products has been based primarily on practitioner and company testimonials, and has typically lacked objective research conducted by universities and/or other independent research facilities. In addition, much of the work done to assess the potential benefits of biostimulant products is often conducted in non-replicated and highly variable field settings. Consequently, the research reported on here-in was conducted in highly controlled growth chambers. The preliminary objective was to determine if one biostimulant, Macro-Sorb (Foliar), would exhibit plant growth regulating activity *in vitro* using carefully selected plant materials highly sensitive to a specific natural plant growth hormone. The next objective was to determine the impact of Foliar applications on the photosynthetic efficiency of perennial ryegrass (*Lolium perenne* L.) exposed to heat stress. All research was conducted at the Agricultural Science and Industries Building, Penn State University, University Park, PA.

Materials and Methods

The plant growth hormones most commonly documented in the literature for stress tolerance enhancing attributes are auxins and cytokinins (Schmidt, 1999). Therefore, bioassays were conducted for both auxin and cytokinin to assess the capability of Foliar to elicit responses consistent with these two natural plant growth regulators. Each experiment included nitrogen controls to evaluate whether the plant responses measured, either *in vivo* or *in vitro*, were due to any factor other than nitrogen. The nitrogen associated with Foliar is in the form of amide groups from amino acids, which is a minimal amount of nitrogen when applied at the 2 oz/1000ft^2 recommended rates.

[1] PhD Candidate, Professor of Turfgrass Science, and Associate Professor of Crop Physiology respectively.

Auxin activity was assessed using the *Avena* (oat) first internode straight growth bioassay. The cultivar 'Brighton' was selected because of its high degree of sensitivity to auxin. Oat seedlings were grown in the dark for 7 days and excised into 3 mm segments near the coleoptilar node. Plant materials were incubated in solutions with different concentrations of auxin in order to develop a standard curve. Excised segments were also treated with either Foliar (5µl/ml), or a nitrogen control (16mM NH_4^+ + NO_3^-). The growth of each segment was measured to nearest 0.1 mm.

Cytokinin activity was assessed using the *Raphanus* (radish) cotyledon expansion bioassay. The cultivar 'Cherry Belle' was selected because of its high degree of sensitivity to cytokinins. Radish seeds were germinated in complete darkness for 35 hours and uniform cotyledons were excised. The cotyledons were incubated in solutions with different concentrations of zeatin (cytokinin) to develop a standard curve. In addition, cotyledons were treated with either Foliar (5µl/ml), or a nitrogen control (16mM NH_4^+ + NO_3^-). Each cotyledon was blotted dry, and weighed to the nearest mg. Both bioassay experiments were statistically analyzed using regression analysis and the means were separated using Tukey's Honestly Significant Difference (HSD).

Growth chamber experiments were conducted to assess the impact of Foliar treatments on the photosynthetic efficiency of perennial ryegrass during exposure to high temperatures (36^{o}C). A perennial ryegrass blend (Cutter, Express, and Edge) was established in the greenhouse and grown in 4" diameter pots filled with Mapleton sand. A sand rootzone was chosen to eliminate variability due to soil factors. Plants were then placed in a growth chamber maintained at 20, 28, or 36^{o}C. Heat was chosen as the stress treatment due to the high degree of control, and growth chambers were programmed to reach their maximum temperature for 5 hrs per day.

The growth chamber experiment was analyzed as a split-plot design with 3 replications per treatment per chamber. Treatments were applied at 3 day intervals for 2 weeks prior to being placed in the growth chambers and then during heat exposure (21 days). The treatments consisted of Foliar (F) (2 oz/1000ft^2), Foliar + Hoagland's nutrient solution (F+NS), nutrient solution + nitrogen to match the N content of Foliar (NS+N), and nitrogen to match that in Foliar (60 ml NH_4^+ /1000ft^2) (N).

Photosynthetic efficiency measurements (Fv/Fm ratio) were taken every 3 days using the PAM-2000™ fluorometer. The fluorometer records the variable fluorescence divided by the maximum fluorescence, and effectively measures how efficiently electrons are being transported during the light reactions of photosynthesis. Photochemical efficiency dictates carbon dioxide fixation and ultimately sugar production. These sugars are then utilized by the plant for vital metabolic processes, or are stored as non-structural carbohydrates which might be used at a later time to improve high temperature stress tolerance.

Results and Discussion

Bioassay results revealed that Foliar exhibited plant growth regulator (PGR) activity *in vitro*. Foliar treated oat hypocotyls exhibited significantly more auxin response than untreated plant material in all trials (Figure 1.).

Auxin Bioassay (Foliar plus Nitrogen Controls)

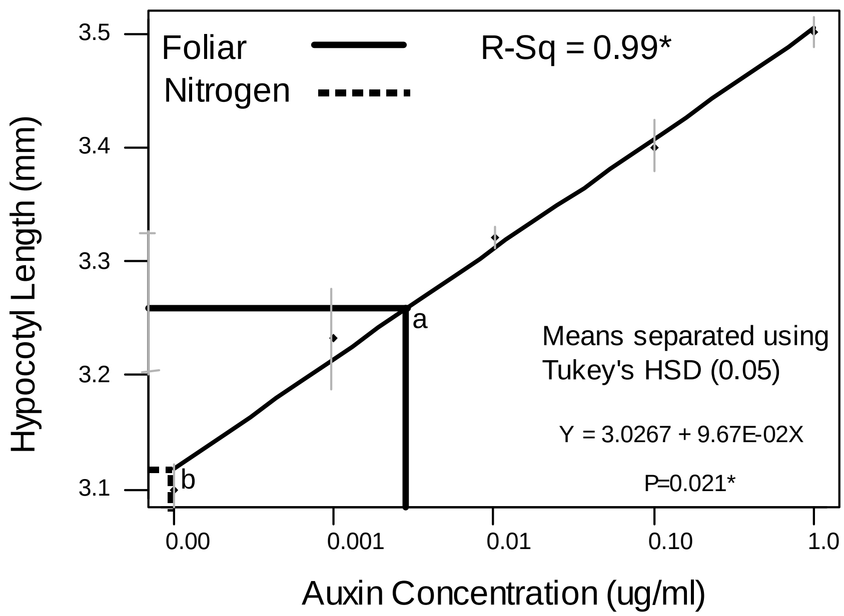

Figure 1.

Conversely, Foliar treated radish cotyledons did not respond differently than untreated control tissue for all trials (Figure 2). Based on these results, it is possible that Foliar contains some chemically active compound(s) responsible for cell elongation and growth, similar to auxin, but different than a typical nitrogen response. In addition to growth regulating activity, a potentially active compound(s) might also be contributing to improved metabolic performance during stress. Unlike plant growth regulators that slow growth, a compound with auxin-like activity, applied at the proper dose, might enhance vital metabolic processes allowing plants to better withstand abiotic stresses such as drought, heat, or salinity. Such a response would be very different than that which is caused by auxin containing herbicides like 2,4-D. These experiments illustrate the need for further research in this area, which should include fractionating Foliar based on solubility in order to identify the chemical properties of the compound(s) with biological activity.

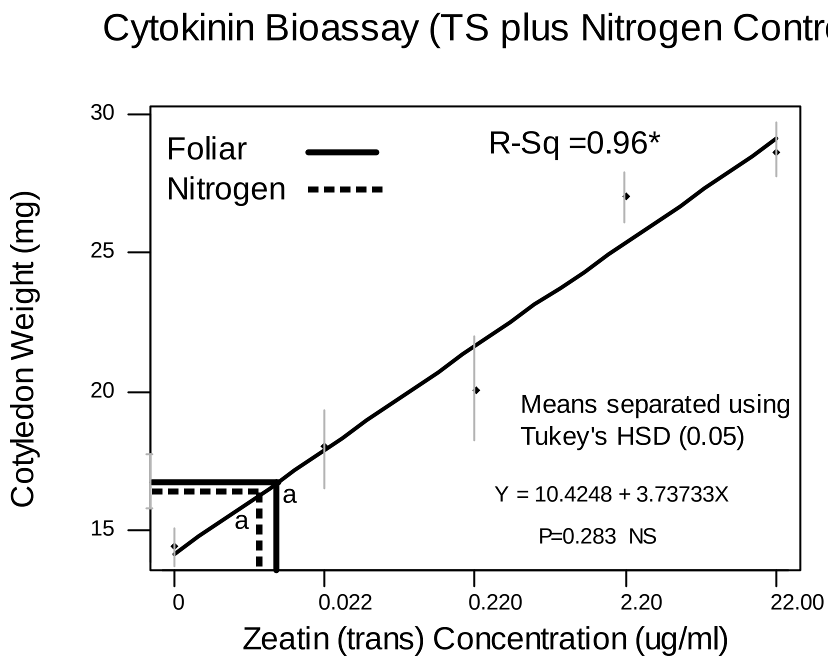

Figure 2.

The growth chamber experiment results indicated that there was a significant treatment main effect of Foliar on leaf photosynthetic efficiency (Figure 3.). In addition, a significant interaction between temperature and treatment was found (Table 1.). As temperature increased, plants treated with Foliar exhibited significantly greater photosynthetic efficiency than the nitrogen or nutrient solution plus nitrogen controls. These results are consistent with earlier studies (Zhang and Schmidt, 2000) which assessed the efficacy of biostimulants, showing that treatment differences and product effectiveness become most evident when plans are subjected to an abiotic stress treatment.

Table 1.

Source	DF	Type I SS	Mean Sq	F value	Pr>F
Temp	2	0.02409268	0.01204634	51.72	<.0001
Treatment	3	0.01645746	0.00548582	23.55	<.0001
Trt*Temp	6	0.00461047	0.00076841	3.30	0.0045
Time	5	0.00911286	0.00182257	7.83	<.0001
Trt*time	15	0.00558624	0.00037242	1.60	0.0807
Trt*temp*time	40	0.01461285	0.00036532	1.57	0.0290

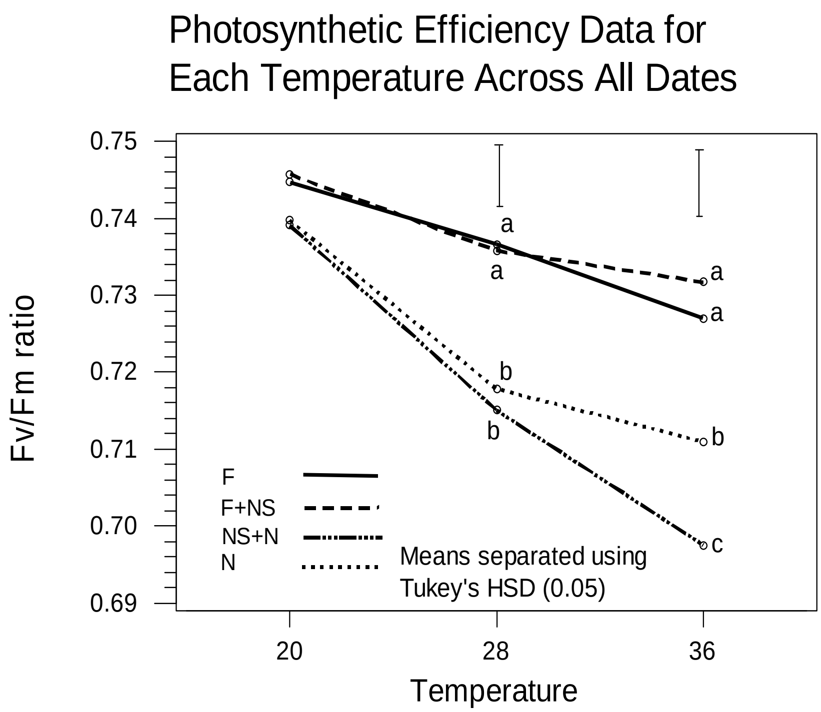

Figure 3.

Improved Fv/Fm ratios indicate that chloroplast light harvesting and reaction center electron transfer functioned more efficiently for perennial ryegrass treated with Foliar, compared to the control. No treatment benefit was evident in plants grown at 20^{o}C, indicating that the potentially active compound(s) contained within Foliar are most effective when plants are subjected to heat stress, or are not useful at non-stressing temperatures. These results also indicated that responses to Foliar were not as a result of nitrogen. It appears that Foliar should be used as a supplement to an already existing, sound agronomic fertility program, rather than substitute. Plants treated with Foliar and exposed to heat stress exhibited positive responses such as better overall quality, color, and slower leaf senescence. These results will be verified and quantified in future experiments. Possible explanations for the higher Fv/Fm ratios and improved turf quality include improved metabolism and antioxidant production, less degradation of leaf chlorophyll a and b, and better membrane thermostability in leaf tissue during heat stress.

Conclusions

This study produced supporting evidence for a positive growth regulating effect of Macro-Sorb Foliar *in vitro*. In addition, applications of Foliar improved the heat tolerance of perennial ryegrass (photosynthetic efficiency and overall quality), indicating that Foliar might contain some biologically active compound(s) responsible for the abiotic stress tolerance enhancement of perennial ryegrass. Whether these two findings are directly related has yet to be determined. Future work will focus on a comprehensive analysis and fractionation of Foliar, using different bioassays and high performance liquid chromatography (HPLC). Application management of Foliar will be studied to determine best management practices for turfgrass practitioners (specifically, to determine the effect of sequential applications prior to stress compared to applications at the onset of stress). Further work will also lead to a better understanding of the mechanisms of action of Foliar, and to its practical use as a viable growth regulating/abiotic stress tolerance enhancing biostimulant for the turfgrass industry.

References

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X Zhang, and RE Schmidt. 2000. Hormone-Containing Products' Impact on Antioxidant Status of Tall Fescue and Creeping Bentgrass Subjected to Drought. *Crop Science*. 40:1344-1349.

Bluegrass Billbug Suppression with Merit and Tempo

By P.R. Heller and R. Walker, Department of Entomology

This study was undertaken to determine suppression of bluegrass billbug (BGB) on turfgrass maintained at Penn State's Valentine Turfgrass Research Center at University Park. The turfgrass area consisted primarily of Kentucky bluegrass (100%). Treatment plots were 6 x 5 ft, arranged in a RCB design and replicated three times. A one ft barrier was located between each replicate and block. Liquid formulations were applied at the rate of 2 gal/1,000 ft^2 (227 ml water per 30 ft^2) using a CO_2 compressed air sprayer with four 8002VS TeeJet nozzles mounted on a six ft boom operating at 28 psi. At treatment time one (6 May), the following environmental conditions existed: air temp, 44°F; soil temp at l inch depth, 44°F; soil temp at 2 inch, 46 F; RH, 80%; amt of thatch, 1.0 inch; water pH, 7.0; application time, early morning; soil, very moist; thatch, moist; and partly cloudy skies. All treatments received 0.2 inch of rainfall at 7:30 AM on 7 May. General soil conditions were as follows: soil textural class, silt loam; soil particle size analysis: sand, 18.1%; silt, 58.5%; clay, 23.4%; soil percent water content (percent by wt), 20.2; organic matter, 4.0%; CEC, 8.1; and soil pH, 7.0. At treatment time two (7 Jun), the following environmental conditions existed: air temp, 54°F; soil temp at l inch depth, 52°F; soil temp at 2 inch, 52°F; RH, 90%; amt of thatch, 1.0 inch; water pH, 7.0; application time, early morning; soil, wet; thatch, wet; and cloudy skies. General soil conditions were as follows: soil textural class, silt loam; soil particle size analysis: sand, 18.3%; silt, 66.0%; clay, 15.7%; soil percent water content (percent by wt), 23.6; organic matter, 4.5%; CEC, 12.9; and soil pH, 6.5. All treatments were irrigated in with 0.1 inch of water immediately after treatment. Adult billbugs were actively recovered from pitfall traps positioned at the experimental site prior to treatment on 6 May. Post treatment counts were made on 14 Jul. Two four inch cup cutter sod samples were randomly taken from each replicate. The total number of BGB larvae recovered from two four inch cup cutter sod samples were recorded and converted to a ft^2 count. Data was analyzed by using WD.

All treatments provided significant reduction of BGB when compared to the untreated check. Merit 75WP applied at 0.3 lb AI/A when adults were first active provided the most reduction of billbugs. No phytotoxicity was noted.

Treatment/ formulation	Rate lb (AI)/acre	Avg no. BGB larvae/ft^2 14 Jul	(% Reduction)
Untreated check	---	34.5 a	---
Merit 75WP [a]	0.3	1.9 b	(94.5)
Merit 75WP [a]	0.4	11.5 b	(66.7)
Tempo Ultra [a]	0.092	7.7 b	(77.7)
Merit 75WP [b]	0.3	7.7 b	(77.7)
Merit 75WP [b]	0.4	11.5 b	(66.7)

Means followed by the same letter are not significantly different (P = 0.05; WD).

[a] Treatments applied on 6 May.
[b] Treatment applied on 7 Jun.

(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Management of White Grubs with Imidacloprid and Curative Management of White Grubs with Trichlorfon

By P.R. Heller and R. Walker, Department of Entomology

This experiment was conducted on a golf course rough located in Beaver Falls which was infested with a natural population of Japanese beetle (JB) and Northern masked chafer (NMC) white grubs to determine the effectiveness of formulations applied at different application timing intervals. The turfgrass area consisted primarily of perennial ryegrass (50%) and annual bluegrass (50%). Treatment plots were 8 x 6 ft, arranged in a RCB block design and replicated three times. Liquid formulations were applied by using a CO_2 sprayer with four 8002VS TeeJet nozzles mounted on a 6 ft boom, operating at 28 psi, and applied in 726 ml of water/48 ft^2 or delivering 4.0 gal/1000 ft^2. Granular formulations were applied with a hand-held shaker and mixed with fine top dressing sand to facilitate product distribution. At treatment time one (26 Jun) the following soil and environmental conditions existed: air temp, 75°F; soil temp at l inch depth, 74°F; soil temp at 2 inch, 73°F; RH, 85%; amt of thatch, 0.125 – 0.25 inch; percent water content (percent by wt), 26.0; soil textural class, silt loam; soil particle size analysis: 33.8% sand, 62.3% silt, 3.9% clay; organic matter, 4.9%; CEC, 11.4; and soil pH, 4.7; soil dry; thatch dry ; water pH, 7.0; application time, mid-morning; and cloudy skies. Immediately after application treatments were irrigated in with 0.5 inch of water. At treatment time two (18 Jul) the following soil and environmental conditions existed: air temp, 72°F; soil temp at l inch depth, 71°F; soil temp at 2 inch, 70°F; RH, 80%; amt of thatch, 0.125 – 0.25 inch; percent water content (percent by wt), 17.3; soil textural class, silt loam; soil particle size analysis: 11.0% sand, 77.8% silt, 11.2% clay; organic matter, 4.8%; CEC, 11.2; and soil pH, 4.7; soil dry; thatch moist ; water pH, 7.0; application time, early morning; and cloudy skies. Immediately after application treatments were irrigated in with 0.5 inch of water. Northern masked chafer eggs were present. At treatment time three (16 Aug) the following soil and environmental conditions existed: air temp, 78°F; soil temp at l inch depth, 70°F; soil temp at 2 inch, 68°F; RH, 90%; amt of thatch, 0.125 – 0.25 inch; percent water content (percent by wt), 18.3 soil textural class, silt loam; soil particle size analysis: 10.4% sand, 76.4% silt, 13.2% clay; organic matter, 5.2%; CEC, 10.1; and soil pH, 5.0; soil moist; thatch moist; water pH, 7.0; application time, early morning; and overcast skies. Immediately after application treatments were irrigated in with 0.4 inch of water. The experimental area was previously infested in the spring of 2002 with populations of NMC and a few JB grubs. Pre-treatment counts recorded on 26 Apr averaged 20.7 third instar NMC grubs per ft^2. White grub populations were negatively impacted by the extreme drought and emergency water restrictions placed on township residents which prevented regular irrigation. Second instar NMC grubs were present on 16 Aug. The experimental area was irrigated on a regular basis throughout the summer months twice a week with ca. 0.5 inch total irrigation applied on a weekly basis. The area was under a water restriction emergency because of severe 2002 drought conditions. Three ft^2 sod samples were randomly taken from each replicate on 2 Oct, and the total no. of scarab white grubs/ft^2 was recorded according to species. Data was analyzed using WD.

Post-treatment grub counts were lower than expected because of extreme drought conditions. JB grubs populations were minimal, while the predominant white grub species present was NMC.

Both preventive Merit and curative Dylox treatments provided significant reduction of NMC and JB grubs. No phytotoxicity was noted.

		Avg no. white grubs/ft^2		
		JB Grubs	NMC Grubs	Tt[a]
Treatment/ formulation	Rate lb (AI)/acre	2 Oct	2 Oct	2 Oct
Merit 75WP[b]	0.3	0.0 b	0.0 b	0.0 b
Merit 75WP[c]	0.3	0.1 b	0.0 b	0.1 b
Dylox 6.2G[d]	8.1	0.1 b	0.0 b	0.1 b
Untreated check	---	1.1 a	7.6 a	8.7 a

Means followed by the same letter are not significantly different (P = 0.05; WD).

[a] Total number of JB and NMC white grubs.
[b] Treatments applied on 26 Jun.
[c] Treatments applied on 18 Jul.
[d] Treatments applied on 16 Aug.

(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Scarab Grub Timing Study with Applications of Dylox and Merit

By P.R. Heller and R. Walker, Department of Entomology

This experiment was conducted on turfgrass maintained at Penn State's Valentine Turfgrass Research Center which was infested with a natural population of Northern masked chafer (NMC) and Japanese beetle (JB) white grubs to determine the effectiveness of formulations applied at different intervals. The turfgrass area consisted primarily of Kentucky bluegrass (100%). Treatment plots were 9 x 6 ft, arranged in a RCB block design and replicated three times. Liquid formulations were applied by using a CO_2 sprayer with four 8002VS TeeJet nozzles mounted on a 6 ft boom, operating at 28 psi, and applied in 817 ml of water/54 ft^2 or delivering 4.0 gal/1000 ft^2. Granular formulations were applied with a hand-held shaker and mixed with fine top dressing sand to facilitate product distribution. At treatment time one (24 Jun) the following soil and environmental conditions existed: air temp, 83°F; soil temp at l inch depth, 80° F; soil temp at 2 inch, 77°F; RH, 65%; amt of thatch, 0.125 – 0.5 inch; percent water content (percent by wt), 23.5; soil textural class, silt loam; soil particle size analysis: 25.3% sand, 70.2% silt, 4.5% clay; organic matter, 3.9%; CEC, 9.9; and soil pH, 6.5; soil moist; thatch moist; water pH, 7.0; application time, late morning; and hazy skies. Immediately after application treatments were irrigated in with 0.3 inch of water. At treatment time two (16 Jul) the following soil and environmental conditions existed: air temp, 66°F; soil temp at l inch depth, 62° F; soil temp at 2 inch, 63°F; RH, 85%; amt of thatch, 0.125 – 0.5 inch; percent water content (percent by wt), 21.1; soil textural class, silt loam; soil particle size analysis: 21.4% sand, 61.8% silt, 16.8% clay; organic matter, 3.1%; CEC, 8.5; and soil pH, 5.8; soil wet; thatch wet; water pH, 7.0; application time, early morning; and cloudy skies. Immediately after application treatments were irrigated in with 0.2 inch of water followed by an additional 0.2 inch during the evening. At treatment time three (20 Aug) the following soil and environmental conditions existed: air temp, 71°F; soil temp at l inch depth, 70°F; soil temp at 2 inch, 70°F; RH, 85%; amt of thatch, 0.125 – 0.5 inch; percent water content (percent by wt), 22.3; soil textural class,silt loam; soil particle size analysis: 15.4% sand, 63.5% silt, 21.1% clay; organic matter, 4.5%; CEC, 9.6; and soil pH, 5.4; soil moist; thatch moist; water pH, 7.0; application time, early morning; and cloudy skies. Immediately after application treatments were irrigated in with 0.3 inch of water. The experimental area was previously infested in the spring of 2002 with populations of NMC and a few JB grubs. Pre-treatment counts recorded on 25 Apr averaged 11.5 third instar NMC grubs per ft^2. JB grubs populations were minimal. The predominant white grub present was NMC and all treatments provided significant reduction of NMC grubs. The first adult NMC was collected on 24 Jun 2002. Peak NMC adult flight was recorded from ca. June 24 through 15 Jul. The last NMC adult was collected on 31 Jul. Second instar NMC grubs were present in the soil on 20 Aug. The experimental area was irrigated on a regular basis throughout the summer of 2002 because of severe drought conditions. Rainfall and irrigation data was recorded, respectively, 10.27 inches between 24 Jun through 16 Jul, 10.78 inches between 17 Jul through 20 Aug, and 6.54 inches between 21 Aug through 24 Sep. Three ft^2 sod samples were randomly taken from each replicate 24 Sep, and the total no. of scarab white grubs/ft^2 was recorded according to species. Data was analyzed using WD.

No treatments provided significant reduction of JB grubs since populations were extremely low. Preventive Merit treatments provided significant control of NMC and combined white grubs present on both application dates. Dylox applied as a curative application provided significant reduction of NMC and combined white grubs. No phytotoxicity was noted.

		Avg no. white grubs/ft^2		
		JB Grubs	NMC Grubs	Tt[a]
Treatment/ formulation	Rate lb (AI)/acre	24 Sep	24 Sep	24 Sep
Merit 75WP[b]	0.3	0.0 a	0.6 b	0.6 b
Merit 75WP[c]	0.3	0.0 a	0.0 b	0.0 b
Dylox 6.2G[d]	8.1	0.2 a	1.9 b	2.1 b
Untreated check	---	0.7 a	21.0 a	21.7 a

Means followed by the same letter are not significantly different (P = 0.05; WD).

[a] Total number of JB and NMC white grubs.
[b] Treatments applied on 24 Jun.
[c] Treatments applied on 16 Jul.
[d] Treatments applied on 20 Aug.

(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Hairy Chinch Bug Suppression with Talstar EZ and Cylfluthrin

By P.R. Heller and R. Walker, Department of Entomology

This experiment was conducted to compare the effectiveness of Talstar EZ and Advanced Lawn Power Force (0.1% cyfluthrin) on a natural hairy chinch bug (HCB) population without post treatment irrigation. The turfgrass area consisted primarily of fine leafed fescue. Treatment plots were 5 x 6 ft arranged in a RCB design and replicated three times. Granular formulations were applied with a hand held shaker with top dressing sand used to provide even distribution of product. At treatment time (20 Jun) the following soil and environmental conditions existed: air temperature, 78°F; soil temperature at 1 inch depth, 76°F; soil temperature at 2 inch depth, 75°F; RH, 74%; amount of thatch, 0.75 inch; soil textural class, silt loam; soil particle size analysis: 43.6% sand, 51.6% silt, 4.8% clay; percent water content (percent by wt), 19.9%; organic matter, 5.4%; water pH, 7.0; CEC (meg/100 g), 9.4; soil pH, 5.6; application time, early afternoon; soil and thatch moist; and sunny skies. The experimental area was not irrigated after treatment. A natural occurring HCB population sampled on 20 Jun averaged 9.2 HCB life stages/ft^2. HCB first instar nymphs represented 80% of the population sampled. HCB were sampled by driving a six inch-diameter stainless steel cylinder into the turf, filling it with water, and counting the number of HCB nymphs and adults floating to the surface during a 10 min period on 11 Jul (21 DAT). Two floatation samples were taken randomly from each replicate, and the total number of HCB from each sample was recorded and converted to a ft^2 count.

Posttreatment counts completed on 11 Jul indicated that both treatments, respectively Talstar EZ and Advanced Lawn Power Force Multi-Insect Killer, provided significant control. No phytotoxicity was noted.

Treatment/ formulation	Rate lb (AI)/acre	Avg no. HCB/ft^2 11 Jul
Untreated check	---	29.7 a
Talstar EZ	0.1	0.8 c
Advanced Lawn Power Force Multi-Insect Killer (0.1% cyfluthrin)	0.1	17.0 b

Means followed by the same letter are not significantly different (P = 0.05, WD).
(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Black Cutworm Larval Suppression with Pyrethroids and Conserve

By P.R. Heller and R. Walker, Department of Entomology

This experiment was completed on a golf course green maintained at the Penn State Valentine Turfgrass Research Center at University Park to determine the effectiveness of treatments against second and early third instar black cutworm (BCW) larvae. Treatment plots were 6 x 6 ft, arranged in a RCB design and replicated four times. A one foot barrier was established between each replicate and block. Liquid formulations were applied by using a CO_2 sprayer with four 8002VS TeeJet nozzles mounted on a six ft boom operating at 28 psi, and applied in 272 ml water/36 ft^2 or delivering 2.0 gal/1000 ft^2. No irrigation was applied to the experimental area after application. At treatment time (8 Aug), the following soil and environmental conditions existed: air temp, 66°F; soil temp at l inch depth, 62°F; soil temp at 2 inch depth, 62°F; RH, 95%; amt of thatch, 0.75 inch; water pH, 7.0; time of application, early morning; thatch, moist; soil, moist; and cloudy skies. General soil conditions were as follows: soil textural class, sandy loam; soil particle size analysis: sand, 55.7%; silt, 37.4%; clay, 6.9%; soil percent water content (percent by wt), 17.8; organic matter, 2.6%; CEC, 8.0; and soil pH, 7.0. One eight inch diameter by six inch long white PVC cylinder was placed in each replicate and secured in place on two separate infestation dates, respectively 8 Aug and 13 Aug. Ten late second to early third instar BCW larvae were added to each cylinder. Next, each cylinder was covered with white meshed shade cloth. Efficacy data was recorded on 13 Aug and 18 Aug by counting the no. of BCW larvae flushed to the surface within one eight inch PVC cylinder per replicate by using a soap irritant drench. Data was analyzed by using WD and an Abbott's transformation.

Four treatments provided significant reduction of black cutworm on 13 Aug, while three treatments provided significant reduction on 18 Aug. Pyrethroid formulations provided the most significant reduction. No phytoxtoicity was noted.

Treatment/ formulation	Rate lb (AI)/acre	Avg no. BCW larvae flushed to surface/8 inch cylinder	
		13 Aug [abc]	18 Aug [abd]
DeltaGard GC 5SC	0.06	82.1 ab (1.2 bc)	100.0 a[e] (0.0 b)
Tempo 20WP	0.096	89.3 a (0.7 c)	100.0 a[e] (0.0 b)
Scimitar GC	0.0687	90.6 a (0.7 c)	100.0 a[e] (0.0 b)
Conserve SC	0.4028	55.8 b (3.2 b)	4.2 b[e] (7.0 a)
Untreated check	---	0.0 c (7.2 a)	0.0 c[e] (7.5 a)

Means followed by the same letter are not significantly different (P = 0.05, WD).

[a] Represents an Abbotts transformation.
[b] ( ) Represents mean no. black cutworm larvae recovered per cylinder.
[c] Infested with black cutworm larvae on 8 Aug.
[d] Infested with black cutworm larvae on 13 Aug.
[e] Abbott's data transformed to an arcsine square root percent prior to ANOVA/WD. Untransformed means are presented in the table.

(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Black Cutworm Larval Management with Talstar and Scimitar Formulations on Creeping Bentgrass

By P.R. Heller and R. Walker, Department of Entomology

This experiment was completed on a golf course green maintained at the Penn State Valentine Turfgrass Research Center at University Park to determine the effectiveness of treatments against second and early third instar black cutworm (BCW) larvae. Treatment plots were 6 x 9 ft, arranged in a RCB design and replicated four times. A one foot barrier was established between each replicate and block. Liquid formulations were applied by using a CO_2 sprayer with four 8002VS TeeJet nozzles mounted on a six ft boom operating at 28 psi, and applied in 408 ml water/54 ft^2 or delivering 2.0 gal/1000 ft^2. At treatment time (8 Jul), the following soil and environmental conditions existed: air temp, 65°F; soil temp at l inch depth, 58°F; soil temp at 2 inch depth, 60°F; RH, 65%; amt of thatch, 0.5 inch; soil textural class, silt loam; soil particle size analysis: 15.7% sand, 68.6% silt, 15.7% clay; percent water content (percent by wt), 22.7; organic matter, 4.1%; water pH, 7.0; soil pH, 6.4; CEC, 10.0; time of application, early morning; thatch and soil, moist; and clear skies. Eight inch diameter by six inch long white PVC cylinders were placed in each replicate and secured in place. The experimental area was irrigated on a regular basis. Each cylinder was covered with white meshed shade cloth. One cylinder was placed in each replicate and 10 late second to early third instar BCW larvae were added to each cylinder on 9 Jul. Efficacy data was recorded on 12 Jul by counting the no. of BCW larvae flushed to the surface within one eight inch PVC cylinder per replicate by using a soap irritant drench. Data was analyzed by using WD.

Scimitar and Talstar treatments provided significant reduction of BCW on 12 Jul (3 DAT). No phytotoxicity was noted.

Treatment/ formulation	Rate lb (AI)/acre	Mean No. of BCW larvae flushed to surface/8 inch cylinder 12 Jul
Untreated check one	---	5.5 a
Untreated check two	---	6.2 a
Talstar LTF	0.025	0.5 b
Scimitar CS	0.025	0.5 b

Means followed by the same letter are not significantly different (P = 0.05, WD).
(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Green June Beetle Grub Suppression on a Golf Course Fairway

By P.R. Heller and R. Walker, Department of Entomology

This study determined the effectiveness of Mach 2 and Merit to suppress an active population of green June beetle (GJB) grubs on a golf course fairway in Lancaster. The fairway consisted primarily of perennial ryegrass (80%) and creeping bentgrass (20%). Treatment plots were 48 ft^2 (6 x 8), arranged in a RCB design and replicated three times. Liquid formulations were applied with a CO_2 compressed air sprayer with four 8002VS TeeJet nozzles mounted on a 6 ft boom, operating at 28 psi, and applied in 726 ml of water/48 ft^2 or delivering 2 gal/1000 ft^2. At treatment time one (11 Aug), the following soil and environmental conditions existed: air temp, 81 F; soil temp at l inch depth, 80°F; soil temp at 2 inch depth, 78°F; RH, 95%; amt of thatch, 0.25 inch; water pH, 7.0; soil and thatch wet; time of treatment, early afternoon; and partly sunny skies. The experimental area received 0.31 inch of rainfall on the evening of 11 Aug. General soil conditions were as follows: soil textural class, silt loam; soil particle size analysis: sand, 22.6%; silt, 63.5%; clay, 13.9%; soil percent water content (percent by wt), 25.7; organic matter, 7.2%; CEC, 10.7; and soil pH, 5.5. At treatment time two (27 Aug), the following soil and environmental conditions existed: air temp, 86°F; soil temp at l inch depth, 81°F; soil temp at 2 inch depth, 79°F; RH, 65%; amt of thatch, 0.25 inch; water pH, 7.0; soil and thatch, moist; time of treatment, late morning; and hazy skies. General soil conditions were as follows: soil textural class, silt loam; soil particle size analysis: sand, 21.4%; silt, 63.0%; clay, 15.6%; soil percent water content (percent by wt), 22.4; organic matter, 5.2%; CEC, 9.0; and soil pH, 5.4. The experimental area was irrigated with 0.1 inch of water immediately after treatment. GJB grub populations were very high on this fairway during the fall of 2002. However, excessive rainfall in 2003 could have negatively impacted the GJB population in Sep. GJB larvae were sampled on 16 Sep by flushing larvae to the surface following an application of Sevin SL then recording the total no. of living grubs/48ft^2. Data was analyzed by using WD.

No treatments provided significant reduction of GJB grubs. Excessive rainfall could have affected efficacy results. No phytotoxicity was noted.

Treatment/ formulation	Rate lb (AI)/acre	Avg no. GJB grubs/48 ft^2 16 Sep
Mach 2 Liquid [a]	1.5	1.0 a
Mach 2 Liquid [a]	2.0	0.0 a
Merit 75WP [a]	0.3	0.0 a
Merit 75WP [b]	0.3	1.3 a
Mach 2 Liquid [b]	2.0	0.0 a
Untreated check	---	1.3 a

Means followed by the same letter are not significantly different (P = 0.05, WD).

[a] Treatments applied on 11 Aug.
[b] Treatments applied on 27 Aug.

(Note: Only use products labeled and registered for your use site and at recommended label rates. Some products are applied as experimentals.)

Nuisance Ant Management with Pyrethroid Formulations

By P.R. Heller and R. Walker, Department of Entomology

This experiment was completed on a fairway consisting of 60% annual bluegrass and 40% perennial ryegrass maintained at a golf course in Clinton Co. to determine the residual effectiveness of treatments against the destructive nuisance ant (NA). Treatment plots were 6 x 10 ft, arranged in a RCB design and replicated three times. Liquid formulations were applied by using a CO_2 sprayer with four 8002VS TeeJet nozzles mounted on a six ft boom operating at 28 psi, and applied in 454 ml of water/60 ft^2 or delivering 2.0 gal/1000 ft^2. At treatment time (24 Jun), the following soil and environmental conditions existed: air temp, 67°F; soil temp at l inch depth, 66°F; soil temp at 2 inch depth, 66°F; RH, 76%; amt of thatch, 0.875 inch; soil and thatch, moist; water pH, 7.0; time of application, mid - morning; and sunny skies. General soil conditions were as follows: soil textural class, sandy loam; soil particle size analysis: sand, 52.5%; silt, 37.5%; clay, 10.0%; soil percent water content (percent by wt), 16.0; organic matter, 2.2%; CEC, 7.4; and soil pH, 6.3. The experimental areas received 0.1 inch of irrigation 24 h after treatment. The area received excessive rainfall in 2003 as a result of an extremely wet weather trend. The fairway was infested prior to treatment and had a history of NA infestations. Efficacy data was recorded 1 Jul, 10 Jul, 17 Jul, and 22 Jul by counting the number of active mounds located within a one yd^2 wood sampling frame from each treatment replicate. Data was analyzed by using WD.

No treatments provided significant reduction on 1 Jul, 17 Jul or 22 Jul as noted. Talstar LTF provided significant reduction on 10 Jul. Residual activity and the NA population could have been negatively affected by the excessive rainfall. No phytotoxicity was noted

		Avg no. active NA mounds recorded on surface/yd^2			
Treatment/ formulation	Rate lb (AI)/acre	1 Jul	10 Jul	17 Jul	22 Jul
DeltaGard GC 5SC	0.08	5.0 a	6.0 ab	6.3 a	5.3 a
Scimitar GC	0.06875	5.3 a	6.7 ab	3.7 a	4.7 a
Talstar LTF	0.20	4.3 a	4.3 b	6.3 a	4.0 a
Tempo 20WP	0.096	5.7 a	9.3 a	6.3 a	4.7 a
Untreated check	---	7.7 a	10.0 a	6.0 a	5.3 a

Means followed by the same letter are not significantly different (P = 0.05, WD).

(Note: Only use products labeled and registered for your use site and at recommended label rates.
Some products are applied as experimentals.)

Nitrogen Rates and Forms for Maximum Quality and Growth of Penn 'A-4' Creeping Bentgrass

Maxim J. Schlossberg and Andrew S. McNitt

Introduction

Penn 'A-4' creeping bentgrass is a relatively recent release from Dr. Joe Duich's breeding program. Considered a 'high-density' bentgrass, A-4 demonstrates particularly aggressive growth habit at mowing heights of 0.1 to 0.125 inches, as well as exceptional heat and wear tolerance. In NTEP trials conducted across the country (1999-2003), A-4 performed consistently as a member of the highest statistical group (NTEP, 2004). Because A-4 is well-adapted to several geographic regions, has demonstrated good genetic stability, possesses exceptional quality for golf course putting green use, and has been installed on thousands of golf course putting greens around the world, we determined evaluation of A-4 to various fertilizer regiments to be a worthwhile effort toward development of fertilizer guidelines for Penn A-4 bentgrass.

Objectives

To identify:

- A narrow range of annual nitrogen rates (applied bimonthly) that optimize color, vigor, and stress tolerance of A-4 bentgrass
- And the potential interactive effects of nitrogen forms as components of those annual N rates

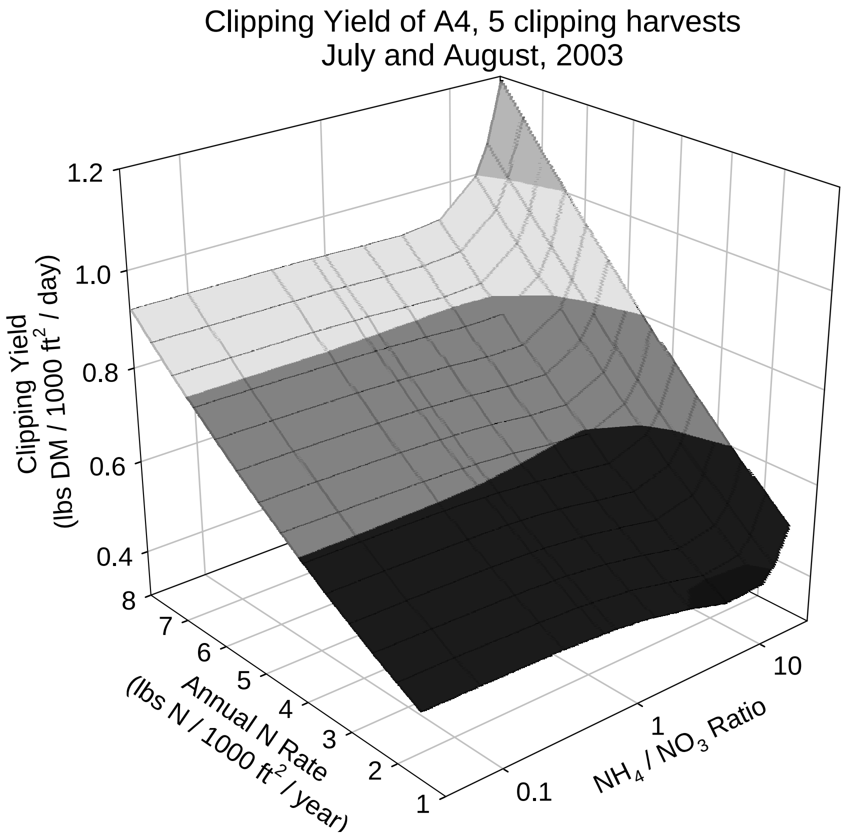
Materials and Methods

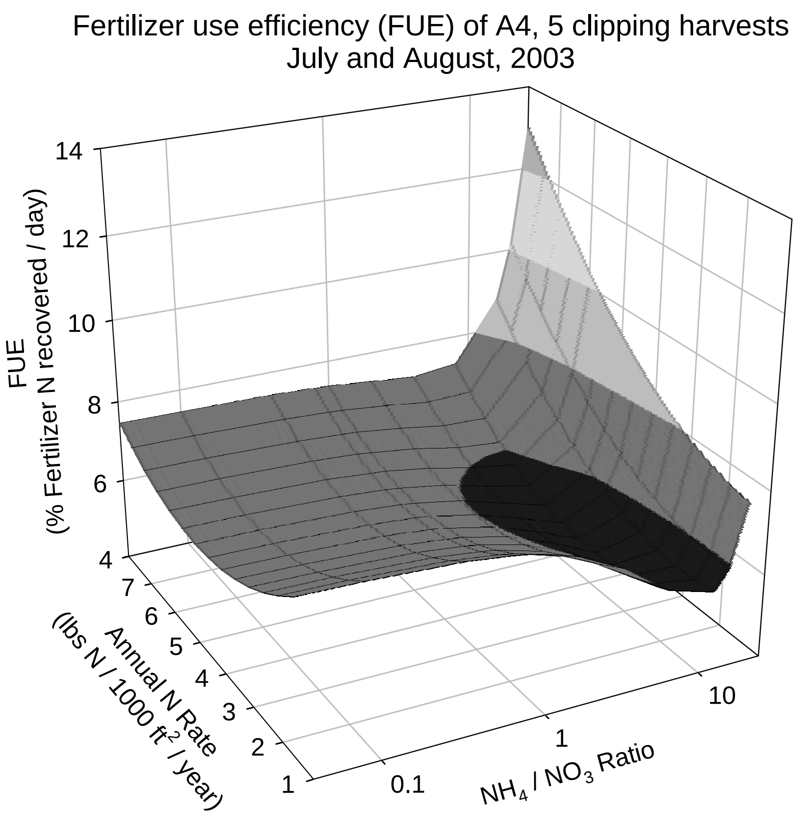
This experiment was initiated in April 2003 on a ~3,000 square feet of a 3-year-old established A-4 creeping bentgrass putting green. The green root mix is of the topdressed-pushup variety, comprised of a slightly calcareous sand (CCE ~ 10%) upper layer and an underlying Hagerstown silt loam mineral soil. Nutritional status of the upper 4" of root mix was optimal for all primary, macro-, and micro-nutrients.

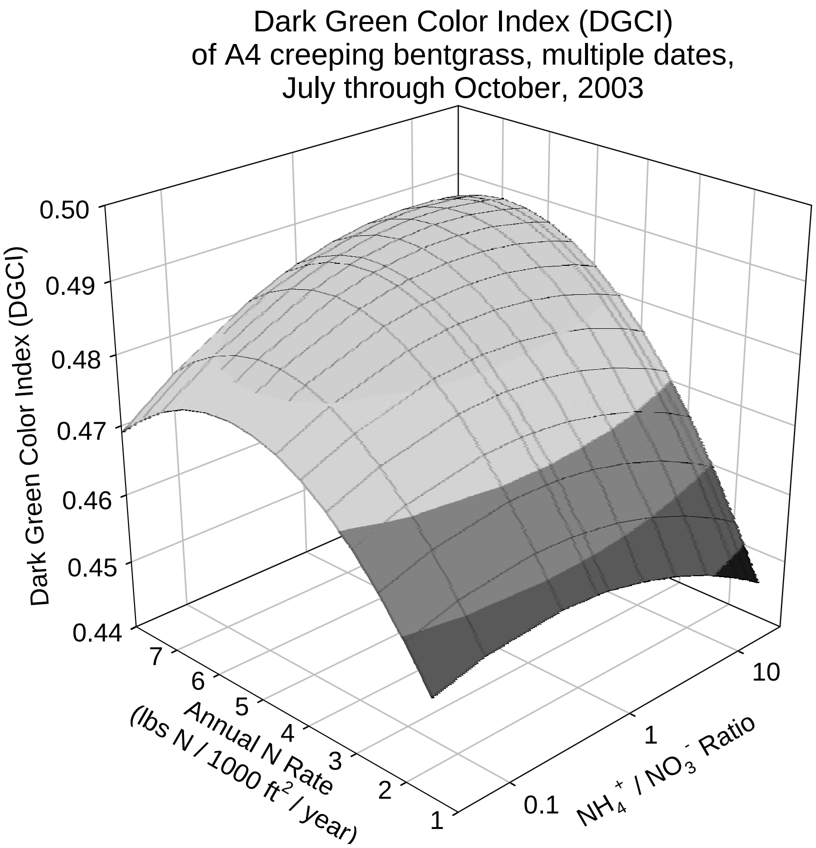
Beginning April 15, fertilizer treatments were applied every 13-16 days. The initial fertilizer treatment was comprised of 1/5 of the corresponding annual rate, and the continuous bi-monthly applications were comprised of 1/15 of the annual rate thereafter. Annual nitrogen fertilizer rates varied from 0-8 lbs of N per 1000 ft^2. Thus, at the highest rates, applications of 0.5 lbs N per 1000 ft^2 were made every 13-16 days. The water soluble form of N was also varied, by NH_4^+ or NO_3^- content of the total N applied. Varying ratios of ammonium sulfate to calcium nitrate resulted in an array of N forms, from 0 to 100% NH_4^+ and 100 to 0% NO_3^-, respectively. These applications were made by a CO_2 sprayer at a corresponding rate of 112 GPA (~2.5 gal/1000 ft^2).

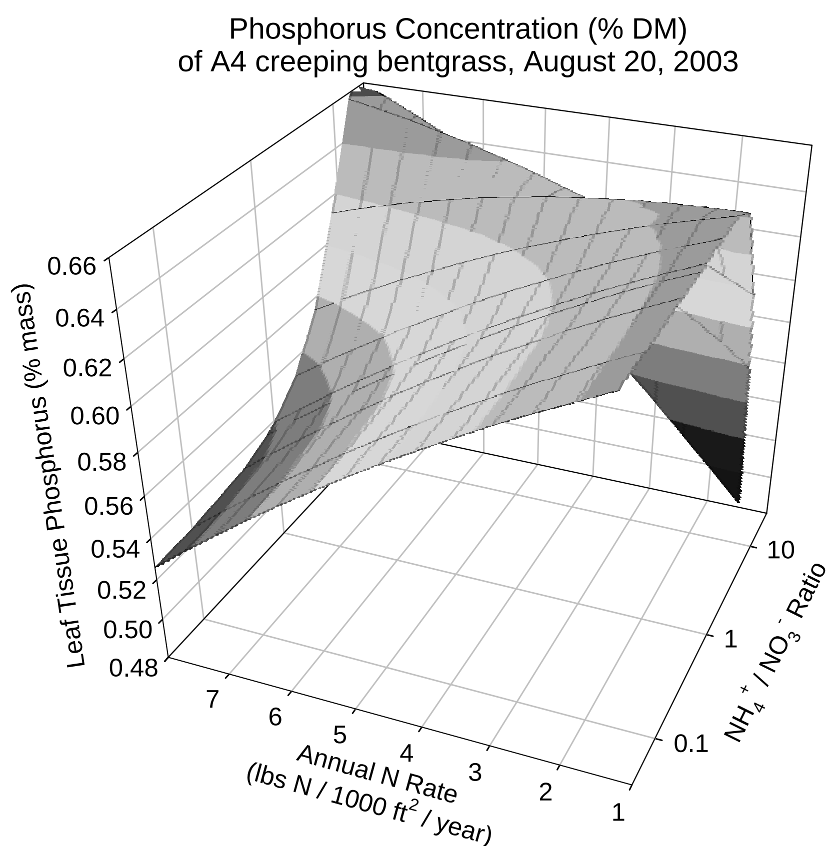
Cultural practices conducted on the site were similar to standard golf course practice. Irrigation was applied to prevent wilt, and plant protectants were used to control disease activity when necessary. The green was mowed at a height of 0.125 inches, 6-7 times each week. Clipping yields were collected twice in July, twice in August, and once in September. Color ratings were made near clipping yield harvests and additionally in October (2003).

Results

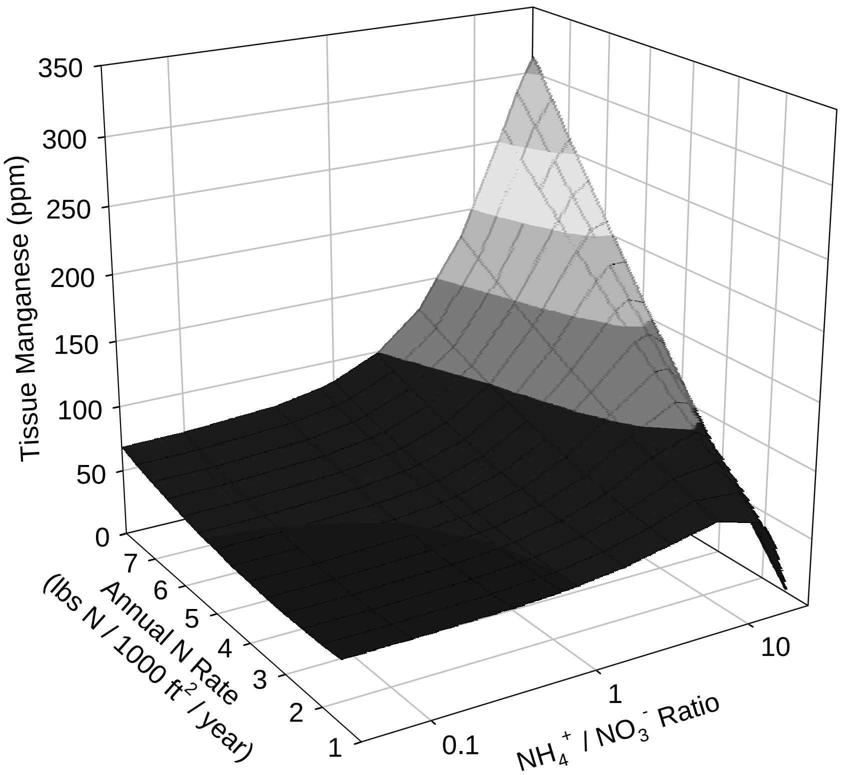

Clipping Yield of A4, 5 clipping harvests
July and August, 2003
Clipping Yield
(lbs DM / 1000 ft^2 / day)
1.2
1.0
0.8
0.6
0.4
8
7
6
5
4
3
2
1
Annual N Rate
(lbs N / 1000 ft^2 / year)
0.1
1
10
NH_4 / NO_3 Ratio


Fertilizer use efficiency (FUE) of A4, 5 clipping harvests
July and August, 2003
FUE
(% Fertilizer N recovered / day)
14
12
10
8
6
4
7
6
5
4
3
2
1
Annual N Rate
(lbs N / 1000 ft^2 / year)
0.1
1
10
NH_4 / NO_3 Ratio

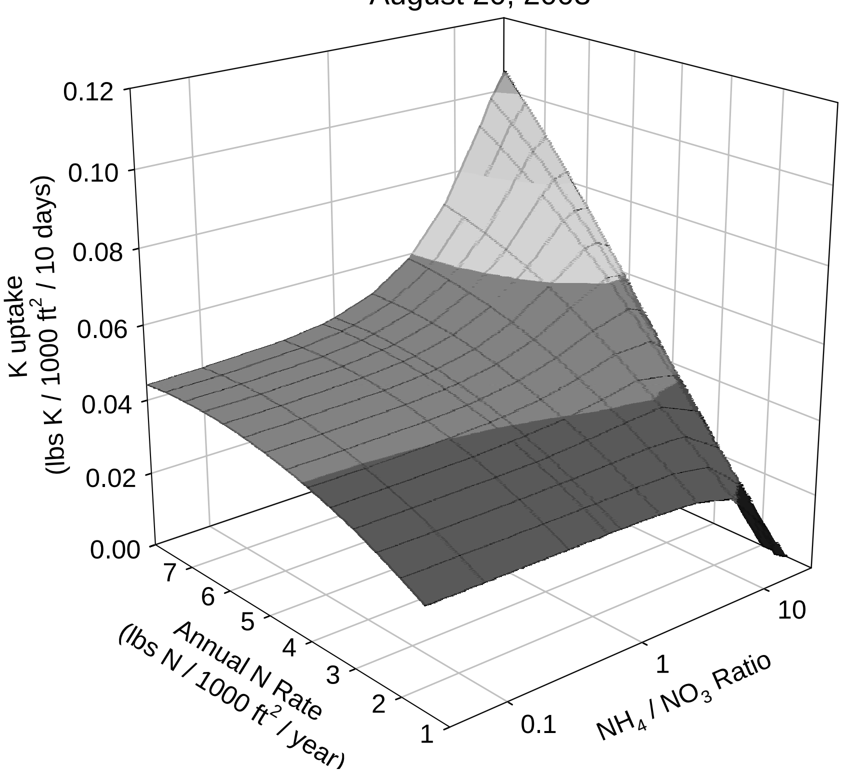

Dark Green Color Index (DGCI)
of A4 creeping bentgrass, multiple dates,
July through October, 2003
Dark Green Color Index (DGCI)
0.50
0.49
0.48
0.47
0.46
0.45
0.44
7
6
5
4
3
2
1
Annual N Rate
(lbs N / 1000 ft^2 / year)
0.1
1
10
NH_4^+ / NO_3^- Ratio


Phosphorus Concentration (% DM)
of A4 creeping bentgrass, August 20, 2003
Leaf Tissue Phosphorus (% mass)
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
7
6
5
4
3
2
1
Annual N Rate
(lbs N / 1000 ft^2 / year)
0.1
1
10
NH_4^+ / NO_3^- Ratio

Manganese Concentration (mg/kg DM)
of A4 creeping bentgrass,
August 20, 2003



Potassium (K) uptake of A4 creeping bentgrass
August 20, 2003



Conclusions
Under the limited cultural conditions of this experiment, preparing water soluble N applications (>0.2 lbs N/1000 ft^2/2-weeks) with ammonium sulfate as the primary N form resulted in enhanced color, growth, K uptake, Mn uptake, and P uptake, when compared to calcium nitrate as the N source.

Root measurements were not taken. It is possible that these benefits occurred at the expense of root length density. Due to high rainfall and lack of high temperature stress on the bentgrass putting green this year (2003), adverse repercussions of limited root length were not observed.

Further research will be conducted on multiple sites in 2004. Further results of this continual project will be presented in the 2004 progress report.

References
National Turfgrass Evaluation Program (NTEP). 2004. Bentgrass Putting Green Trials, Online. Available at: http://www.ntep.org/data/bt98g/bt98g_03-8f/bt98g03ftqsum.txt

Evaluation of Bentgrass Root Structure and Development on Greens of Varying Soil Depth

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Introduction

United States Golf Association (USGA) putting greens are built to a depth of 12-inches. The depth of the root zone was set to accommodate cutting the cup, and not the turfgrass species being grown. Currently, there is little research on how different root zone depths affect bentgrass root structure. The objectives of this study are to document root structure using the minirhizotron method, determine how varying root zone depths affect root structure, and determine how changes in root zone depth and root structure affect water use.

Materials and Methods

Experimental containers were constructed from 15-inch sections of 12-inch diameter polyvinyl chloride (PVC) pipe (Fig. 1). A 14 X 14-inch section of fiberglass was glued to the bottom of the pipe having a .25-inch hole for drainage. Two 1.5-inch holes were drilled opposite one another at 1.5, 5.5, and 9.5-inches from the top to accommodate horizontal minirhizotron tubes. One of the 1.5-inch holes at each depth had a .25-inch hole drilled beside it to permit TDR connectors to pass through. The experimental root zones consisted of 4, 8, and 12-inch root zone depths. There was one minirhizotron tube and two multiplexed TDR probes for every four inches of root zone. Penncross creeping bentgrass was sown on 9/4/02 at a rate of 1 pound per 1000ft^2. A modified Hoagland's solution was used at a rate of 7 lbs of N per year. All treatments received the same amount of water per week.

Fig 1. Study design

Results

Only data for root counts at the 1.5 and 5.5-inch depths will be presented in this report. Dry down data is still being analyzed. Data was collected for 41 weeks. Weeks 1, 2, 3, 12, 16, 19, 22, 26, and 41 are included in this report. All treatments at the 1.5-inch depth for weeks 1, 3, 19, 22, and 26 were not significantly different (graph 1). At week 2, the 4-inch treatment was significantly higher than the 12-inch root zone. The 8-inch treatment was intermediate. At weeks 12, 16, and 41, the 4-inch treatment was significantly higher compared to the 8 and 12-inch treatments, which were not different. The root counts at the 5.5-inch depth for the 8 and 12-inch treatments were not significantly different for all weeks evaluated (graph 2).

Under the conditions of the study, the shallow root zone measured higher root counts during establishment. After the turfgrass stand matured there seems to be little advantage to a deeper root zone especially when comparing the 8 and 12-inch treatments.

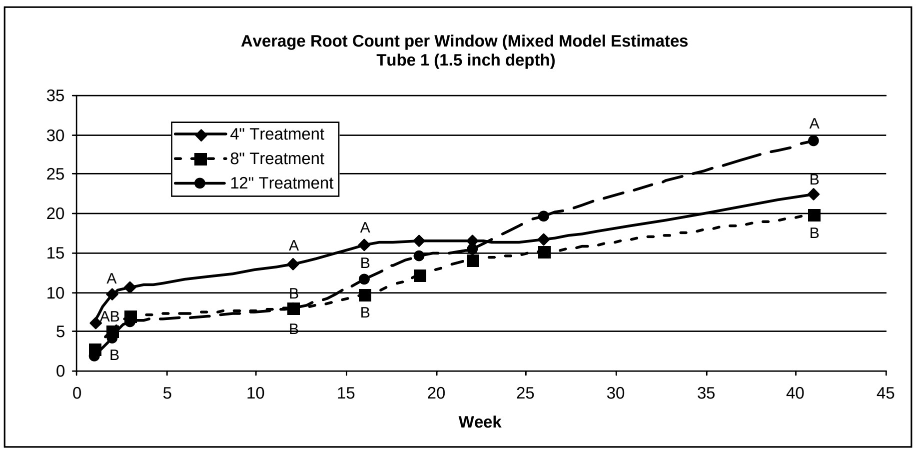

Fig 2. Graph of root number over time at the 1.5-inch depth

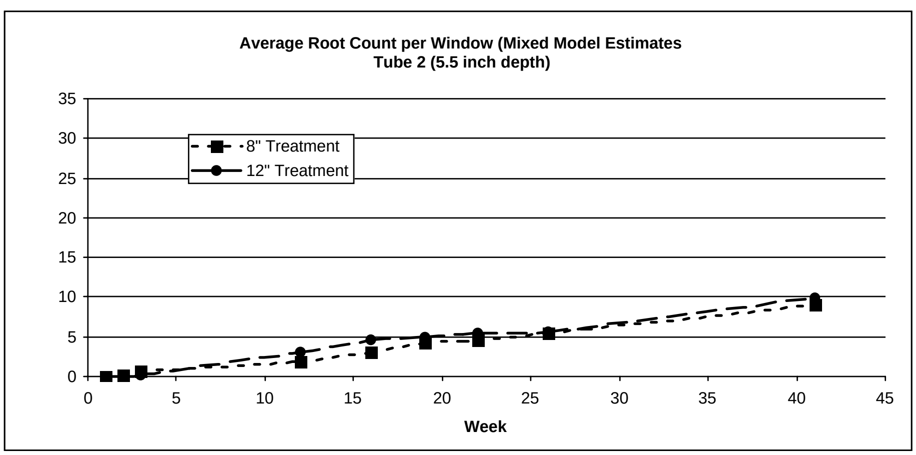

Fig 3. Graph of root number over time at the 5.5-inch depth