PENNSTATE

2004 Turfgrass Research Report

In Cooperation With The

Pennsylvania Turfgrass Council

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TOPDRESSING

ATHLETIC FIELD STUDIES

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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 2004.

Respectfully,
Jill Seymour,
Editor

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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 '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*) and white clover (*Trifolium repens*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

All plots were rated for percent dandelion and white clover prior to treatment.

The study was a randomized complete block design with three replications. All of the treatments were applied on May 25, 2004 and some re-applied on June 9, 2004 (14 DAT) 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.

Results and Discussion

Turfgrass phytotoxicity was rated three times (May 23, June 1, and June 7, 2004). No unacceptable turfgrass phytotoxicity was found on any of the rating dates (Table 1).

The change in broadleaf weed (dandelion and white clover) population was rated four times (June 7, June 18, July 6, and July 20, 2004). Some level of control was found across all rating dates for most treated turfgrass. By the final rating date, July 20, only V-10142 at 0.25 and 0.5 lb ai/A plus MSO, Spotlight at 0.67 and 1.33 pt/A, alone or combined with MacroSorb Foliar, Spotlight at 1 pt/A alone or combined with 2,4-D Amine 4 at 0.5 lb ai/A, and Garlon EV at 4.5 pt/A combined with 2,4-D Amine 4 at 1 pt/A provided less than 70% reduction of the dandelion population (Table 2).

On July 20, 2004, only V-10142 at 0.25, 0.5 and 1.0 lb ai/A plus MSO, and 2,4-D Amine 4 at 1 and 2 lbs ai/A provided less than 70% reduction of the white clover population.

Some complementary effects were found. For example, when Spotlight at 1 pt/A was combined with 2,4-D Amine 4 at 1 lb ai/A dandelions were reduced by 88.1% and white clover by 100%. Additionally, when V-10142 at 0.25 lb ai/A was combined with MSO at 0.25 % v/v and Drive at 0.75 lb ai/A near complete control of dandelions and white clover was achieved (98.2% and 100% respectively).

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

Treatment	Form	Rate	Re App	(----------------Phytotoxicity-------------)		
		pt/A		5-23	6-1	6-7
VELOCITY	80WP	30 g ai/A	14 DAT	10.0	10.0	8.7
VELOCITY	80WP	45 g ai/A	14 DAT	10.0	10.0	8.0
V-10142	3.3SC	0.25 lb ai/A		10.0	10.0	10.0
MSO	L	0.25 % V/V				
V-10142	3.3SC	0.5 lb ai/A		10.0	10.0	9.0
MSO	L	0.25 % V/V				
V-10142	3.3SC	1.0 lb ai/A		10.0	10.0	9.3
MSO	L	0.25 % V/V				
V-10142	3.3SC	0.25 lb ai/A		10.0	10.0	9.0
MSO	L	0.25 % V/V				
DRIVE	75DF	0.75 lb ai/A				
CHECK				10.0	10.0	10.0
SPOTLIGHT	1.5EC	1		10.0	10.0	8.0
BASTION T	3.1EW	2.5		10.0	10.0	8.7
GARLON EV	1.33EW	4.5		10.0	10.0	8.3
2,4-D AMINE 4	3.8SL	2		10.0	10.0	10.0
SPOTLIGHT	1.5EC	1		10.0	10.0	8.7
2,4-D AMINE 4	3.8SL	0.5				
SPOTLIGHT	1.5EC	1		10.0	10.0	8.0
2,4-D AMINE 4	3.8SL	1				
SPOTLIGHT	1.5EC	1		10.0	10.0	9.7
2,4-D AMINE 4	3.8SL	2				
BASTION T	3.1EW	2.5		10.0	10.0	8.3
2,4-D AMINE 4	3.8SL	0.5				
BASTION T	3.1EW	2.5		10.0	10.0	8.3
2,4-D AMINE 4	3.8SL	1				
BASTION T	3.1EW	2.5		10.0	10.0	9.0
2,4-D AMINE 4	3.8SL	2				
GARLON EV	1.33EW	4.5		10.0	10.0	8.7
2,4-D AMINE 4	3.8SL	0.5				
GARLON EV	1.33EW	4.5		10.0	10.0	8.3
2,4-D AMINE 4	3.8SL	1				
GARLON EV	1.33EW	4.5		10.0	10.0	8.7
2,4-D AMINE 4	3.8SL	2				
SPOTLIGHT	1.5EC	0.67		10.0	10.0	9.7
SPOTLIGHT	1.5EC	1.33		10.0	10.0	9.3
TRIMEC CLASSIC	3.32L	3		10.0	10.0	9.0
TRIMEC CLASSIC	3.32L	4		10.0	10.0	9.3
CHASER	3EC	2.2		10.0	10.0	9.7
2,4-D AMINE 4	3.8SL	1.5		10.0	10.0	10.0
2,4-D AMINE 4	3.8SL	1.0 lb ai/A		10.0	10.0	10.0
SPOTLIGHT	1.5EC	0.67		10.0	10.0	7.3
TRIMEC CLASSIC	3.32L	3				
SPOTLIGHT	1.5EC	0.67		10.0	10.0	9.0
CHASER	3EC	2.2				
SPOTLIGHT	1.5EC	0.67		10.0	10.0	9.3
2,4-D AMINE 4	3.8SL	1.5				
SPOTLIGHT	1.5EC	1.33		10.0	10.0	9.0
TRIMEC CLASSIC	3.32L	3				
SPOTLIGHT	1.5EC	1.33		10.0	10.0	8.7
CHASER	3EC	2.2				
SPOTLIGHT	1.5EC	1.33		10.0	10.0	9.0
2,4-D AMINE 4	3.8SL	1.5				
SPOTLIGHT	1.5EC	1.33		10.0	10.0	9.0
MACROSORB FOLIAR	L	2 oz/M				
SPOTLIGHT	1.5EC	0.67		10.0	10.0	9.0
MACROSORB FOLIAR	L	2 oz/M				
DRIVE	75DF	0.75 lb ai/A		10.0	10.0	8.7
2,4-D AMINE 4	3.8SL	1.0 lb ai/A				
MSO	L	1 % V/V				

Table 2. Percent change of the dandelion and white clover populations following applications of selected herbicides.

Treatment	Form	Rate pt/A	Re App	(--------Percent Change June 7, 2004----------) Dandelion [1,2]	White Clover
VELOCITY	80WP	30 g ai/A	14 DAT	45.8cd	-6.7f-k
VELOCITY	80WP	45 g ai/A	14 DAT	51.1bcd	-21.1ijk
V-10142 MSO	3.3SC L	0.25 lb ai/A 0.25 % V/V		46.7cd	-30.0jk
V-10142 MSO	3.3SC L	0.5 lb ai/A 0.25 % V/V		42.2d	-46.7k
V-10142 MSO	3.3SC L	1.0 lb ai/A 0.25 % V/V		67.2a-d	-8.3g-k
V-10142 MSO DRIVE	3.3SC L 75DF	0.25 lb ai/A 0.25 % V/V 0.75 lb ai/A		61.1a-d	33.3a-i
CHECK				2.2e	-12.2h-k
SPOTLIGHT	1.5EC	1		82.5ab	60.0a-e
BASTION T	3.1EW	2.5		81.9ab	74.6ab
GARLON EV	1.33EW	4.5		85.6a	61.1a-e
2,4-D AMINE 4	3.8SL	2		45.8cd	7.5c-k
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 0.5		68.3a-d	43.9a-h
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 1		86.1a	57.5a-f
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 2		84.4a	57.5a-f
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 0.5		84.4a	74.2ab
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 1		85.0a	74.3ab
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 2		75.8abc	74.4ab
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 0.5		83.3ab	75.3ab
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 1		81.1ab	20.0a-j
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 2		89.2a	81.0ab
SPOTLIGHT	1.5EC	0.67		74.4abc	0.0e-k
SPOTLIGHT	1.5EC	1.33		79.4ab	55.6a-g
TRIMEC CLASSIC	3.32L	3		77.8abc	40.1a-i
TRIMEC CLASSIC	3.32L	4		87.5a	59.0a-e
CHASER	3EC	2.2		69.4a-d	31.9a-j
2,4-D AMINE 4	3.8SL	1.5		76.7abc	16.7b-j
2,4-D AMINE 4	3.8SL	1.0 lb ai/A		73.5a-d	2.5d-k
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	0.67 3		71.1a-d	53.2a-g
SPOTLIGHT CHASER	1.5EC 3EC	0.67 2.2		83.3ab	55.4a-g
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	0.67 1.5		70.8a-d	22.5a-j
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	1.33 3		82.5ab	63.3a-e
SPOTLIGHT CHASER	1.5EC 3EC	1.33 2.2		88.3a	84.2a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1.33 1.5		76.1abc	69.6abc
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	1.33 2 oz/M		70.0a-d	62.4a-e
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	0.67 2 oz/M		66.7a-d	48.1a-h
DRIVE 2,4-D AMINE 4 MSO	75DF 3.8SL L	0.75 lb ai/A 1.0 lb ai/A 1 % V/V		71.7a-d	65.3a-d

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 (Cont.). Percent change of the dandelion and white clover populations following applications of selected herbicides.

Treatment	Form	Rate pt/A	Re App	(--------Percent Change June 18, 2004---------) Dandelion [1,2]	White Clover
VELOCITY	80WP	30 g ai/A	14 DAT	98.3ab	92.2ab
VELOCITY	80WP	45 g ai/A	14 DAT	98.2ab	93.2ab
V-10142 MSO	3.3SC L	0.25 lb ai/A 0.25 % V/V		84.2a-d	0.0d
V-10142 MSO	3.3SC L	0.5 lb ai/A 0.25 % V/V		86.1a-d	26.2c
V-10142 MSO	3.3SC L	1.0 lb ai/A 0.25 % V/V		92.9ab	41.8c
V-10142 MSO DRIVE	3.3SC L 75DF	0.25 lb ai/A 0.25 % V/V 0.75 lb ai/A		100.0a	100.0a
CHECK				0.0g	0.0d
SPOTLIGHT	1.5EC	1		79.2bcd	100.0a
BASTION T	3.1EW	2.5		96.4ab	100.0a
GARLON EV	1.33EW	4.5		98.8ab	100.0a
2,4-D AMINE 4	3.8SL	2		97.5ab	44.2c
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 0.5		95.0ab	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 1		99.4a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 2		99.3a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 0.5		99.3a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 1		99.3a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 2		99.3a	100.0a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 0.5		98.0ab	100.0a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 1		73.3cde	72.2b
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 2		100.0a	100.0a
SPOTLIGHT	1.5EC	0.67		48.6f	99.2a
SPOTLIGHT	1.5EC	1.33		91.1abc	100.0a
TRIMEC CLASSIC	3.32L	3		98.3ab	100.0a
TRIMEC CLASSIC	3.32L	4		98.3ab	100.0a
CHASER	3EC	2.2		99.4a	93.4ab
2,4-D AMINE 4	3.8SL	1.5		91.1abc	38.9c
2,4-D AMINE 4	3.8SL	1.0 lb ai/A		93.3ab	25.0c
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	0.67 3		99.4a	100.0a
SPOTLIGHT CHASER	1.5EC 3EC	0.67 2.2		100.0a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	0.67 1.5		98.6ab	99.4a
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	1.33 3		99.2a	100.0a
SPOTLIGHT CHASER	1.5EC 3EC	1.33 2.2		100.0a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1.33 1.5		100.0a	100.0a
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	1.33 2 oz/M		69.2de	100.0a
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	0.67 2 oz/M		60.8ef	100.0a
DRIVE 2,4-D AMINE 4 MSO	75DF 3.8SL L	0.75 lb ai/A 1.0 lb ai/A 1 % V/V		100.0a	100.0a

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 (Cont.). Percent change of the dandelion and white clover populations following applications of selected herbicides.

Treatment	Form	Rate pt/A	Re App	(--------Percent Change July 6, 2004------------) Dandelion [1,2]	White Clover
VELOCITY	80WP	30 g ai/A	14 DAT	77.5a-d	95.5a
VELOCITY	80WP	45 g ai/A	14 DAT	97.6a	99.3a
V-10142 MSO	3.3SC L	0.25 lb ai/A 0.25 % V/V		0.0g	-11.4e
V-10142 MSO	3.3SC L	0.5 lb ai/A 0.25 % V/V		11.1fg	13.3cde
V-10142 MSO	3.3SC L	1.0 lb ai/A 0.25 % V/V		82.8abc	15.6cde
V-10142 MSO DRIVE	3.3SC L 75DF	0.25 lb ai/A 0.25 % V/V 0.75 lb ai/A		98.9a	100.0a
CHECK				0.0g	0.0e
SPOTLIGHT	1.5EC	1		30.0efg	100.0a
BASTION T	3.1EW	2.5		79.4a-d	100.0a
GARLON EV	1.33EW	4.5		88.2ab	100.0a
2,4-D AMINE 4	3.8SL	2		51.4b-e	36.7c
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 0.5		52.5b-e	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 1		72.2a-d	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 2		94.9a	99.4a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 0.5		94.9a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 1		94.3a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 2		98.3a	100.0a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 0.5		86.0ab	100.0a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 1		62.2a-e	66.7b
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 2		96.0a	100.0a
SPOTLIGHT	1.5EC	0.67		5.6g	100.0a
SPOTLIGHT	1.5EC	1.33		62.8a-e	100.0a
TRIMEC CLASSIC	3.32L	3		92.2a	100.0a
TRIMEC CLASSIC	3.32L	4		96.1a	100.0a
CHASER	3EC	2.2		87.8ab	94.4a
2,4-D AMINE 4	3.8SL	1.5		34.4efg	30.6cd
2,4-D AMINE 4	3.8SL	1.0 lb ai/A		43.8def	6.7de
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	0.67 3		87.0ab	100.0a
SPOTLIGHT CHASER	1.5EC 3EC	0.67 2.2		92.2a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	0.67 1.5		83.6abc	99.4a
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	1.33 3		95.8a	100.0a
SPOTLIGHT CHASER	1.5EC 3EC	1.33 2.2		92.5a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1.33 1.5		94.7a	100.0a
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	1.33 2oz/M		47.5cde	100.0a
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	0.67 2 oz/M		28.3efg	100.0a
DRIVE 2,4-D AMINE 4 MSO	75DF 3.8SL L	0.75 lb ai/A 1.0 lb ai/A 1 % V/V		99.2a	100.0a

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 (Cont.). Percent change of the dandelion and white clover populations following applications of selected herbicides.

Treatment	Form	Rate pt/A	Re App	(--------Percent Change July 20, 2004-----------) Dandelion [1,2]	White Clover
VELOCITY	80WP	30 g ai/A	14 DAT	79.2ab	92.8a
VELOCITY	80WP	45 g ai/A	14 DAT	97.6a	96.0a
V-10142 MSO	3.3SC L	0.25 lb ai/A 0.25 % V/V		41.7cd	6.7c
V-10142 MSO	3.3SC L	0.5 lb ai/A 0.25 % V/V		42.8cd	34.8b
V-10142 MSO	3.3SC L	1.0 lb ai/A 0.25 % V/V		87.2a	17.5bc
V-10142 MSO DRIVE	3.3SC L 75DF	0.25 lb ai/A 0.25 % V/V 0.75 lb ai/A		98.2a	100.0a
CHECK				0.0f	0.0c
SPOTLIGHT	1.5EC	1		38.3cde	100.0a
BASTION T	3.1EW	2.5		89.2a	100.0a
GARLON EV	1.33EW	4.5		93.8a	100.0a
2,4-D AMINE 4	3.8SL	2		88.3a	35.6a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 0.5		48.3bcd	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 1		88.1a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1 2		97.6a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 0.5		93.3a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 1		98.7a	100.0a
BASTION T 2,4-D AMINE 4	3.1EW 3.8SL	2.5 2		97.7a	100.0a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 0.5		92.7a	100.0a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 1		62.2abc	88.9a
GARLON EV 2,4-D AMINE 4	1.33EW 3.8SL	4.5 2		96.0a	100.0a
SPOTLIGHT	1.5EC	0.67		6.7ef	100.0a
SPOTLIGHT	1.5EC	1.33		50.6bcd	100.0a
TRIMEC CLASSIC	3.32L	3		89.5a	100.0a
TRIMEC CLASSIC	3.32L	4		98.3a	100.0a
CHASER	3EC	2.2		98.3a	93.4a
2,4-D AMINE 4	3.8SL	1.5		95.5a	73.0a
2,4-D AMINE 4	3.8SL	1.0 lb ai/A		97.0a	21.7bc
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	0.67 3		97.4a	100.0a
SPOTLIGHT CHASER	1.5EC 3EC	0.67 2.2		97.2a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	0.67 1.5		92.5a	97.2a
SPOTLIGHT TRIMEC CLASSIC	1.5EC 3.32L	1.33 3		95.8a	100.0a
SPOTLIGHT CHASER	1.5EC 3EC	1.33 2.2		95.0a	100.0a
SPOTLIGHT 2,4-D AMINE 4	1.5EC 3.8SL	1.33 1.5		91.4a	100.0a
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	1.33 2oz/M		41.7cd	100.0a
SPOTLIGHT MACROSORB FOLIAR	1.5EC L	0.67 2 oz/M		16.7def	100.0a
DRIVE 2,4-D AMINE 4 MSO	75DF 3.8SL L	0.75 lb ai/A 1.0 lb ai/A 1 % V/V		100.0a	100.0a

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.

Post Emergence Control of Broadleaf Weeds and Phytotoxicity Evaluations

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

Introduction

Broadleaf weed control and phytotoxicity 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*) and white clover (*Trifolium repens*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass when applied to wet and dry turfgrass.

Methods and Materials

All plots were rated for percent dandelion and white clover prior to treatment.

The study was a randomized complete block design with three replications. All of the treatments were applied on May 24, 2004 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi to both wet and dry turfgrass.

The perennial ryegrass was mowed at 1.5 inches twice weekly with a rotary mower with clippings returned to the site.

Results and Discussion

Turfgrass phytotoxicity was rated four times (May 28, June 1, June 7, and June 14, 2004) (Table 1). No turfgrass phytotoxicity was found.

The change in broadleaf weed (dandelion and white clover) population was rated four times (June 7, June 18, July 6, and July 20, 2004) (Table 2). All test materials except NUP 3P 04 applied to wet or dry turfgrass provided at least an 80% reduction in the dandelion and white clover population on the June 18, 2004 rating date. By the final rating date, July 20, 2004, only NUP 1S 04 applied to wet turfgrass reduced the dandelion population by at least 80%. On July 20, 2004, all test materials except NUP 3P 04 applied to wet or dry turfgrass provided at least a 97% reduction in the white clover population. There was no significant difference in the control of dandelion or white clover when the same test material was applied to wet or dry turfgrass, with one exception. There was significantly more reduction in the white clover population when NUP 3P 04 was applied to wet turfgrass (56.9%) than when applied to dry turfgrass (22.7%).

It appears that these test materials (except NUP 3P 04 applied to wet or dry turfgrass) can provide good control of dandelions soon after application, but complete eradication was not accomplished as some re-growth was evident. The eradication of white clover appeared to be more complete.

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[1] Research Assistant and Professor respectively, Department of Crop and Soil Sciences, Penn State University, University Park, Pa, 16802

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

Treatment	Form	Rate lb/M	(------------Phytotoxicity------------------) 5-28	6-1	6-7	6-14
	Test Materials Applied to Wet Turfgrass					
NUP 12H 02	G	3.2	10.0	10.0	10.0	10.0
NUP 1Q 04	G	3.2	10.0	10.0	10.0	10.0
NUP 1R 04	G	3.2	10.0	10.0	10.0	10.0
NUP 2C 04	G	3.2	10.0	10.0	10.0	10.0
NUP 1S 04	G	3.2	10.0	10.0	10.0	10.0
NUP 3P 04	G	2.85	10.0	10.0	10.0	10.0
CHECK			10.0	10.0	10.0	10.0
	Test Materials Applied to Dry Turfgrass					
NUP 12H 02	G	3.2	10.0	10.0	10.0	10.0
NUP 1Q 04	G	3.2	10.0	10.0	10.0	10.0
NUP 1R 04	G	3.2	10.0	10.0	10.0	10.0
NUP 2C 04	G	3.2	10.0	10.0	10.0	10.0
NUP 1S 04	G	3.2	10.0	10.0	10.0	10.0
NUP 3P 04	G	2.85	10.0	10.0	10.0	10.0

Table 2. Percent change of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	June 7, 2004 [1,2]		June 18, 2004		July 6, 2004		July 20, 2004	
		lb/M	Dand	Clover	Dand	Clover	Dand	Clover	Dand	Clover
	Test Materials Applied to Wet Turfgrass									
NUP 12H 02	G	3.2	78.6a	75.7a	96.8a	100.0a	62.7abc	100.0a	71.9ab	100.0a
NUP 1Q 04	G	3.2	69.4abc	68.5ab	98.1a	100.0a	79.2a	99.6a	78.1ab	98.1a
NUP 1R 04	G	3.2	76.7a	60.4ab	80.0a	97.1a	40.0cd	99.6a	50.0abc	99.6a
NUP 2C 04	G	3.2	64.1abc	48.3ab	97.1a	99.2a	64.9abc	100.0a	78.5ab	100.0a
NUP 1S 04	G	3.2	76.9a	72.4a	91.4a	100.0a	74.7a	100.0a	80.3a	99.5a
NUP 3P 04	G	2.85	38.9c	32.8bc	25.0b	50.8b	11.1e	39.7b	16.7cd	56.9b
CHECK			-17.8d	3.7c	0.0c	0.0c	6.7e	3.7c	0.0d	0.0c
	Test Materials Applied to Dry Turfgrass									
NUP 12H 02	G	3.2	75.0ab	66.9ab	96.9a	99.2a	54.2abc	100.0a	69.4ab	100.0a
NUP 1Q 04	G	3.2	79.2a	70.6ab	96.9a	99.6a	70.8ab	99.6a	41.7bc	100.0a
NUP 1R 04	G	3.2	50.0abc	52.8ab	86.7a	96.8a	44.4bc	99.0a	50.0abc	97.9a
NUP 2C 04	G	3.2	55.6abc	53.8ab	92.2a	99.6a	55.6abc	100.0a	61.1ab	100.0a
NUP 1S 04	G	3.2	44.2bc	63.3ab	82.0a	99.6a	53.3abc	99.6a	44.2abc	100.0a
NUP 3P 04	G	2.85	42.8c	39.8ab	23.3b	32.5b	17.8de	35.4b	17.8cd	22.7c

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.

Post Emergence Control of Broadleaf Weeds and Phytotoxicity Evaluations

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

Introduction

Broadleaf weed control and phytotoxicity 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*) and white clover (*Trifolium repens*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

All plots were rated for percent dandelion and white clover prior to treatment.

The study was a randomized complete block design with three replications. All of the treatments were applied on May 24, 2004 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.

Results and Discussion

Turfgrass phytotoxicity was rated three times (May 23, June 1, and June 15, 2004). No turfgrass phytotoxicity was observed on any rating date (Table 1).

The change in broadleaf weed (dandelion and white clover) population was rated four times (June 7, June 18, July 6, and July 20, 2004) (Table 2). By the June 18, 2004 rating date all treatments reduced the dandelion population by 90% or more and a complete elimination of the white clover population was observed. These levels of reduction were also found on the final rating date July 20, 2004.

[1] Research Assistant and Professor respectively, Department of Crop and Soil Sciences, Penn State University, University Park, Pa, 16802

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

Treatment	Form	Rate pt/A	(------------Phytotoxicity------------------) 5-28	6-1	6-15
NUP 7I 02	L	2.5	10.0	10.0	10.0
NUP 1C 03	L	2.5	10.0	10.0	10.0
NUP 1D 04	L	2.5	10.0	10.0	10.0
NUP 1E 04	L	2.5	10.0	10.0	10.0
NUP 1F 04	L	2.5	10.0	10.0	10.0
NUP 1G 04	L	3.5	10.0	10.0	10.0
NUP 1H 04	L	3.5	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
NUP 1J 04	L	3.5	10.0	10.0	10.0
NUP 1K 04	L	3.5	10.0	10.0	10.0
NUP 3Q 04	L	3.5	10.0	10.0	10.0
NUP 7U 02	L	2.5	10.0	10.0	10.0
NUP 1L 04	L	2.5	10.0	10.0	10.0
NUP 1M 04	L	2.5	10.0	10.0	10.0
NUP 1T 04	L	4.0	10.0	10.0	10.0
NUP 1U 04	L	4.0	10.0	10.0	10.0

Table 2. Percent change of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	June 7, 2004 [1,2]		June 18, 2004		July 6, 2004		July 20, 2004	
		pt/A	Dand	Clover	Dand	Clover	Dand	Clover	Dand	Clover
NUP 7I 02	L	2.5	80.6ab	58.3ab	99.4a	100.0a	96.1ab	100.0a	96.7a	100.0a
NUP 1C 03	L	2.5	88.3a	68.3ab	99.3a	100.0a	98.2a	100.0a	98.8a	100.0a
NUP 1D 04	L	2.5	90.3a	71.1ab	99.2a	100.0a	93.6ab	100.0a	92.5a	100.0a
NUP 1E 04	L	2.5	84.3ab	26.4bc	98.9a	100.0a	94.3ab	100.0a	96.3a	100.0a
NUP 1F 04	L	2.5	89.7a	43.3ab	100.0a	100.0a	96.1ab	100.0a	96.1a	100.0a
NUP 1G 04	L	3.5	86.1ab	60.8ab	100.0a	100.0a	95.6ab	100.0a	96.7a	100.0a
NUP 1H 04	L	3.5	91.5a	77.8ab	100.0a	100.0a	89.1b	100.0a	94.2a	100.0a
CHECK			-0.6c	-17.1c	0.0b	0.0b	0.0c	0.0b	0.0b	0.0b
NUP 1J 04	L	3.5	71.1b	47.2ab	100.0a	100.0a	95.2ab	100.0a	90.4a	100.0a
NUP 1K 04	L	3.5	90.6a	82.8a	99.4a	100.0a	93.8ab	100.0a	93.8a	100.0a
NUP 3Q 04	L	3.5	85.1ab	64.5ab	99.2a	100.0a	97.9a	100.0a	94.5a	100.0a
NUP 7U 02	L	2.5	87.8ab	83.3a	99.3a	100.0a	93.9ab	100.0a	96.6a	100.0a
NUP 1L 04	L	2.5	81.3ab	56.3ab	99.6a	100.0a	94.5ab	100.0a	97.3a	100.0a
NUP 1M 04	L	2.5	80.6ab	61.7ab	100.0a	100.0a	95.8ab	100.0a	95.8a	100.0a
NUP 1T 04	L	4.0	80.6ab	56.0ab	100.0a	100.0a	98.3a	100.0a	98.3a	100.0a
NUP 1U 04	L	4.0	84.1ab	36.1ab	99.5a	100.0a	96.5ab	100.0a	96.5a	100.0a

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 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 phytotoxicity, seedhead suppression of annual bluegrass, and quality. Additionally, early applications were made to assess when such treatments would have an effect on spring "green-up".

Methods and Materials

Treatments were applied on April 7 (2 ND MOW), April 14 (2 ND MOW + 1), April 20 (2 ND MOW + 2) (BOOT), April 29 (2 ND MOW + 3), May 3 (SEQ), and May 11, 2004 (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 first mowing of the green was conducted on March 24, 2004 and the second mowing on April 7, 2004. On April 7, 2004 the turf was at about 75% green-up. On April 20, 2004 the forsythia was in full bloom. On April 21, 2004 annual bluegrass was at the boot stage of development. On April 28, 2004 forsythia was at the petal drop stage.

The turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a putting green.

Results and Discussion

None of the treatments appeared to have any effect on "green-up" when compared to untreated (Table 1). Ratings for seedhead suppression, phytotoxicity, and quality on May 12, 2004 are presented in Table 2. When Proxy/Primo MAXX was applied at the second mowing timing followed by a sequential application on May 3, it did not appear to matter whether the Proxy rate was 3 or 5 oz/M. However, when the timing was second mowing followed by a sequential application one week later, the 5 oz/M Proxy rate tended to provide better seedhead suppression, particularly compared to the time referred to above.

[1] Professor and Research Assistant respectively, Department of Crop and Soil Sciences, Penn State University, University Park, Pa, 16802

There was also a tendency for increased phytotoxicity (not unacceptable). The higher Proxy rate of the combination also tended to provide better seedhead suppression than the lower rate for the second mowing plus 3 week sequential application. However, at this timing the lower rate had unacceptable quality due to relatively poor seedhead suppression (63%). When MacroSorb Foliar was added to Proxy/Primo MAXX at boot stage followed by a sequential three weeks later the 3 oz/M rate of Proxy provided comparable seedhead suppression to the 5 oz/M rate with less phytotoxicity and slightly enhanced quality.

Ratings for seedhead suppression, phytotoxicity, and quality taken on May 18, 2004 are shown in Table 3. None of the treatments caused unacceptable phytotoxicity, however, those that did not provide at least 68% seedhead suppression were rated to have unacceptable quality as a result. Embark T & O, applied at boot stage and/or followed by a repeated application at a lower rate three weeks later, provided excellent seedhead suppression on both rating dates, but caused unacceptable phytotoxicity on the May 12 rating date. Applying Embark T & O at 40 oz/A at the second mowing timing did not provide good seedhead suppression which resulted in unacceptable quality. The boot stage followed by a 3 week sequential timing for Proxy/Primo MAXX at 3 oz/M only provided 50% suppression on the May 18 rating date. However, by amending this treatment with MacroSorb Foliar at 8 oz/M the seedhead suppression was improved to nearly 70% resulting in a quality rating of 8.

Table 1. Ratings of green-up of an annual bluegrass/creeping bentgrass putting green on a scale of 0 to 10 where 0 = least and 10 = most.

Treatment	Form	Rate oz/M	Timing	4/14/04	4/21/04	4/28/04
PROXY	2SL	3	2NDMOW/SEQ	7.3	9.0	9.3
PRIMO MAXX	1MEC	0.125	2NDMOW/SEQ			
PROXY	2SL	5	2NDMOW/SEQ	7.0	9.0	9.3
PRIMO MAXX	1MEC	0.125	2NDMOW/SEQ			
PROXY	2SL	3	2NDMOW+1/SEQ	7.3	9.0	9.7
PRIMO MAXX	1MEC	0.125	2NDMOW+1/SEQ			
PROXY	2SL	5	2NDMOW+1/SEQ	6.7	9.0	9.3
PRIMO MAXX	1MEC	0.125	2NDMOW+1/SEQ			
PROXY	2SL	3	2NDMOW+2/SEQ	7.0	9.0	10.0
PRIMO MAXX	1MEC	0.125	2NDMOW+2/SEQ			
PROXY	2SL	5	2NDMOW+2/SEQ	7.3	9.0	10.0
PRIMO MAXX	1MEC	0.125	2NDMOW+2/SEQ			
CHECK				7.0	9.0	10.0
PROXY	2SL	3	2NDMOW+3/SEQ	6.7	9.0	9.3
PRIMO MAXX	1MEC	0.125	2NDMOW+3/SEQ			
PROXY	2SL	5	2NDMOW+3/SEQ	7.0	9.0	9.7
PRIMO MAXX	1MEC	0.125	2NDMOW+3/SEQ			
PROXY	2SL	3	BOOT/3WAT	7.3	9.0	9.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
FOLIAR	L	8	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	6.7	9.0	9.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
PROXY	SL	5	BOOT	6.7	9.0	10.0
PRIMO MAXX	1MEC	0.125	BOOT			
EMBARK T/O	0.2L	40/20 OZ/A	BOOT/3WAT	7.3	9.0	10.0
FERROMEC	L	5	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	7.7	9.0	10.0
FERROMEC	L	5	BOOT			
EMBARK T/O	0.2	40 OZ/A	2NDMOW	9.0	9.0	10.0
FERROMEC	L	5	2NDMOW			

Table 2. Ratings of the percent seedhead suppression, phytotoxicity, and quality of an annual bluegrass/creeping bentgrass putting green on May 12, 2004.

Treatment	**Form**	**Rate oz/M**	**Timing**	**%Supp[1]**	**Phyto[2]**	**Quality[3]**
PROXY PRIMO MAXX	2SL 1MEC	3 0.125	2NDMOW/SEQ 2NDMOW/SEQ	78.3abc	10.0	7.7
PROXY PRIMO MAXX	2SL 1MEC	5 0.125	2NDMOW/SEQ 2NDMOW/SEQ	76.7abc	9.0	7.7
PROXY PRIMO MAXX	2SL 1MEC	3 0.125	2NDMOW+1/SEQ 2NDMOW+1/SEQ	76.7abc	9.0	7.3
PROXY PRIMO MAXX	2SL 1MEC	5 0.125	2NDMOW+1/SEQ 2NDMOW+1/SEQ	90.0ab	7.0	7.7
PROXY PRIMO MAXX	2SL 1MEC	3 0.125	2NDMOW+2/SEQ 2NDMOW+2/SEQ	83.3abc	8.3	8.0
PROXY PRIMO MAXX	2SL 1MEC	5 0.125	2NDMOW+2/SEQ 2NDMOW+2/SEQ	83.3abc	8.7	8.7
CHECK				0.0d	10.0	6.0
PROXY PRIMO MAXX	2SL 1MEC	3 0.125	2NDMOW+3/SEQ 2NDMOW+3/SEQ	63.3c	8.7	6.7
PROXY PRIMO MAXX	2SL 1MEC	5 0.125	2NDMOW+3/SEQ 2NDMOW+3/SEQ	78.3abc	9.3	7.3
PROXY PRIMO MAXX FOLIAR	2SL 1MEC L	3 0.125 8	BOOT/3WAT BOOT/3WAT BOOT/3WAT	81.7abc	9.0	8.3
PROXY PRIMO MAXX	2SL 1MEC	3 0.125	BOOT/3WAT BOOT/3WAT	75.0abc	8.3	7.7
PROXY PRIMO MAXX	SL 1MEC	5 0.125	BOOT BOOT	81.7abc	8.3	7.7
EMBARK T/O FERROMEC	0.2L L	40/20 OZ/A 5	BOOT/3WAT BOOT	93.3a	5.7	6.3
EMBARK T/O FERROMEC	0.2L L	40 OZ/A 5	BOOT BOOT	95.0a	5.7	6.7
EMBARK T/O FERROMEC	0.2 L	40 OZ/A 5	2NDMOW 2NDMOW	70.0bc	9.0	6.7

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

Table 3. Ratings of the percent seedhead suppression, phytotoxicity, and quality of an annual bluegrass/creeping bentgrass putting green on May 18, 2004.

Treatment	Form	Rate oz/M	Timing	%Supp[1]	Phyto[2]	Quality[3]
PROXY	2SL	3	2NDMOW/SEQ	68.3a-e	10.0	7.7
PRIMO MAXX	1MEC	0.125	2NDMOW/SEQ			
PROXY	2SL	5	2NDMOW/SEQ	76.7a-e	10.0	7.7
PRIMO MAXX	1MEC	0.125	2NDMOW/SEQ			
PROXY	2SL	3	2NDMOW+1/SEQ	63.3b-e	8.7	6.7
PRIMO MAXX	1MEC	0.125	2NDMOW+1/SEQ			
PROXY	2SL	5	2NDMOW+1/SEQ	85.0abc	8.3	7.7
PRIMO MAXX	1MEC	0.125	2NDMOW+1/SEQ			
PROXY	2SL	3	2NDMOW+2/SEQ	78.3a-d	8.7	7.7
PRIMO MAXX	1MEC	0.125	2NDMOW+2/SEQ			
PROXY	2SL	5	2NDMOW+2/SEQ	78.3a-d	9.0	8.0
PRIMO MAXX	1MEC	0.125	2NDMOW+2/SEQ			
CHECK				0.0f	10.0	6.0
PROXY	2SL	3	2NDMOW+3/SEQ	56.7de	8.7	7.0
PRIMO MAXX	1MEC	0.125	2NDMOW+3/SEQ			
PROXY	2SL	5	2NDMOW+3/SEQ	80.0a-d	9.0	8.3
PRIMO MAXX	1MEC	0.125	2NDMOW+3/SEQ			
PROXY	2SL	3	BOOT/3WAT	68.3a-e	10.0	8.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
FOLIAR	L	8	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	50.0e	10.0	6.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
PROXY	SL	5	BOOT	60.0cde	10.0	7.0
PRIMO MAXX	1MEC	0.125	BOOT			
EMBARK T/O	0.2L	40/20 OZ/A	BOOT/3WAT	90.0ab	9.0	8.3
FERROMEC	L	5	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	91.7a	9.3	9.0
FERROMEC	L	5	BOOT			
EMBARK T/O	0.2	40 OZ/A	2NDMOW	53.3de	10.0	6.7
FERROMEC	L	5	2NDMOW			

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

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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 20 (BOOT) and May 11, 2004 (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 first mowing of the green was conducted on March 24, 2004 and the second mowing on April 7, 2004. On April 7, 2004 the turf was at about 75% green-up. On April 20, 2004 the forsythia was in full bloom. On April 21, 2004 annual bluegrass was at the boot stage of development. On April 28, 2004 forsythia was at the petal drop stage.

The turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a putting green.

Results and Discussion

Color was rated on April 27 and May 3 (Table 1). On the April 27 rating date, only turf treated with Velocity, Banner MAXX, Embark T&O plus 8 oz of MacroSorb Foliar, and Banner MAXX plus Primo MAXX had unacceptable color. By the May 3 rating date, Embark T&O alone, Embark T&O with MacroSorb Foliar (except when Ferromec was added), Embark T&O with GBJ2, Embark T&O with CoRon, Banner MAXX, and Banner MAXX plus Primo MAXX had unacceptable color. The unacceptable color rating found for turf treated with Velocity (April 27) improved to an acceptable level by May 3.

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Seedhead suppression rated on May 12 revealed that treatments that contained Embark T&O provided the best efficacy (Table 2). However, only the combination of Embark T&O, Ferromec, and MacroSorb Foliar had acceptable phytotoxicity and quality. Treatments containing Proxy/Primo MAXX and various additives provided suppression from 65 to 80%. While this level of suppression was not as high as that provided by Embark T&O, phytotoxicity was lower which resulted in generally higher quality ratings. Some seedhead suppression was observed as a result of Banner MAXX and the combination of Banner MAXX and Primo MAXX, however, severe phytotoxicity was caused which resulted in unacceptable turf quality.

By the May 18 rating date (Table 3), seedhead suppression levels of turf treated with applications containing the Proxy/Primo MAXX combinations were generally less than 60%. The two exceptions were when the Proxy/Primo MAXX combination was supplemented with either MacroSorb Foliar (65%) or CoRon (68%). Embark T&O, with and without additives maintained relatively high (generally above 85%) seedhead suppression while the turf had acceptable levels of phytotoxicity and quality. The untreated turf had unacceptable quality on both rating dates because of the presence of seedheads. Again, turf treated with Banner MAXX and combinations of Banner MAXX and Primo MAXX had minimal seedhead suppression, and that combined with phytotoxicity issues resulted in turf with unacceptable quality. It did not appear that sequential application (3 WAT) provided significant improvement in suppression of seedheads.

Table 1. Color ratings of an annual bluegrass/creeping bentgrass putting green on a scale of 0 to 10 where 0 = brown, 7 = acceptable, and 10 = dark green.

Treatment	Form	Rate oz/M	Timing	4/27/04	5/3/04
PROXY	2SL	5	BOOT	8.3	9.7
PRIMO MAXX	1MEC	0.125	BOOT		
PROXY	2 SL	3	BOOT	7.7	9.3
PRIMO MAXX	1MEC	0.125	BOOT		
PROXY	2SL	3	BOOT/3WAT	7.3	9.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	8.0	5.3
EMBARK T/O	0.2L	40 OZ/A	BOOT	9.2	8.0
FERROMEC	L	5	BOOT		
CHECK				7.7	10.0
EMBARK T/O	0.2L	40 OZ/A	BOOT	6.7	6.0
FOLIAR	L	8	BOOT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	7.0	5.7
FOLIAR	L	4	BOOT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	8.7	7.7
FERROMEC	L	5	BOOT		
FOLIAR	L	4	BOOT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	7.2	6.3
GBJ2	L	4	BOOT		
PROXY	2SL	5/3	BOOT/3WAT	8.0	9.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
PROXY	2SL	3	BOOT/3WAT	8.3	10.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
FOLIAR	L	2	BOOT/3WAT		
PROXY	2SL	3	BOOT/3WAT	8.3	9.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
MINORS	L	1.5	BOOT/3WAT		
PROXY	2SL	5/3	BOOT/3WAT	7.3	9.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
FOLIAR	L	2	BOOT/3WAT		
PROXY	2SL	3	BOOT/3WAT	9.2	10.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
18-3-4	1.75L	0.2 LB AI/M	BOOT/3WAT		
PROXY	2SL	3	BOOT/3WAT	9.2	9.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT		
CORON	2.9L	0.2 LB AI/M	BOOT/3WAT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	7.7	6.0
CORON	2.9L	0.2 LB AI/M	BOOT		
PROXY	2SL	3	BOOT/3WAT	8.7	9.3
PRIMO MAXX	1 MEC	0.125	BOOT/3WAT		
FOLIAR	L	4	BOOT/3WAT		
PROXY	2SL	3	BOOT/3WAT	7.7	9.7
PRIMO MAXX	1 MEC	0.125	BOOT/3WAT		
FOLIAR	L	8	BOOT/3WAT		
VELOCITY	17.6 WG	5 G A/A	BOOT	6.7	7.7
BANNER MAXX	MEC	2	BOOT	5.7	5.7
BANNER MAXX	MEC	4	BOOT	5.3	5.3
BANNER MAXX	MEC	2	BOOT	5.3	5.3
PRIMO MAXX	1 MEC	0.125	BOOT		
BANNER MAXX	MEC	4	BOOT	5.3	4.7
PRIMO MAXX	1 MEC	0.125	BOOT		

Table 2. Ratings of the percent seedhead suppression, phytotoxicity, and quality of an annual bluegrass/creeping bentgrass putting green on May 12, 2004.

Treatment	Form	Rate oz/M	Timing	%Supp[1]	Phyto[2]	Quality[3]
PROXY	2SL	5	BOOT	68.3d-g	9.0	8.3
PRIMO MAXX	1MEC	0.125	BOOT			
PROXY	2 SL	3	BOOT	65.0efg	9.3	7.0
PRIMO MAXX	1MEC	0.125	BOOT			
PROXY	2SL	3	BOOT/3WAT	70.0d-g	8.7	7.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	93.3a	5.7	6.0
EMBARK T/O	0.2L	40 OZ/A	BOOT	90.0ab	8.7	8.3
FERROMEC	L	5	BOOT			
CHECK				0.0i	10.0	6.0
EMBARK T/O	0.2L	40 OZ/A	BOOT	88.3abc	6.7	5.3
FOLIAR	L	8	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	86.7a-d	5.3	4.7
FOLIAR	L	4	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	91.7a	8.0	7.3
FERROMEC	L	5	BOOT			
FOLIAR	L	4	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	93.3a	6.7	6.3
GBJ2	L	4	BOOT			
PROXY	2SL	5/3	BOOT/3WAT	71.7c-g	9.7	8.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	70.0d-g	9.3	7.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
FOLIAR	L	2	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	78.3a-e	9.3	8.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
MINORS	L	1.5	BOOT/3WAT			
PROXY	2SL	5/3	BOOT/3WAT	80.0a-e	8.7	7.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
FOLIAR	L	2	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	78.3a-e	9.3	8.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
18-3-4	1.75L	0.2 LB AI/M	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	76.7a-e	8.7	8.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
CORON	2.9L	0.2 LB AI/M	BOOT/3WAT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	93.3a	6.7	6.0
CORON	2.9L	0.2 LB AI/M	BOOT			
PROXY	2SL	3	BOOT/3WAT	73.3b-f	9.0	6.7
PRIMO MAXX	1 MEC	0.125	BOOT/3WAT			
FOLIAR	L	4	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	68.3d-g	9.0	8.0
PRIMO MAXX	1 MEC	0.125	BOOT/3WAT			
FOLIAR	L	8	BOOT/3WAT			
VELOCITY	17.6 WG	5 G A/A	BOOT	56.7fgh	9.7	6.3
BANNER MAXX	MEC	2	BOOT	43.3h	4.7	4.0
BANNER MAXX	MEC	4	BOOT	68.3d-g	4.0	4.0
BANNER MAXX	MEC	2	BOOT	55.0gh	4.3	5.0
PRIMO MAXX	1 MEC	0.125	BOOT			
BANNER MAXX	MEC	4	BOOT	65.0efg	4.0	4.0
PRIMO MAXX	1 MEC	0.125	BOOT			

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

Table 3. Ratings of the percent seedhead suppression, phytotoxicity, and quality of an annual bluegrass/creeping bentgrass putting green on May 18, 2004.

Treatment	Form	Rate oz/M	Timing	%Supp[1]	Phyto[2]	Quality[3]
PROXY	2SL	5	BOOT	48.3cde	9.7	6.7
PRIMO MAXX	1MEC	0.125	BOOT			
PROXY	2 SL	3	BOOT	33.3e	10.0	6.0
PRIMO MAXX	1MEC	0.125	BOOT			
PROXY	2SL	3	BOOT/3WAT	51.7cde	9.3	7.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	88.3a	7.7	8.7
EMBARK T/O	0.2L	40 OZ/A	BOOT	80.0ab	10.0	8.7
FERROMEC	L	5	BOOT			
CHECK				0.0f	10.0	6.0
EMBARK T/O	0.2L	40 OZ/A	BOOT	90.0a	7.3	8.3
FOLIAR	L	8	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	90.0a	8.3	8.3
FOLIAR	L	4	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	90.0a	9.3	9.0
FERROMEC	L	5	BOOT			
FOLIAR	L	4	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	85.0ab	10.0	9.0
GBJ2	L	4	BOOT			
PROXY	2SL	5/3	BOOT/3WAT	38.3e	10.0	6.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	46.7cde	9.7	6.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
FOLIAR	L	2	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	43.3de	10.0	6.7
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
MINORS	L	1.5	BOOT/3WAT			
PROXY	2SL	5/3	BOOT/3WAT	65.0bcd	9.3	7.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
FOLIAR	L	2	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	50.0cde	10.0	6.3
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
18-3-4	1.75L	0.2 LB AI/M	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	68.3abc	10.0	7.0
PRIMO MAXX	1MEC	0.125	BOOT/3WAT			
CORON	2.9L	0.2 LB AI/M	BOOT/3WAT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	86.7a	9.3	9.0
CORON	2.9L	0.2 LB AI/M	BOOT			
PROXY	2SL	3	BOOT/3WAT	48.3cde	9.7	6.0
PRIMO MAXX	1 MEC	0.125	BOOT/3WAT			
FOLIAR	L	4	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	46.7cde	10.0	6.3
PRIMO MAXX	1 MEC	0.125	BOOT/3WAT			
FOLIAR	L	8	BOOT/3WAT			
VELOCITY	17.6 WG	5 G A/A	BOOT	38.3e	10.0	6.0
BANNER MAXX	MEC	2	BOOT	33.3e	5.7	4.0
BANNER MAXX	MEC	4	BOOT	43.3de	4.7	3.7
BANNER MAXX	MEC	2	BOOT	43.3de	6.0	5.0
PRIMO MAXX	1 MEC	0.125	BOOT			
BANNER MAXX	MEC	4	BOOT	46.7cde	4.3	3.3
PRIMO MAXX	1 MEC	0.125	BOOT			

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

Seedhead Suppression of Annual Bluegrass at Fairway Height

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

Introduction

This study was conducted on a mature stand of annual bluegrass (*Poa annua*) at the Valentine Turfgrass 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.

Methods and Materials

Treatments were applied on April 19 (BOOT) and May 11, 2004 (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 study was not replicated.

The turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a fairway.

Results and Discussion

On the May 3 rating date for phytotoxicity, only turf treated with the high rate of Banner MAXX alone or combined with Primo MAXX had unacceptable ratings (Table 1). By the May 12 rating date for phytotoxicity, those treatments causing unacceptable phytotoxicity on May 3 caused even more severe phytotoxicity (Table 2). Seedhead suppression was rated on May 12 (Table 2). Several treatments provided 80% or better seedhead suppression without causing unacceptable phytotoxicity. The addition of CoRon or GBJ2 to Embark (at the high rate) appeared to provide considerable safening without compromising suppression. The activity of the Proxy/Primo MAXX combination appeared to be appreciably enhanced by both NutraMax Minors, 18-3-4, and CoRon. Although seedhead suppression was found for applications of Banner MAXX at the 4 oz/M rate and when combined with Primo MAXX, the phytotoxicity caused by these treatments was found to be unacceptable.

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Table 1. Phytotoxicity ratings of an annual bluegrass at fairway height on a scale of 0 to 10 where 0 = brown, 7 = acceptable, and 10 = dark green.

Treatment	Form	Rate oz/M	Timing	4/21/04	4/28/04	5/3/04
PROXY	2SL	5	BOOT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT			
PROXY	2SL	5	BOOT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT			
FOLIAR	L	2	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10.0	10.0	7.0
EMBARK T/O	0.2L	60 OZ/A	BOOT	10.0	10.0	7.0
FOLIAR	L	2	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10.0	10.0	10.0
GBJ2	L	2	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	10.0	10.0	10.0
FOLIAR	L	4	BOOT			
EMBARK T/O	0.2L	40 OZ/A	BOOT	10.0	10.0	10.0
GBJ2	L	4	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10.0	10.0	10.0
CORON	2.9L	0.2 LB AI/M	BOOT			
EMBARK T/O	0.2L	60 OZ/A	BOOT	10.0	10.0	10.0
CORON	2.9L	0.2 LB AI/M	BOOT			
FOLIAR	L	2	BOOT			
CHECK				10.0	10.0	10.0
PROXY	2SL	5	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT/3WAT			
PROXY	2SL	3	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT			
MINORS	L	1.5	BOOT/3WAT			
PROXY	2SL	5	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT			
18-3-4	1.75L	0.2 LB AI/M	BOOT/3WAT			
PROXY	2SL	5	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT			
CORON	2.9L	0.2 LB AI/M	BOOT/3WAT			
PROXY	2SL	5/3	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.5/0.25	BOOT/3WAT			
PROXY	2SL	5/3	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.5/0.25	BOOT/3WAT			
FOLIAR	L	2	3WAT			
PROXY	2SL	5	BOOT/3WAT	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT			
FOLIAR	L	2	BOOT/3WAT			
VELOCITY	17.6 WG	5 G A/A	BOOT	10.0	10.0	10.0
BANNER MAXX	MEC	2	BOOT	10.0	10.0	7.0
BANNER MAXX	MEC	4	BOOT	10.0	10.0	5.0
BANNER MAXX	MEC	2	BOOT	10.0	10.0	5.0
PRIMO MAXX	1 MEC	0.25	BOOT			
BANNER MAXX	MEC	4	BOOT	10.0	10.0	5.0
PRIMO MAXX	1 MEC	0.25	BOOT			

Table 2. Ratings of the percent seedhead suppression and phytotoxicity of an annual bluegrass at fairway height.

Treatment	Form	Rate oz/M	Timing	%Supp 5/12/04	Phyto[1] 5/12/04
PROXY	2SL	5	BOOT	15.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT		
PROXY	2SL	5	BOOT	10.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT		
FOLIAR	L	2	BOOT		
EMBARK T/O	0.2L	60 OZ/A	BOOT	80.0	10.0
EMBARK T/O	0.2L	60 OZ/A	BOOT	85.0	10.0
FOLIAR	L	2	BOOT		
EMBARK T/O	0.2L	60 OZ/A	BOOT	80.0	10.0
GBJ2	L	2	BOOT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	75.0	10.0
FOLIAR	L	4	BOOT		
EMBARK T/O	0.2L	40 OZ/A	BOOT	75.0	10.0
GBJ2	L	4	BOOT		
EMBARK T/O	0.2L	60 OZ/A	BOOT	80.0	10.0
CORON	2.9L	0.2 LB AI/M	BOOT		
EMBARK T/O	0.2L	60 OZ/A	BOOT	80.0	10.0
CORON	2.9L	0.2 LB AI/M	BOOT		
FOLIAR	L	2	BOOT		
CHECK				0.0	10.0
PROXY	2SL	5	BOOT/3WAT	15.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT/3WAT		
PROXY	2SL	3	BOOT/3WAT	70.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT		
MINORS	L	1.5	BOOT/3WAT		
PROXY	2SL	5	BOOT/3WAT	80.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT		
18-3-4	1.75L	0.2 LB AI/M	BOOT/3WAT		
PROXY	2SL	5	BOOT/3WAT	85.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT		
CORON	2.9L	0.2 LB AI/M	BOOT/3WAT		
PROXY	2SL	5/3	BOOT/3WAT	70.0	10.0
PRIMO MAXX	1MEC	0.5/0.25	BOOT/3WAT		
PROXY	2SL	5/3	BOOT/3WAT	50.0	10.0
PRIMO MAXX	1MEC	0.5/0.25	BOOT/3WAT		
FOLIAR	L	2	3WAT		
PROXY	2SL	5	BOOT/3WAT	40.0	10.0
PRIMO MAXX	1MEC	0.5	BOOT/3WAT		
FOLIAR	L	2	BOOT/3WAT		
VELOCITY	17.6 WG	5 G A/A	BOOT	50.0	10.0
BANNER MAXX	MEC	2	BOOT	10.0	7.0
BANNER MAXX	MEC	4	BOOT	95.0	4.0
BANNER MAXX	MEC	2	BOOT	50.0	6.0
PRIMO MAXX	1 MEC	0.25	BOOT		
BANNER MAXX	MEC	4	BOOT	95.0	4.0
PRIMO MAXX	1 MEC	0.25	BOOT		

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

Annual Bluegrass Prevention on a Newly Established Putting Green

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

Introduction

This study was conducted on a mixed stand of 'Penncross' creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass (*Poa annua*) at the Valentine Turfgrass Research Center, University Park, PA. The objective of the study was to evaluate selected materials for the suppression of annual bluegrass encroachment into a newly established area maintained similar to a putting green.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on September 4 (FALL), September 16 (14DAT), and October 1, 2003 (28DAT) using a three-foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two 11004 flat fan nozzles at 40 psi.

The test area established in July of 2002. Normal practices for a putting green establishment were conducted. Subsequently, the turf was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a putting green.

Results and Discussion

None of the treatments caused discernable phytotoxicity to the turf (Table 1). Ratings for annual bluegrass encroachment the following spring revealed that the untreated turf had the greatest percent increase, but the amount was not significantly different from that found as a result of any of the treatments (Table 2).

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Table 1. Phytotoxicity ratings of a simulated 'Penncross' creeping bentgrass/annual bluegrass putting green on a scale of 0 to 10 where 0 =most, 7 = acceptable, and 10 = none. Ratings were taken in 2003.

Treatment	Form	Rate oz/M	Timing	9/5	9/8	9/11	9/16	9/18	9/23	9/30	10/7
BETASAN	4EC	9.2	FALL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN	4EC	9.2	FALL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
RUBIGAN	AS	2	14DAT								
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN	4EC	9.2	FALL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
RUBIGAN	AS	2	14DAT/28DAT								
BETASAN	4EC	9.2	FALL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
RUBIGAN	AS	2/4	14DAT/28DAT								
RUBIGAN	AS	2	FALL /14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 2. Percent annual bluegrass ratings of a simulated 'Penncross' creeping bentgrass/annual bluegrass putting green.

Treatment	Form	Rate oz/M	Timing	9/4/03	4/21/04
BETASAN	4EC	9.2	FALL	1.0a[1]	1.3a
BETASAN	4EC	9.2	FALL	1.0a	1.7a
RUBIGAN	AS	2	14DAT		
CHECK				1.0a	2.7a
BETASAN	4EC	9.2	FALL	1.0a	1.7a
RUBIGAN	AS	2	14DAT/28DAT		
BETASAN	4EC	9.2	FALL	1.0a	1.0a
RUBIGAN	AS	2/4	14DAT/28DAT		
RUBIGAN	AS	2	FALL /14DAT/28DAT	1.0a	1.0a

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

Annual Bluegrass Control in Fairway Height Creeping Bentgrass

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

Introduction

This study was conducted on a mature stand of 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 whether applications of Trimmit, Banner MAXX, and Primo MAXX could control annual bluegrass under fairway conditions.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on June 2, 10, 30, July 15, 28, August 13, 25, Sept 11, 24, Oct 7, 21, and Nov 11, 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 area was maintained at 0.5" using a triplex reel mower with the clippings collected.

Results and Discussion

Phytotoxicity, as a result of the treatments, was rated separately for creeping bentgrass and annual bluegrass (Tables 1 and 2). For the creeping bentgrass, the only date where unacceptable phytotoxicity was observed was on June 19, for turf treated with Trimmit 2SC at 0.368 oz/M at shatter and with the combination of Trimmit 2SC at 0.184 oz/M plus Primo MAXX at 0.15 oz/M four weeks later. This same treatment was observed to be more injurious to annual bluegrass, as was the Trimmit 2SC at 0.368 oz/M plus Banner MAXX 1.3MEC at 2 oz/M (Table 2). None of the treatments caused unacceptable phytotoxicity to either grass species after June 19. Quality ratings for creeping bentgrass were taken on seven dates and, at no time, was quality found to be unacceptable (Table 3).

Considerable variation was found when the percent change in the annual bluegrass population was assessed on all six rating dates during 2003 (Table 4). By the May 12, 2004 rating date, the Trimmit only treatment resulted in significantly more reduction in annual bluegrass than untreated turfgrass and turfgrass treated with Primo MAXX only. Although not significant, the annual bluegrass population increased by 22.2% following Primo MAXX only applications and the untreated annual bluegrass increased by 21.4%. Interestingly, when Trimmit only (50% reduction) was compared to Trimmit plus Primo MAXX only (5.6% reduction) annual bluegrass populations were not significantly different, but it appeared that the addition of Primo MAXX to the application regime may lessen annual bluegrass control.

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Table 1. Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best taken in 2003.

Treatment	**Form**	**Rate (oz/M)**	**Timing**	**6-12**	**6-19**	**6-26**	**7-02**	**7-10**	**7-31**	**8-7**	**8-14**	**8-21**	**8-28**	**9-4**
				(-----				**Phytotoxicity**						**-----)**
TRIMMIT TRIMMIT	2SC 2SC	0.368 0.184	SHATTER/OCT 4 WAT	9.0	8.0	8.0	8.7	8.0	10.0	10.0	9.7	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.15	SHATTER/ 4WAT/OCT	9.0	9.0	8.7	8.7	9.0	10.0	10.0	9.3	10.0	10.0	10.0
TRIMMIT PRIMO MAXX	2SC 1MEC	0.368 0.15	SHATTER/OCT 4WAT	9.0	8.3	8.3	8.7	8.7	10.0	10.0	9.3	10.0	10.0	10.0
TRIMMIT PRIMO MAXX TRIMMIT	2SC 1MEC 2SC	0.368 0.15 0.184	SHATTER/OCT SHATTE/4WAT/OCT 4WAT	8.0	6.7	8.0	8.3	8.0	10.0	10.0	9.3	10.0	10.0	9.7
TRIMMIT BANNER MAXX	2SC 1.3MEC	0.368 2	SHATTER/OCT 2 WAT	8.7	7.7	8.0	8.0	8.3	9.0	10.0	9.0	10.0	9.0	9.0
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 1 (cont). Evaluations of fairway height creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best taken in 2003.

Treatment	**Form**	**Rate (oz/M)**	**Timing**	**9-18**	**9-26**	**10-1**	**10-10**	**10-17**	**11-8**
				(-----		**Phytotoxicity**			**-----)**
TRIMMIT TRIMMIT	2SC 2SC	0.368 0.184	SHATTER/OCT 4 WAT	10.0	9.3	9.5	9.7	10.0	6.7
PRIMO MAXX	1MEC	0.15	SHATTER/ 4WAT/OCT	10.0	8.7	9.0	9.3	10.0	8.3
TRIMMIT PRIMO MAXX	2SC 1MEC	0.368 0.15	SHATTER/OCT 4WAT	9.7	8.7	9.0	9.0	10.0	7.0
TRIMMIT PRIMO MAXX TRIMMIT	2SC 1MEC 2SC	0.368 0.15 0.184	SHATTER/OCT SHATTE/4WAT/OCT 4WAT	9.3	8.3	8.5	9.0	8.0	5.0
TRIMMIT BANNER MAXX	2SC 1.3MEC	0.368 2	SHATTER/OCT 2 WAT	9.0	8.0	8.5	9.0	10.0	5.7
CHECK				10.0	10.0	10.0	10.0	10.0	10.0

Table 2. Evaluations of fairway height annual bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best taken in 2003.

Treatment	Form	Rate (oz/M)	Timing	Phytotoxicity 6-12	6-19	6-26	7-02	7-10	7-31	8-7	8-14	8-21	8-28	9-4
TRIMMIT	2SC	0.368	SHATTER/OCT	8.7	7.7	8.0	8.7	8.0	10.0	10.0	9.7	10.0	10.0	10.0
TRIMMIT	2SC	0.184	4 WAT											
PRIMO MAXX	1MEC	0.15	SHATTER/ 4WAT/OCT	9.0	9.0	8.3	8.7	9.0	10.0	10.0	9.3	10.0	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER/OCT	8.7	7.7	8.0	8.7	8.7	10.0	10.0	9.3	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.15	4WAT											
TRIMMIT	2SC	0.368	SHATTER/OCT	6.7	5.7	7.3	8.3	8.0	10.0	10.0	9.3	10.0	10.0	9.7
PRIMO MAXX	1MEC	0.15	SHATTE/4WAT/OCT											
TRIMMIT	2SC	0.184	4WAT											
TRIMMIT	2SC	0.368	SHATTER/OCT	8.7	6.0	7.7	8.0	8.3	9.0	10.0	9.0	10.0	9.0	9.0
BANNER MAXX	1.3MEC	2	2 WAT											
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 2 (cont). Evaluations of fairway height annual bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = best taken in 2003.

Treatment	Form	Rate (oz/M)	Timing	Phytotoxicity 9-18	9-26	10-1	10-10	10-17	11-8
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	9.3	9.5	9.7	10.0	6.7
TRIMMIT	2SC	0.184	4 WAT						
PRIMO MAXX	1MEC	0.15	SHATTER/ 4WAT/OCT	10.0	8.7	9.0	9.3	10.0	8.3
TRIMMIT	2SC	0.368	SHATTER/OCT	9.7	8.7	9.0	9.0	10.0	7.0
PRIMO MAXX	1MEC	0.15	4WAT						
TRIMMIT	2SC	0.368	SHATTER/OCT	9.3	8.3	8.5	9.0	8.0	5.0
PRIMO MAXX	1MEC	0.15	SHATTE/4WAT/OCT						
TRIMMIT	2SC	0.184	4WAT						
TRIMMIT	2SC	0.368	SHATTER/OCT	9.0	8.0	8.5	9.0	10.0	5.7
BANNER MAXX	1.3MEC	2	2 WAT						
CHECK				10.0	10.0	10.0	10.0	10.0	10.0

Table 3. Evaluations of creeping bentgrass quality where 0 = worst, 7 = acceptable and 10 = best taken in 2003.

Treatment	Form	Rate (oz/M)	Timing	(----Quality----) 7-17	7-24	7-31	8-7	8-14	8-28	9-4	9-11	9-18	9-26
TRIMMIT TRIMMIT	2SC 2SC	0.368 0.184	SHATTER/OCT 4 WAT	8.7	8.0	8.3	8.8	8.0	9.0	9.0	9.0	9.0	8.0
PRIMO MAXX	1MEC	0.15	SHATTER/ 4WAT/OCT	8.0	8.2	8.8	9.3	9.0	9.0	9.0	9.2	9.0	7.7
TRIMMIT PRIMO MAXX	2SC 1MEC	0.368 0.15	SHATTER/OCT 4WAT	8.7	8.7	8.7	9.3	8.7	9.0	9.0	8.7	8.7	7.7
TRIMMIT PRIMO MAXX TRIMMIT	2SC 1MEC 2SC	0.368 0.15 0.184	SHATTER/OCT SHATTE/4WAT/OCT 4WAT	8.7	8.7	9.0	9.3	9.0	9.0	8.3	8.7	8.3	7.3
TRIMMIT BANNER MAXX	2SC 1.3MEC	0.368 2	SHATTER/OCT 2 WAT	8.7	9.0	8.3	9.5	8.3	8.0	8.3	9.0	8.0	7.0
CHECK				8.3	7.7	7.8	7.8	8.0	9.0	8.7	9.0	8.0	8.0

Table 4. Percent change of annual bluegrass in 2003 and May 12, 2004.

Treatment	Form	Rate (oz/M)	Timing	(----% Change----) 6-26	7-17	7-31	8-14	8-28	9-26	5-12
TRIMMIT TRIMMIT	2SC 2SC	0.368 0.184	SHATTER/OCT 4 WAT	16.7a[1,2]	33.3a	50.0ab	41.7a	25.0b	33.3ab	50.0a
PRIMO MAXX	1MEC	0.15	SHATTER/ 4WAT/OCT	16.7a	47.2a	55.6ab	44.4a	36.1ab	27.8ab	-22.2b
TRIMMIT PRIMO MAXX	2SC 1MEC	0.368 0.15	SHATTER/OCT 4WAT	0.0a	55.6a	55.6ab	55.6a	55.6a	38.9ab	5.6ab
TRIMMIT PRIMO MAXX TRIMMIT	2SC 1MEC 2SC	0.368 0.15 0.184	SHATTER/OCT SHATTE/4WAT/OCT 4WAT	0.0a	50.0a	50.0ab	50.0a	25.0b	16.7b	33.3ab
TRIMMIT BANNER MAXX	2SC 1.3MEC	0.368 2	SHATTER/OCT 2 WAT	0.0a	41.1a	41.1b	52.2a	52.2ab	45.6a	4.4ab
CHECK				0.0a	22.6a	57.1a	47.6a	47.6ab	29.8ab	-21.4b

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

2 – Positive numbers represent a percent decrease and negative numbers a percent increase.

Post Emergence Control of Ground Ivy and Other 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. Thus, the term "other weed" (used in this report) 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 which were all 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 25, 2003 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 Aug 25, 2003. Each plot was rated for ground ivy cover and other weed cover on June 25 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

All of the treatments, except Quicksilver provided excellent control of ground ivy (>90%) (Table 1) on the first rating date August 25, 2003. By the last rating date, June 4, 2004, almost one year after treatment application, almost no control of ground ivy was observed. Control of the entire weed population present to an acceptable degree (>80%) was only attained from the application of Confront and Trimec Classic (Table 2). Drive plus 2,4-d plus MSO, Quicksilver plus Trimec Classic, and Speed Zone alone did not exhibit acceptable broad spectrum control for the weeds found on this experimental site

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Table1. Rating of percent reduction of the ground ivy population.

Treatment	Form	Rate	8-25-03	6-4-04
QUICK SILVER	1.9EW	0.019 LB A/A	18.1c[1]	25.0ab
CHECK			0.0c	36.7a
DRIVE	75DF	0.75 LB A/A	100.0a	6.7c
2,4-D	3.8L	1.0 LB A/A		
MSO	L	1 % V/V		
SPEED ZONE	L	3 PT/A	90.5a	10.3c
QUICK SILVER	1.9EW	0.019 LB A/A	90.6a	3.3c
TRIMEC CLASSIC	L	3 PT/A		
CONFRONT	3SL	0.75 LB A/A	100.0a	1.7c
TRIMEC CLASSIC	L	4 PT/A	99.5a	10.0c

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

Table 2. Rating of percent reduction of the "other weed" populations.

Treatment	Form	Rate	8-25-03
QUICK SILVER	1.9EW	0.019 LB A/A	11.1c[1]
CHECK			9.7c
DRIVE	75DF	0.75 LB A/A	55.8abc
2,4-D	3.8L	1.0 LB A/A	
MSO	L	1 % V/V	
SPEED ZONE	L	3 PT/A	37.2abc
QUICK SILVER	1.9EW	0.019 LB A/A	27.8bc
TRIMEC CLASSIC	L	3 PT/A	
CONFRONT	3SL	0.75 LB A/A	81.1ab
TRIMEC CLASSIC	L	4 PT/A	92.8a

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

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).

On the final rating date, June 4, 2004, almost two years after the single application of materials, the ground ivy population increased on most of the treated plots and the untreated plots (Table 1). But, there was still greater than 55% reduction of ground ivy following the application of Drive plus 2,4-D plus MSO, Power Zone, Confront, and Trimec Classic.

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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	6-4-04
LEBANON TURF HERBICIDE	0.68G	157 LB/A	8.9c[1]	22.2b	-8.9c	8.9ab
CHECK			-6.7c	-13.3b	-13.8c	-40.0b
DRIVE	75DF	0.75 LB A/A	100.0a	100.0a	98.9a	65.3a
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	26.7ab
POWER ZONE	L	3.5 PT/A	94.5a	75.8a	40.8bc	55.8a
CONFRONT	3SL	0.75 LB A/A	97.2a	100.0a	90.8ab	79.2a
TRIMEC CLASSIC	L	4 PT/A	100.0a	100.0a	89.6ab	60.0a

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.

Annual Bluegrass Control in Green Height Creeping Bentgrass

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

Introduction

This study was conducted on a mature stand of 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 the efficacy of plant growth regulators and fungicides to control annual bluegrass on a simulated putting green.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on May 5 (SHATTER), May 30 (2WAT), June 11 (4WAT), June 26 (6WAT), July 10 (10WAT), July 22 (12WAT), Aug 6 (16WAT), Aug 20 (18WAT), Sept 4 (22WAT), Sept 17 (24WAT), and Oct 1, 2002 (OCT) using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi. In 2003 treatments were applied on May 16 (SHATTER), May 30 (2WAT), June 13 (4WAT), and June 27 (6WAT). The test site was maintained similar to that of a golf course putting green with respect to irrigation, fertilization and mowing. All test plots were rated for the percentage of annual bluegrass prior to the application of test materials.

A soil test was conducted on the test site on April 10, 2002 by the Agricultural Analytical Services Laboratory, Penn State University, University Park, PA. The soil test revealed a soil pH of 6.1, phosphorus concentration of 61 ppm, and potassium concentration of 115 ppm. The soil test report recommended the site receive 2 lbs K_2O/M for optimum growing conditions. Therefore, 1 lb K_2O/M was applied to the site on April 24 and May 7, 2002 from an 0-0-60 basic fertilizer using a three foot drop spreader. On May 7, 2002 1 lb P_2O_5/M was applied using a three foot drop spreader from a 0-46-0 basic fertilizer.

On April 10, 2002 1.5 lbs N/M was applied to the test site using a three foot drop spreader. The nitrogen source was IBDU 31-0-0 (Par Ex IBDU greens grade) with an analysis of 27% water insoluble nitrogen and 4% urea nitrogen.

The soil of the test site was also evaluated for particle size using the pipette method. The test revealed this particle size percent by weight; gravel (>2mm) 1.6, very coarse sand (2 - 1mm) 3.6, coarse sand (1 - 0.5mm) 25.1, medium sand (0.5 - 0.25mm) 33.3, fine sand (0.25 - 0.15mm) 12.4, very fine sand (0.15 - 0.05mm) 3.8, silt (0.05 – 0.002mm) 14.7, and clay (< 0.002mm) 5.7.

A tank mix of Bravo Ultrex (2.6 oz/M), Chipco GT (2oz/M), and Bayleton 50 (0.11 oz/M) was applied on June 4, 2002 as dollar spot had been identified on the test site. On June 19, 2002 Cleary's 3336 (3 oz/M) and Fungo (2 oz/M) were tank mixed and applied to the test site to control dollar spot again. In order to control cutworms found in the test site, Scimitar was applied on June 20, 2002 at a rate of 10 oz/A. Dollar spot was again identified and a tank mix of Bravo Ultrex (2.6 oz/M), Chipco GT (2oz/M), and Bayleton 50 (0.11 oz/M) was applied on July 21, Aug 29, and Sept 25, 2002.

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On Aug 5, 2002 Scimitar (10 oz/A) was applied to control cut worms that had been identified on the test site. On Aug 29, 2002 Talstar (0.25 oz/M) was applied to the test site as sod webworms had been identified. All the general maintenance applications were made with a Toro Multi Pro 5500 with 11, ¼ TT J10-VS flood jet nozzles spaced at 20 inches and calibrated to deliver two gpm.

Results and Discussion

At some point during 2002, all treatments caused unacceptable phytotoxicity to the annual bluegrass in the mixed sward (Table 1). At times, the untreated annual bluegrass was rated as having unacceptable phytotoxicity which was the result of environmental stress, disease, or insects, not as a result of any chemical applications. In general, the treatment that caused the harshest phytotoxicity was Trimmit 2SC at 0.368 oz/M at annual bluegrass seedhead shatter and in October with Primo MAXX applied at 0.15 oz/M with a timing of 4, 10, 16, and 22 WAT, plus Banner MAXX at 2 oz/M with a timing of 2, 6, 12, 18, and 24 WAT. The treatment causing the least phytotoxicity to the annual bluegrass was Primo MAXX at 0.15 with a timing of SHATTER, 4, 10, 16, and 22 WAT. In fact the Primo MAXX treated annual bluegrass had fewer dates (4) when it was rated as having unacceptable phytotoxicity compared to untreated which was rated as unacceptable six times. Phytotoxicity of annual bluegrass was rated three times in 2003 resulting in information that was similar to that found in 2002.

A significant different set of phytotoxicity data was collected in 2002 and 2003 for creeping bentgrass (Table 2). With the exception of the treatment that was the harshest to annual bluegrass, none of the other treatments ever caused an unacceptable level of phytotoxicity.

Quality was rated four times in 2002 (Table 3). This rating was a whole plot rating which consequently combined the quality of both species. In addition, plots containing more annual bluegrass had poorer quality than those with a higher percentage of creeping bentgrass. Even so, by the June 27 rating date, all treated turfgrass had essentially the same quality.

The percent change (plot by plot) in the annual bluegrass population was rated four times in 2002 and on May 1, 2003 (Table 4). The treatment using only Trimmit throughout the season provided the most consistent annual bluegrass reduction. The annual bluegrass population in the untreated plots remained relatively stable throughout the experiment. Having Primo MAXX as part of a treatment regime with Trimmit tended to decrease the level of annual bluegrass suppression.

An increase of brown patch disease occurred in August of 2002. Interestingly, the treatment containing Banner MAXX had more sever disease than any of the other treatments, including the untreated check (Table 5).

Table 1. Phytotoxicity of the annual bluegrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	5-23	5-31	6-7	6-12	6-19	6-27
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	6.0	8.0	6.3	6.5	6.0
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	10.0	7.0	10.0	7.0	8.7	7.3
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	6.2	6.3	7.0	7.3	8.3
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
CHECK				9.3	7.2	9.7	6.5	10.0	8.3
TRIMMIT	2SC	0.368	SHATTER	8.0	5.0	5.7	6.3	5.8	6.7
PRIMO MAXX	1MEC	0.15	SHATTER						
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	5.8	4.7	5.0	4.3	8.0
BANNER MAXX	L	2	2/6/12/18/24WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						

Table 1 (Continued). Phytotoxicity of the annual bluegrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	7-2	7-11	7-18	7-24	8-8	8-15	8-22
TRIMMIT	2SC	0.368	SHATTER/OCT	6.0	8.2	5.2	6.3	7.3	4.7	5.7
TRIMMIT	2SC	0.184	4/10/16/22WAT							
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	6.3	8.0	5.8	8.3	7.5	5.3	7.0
TRIMMIT	2SC	0.368	SHATTER/OCT	7.0	9.0	6.8	9.3	8.0	5.3	6.7
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT							
CHECK				6.7	8.7	6.7	8.7	7.3	5.7	7.0
TRIMMIT	2SC	0.368	SHATTER	6.3	8.0	5.0	4.0	8.0	4.0	5.7
PRIMO MAXX	1MEC	0.15	SHATTER							
TRIMMIT	2SC	0.184	4/10/16/22WAT							
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT							
TRIMMIT	2SC	0.368	SHATTER/OCT	5.7	8.0	10.0	10.0	7.8	5.7	7.0
BANNER MAXX	L	2	2/6/12/18/24WAT							
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT							

Table 1 (Continued). Phytotoxicity of the annual bluegrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	8-29	9-5	9-12	9-26	10-18
TRIMMIT	2SC	0.368	SHATTER/OCT	6.0	6.7	7.0	1 0.0	9.3
TRIMMIT	2SC	0.184	4/10/16/22WAT					
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	6.7	7.0	7.7	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER/OCT	7.3	6.7	7.0	10.0	9.3
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT					
CHECK				6.7	6.3	7.7	9.7	10.0
TRIMMIT	2SC	0.368	SHATTER	5.7	6.3	5.0	10.0	10.0
PRIMO MAXX	1MEC	0.15	SHATTER					
TRIMMIT	2SC	0.184	4/10/16/22WAT					
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT					
TRIMMIT	2SC	0.368	SHATTER/OCT	5.3	5.7	8.3	10.0	9.0
BANNER MAXX	L	2	2/6/12/18/24WAT					
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT					

Table 1 (Continued). Phytotoxicity of the annual bluegrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2003 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	**Form**	**Rate Oz/M**	**Timing**	**6-5**	**6-19**	**7-15**
TRIMMIT	2SC	0.368	SHATTER/OCT	6.0	8.7	10.0
TRIMMIT	2SC	0.184	4/10/16/22WAT			
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	10.0	7.3	10.0
TRIMMIT	2SC	0.368	SHATTER/OCT	5.0	7.3	10.0
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT			
CHECK				10.0	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER	5.3	7.3	10.0
PRIMO MAXX	1MEC	0.15	SHATTER			
TRIMMIT	2SC	0.184	4/10/16/22WAT			
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT			
TRIMMIT	2SC	0.368	SHATTER/OCT	4.3	5.7	10.0
BANNER MAXX	L	2	2/6/12/18/24WAT			
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT			

Table 2. Phytotoxicity of the creeping bentgrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	5-23	5-31	6-7	6-12	6-19	6-27
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	10.0	9.3	8.7	10.0	10.0
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	10.0	10.0	10.0	9.0	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	10.0	8.7	9.7	10.0	10.0
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
CHECK				10.0	10.0	9.7	9.5	10.0	9.7
TRIMMIT	2SC	0.368	SHATTER	10.0	10.0	8.0	9.5	10.0	10.0
PRIMO MAXX	1MEC	0.15	SHATTER						
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	10.0	5.7	5.7	8.0	10.0
BANNER MAXX	L	2	2/6/12/18/24WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						

Table 2 (Continued). Phytotoxicity of the creeping bentgrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	7-2	7-11	7-18	7-24	8-8	8-15
TRIMMIT	2SC	0.368	SHATTER/OCT	8.8	10.0	10.0	10.0	10.0	8.8
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	8.7	10.0	10.0	10.0	10.0	9.2
TRIMMIT	2SC	0.368	SHATTER/OCT	9.0	10.0	10.0	10.0	10.0	9.3
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
CHECK				8.7	10.0	10.0	10.0	10.0	9.0
TRIMMIT	2SC	0.368	SHATTER	9.3	10.0	10.0	10.0	9.7	8.0
PRIMO MAXX	1MEC	0.15	SHATTER						
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
TRIMMIT	2SC	0.368	SHATTER/OCT	9.3	10.0	10.0	10.0	10.0	10.0
BANNER MAXX	L	2	2/6/12/18/24WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						

Table 2 (Continued). Phytotoxicity of the creeping bentgrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	8-22	8-29	9-5	9-12	9-26	10-18
TRIMMIT	2SC	0.368	SHATTER/OCT	9.3	10.0	10.0	9.3	10.0	9.3
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	10.0	10.0	10.0	9.0	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	10.0	10.0	9.3	10.0	9.3
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
CHECK				9.7	10.0	9.0	9.7	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER	8.7	10.0	10.0	9.0	10.0	10.0
PRIMO MAXX	1MEC	0.15	SHATTER						
TRIMMIT	2SC	0.184	4/10/16/22WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						
TRIMMIT	2SC	0.368	SHATTER/OCT	10.0	10.0	10.0	9.0	10.0	9.0
BANNER MAXX L		2	2/6/12/18/24WAT						
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT						

Table 2 (Continued). Phytotoxicity of the creeping bentgrass population in a creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2003 on a scale of 0 to 10 where 0 = most phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity.

Treatment	Form	Rate Oz/M	Timing	6-5	6-19	7-15
TRIMMIT	2SC	0.368	SHATTER/OCT	8.7	10.0	10.0
TRIMMIT	2SC	0.184	4/10/16/22WAT			
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	10.0	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER/OCT	7.7	10.0	10.0
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT			
CHECK				10.0	10.0	10.0
TRIMMIT	2SC	0.368	SHATTER	7.3	10.0	10.0
PRIMO MAXX	1MEC	0.15	SHATTER			
TRIMMIT	2SC	0.184	4/10/16/22WAT			
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT			
TRIMMIT	2SC	0.368	SHATTER/OCT	4.3	7.3	10.0
BANNER MAXX L		2	2/6/12/18/24WAT			
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT			

Table 3. Quality of the creeping bentgrass/annual bluegrass simulated putting green. Rating were taken in 2002 on a scale of 0 to 10 where 0 = worst, 7 = acceptable, and 10 = best.

Treatment	Form	Rate Oz/M	Timing	5-31	6-12	6-27	7-11
TRIMMIT	2SC	0.368	SHATTER/OCT	6.0	6.3	8.3	9.0
TRIMMIT	2SC	0.184	4/10/16/22WAT				
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	6.7	8.2	8.7	9.0
TRIMMIT	2SC	0.368	SHATTER/OCT	6.3	8.0	9.0	9.0
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT				
CHECK				7.2	6.8	9.0	9.0
TRIMMIT	2SC	0.368	SHATTER	5.3	7.8	8.7	9.0
PRIMO MAXX	1MEC	0.15	SHATTER				
TRIMMIT	2SC	0.184	4/10/16/22WAT				
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT				
TRIMMIT	2SC	0.368	SHATTER/OCT	5.7	3.3	9.3	9.0
BANNER MAXX L		2	2/6/12/18/24WAT				
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT				

Table 4. Percent change in the annual bluegrass population in a creeping bentgrass annual bluegrass simulated putting green.

Treatment	Form	Rate Oz/M	Timing	6-12-02	7-11-02	8-8-02	9-5-02	5-1-03
				(-------% Change in Annual Bluegrass Population---------)				
TRIMMIT	2SC	0.368	SHATTER/OCT	6.7a[1,2]	19.8a	66.3a	66.5ab	62.6a
TRIMMIT	2SC	0.184	4/10/16/22WAT					
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	0.0a	16.1a	26.1c	16.3d	16.4bc
TRIMMIT	2SC	0.368	SHATTER/OCT	0.0a	13.7a	44.4b	29.4cd	38.1abc
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT					
CHECK				0.0a	10.8a	14.8c	2.0d	2.0c
TRIMMIT	2SC	0.368	SHATTER	3.7a	21.1a	68.7a	74.0a	44.2ab
PRIMO MAXX	1MEC	0.15	SHATTER					
TRIMMIT	2SC	0.184	4/10/16/22WAT					
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT					
TRIMMIT	2SC	0.368	SHATTER/OCT	3.7a	19.6a	50.8ab	46.1bc	30.1abc
BANNER MAXX L		2	2/6/12/18/24WAT					
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT					

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

2 – Positive numbers are a decrease in population and negative numbers an increase in population.

Table 5. Ratings of the percent brown patch of the creeping bentgrass/annual bluegrass simulated putting green. Ratings were taken on a percent of the infected area of the test plots.

Treatment	Form	Rate Oz/M	Timing	% Brown Patch 8-16-02
TRIMMIT	2SC	0.368	SHATTER/OCT	5.0b[1]
TRIMMIT	2SC	0.184	4/10/16/22WAT	
PRIMO MAXX	1MEC	0.15	SHATTER/4/10/16/22WAT	0.7b
TRIMMIT	2SC	0.368	SHATTER/OCT	3.7b
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT	
CHECK				0.7b
TRIMMIT	2SC	0.368	SHATTER	10.0b
PRIMO MAXX	1MEC	0.15	SHATTER	
TRIMMIT	2SC	0.184	4/10/16/22WAT	
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT	
TRIMMIT	2SC	0.368	SHATTER/OCT	28.3a
BANNER MAXX	L	2	2/6/12/18/24WAT	
PRIMO MAXX	1MEC	0.15	4/10/16/22WAT	

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

Evaluation of Plant Growth Regulators on Fairway Height Creeping Bentgrass

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

Introduction

This study was conducted on a mature stand of 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 the efficacy of granular and liquid plant growth regulators alone or in combination with a fertilizer using color ratings and measurements of plant height and fresh weight foliar yield. Additionally, an application of a granular fertilizer was evaluated for growth effects.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on June 2 (SUMMER), June14 (14DAT), and June 30, 2004 (21 DAT) using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi. and a shaker jar. The test site was maintained similar to that of a golf course fairway with respect to irrigation, fertilization and mowing. Turfgrass height was measured using a Turfcheck 1 prism.

Results and Discussion

The most consistent and best color ratings were found for the 16-4-8 fertilizer (Table 1). However, none of the treatments were found to reduce color ratings below that of acceptable. On June 15, turf treated with Trimmit at 8 oz/A in combination with Primo MAXX at 5.5 oz/A was significantly shorter than untreated while the fertilizer only treatment was significantly taller than the untreated (Table 2). On June 29, July 6, and July13 turf treated with Cutless 0.175G at 214.3 lbs/A was taller than untreated. On July 20, turf treated with fertilizer, Cutless 0.175G at 214.3 lbs/A, and Velocity 80WP at 10 g ai/A was taller than untreated. On July 28 and August 5, only turf treated with Cutless 0.175G at 214.3 lbs/A was taller than untreated. On June 7, turf treated with Velocity 80WP at 10 g ai/A, Cutless 0.175G at 214.3 lbs/A, and the 16-4-8 fertilizer at 214.3 lbs/A had significantly higher fresh weight yield than untreated (Table 3). On June 15, turf treated with Trimmit 2SC at 8 oz/A in combination with Primo MAXX at 5.5 oz/A and Cutless 0.33G at 113.6 lbs/A had less yield than untreated while turf treated with the 16-4-8 fertilizer continued to have higher yield than untreated. On June 24, turf treated with Cutless 0.33G at 113.6 lbs/A had less yield than untreated while turf treated with Cutless 0.175G at 214.9 lbs/A and fertilizer alone had greater yields than the untreated. On June 29, none of the treatments resulted in significantly less yield than untreated while turf treated with Cutless 0.175G at 214.3 lbs/A and fertilizer alone continued to out yield the untreated. None of the treatments significantly reduced yield compared to untreated on the July 20 and 28 and August 5 rating dates. However, some treatments resulted in significantly more yield than untreated on those dates as a result of fertility or rebound effect or both (Table 3).

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Table 1. Color ratings on a scale of 0-10 where 0 = brown, 7= acceptable, and 10 = dark green of PGR's applied to creeping bentgrass taken in 2004.

Treatment	Form	Rate lb/A	Timing	6-7	6-15	6-29	7-6	7-13	7-20	7-28	8-5
VELOCITY	80WP	10 G A/A	SUMMER/14DAT	8.3	8.7	8.5	8.7	8.7	9.2	9.3	9.7
VELOCITY	17.6WDG	10 G A/A	SUMMER/14DAT	7.7	8.5	8.3	8.5	8.2	8.3	8.5	9.3
TRIMMIT	2SC	12 OZ/A	SUMMER/21DAT	8.5	9.0	8.7	8.3	8.3	8.8	9.3	9.8
TRIMMIT PRIMO	2SC 1MEC	8 OZ/A 5.5 OZ/A	SUMMER/21DAT SUMMER/21DAT	8.5	9.0	8.7	8.8	8.8	8.8	9.7	9.8
TRIMMIT	2SC	8 OZ/A	SUMMER/21DAT	8.3	8.5	8.2	8.2	8.0	8.0	8.8	9.3
CHECK				8.7	8.8	8.7	8.7	8.7	8.2	9.0	9.5
TRIMMIT 18-3-4	2SC 1.75L	8 OZ/A 0.2 OZ A/M	SUMMER/21DAT SUMMER/21DAT	8.8	9.2	8.8	9.0	8.8	9.3	9.7	9.8
CUTLESS	50WP	0.38	SUMMER/21DAT	8.3	8.0	8.3	8.0	8.3	8.7	9.3	9.5
CUTLESS	50WP	0.75	SUMMER/21DAT	8.3	8.5	8.7	8.3	7.7	9.2	8.7	9.7
CUTLESS	0.175G	214.3	SUMMER/21DAT	9.5	9.5	9.3	9.5	9.5	9.5	10.0	9.8
CUTLESS	0.33G	113.6	SUMMER/21DAT	8.0	7.7	8.0	8.3	8.3	9.0	9.2	9.5
16-4-8 FERT	0.16G	214.3	SUMMER/21DAT	9.5	9.5	9.3	9.5	9.5	9.5	9.7	9.7

Table 2. Height ratings (in inches) of PGR's applied to creeping bentgrass taken in 2004.

Treatment	Form	Rate lb/A	Timing	6-7 [1]	6-15	6-24	6-29	7-6	7-13	7-20	7-28	8-5
VELOCITY	80WP	10 G A/A	SUMMER/14DAT	0.43a	0.48bcd	0.51cd	0.52bcd	0.52bc	0.33b	0.41b	0.54c	0.54ab
VELOCITY	17.6WDG	10 G A/A	SUMMER/14DAT	0.41a	0.49bcd	0.50cd	0.48d	0.50bcd	0.36b	0.36bc	0.58bc	0.49b
TRIMMIT	2SC	12 OZ/A	SUMMER/21DAT	0.44a	0.47b-e	0.54bc	0.52bcd	0.51bcd	0.33b	0.38bc	0.58bc	0.53ab
TRIMMIT PRIMO	2SC 1MEC	8 OZ/A 5.5 OZ/A	SUMMER/21DAT SUMMER/21DAT	0.40a	0.42e	0.50cd	0.52bcd	0.48cd	0.32b	0.39bc	0.60bc	0.54ab
TRIMMIT	2SC	8 OZ/A	SUMMER/21DAT	0.43a	0.46cde	0.51cd	0.52bcd	0.49bcd	0.32b	0.36bc	0.58bc	0.49b
CHECK				0.43a	0.49bcd	0.51cd	0.53bcd	0.50bcd	0.34b	0.32c	0.53c	0.50ab
TRIMMIT 18-3-4	2SC 1.75L	8 OZ/A 0.2 OZ A/M	SUMMER/21DAT SUMMER/21DAT	0.42a	0.49bcd	0.51cd	0.53bcd	0.49bcd	0.33b	0.36bc	0.56c	0.52ab
CUTLESS	50WP	0.38	SUMMER/21DAT	0.42a	0.51bc	0.55bc	0.51cd	0.54b	0.32b	0.35bc	0.61bc	0.57ab
CUTLESS	50WP	0.75	SUMMER/21DAT	0.42a	0.45de	0.50cd	0.54bc	0.49bcd	0.30b	0.34bc	0.57bc	0.52ab
CUTLESS	0.175G	214.3	SUMMER/21DAT	0.43a	0.51b	0.58ab	0.61a	0.63a	0.44a	0.53a	0.73a	0.57a
CUTLESS	0.33G	113.6	SUMMER/21DAT	0.40a	0.45de	0.46d	0.48d	0.46d	0.33b	0.38bc	0.59bc	0.54ab
16-4-8 FERT	0.16G	214.3	SUMMER/21DAT	0.41a	0.63a	0.63a	0.57ab	0.62a	0.44a	0.50a	0.65b	0.57ab

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

Table 3. Fresh clipping weight (grams) of creeping bentgrass taken in 2004.

Treatment	Form	Rate lb/A	Timing	6-7 [1]	6-15	6-24	6-29	7-6	7-20	7-28	8-5
VELOCITY	80WP	10 G A/A	SUMMER/14DAT	6.5ab	10.5bc	8.9cd	5.3c	6.8cde	10.9cd	31.6bcd	17.3c
VELOCITY	17.6WDG	10 G A/A	SUMMER/14DAT	2.4d	13.3b	10.7c	6.4bc	8.1c	13.5bcd	28.9bcd	21.0c
TRIMMIT	2SC	12 OZ/A	SUMMER/21DAT	4.7bc	9.1bc	11.2c	8.2bc	5.6cde	15.1bcd	32.9bcd	19.1c
TRIMMIT	2SC	8 OZ/A	SUMMER/21DAT	2.2d	3.7d	8.8cd	7.5bc	4.1e	17.7bc	43.9b	26.7bc
PRIMO	1MEC	5.5 OZ/A	SUMMER/21DAT								
TRIMMIT	2SC	8 OZ/A	SUMMER/21DAT	3.7cd	10.0bc	12.2c	8.2bc	6.1cde	9.9cd	23.8cd	16.4c
CHECK				4.2cd	13.3b	12.2c	6.1bc	5.9cde	8.1d	22.4d	14.3c
TRIMMIT	2SC	8 OZ/A	SUMMER/21DAT	4.3cd	9.9bc	12.4c	9.2b	6.2cde	9.8cd	31.1bcd	18.4c
18-3-4	1.75L	0.2 OZ A/M	SUMMER/21DAT								
CUTLESS	50WP	0.38	SUMMER/21DAT	4.9bc	10.0bc	12.3c	6.8bc	7.8cd	20.0b	43.6bc	25.8bc
CUTLESS	50WP	0.75	SUMMER/21DAT	4.6bc	9.2bc	9.9cd	8.9bc	6.9cde	7.3d	27.4bcd	18.7c
CUTLESS	0.175G	214.3	SUMMER/21DAT	6.7ab	11.3b	19.5b	20.0a	25.6b	44.5a	83.0a	43.1a
CUTLESS	0.33G	113.6	SUMMER/21DAT	3.2cd	6.7cd	7.1d	5.6bc	4.6de	11.6bcd	39.6bcd	24.6bc
16-4-8 FERT	0.16G	214.3	SUMMER/21DAT	8.5a	33.9a	27.1a	21.1a	29.8a	40.2a	67.7a	35.4ab

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

Annual Bluegrass Control and Discoloration Evaluations of Fairway Height Creeping Bentgrass

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

Introduction

This study was conducted on a mature stand of ‘Penneagle’ 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 Velocity could control annual bluegrass and if certain supplements could reduce the discoloration caused by Velocity under fairway height conditions.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on June 1 (1DBT), June 2 (SHATTER), June 3 (1DAT), June 5 (3DAT), and June 10 (7DAT), 2003 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi.

A soil test was conducted on the test site on April 10, 2002 by the Agricultural Analytical Services Laboratory, Penn State University, University Park PA. The soil test revealed a soil pH of 7.0, phosphorus concentration of 82 ppm, and potassium concentration of 104 ppm. The soil test report recommended the site receive 2 lb K_2O/M for optimum growing conditions. Therefore, 1 lb K_2O/M was applied to the site on May 6, 2002 from an 0-0-60 basic fertilizer using a three foot drop spreader.

The soil of the test site was also evaluated for particle size using the pipette method. The test revealed this particle size percent by weight; gravel (>2mm) 6.2, very coarse sand (2 - 1mm) 4.4, coarse sand (1 - 0.5mm) 4.2, medium sand (0.5 - 0.25mm) 3.6, fine sand (0.25 - 0.15mm) 2.4, very fine sand (0.15 - 0.05mm) 5.0, silt (0.05 – 0.002mm) 57.9, and clay (< 0.002mm) 16.2. Examination of a soil textural triangle reveals this soil to be a silt loam.
The test area was maintained at 0.5 inch using a five gang reel mower that collected the clippings three times per week. The site was irrigated on an as needed basis to keep turfgrass from moisture stress.

Discoloration was rated on a scale of 0 to 10 where 0 = most discoloration, 7 = acceptable discoloration, and 10 = no discoloration. The percent change of the annual bluegrass population was calculated using this formula 100*(1-(current/original)) where current = visual percent annual bluegrass population following treatment application and original = visual percent annual bluegrass population before treatment application. All percent annual bluegrass populations ratings were done on a plot by plot basis.

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Results and Discussion

Penneagle creeping bentgrass that was treated with Velocity expressed the so called "yellow flash" for a period of approximately two weeks (Table 1). Three supplements at various rates were used in an attempt to lessen the severity of the discoloration. On the June 12 rating date, only treatments containing MacroSorb Foliar at 8 oz/M (for both Velocity rates) and 2 oz/M with the 30 g ai/A rate kept discoloration to an acceptable level (7.0). However, discoloration did occur when compared to untreated (rated 10.0). Although the discoloration persisted until the June 19, rating date, it was not rated as being unacceptable.

With regard to annual bluegrass control, the results were highly variable (Table 2). On June 29, several treatments reduced annual bluegrass compared to untreated, however by August 6, only turf treated with Velocity at the low rate supplemented with either the high rate of MacroSorb Foliar or CoRon had significant reduction in annual bluegrass compared to untreated. On May 12, 2004, the final rating date, only turf treated with Velocity at the 60 g ai/A rate followed seven days later by iron sulfate at 1.5 oz/M had significantly less annual bluegrass (52.8 percent) than untreated. Although not significant, Velocity at 60 g ai/A combined with MacroSorb Foliar at 8 oz/M provided a 41.7 percent reduction in the annual bluegrass population.

Table 1. Discoloration ratings on a scale of 0 to 10 where 0 = worst, 7= acceptable, and 10 = best of materials applied to fairway height 'Penneagle' creeping bentgrass and annual bluegrass taken in 2003.

Treatment	Form	Rate (g ai/A)	Timing	(----Discoloration----) 6-5	6-12	6-19	6-26	7-2	7-10	7-17	7-24	7-31	8-7
IRON SULFATE VELOCITY	WDG 80WP	1.5 OZ/M 60	1DBT SHATTER	9.0	6.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER SHATTER	9.0	6.3	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER 1DAT	9.3	6.3	7.3	10.0	10.0	10.0	10.0	10.0	10.0	10.0
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER 3DAT	9.7	6.2	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER 7DAT	9.0	6.7	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY	80WP	60	SHATTER	9.0	6.0	7.7	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY MACROSORB FOLIAR	80WP L	60 2 OZ/M	SHATTER SHATTER	9.7	6.1	6.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY MACROSORB FOLIAR	80WP L	60 4 OZ/M	SHATTER SHATTER	9.3	6.3	7.7	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY MACROSORB FOLIAR	80WP L	60 8 OZ/M	SHATTER SHATTER	9.3	7.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY CORON	80WP 2.9L	60 0.9 LBS AI/A	SHATTER SHATTER	8.7	6.8	7.3	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY	80WP	30	SHATTER	9.0	6.8	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY MACROSORB FOLIAR	80WP L	30 2 OZ/M	SHATTER SHATTER	8.7	7.3	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY MACROSORB FOLIAR	80WP L	30 4 OZ/M	SHATTER SHATTER	9.0	6.3	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY MACROSORB FOLIAR	80WP L	30 8 OZ/M	SHATTER SHATTER	9.0	7.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VELOCITY CORON	80WP 2.9L	30 0.9 LBS AI/A	SHATTER SHATTER	8.3	6.3	7.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 2. Percent change of the annual bluegrass population in fairway height 'Penneagle' creeping bentgrass. Data were taken May 8, 2003 on a plot by plot basis and used to calculate the population change.

Treatment	Form	Rate (g ai/A)	Timing	(-------------------% Change-----------------------) 6-29-03	08-06-03	05-12-04
IRON SULFATE VELOCITY	WDG 80WP	1.5 OZ/M 60	1DBT SHATTER	65.6a[1,2]	45.6ab	38.9ab
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER SHATTER	75.6a	62.2ab	33.3ab
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER 1DAT	63.9a	53.9ab	27.8abc
CHECK				8.3b	27.8b	19.4bc
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER 3DAT	67.8a	54.4ab	0.0c
VELOCITY IRON SULFATE	80WP WDG	60 1.5 OZ/M	SHATTER 7DAT	76.1a	58.3ab	52.8a
VELOCITY	80WP	60	SHATTER	76.7a	63.3ab	25.0abc
VELOCITY MACROSORB FOLIAR	80WP L	60 2 OZ/M	SHATTER SHATTER	38.9ab	54.4ab	0.0c
VELOCITY MACROSORB FOLIAR	80WP L	60 4 OZ/M	SHATTER SHATTER	63.9a	63.9ab	27.8abc
VELOCITY MACROSORB FOLIAR	80WP L	60 8 OZ/M	SHATTER SHATTER	50.0ab	50.0ab	41.7ab
VELOCITY CORON	80WP 2.9L	60 0.9 LBS AI/A	SHATTER SHATTER	45.6ab	44.4ab	22.2bc
VELOCITY	80WP	30	SHATTER	60.0a	57.8ab	22.2bc
VELOCITY MACROSORB FOLIAR	80WP L	30 2 OZ/M	SHATTER SHATTER	63.3a	60.0ab	33.3ab
VELOCITY MACROSORB FOLIAR	80WP L	30 4 OZ/M	SHATTER SHATTER	73.9a	55.6ab	27.8abc
VELOCITY MACROSORB FOLIAR	80WP L	30 8 OZ/M	SHATTER SHATTER	71.1a	64.4a	33.3ab
VELOCITY CORON	80WP 2.9L	30 0.9 LBS AI/A	SHATTER SHATTER	65.6a	65.6a	16.7bc

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

2 – Positive numbers represent a percent decrease and negative numbers a percent increase.

Annual Bluegrass Control in Fairway Height Creeping Bentgrass

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

Introduction

This study was conducted on a mature stand of 'Penneagle' 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 seasonal applications of Trimmit, Trimmit plus Coron, Trimmit followed by Primo MAXX, and Primo MAXX alone could reduce the annual bluegrass population under fairway conditions over a three year period.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on May 30 (SHATTER), June 27 (28 DAT), July 18 (21 DAT), Aug 14 (21 DAT), Sept 13 (SEPT), Oct 12, 2001 (OCT), April 4 (APRIL), May 15 (SHATTER), July 10 (21 DAT), July 31 (21 DAT), Sept 10, (SEPT), Oct 9, 2002 (OCT), April 15, May 15 (30 DAT), May 27 (SHATTER), June 10 (28 DAT), July 10 (21 DAT), July 28 (21 DAT), Sept 11 (SEPT), and Oct 7, 2003 (OCT) 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 area was maintained at 0.5 inch using a triplex reel mower that collected clippings. Turfgrass was irrigated on an as needed basis to prevent moisture stress.

The test site consisted of approximately 80 percent creeping bentgrass and 20 percent annual bluegrass at the initiation of the study. The annual bluegrass population was visually evaluated on May 30, 2001, on a plot by plot basis, to determine the baseline population in each plot. The change in the annual bluegrass population in subsequent years was compared to these baseline ratings.

Results and Discussion

Ratings of percent change in the annual bluegrass population after the first year of treatments are shown in Table 1. Annual bluegrass increased in the untreated check (34.4 percent), but increased significantly more in plots treated with Primo MAXX alone (100 percent). Plots that received Trimmit with Coron had the greatest reduction of annual bluegrass, but not significantly more than those that received Trimmit alone.

On the May 8, 2003 rating date (after two years of treatment), a similar trend was found. The untreated annual bluegrass population increased by 58.3 percent, but not significantly more that turfgrass treated with Primo MAXX (91.7 percent increase). Again, turfgrass treated with Trimmit, with or without Coron, had a significant reduction of the annual bluegrass population when compared to untreated.

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On the final rating date, May 12, 2004, most trends continued. The untreated annual bluegrass population increased by 66.7 percent, again not significantly different than the increase in annual bluegrass treated with Primo MAXX alone (92.2 percent). On this date, all turfgrass treated with Trimmit with or with out Coron or Primo MAXX had a significant reduction in the annual bluegrass population when compared to untreated turfgrass.

It should be noted that, from a turf color/quality perspective, when Trimmit was supplemented with Coron, the treated turfgrass had higher quality than turfgrass without the Coron supplement.

It appears that, multiple lower rate (0.35 oz/M) applications of Trimmit throughout the year and for three consecutive years can reduce the annual bluegrass population. There did appear to be a trend whereby including an October application of Trimmit as part of the management strategy the reduction of annual bluegrass increased compared to Trimmit applied twice (SHATTER and SEPT). But, the addition of Coron lessened any discoloration of the turfgrass and improved quality. When Primo MAXX was part of the management strategy there was less annual bluegrass reduction (significant in 2002 and 2003 only). When Trimmit was applied in the spring and fall (SHATTER and SEPT) and Primo MAXX was applied sequentially during summer (28 DAT and 21 DAT) there was a significant reduction of annual bluegrass compared to Primo MAXX alone applied throughout the growing season.

When Trimmit was applied throughout the growing season, the annual bluegrass population can be reduced from the sward. Overall, a slower conversion toward creeping bentgrass would be provided if Trimmit was followed by applications of Primo MAXX. However, if annual bluegrass was the desired species, then the management strategy should only utilize multiple applications of Primo MAXX throughout the growing season.

Table 1. The percent change of the annual bluegrass population in a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass from May 30, 2001 to May 12, 2003.

Treatment	Form	Rate (oz/M)	Timing	(-------------Percent Change--------------) 5-13-02	5-8-03	5-12-04
TRIMMIT	2SC	0.7	SHATER/SEPT	38.9ab[1,2]	40.5ab	35.7a
TRIMMIT CORON	2SC 2.9L	0.7 0.9 lb N/M	SHATTER/SEPT	47.2a	61.1a	40.8a
TRIMMIT	2SC	0.35	APRIL/30 DAT/SEPT/OCT	24.4ab	70.0a	60.9a
CHECK				-34.4c	-58.3c	-66.7b
TRIMMIT CORON	2SC 2.9L	0.35 0.5 lb N/M	APRIL/30 DAT/SEPT/OCT	46.7a	71.1a	72.7a
TRIMMIT PRIMO MAXX	2SC 1MEC	0.7 0.25	SHATTER/SEPT (only) 28 DAT/21 DAT (only)	0.0bc	13.9b	36.1a
PRIMO MAXX	1MEC	0.25	SHATTER/28 DAT/ 21 DAT/SEPT	-100.0d	-91.7c	-92.2b

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

2 – Positive numbers represent a percent decrease and negative numbers a percent increase.

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 and safety to desired species.

Methods and Materials

This study was a randomized complete block design with three replications. All treatments were applied on April 8, 2004 and some treatments were applied on May 7, 2004 (4WAT) using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two, flat fan, 11004 nozzles at 40 psi. and a shaker jar. After application the entire test site received approximately 0.5 inch of water. On April 21, 2004, 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 where materials had been applied that did not contain any fertilizer. 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 April 26, 2004.

Results and Discussion

None of the materials in the study caused injury to the Kentucky bluegrass (Table 1). Several materials provided commercially acceptable smooth crabgrass control (Table 2). The CS formulation and the split application (1.5 plus 1.5 lbs ai/A) of the 3.3EC formulation of Pendulum; the Barricade 65WDG at 0.65, 0.75, and 0.38 plus 0.38 lbs ai/A; the Barricade 4FL at 0.75 and 0.38 plus 0.38 lbs ai/A split; and all Dimension 40WP treatments controlled smooth crabgrass greater than 85 percent.

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Table 1. Evaluations of phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity taken in 2004..

Treatment	Form	Rate (lbs ai/A)	Timing	4-15	4-22
BETASAN	4EC	7.3 OZ/M		10.0	10.0
BETASAN	4EC	7.3 OZ/M		10.0	10.0
BETASAN	4EC	5 OZ/M	4WAT		
PENDULUM	3.3EC	2.0		10.0	10.0
PENDULUM	3.3EC	1.5	4WAT		
PENDULUM	3.3EC	1.5		10.0	10.0
PENDULUM	3.3EC	1.5	4WAT		
PENDULUM	3.8CS	2.0		10.0	10.0
PENDULUM	3.8CS	1.5	4WAT		
PENDULUM	3.8CS	1.5		10.0	10.0
PENDULUM	3.8CS	1.5	4WAT		
BARRICADE	65WDG	0.65		10.0	10.0
BARRICADE	65WDG	0.75		10.0	10.0
BARRICADE	65WDG	0.38		10.0	10.0
BARRICADE	65WDG	0.38	4WAT		
BARRICADE	4FL	0.65		10.0	10.0
BARRICADE	4FL	0.75		10.0	10.0
BARRICADE	4FL	0.38		10.0	10.0
BARRICADE	4FL	0.38	4WAT		
DIMENSION ULTRA	40WP	0.25		10.0	10.0
DIMENSION ULTRA	40WP	0.25	4WAT		
DIMENSION ULTRA	40WP	0.5		10.0	10.0
DIMENSION ULTRA	40WP	0.125		10.0	10.0
DIMENSION ULTRA	40WP	0.125	4WAT		
VELOCITY	17.6WDG	60 G A/A		10.0	10.0
VELOCITY	80WP	60 G A/A		10.0	10.0
VELOCITY	17.6WDG	60 G A/A		10.0	10.0
VELOCITY	17.6WDG	60 G A/A	4WAT		
VELOCITY	80WP	60 G A/A		10.0	10.0
VELOCITY	80WP	60 G A/A	4WAT		
CHECK				10.0	10.0

Table 2. Evaluations of the percent control of smooth crabgrass taken on Aug 16, 2004. Commercially acceptable control was considered to be 85% and above.

Treatment	Form	Rate (lbs ai/A)	Timing	% Control
BETASAN	4EC	7.3 OZ/M		60.0
BETASAN	4EC	7.3 OZ/M		74.3
BETASAN	4EC	5 OZ/M	4WAT	
PENDULUM	3.3EC	2.0		76.7
PENDULUM	3.3EC	1.5	4WAT	
PENDULUM	3.3EC	1.5		90.0
PENDULUM	3.3EC	1.5	4WAT	
PENDULUM	3.8CS	2.0		90.0
PENDULUM	3.8CS	1.5	4WAT	
PENDULUM	3.8CS	1.5		91.7
PENDULUM	3.8CS	1.5	4WAT	
BARRICADE	65WDG	0.65		95.0
BARRICADE	65WDG	0.75		93.3
BARRICADE	65WDG	0.38		94.3
BARRICADE	65WDG	0.38	4WAT	
BARRICADE	4FL	0.65		76.7
BARRICADE	4FL	0.75		88.3
BARRICADE	4FL	0.38		88.3
BARRICADE	4FL	0.38	4WAT	
DIMENSION ULTRA	40WP	0.25		93.3
DIMENSION ULTRA	40WP	0.25	4WAT	
DIMENSION ULTRA	40WP	0.5		94.3
DIMENSION ULTRA	40WP	0.125		91.7
DIMENSION ULTRA	40WP	0.125	4WAT	
VELOCITY	17.6WDG	60 G A/A		16.7
VELOCITY	80WP	60 G A/A		0.0
VELOCITY	17.6WDG	60 G A/A		31.7
VELOCITY	17.6WDG	60 G A/A	4WAT	
VELOCITY	80WP	60 G A/A		16.7
VELOCITY	80WP	60 G A/A	4WAT	
CHECK				0.0

Phytotoxicity and Quality Evaluations of Proxy and Primo MAXX Combinations on Fairway Height Creeping Bentgrass

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

Introduction

This study was conducted on a mature stand of 'Penneagle' creeping bentgrass (*Agrostis stolonifera*) at the Valentine Turfgrass Research Center, Penn State University, University Park, Pa. The objective of the study was to assess the response of Penneagle creeping bentgrass to multiple applications of Proxy and Primo MAXX combinations applied at different timings.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on April 19 (BOOT), May 20 (4 WAT), June 14 (JUNE), and July 15, 2004 (4 WAT) 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 fairway with respect to irrigation, fertilization and mowing. The test area was maintained at 0.5 inch using a reel mower that collected the clippings three times per week.

Results and Discussion

On the May 23 rating date, Proxy (at both rates) in combination with Primo MAXX caused unacceptable injury (Table 1). Some injury was observed on July 23 as a result of the combination applications that were made on June 14 followed sequentially on July 15. This injury was reflected in the quality ratings taken on July 23 (although acceptable) (Table 2). By August 16, the combination with the highest Proxy rate (5 oz/M) had slightly better quality than all other treated or untreated turfgrass.

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Table 1. Phytotoxicity ratings of fairway height 'Penneagle' creeping bentgrass on a scale of 0-10 where 0 = worst, 7= acceptable, and 10 = no phytotoxicity taken in 2004.

Treatment	Form	Rate Oz/M	Timing	5-23	6-14	6-18	6-29	7-2	7-9	7-16	7-23	8-3	8-16
PROXY	L	3	BOOT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
PROXY	L	5	BOOT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
PROXY	L	3	BOOT/4 WAT	6.2	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT/4 WAT										
PROXY	L	5	BOOT/4 WAT	6.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.25	BOOT/4 WAT										
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
PROXY	L	3	JUNE/4WAT	10.0	10.0	10.0	8.0	10.0	10.0	10.0	7.7	10.0	10.0
PRIMO MAXX	1MEC	0.25	JUNE/4WAT										
PROXY	L	5	JUNE/4WAT	10.0	10.0	10.0	7.7	10.0	10.0	10.0	7.0	10.0	10.0
PRIMO MAXX	1MEC	0.25	JUNE/4WAT										

Table 2. Quality ratings of fairway height 'Penneagle' creeping bentgrass on a scale of 0-10 where 0 = worst, 7= acceptable, and 10 = best taken in 2004.

Treatment	Form	Rate Oz/M	Timing	6-14	6-18	6-29	7-2	7-9	7-16	7-23	8-3	8-16
PROXY	L	3	BOOT	9.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
PROXY	L	5	BOOT	9.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
CHECK				9.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
PROXY	L	3	BOOT/4 WAT	9.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
PRIMO MAXX	1MEC	0.25	BOOT/4 WAT									
PROXY	L	5	BOOT/4 WAT	9.0	10.0	9.0	9.0	9.0	9.0	8.3	9.0	9.0
PRIMO MAXX	1MEC	0.25	BOOT/4 WAT									
CHECK				9.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
PROXY	L	3	JUNE/4WAT	9.0	10.0	8.0	9.0	9.0	9.0	7.7	9.0	9.0
PRIMO MAXX	1MEC	0.25	JUNE/4WAT									
PROXY	L	5	JUNE/4WAT	9.0	10.0	7.7	9.0	9.0	9.0	7.0	9.0	9.5
PRIMO MAXX	1MEC	0.25	JUNE/4WAT									

Evaluation of Phosphonate Fungicides for Control of Anthracnose Basal Rot of Annual Bluegrass and Putting Green Quality

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Introduction

Phosphonate fungicides are used by golf course managers to control Pythium diseases, suppress anthracnose basal rot, alleviate summer stress, and improve turf quality. In many areas of the northeast, phosphonate products are applied at regular intervals throughout the summer as part of a putting green management program. Over a dozen phosphonate fungicides and fertilizers are currently available for use on golf courses. Although these products have similar active ingredients, they differ in trade name, formulation, label terminology, uses, and price. Understanding the different phosphonate products and how they perform in the field should help golf course managers choose the appropriate product for their particular need.

The objective of this study was to determine the efficacy of phosphonate fungicides (fosetyl aluminum and phosphorus acid-based products) on anthracnose basal rot and quality of a mixed annual bluegrass (*Poa annua* L.)/creeping bentgrass (*Agrostis stolonifera* L.) putting green.

Materials and Methods

This study was conducted at the Joseph Valentine Turfgrass Research Center, University Park, PA during 2004. The putting green soil is a uniform sandy loam with a pH of 7.2, 138 lb P/A (69 ppm P), 0.07 meq K/100g soil (28 ppm), and a CEC of 6.2 meq /100g soil. The turfgrass is a 7-yr-old mixed stand of 'Providence' creeping bentgrass (~75%) and annual bluegrass (~25%). The test area was fertilized with urea at 0.5 lb N/1000 ft^2 in April, 2004, prior to initiation of the test and again on 29 June (during the test period). No fungicides were applied to the area in 2004 other than those used as treatments in the test.

Two sets of treatments were included in this test, one set with no Curalan 50EG (vinclozolin) (BASF Corp., Research Triangle Park, NC) added, and a second set containing 1.0 oz/1000 ft^2 of Curalan to control dollar spot. Phosphonate fungicides do not control dollar spot disease and this disease will severely damage unprotected plots. Also, Curalan has very little effect on anthracnose basal rot, and thus, would not greatly influence results of the test (B. Clarke, personal communication). The first set of treatments included commercial formulations of three phosphonate fungicides; Alude (Cleary Chemical Corp, Dayton, NJ), Aliette (Bayer Environmental Science, Montvale, NJ), and Signature (Bayer Environmental Science, Montvale, NJ); a solution of reagent-grade phosphorous acid (H_3PO_3) and potassium hydroxide (KOH) (pH 6.2); and a solution of reagent grade potassium phosphate (KH_2PO_4). The second set of treatments included the same treatments as in the first set, but with 1.0/1000 ft^2 of Curalan added to each treatment. Controls included Curalan alone and an untreated control.

All phosphonate fungicides and the phosphorous acid/potassium hydroxide solution were applied at equivalent amounts of phosphorous acid (based on phosphorus acid equivalents listed on the label (Alude) or according to active ingredients and chemical formulas of fosetyl aluminum (Aliette and Signature). The phosphorous acid equivalent rate used in this study was based on intermediate rates listed for anthracnose disease on the Signature label and for summer stress complex on the Alude label. The product rates are listed for each treatment in Table 1.

The experimental design was a randomized complete block design with four replications. Plot size was 10 ft by 3 ft. All treatments were applied every 14 d beginning on 21 May, 2004 and ending 13 Aug, 2004 for a total of seven applications. Treatments were applied with a CO_2-powered backpack sprayer equipped with a single boom fitted with an 11008E nozzle. Applications were made at 40 psi with a dilution rate equivalent to 2 gal H_2O/1000 ft^2.

Dollar spot disease became problematic during late June in the treatments that did not contain Curalan, thus Curalan (1.0 oz/1000 ft^2) was added to these treatments beginning with the 30 June application and throughout the remainder of the test. Although this change did not affect anthracnose basal rot ratings (all disease severity data was collected before the 30 June application), it could influence quality data after 30 June.

Anthracnose basal rot disease severity and turf quality assessments were made every 14 d, just prior to treatment applications. Disease severity was visually assessed on a scale of 0 to 10, with 10 indicating severe disease symptoms and 0 indicating no disease visible. Quality was assessed visually using a scale of 0 to 10, with 10 indicating excellent turf quality and 0 poor quality. Disease severity and quality data were subjected to analysis of variance and means were separated using Fisher's Least Significant Differences Test at the 0.05 level of significance.

Results

Anthracnose basal rot symptoms were apparent in mid to late June, but symptoms did not become severe at any time during the summer. The only treatments that showed reduced disease symptoms compared to the untreated and Curalan controls on both rating dates were Signature and Signature + Curalan. The Alude + Curalan treatment showed less severe symptom development compared to the untreated control, Curalan control, and Alude on 22 June but not on 30 June.

The fact that Aliette and Signature treatments contained the same amount of active ingredient (fosetyl aluminum) indicates that differences in formulation may account for improved disease control with Signature.

Turf quality data reveal differences among treatments 14 d following the first application and on all subsequent rating dates. Phosphonate fungicides and the phosphorous acid/potassium hydroxide treatment provided better quality than the untreated control on most rating dates (note that Curalan was added to these treatments beginning on 30 June and throughout the remainder of the test due to dollar spot development). Aliette (fosetyl aluminum) produced turf quality ratings very similar to phosphorous acid/potassium hydroxide, indicating that phosphorous acid and fosetyl aluminum have similar effects on turf when applied at equivalent amounts of phosphorous acid. Signature and Signature + Curalan provided the highest quality of all treatments throughout the entire test.

Table 1. Treatments, rates, and anthracnose basal rot disease severity ratings for 2004 anthracnose basal rot phosphonate fungicide trial.

Treatment	Rate oz /1000 ft^2	H_3PO_3 equiv. (g/1000 ft^2)	Disease severity 22 Jun	30 Jun
			(0-10) §	(0-10)
Control	----	---	2.8 ab§§	2.5 a
Curalan (vinclozalin)	1.0 oz	---	2.8 ab	2.8 a
KH_2PO_4	4.0 oz	---	3.3 a	2.8 a
H_3PO_3/KOH	43.6 fl oz	89.4 g	2.5 bc	2.0 ab
Alude	7.4 fl oz	89.4 g	2.8 ab	2.0 ab
Aliette	5.7 oz	89.4 g	2.5 bc	2.5 a
Signature	5.7 oz	89.4 g	1.5 de	1.0 c
KH_2PO_4 + Curalan	4.0 oz + 1.0 oz	---	3.3 a	2.5 a
H_3PO_3/KOH + Curalan	43.6 fl oz + 1.0 oz	89.4 g	2.3 bc	2.0 ab
Alude + Curalan	7.4 fl oz + 1.0 oz	89.4 g	2.0 cd	1.8 ab
Aliette + Curalan	5.7 oz + 1.0 oz	89.4 g	2.5 bc	1.8 ab
Signature + Curalan	5.7 oz + 1.0 oz	89.4 g	1.0 e	0.5 c

§ Anthracnose basal rot disease severity ratings based on a 0-10 scale, 0 = no disease and 10 = severe disease symptoms.

§§ Data means within the same column and followed by the same letter are not significantly different as determined by Fisher's Protected Least Significant Difference test at *P*=0.5.

Table 2. Treatments, rates, and quality ratings for 2004 anthracnose basal rot phosphonate fungicide trial.

Treatment	Rate oz/1000 ft^2	Turf Quality 21 May	2 Jun	16 Jun	30 Jun	16 Jul	28 Jul	13 Aug	26 Aug
					(0-10)§§				
Control§	----	5.8 a§§§	5.3 cd	4.8 e	4.3 g	4.8 d	4.8 c	4.3 f	4.3 g
Curalan	1.0 oz	5.8 a	6.0 b	6.0 cd	6.0 cd	5.5 d	5.0 c	5.3 de	4.8 g
KH_2PO_4§	4.0 oz	5.5 a	5.8 bc	5.8 d	5.0 f	5.3 d	5.5 c	4.8 ef	5.0 fg
H_3PO_3/KOH§	43.6 fl oz	6.0 a	6.0 b	6.5 bc	5.5 def	7.8 bc	7.8 ab	5.8 cd	6.3 cde
Alude§	7.4 fl oz	5.8 a	5.0 d	5.5 d	5.0 f	7.0 c	7.3 b	5.8 cd	5.8 ef
Aliette§	5.7 oz	5.8 a	6.0 b	6.5 bc	5.8 de	8.0 bc	7.3 b	6.3 abc	6.3 cde
Signature§	5.7 oz	5.8 a	6.0 b	7.8 a	6.8 ab	8.3 ab	7.8 ab	6.5 ab	7.3 ab
KH_2PO_4 + Curalan	4.0 + 1.0	5.5 a	5.8 bc	6.5 bc	5.3 ef	5.5 d	5.3 c	5.0 e	4.5 g
H_3PO_3 + Curalan	43.6 + 1.0	5.5 a	6.3 a	6.8 b	6.8 ab	7.8 bc	7.8 ab	6.5 ab	6.8 bcd
Alude + Curalan	7.4 + 1.0	5.5 a	5.8 bc	6.8 b	6.5 bc	7.5 bc	7.8 ab	6.0 bc	6.0 de
Aliette + Curalan	5.7 + 1.0	5.5 a	6.0 b	6.8 b	6.5 bc	8.3 ab	8.5 a	6.3 abc	7.0 abc
Signature + Curalan	5.7 + 1.0	5.8 a	6.8 a	7.8 a	7.4 a	9.3 a	8.5 a	6.8 a	7.8 a

§ Dollar spot disease became problematic during late June in treatments that did not contain Curalan, thus Curalan (1.0 oz/1000 ft^2) was added to these treatments beginning with the 30 June application and throughout the remainder of the test.

§§ Turf quality ratings based on a 0-10 scale, 10 = excellent turf quality 0 = poor turf quality.

§§§ Data means within the same column and followed by the same letter are not significantly different as determined by Fisher's Protected Least Significant Difference test at *P*=0.5.

Evaluation of Phosphonate Fungicides for Control of Pythium Blight on Creeping Bentgrass and Perennial Ryegrass

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December 2, 2004

Introduction

Phosphonate fungicides are used by golf course managers to control Pythium diseases, suppress anthracnose basal rot, alleviate summer stress, and improve turf quality. In many areas of the northeast, phosphonate products are applied at regular intervals throughout the summer as part of a putting green management program. Currently, there are over a dozen phosphonate fungicides and fertilizers on the golf turf market. Although these products have similar active ingredients and modes of action, they differ in trade name, formulation, label terminology, uses, and price. Understanding the different phosphonate products and how they perform in the field should help superintendents decide which product is most suitable for their particular need.

The objective of this study was to determine the efficacy of phosphonate fungicides (fosetyl aluminum and phosphorus acid-based products) on Pythium blight of creeping bentgrass and perennial ryegrass.

Materials and Methods

This study was conducted at the Joseph Valentine Turfgrass Research Center, University Park, PA during 2004. The soil is a Hagerstown Silt Loam with a pH of 6.8, 150 lb P/A (75 ppm P), 0.54 meq K/100 g soil (210 ppm K), and a CEC of 13.4 meq/100 g soil. The turfgrasses used in this study, perennial ryegrass ('Integra') and creeping bentgrass ('Penncross'), were established from seed on the test site in Sep, 2003. The turf was mowed at 1.0 inch every other day with a rotary mower (clipping returned) and fertilized in spring and summer with 1.0 lb N/1000 ft^2 per application with IBDU.

The Pythium blight study was conducted in a 30 ft by 48 ft chamber constructed of an aluminum frame and covered with polyethylene plastic. An automatic misting system designed to increase humidity and cool the turf was suspended from the chamber frame. After treatments were applied, the two open ends of the chamber were sealed with preassembled wooded frames covered with polyethylene plastic (Fig 1.). Each end was equipped with a hinged window that could be opened or closed to facilitate heating or cooling. Two electric heaters equipped with fans and thermostats were placed on either side of the chamber to aid in heating when nighttime temperatures dropped below 60^oF.

Fig. 1. Pythium chamber with plastic-covered wooden frames sealing the ends of the chamber.

Treatments included commercial formulations of three phosphonate fungicides; Alude (Cleary Chemical Corp., Dayton, NJ), Aliette (Bayer Environmental Science, Montvale, NJ), and Signature (Bayer Environmental Science, Montvale, NJ); a solution of reagent-grade phosphorous acid (H_3PO_3) and potassium hydroxide (KOH) (pH 6.2); a solution of reagent grade potassium phosphate (KH_2PO_4); a commercial formulation of mefenoxam (Subdue MAXX) (Syngenta Crop Protection, Inc., Greensboro, NC); and an untreated control. All phosphonate fungicides and the phosphorous acid/potassium hydroxide solution were applied at equivalent amounts of phosphorous acid [based on phosphorous acid equivalents listed on the Alude label and according to active ingredients and chemical formulas of fosetyl aluminum (Aliette and Signature)]. The rate of phosphorous acid used in this study was based on the intermediate rate listed on the Alude label for Pythium diseases. The actual rates of product and phosphorous acid are provided in Table 1. The product rates of potassium phosphate and Subdue MAXX are also listed in Table 1. The experimental design was a split block design with fungicide treatments serving as whole plots and grass species as sub plots. Each treatment was replicated four times. The whole plots were 3 ft by 8 ft and sub plots were 3 ft by 4 ft.

Prior to inoculation and treatment application, Cleary's 3336 F (thiophanate methyl) (Cleary Chemical Corp., Dayton, NJ) was sprayed at 4 fl oz/1000 ft^2 to prevent brown patch and dollar spot. Previous studies revealed that benzimidazole fungicides suppress brown patch and dollar spot and sometimes enhance Pythium blight development.

Treatments were applied on 30 Aug, 2004 with a CO_2-powered backpack sprayer equipped with a single boom and 11008E nozzle. Applications were made at 40 psi with a dilution rate equivalent to 2 gal H_2O/1000 ft^2. On 31 Aug, 2004, the open ends of the chamber were sealed with the plastic-covered end frames. The entire test area was inoculated on 1 Sep, 2004 with 36 qt of a mycelia and rye grain slurry made from a six-isolate pool of *Pythium aphanidermatum*. The slurry was distributed over the test area by hand using a jar with a perforated lid. To insure uniform coverage, four passes were made over the entire test area in different directions.

Immediately following inoculation, the misting system was activated for approximately five minutes and the chamber was sealed to maintain high temperatures and humidity.

Over the next 10 days, temperatures in the chamber ranged from approximately 50 to 104^{o}F. Temperatures were regulated by venting, misting, and activation of electric heaters. Humidity levels ranged from 50 to 100%. Test plots were not mowed between the day of treatment application and disease assessment (12 days).

Disease assessments were made on both grass species on 10 Sep, 2004 (10 days after inoculation and 12 days after treatments were applied). Visual assessments were based on the percentage of plot area showing Pythium blight symptoms (% blighting). Data were subjected to analysis of variance and means were separated using Fisher's Least Significant Differences Test at the 0.05 level of significance.

Table 1. Treatments and rates used in the Pythium blight phosphonate fungicide study.

Treatment	Rate/1000 ft^2	H_3PO_3 equivalent/1000 ft^2
Control	----	---
KH_2PO_4 solution	4.0 oz	---
H_3PO_3/KOH solution	43.6 fl oz	89.4 g
Alude	7.4 fl oz	89.4 g
Aliette	5.7 oz	89.4 g
Signature	5.7 oz	89.4 g
Subdue MAXX	1.0 fl oz	----

Results

Analysis of variance of % blighting of turf indicates that the main effects of turf species and fungicide treatment were significant ($P \leq 0.001$) (Table 2). Disease symptoms (% blighting) were more severe on perennial ryegrass than creeping bentgrass and fungicides provided better control of Pythium blight on creeping bentgrass than on perennial ryegrass (Fig. 1 & 2). All fungicide treatments (including the reagent grade H_3PO_3/KOH solution) provided good control (> 89%) of Pythium blight on creeping bentgrass and perennial ryegrass relative to the untreated controls. A significant treatment by species interaction ($P \leq 0.001$) indicates some differences in efficacy occurred among fungicide treatments on the two grass species (Table 2). On creeping bentgrass, no differences were detected among any of the fungicides used in this test (Fig. 1). On perennial ryegrass, Subdue MAXX provided better control of Pythium blight than the solution of reagent grade H_3PO_3/KOH and Alude, but was not different from the Aliette and Signature treatments (Fig. 2).

Table 2. Analysis of variance of % blighting data as influenced by fungicide treatments and turfgrass species.

Source	df	Mean squares of % blighting of turf 2004
Replication (R)	3	209.07 ^{NS}
Species (S)	1	3664.45 ***
R x S	3	112.11 ^{NS}
Treatment (T)	6	10046.10 ***
T x S	6	829.70 ***
Error	36	82.76
Corrected total	55	-----

^{NS} = Non-significant; ** = significant at $P \leq 0.01$; *** = significant at $P \leq 0.001$

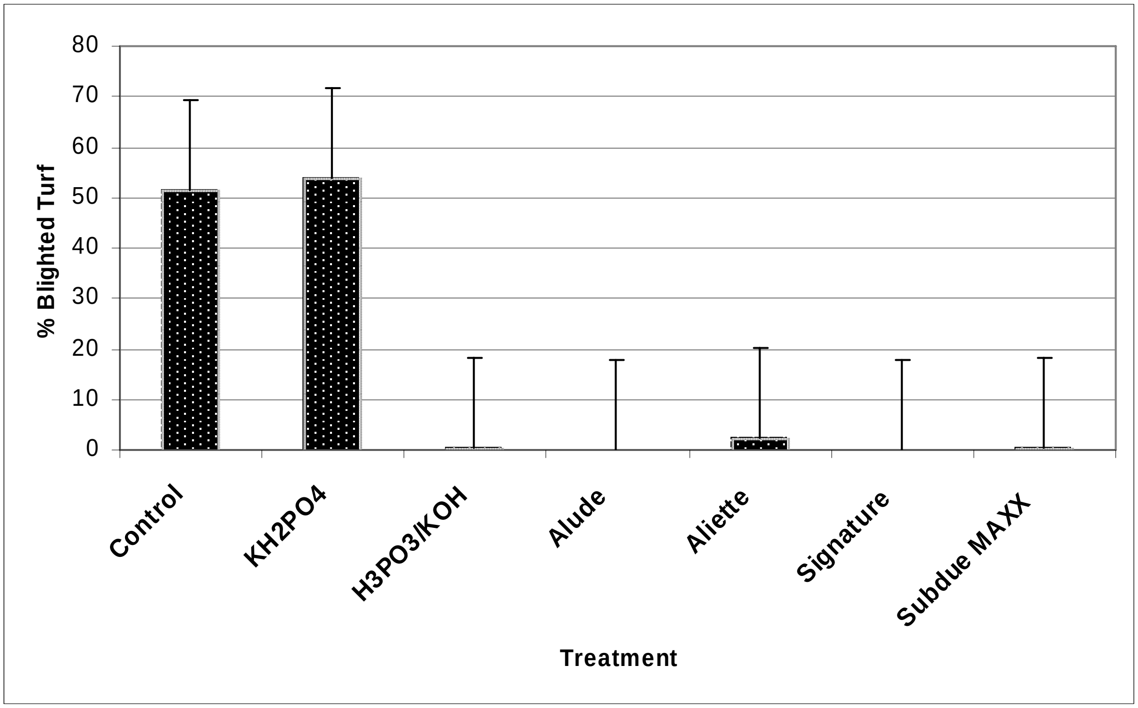

Fig. 1. Effect of phosphonate fungicides on Pythium blight development of ‘Penncross’ creeping bentgrass, expressed as % bighted turf. Bars above columns indicate LSD @ 5% level of significance (LSD = 18.0)

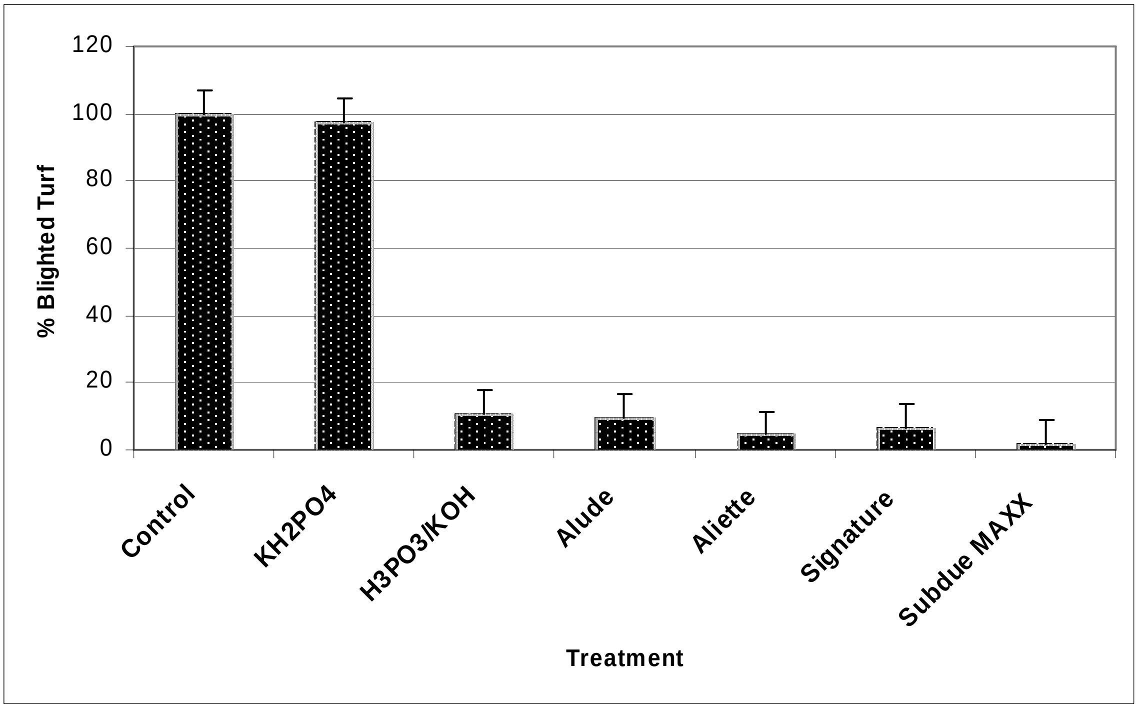

Fig. 2. Effect of phosphonate fungicides on Pythium blight development on ‘Integra’ perennial ryegrass, expressed as % bighted turf. Bars above columns indicate LSD @ 5% level of significance (LSD = 6.9)

Management of Basal-rot Anthracnose on a Putting Green with Fungicides, 2004

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Introduction

Basal-rot Anthracnose *(Colletotrichum graminicola)* frequently causes major injury to putting greens; particularly those comprised of high populations of annual bluegrass *(Poa annua)*. The use of fungicides is a significant component of a turf manager's approach in the management of basal-rot Anthracnose. The objective of this study was to evaluate the effects of various products, rates, rotations, and application timings for controlling Anthracnose infection on *Poa annua*.

Materials and Methods

The experiment was carried out at the Valentine Turfgrass Research Center on a mixed-stand of annual bluegrass and creeping bentgrass maintained under golf course greens-management conditions. The study was 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 19 May with 0.75 lb nitrogen (Lebanon 10-18-18) per 1000 sq ft, and on 6 Jul with 0.5 lb nitrogen (urea 46-0-0) per 1000 sq ft. Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with three replications. Treatments were applied with a CO_2-powered sprayer, equipped with a TeeJet 11008E nozzle, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 4 and 20 May, 1, 15, and 29 Jun, and 13 and 27 Jul, unless otherwise noted in the table. The experiment was inoculated on 12 May with a spore suspension of *Colletotrichum graminicola* containing 37,000 conidia per ml. The spore suspension was delivered at a rate of 2 gal per 1000 sq ft. Disease severity was evaluated on 2 and 28 Jun. 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

Disease severity was light and variable in this study due to moderate temperatures combined with abnormally high rainfall during the growing season. The turfgrass was not under any prolonged period of stress at any point during the experiment. On 18 Jun phytotoxicity, appearing as dark green to bronze colored turfgrass, was observed in the three treatments containing Rubigan. Phytotoxicity was increasingly severe, and turf density declined as the study progressed. The most effective treatments in the study were EcoGuard (7-day interval), the EcoGuard + Daconil Ultrex (2.45 oz) mixture, the EcoGuard + 3336 mixture, the mixtures of

Signature + 26GT alternated with Signature + Daconil Ultrex, and the Signature + Fore combination.

Table. Management of basal-rot anthracnose on a putting green with fungicides, 2004.

	Anthracnose severity[z]			
Treatment, formulation, and rate per 1000 sq ft	2 Jun		28 Jun	
EcoGuard L 20.0 fl oz[y]	0.0	g[x]	0.0	j[x]
EcoGuard L 20.0 fl oz	0.7	g	1.7	g-j
EcoGuard L 20.0 fl oz **alt** Daconil Ultrex 82.5WG 3.25 oz[w]	0.7	g	2.3	e-i
EcoGuard L 20.0 fl oz + Daconil Ultrex 82.5WG 3.25 oz	1.0	fg	1.7	g-j
EcoGuard L 20.0 fl oz + Daconil Ultrex 82.5WG 2.45 oz	0.7	g	1.0	ij
EcoGuard L 20.0 fl oz + Daconil Ultrex 82.5WG 0.81 oz	0.7	g	2.0	f-j
EcoGuard L 20.0 fl oz **alt** 3336 50WP 4.0 oz[w]	1.3	efg	3.0	c-i
EcoGuard L 20.0 fl oz + 3336 50WP 4.0 oz	0.7	g	1.3	hij
3336 4F 6.0 fl oz	3.0	cde	6.0	a
3336 4F 4.0 fl oz + Alude L 5.5 fl oz	3.7	bcd	5.0	abc
Alude L 5.5 fl oz + Protect T&O 80WP 8.0 oz	3.7	bcd	3.7	b-g
Endorse 2.5WP 4.0 oz	4.7	abc	4.3	a-e
Endorse DF 0.9 oz	4.0	bcd	5.0	abc
Endorse 2.5WP 4.0 oz + Alude L 5.5 fl oz	4.0	bcd	5.0	abc
Spectro 90WDG 4.0 oz	3.3	cd	3.3	b-h
Cleary Solutions[v]	2.7	def	2.7	d-i
1. Spectro 90WDG 4.0 oz + Magnum (2-40-16) L 3.0 fl oz				
2. Confidential + Magnum (2-40-16) L 3.0 fl oz				
3. Banner MAXX 1.3MEC 2.0 fl oz +Spotrete 4F 6.0 fl oz + Magnum L 3.0 fl oz				
4. Spectro 90WDG 4.0 oz + Alude L 5.5 fl oz				
5. Endorse WP 4.0 oz + Protect T&O 80WP 6.0 oz + Alude L 5.5 fl oz				
6. 3336 4F 4.0 fl oz + Protect T&O 80WP 6.0 oz + Alude L 5.5 fl oz				
Signature 80WDG 4.0 oz + 26GT 2SC 4.0 fl oz **alt** Armada 50WG 0.6 oz[w]	1.0	fg	5.3	ab
Signature 80WDG 4.0 oz + 26GT 2SC 4.0 fl oz **alt** Signature 80WDG 4.0 oz + Daconil Ultrex 82.5WDG 3.2 oz[w]	0.7	g	1.3	hij
26GT 2SC 4.0 fl oz **alt** Daconil Ultrex 82.5WDG 3.2 oz[w]	3.0	cde	2.7	d-i

Table. Management of basal-rot anthracnose on a putting green with fungicides, 2004.

Treatment, formulation, and rate per 1000 sq ft	Anthracnose severity[z] 2 Jun		28 Jun	
Bayer Program[u]	1.3	efg	4.7	a-d
1. Signature 80WDG 4.0 oz + Daconil Ultrex 82.5WDG 3.2 oz				
2. Armada 50WG 1.2 oz				
3. Signature 80WDG 4.0 oz + 26GT 2SC 4.0 fl oz				
4. Armada 50WG 1.2 oz				
5. Signature 80WDG 4.0 oz + Daconil Ultrex 82.5WDG 3.2 oz				
6. Signature 80WDG 4.0 oz + 26GT 2SC 4.0 fl oz				
7. Signature 80WDG 4.0 oz + Daconil Ultrex 82.5WDG 4.0 oz				
26/36 1.57SC 2.6 fl oz	4.3	a-d	3.0	c-i
26/36 1.57SC 3.8 fl oz	3.7	bcd	3.3	b-h
26/36 1.57SC 5.0 fl oz	4.0	bcd	3.7	b-g
Signature 80WDG 4.0 oz + Fore 80WP 4.0 oz	0.0	g	1.3	hij
Endorse 2.5WP 4.0 oz + Rubigan 1AS 1.75 fl oz	4.0	bcd	3.7	b-g
Endorse 2.5WP 4.0 oz + Rubigan 1AS 2.5 fl oz	6.0	a	4.3	a-e
Endorse 2.5WP 4.0 oz + Rubigan 1AS 3.5 fl oz	5.3	ab	4.0	a-f
Insignia 20WG 0.9 oz	3.3	cd	3.3	b-h
Insignia 20WG 0.9 oz + Manicure Ultrex 82.5WG 3.2 oz	3.3	cd	2.3	e-i
Insignia 20WG 0.9 oz + Propiconazole Pro 1.3ME 1.0 fl oz	4.3	a-d	6.0	a
Daconil Ultrex 82.5WDG 3.25 oz	3.7	bcd	2.0	f-j
Untreated check	2.7	def	3.7	b-g

[z]Disease severity index 0-10; 0=asymptomatic, and 10=>90% annual bluegrass symptomatic, mean of three replications.

[Y]Treatment applied on a 7-day interval (4 May through 27 Jul).

[x]Means within column followed by different letters are significantly different (P≤0.05) according to the Waller-Duncan k-ratio test.

[w]Products were applied alternately on a 14-day interval.

[v]Treatments were applied on 14-day intervals in the order indicated in the table beginning 20 May.

[u]Treatments were applied on 14-day intervals in the order indicated in the table beginning 4 May.

Control of Brown Patch on a Fairway Turf with Fungicides, 2004

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Introduction

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

Materials and Methods

The experiment was conducted at the Valentine Turfgrass Research Center, University Park, PA, on colonial bentgrass maintained under golf course fairway management conditions, mowed three times per week at 0.5-inch cutting height. The soil was Hagerstown silt loam with pH 6.7. The test area was fertilized on 6 May with 1.0 lb nitrogen (31-0-0) per 1000 sq ft and 6 Jul with 0.5 lb nitrogen (46-0-0) per 1000 sq ft. Betasan 4E was applied at 9.0 fl oz per 1000 sq ft on 5 May for pre-emergent control of crabgrass. Talstar GC Flowable 0.25 fl oz per 1000 sq ft) was applied on 15 Jul for control of cutworms. Treatment plots, 3 ft x 6 ft, were arranged in a randomized complete block design with three replications. Applications were made with a CO_2-powered sprayer, using a TeeJet 11008E nozzle, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Treatments were applied on 16 and 30 Jun, and 15 and 29 Jul. The experimental area was inoculated on 22 Jun by hand-scattering *Rhizoctonia solani*-infested rye grains at a density of 15-20 grains per sq ft. Disease severity was assessed on 8 and 14 Jul. Data were subjected to analysis of variance and multiple comparisons of the mean values were made using the Waller-Duncan k-ratio test ($P \leq 0.05$).

Results and Discussion

Disease severity was moderate to heavy in the trial through mid-Jul, while disease incidence was variable. In the 8 Jul evaluation, 13 of the 33 treatments showed excellent control of brown patch. On 14 Jul, 21 treatments provided excellent control. Heritage, Heritage TL (a new liquid formulation), and Insignia at the 0.5 and 0.9 oz rates provided complete suppression of brown patch in the study when applied on a 14-day interval. No phytotoxicity was observed in the experiment.

Table. Control of brown patch on a fairway turf with fungicides, 2004.

Treatment, formulation, and rate per 1000 sq ft	Brown Patch Severity[z] 8 Jul		14 Jul	
Spectator EC 0.72 fl oz[y]	2.5	b-f[x]	7.0	a[x]
Spectator EC 0.37 fl oz	0.8	efg	4.7	b
Iprodione Pro 2SC 4.0 fl oz	0.5	efg	4.5	b
Daconil Ultrex 82.5WG 3.25 oz	0.0	g	3.3	bc
Untreated Check	2.8	a-e	3.2	bcd
Insignia 20WG 0.9 oz[w]	0.3	fg	3.0	bcd
Echo 720 6F 3.6 fl oz	0.0	g	2.2	cde
Spectro 90WDG 4.0oz	0.0	g	2.0	c-f
Emerald 70WG 0.13 oz[w]	5.0	a	2.0	c-f
Propiconazole 1.3ME 2.0 fl oz	0.3	fg	1.8	c-f
Echo 825 82.5WG 3.25 oz	0.0	g	1.5	c-f
FarmSaver Propiconazole 1.3ME 1.25 oz +QP Chlorothalonil 6F 2.5 oz	0.8	efg	1.2	def
Quali-Pro TM/C 66.7WG 5.0 oz	1.8	b-g	0.7	ef
T-Storm Flowable 4.5F 2.5 fl oz	0.7	efg	0.7	ef
Super GT 3SC 2.7 fl oz[w]	3.3	a-d	0.5	ef
Eagle 40WP 0.6 oz	0.5	efg	0.3	ef
Eagle 1.67EW 1.2fl oz	0.3	fg	0.2	ef
Endorse 2.5WP 4.0 oz + Spotrete 75WG 5.0 oz	0.0	g	0.2	ef
Armada 50WG 0.6 oz[w]	1.0	d-g	0.2	ef
Banner MAXX 1.3ME 1.25 fl oz + Daconil Weatherstik 6F 2.5 fl oz	0.0	g	0.2	ef
18 Plus Flowable 2F 3.0 fl oz[w]	3.8	abc	0.2	ef
Heritage 50WG 0.2 oz	0.0	g	0.0	f
Heritage TL 0.8ME 1.0 fl oz	0.0	g	0.0	f
Endorse 2.5WP 4.0 oz	1.5	c-g	0.0	f
Compass 50WG 0.2 oz[w]	2.3	b-g	0.0	f
Armada 50WG 1.2 oz[w]	1.0	d-g	0.0	f
Bayleton 50WG 1.0 oz[w]	0.8	efg	0.0	f
Compass 50WG 0.1 oz + Lynx 45WP 0.3 oz[w]	0.5	efg	0.0	f
Insignia 20WG 0.9 oz	0.0	g	0.0	f
26GT 2SC 4.0 fl oz[w]	4.2	ab	0.0	f
ProStar 70WP 2.2 oz + Bayleton 50WG 0.5 oz[w]	0.5	efg	0.0	f
Insignia 20WG 0.5 oz	0.0	g	0.0	f
ProStar 70WP 1.5 oz	0.5	efg	0.0	f

[z]Disease severity index 0-10; 0=asymptomatic, and 10=>90% turf area symptomatic, mean of three replications.
[y]Treatment applied on a 28-day interval (16 Jun and 15 Jul).
[x]Means within each column followed by different letters are significantly different ($P \leq 0.05$) according to the Waller-Duncan k-ratio test.
[w]Treatment applied on a 21-day interval (16 Jun, 8 and 29 Jul).

Effects of Fungicides for Dollar Spot Control on a Putting Green, 2004

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Introduction

The use of fungicides for managing dollar spot (*Sclerotinia homoeocarpa*) on golf courses is a fundamental 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 conducted at the Valentine Turfgrass Research Center, University Park, PA, on a mixed stand of creeping bentgrass and annual bluegrass maintained under golf course greens management conditions. The turfgrass was mowed six times per week at 0.125-inch cutting height. The soil was a modified sandy clay loam with pH 7.0. The experiment was fertilized 19 May with 0.75 lb nitrogen (Lebanon 28-7-14), and on 6 Jul with 0.5 lb nitrogen (46-0-0) per 1000 sq ft. Talstar GC Flowable (0.25 fl oz per 1000 sq ft) was applied 15 Jul for control of black cutworms. 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, using a TeeJet 11008E nozzle at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 1, 16, 29 Jun, and 13 and 29 Jul, unless otherwise noted in the table. The experimental turf area was inoculated on 13 Jun and 6 Jul by hand-broadcasting *S. homoeocarpa*-infested rye grains at the rate of 20-30 grains and 10-15 grains respectively per sq ft. A pool of five isolates of *S. homoeocarpa* was used in each of the inoculations. Disease severity was evaluated and data were subjected to analysis of variance and multiple comparisons of the mean values were made using the Waller-Duncan k-ratio test.

Results and Discussion

Dollar spot incidence was variable across the experiment, and disease severity was light to moderate during the study. On 9 Jul seven treatments provided control that was no different than the untreated check. The 20 Jul evaluation showed 10 treatments were ineffective; while fourteen treatments provided complete suppression of dollar spot. Phytotoxicity, in the form of darkened green to bronze coloration was noted in plots treated with Farmsaver.com Propiconazole and treatments containing Banner MAXX.

Table. Effects of fungicides for dollar spot control on a putting green, 2004.

Treatment, formulation, and rate per 1000 sq ft	Infection centers per plot[z] 9 Jul		20 Jul	
Eagle 1.67EW 1.2 fl oz	0.0	d[y]	0.0	e[y]
Eagle 40WP 0.6 oz	0.0	d	0.0	e
EcoGuard L 20.0 fl oz[x]	15.0	a	12.7	b
EcoGuard L 20.0 fl oz	9.0	ab	12.0	bc
EcoGuard L 20.0 fl oz ***alternate*** Daconil Ultrex 82.5WG 3.25 oz[w]	5.0	bcd	3.7	cde
EcoGuard L 20.0 fl oz + Daconil Ultrex 82.5WG 3.235 oz	0.0	d	3.3	cde
Emerald 70WG 0.184 oz	0.0	d	0.0	e
Rubigan AS 1AS 1.5 fl oz	0.0	d	0.0	e
3336 4F 4.0 fl oz	3.7	bcd	5.7	b-e
Spectro 90WDG 4.0 oz	0.0	d	0.3	e
Armada 50WG 0.6 oz[v]	0.0	d	0.0	e
Armada 50WG 1.2 oz[v]	0.0	d	0.0	e
Compass 50WG 0.2 oz[u]	7.7	b	6.3	b-e
Bayleton 50WG 1.0 oz[u]	0.0	d	3.0	de
Insignia 20WG 0.9 oz[u]	6.7	bc	26.7	a
Emerald 70WG 0.13 oz[u]	0.7	cd	0.7	e
Emerald 70WG 0.13 oz	0.0	d	0.0	e
Emerald 70WG 0.18 oz[t]	0.0	d	0.0	e
Emerald 70WG 0.18 oz[s]	0.0	d	0.0	e
Emerald 70WG 0.18 oz + Curalan 50EG 1.0 oz[t]	0.0	d	0.0	e
Insignia 20WG 0.9 oz	0.0	d	0.0	e
26GT 2SC 3.0 fl oz	0.3	cd	1.7	e
Banner MAXX 1.3MEC 1.0 fl oz	0.0	d	2.7	de
Banner MAXX 1.3MEC 1.0 fl oz + Heritage 50WG 0.2 oz	0.0	d	1.0	e
Banner MAXX 1.3MEC 1.0 fl oz + Heritage TL 0.8MEC 1.0 fl oz	0.0	d	0.0	e
FarmSaver Propiconazole 1.3MEC 1.0 fl oz	0.0	d	0.0	e
Quali-Pro TM/C 66.7WG 5.0 oz	0.0	d	0.0	e
Daconil Ultrex 82.5WG 3.25 oz	0.0	d	0.3	e
Untreated Check	10.0	ab	11.0	bcd

[z]Number of infection centers per plot, mean of three replications.
[y]Means within 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 7-day interval (1, 7, 16, 23, 29 Jun, and 7, 13, 21, 29 Jul).
[w]Products applied alternately on a 14-day interval.
[v]Treatment applied as a curative application 29 Jun and 13 Jul.
[u]Treatment applied as a curative application 13 Jul.
[t]Treatment applied on a 21-day interval (1 and 23 Jun, and 13 Jul).
[s]Treatment applied on a 28-day interval (1 and 29 Jun, and 29 Jul).

Evaluation of Fungicides for Control of Gray Leaf Spot on Perennial Ryegrass, 2004

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Introduction

Gray leaf spot (*Pyricularia grisea*) is an important disease on perennial ryegrass (*Lolium perenne*) golf course fairways and roughs 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 of the study was to evaluate various fungicides, rates, and fungicide combinations for their effectiveness in suppressing gray leaf spot.

Materials and Methods

The experiment was conducted on perennial ryegrass at the Valentine Turfgrass Research Center, University Park, PA. The site was maintained under golf course fairway management conditions; mowed three times per week at 1.0-inch cutting height. The soil was Hagerstown silt loam, pH 6.8. The experimental area was fertilized on 4, 6, and 20 May with 0.75 lb nitrogen (46-0-0), 1.0 lb nitrogen (31-0-0), and 0.5 lb nitrogen (16-16-16) respectively per 1000 sq ft; and on 6 Jul with 0.5 lb nitrogen (46-0-0) per 1000 sq ft. Dimension Ultra 40WP was applied 5 May at the rate of 0.17 oz per 1000 sq ft for control of crabgrass. Confront 3SL and Amine 400 were applied at the rates of 0.74 fl oz and 0.5 fl oz respectively per 1000 sq ft for control of broadleaf weeds. Subdue MAXX (1.0 fl oz per 1000 sq ft) was applied 12 May for control of Pythium foliar blight; and Banol and ProStar were applied 7 Jul at the rates of 2.0 fl oz and 2.0 oz respectively per 1000 sq ft for control of Pythium foliar blight and brown patch. On 15 Jul Mach 2 2SC (2.9 fl oz per 1000 sq ft) was applied for control of grubs. 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 using a TeeJet 11008E nozzle at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Treatments were applied on 30 Jun, and 15 and 29 Jul, unless otherwise noted in the table. The experiment was inoculated on 19 and 28 Jul by spraying a *P. grisea*-spore suspension over the experimental site. The study was lightly irrigated and covered each night from 19 through 22 Jul, and 28 Jul through 5 Aug, with a 6-mil translucent plastic sheet. The cover was removed between 10:00 a.m. and 4:00 p.m. daily. After the initial inoculation, the experiment was maintained at a 2.0-inch cutting height; mowed once per week. Disease severity was evaluated on 13 and 18 Aug. Data were subjected to analysis of variance and multiple comparisons of the mean values were made using the Waller-Duncan k-ratio test.

Results and Discussion

Temperatures in central Pennsylvania were lower than normal during the experiment due to extensive cloud cover, while rainfall was high. All treatments gave Gray leaf spot control that was significantly different from the untreated check. Fourteen of the 18 treatments provided excellent control throughout the experiment. Total Gray leaf spot suppression was provided by QP TM/C alternated with a Banner MAXX + QP Chlorothalonil mixture, Echo 825, Daconil Ultrex, and Spectro. No phytotoxicity was observed in the experiment.

Table. Evaluation of fungicides for control of gray leaf spot on perennial ryegrass, 2004.

	Disease severity[z]			
Treatment, formulation, and rate per 1000 sq ft	13 Aug		18 Aug	
Untreated check	5.0	a[y]	5.3	a[y]
Propiconazole EC 1.3EC 2.0 fl oz	3.0	b	3.7	b
Heritage TL 0.8ME 2.0 fl oz[x]	1.0	c	2.0	c
Heritage 50WG 0.2 oz + Banner MAXX 1.3ME 1.0 fl oz	1.0	c	1.0	d
Heritage 50WG 0.2 oz	0.3	cd	0.7	de
Heritage 50WG 0.4 oz[x]	0.7	cd	0.7	de
Compass 50WG 0.2 oz	0.7	cd	0.7	de
QP TM/C 66.7WG 6.0 oz ***alternate***	0.3	cd	0.7	de
Farmsaver Propiconazole ME 1.25 fl oz + QP Chlorothalonil 6F 2.5 fl oz[w]				
Heritage TL 0.8ME 1.0 fl oz	0.3	cd	0.3	de
Insignia 20WG 0.5 oz	0.3	cd	0.3	de
Insignia 20WG 0.9 oz[x]	0.0	d	0.3	de
Insignia 20WG 0.5 oz + Manicure 82.5WG 3.2 oz	0.0	d	0.3	de
Echo 720 6F 3.6 fl oz	0.3	cd	0.3	de
3336 4F 6.0 fl oz	0.3	cd	0.0	e
Spectro 90WDG 5.0 oz	0.0	d	0.0	e
Daconil Ultrex 82.5WG 3.2 oz	0.0	d	0.0	e
Echo 825 82.5WG 3.25 oz	0.0	d	0.0	e
QP TM/C 66.7WG 6.0 oz ***alternate***	0.0	d	0.0	e
Banner MAXX 1.3ME 1.25 fl oz + QP Chlorothalonil 6F 2.5 fl oz[v]				

[z]Disease severity index 0-10; 0=asymptomatic, and 10=>90% turf area symptomatic, mean of three replications.
[y]Within column, means followed by different letters are significantly different ($P \leq 0.05$)according to the Waller-Duncan k-ratio test.
[x]Treatment applied on a 28-day interval (16 Jun and 15 Jul).
[w]Treatment applications were alternated on a 14-day interval (QP TM/C 30 Jun and 29 Jul; Farmsaver Propiconazole + QP Chlorothalonil 15 Jul).
[v]Treatment applications were alternated on a 14-day interval (QP TM/C 30 Jun and 29 Jul; Banner MAXX + QP Chlorothalonil 15 Jul).

Control of Spring Leaf Spot/Melting-out on Kentucky Bluegrass, 2004

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Introduction

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

Materials and Methods

The study was conducted at the Valentine Turfgrass Research Center on Kentucky bluegrass mowed three times per week at 1.5-inch cutting height. The soil was Hagerstown silt loam with a soil pH of 6.8. The site was fertilized on 6 Apr with 1.7 lb nitrogen (urea 46-0-0) per 1000 sq ft. On 5 May, Dimension Ultra 40WP was applied at the rate of 0.17 oz per 1000 sq ft for control of crabgrass. Treatment plots, 3 ft by 6 ft, were arranged in a randomized complete block design with three replications. Fungicides were applied with a CO_2-powered boom sprayer, using a TeeJet 11008E nozzle, at 40 psi, in water equivalent to 2 gal per 1000 sq ft. Applications were made on 16 and 30 Apr, and 13 May, unless otherwise indicated in the table. Data were subjected to analysis of variance, and the mean values were separated using the Waller-Duncan k-ratio Test ($P \leq 0.05$).

Results and Discussion

Severity of leaf spot/melting-out was increasingly high in this experiment. With the exception of the 6 May evaluation, all treatments provided control significantly different from the untreated check. No treatment provided complete control at any point during the experiment; nor was there any phytotoxicity observed.

Table. Control of spring leaf spot/melting-out on Kentucky bluegrass, 2004.

Treatment, formulation, and rate per 1000 sq ft	Disease severity[z] 6 May		13 May		21 May		26 May	
Heritage 50WG 0.4 oz[x]	2.1	cde[y]	1.0	b[y]	1.7	bc[y]	1.3	bc[y]
Compass 50WG 0.15 oz[x]	2.0	de	2.3	b	3.7	bc	2.3	bc
Insignia 20WG 0.9 oz[x]	1.9	de	1.0	b	1.7	bc	1.7	bc
26GT 2SC 3.0 fl oz[x]	1.3	e	1.0	b	1.3	c	0.3	c
Daconil Ultrex 82.5WG 1.8 oz	2.3	bcd	3.0	b	4.0	b	4.0	b
Endorse 2.5WP 4.0 oz[w]	2.9	bc	2.3	b	1.3	c	2.3	bc
Endorse 11.3DF 0.9 oz[w]	3.0	ab	2.3	b	2.3	bc	2.0	bc
Check	3.8	a	6.7	a	7.7	a	8.3	a

[z]Disease severity index 0-10; 0=asymptomatic, and 10=>90% turf area symptomatic, mean of three replications.
[y]Means within 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 (16 Apr and 6 May).
[w]Treatment applied beginning 30 Apr.

Control of Pythium Foliar Blight on Perennial Ryegrass, 2004

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Introduction

Pythium foliar blight is a potentially devastating disease on fine turf. The use of fungicides plays a crucial role in 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 5 May with 0.75 lb nitrogen (46-0-0) per 1000 sq ft, and 6 May and 29 Jun each with 1.0 lb nitrogen (31-0-0) per 1000 sq ft. Dimension Ultra 40WP was applied 5 May at the rate of 0.17 oz per 1000 sq ft for control of crabgrass. Daconil Ultrex (4.0 oz/1000 sq ft) and Farmsaver.com TM85 (0.5 oz per 1000 sq ft) were applied 12 May and 16 Jun respectively for control of brown patch. Confront 3L (0.74 fl oz per 1000 sq ft) and Amine 400 (0.5 fl oz per 1000 sq ft) were applied 18 Jun for control of broadleaf weeds. Treatment plots, 3 ft x 3 ft, were arranged in a randomized complete block design with three replications. Treatments were applied on 5 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 7 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 five-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 13 through 16 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

Pythium foliar blight severity was high in the experiment. Fifteen of the 24 treatments gave excellent control of the disease throughout the study. Two tank-mixtures, Insignia 0.9 oz +

Signature 4.0 oz, and Cyazofamid 0.45 fl oz + Subdue MAXX 0.5 fl oz, provided complete suppression of Pythium foliar blight throughout the experiment. No phytotoxicity was observed in the test.

Table. Control of Pythium foliar blight on perennial ryegrass, 2004.

	Disease severity*							
Treatment, formulation, and rate per 1000 sq ft	13 Jul		14 Jul		15 Jul		16 Jul	
Untreated Check	8.8	a**	9.2	a**	9.7	a**	9.8	a**
Signature 80WG 4.0 oz	5.5	b	6.3	b	7.5	ab	7.8	ab
Biophos L 15.0 fl oz	3.7	bcd	5.8	bc	7.0	abc	7.2	ab
Banol 6SL 2.0 fl oz	2.7	cde	4.8	bc	6.5	bc	7.0	abc
Signature 80WG 2.0 oz + Banol 6SL 1.0 fl oz	4.0	bc	4.0	bcd	6.5	bc	6.5	bcd
Signature 80WG 8.0 oz	2.5	c-f	4.2	bcd	4.3	cde	5.8	b-e
Alude 5.17L 5.5 fl oz	1.7	d-g	3.7	cde	4.5	cd	4.8	b-f
Megaphos WG 4.0 oz	2.5	c-f	3.5	c-f	4.5	cd	4.5	b-g
Alude 5.17L 10.0 fl oz	2.2	c-g	2.2	d-g	3.0	def	3.7	c-h
Alude 5.17L 5.5 fl oz + Protect T&O 80WG 8.0 oz	1.7	d-g	1.7	efg	2.2	d-g	2.8	d-i
Insignia 20WG 0.9 oz	1.7	d-g	1.7	efg	2.3	d-g	2.7	e-i
Farmsaver Mefenoxam 2 MAXX 2ME 0.5 fl oz	0.0	g	1.0	g	1.7	d-g	1.8	f-i
Farmsaver Mefenoxam 2 MAXX 2ME 1.0 fl oz	0.7	efg	0.7	g	0.8	fg	1.8	f-i
Cyazofamid 3.34SC 0.45 fl oz + Subdue MAXX 2ME 1.0 fl oz	0.0	g	1.2	fg	1.5	efg	1.7	f-i
Cyazofamid 3.34SC 0.9 fl oz	0.0	g	0.2	g	1.0	fg	1.3	ghi
Alude 5.17L 5.5 fl oz + Spectro 90WDG 5.0 oz	0.3	fg	0.7	g	1.3	fg	1.3	hi
Cyazofamid 3.34SC 0.9 fl oz + Silwet L-77 L 0.1% v/v	0.3	fg	0.3	g	0.7	fg	0.8	hi
Subdue MAXX 2ME 1.0 fl oz	0.0	g	0.5	g	0.7	fg	0.8	hi
Cyazofamid 3.34SC 0.45 fl oz + Signature 80WG 4.0 oz	0.3	fg	0.5	g	0.7	fg	0.7	hi
Cyazofamid 3.34SC 0.45 fl oz + Banol 6SL 1.5 fl oz	0.3	fg	0.3	g	0.7	fg	0.7	hi
Cyazofamid 3.34SC 0.45 fl oz	0.3	fg	0.3	g	1.0	fg	0.5	hi
Subdue MAXX 2ME 0.5 fl oz	0.0	g	0.2	g	0.3	fg	0.5	hi
Cyazofamid 3.34SC 0.45 fl oz + Subdue MAXX 2ME 0.5 fl oz	0.0	g	0.0	g	0.0	g	0.0	i
Insignia 20WG 0.9 oz + Signature 80WG 4.0 oz	0.0	g	0.0	g	0.0	g	0.0	i

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

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 considered a 'high-density' bentgrass, demonstrating 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 development of fertilizer guidelines for A-4 to be a worthwhile effort.

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 ~3,000 square feet of a 3-year-old established A-4 creeping bentgrass putting green. The green root mix is a topdressed-pushup variety, comprised of a slightly calcareous sand (CCE ~ 10%) upper layer and an underlying Hagerstown silt loam mineral soil. *Poa annua* encroachment in the plots varies form 0 to 30%. Nutritional status of the upper 4" of root mix has been maintained at optimal levels of all primary, macro-, and micro-nutrients.

Beginning April 15, 2003 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. Beginning April 20, 2004 1/6 of the annual rate was applied, and 1/13 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 N form 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 arrays of N forms, from 0 to 100% NH_4^+ and 100 to 0% NO_3^-, respectively. These two variables, N quantity and N form, comprised the factorial arrangement in a rotatable composite design. Fertilizer applications were made by 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 and dark green color index (DGCI) measures were collected throughout the 2003 and

2004 seasons. Leaf tissue from clipping yields was analyzed for total nutrient content, while carbohydrate analysis is still pending. Root length and soil chemical parameters of cores removed from plots in 2003-04 are still being measured and statistical analysis is pending.

Results

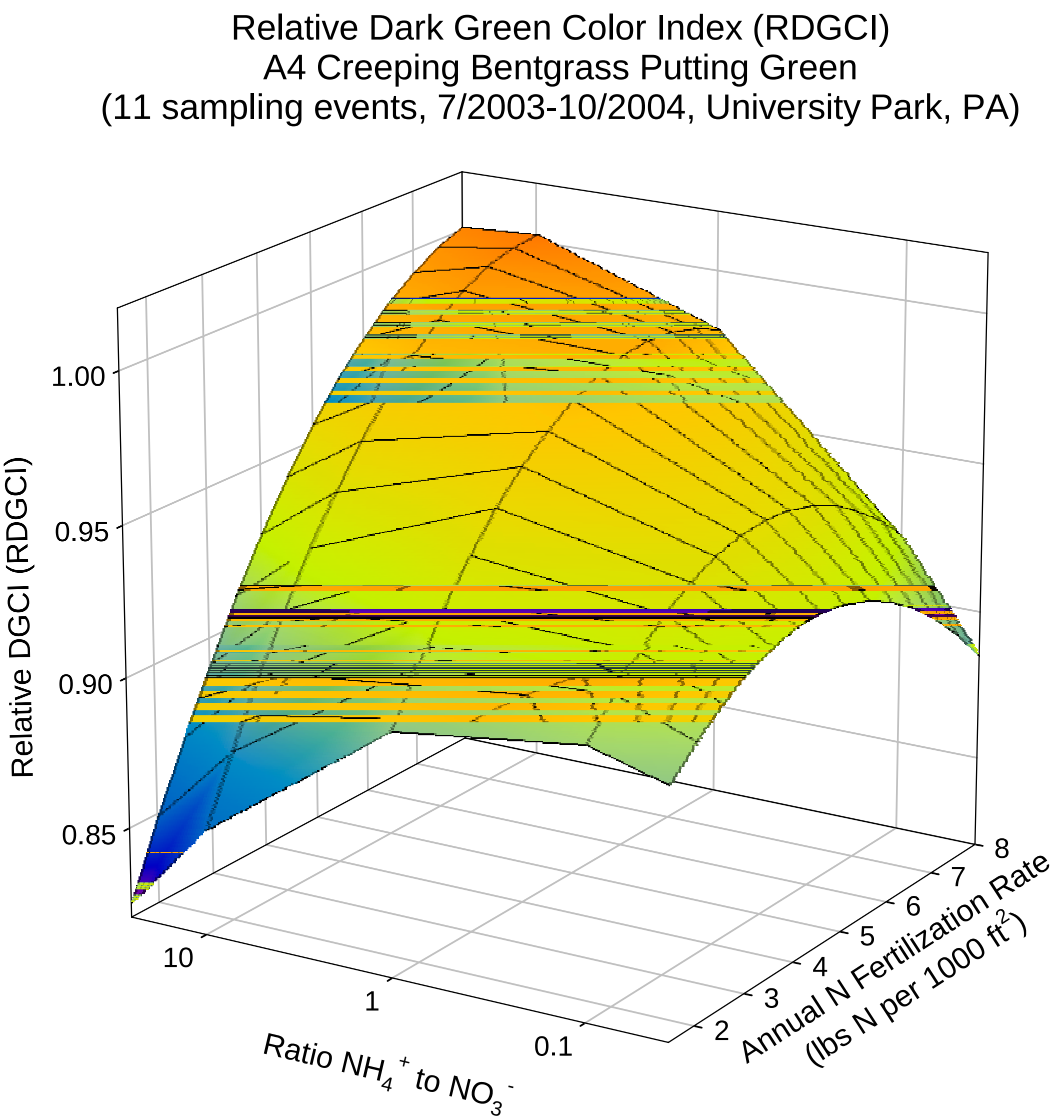

Figure 1. Relative Dark Green Color Index (RDGCI) of plots, as affected by N rate, form, and date (relativity was determined by dividing maximum observed level by observed level on a per date basis). The maximum NH_4 to NO_3 ratio used in the study was 26:1 (far left). Dark green color index (DGCI) analysis was performed using a slight modification (brightness excluded) of the original method (Karcher and Richardson, 2003). The illustrated response surface passed *f*-test and lack of fit scrutiny ($P_r > f$ = <0.001 and 0.0508, respectively).

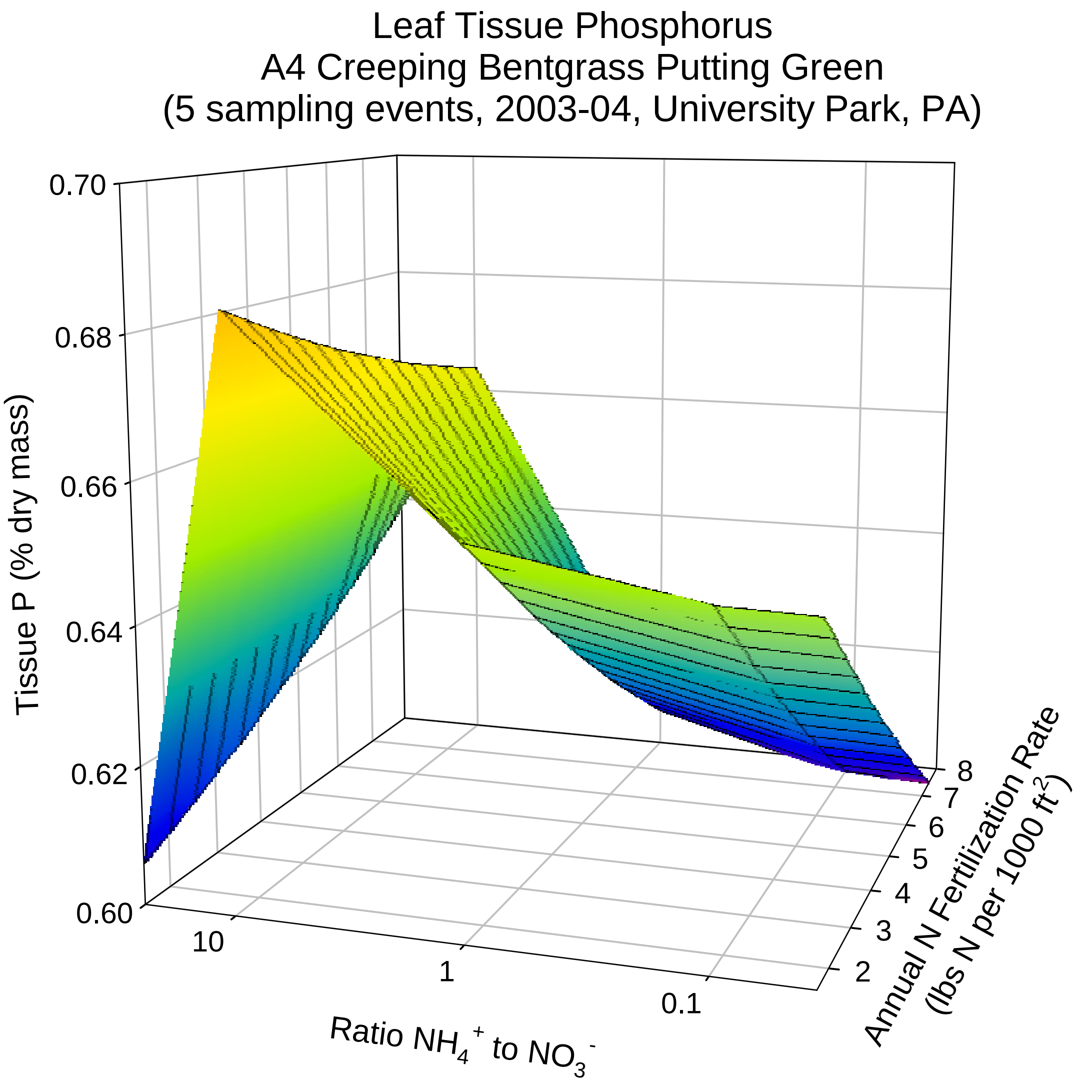

Figure 2. Phosphorus concentration of leaf tissue, as affected by N rate and form. The maximum NH_4 to NO_3 ratio used in the study was 26:1 (far left). The illustrated response surface does not include data from a clipping yield in both 2003 and 2004 (currently being analyzed) and passed *f*-test and lack of fit scrutiny ($P_r > f$ = 0.006 and 1.0, respectively).

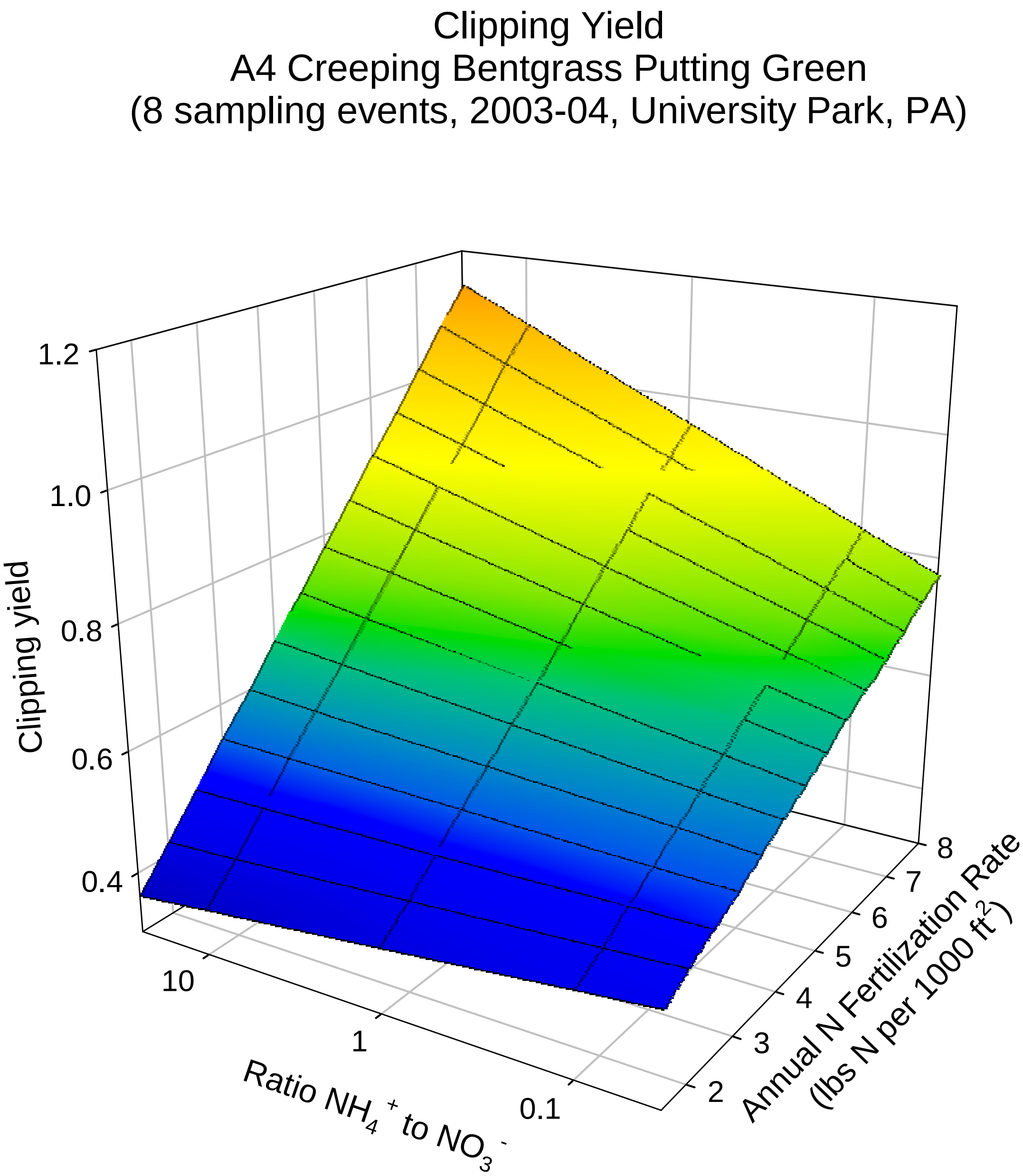

Figure 3. Clipping yield as affected by N rate and form. The maximum NH_4 to NO_3 ratio used in the study was 26:1 (far left). The illustrated response surface passed *f*-test and lack of fit scrutiny (P_r>*f* = <0.001 and 0.2, respectively).

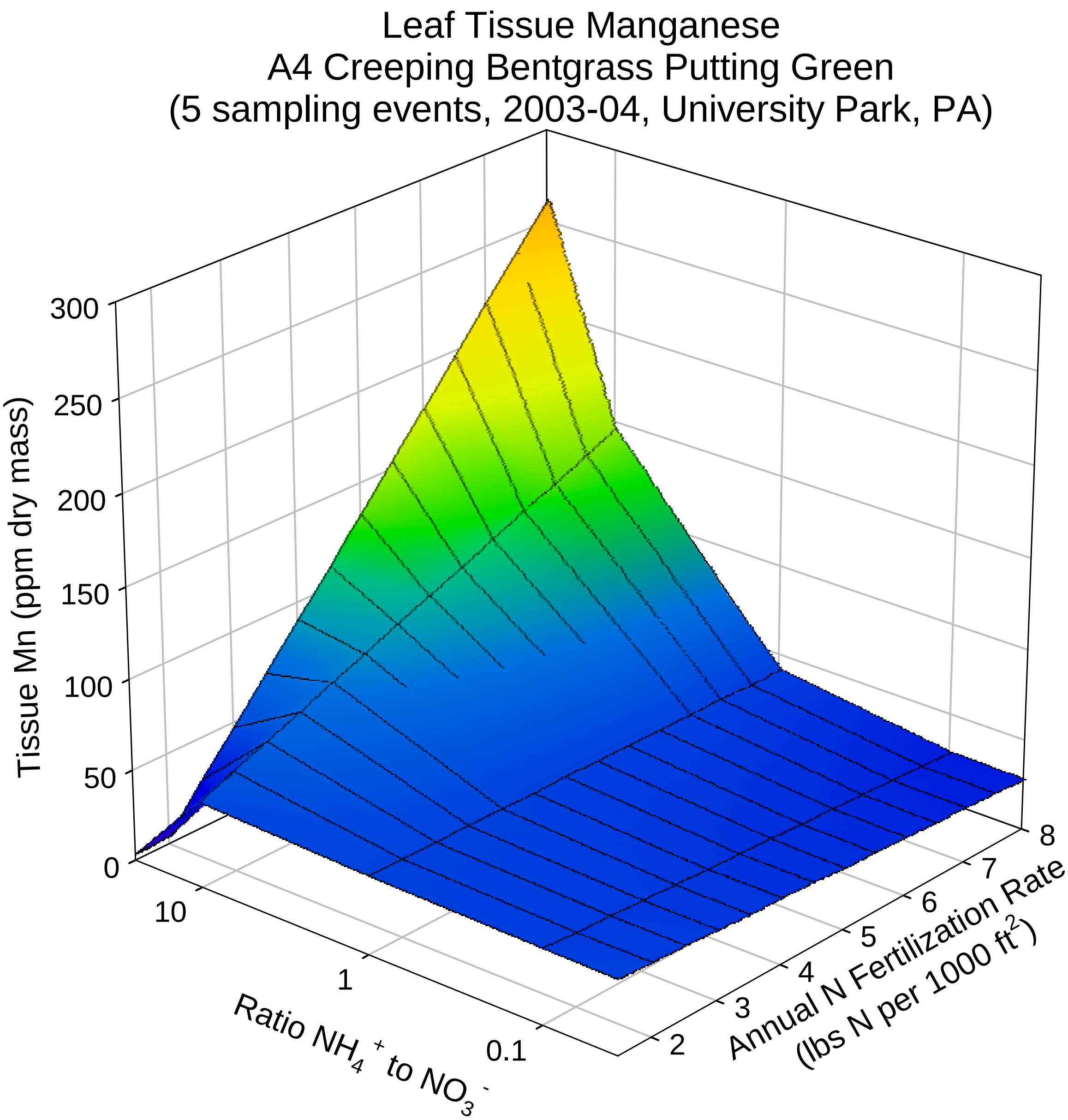

Figure 4. Manganese concentration of leaf tissue as affected by N rate and form. The maximum NH_4 to NO_3 ratio used in the study was 26:1 (far left). The illustrated response surface does not include data from a clipping yield in both 2003 and 2004 (currently being analyzed) and passed *f*-test and lack of fit scrutiny (P_r>*f* = <0.001 and 0.71, respectively).

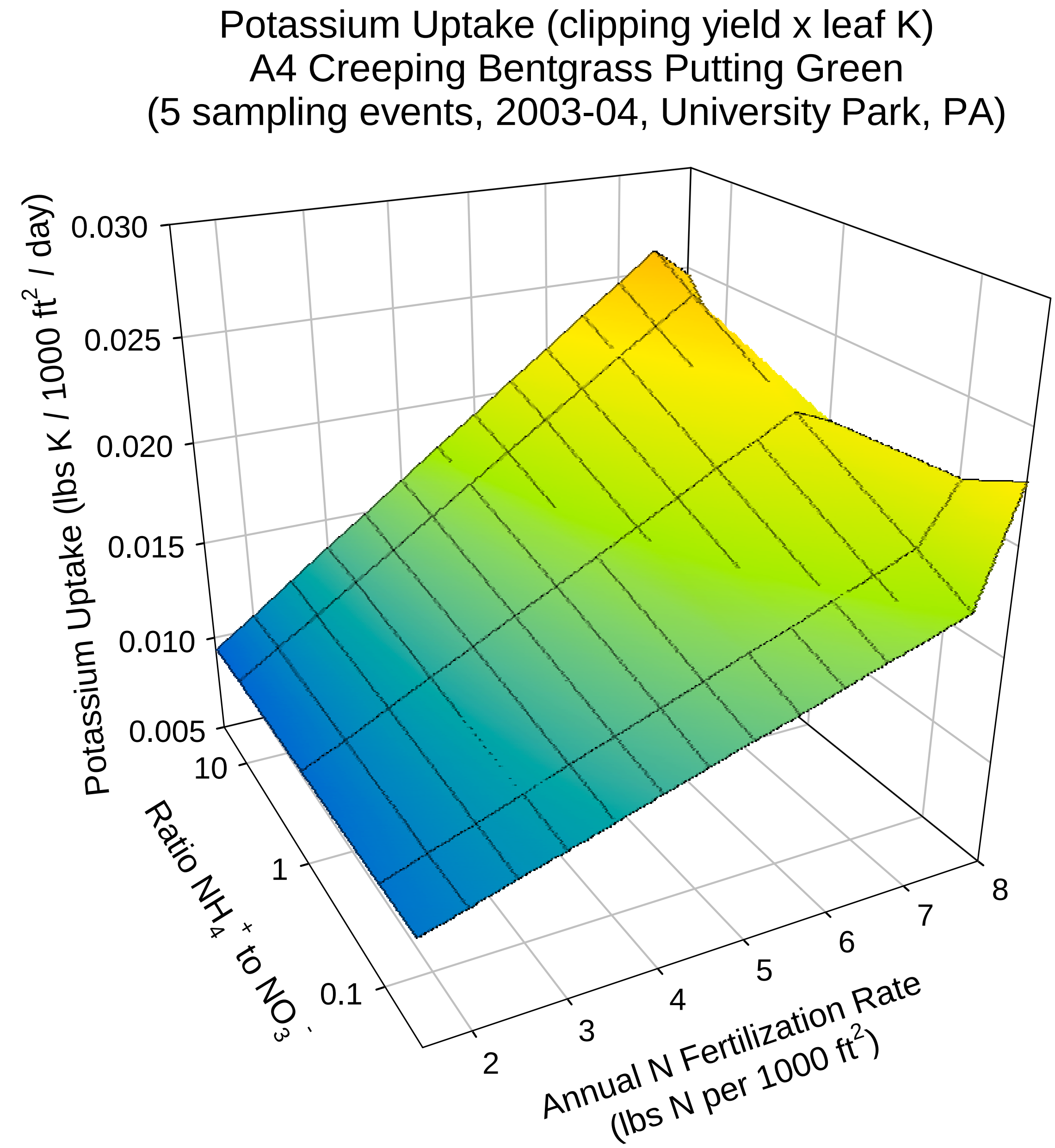

Figure 5. Potassium uptake as affected by N rate and form. The maximum NH_4 to NO_3 ratio used in the study was 26:1 (far left). The illustrated response surface does not include data from a clipping yield in both 2003 and 2004 (currently being analyzed) and passed *f*-test and lack of fit scrutiny ($P_r > f$ = <0.001 and 0.35, respectively).

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, and P and Mn concentrations in tissue; when compared to ammonium or calcium nitrate as the N source.

Root measurements are continually being analyzed. It is possible that the benefits reported herein occurred at the expense of root length density. Carbohydrate partitioning may also have been affected by primary N form, this analysis is underway. Due to high rainfall and lack of high temperature stress on the bentgrass putting green over the entire experimental period, adverse repercussions of limited root length were not observed nor expected.

Further experimentation, including interactions with PRIMO MAXX growth regulator, were conducted on multiple sites in 2004 (Bent Creek C.C. and Gulph Mills G.C.). This data is not reported here. Further results of this continual project will be presented in the 2005 PTC Annual Report.

Acknowledgements

The authors thank the Pennsylvania Turfgrass Council and The Foundation for Agronomic Research for their fiscal support of the described research. We also thank the Honeywell Specialty Products Division for providing materials.

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Black Sand and Turf Cover Effects on New Putting Green Spring Green-up and Tillering

Dr. G. W. Hamilton, Jr. and R. B. Raley
Penn State University

Introduction

Green covers have been used to help new golf course putting greens mature in the first year after planting; to hasten spring green-up and tillering. Mainly a result of budget concerns, new putting greens are planted very late in the fall, and scheduled to open early in the spring.

The objective of the study was to evaluate how a new product, Early Green Black Sand Topdressing, compared to the traditional standard polyethylene turf cover in effecting spring green-up and tillering on a newly established L-93 creeping bentgrass putting green.

Materials and Methods

This study was conducted at Hobbit's Glen Golf Club in Columbia, MD. The study was conducted on a USGA Spec putting green that was seeded with L-93 creeping bentgrass on October 25, 2003. The putting green was maintained at 0.22 inches at the beginning of the study and was at 0.19 inches at the conclusion if the study.

Plots were 2 feet by 2 feet and treatments were arranged in a randomized design with three replications. Treatments consisted of an Evergreen white polyethylene turf cover and Early Green black sand topdressing at 250 lbs per 1000 sq ft. Treatments were applied on March 9, 2004 and the study ended on April 9, 2004. The turf covers were removed regularly for maintenance, i.e. mowing, and promptly reapplied. The green was mowed without removing clippings, and therefore no sand was removed.

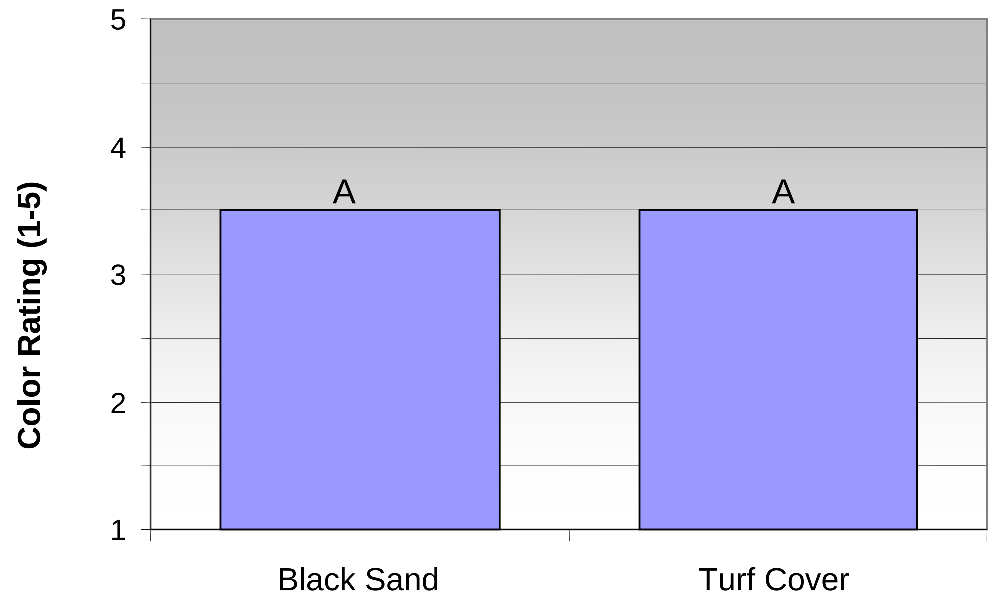
Tillering and color ratings were recorded on April 9, 2004. Tillering was measured by removing core samples with a soil probe, and counting all tillers. Color was rated visually on a scale of 1-5 with 3 or above considered acceptable color.

Tillering and color data were statistically analyzed using Analysis of Variance and treatments were separated using Duncan's New Multiple Range Test with p = 0.05.

Results and Discussion

Turfgrass color

There was no difference in color between the cover and the black sand treatments on April 9, 2004, but during the study the turf color of treatments fluctuated. The black sand had an average color rating of 4, and the turf cover treatments had an average color rating of 4, which was well above the acceptable color rating of 3.0 (Fig. 1).

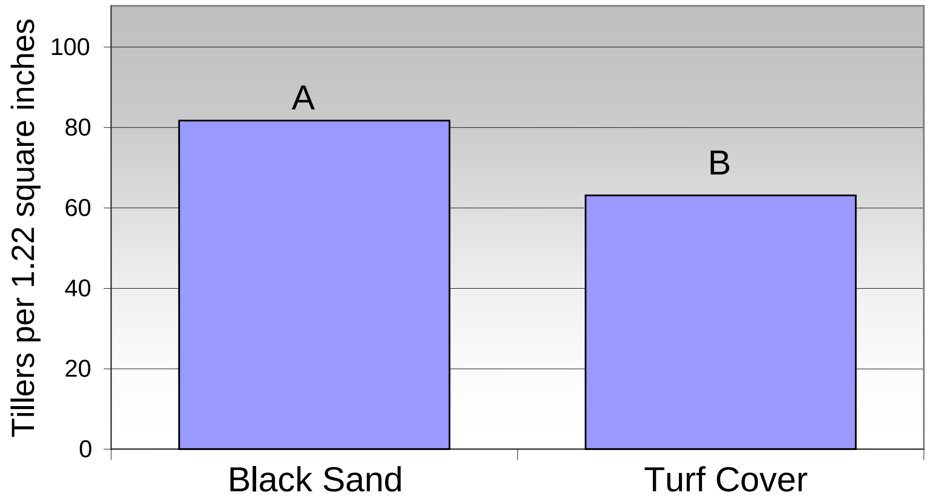


*bars with the same letter within a rating date are not statistically different according to Duncan's New Multiple Range Test with p=0.05.

Fig. 1 Black sand and turf cover effect on color of a newly established creeping bentgrass putting green.

Tillering

There was an obvious visual difference in tillering between the black sand treatment and the turf cover treatment. The turf under cover was taller and thinner than the black sand treatment, which was noticeably denser. There was a statistical difference in tillering with the black sand producing significantly higher (29%) tillers than the turf cover treatment (Fig. 2).



*bars with the same letter within a rating date are not statistically different according to Duncan's New Multiple Range Test with p=0.05.

Fig. 2 Black sand and turf cover effect on tillering of a newly established creeping bentgrass putting green.

Conclusions

The black sand treatment increased turf tillering but did not have an effect on turf color. The amount of tillering was an average 29% higher with the black sand than the turf cover. This data set is somewhat limited, and the study should be conducted again, at another site.

Future Research

The black sand application may be a good alternative to turf covers, but too much black topdressing on the surface in the summer could lead to additional turf stresses; high temperature stress, and increased disease pressure. It is not clear what, if any, effect the black sand has on the rooting of a newly established putting green. Future studies should evaluate added summer heat stress and rooting.

Turf Cover Effects on Putting Green Winter Temperature Spring Green-up and Growth

Dr. G. W. Hamilton, Jr. and R. B. Raley
Penn State University

Introduction

Various types of greens covers have been developed to protect golf course putting greens from different types of winter kill and to hasten spring green-up and growth.
Cover materials range from geo-textile fabrics to solid or woven polypropylene or solid polypropylene sheets. Covers are usually placed on putting greens just prior to the onset of winter conditions and removed a week or two after spring green-up has started.

The objective of the study was to evaluate CoverSports USA's polypropylene winter cover's effect on winter turfgrass canopy temperature, spring green-up, and growth.

Materials and Methods

This study was conducted at the Valentine Turfgrass Research Center in University Park, PA. The study was conducted on a "push-up" style putting green and the turf was a mixture of creeping bentgrass and annual bluegrass maintained at 0.125 inches.

Plots were 2 by 2 feet and treatments were arranged in a randomized complete block design with three replications. Treatments consisted of CoverSports USA polypropylene turf cover and an untreated control. Treatments were applied on December 13, 2003 and removed on March 28, 2004.

Turfgrass canopy temperatures were recorded every four hours with Onset HOBO H8 data loggers and Onset wide range temperature sensors placed within the canopy of turf. Yield and color ratings were recorded on March 29, 2004, April 6, 2004, and April 15, 2004. Growth was measured by removing clippings (yield) with a 22-inch walk-behind greens mower. Clippings were dried at 60^{o}C for 24 hours and dry weights were recorded. Color was rated visually on a scale of 1-5 with 3 or above considered acceptable color.

Yield and color data were statistically analyzed using Analysis of Variance and treatments were separated using Duncan's New Multiple Range Test with p = 0.05.

Results and Discussion

Canopy Temperature

On average, the canopy temperatures of the turf cover were 2^{o}F above the control (Table 1). For the duration of the experiment, the average temperature of the Turf cover was 34.4^{o}F and 32.1^{o}F for the untreated control. This increase in average temperature would increase spring green-up and growth in the spring when temperatures would start to increase.

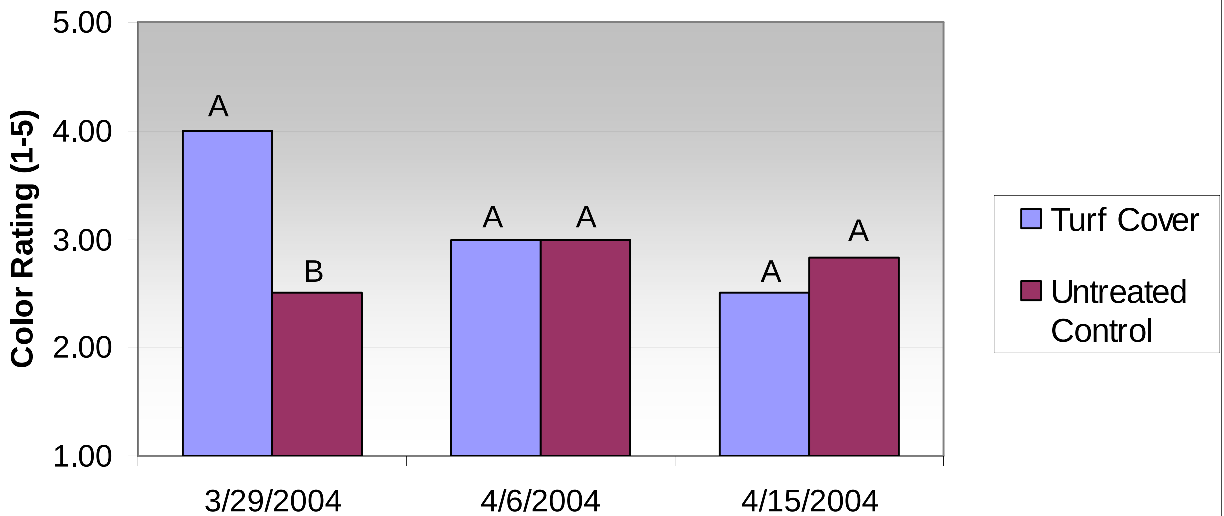
Table 1. Monthly and overall minimum, maximum, and average temperatures

	Turf Cover			**Untreated Control**		
	Minimum	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**
----- ^{O} Fahrenheit -----						
December	29.83	41.96	30.74	24.76	43.96	30.19
January	16.90	44.90	30.74	7.72	46.80	27.80
February	28.73	31.72	31.16	27.03	30.63	29.79
March	30.37	76.86	42.41	26.92	78.02	40.23
December 13 - March 30	16.90	76.86	34.37	7.72	78.02	32.14

The turf cover treatments also maintained higher minimum temperatures than the untreated control. During all four months of the study, the untreated control had minimum temperatures lower than the turf cover treatments. This restriction of lower temperatures by the turf cover may help prevent certain types of turfgrass winter injury such as direct low temperature kill.

Turfgrass color

There was a significant difference in color when the covers were removed in late March. The turf cover treatments had an average color rating of 4, which was well above the acceptable color of 3.0 and significantly higher than the untreated control rating of 2.5 (Fig. 1).



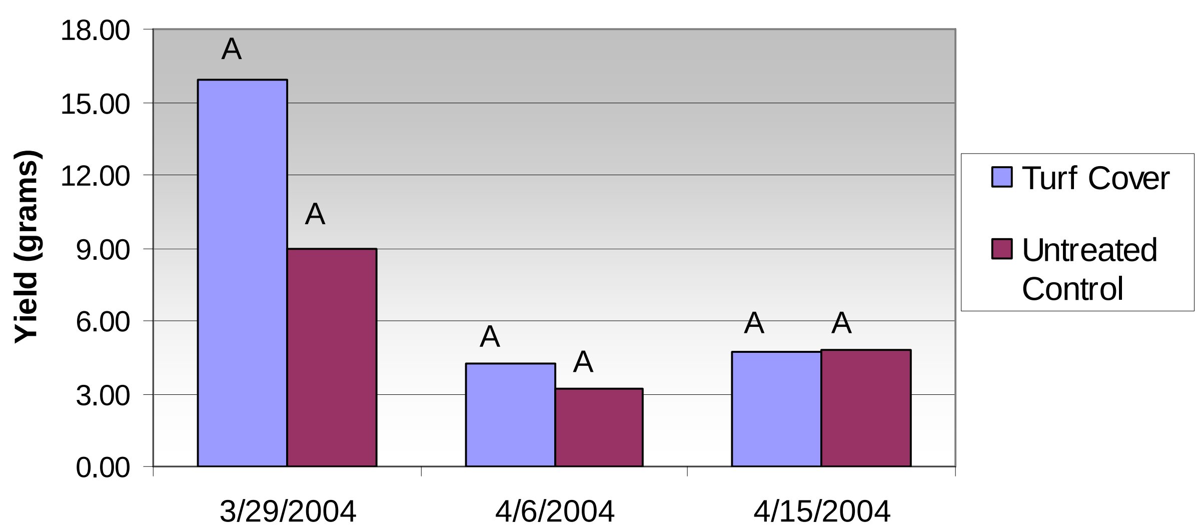
*bars with the same letter within a rating date are not statistically different according to Duncan's New Multiple Range Test with p=0.05.

Fig. 1 Color ratings for turf cover, and untreated control

For the next two subsequent ratings, April 6 and April 15, there were no significant color differences between the turf cover and the untreated control. Color of the turf cover treatments actually decreased over the two-week period. This was caused by an increase in growth under the covers, and the initial mowing caused some slight scalping. Cold temperatures following the initial mowing slowed growth and restricted the turf cover treatment turf to outgrow the scalped condition.

Yield

There was an obvious visual difference in growth between the turf cover treatment and the untreated control. The turf under the turf cover was taller and slightly thinner than the untreated control turf. Although there was a visual difference, the yield measurements were not statistically different on any of the three rating dates (Fig. 2).



*bars with the same letter within a rating date are not statistically different according to Duncan's New Multiple Range Test with p=0.05.

Fig. 2 Yield for turf cover and untreated control

Conclusions

The CoverSports USA turf cover treatment did increase canopy temperatures throughout winter and did have improved color when the treatments were removed. Canopy temperatures were on average 7% higher with the cover (34.4^{O}F vs. 32.1 ^{O}F) than the untreated control. The cover maintained higher minimum temperatures vs. the untreated control area. The improvement in color for the turf cover treatment lasted less than a week after treatments were removed, and there were no statistical differences in yields of the two treatments.

Future Research

The difficulty in managing covers is deciding when they should be removed and whether or not they should be replaced after initial mowings. Future studies should evaluate various removal times and the advantages or disadvantages of replacing the covers after mowing.

Evaluation of spent mushroom substrate as a topdressing to established turf

A. S. McNitt, D.M. Petrunak, and W.X. Uddin

Introduction:

In the Northeastern United States, a number of sewage sludge composts are being shipped interstate for use on turfgrass sites. Numerous athletic field managers are using the composted sewage sludge as a topdressing prior to aeration. In Pennsylvania, spent mushroom substrate is a potentially inexpensive alternative organic matter source. Landschoot, McNitt, and Hoyland (1993) reported improved soil physical properties when spent mushroom substrate was tilled into a clay loam subsoil.

Objectives:

The objectives of this study were to evaluate the effect of mushroom substrate topdressing on the resistance to wear damage, surface hardness, and soil compaction of a sodded Kentucky bluegrass (*Poa pratensis*, L.) turf over time.

Procedures:

A silt loam soil was prepared at the Joseph Valentine Turfgrass Research Center in State College, PA. Kentucky Bluegrass big roll sod seeded to 40% Limosine, 30% Adelphi and 30% Midnight was installed on 16 May, 2001.

On 24 July, 2001 the first set of treatments was applied. Treatments were again applied on 19 December 2001 and 7 May 2002. The experimental design was a two by two by two factorial with eight replications. Treatments for the factorial included:

Level 1
•Mushroom Substrate Application (6.3 mm surface application)
•No Substrate Application

Level 2
•Heavy hollow-tine aeration
(2 cm diameter tines on 5 cm by 5 cm spacing)
•No aeration

Level 3
•Nitrogen Fertilization (49 kg ha^{-1})
•No Fertilization

The individual plots were split with levels of simulated traffic (wear) beginning 8 Aug. 2001. There were two levels of wear: no wear and wear approximating a football game per day (Cockerham and Brinkman, 1989). The traffic was applied with a

Brinkman traffic simulator (Cockerham and Brinkman, 1989). Wear ended on 2 Nov. 2001. During year two of the study wear began on 1 Jun 2002 and ended on 20 Oct 2002.

Each experimental unit was evaluated by measuring soil bulk density, soil water content, soil organic matter content, surface hardness, and percent living ground cover. Soil chemical properties were also monitored but due to space limitations the data is not presented here.

Soil bulk density data and soil water content are derived from measurements of soil total density and volumetric water content taken with a Troxler 3400-B (Troxler Electronic Laboratories Inc., Research Triangle Park, NC) series surface moisture/density gauge. The Troxler gauge uses neutron scattering simultaneously with gamma ray attenuation to measure the volumetric water content and bulk density of the soil (Gardner, 1986).

Surface hardness was measured using a Clegg Impact Tester (CIT) (Lafayette Instrument Company, Lafayette, IN) equipped with a 2.25 kg missile (Rogers and Waddington, 1990). The average of six hardness measurements taken in different locations on each subplot was used to represent the hardness value of the subplot.

Percent living ground cover was rated visually and serves as an estimate of turfgrass cover

Results:

Due to space restraints, only the data from subplots receiving wear will be presented. Data from the subplots not receiving wear can be obtained from the authors. The treatments in this study had significant effects on the turfgrass and soil physical properties measured.

The aeration and mushroom substrate applications affected percent turfgrass ground cover (Table 1). During 2001, only the mushroom substrate combined with nitrogen treatments measured higher than the control on 29 Oct 2002. These data were measured after only one topdressing application. Plots receiving aeration tended to have less ground cover than the control. During 2002, plots receiving aeration alone had a percent ground cover lower than the control on only two rating dates and were higher than the control on one date. In 2003, plots receiving aeration had higher percent ground cover than the control on 3 Jun 2003 and on every rating date from 23 Jun to the end of the 2003 growing season. As the study continued into the third growing season, treatment differences are becoming more pronounced.

From the first rating date of 2002 through 12 Jul 2002, the plots receiving spent mushroom substrate consistently measured higher in percent ground cover compared to the other treatments. Beginning on the 18 Jul 2002 rating date all treatments measured higher in percent ground cover than the control but the plots receiving mushroom substrate tended to have more ground cover than those treatments not receiving mushroom substrate. For instance, the mushroom substrate alone tended to have greater turf cover than the nitrogen treatment alone and the mushroom substrate combined with aeration tended to have greater turf cover than the nitrogen combined with aeration treatment. These trends were more pronounced in 2003. The mushroom substrate treatment resulted in a higher percent ground cover than the nitrogen treatment on every rating date in 2003. The 2002 data was collected after three treatments had been applied and the 2003 data was collected after five treatment applications. Nitrogen differences may have accounted for some of the percent ground cover results, although color differences between treatments receiving the mushroom substrate alone and those receiving the nitrogen treatment alone are small in 2001 (Table 2). Near the end of the 2002 growing season, the mushroom substrate may have been supplying more nitrogen than the nitrogen treatment as indicated by the higher color ratings (Table 2); however, this trend was not consistent in 2003 where few significant color differences between the nitrogen and mushroom substrate treatments were found.

Differences in percent ground cover could also be due to the mushroom substrate treatments reducing soil bulk density and increasing soil water content. The mushroom substrate tended to lower soil bulk density, compared to the control, to a greater degree than other treatments (Table 3). As with many of the other parameters measured, this trend became more pronounced as more treatments were applied.

The application of spent mushroom substrate as a topdressing tended to increase the water retention of the soil (Table 4). The differences measured during 2001, while statistically different, may be of little practical significance. During 2002 and 2003, after three and five mushroom substrate applications, respectively, the water retention of the treatments containing mushroom substrate increased substantially. This may have been due to the increased organic content of the soil or due to the substrate acting as a mulch on the soil surface.

The decrease of soil bulk density and the increase in water retention and percent ground cover could account for the measured reduction in surface hardness as measured by the Clegg impact tester. Treatments that received mushroom substrate applications tended to measure lower in surface hardness than treatments that did not (Table 5). This would indicate that an athletic field playing surface that received regular spent mushroom substrate topdressing applications would be safer when fallen upon by an athlete than the same field without the substrate applications.

The changes in soil fertility that resulted from five applications of spent mushroom substrate can be seen in Table 6. These changes, while significant, create no negative impact on turfgrass growth and development. The pH of plots receiving mushroom substrate increased from 6.7 to about 7.1. Individual turfgrass sites with a pH higher than 7.2 may need to consider an organic matter source other than spent mushroom substrate. High pH native soils are somewhat rare in the Northeastern United States. Phosphorus, potassium, magnesium, and calcium levels generally increased with increasing applications of spent mushroom substrate. The cation exchange capacity also increased as a result of mushroom substrate applications. Soluble salt levels, generally thought to prohibit the use of mushroom substrate on turfgrass were increased only slightly and do not begin to approach a level of concern.

Conclusions:

It should be noted that data continued to be collected through the 2004 growing season. This is the fourth growing season in which data was collected. We have data from both the wear and no-wear splits of the treatments and only data from the wear side have been presented here. Soil nutrient data has been collected in every year of the study and was presented this past November at the American Society of Agronomy meetings in

Seattle, WA. Only nutrient data from 2003 is presented here. Although year four data is still being analyzed, it appears that there is a positive effect to adding spent mushroom substrate topdressing to the maintenance regime of high-wear Kentucky bluegrass turfgrass. The advantages of five 6.3 mm applications include an increase in percent ground cover after wear, decreased soil bulk density, increased soil water retention, and decreased surface hardness when compared to a control and the traditional practices of aeration and fertilization.

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Table 1. Percent ground cover[1] in 2001 and 2002 for Kentucky bluegrass plots receiving wear treatments[2].

2001

Treatment[3]	23-Aug	30-Aug	6-Sep	13-Sep	20-Sep	28-Sep	5-Oct	15-Oct	19-Oct	29-Oct
Control	99.4	98.3	97.9	96.3	94.6	91.6	83.6	85.4	80.8	74.5
M	99.4	98.1	98.9	97.5	95.4	93.5	84.8	87.0	82.4	76.6
A	95.8	93.6	95.6	92.1	89.4	83.0	74.4	76.3	70.3	61.3
N	99.3	97.6	97.3	95.1	92.8	85.9	75.0	80.1	73.6	63.6
MA	96.4	94.6	96.4	94.1	91.1	87.8	78.4	81.3	74.3	65.9
MN	98.6	98.0	98.3	97.6	95.4	94.9	85.0	87.6	82.8	81.4
AN	97.3	95.5	98.0	94.5	89.3	85.6	77.0	82.4	74.9	65.1
MAN	97.8	97.1	98.3	96.6	94.3	92.4	82.4	85.6	81.5	76.4
LSD (p = 0.05)	1.0	1.8	1.1	1.7	2.4	3.5	4.5	3.0	4.0	5.7

2002

Treatment[3]	7-Jun	14-Jun	21-Jun	28-Jun	8-Jul	12-Jul	18-Jul	29-Jul	9-Aug	16-Aug	26-Aug	6-Sep	13-Sep	7-Oct	14-Oct	21-Oct
Control	91.5	85.1	83.8	84.9	77.9	71.8	68.0	65.0	61.4	63.0	67.9	61.4	63.1	59.8	56.0	41.9
M	96.8	95.3	94.1	94.0	91.6	90.9	89.0	87.9	86.4	87.4	88.6	80.3	82.6	79.8	75.8	68.8
A	86.8	82.3	77.8	82.3	76.1	71.6	75.4	69.5	72.9	72.9	73.9	67.9	72.1	70.9	66.4	53.1
N	91.4	88.6	87.3	88.1	80.5	77.6	76.8	74.3	70.1	72.3	76.3	64.8	68.9	66.5	61.6	45.1
MA	95.4	90.3	88.0	90.3	86.5	85.6	88.3	86.5	86.3	86.1	85.0	77.6	81.4	78.1	73.9	60.6
MN	99.4	99.0	98.5	98.3	97.9	95.3	96.3	95.4	92.5	93.5	93.0	88.3	87.5	85.8	84.9	79.9
AN	93.4	88.9	83.4	88.4	79.4	77.8	81.5	77.0	78.6	77.6	80.9	69.6	75.5	73.1	67.1	47.0
MAN	95.9	94.6	93.7	94.1	93.3	91.0	93.8	91.8	90.5	87.6	90.4	83.3	86.4	83.6	79.0	70.5
LSD (p = 0.05)	3.7	4.3	4.9	4.9	5.2	6.0	6.5	6.5	6.2	6.0	5.9	6.2	5.5	5.9	7.1	9.2

[1] Percent ground cover was determined by estimating the percent of the plot area covered by living turf.

[2] Plots receiving wear treatments were exposed to wear as four passes three times per week with the Brinkman Traffic Simulator beginning on 8 Aug and ending on 2 Nov 2001and beginning on 4 Jun and ending on 21 Oct 2002.

[3] Treatments include untreated control, M = spent mushroom substrate application at 6.33 mm depth, A = aerification with 20 mm hollow tines, N= nitrogen fertilization at 49 kg ha^{-1} N with Nutralene 40-0-0 fertilizer, MA = mushroom substrate application followed by aerification, MN = mushroom substrate application followed by fertilizer application, AN = aerification followed by fertilizer application, MAN = mushroom substrate application followed by aerification followed by fertilizer application. Treatment applications were made on 24-26 Jul, 19 Dec 2001, and 8-10 May, 2002.

Table 2. Turf color ratings[1] in 2001 and 2002 for Kentucky bluegrass plots receiving wear[2] treatments.

2001

Treatment	2-Aug	10-Aug	16-Aug	23-Aug	30-Aug	6-Sep	13-Sep	20-Sep	28-Sep	5-Oct	15-Oct	19-Oct	29-Oct
Control	3.8	3.9	4.3	3.7	3.9	4.1	3.7	3.7	3.0	2.6	2.2	1.6	1.4
M	4.3	4.3	4.5	3.9	4.2	4.3	3.8	3.9	3.3	2.9	2.3	1.7	1.5
A	3.2	3.9	4.2	3.8	4.0	4.1	3.9	3.9	3.3	2.9	2.3	1.7	1.5
N	3.8	4.3	4.4	3.8	4.0	4.1	3.9	3.9	2.9	2.7	2.3	1.6	1.4
MA	3.8	4.4	4.4	4.0	4.1	4.1	3.9	4.1	3.3	2.8	2.4	1.7	1.6
MN	4.2	4.8	4.6	4.4	4.4	4.3	4.1	4.2	3.5	3.1	2.5	1.9	1.7
AN	3.4	4.3	4.4	3.8	4.1	4.2	4.0	4.0	3.3	2.7	2.3	1.7	1.6
MAN	3.8	4.8	4.6	4.2	4.4	4.3	4.1	4.3	3.6	3.0	2.4	1.8	1.6
LSD (p = 0.05)	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1

2002

Treatment	17-May	7-Jun	14-Jun	21-Jun	28-Jun	8-Jul	12-Jul	18-Jul	29-Jul	9-Aug	16-Aug	26-Aug	6-Sep	13-Sep	7-Oct	14-Oct
Control	3.4	3.7	3.4	3.1	3.2	3.4	3.7	3.0	3.8	3.8	3.9	3.9	3.3	3.3	3.3	3.3
M	4.2	4.2	4.0	3.7	4.1	4.1	4.3	4.0	4.3	4.3	4.3	4.2	3.5	3.5	3.3	3.5
A	3.5	3.9	3.9	3.7	4.0	4.3	4.3	4.1	4.2	4.4	4.1	4.3	3.4	3.4	3.5	3.5
N	4.0	4.3	4.2	3.8	4.0	3.9	4.1	3.8	4.1	4.3	3.9	3.9	3.3	3.3	3.3	3.4
MA	3.7	4.3	4.4	4.3	4.6	4.7	4.7	4.5	4.6	4.6	4.5	4.3	3.6	3.6	3.5	3.5
MN	4.2	4.5	4.4	4.4	4.6	4.8	4.6	4.6	4.6	4.6	4.4	4.3	3.5	3.5	3.5	3.5
AN	3.7	4.5	4.4	4.2	4.4	4.5	4.5	4.2	4.3	4.4	4.0	4.1	3.5	3.5	3.4	3.4
MAN	3.8	4.7	4.8	4.8	5.0	4.9	4.9	4.8	4.8	4.7	4.7	4.3	3.8	3.8	3.4	3.5
LSD (p = 0.05)	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1

[1]Color is rated on a 1-5 scale with half units with 1 = brown, 5 = dark green.

[2] Plots receiving wear treatments were exposed to wear as four passes three times per week with the Brinkman Traffic Simulator beginning on 8 Aug and ending on 2 Nov 2001and beginning on 4 Jun and ending on 21 Oct 2002.

[3] Treatments include untreated control, M = spent mushroom substrate application at 6.33 mm depth, A = aerification with 20 mm hollow tines, N= nitrogen fertilization at 49 kg ha^{-1} N with Nutralene 40-0-0 fertilizer, MA = mushroom substrate application followed by aerification, MN = mushroom substrate application followed by fertilizer application, AN = aerification followed by fertilizer application, MAN = mushroom substrate application followed by aerification followed by fertilizer application. Treatment applications were made on 24-26 Jul, 19 Dec 2001, and 8-10 May, 2002.

Table 3. Bulk density[1] (g cc3) of treatments receiving simulated traffic in 2001 and 2002[2].

Treatment[3]	2001 16-Aug	2001 2-Oct	2002 13-Nov	2002 23-May	2002 23-Oct
Control	1.13	1.28	1.27	1.21	1.29
M	1.11	1.25	1.21	1.05	1.16
A	1.13	1.27	1.22	1.11	1.23
N	1.14	1.29	1.27	1.19	1.28
MA	1.11	1.26	1.21	1.03	1.17
MN	1.08	1.23	1.18	0.98	1.13
AN	1.15	1.29	1.24	1.14	1.24
MAN	1.07	1.22	1.17	0.95	1.14
LSD (p = 0.05)	0.02	0.02	0.03	0.03	0.03

[1] Soil bulk density data were derived from measurements of soil total density and volumetric water content taken with a Troxler 3400-B Series Moisture-Density Gauge (Troxler Electronic Laboratories Inc., Triangle Park, NC).

[2] Plots receiving wear treatments were exposed to wear as four passes three times per week with the Brinkman Traffic Simulator beginning on 8 Aug and ending on 2 Nov 2001and beginning on 4 Jun and ending on 21 Oct 2002.

Table 4. Volumetric water content[1] of soil after exposure to simulated traffic in 2001 and 2002[2].

Treatment[3]	2001 16-Aug	2001 2-Oct	2001 13-Nov	2002 23-May	2002 1-Aug	2002 3-Sep	2002 8-Oct	2002 22-Oct
Control	28.7	19.4	23.5	21.5	27.9	19.6	20.1	27.8
M	31.7	20.2	25.5	24.8	36.9	23.8	25.9	36.3
A	29.3	18.6	23.7	22.4	27.6	20.1	21.5	29.8
N	28.3	18.3	22.5	20.9	27.5	18.5	19.2	28.3
MA	31.5	19.9	25.6	26.5	34.8	23.4	25.2	34.5
MN	32.0	20.3	25.8	26.6	35.3	24.6	26.2	37.0
AN	28.8	18.1	23.9	21.5	27.8	19.9	21.5	29.6
MAN	33.1	20.1	25.6	27.0	34.3	22.6	24.5	36.7
LSD (p = 0.05)	0.9	0.7	0.8	1.1	1.6	1.3	1.1	1.3

[1]Volumetric water content data were derived from measurements of soil total density and volumetric water content taken with a Troxler 3400-B Series Moisture-Density Gauge (Troxler Electronic Laboratories Inc., Triangle Park, NC).

[2] Plots receiving wear treatments were exposed to wear as four passes three times per week with the Brinkman Traffic simulator beginning on 8 Aug and ending on 2 Nov 2001and beginning on 4 Jun and ending on 21 Oct 2002.

[3] Treatments include untreated control, M = spent mushroom substrate application at 6.33 mm depth, A = aerification with 20 mm hollow tines, N= nitrogen fertilization at 49 kg ha^{-1} N with Nutralene 40-0-0 fertilizer, MA = mushroom substrate application followed by aerification, MN = mushroom substrate application followed by fertilizer application, AN = aerification followed by fertilizer application, MAN = mushroom substrate application followed by aerification followed by fertilizer application. Treatment applications were made on 24-26 Jul, 19 Dec 2001, and 8-10 May, 2002.

Table 5. Surface hardness (Gmax) [1] of treatments exposed to simulated traffic in 2001 and 2002[2].

	2001	2002					
Treatment[3]	13-Nov	23-May	17-Jun	2-Jul	1-Aug	3-Sep	8-Oct
Control	93.4	77.2	57.5	99.2	71.4	104.8	102.7
M	91.5	65.2	55.6	85.5	62.1	86.8	87.0
A	96.1	67.1	62.9	94.0	63.3	98.5	98.8
N	107.0	77.6	56.2	105.1	76.1	105.1	102.2
MA	94.4	61.3	69.1	86.0	61.5	90.2	91.0
MN	92.6	61.1	64.8	80.7	63.2	81.1	85.7
AN	98.5	68.5	60.0	98.8	66.1	99.2	100.8
MAN	103.5	56.9	57.7	80.9	60.3	85.7	89.4
LSD (p = 0.05)	5.6	3.3	4.3	6.3	2.2	5.3	6.5

[1] Surface hardness was measured using a Clegg Impact Tester (Lafayette Instrument Company, Lafayette, IN) equipped with a 2.25 kg missile and a drop height of 450 mm.

[2] Plots receiving wear treatments were exposed to wear as four passes three times per week with the Brinkman Traffic simulator beginning on 8 Aug and ending on 2 Nov 2001and beginning on 4 Jun and ending on 21 Oct 2002.

[3] Treatments include untreated control, M = spent mushroom substrate application at 6.33 mm depth, A = aerification with 20 mm hollow tines, N= nitrogen fertilization at 49 kg ha^{-1} N with Nutralene 40-0-0 fertilizer, MA = mushroom substrate application followed by aerification, MN = mushroom substrate application followed by fertilizer application, AN = aerification followed by fertilizer application, MAN = mushroom substrate application followed by aerification followed by fertilizer application. Treatment applications were made on 24-26 Jul, 19 Dec 2001, and 8-10 May, 2002.

Table 6. Nutrient[1] levels for treatment plots at the end of the 2003 growing season.

Treatment[3]	pH[4]	P (lb/A)[5]	Acidity[6]	Exchangeable cations[2] K	Mg	Ca	CEC[7]	Soluble salts (mmhos/cm)[8]
Control	6.7	198.5	1.38	0.46	1.44	6.15	9.4	0.11
M	7.0	227.8	0.00	0.77	1.53	7.82	10.1	0.14
A	6.8	202.8	1.06	0.48	1.50	6.86	9.9	0.13
N	6.8	214.3	1.50	0.45	1.49	6.64	10.1	0.12
MA	7.1	346.5	0.25	0.72	1.66	9.44	12.1	0.16
MN	7.1	301.5	0.00	0.74	1.60	8.64	11.0	0.15
AN	6.7	184.5	1.31	0.44	1.42	6.31	9.5	0.11
MAN	7.2	355.3	0.00	0.75	1.72	9.96	12.4	0.16
LSD ($p = 0.05$)	0.1	29.7	0.38	0.04	0.06	0.58	0.6	0.01

[1] Soil samples were collected on 15 November, 2003 from plots not receiving wear treatments.

[2] Determined by Mehlich 3 Extractant and expressed as meq/100g soil

[3] Treatments include untreated control, M = spent mushroom compost application at 0.25” depth, A = aerification with 0.75” hollow tines, N= nitrogen fertilization at 1 lb N/1000 ft^2 with Nutralene 40-0-0 fertilizer, MA = compost application followed by aerification, MN = compost application followed by fertilizer application, AN = aerification followed by fertilizer application, MAN = compost application followed by aerification followed by fertilizer application. Treatment applications were made on 24-26 Jul, 19 Dec 2001, 7 May 2002, and 15 Apr 2003.

[4] 1:1 soil:water pH

[5] Determined by Mehlich 3 Extractant

[6] SMP Buffer pH

[7] Summation of cations

[8] Determined by 1:2 (soil:water) method