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Creeping Bentgrass Phytotoxicity and Control Evaluation of Lawn Height 'Park' Kentucky Bluegrass

J. A. Borger and M. B. Naedel[1]

Introduction

Phytotoxicity and control evaluations were conducted on a stand of mature 'Park' Kentucky bluegrass (*Poa pratensis*) with mature 'Pencross' creeping bentgrass (*Agrostis stolonifera*) inserted into the sward at the Valentine Turfgrass Research Center, Penn State University, University Park, Pa. The objective of the study was to determine the phytotoxicity to creeping bentgrass and Kentucky bluegrass as well as efficacy of these compounds to reduce the creeping bentgrass population.

Methods and Materials

The study was a randomized complete block design with three replications. Plot size for the study was 30 ft^2. Two eighteen inch strips of 'Pencross' creeping bentgrass sod were planted on April 6, 2005 in each replication making each plot approximately 70% Kentucky bluegrass and 30% creeping bentgrass. Treatments were applied on September 2 (FALL), September 20 (2 WAT), and October 10 (4 WAT), and October 28 (6 WAT), 2005 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 mowed at one and one half inches twice weekly with a rotary mower with clippings returned to the site. The site was fertilized with a 19-3-7 complete methylene urea fertilizer calibrated to deliver 1 lb N/1000 ft^2 in late April and again in late May. Additionally, a 31-0-0 IBDU application of 1 lb N/1000 ft^2 was made in early August. The test area received maintenance fungicide applications to control disease during the study.

Results and Discussion

Kentucky bluegrass phytotoxicity was rated six times during the study (Table 1). No phytotoxicity was found on any rating date.

Creeping bentgrass phytotoxicity was rated six times during the study (Table 2). All treated creeping bentgrass was rated below acceptable (7.0) at some time in the study. No creeping bentgrass phytotoxicity was observed on the final rating date, December 12, 2005. On this rating date, phytotoxicity was evaluated on creeping bentgrass that did not appear dead.

The percent control of creeping bentgrass was rated six times during the 2005 year (Table 3) and once in the 2006 season (Table 4). The control of creeping bentgrass varied during the study, with a general trend of reducing the population. On the final rating date, all of the treated creeping bentgrass population was significantly reduced compared to the untreated. Only creeping bentgrass treated with mesotrione at 0.125 lb ai/A plus NIS at 0.25 % v/v applied Fall, and 2WAT had less than 90% reduction of the population.

The percent Kentucky bluegrass cover and percent bare ground cover was rated on April 21, 2006 (Table 4). The percent Kentucky bluegrass cover in all treated plots was rated significantly higher than untreated but, there was bare soil still remaining at the conclusion of the study.

It appears that a creeping bentgrass population in a Kentucky bluegrass sward can be reduced or eliminated following application of mesotrione in the fall of the year. Additionally, an overseeding of Kentucky bluegrass might be warranted to reduce any remaining voids in the stand.

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Table 1. Evaluations of Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity in 2005.

Treatment	Form	Rate lb ai/A	Timing	(----Phytotoxicity----) 9/9	9/17	10/6	10/19	11/1	12/1
MESOTRIONE	4SC	0.125	FALL/2 WAT	10.0	10.0	10.0	10.0	10.0	10.0
NIS	L	0.25 %V/V	FALL/2 WAT						
MESOTRIONE	4SC	0.187	FALL/2 WAT	10.0	10.0	10.0	10.0	10.0	10.0
NIS	L	0.25 %V/V	FALL/2 WAT						
MESOTRIONE	4SC	0.125	FALL/2/4 WAT	10.0	10.0	10.0	10.0	10.0	10.0
NIS	L	0.25 %V/V	FALL/2/4 WAT						
MESOTRIONE	4SC	0.187	FALL/2 WAT	10.0	10.0	10.0	10.0	10.0	10.0
NIS	L	0.25 %V/V	FALL/2/4 WAT						
MESOTRIONE	4SC	0.125	4 WAT						
CHECK				10.0	10.0	10.0	10.0	10.0	10.0
MESOTRIONE	4SC	0.125	FALL/2/4/6 WAT	10.0	10.0	10.0	10.0	10.0	10.0
NIS	L	0.25 %V/V	FALL/2/4/6 WAT						

Table 2. Evaluations of creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity in 2005.

Treatment	Form	Rate lb ai/A	Timing	(----Phytotoxicity----) 9/9	9/17	10/6	10/19	11/1	12/1
MESOTRIONE	4SC	0.125	FALL/2 WAT	7.3	5.0	6.7	2.0	3.0	10.0
NIS	L	0.25 %V/V	FALL/2 WAT						
MESOTRIONE	4SC	0.187	FALL/2 WAT	6.0	4.3	6.0	1.0	1.0	10.0
NIS	L	0.25 %V/V	FALL/2 WAT						
MESOTRIONE	4SC	0.125	FALL/2/4 WAT	6.0	5.3	6.0	1.3	1.0	10.0
NIS	L	0.25 %V/V	FALL/2/4 WAT						
MESOTRIONE	4SC	0.187	FALL/2 WAT	6.0	5.0	5.3	1.3	1.0	10.0
NIS	L	0.25 %V/V	FALL/2/4 WAT						
MESOTRIONE	4SC	0.125	4 WAT						
CHECK				10.0	10.0	10.0	10.0	10.0	10.0
MESOTRIONE	4SC	0.125	FALL/2/4/6 WAT	6.0	5.0	5.7	2.0	1.0	10.0
NIS	L	0.25 %V/V	FALL/2/4/6 WAT						

Table 3. Percent control of the 'Pencross' creeping bentgrass population in 'Park' Kentucky bluegrass in 2005.

Treatment	Form	Rate lb ai/A	Timing	% Bent Control[1] 9/9	9/17	10/6	10/19	11/1	12/1
MESOTRIONE	4SC	0.125	FALL/2 WAT	0.0a	0.0a	24.4d	38.89bc	61.1cd	55.5b
NIS	L	0.25 %V/V	FALL/2 WAT						
MESOTRIONE	4SC	0.187	FALL/2 WAT	0.0a	0.0a	55.5c	77.78a	92.2ab	92.2a
NIS	L	0.25 %V/V	FALL/2 WAT						
MESOTRIONE	4SC	0.125	FALL/2/4 WAT	0.0a	0.0a	44.4cd	50.0abc	96.6a	96.6a
NIS	L	0.25 %V/V	FALL/2/4 WAT						
MESOTRIONE	4SC	0.187	FALL/2 WAT	0.0a	0.0a	61.1bc	55.5abc	92.2ab	96.6a
NIS	L	0.25 %V/V	FALL/2/4 WAT						
MESOTRIONE	4SC	0.125	4 WAT						
CHECK				0.0a	0.0a	0.0e	0.00d	0.0e	0.0d
MESOTRIONE	4SC	0.125	FALL/2/4/6 WAT	0.0a	0.0a	38.8cd	55.5abc	82.2abc	96.6a
NIS	L	0.25 %V/V	FALL/2/4/6 WAT						

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

Table 4. Percent 'Pencross' creeping bentgrass control, percent 'Park' Kentucky bluegrass cover, and percent bare ground on April 21, 2006.

Treatment	Form	Rate lb ai/A	Timing	(-% Bent Control[1]-)	(-% KBG Cover[1]-)	(% Bare Ground[1])
MESOTRIONE	4SC	0.125	FALL/2 WAT	61.1b	81.7bc	6.7de
NIS	L	0.25 %V/V	FALL/2 WAT			
MESOTRIONE	4SC	0.187	FALL/2 WAT	94.4a	85.0ab	13.3c
NIS	L	0.25 %V/V	FALL/2 WAT			
MESOTRIONE	4SC	0.125	FALL/2/4 WAT	100.0a	88.3ab	11.7cd
NIS	L	0.25 %V/V	FALL/2/4 WAT			
MESOTRIONE	4SC	0.187	FALL/2 WAT	100.0a	90.0a	10.0cd
NIS	L	0.25 %V/V	FALL/2/4 WAT			
MESOTRIONE	4SC	0.125	4 WAT			
CHECK				0.0d	70.0d	0.0f
MESOTRIONE	4SC	0.125	FALL/2/4/6 WAT	100.0a	86.7ab	13.3c
NIS	L	0.25 %V/V	FALL/2/4/6 WAT			

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

Post Emergence Control of Broadleaf Weeds and Phytotoxicity Evaluations

J. A. Borger and M. B. Naedel[1]

Introduction

Broadleaf weed control and phytotoxicity evaluations were conducted on a stand of mature 'SR-4200' 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 selected broadleaf weed herbicides for the control of dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and buckhorn plantain (*Plantago lanceolata*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

All plots were rated for the percent dandelion, white clover, and buckhorn plantain prior to the application of any treatment on a plot by plot basis. The test plots were 21 ft^2 and had approximately 80 percent broadleaf weed cover.

The study was a randomized complete block design with three replications. All of the treatments were applied on May 22, 2006 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one, flat fan, 11004E nozzle at 40 psi.

The test site was mowed at one and one half inches weekly with a rotary mower with clippings returned to the site. The test site was irrigated to prevent moisture stress.

Results and Discussion

Turfgrass phytotoxicity was rated three times during the study (Table 1). No turfgrass phytotoxicity was found during the study.

The percent control of dandelion, white clover and buckhorn plantain was rated seven times during the study (Table 2). The percent control was somewhat variable during the rating period. On the final rating date, August 15, 2006, all treated turfgrass had a significant reduction in all the weed populations when compared to non treated turfgrass. There was a trend, of all treated turfgrass, that revealed a slight decrease in the control of dandelion by the final rating date. Only turfgrass treated with EH 1382 fell below the 70 percent control level of dandelion while all other treated turfgrass had at least 70 percent control or greater. During the evaluation period the non treated turfgrass broadleaf weed population remained constant.

To better determine the control of these broadleaf weed populations over time, in the late spring/early summer of 2007 further evaluations will be conducted and reported. It should be stated that a single application of broadleaf weed herbicides to a high population of weeds such as this test site have produced very good results to date. With this type of weed population one would expect that a second application of materials would be necessary to completely eradicate the weeds.

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

Table 1. Evaluations of turfgrass phytotoxicity in 2006 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	Form	Rate	(-----------Phytotoxicity---------)		
		PT/A	5/31	6/7	6/14
EH 1381	L	4	10.0	10.0	10.0
EH 1406	L	4	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
EH 1403	L	4	10.0	10.0	10.0
EH 1411	L	4	10.0	10.0	10.0
EH 1382	L	5	10.0	10.0	10.0

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

Treatment	Form	Rate	(-----------May 31, 2006 [1] -------)			(---------------June 7, 2005 -----------)		
		PT/A	Dand	Clover	Plant	Dand	Clover	Plant
EH 1381	L	4	76.7a	85.0a	66.7a	96.7a	96.1a	96.7a
EH 1406	L	4	53.9ab	79.2a	46.9a	82.8a	95.0a	87.2a
CHECK			16.7b	0.0b	0.0a	0.0b	0.0b	0.0b
EH 1403	L	4	81.6a	91.6a	80.4a	92.7a	98.7a	90.8a
EH 1411	L	4	91.7a	88.9a	80.4a	100.0a	100.0a	100.0a
EH 1382	L	5	90.0a	80.8a	63.3a	83.3a	91.7a	90.0a

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	(-----------June 14, 2006 [1]-------)			(---------------June 20, 2005 -----------)		
		PT/A	Dand	Clover	Plant	Dand	Clover	Plant
EH 1381	L	4	96.7a	97.2b	100.0b	100.0a	100.0a	100.0a
EH 1406	L	4	100.0a	99.2ab	100.0a	97.2a	100.0a	98.5a
CHECK			0.0b	0.0c	0.0e	0.0c	0.0c	0.0b
EH 1403	L	4	95.0a	99.9a	100.0d	75.6b	97.5b	100.0a
EH 1411	L	4	100.0a	100.0a	100.0c	100.0a	100.0a	100.0a
EH 1382	L	5	93.3a	100.0a	100.0b	96.7a	100.0a	93.3a

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	(-----------June 30, 2006 [1]-------)			(---------------July 18, 2005 -----------)		
		PT/A	Dand	Clover	Plant	Dand	Clover	Plant
EH 1381	L	4	93.3a	97.2a	100.0a	90.0a	100.0a	100.0a
EH 1406	L	4	92.8a	97.5a	87.2a	89.4a	98.3a	100.0a
CHECK			0.0b	0.0b	0.0b	0.0b	0.0b	0.0b
EH 1403	L	4	94.7a	96.9a	92.4a	74.4a	97.2a	100.0a
EH 1411	L	4	95.0a	100.0a	100.0a	95.0a	98.9a	100.0a
EH 1382	L	5	76.7a	98.3a	93.3a	76.7a	100.0a	100.0a

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	(-----------August 15, 2006 [1] -------)		
		PT/A	Dand	Clover	Plant
EH 1381	L	4	93.3a	98.9a	100.0a
EH 1406	L	4	70.6a	95.0a	100.0a
CHECK			0.0c	0.0b	0.0b
EH 1403	L	4	71.6a	99.3a	98.2a
EH 1411	L	4	91.7a	98.9a	98.2a
EH 1382	L	5	33.3b	89.2a	93.3a

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

Post Emergence Control of Broadleaf Weeds and Phytotoxicity Evaluations

J. A. Borger and M. B. Naedel[1]

Introduction

Broadleaf weed control and phytotoxicity evaluations were conducted on a stand of mature 'SR-4200' 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 selected broadleaf weed herbicides for the control of dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and buckhorn plantain (*Plantago lanceolata*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

All plots were rated for the percent dandelion, white clover, and buckhorn plantain prior to the application of any treatment on a plot by plot basis. The test plots were 21 ft^2 and had approximately 80 percent broadleaf weed cover.

The study was a randomized complete block design with three replications. All of the treatments were applied on May 22, 2006 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one, flat fan, 11004E nozzle at 40 psi.

The test site was mowed at one and one half inches weekly with a rotary mower with clippings returned to the site. The test site was irrigated to prevent moisture stress.

Results and Discussion

Turfgrass phytotoxicity was rated seven times during the study (Table 1). No turfgrass phytotoxicity was found during the study.

The percent control of dandelion, white clover and buckhorn plantain was rated seven times during the study (Table 2). The population change was somewhat variable during the rating period. On the final rating date, July 18, 2006, turfgrass treated with V-10142 at 0.5 lb ai/A plus Resource or NIS did not significantly reduce the dandelion or the white clover populations with respect to non treated turfgrass. On this date, turfgrass treated with V-10142 at 0.5 lb ai/A plus Resource or NIS and Turflon alone did not significantly reduced the population of buckhorn plantain compared to non treated turfgrass.

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Table 1. Evaluations of turfgrass phytotoxicity in 2006 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	**Form**	**Rate QT/A**	**(--Phytotoxicity--) 5/26**	**5/31**	**6/7**	**6/14**	**6/20**
V-10142	75WD	0.5 LB AI/A	10.0	10.0	10.0	10.0	10.0
RESOURCE	0.86EC	3 OZ/A					
V-10142	75WD	0.5 LB AI/A	10.0	10.0	10.0	10.0	10.0
NIS	L	0.25% V/V					
V-10142	75WD	0.25 LB AI/A	10.0	10.0	10.0	10.0	10.0
TURFLON	4EC	1					
CHECK			10.0	10.0	10.0	10.0	10.0
V-10142	75WD	0.5 LB AI/A	10.0	10.0	10.0	10.0	10.0
TURFLON	4EC	1					
V-10142	75WD	0.75 LB AI/A	10.0	10.0	10.0	10.0	10.0
TURFLON	4EC	1					
TURFLON	4EC	1	10.0	10.0	10.0	10.0	10.0
SPEEDZONE	2.2EC	2	10.0	10.0	10.0	10.0	10.0

Table 1 (continued). Evaluations of turfgrass phytotoxicity in 2006 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	**Form**	**Rate QT/A**	**(--Phytotoxicity--) 7/5**	**7/18**
V-10142	75WD	0.5 LB AI/A	10.0	10.0
RESOURCE	0.86EC	3 OZ/A		
V-10142	75WD	0.5 LB AI/A	10.0	10.0
NIS	L	0.25% V/V		
V-10142	75WD	0.25 LB AI/A	10.0	10.0
TURFLON	4EC	1		
CHECK			10.0	10.0
V-10142	75WD	0.5 LB AI/A	10.0	10.0
TURFLON	4EC	1		
V-10142	75WD	0.75 LB AI/A	10.0	10.0
TURFLON	4EC	1		
TURFLON	4EC	1	10.0	10.0
SPEEDZONE	2.2EC	2	10.0	10.0

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

Treatment	Form	Rate	(-----------May 26, 2006 [1] -------)			(---------------May 31, 2005 -----------)		
		QT/A	Dand	Clover	Plant	Dand	Clover	Plant
V-10142 RESOURCE	75WD 0.86EC	0.5 LB AI/A 3 OZ/A	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
V-10142 NIS	75WD L	0.5 LB AI/A 0.25% V/V	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
V-10142 TURFLON	75WD 4EC	0.25 LB AI/A 1	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
CHECK			0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
V-10142 TURFLON	75WD 4EC	0.5 LB AI/A 1	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
V-10142 TURFLON	75WD 4EC	0.75 LB AI/A 1	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
TURFLON	4EC	1	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
SPEEDZONE	2.2EC	2	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	(-----------June 7, 2006 [1] -------)			(---------------June 14, 2005 -----------)		
		QT/A	Dand	Clover	Plant	Dand	Clover	Plant
V-10142 RESOURCE	75WD 0.86EC	0.5 LB AI/A 3 OZ/A	47.2b	19.4b	50.0ab	98.9a	11.1b	90.0a
V-10142 NIS	75WD L	0.5 LB AI/A 0.25% V/V	0.0c	11.1b	100.0a	83.3b	0.0b	80.0a
V-10142 TURFLON	75WD 4EC	0.25 LB AI/A 1	94.4a	94.7a	100.0a	100.0a	99.2a	100.0a
CHECK			0.0c	0.0b	0.0b	0.0c	0.0b	0.0b
V-10142 TURFLON	75WD 4EC	0.5 LB AI/A 1	97.8a	95.0a	75.0ab	97.8a	95.0a	95.0a
V-10142 TURFLON	75WD 4EC	0.75 LB AI/A 1	92.8a	84.4a	100.0a	100.0a	100.0a	100.0a
TURFLON	4EC	1	96.1a	91.7a	80.0ab	98.3a	88.9a	100.0a
SPEEDZONE	2.2EC	2	95.0a	98.9a	90.0a	96.7a	98.1a	100.0a

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate QT/A	June 20, 2006 [1] Dand	Clover	Plant	July 5, 2006 Dand	Clover	Plant
V-10142 RESOURCE	75WD 0.86EC	0.5 LB AI/A 3 OZ/A	92.2a	0.0b	90.0a	80.0ab	0.0b	50.0ab
V-10142 NIS	75WD L	0.5 LB AI/A 0.25% V/V	71.7b	0.0b	100.0a	48.3b	0.0b	0.0b
V-10142 TURFLON	75WD 4EC	0.25 LB AI/A 1	98.9a	96.9a	100.0a	95.6a	96.9a	80.0ab
CHECK			0.0c	0.0b	0.0b	0.0c	0.0b	0.0b
V-10142 TURFLON	75WD 4EC	0.5 LB AI/A 1	100.0a	96.7a	100.0a	96.7a	95.0a	90.0a
V-10142 TURFLON	75WD 4EC	0.75 LB AI/A 1	98.3a	97.2a	100.0a	96.1a	95.6a	100.0a
TURFLON	4EC	1	100.0a	96.1a	100.0a	98.9a	96.1a	0.0b
SPEEDZONE	2.2EC	2	100.0a	93.6a	90.0a	95.0a	89.2a	80.0ab

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate QT/A	July 18, 2006 [1] Dand	Clover	Plant
V-10142 RESOURCE	75WD 0.86EC	0.5 LB AI/A 3 OZ/A	22.2b	0.0c	50.0ab
V-10142 NIS	75WD L	0.5 LB AI/A 0.25% V/V	16.7b	0.0c	0.0b
V-10142 TURFLON	75WD 4EC	0.25 LB AI/A 1	97.8a	96.9a	100.0a
CHECK			0.0b	0.0c	0.0b
V-10142 TURFLON	75WD 4EC	0.5 LB AI/A 1	97.8a	95.0a	90.0a
V-10142 TURFLON	75WD 4EC	0.75 LB AI/A 1	100.0a	97.2a	100.0a
TURFLON	4EC	1	98.3a	97.8a	80.0ab
SPEEDZONE	2.2EC	2	98.3a	89.1b	100.0a

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

Seedhead Suppression of Annual Bluegrass on a Putting Green

J. A. Borger and M. B. Naedel[1]

Introduction

This study was conducted on a mixed stand of 'Penncross' 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

This study was a randomized complete block design with three replications, and a plot size of 21 ft^2. Treatments were applied on April 6 (PRIOR), April 13 (BOOT), and May 6 (3 WAT), 2006, respectively, using a three-foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one 11004E even tip/flat fan nozzle at 40 psi.

Boot stage of the annual bluegrass was observed April 16, 2006. Non treated test areas within the test site revealed approximately 100% coverage of annual bluegrass seedheads.

The site was maintained using cultural practices for irrigation, mowing, and fertilization that would be typical for a putting green. The test area was mowed twice with a Toro Triplex, bench set to 0.115", before the April 6, 2006 application of selected materials. During the study the site was fertilized with a Nature Safe 8-3-5 fertilizer at a rate of 1 lb N/M on May 1, 2006.

Results and Discussion

Turfgrass phytotoxicity was rated five times during the study (Table 1). The turfgrass phytotoxicity was variable and in some cases lasted for several weeks. On the first rating date, April 24, 2005, turfgrass treated with Embark at 40 oz/A, Embark at 40 oz/A plus MacroSorb Foliar at any rate, Embark at 20 oz/A plus Primo and Proxy applies twice, Embark at 40 oz/A plus ECO-N, Proxy plus Primo plus Trimmit with or without ECO-N (BOOT), any combination of Trimmit and Embark, and Primo (PRIOR) plus Embark at 40 oz/A (BOOT) plus Ferromec (BOOT) was rated less than acceptable for phytotoxicity 7.0.

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Annual bluegrass seedhead suppression was rated three times during the study (Table 2). On the last rating date, May 26, 2006, turfgrass treated with Embark at 40 oz/A with and without Ferromec, Embark at 40 oz/A plus MacroSorb Foliar at 8 oz/M, Embark at 40 oz/A plus MacroSorb Foliar at 4 oz/M, plus Ferromec, Proxy plus Primo plus ECO-N (BOOT/3 WAT), Embark at 20 oz/A (BOOT) plus Primo plus Proxy (BOOT/3 WAT), Embark at 40 oz/A plus ECO-N, Proxy plus Primo plus Trimmit plus ECO-N, Primo plus Trimmit plus Embark at 40 oz/A with and without ECO-N, Trimmit plus Embark at 40 oz/A with and without ECO-N, Proxy (PRIOR) plus Embark at 40 oz/A plus Ferromec (BOOT), Primo (PRIOR) plus Embark at 40 oz/A plus Ferromec (BOOT), ECO-N (PRIOR) plus Embark at 40 oz/A plus Ferromec (BOOT), and Embark at 40 oz/A plus Signature plus Ferromec had significantly fewer annual bluegrass seedheads than untreated turfgrass and had at least 75% reduction of the seedheads.

Table 1. Ratings of phytotoxicity of an annual bluegrass/creeping bentgrass putting green on a scale of 0 to 10 where 0 = complete phytotoxicity, 7 = acceptable, and 10 = no phytotoxicity in 2006.

				(---------------Phytotoxicity--------------)				
Treatment	**Form**	**Rate oz/M**	**Timing**	**4/24**	**5/4**	**5/9**	**5/17**	**5/26**
EMBARK	0.2SL	40 OZ/A	BOOT	6.0	6.7	7.7	10.0	10.0
EMBARK	0.2SL	40 OZ/A	BOOT	7.0	6.7	6.8	10.0	10.0
FERROMEC	L	5	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT	6.3	7.7	7.3	10.0	10.0
MACROSORB FOLIAR	L	4	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT	6.0	6.7	7.3	9.0	10.0
MACROSORB FOLIAR	L	8	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT	7.0	7.3	8.7	10.0	10.0
MACROSORB FOLIAR	L	4	BOOT					
FERROMEC	L	5	BOOT					
PROXY	2SL	5	BOOT/3 WAT	9.7	9.7	10.0	10.0	10.0
PRIMO	1MEC	0.125	BOOT/3 WAT					
MACROSORB FOLIAR	L	4	BOOT/3 WAT					
PROXY	2SL	3	BOOT/3 WAT	9.7	10.0	10.0	10.0	10.0
PRIMO	1MEC	0.125	BOOT/3 WAT					
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT/3 WAT					
EMBARK	0.2SL	20 OZ/A	BOOT	6.7	8.0	9.2	10.0	10.0
PRIMO	1MEC	0.125	BOOT/3 WAT					
PROXY	2SL	5	BOOT/3 WAT					
EMBARK	0.2SL	40 OZ/A	BOOT	6.7	6.7	7.0	10.0	10.0
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT					
PROXY	2SL	5	BOOT	6.3	6.0	5.7	6.3	10.0
PRIMO	1MEC	0.125	BOOT					
TRIMMIT	2SC	6 OZ/A	BOOT					
PROXY	2SL	5	BOOT	6.7	8.0	7.5	8.0	10.0
PRIMO	1MEC	0.125	BOOT					
TRIMMIT	2SC	6 OZ/A	BOOT					
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT					
PRIMO	1MEC	0.125	BOOT	5.7	4.7	5.0	5.3	10.0
TRIMMIT	2SC	6 OZ/A	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT					
CHECK				10.0	10.0	10.0	10.0	10.0
PRIMO	1MEC	0.125	BOOT	5.7	4.3	5.0	5.0	10.0
TRIMMIT	2SC	6 OZ/A	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT					
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT					
TRIMMIT	2SC	6 OZ/A	BOOT	5.7	4.7	5.0	5.0	10.0
EMBARK	0.2SL	40 OZ/A	BOOT					
TRIMMIT	2SC	6 OZ/A	BOOT	5.7	4.0	5.2	5.3	10.0
EMBARK	0.2SL	40 OZ/A	BOOT					
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT					
BANNER MAXX	1.3EC	4	BOOT	9.7	10.0	9.7	8.7	10.0
BANNER MAXX	1.3EC	4	BOOT	9.7	9.7	9.7	9.0	10.0
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT					
PROXY	2SL	5	PRIOR	7.7	7.3	8.5	10.0	10.0
EMBARK	0.2SL	40 OZ/A	BOOT					
FERROMEC	L	5	BOOT					
PROXY	2SL	5	PRIOR	8.7	7.0	8.0	7.7	10.0
TRIMMIT	2SC	6 OZ/A	BOOT					
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT					
PROXY	2SL	5	PRIOR/BOOT	7.7	10.0	9.3	10.0	10.0
PRIMO	1MEC	0.125	BOOT					
PRIMO	1MEC	0.125	PRIOR	6.3	7.7	7.8	10.0	10.0
EMBARK	0.2SL	40 OZ/A	BOOT					
FERROMEC	L	5	BOOT					
TRIMMIT	2SC	6 OZ/A	PRIOR	6.0	5.3	5.5	6.0	10.0
EMBARK	0.2SL	40 OZ/A	BOOT					
FERROMEC	L	5	BOOT					
ECO-N (24-0-0)	2.2L	0.2 LB N/M	PRIOR	8.0	7.0	6.3	10.0	10.0
EMBARK	0.2SL	40 OZ/A	BOOT					
FERROMEC	L	5	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT	7.0	6.6	6.6	10.0	10.0
SIGNATURE	80WG	4	BOOT					
EMBARK	0.2SL	40 OZ/A	BOOT	8.7	8.7	8.2	10.0	10.0
SIGNATURE	80WG	4	BOOT					
FERROMEC	L	5	BOOT					

Table 2. Ratings of the percent seedhead suppression of an annual bluegrass/creeping bentgrass putting green in 2006.

Treatment	Form	Rate oz/M	Timing	(--------------%Suppression[1]------------) 5/4	5/17	5/26
EMBARK	0.2SL	40 OZ/A	BOOT	81.7bcd	78.3a-e	75.0a-d
EMBARK	0.2SL	40 OZ/A	BOOT	76.7de	85.0a-d	80.0abc
FERROMEC	L	5	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT	92.7abc	81.7a-e	70.0a-d
MACROSORB FOLIAR	L	4	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT	91.7abc	75.0b-e	75.0a-d
MACROSORB FOLIAR	L	8	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT	91.7abc	90.0abc	80.0abc
MACROSORB FOLIAR	L	4	BOOT			
FERROMEC	L	5	BOOT			
PROXY	2SL	5	BOOT/3 WAT	73.3def	60.0e	61.7cd
PRIMO	1MEC	0.125	BOOT/3 WAT			
MACROSORB FOLIAR	L	4	BOOT/3 WAT			
PROXY	2SL	3	BOOT/3 WAT	78.3cde	68.3cde	86.7abc
PRIMO	1MEC	0.125	BOOT/3 WAT			
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT/3 WAT			
EMBARK	0.2SL	20 OZ/A	BOOT	91.7abc	88.3a-d	88.3ab
PRIMO	1MEC	0.125	BOOT/3 WAT			
PROXY	2SL	5	BOOT/3 WAT			
EMBARK	0.2SL	40 OZ/A	BOOT	93.3ab	90.0abc	85.0abc
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT			
PROXY	2SL	5	BOOT	92.7abc	68.3cde	73.3a-d
PRIMO	1MEC	0.125	BOOT			
TRIMMIT	2SC	6 OZ/A	BOOT			
PROXY	2SL	5	BOOT	91.7abc	90.0abc	85.0abc
PRIMO	1MEC	0.125	BOOT			
TRIMMIT	2SC	6 OZ/A	BOOT			
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT			
PRIMO	1MEC	0.125	BOOT	97.0a	97.7ab	76.7abc
TRIMMIT	2SC	6 OZ/A	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT			
CHECK				0.0h	0.0g	0.0g
PRIMO	1MEC	0.125	BOOT	98.0a	99.0a	93.3a
TRIMMIT	2SC	6 OZ/A	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT			
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT			
TRIMMIT	2SC	6 OZ/A	BOOT	98.0a	97.7ab	80.0abc
EMBARK	0.2SL	40 OZ/A	BOOT			
TRIMMIT	2SC	6 OZ/A	BOOT	98.0a	97.7ab	88.3ab
EMBARK	0.2SL	40 OZ/A	BOOT			
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT			
BANNER MAXX	1.3EC	4	BOOT	53.3g	10.0g	0.0g
BANNER MAXX	1.3EC	4	BOOT	61.7fg	40.0f	26.7f
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT			
PROXY	2SL	5	PRIOR	91.7abc	88.3a-d	90.0ab
EMBARK	0.2SL	40 OZ/A	BOOT			
FERROMEC	L	5	BOOT			
PROXY	2SL	5	PRIOR	65.0efg	30.0f	33.3ef
TRIMMIT	2SC	6 OZ/A	BOOT			
ECO-N (24-0-0)	2.2L	0.2 LB N/M	BOOT			
PROXY	2SL	5	PRIOR/BOOT	86.7a-d	66.7de	68.3a-d
PRIMO	1MEC	0.125	BOOT			
PRIMO	1MEC	0.125	PRIOR	95.0ab	86.7a-d	78.3abc
EMBARK	0.2SL	40 OZ/A	BOOT			
FERROMEC	L	5	BOOT			
TRIMMIT	2SC	6 OZ/A	PRIOR	93.7ab	94.7ab	65.0bcd
EMBARK	0.2SL	40 OZ/A	BOOT			
FERROMEC	L	5	BOOT			
ECO-N (24-0-0)	2.2L	0.2 LB N/M	PRIOR	94.3ab	86.7a-d	83.3abc
EMBARK	0.2SL	40 OZ/A	BOOT			
FERROMEC	L	5	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT	97.0a	90.8abc	72.4a-d
SIGNATURE	80WG	4	BOOT			
EMBARK	0.2SL	40 OZ/A	BOOT	94.3ab	90.0abc	83.3abc
SIGNATURE	80WG	4	BOOT			
FERROMEC	L	5	BOOT			

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

Phytotoxicity and Control Evaluations of Selected Materials on Creeping Bentgrass, Rough Bluegrass, Tall Fescue, Perennial Ryegrass, and Kentucky Bluegrass

J. A. Borger and M.B. Naedel[1]

Introduction

Phytotoxicity and tolerance evaluations were conducted on a stand of mature fairway height 'Penneagle' creeping bentgrass (Agrostis stolonifera), fairway height 'Winter Play' rough bluegrass (Poa trivialis), lawn height 'Plantation' tall fescue (Festuca arundinacea S.), lawn height 'Jet-Elite' perennial ryegrass (Lolium perenne L.), and lawn height 'Park' 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 phytotoxicity and control of selected materials on creeping bentgrass, rough bluegrass, tall fescue, perennial ryegrass, and Kentucky bluegrass.

Methods and Materials

The study was a randomized complete block design with three replications. Treatments were applied on June 30 (JUNE) and July 20 (3 WAT) using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one, flat fan, 11004E nozzle at 40 psi.

The creeping bentgrass and rough bluegrass were mowed with a reel mower at one half inch with clippings removed from the test site and the tall fescue, perennial ryegrass, and Kentucky bluegrass were mowed at one and one half inches with clippings returned to the site.

Results and Discussion

Turfgrass phytotoxicity was rated five times for all turfgrass species during the study (Table 1). For all species, on the July 11 and 27, 2006 rating dates, all treated turfgrass was rated less than acceptable (7.0) for phytotoxicity. None of the treated or non treated turfgrass (all species) revealed any phytotoxicity on any of the remaining rating dates.

The percent control of each species was rated five times during the study (Table 2). Certainty applied to creeping bentgrass did not reduce the stand during the study. The percent control was variable during the study for the other species. On the final rating date, November 20, 2006, rough bluegrass treated with Certainty was reduced by at least 85 % or greater, significantly more than untreated. On this rating date, tall fescue treated with Certainty was also reduced by 90 % or greater, significantly more than untreated. Perennial ryegrass and Kentucky bluegrass treated with the high rate of Certainty revealed 26.7% and 28.3% control (respectively) significantly more than untreated.

Additional research should be conducted to evaluate the reduction of the perennial ryegrass and Kentucky bluegrass found in this research. This perennial ryegrass and Kentucky bluegrass stand reduction has not occurred in past research at Penn State. Certainty applications to creeping bentgrass in order to reduce the sward of rough bluegrass appears to be safe to the bentgrass and an effective measure for rough bluegrass reduction.

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Table 1. Evaluations of fairway height 'Penneagle' creeping bentgrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = no phytotoxicity in 2006.

Creeping Bentgrass

Treatment	Form	Rate LB A/A	Timing	Phytotoxicity 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	6.0	5.8	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				10.0	10.0	10.0	10.0	10.0
CERTAINTY	75WG	0.047	JUNE/3 WAT	5.0	5.3	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					

Table 1 (continued). Evaluations of fairway height 'Winter Play' rough bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = no phytotoxicity in 2006.

Rough Bluegrass

Treatment	Form	Rate LB A/A	Timing	Phytotoxicity 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	5.0	4.0	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				10.0	10.0	10.0	10.0	10.0
CERTAINTY	75WG	0.047	JUNE/3 WAT	4.0	3.5	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					

Table 1 (continued). Evaluations of lawn height 'Plantation' tall fescue phytotoxicity where 0 = worst, 7 = acceptable and 10 = no phytotoxicity in 2006.

Tall Fescue

Treatment	Form	Rate LB A/A	Timing	Phytotoxicity 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	6.3	1.0	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				10.0	10.0	10.0	10.0	10.0
CERTAINTY	75WG	0.047	JUNE/3 WAT	6.0	1.0	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					

Table 1 (continued). Evaluations of lawn height 'Jet Elite' perennial ryegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = no phytotoxicity in 2006.

Perennial Ryegrass

Treatment	Form	Rate LB A/A	Timing	(---Phytotoxicity--- 7/11	) 7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	5.3	2.3	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				10.0	10.0	10.0	10.0	10.0
CERTAINTY	75WG	0.047	JUNE/3 WAT	6.0	2.8	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					

Table 1 (continued). Evaluations of lawn height 'Park' Kentucky bluegrass phytotoxicity where 0 = worst, 7 = acceptable and 10 = no phytotoxicity in 2006.

Kentucky Bluegrass

Treatment	Form	Rate LB A/A	Timing	(---Phytotoxicity--- 7/11	) 7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	8.3	5.8	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				10.0	10.0	10.0	10.0	10.0
CERTAINTY	75WG	0.047	JUNE/3 WAT	7.3	5.3	10.0	10.0	10.0
NIS	L	0.25 % V/V	JUNE/3 WAT					

Table 2. Percent control of 'Penneagle' fairway height creeping bentgrass in 2006.

Creeping Bentgrass

Treatment	Form	Rate LB A/A	Timing	(---% Control--- 7/11	) 7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	0.0a[1]	0.0a	0.0a	0.0a	0.0a
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				0.0a	0.0a	0.0a	0.0a	0.0a
CERTAINTY	75WG	0.047	JUNE/3 WAT	0.0a	0.0a	0.0a	0.0a	0.0a
NIS	L	0.25 % V/V	JUNE/3 WAT					

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

Table 2(continued). Percent control of fairway height 'Winter Play' rough bluegrass in 2006.

Rough Bluegrass Treatment	Form	Rate LB A/A	Timing	(---% Control---) 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	0.0a[1]	81.7b	83.3b	91.7b	86.7a
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				0.0a	0.0c	0.0c	0.0c	0.0b
CERTAINTY	75WG	0.047	JUNE/3 WAT	0.0a	91.7a	96.3a	99.0a	95.0a
NIS	L	0.25 % V/V	JUNE/3 WAT					

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

Table 2(continued). Percent control of lawn height 'Plantation' tall fescue in 2006.

Tall Fescue Treatment	Form	Rate LB A/A	Timing	(---% Control---) 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	0.0a[1]	96.3a	97.3a	99.0a	91.0a
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				0.0a	0.0b	0.0b	0.0b	0.0b
CERTAINTY	75WG	0.047	JUNE/3 WAT	0.0a	96.3a	98.3a	99.3a	95.0a
NIS	L	0.25 % V/V	JUNE/3 WAT					

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

Table 2(continued). Percent control of lawn height 'Jet Elite' perennial ryegrass in 2006.

Perennial Ryegrass Treatment	Form	Rate LB A/A	Timing	(---% Control---) 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	0.0a[1]	19.2ab	29.2ab	13.8a	12.1ab
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				0.0a	0.0b	0.0b	0.0b	0.0b
CERTAINTY	75WG	0.047	JUNE/3 WAT	0.0a	53.3a	53.3a	25.0a	26.7a
NIS	L	0.25 % V/V	JUNE/3 WAT					

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

Table 2(continued). Percent control of lawn height 'Park' Kentucky bluegrass in 2006.

Kentucky Bluegrass Treatment	Form	Rate LB A/A	Timing	(----% Control----) 7/11	7/27	8/29	10/25	11/20
CERTAINTY	75WG	0.035	JUNE/3 WAT	0.0a[1]	36.7a	36.7a	11.7ab	18.3ab
NIS	L	0.25 % V/V	JUNE/3 WAT					
CHECK				0.0a	0.0b	0.0b	0.0b	0.0b
CERTAINTY	75WG	0.047	JUNE/3 WAT	0.0a	50.0a	50.0a	26.7a	28.3a
NIS	L	0.25 % V/V	JUNE/3 WAT					

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

Post Emergence Control of Broadleaf Weeds and Phytotoxicity Evaluations

J. A. Borger and M. B. Naedel[1]

Introduction

Broadleaf weed control and phytotoxicity evaluations were conducted on a stand of mature 'SR-4200' 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 selected broadleaf weed herbicides for the control of dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and buckhorn plantain (*Plantago lanceolata*) in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

All plots were rated for the percent dandelion, white clover, and buckhorn plantain, prior to the application of any treatment, on a plot by plot basis. The test plots were 21 ft^2 and had approximately 80 percent broadleaf weed cover.

The study was a randomized complete block design with three replications. All of the treatments were applied on May 23, 2006 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one, flat fan, 11004E nozzle at 40 psi.

The test site was mowed at one and one half inches weekly with a rotary mower with clippings returned to the site. The test site was irrigated to prevent moisture stress.

Results and Discussion

Turfgrass phytotoxicity was rated four times during the study (Table 1). No phytotoxicity was found during the study.

The percent control of dandelion, white clover and buckhorn plantain was rated three times during the study (Table 2). Weed control was somewhat variable during the rating period. On the final rating date, July 18, 2006, turfgrass treated with Spotlight at 2 pt/A had significantly less control of dandelion compared to turfgrass treated with Escalade 2 or Confront. Turfgrass treated with Spotlight alone had significantly more control of white clover than that treated with Spotlight at 1 pt /A plus 2,4-D Amine at 2 pt/A. Finally, turfgrass treated with Spotlight alone had significantly less control of buckhorn plantain than all other treated turfgrass except that treated with Spotlight at 1 pt /A plus 2,4-D Amine at 2 pt/A.

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Table 1. Evaluations of turfgrass phytotoxicity in 2006 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	Form	Rate PT/A	(------------------Phytotoxicity-----------------) 6/1	6/7	6/20	7/18
SPOTLIGHT 2,4-D AMINE	1.5EC 3.8EC	1 2	10.0	10.0	10.0	10.0
SPOTLIGHT 2,4-D AMINE	1.5EC 3.8EC	2 1	10.0	10.0	10.0	10.0
CHECK			10.0	10.0	10.0	10.0
SPOTLIGHT	1.5EC	2	10.0	10.0	10.0	10.0
ESCALADE 2	4EC	3	10.0	10.0	10.0	10.0
CONFRONT	3SL	2	10.0	10.0	10.0	10.0
SURGE	EC	3.5	10.0	10.0	10.0	10.0

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

Treatment	Form	Rate	(-----------June 7, 2006 [1] -------)			(---------------June 20, 2005 -----------)		
		PT/A	Dand	Clover	Plant	Dand	Clover	Plant
SPOTLIGHT 2,4-D AMINE	1.5EC 3.8EC	1 2	92.2a	97.2a	90.0a	97.8a	96.1ab	99.2a
SPOTLIGHT 2,4-D AMINE	1.5EC 3.8EC	2 1	97.2a	97.5a	100.0a	100.0a	99.2ab	100.0a
CHECK			0.0b	0.0b	0.0b	0.0b	0.0c	0.0b
SPOTLIGHT	1.5EC	2	90.0a	99.2a	86.7a	90.0a	96.9ab	96.7a
ESCALADE 2	4EC	3	96.1a	96.4a	93.3a	100.0a	97.2ab	100.0a
CONFRONT	3SL	2	87.8a	98.1a	93.3a	100.0a	100.0a	100.0a
SURGE	EC	3.5	96.1a	96.1a	86.7a	100.0a	89.4b	93.3a

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

Table 2 (continued). Percent control of the dandelion, white clover, and buckhorn plantain populations following applications of selected herbicides.

Treatment	Form	Rate	(-----------July 18, 2006 [1] -------)		
		PT/A	Dand	Clover	Plant
SPOTLIGHT 2,4-D AMINE	1.5EC 3.8EC	1 2	92.2abc	89.5b	89.7b
SPOTLIGHT 2,4-D AMINE	1.5EC 3.8EC	2 1	98.3ab	99.2a	100.0a
CHECK			0.0d	0.0c	0.0c
SPOTLIGHT	1.5EC	2	81.7c	100.0a	83.3b
ESCALADE 2	4EC	3	95.6ab	97.2ab	100.0a
CONFRONT	3SL	2	100.0a	100.0a	100.0a
SURGE	EC	3.5	86.1bc	91.7ab	100.0a

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

Post Emergence Control of Smooth Crabgrass

J. A. Borger and M. B. Naedel[1]

Introduction

Post emergence control of smooth crabgrass (*Digitaria ischaemum*) was evaluated on a mature stand of 'Jet Elite' perennial ryegrass (*Lolium perenne* L.), at the Valentine Turfgrass Research Center, Penn State University, University Park, Pa. The objective of the study was to determine the efficacy of selected herbicides for the post emergence control of smooth crabgrass and the injury to the desired species.

Methods and Materials

This study was a randomized complete block design with three replications. All treatments were applied on June 21, 2006 using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using one, flat fan, 11008E nozzle at 40 psi and granular treatments were applied to wet turf using a shaker jar. The site was mowed once per week with a rotary mower at one inch with clippings returned to the site.

The test site was overseeded with a native source of smooth crabgrass seed in the fall of at least two of the pervious growing seasons. The test site had approximately 90% cover of smooth crabgrass in the non treated areas at the conclusion of the study.

Smooth crabgrass germination was first noted in the test site on April 24, 2006 and was at the two to three leaf stage at the time of application of these materials (June 21, 2006).

Results and Discussion

Turfgrass phytotoxicity was rated three times during the study (Table 1). No turfgrass phytotoxicity was found during the study.

The control of smooth crabgrass was rated three times during the study (Table 2). The percent control was somewhat variable during the rating period. On the final rating date, August 29, 2006, only turfgrass treated with Dimension Ultra 2EW at 0.5 lb ai/A and Dimension 1EC at 0.5 lb ai/A provided commercially acceptable control (85% or greater) of smooth crabgrass.

It appears that the addition of MacroSorb Foliar improved the control of smooth crabgrass when applied in combination with Drive and MSO compared to Drive and MSO alone, but neither of these combinations achieved the 85% level of control.

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Table 1. Evaluations of phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity taken in 2006.

Treatment	Form	Rate	(----------Phytotoxicity----------)		
		LB AI/A	7/5	7/12	7/19
DIMENSION ULTRA	2EW	0.5	10.0	10.0	10.0
DIMENSION	1EC	0.5	10.0	10.0	10.0
DIMENSION ULTRA	40WP	0.5	10.0	10.0	10.0
19-0-6 W/ CONFRONT IV	G	5 LB/M	10.0	10.0	10.0
CHECK			10.0	10.0	10.0
DRIVE	75DF	0.75	10.0	10.0	10.0
DRIVE	75DF	0.75	10.0	10.0	10.0
MACROSORB FOLIAR	L	2 OZ/M			
DRIVE	75DF	0.75	10.0	10.0	10.0
MSO	L	1 % V/V			
DRIVE	75DF	0.75	10.0	10.0	10.0
MACROSORB FOLIAR	L	2 OZ/M			
MSO	L	1 % V/V			
ACCLAIM EXTRA	0.57EW	20 OZ/A	10.0	10.0	10.0
PENDULUM	3.8CS	1.5			

Table 2. Evaluations of the percent control of smooth crabgrass in 2006. Commercially acceptable control was considered to be 85% and above.

Treatment	Form	Rate	(-----------% Control------------)		
		LB AI/A	7/5	8/5	8/29
DIMENSION ULTRA	2EW	0.5	82.8	89.7	88.3
DIMENSION	1EC	0.5	86.1	90.0	88.3
DIMENSION ULTRA	40WP	0.5	82.2	72.2	75.0
19-0-6 W/ CONFRONT IV	G	5 LB/M	77.8	80.8	76.7
CHECK			0.0	0.0	0.0
DRIVE	75DF	0.75	87.6	41.2	40.0
DRIVE	75DF	0.75	88.8	45.4	30.0
MACROSORB FOLIAR	L	2 OZ/M			
DRIVE	75DF	0.75	92.1	44.2	53.3
MSO	L	1 % V/V			
DRIVE	75DF	0.75	98.1	78.7	66.7
MACROSORB FOLIAR	L	2 OZ/M			
MSO	L	1 % V/V			
ACCLAIM EXTRA	0.57EW	20 OZ/A	95.4	82.9	78.3
PENDULUM	3.8CS	1.5			

Preemergence Control of Smooth Crabgrass

J. A. Borger and M. B. Naedel[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 applied in the fall for the control of smooth crabgrass and safety to desired species the following growing season.

Methods and Materials

This study was a randomized complete block design with three replications. All treatments were applied on October 19, 2005 (MID OCT) and November 22, 2005 (NOVEMBER) using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 11004 nozzles at 40 psi and granular treatments were applied to wet turf using a shaker jar. After each application the entire test site received approximately 0.5 inch of water. On April 27, 2006 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 once per week with a rotary mower at one inch with clippings returned to the site.

The test site was overseeded with a native source of smooth crabgrass seed in the fall prior to application of selected materials. The test site had approximately 90% cover of smooth crabgrass in non treated areas at the conclusion of the study.

Smooth crabgrass germination was first noted in the test site on April 24, 2006.

Results and Discussion

Turfgrass phytotoxicity was rated twice during the study (Table 1). No phytotoxicity was found during the study.

The percent control of smooth crabgrass was rated twice, May 22, 2006 and August 15, 2006 (Table 2). On the first rating date no treated or non treated turfgrass provided control as the smooth crabgrass plants, if present, were not detectable by the visual ratings used. On the final rating date, turfgrass treated with Barricade 65WG at 0.75 lb ai/A applied in mid October or November, and Barricade 4FL at 0.375 applied sequentially provided commercially acceptable control of smooth crabgrass (85% or greater). Although not considered commercially acceptable control, it should be noted that turfgrass treated with Dimension 40WP at 0.5 lb ai/A applied in mid October or November each provided 83.3% control of the smooth crabgrass population.

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Table 1. Evaluations of phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity taken in 2005.

Treatment	Form	Rate LB AI/A	Timing	(-------Phytotoxicity-----) 10/26	11/29
DIMENSION	0.21G	180 LB/A	MID OCT	10.0	10.0
DIMENSION	0.21G	240 LB/A	MID OCT	10.0	10.0
STONEWALL	0.2G	250 LB/A	MID OCT	10.0	10.0
STONEWALL	0.43G	175 LB/A	MID OCT	10.0	10.0
DIMENSION	0.21G	180 LB/A	NOVEMBER	10.0	10.0
DIMENSION	0.21G	240 LB/A	NOVEMBER	10.0	10.0
STONEWALL	0.2G	250 LB/A	NOVEMBER	10.0	10.0
STONEWALL	0.43G	175 LB/A	NOVEMBER	10.0	10.0
DIMENSION	40WP	0.5	MID OCT	10.0	10.0
CHECK				10.0	10.0
DIMENSION	40WP	0.5	NOVEMBER	10.0	10.0
DIMENSION	40WP	0.25	MID OCT	10.0	10.0
DIMENSION	40WP	0.25	NOVEMBER		
DIMENSION	1EC	0.5	MID OCT	10.0	10.0
DIMENSION	1EC	0.5	NOVEMBER	10.0	10.0
BARRICADE	65WG	0.75	MID OCT	10.0	10.0
BARRICADE	4FL	0.75	MID OCT	10.0	10.0
BARRICADE	4FL	0.75	NOVEMBER	10.0	10.0
BARRICADE	65WG	0.75	NOVEMBER	10.0	10.0
BARRICADE	65WG	0.375	MID OCT	10.0	10.0
BARRICADE	65WG	0.375	NOVEMBER		
BARRICADE	4FL	0.375	MID OCT	10.0	10.0
BARRICADE	4FL	0.375	NOVEMBER		

Table 2. Evaluations of the percent control of smooth crabgrass in 2006. Commercially acceptable control was considered to be 85% and above.

Treatment	Form	Rate LB AI/A	Timing	(----% Control----) 5/22	8/15
DIMENSION	0.21G	180 LB/A	MID OCT	0.0	50.0
DIMENSION	0.21G	240 LB/A	MID OCT	0.0	73.3
STONEWALL	0.2G	250 LB/A	MID OCT	0.0	60.0
STONEWALL	0.43G	175 LB/A	MID OCT	0.0	53.3
DIMENSION	0.21G	180 LB/A	NOVEMBER	0.0	66.7
DIMENSION	0.21G	240 LB/A	NOVEMBER	0.0	73.3
STONEWALL	0.2G	250 LB/A	NOVEMBER	0.0	60.0
STONEWALL	0.43G	175 LB/A	NOVEMBER	0.0	58.3
DIMENSION	40WP	0.5	MID OCT	0.0	83.3
CHECK				0.0	0.0
DIMENSION	40WP	0.5	NOVEMBER	0.0	83.3
DIMENSION	40WP	0.25	MID OCT	0.0	76.7
DIMENSION	40WP	0.25	NOVEMBER		
DIMENSION	1EC	0.5	MID OCT	0.0	70.0
DIMENSION	1EC	0.5	NOVEMBER	0.0	81.7
BARRICADE	65WG	0.75	MID OCT	0.0	85.0
BARRICADE	4FL	0.75	MID OCT	0.0	71.7
BARRICADE	4FL	0.75	NOVEMBER	0.0	81.7
BARRICADE	65WG	0.75	NOVEMBER	0.0	86.7
BARRICADE	65WG	0.375	MID OCT	0.0	78.3
BARRICADE	65WG	0.375	NOVEMBER		
BARRICADE	4FL	0.375	MID OCT	0.0	85.0
BARRICADE	4FL	0.375	NOVEMBER		

Annual Bluegrass Prevention on a Newly Established Putting Green

J. A. Borger, and M. B. Naedel[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), October 1, 2003 (28DAT), August 25 (FALL), September 7 (14 DAT), and September 21, 2004 (28 DAT), and September 2 (FALL), September 20 (14 DAT), and October 10, 2005 (28 DAT) 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 was 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 in 2004 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). Annual bluegrass encroachment rated in the spring of 2005 revealed some significant differences. Turfgrass treated with Betasan at 9.2 oz/M followed by Rubigan at 2 oz/M (applied twice) and Rubigan at 2 oz/M alone applied three times had significantly less annual bluegrass encroachment than untreated turfgrass. The percent annual bluegrass found in the spring of 2006 revealed an overall increase in the population compared to previous populations. All treated turfgrass had significantly less annual bluegrass than untreated on the April 13, 2006 rating date.

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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 RUBIGAN	4EC AS	9.2 2	FALL 14DAT	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
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN RUBIGAN	4EC AS	9.2 2/4	FALL 14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
RUBIGAN	AS	2	FALL /14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 1 (continued). 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 2004.

Treatment	Form	Rate oz/M	Timing	9/1	9/8	9/16	9/22	9/29	10/18	11/3	11/17
BETASAN	4EC	9.2	FALL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT	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
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN RUBIGAN	4EC AS	9.2 2/4	FALL 14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
RUBIGAN	AS	2	FALL /14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 1 (continued). 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 2005.

Treatment	Form	Rate oz/M	Timing	9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28
BETASAN	4EC	9.2	FALL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT	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
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
BETASAN RUBIGAN	4EC AS	9.2 2/4	FALL 14DAT/28DAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
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 from 2003, 2004, 2005, and 2006.

Treatment	Form	Rate oz/M	Timing	9/4/03	4/21/04	5/2/05	4/13/06
BETASAN	4EC	9.2	FALL	1.0a[1]	1.3a	15.0ab	16.7b
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT	1.0a	1.7a	13.3ab	16.7b
CHECK				1.0a	2.7a	18.3a	28.3a
BETASAN RUBIGAN	4EC AS	9.2 2	FALL 14DAT/28DAT	1.0a	1.7a	8.3b	20.0b
BETASAN RUBIGAN	4EC AS	9.2 2/4	FALL 14DAT/28DAT	1.0a	1.0a	13.3ab	21.7ab
RUBIGAN	AS	2	FALL /14DAT/28DAT	1.0a	1.0a	8.3b	15.0b

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

Control Evaluations of Selected Materials on Lawn Height ‘Park’ Kentucky Bluegrass

J. A. Borger, and M. B. Naedel[1]

Introduction

Green vegetation and control evaluations were conducted on a stand of mature ‘Park’ 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 vegetation reduction of Kentucky bluegrass using selected compounds.

Methods and Materials

The study was a randomized complete block design with three replications. Treatments were applied on September 25 (SEPT), October 28 (4 WAT), and November 28 (8 WAT) 2005 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 mowed at one and one half inches twice weekly with a rotary mower with clippings returned to the site.

Results and Discussion

The percent green vegetation was rated four times during the study (Table 1). In general, there was more green vegetation present on the last rating date (April 21, 2006) following on a single application of materials in comparison to multiple applications of materials. Only turfgrass treated with Reward 2 EC at 1.0 lb ai/A plus NIS at 0.25 % v/v twice was not significantly different than untreated turfgrass on this date. Turfgrass treated with RoundUp Pro applied twice, and Tranxit GTA plus NIS applied twice, had no green vegetation on the final rating date, April 21, 2006.

It appears that the reduction and in some cases the elimination of ‘Park’ Kentucky bluegrass can be accomplished.

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Table 1. Percent green vegetation of 'Park' Kentucky bluegrass in 2005 and 2006.

Treatment	Form	Rate lb ai/a	Timing	(-------------% Green Vegetation-----------) 10/12/05	10/28/05	12/1/05	4/21/06
ROUNDUP PRO	3SL	1.5 lb ae/a	SEPT	66.7bc	17.3cd	9.0cde	20.0cd
ROUNDUP PRO	3SL	1.5 lb ae/a	SEPT/4 WAT	50.0c	1.0d	1.0e	0.0d
FUSILADE II	2EC	0.38	SEPT/4 WAT	78.3ab	43.3b	10.cde	23.3cd
CROP OIL	L	1 % v/v	SEPT/4 WAT				
ENVOY	0.94EC	0.25	SEPT/4 WAT	75.0abc	43.3b	13.7cd	8.3d
CROP OIL	L	1 % v/v	SEPT/4 WAT				
FUSILADE II	2EC	0.38	SEPT/4 WAT	86.7ab	56.7b	10.0cde	15.0d
CROP OIL	L	1 % v/v	SEPT/4 WAT				
FUSILADE II	2EC	0.25	8 WAT				
CROP OIL	L	1 % v/v	8 WAT				
VANTAGE	1EC	0.47	SEPT/4 WAT	76.7abc	40.0b	5.0de	11.7d
CROP OIL	L	1 % v/v	SEPT/4 WAT				
CHECK				100.0a	100.0a	100.0a	100.0a
REVOLVER	0.19SC	0.03	SEPT	80.0ab	46.7b	16.7c	53.3b
REVOLVER	0.19SC	0.03	SEPT/4 WAT	80.0ab	40.0b	10.0cde	0.7d
FINALE	1SL	1.5	SEPT	1.0d	1.0d	1.0e	6.7d
FINALE	1SL	1.0	SEPT/4 WAT	4.0d	1.0d	1.0e	5.3d
REWARD	2EC	1.0	SEPT/4 WAT	93.3ab	100.0a	86.7b	95.0a
NIS	L	0.25 % v/v	SEPT/4 WAT				
TRANXIT GTA	25DF	0.03	SEPT	70.0bc	33.3bc	13.3cd	40.0bc
NIS	L	0.5 % v/v	SEPT				
TRANXIT GTA	25DF	0.03	SEPT/4 WAT	80.0ab	43.3b	10.0cde	0.0d
NIS	L	0.5 % v/v	SEPT/4 WAT				

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

Control Evaluations of Selected Materials on Lawn Height 'Park' Kentucky Bluegrass Using High a Application Volume of Water

J. A. Borger, and M. B. Naedel[1]

Introduction

Green vegetation and control evaluations were conducted on a stand of mature 'Park' 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 vegetation reduction of 'Park' Kentucky bluegrass using selected compounds at 100 gpa application rate.

Methods and Materials

The study was a randomized complete block design with three replications. Treatments were applied on September 25 (SEPT), and October 28 (4 WAT), 2005 using a three foot CO_2 powered boom sprayer calibrated to deliver 100 gpa using two, flat fan, 11004 nozzles at 40 psi.

The test site was mowed at one and one half inches twice weekly with a rotary mower with clippings returned to the site.

Results and Discussion

The percent green vegetation was rated four times during the study (Table 1). Only turfgrass treated with Reward was not rated different than untreated turfgrass on the April 21, 2006 rating date. On this date, all other treated turfgrass had significantly less green vegetation than untreated turfgrass. With the exception of turfgrass treated with Reward, all treated turfgrass had less than 25% green vegetation on the final rating date. It should be noted that turfgrass treated with Finale at 1.5 %v/v, Fusilde at 1.0 % v/v, and any rate of Hyvar XL revealed an increase in the percent green vegetation from the November 28, 2005 rating date to the April 21, 2006 rating date.

It appears that these selected products, with the exception of Reward, can reduce the amount of 'Park" Kentucky bluegrass when applied at 100 gallons of water per acre in the spring of the year following a fall application of materials.

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Table 1. Percent green vegetation of 'Park' Kentucky bluegrass in 2005 and 2006.

Treatment	Form	Rate % v/v	Timing	(----------------% Green Vegetation-------------) 9/25/05	10/28/05	11/28/05	4/21/06
ARSENAL 2	2SL	5.0	SEPT	86.7ab	20.0cde	1.0c	0.0d
ARSENAL 2	2SL	2.5	SEPT	86.7ab	28.3b-e	1.0c	0.0d
ARSENAL 2	2SL	2.5	SEPT/4 WAT	73.3bc	33.3bcd	1.0c	0.0d
FINALE	1SL	3.0	SEPT	5.3f	1.0e	1.0c	0.0d
FINALE	1SL	1.5	SEPT	5.3f	1.0e	1.0c	15.0bc
CHECK				100.0a	100.0a	100.0a	100.0a
FINALE	1SL	1.5	SEPT	3.7f	1.0e	1.0c	0.0d
ARSENAL 2	2SL	2.5	4 WAT				
PLATEAU	2SL	2.5	SEPT	56.7cd	10.3de	1.0c	0.0d
PLATEAU	2SL	1.25	SEPT	76.7bc	30.0b-e	4.0c	0.0d
FUSILADE	2EC	1.0	SEPT	63.3c	40.0bcd	8.7c	21.7b
FUSILADE	2EC	0.5	SEPT	76.7bc	50.0bc	8.3c	8.3cd
FUSILADE	2EC	0.5	SEPT	76.7bc	56.7b	3.7c	0.0d
ARSENAL 2	2SL	2.5	4 WAT				
REWARD	2EC	0.5	SEPT	38.3de	100.0a	40.0b	100.0a
HYVAR XL	2SL	5.0	SEPT	36.7de	1.0e	1.0c	3.3cd
HYVAR XL	2SL	3.0	SEPT	33.3e	1.0e	3.7c	10.0bcd

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

Post Emergence Control of Ground Ivy and Phytotoxicity Evaluations

J. A. Borger, T. L. Watschke, and M.B. Naedel[1]

Introduction

Broadleaf weed control and phytotoxicity evaluations were conducted on a stand of mature 'SR 4200' 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 selected broadleaf weed herbicides for the control of ground ivy *(Glechoma hederacea)* in perennial ryegrass and the phytotoxicity of these compounds on perennial ryegrass.

Methods and Materials

All plots were rated for the percent ground ivy prior to the application of any treatment on a plot by plot basis. The test plots were 21 ft^2 and had approximately 70 percent ground ivy cover. The ground ivy population had been plugged into the area using a typical golf course cup cutter for four years prior to the 2005 growing season. During the study, the ground ivy population was no longer increased by way of plugging. Any population increase was a result of the ground ivy population's growth habit during the study.

The study was a randomized complete block design with three replications. All of the treatments were applied on June 20, 2005 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 mowed at two inches weekly with a rotary mower with clippings returned to the site. The test site was irrigated to prevent moisture stress.

Results and Discussion

Phytotoxicity was evaluated six times during the study (Table 1). There was no phytotoxicity found on the perennial ryegrass on any of the rating dates.

The percent control was evaluated once on August 8, 2005 during the first growing season (Table 2). On this date all treated turfgrass had significantly less ground ivy than untreated. It should be noted that there was an increase in the untreated ground ivy population. Additionally, although not significant, when MacroSorb Foliar was part of the treatment regime there was a trend of increased control of ground ivy with the respective herbicides.

During the second growing season the percent control of ground ivy was rated on August 24, 2006 (Table 2). After approximately fourteen months post application of materials, no control of ground ivy was found. All treated and non treated turfgrass had an increase in the ground ivy populations. It appears that a single application of these materials only provide a single growing season of the population reduction of ground ivy.

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Table 1. Evaluations of perennial ryegrass phytotoxicity in 2005 where 0 = worst, 7 = acceptable and 10 = no phytotoxicity.

Treatment	Form	Rate lb ai/A	Phytotoxicity 6-28	7-5	7-12	7-19	7-26	8-2
DRIVE	75DF	0.75	10.0	10.0	10.0	10.0	10.0	10.0
2,4,D AMINE	3.87L	1						
MSO	L	1 % V/V						
DRIVE	75DF	0.75	10.0	10.0	10.0	10.0	10.0	10.0
2,4,D AMINE	3.87L	1						
MSO	L	1 % V/V						
MACROSORB FOLIAR	L	2 FL OZ/M						
CHECK			10.0	10.0	10.0	10.0	10.0	10.0
DRIVE	75DF	0.75	10.0	10.0	10.0	10.0	10.0	10.0
2,4,D AMINE	3.87L	1						
MACROSORB FOLIAR	L	2 FL OZ/M						
CONFRONT	3SL	32 FL OZ/A	10.0	10.0	10.0	10.0	10.0	10.0
CONFRONT	3SL	32 FL OZ/A	10.0	10.0	10.0	10.0	10.0	10.0
MACROSORB FOLIAR	L	2 FL OZ/M						

Table 2. Percent control of the ground ivy population following applications of selected herbicides.

Treatment	Form	Rate lb ai/A	% Control [1, 2] August 25, 2005	August 24, 2006
DRIVE	75DF	0.75	84.27a	-27.7a
2,4,D AMINE	3.87L	1		
MSO	L	1 % V/V		
DRIVE	75DF	0.75	89.66a	-17.6a
2,4,D AMINE	3.87L	1		
MSO	L	1 % V/V		
MACROSORB FOLIAR	L	2 FL OZ/M		
CHECK			-22.72b	-30.7a
DRIVE	75DF	0.75	98.27a	-27.1a
2,4,D AMINE	3.87L	1		
MACROSORB FOLIAR	L	2 FL OZ/M		
CONFRONT	3SL	32 FL OZ/A	84.76a	-24.2a
CONFRONT	3SL	32 FL OZ/A	87.30a	-43.7a
MACROSORB FOLIAR	L	2 FL OZ/M		

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

2 - Negative numbers indicate an increase in ground ivy population and positive numbers a decrease in population.

Preemergence Control of Smooth Crabgrass Using Various Nozzle Types and Application Volumes

J. A. Borger and M. B. Naedel[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 with different nozzle types and application volumes for the control of smooth crabgrass and safety to the desired species.

Methods and Materials

This study was a randomized complete block design with three replications. All treatments were applied on April 18, 2006 using a three foot CO_2 powered boom sprayer calibrated to deliver 1, 2, and 4 gallons/1000 ft^2 using one TF-3, TF 7.5, and TF-10 nozzle (respectively) at varying pressures. After application the entire test site received approximately 0.5 inch of water. On April 27, 2006 0.5 lb N/M was applied from urea and 0.5 lb N/M from a 31-0-0 IBDU fertilizer was applied to the test site. The site was mowed once per week with a rotary mower at one inch with clippings returned to the site.

The test site was overseeded with a native source of smooth crabgrass seed in the fall of at least two of the pervious growing seasons. The test site had approximately 90% cover of smooth crabgrass in the non treated areas at the conclusion of the study.

Smooth crabgrass germination was first noted in the non treated areas of the test site on April 24, 2006.

Results and Discussion

Turfgrass phytotoxicity was rated twice during the study (Table 1). No phytotoxicity was found during the study.

The percent control of smooth crabgrass was rated on August 15, 2006 (Table 2). All treated turfgrass provided commercially acceptable control of smooth crabgrass (85% or greater).

It would appear in this study on this site, with the weather conditions of this season, using these two products, that nozzle type and the volume of application had little effect on the control of smooth crabgrass.

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Table 1. Evaluations of phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity taken in 2006.

Treatment	Form	Rate LB AI/A	Nozzle Type	GPM	(---Phytotoxicity--) 4/27	5/5
BARRICADE	65WG	0.65	TF-3	1	10.0	10.0
BARRICADE	65WG	0.65	TF-7.5	2	10.0	10.0
BARRICADE	65WG	0.65	TF-10	4	10.0	10.0
CHECK					10.0	10.0
DIMENSION	40WP	0.25	TF-3	1	10.0	10.0
DIMENSION	40WP	0.25	TF 7.5	2	10.0	10.0
DIMENSION	40WP	0.25	TF-10	4	10.0	10.0

Table 2. Evaluations of the percent control of smooth crabgrass in 2006. Commercially acceptable control was considered to be 85% and above.

Treatment	Form	Rate LB AI/A	Nozzle Type	GPM	(----% Control----) 8/15
BARRICADE	65WG	0.65	TF-3	1	89.7
BARRICADE	65WG	0.65	TF-7.5	2	96.3
BARRICADE	65WG	0.65	TF-10	4	89.7
CHECK					0.0
DIMENSION	40WP	0.25	TF-3	1	85.0
DIMENSION	40WP	0.25	TF 7.5	2	90.0
DIMENSION	40WP	0.25	TF-10	4	91.7

Evaluation of Plant Growth Regulators and Fertilizer to Fairway Height Creeping Bentgrass

J.A. Borger and M.B. Naedel [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 alone or in combination with a liquid fertilizer using color ratings, measurements of plant height, and fresh weight foliar yield.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on June 6 (JUNE) and July 11, 2006 (4 WAT) using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one, flat fan, 11004E nozzle at 40 psi.

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. Clipping weights were taken once a week with a John Deere walk behind reel mower bench set to 0.485" with an actual height of cut 0.500".

Results and Discussion

Turfgrass phytotoxicity was evaluated seven times during the study (Table 1). On the July 26th and August 3rd rating dates turfgrass treated with Primo MAXX plus Trimmit with or without fertilizer had unacceptable phytotoxicity (below 7.0). No unacceptable phytotoxicity was found on any of the other rating dates.

Turfgrass color was evaluated eleven times during the study (Table 2). At no time during the study did treated or non turfgrass color ratings fall below acceptable (7.0).

Turfgrass height was evaluated eleven times during the study (Table 3). On the June 14th rating date, turfgrass treated with Primo MAXX at 0.09, 0.12, and 0.17 lb ai/A plus fertilizer and Primo MAXX at 0.125 oz/M plus Trimmit had significantly lower turfgrass height compared to non treated turfgrass.

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On the June 21st rating date, only turfgrass treated with Trimmit plus fertilizer were not significantly different than non treated turfgrass. On the June 28th rating date, turfgrass treated with Primo MAXX plus Trimmit with or without fertilizer had significantly lower turfgrass height than non treated. On the July 13th rating date, only turfgrass treated with Trimmit plus fertilizer had significantly higher height than non treated. On the July 19th rating date Primo MAXX at 0.07, 0.12, 0.17 lb ai/A plus fertilizer and Primo MAXX plus Trimmit with or without fertilizer had significantly lower turfgrass height than non treated. On the July 26th rating date, turfgrass treated with Primo MAXX at 0.07, 0.09, 0.12, 0.17 lb ai/A plus fertilizer, and Primo MAXX plus Trimmit with or without fertilizer had significantly lower turfgrass height than non treated. Finally, on the August 23rd rating date, turfgrass treated with Primo MAXX plus Trimmit plus fertilizer had significantly lower turfgrass height than non treated.

Turfgrass fresh clipping weights were evaluated ten times during the study (Table 4). On the June 14th and June 21st rating dates, all treated turfgrass had significantly less yield than non treated turfgrass. On the June 28th rating date, all treated turfgrass had significantly less yield than non treated. On the July 13th rating date, turfgrass treated with Trimmit plus fertilizer and Primo MAXX plus Trimmit plus fertilizer had significantly greater yield than non treated. On the July 19th rating date, turfgrass treated with Primo MAXX at 0.09, 0.12, 0.17 lb ai/A plus fertilizer and Primo MAXX plus Trimmit with or without fertilizer had significantly less yield than non treated. On the July 26th rating date, all treated turfgrass had significantly less yield than non treated turfgrass except for turfgrass treated with Trimmit plus fertilizer. On the August 3rd rating date, turfgrass treated with Primo MAXX plus Trimmit plus fertilizer had significantly less yield than non treated turfgrass. Finally on the August 23rd rating date, turfgrass treated with Primo MAXX at 0.09 and 0.17 lb ai/A plus fertilizer, and Primo MAXX plus Trimmit with or without fertilizer had significantly greater yield than non treated.

Generally, the rebound effects of the PGRs used in this study were apparent as were the reduction in plant growth. Future research should be conducted to evaluate the intervals of application timings in order to better understand when rebound might occur. In general, all of the materials evaluated in this study preformed well and could be apart of a turfgrass management scheme.

Table 1. Phytotoxicity ratings on a scale of 0-10 where 0 = dead turf, 7= acceptable, and 10 = no phytotoxicity of materials applied to creeping bentgrass taken in 2006.

Treatment	**Form**	**Rate lb ai/A**	**Timing**	**(------Phytotoxicity------)** 6/11	6/21	6-28	7/19	7-26	8/3	8/16
PRIMO MAXX	1MEC	0.07	JUNE/4 WAT	10.0	9.7	10.0	10.0	10.0	10.0	10.0
ECO-N (24-0-0)	2.2L	0.144 lb N/M	JUNE/4 WAT							
PRIMO MAXX	1MEC	0.09	JUNE/4 WAT	10.0	9.7	10.0	10.0	10.0	10.0	10.0
ECO-N (24-0-0)	2.2L	0.18 lb N/M	JUNE/4 WAT							
CHECK				10.0	10.0	10.0	10.0	10.0	10.0	10.0
PRIMO MAXX	1MEC	0.12	JUNE/4 WAT	10.0	9.7	10.0	10.0	10.0	10.0	10.0
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT							
PRIMO MAXX	1MEC	0.17	JUNE/4 WAT	10.0	9.3	10.0	10.0	10.0	10.0	10.0
ECO-N (24-0-0)	2.2L	0.35 lb N/M	JUNE/4 WAT							
TRIMMIT	2SC	0.25	JUNE/4 WAT	10.0	10.0	10.0	10.0	10.0	10.0	10.0
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT							
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	10.0	8.7	10.0	10.0	6.0	6.2	10.0
TRIMMIT	2SC	0.25	JUNE/4 WAT							
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	10.0	10.0	10.0	10.0	6.3	6.5	10.0
TRIMMIT	2SC	0.25	JUNE/4 WAT							
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT							

Table 2. Color ratings on a scale of 0-10 where 0 = brown, 7= acceptable, and 10 = dark green of materials applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate lb ai/A	Timing	6/14 [1]	6/21	6/28	7/5	7/13	7/19	7/26	8/3	8/16	8/23	8/30
PRIMO MAXX	1MEC	0.07	JUNE/4 WAT	7.8	8.8	8.5	8.8	8.5	9.3	9.3	9.2	8.0	8.0	7.5
ECO-N (24-0-0)	2.2L	0.144 lb N/M	JUNE/4 WAT											
PRIMO MAXX	1MEC	0.09	JUNE/4 WAT	7.8	8.8	8.7	9.2	8.8	9.5	9.3	9.2	8.0	8.0	7.5
ECO-N (24-0-0)	2.2L	0.18 lb N/M	JUNE/4 WAT											
CHECK				7.7	8.3	8.2	8.2	8.2	8.7	8.3	8.2	8.0	8.0	7.5
PRIMO MAXX	1MEC	0.12	JUNE/4 WAT	8.0	9.3	8.8	8.8	9.0	9.3	9.5	9.5	8.0	8.0	7.5
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT											
PRIMO MAXX	1MEC	0.17	JUNE/4 WAT	8.0	8.7	8.8	9.3	9.2	9.8	9.5	9.7	8.0	8.0	7.5
ECO-N (24-0-0)	2.2L	0.35 lb N/M	JUNE/4 WAT											
TRIMMIT	2SC	0.25	JUNE/4 WAT	8.0	8.8	8.5	8.8	8.7	9.0	8.7	9.0	8.0	8.0	7.5
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT											
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	7.8	7.5	8.3	9.2	8.7	9.0	8.3	7.0	8.0	8.0	7.5
TRIMMIT	2SC	0.25	JUNE/4 WAT											
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	8.5	9.3	8.8	9.2	9.3	9.3	8.5	7.0	8.0	8.0	7.5
TRIMMIT	2SC	0.25	JUNE/4 WAT											
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT											

1 – Color ratings exclude phytotoxicity if present (see Table 1 for phytotoxicity ratings).

Table 3. Height ratings (in inches) of materials applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate lb ai/A	Timing	Height [1] 6/14	6/21	6/28	7/5	7/13	7/19
PRIMO MAXX	1MEC	0.07	JUNE/4 WAT	0.42bcd	0.44bc	0.67a	0.62b	0.53b	0.50cd
ECO-N (24-0-0)	2.2L	0.144 lb N/M	JUNE/4 WAT						
PRIMO MAXX	1MEC	0.09	JUNE/4 WAT	0.39cd	0.44bc	0.66a	0.62b	0.55ab	0.54bc
ECO-N (24-0-0)	2.2L	0.18 lb N/M	JUNE/4 WAT						
CHECK				0.49ab	0.57a	0.72a	0.66ab	0.54b	0.62ab
PRIMO MAXX	1MEC	0.12	JUNE/4 WAT	0.40cd	0.42c	0.66a	0.66ab	0.53b	0.50cd
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT						
PRIMO MAXX	1MEC	0.17	JUNE/4 WAT	0.38d	0.39c	0.63a	0.65ab	0.52b	0.49cd
ECO-N (24-0-0)	2.2L	0.35 lb N/M	JUNE/4 WAT						
TRIMMIT	2SC	0.25	JUNE/4 WAT	0.52a	0.52ab	0.62a	0.72a	0.68a	0.59abc
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT						
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	0.41cd	0.38c	0.48b	0.70ab	0.64ab	0.43d
TRIMMIT	2SC	0.25	JUNE/4 WAT						
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	0.42bcd	0.43c	0.53b	0.71ab	0.64ab	0.41d
TRIMMIT	2SC	0.25	JUNE/4 WAT						
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT						

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

Table 3 (continued). Height ratings (in inches) of materials applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate lb ai/A	Timing	(----Height [1] 7/26	8/3	8/16	8/23	8/3----)
PRIMO MAXX	1MEC	0.07	JUNE/4 WAT	0.49bcd	0.52abc	0.50a	0.53b	0.67c
ECO-N (24-0-0)	2.2L	0.144 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.09	JUNE/4 WAT	0.47bcd	0.51abc	0.52a	0.57b	0.72abc
ECO-N (24-0-0)	2.2L	0.18 lb N/M	JUNE/4 WAT					
CHECK				0.60a	0.49abc	0.47a	0.52b	0.72abc
PRIMO MAXX	1MEC	0.12	JUNE/4 WAT	0.44cde	0.53abc	0.54a	0.59ab	0.73abc
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.17	JUNE/4 WAT	0.47bcd	0.57ab	0.54a	0.58ab	0.70abc
ECO-N (24-0-0)	2.2L	0.35 lb N/M	JUNE/4 WAT					
TRIMMIT	2SC	0.25	JUNE/4 WAT	0.51abc	0.59a	0.54a	0.59ab	0.73abc
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	0.41de	0.43c	0.52a	0.59ab	0.80ab
TRIMMIT	2SC	0.25	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	0.36e	0.43c	0.50a	0.66a	0.81a
TRIMMIT	2SC	0.25	JUNE/4 WAT					
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					

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

Table 4. Fresh clipping weight (grams) of materials applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate lb ai/A	Timing	(------------------------Fresh Clipping Weight [1]------------------) 6/14	6/21	6/28	7/5	7/13
PRIMO MAXX	1MEC	0.07	JUNE/4 WAT	1.2c	6.7bcd	45.3bcd	31.0abc	12.6c
ECO-N (24-0-0)	2.2L	0.144 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.09	JUNE/4 WAT	0.8c	4.7bcd	39.2b-e	23.7c	9.6c
ECO-N (24-0-0)	2.2L	0.18 lb N/M	JUNE/4 WAT					
CHECK				5.9a	23.0a	81.8a	29.0abc	13.0c
PRIMO MAXX	1MEC	0.12	JUNE/4 WAT	0.9c	5.3bcd	36.6b-e	26.5bc	8.4c
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.17	JUNE/4 WAT	1.1c	2.9cd	25.0cde	20.7c	9.8c
ECO-N (24-0-0)	2.2L	0.35 lb N/M	JUNE/4 WAT					
TRIMMIT	2SC	0.25	JUNE/4 WAT	3.1b	7.0bcd	37.8b-e	43.2a	32.5a
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	1.1c	2.5d	17.1e	29.1abc	20.2abc
TRIMMIT	2SC	0.25	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	1.2c	2.3d	19.4de	40.6ab	30.4ab
TRIMMIT	2SC	0.25	JUNE/4 WAT					
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					

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

Table 4 (continued). Fresh clipping weight (grams) of materials applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate lb ai/A	Timing	7/19	7/26	8/3	8/16	8/23
				(------Fresh Clipping Weight [1]------)				
PRIMO MAXX	1MEC	0.07	JUNE/4 WAT	6.9cde	5.0bcd	11.0ab	20.6ab	18.7bc
ECO-N (24-0-0)	2.2L	0.144 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.09	JUNE/4 WAT	6.1de	5.8bc	9.0ab	31.2ab	26.8ab
ECO-N (24-0-0)	2.2L	0.18 lb N/M	JUNE/4 WAT					
CHECK				14.6bc	9.4a	10.6ab	14.7b	11.5c
PRIMO MAXX	1MEC	0.12	JUNE/4 WAT	6.3de	5.1bcd	8.5ab	21.3ab	27.0ab
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.17	JUNE/4 WAT	5.2e	3.7cde	9.5ab	26.1ab	30.8ab
ECO-N (24-0-0)	2.2L	0.35 lb N/M	JUNE/4 WAT					
TRIMMIT	2SC	0.25	JUNE/4 WAT	14.9bc	7.6ab	15.0a	20.5ab	20.2bc
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	2.3e	1.2e	2.2c	27.0ab	27.6ab
TRIMMIT	2SC	0.25	JUNE/4 WAT					
PRIMO MAXX	1MEC	0.125 oz/M	JUNE/4 WAT	4.2e	2.2de	4.4bc	30.5ab	38.5a
TRIMMIT	2SC	0.25	JUNE/4 WAT					
ECO-N (24-0-0)	2.2L	0.25 lb N/M	JUNE/4 WAT					

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

J. A. Borger, M. B. Naedel, M. D. Soika and 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 selected materials could reduce the annual bluegrass population under simulated fairway conditions.

Methods and Materials

This study was a randomized complete block design with three replications. Treatments were applied on June 6 (JUNE), June 13 (7 DAT), June 20 (14 DAT), June 28 (21 DAT), July 11 (28 DAT), July 14 (35 DAT), July 18 (42 DAT), August 8 (56 DAT), August 18 (70 DAT), September 2 (84 DAT), September 14 (98 DAT), October 12 (112 DAT), October 24 (126 DAT), November 2 (140 DAT), November 4 (NOV), and Nov 22, 2005 (LATE NOV) using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa and Betasan was applied at 80 gpa using two, flat fan, 11004 nozzles at 40 psi. After pre-emergent applications of Betasan the area was irrigated with 0.25” of water. The test area was maintained at 0.5 inch using a five-plex reel mower that collected clippings. Turfgrass was irrigated on an as needed basis to prevent moisture stress. The study was fertilized prior to green up (March 20, 2005) with 2 lbs /M of IBDU and again in May with 0.75 lb N/M of Urea. The test area received maintenance fungicide applications to control disease.

The test site consisted of approximately 45 percent creeping bentgrass and 55 percent annual bluegrass at the initiation of the study. The annual bluegrass population was visually evaluated on May 24, 2005 and May 9, 2006, on a plot by plot basis, to determine the baseline population and percent change of the population in each plot.

Results and Discussion

Turfgrass discoloration was rated five times during the study (Table 1). Only turfgrass treated with Velocity, alone or in combination with other materials, was rated below acceptable (7.0) at some time in the study.

Turfgrass quality was rated five times during the study (Table 2). Turfgrass quality was never rated below acceptable (7.0) on any rating date.

Turfgrass spring color was rated twice during the study (Table 3). On the April 13, 2006 rating date only turfgrass treated with Prograss, alone or in combination with other materials, was rated below 6.0. By the May 9, 2006 rating date, all turfgrass spring color was rated 9.0.

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The annual bluegrass population change was rate on May 9, 2006 (Table 4). Turfgrass treated with Trimmit plus Rubigan at 0.75 oz/M with or without an 18-3-1 fertilizer applied at the June, 28, 56, 112, and 140 DAT timings, Trimmit plus Rubigan at 1.5 oz/M applied at the June, 28, 56, 112, and 140 DAT timings, Velocity at 60 g ai/A June and 14 DAT plus Rubigan at 0.75 oz/M June 14, 42, 70, and 98 DAT, Trimmit with or without Rubigan at 0.75 oz/M plus an 18-3-1 fertilizer applied at the June, 28, 56, 112, and 140 DAT timings with or without Betasan at 5.6 oz/M applied at June, and 56 DAT timings, Trimmit plus Signature at 8 oz/M plus an 18-3-1 fertilizer applied at the June, 28, 56, 112, and 140 DAT timings with or without Betasan at 5.6 oz/M applied at June, and 56 DAT timings, Trimmit applied at the June, 28, 56, 112, and 140 DAT timings plus Rubigan at 0.75 oz/M applied at the June, 14, 28, 42, 56, 70, 84, 98, 112, and 140 DAT timings, Prograss alone or in combination with Trimmit at any rate, and Trimmit plus Signature applied at the June, 28, 56, 112, and 140 DAT timings reduced the annual bluegrass population by 70% or more, significantly more reduction than untreated.

It appears that annual bluegrass populations can be reduced in a mixed sward of creeping bentgrass/annual bluegrass using Trimmit, Velocity, and Prograss alone or in combination with a fertilizer, fungicides, and a preemergence. Although some turfgrass discoloration was noted there was no long lasting effect and the overall quality of the turfgrass was not adversely effected. There was a delay in the turfgrass spring color following applications of Prograss alone or in combination with Trimmit.

Table 1. Discoloration of a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass in 2005.

Treatment	Form	Rate (lb ai/A)	Timing	(------------Discoloration [1]---------) 6/9	6/20	6/28	7/6	7/11
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.0	8.7	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.3	9.0	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.5	8.3	10.0	10.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.0	8.7	10.0	10.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
VELOCITY	80WP	30 G AI/A	June/14 DAT	6.0	10.0	6.0	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	45 G AI/A	June/14 DAT	6.0	10.0	6.0	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	60 G AI/A	June/14 DAT	6.0	10.0	5.7	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	60 G AI/A	June/14 DAT	6.0	10.0	5.7	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	6.0	8.7	6.2	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/28/56/84/112 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.3	8.7	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.0	9.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56/ DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	8.3	8.3	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.7	9.0	10.0	10.0
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	8.7	8.7	10.0	10.0
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	10.0	10.0	9.3	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	10.0	10.0	10.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	10.0	10.0	10.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	10.0	9.7	10.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	10.0	10.0	10.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	10.0	10.0	10.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	10.0	10.0	10.0	10.0	10.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	10.0	9.7	10.0	10.0	10.0
CHECK				10.0	10.0	10.0	10.0	10.0

1 – Discoloration rated on a scale of 0 to 10 where 0= worst, 7 = acceptable, and 10 = no discoloration.

Table 1 (continued). Discoloration of a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass in 2005.

Treatment	Form	Rate (lb ai/A)	Timing	(------------Discoloration [1]---------) 6/9	6/20	6/28	7/6	7/11
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	10.0	9.7	10.0	10.0	10.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	10.0	10.0	10.0	10.0	10.0
VELOCITY	80WP	30 G AI/A	June/14 DAT	6.0	10.0	6.3	10.0	10.0
VELOCITY	80WP	45 G AI/A	June/14 DAT	6.0	10.0	5.7	10.0	10.0
VELOCITY	80WP	60 G AI/A	June/14 DAT	6.0	9.7	5.7	10.0	10.0
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	6.0	9.0	6.3	10.0	10.0
VELOCITY	17.6WP	30 G AI/A	June/14 DAT	6.0	8.3	6.0	10.0	10.0
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.3	8.7	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.7	8.0	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	6.0	10.0	10.0	10.0	10.0
VELOCITY	80WP	30 G AI/A	June					
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	10.0	9.7	10.0	10.0	10.0
VELOCITY	80WP	30 G AI/A	June	6.0	10.0	9.3	10.0	10.0
BETASAN	4EC	5.6 OZ/M	June/56 DAT	10.0	10.0	9.7	10.0	10.0
PROGRASS	1.5EC	0.75	NOV/LATE NOV	10.0	10.0	10.0	10.0	10.0
PROGRASS	1.5EC	0.75	NOV/LATE NOV	10.0	10.0	10.0	10.0	10.0
TRIMMIT	2SC	0.75	NOV/LATE NOV					
PROGRASS	1.5EC	0.375	NOV/LATE NOV	10.0	10.0	10.0	10.0	10.0
TRIMMIT	2SC	0.375	NOV/LATE NOV					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	10.0	7.7	8.3	10.0	10.0
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	10.0	9.7	10.0	10.0	10.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT					
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	10.0	8.7	10.0	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	10.0	8.7	10.0	10.0	10.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
VELOCITY	80WP	60 G AI/A	June/14 DAT	6.0	10.0	5.3	10.0	10.0
PSU EXP (PART A)	WP	10.4 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
PSU EXP (PARTB)	WP	11.2 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
PSU EXP (PART A)	WP	20.8 OZ/M	June/28/56/112/140 DAT	6.0	10.0	10.0	10.0	10.0
PSU EXP (PARTB)	WP	22.4 OZ/M	June/28/56/112/140 DAT					

1 – Discoloration rated on a scale of 0 to 10 where 0= worst, 7 = acceptable, and 10 = no discoloration.

Table 2. Quality, in terms of density, color, and uniformity of a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass in 2005.

Treatment	Form	Rate (lb ai/A)	Timing	(---------------Quality [1]--------------) 7/25	8/8	8/18	8/30	9/16
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.5	8.5
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.5	8.5
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
VELOCITY	80WP	30 G AI/A	June/14 DAT	8.7	8.0	9.0	9.0	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	45 G AI/A	June/14 DAT	9.0	8.5	9.0	9.0	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	60 G AI/A	June/14 DAT	8.7	9.0	9.0	9.0	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	60 G AI/A	June/14 DAT	8.5	9.0	9.0	8.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT					
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	9.0	9.0	9.0	9.0	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/28/56/84/112 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	8.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.3	9.5	9.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56/ DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	8.5	8.5
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.0	8.5
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	8.7	8.5	8.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	9.0	8.5	8.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	8.5	8.5	8.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	9.0	9.0	8.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	8.8	9.0	8.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
BETASAN	4EC	5.6 OZ/M	June/56 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	9.0	9.0	8.5	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	8.8	8.5	8.5	9.0	8.5
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	9.2	8.0	8.0	8.5	8.5
CHECK				8.7	8.0	8.0	8.5	8.5

1 – Quality rated on a scale of 0 to 10 where 0= worst, 7 = acceptable, and 10 = excellent quality.

Table 2 (cont.). Quality, in terms of density, color, and uniformity of a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass in 2005.

Treatment	Form	Rate (lb ai/A)	Timing	(---------------Quality [1]				--------------)
				6/9	6/20	6/28	7/6	7/11
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	8.8	8.5	8.0	8.5	8.5
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	9.2	9.0	8.0	8.5	8.5
VELOCITY	80WP	30 G AI/A	June/14 DAT	8.8	8.5	8.0	8.5	8.5
VELOCITY	80WP	45 G AI/A	June/14 DAT	9.0	8.5	8.0	8.5	8.5
VELOCITY	80WP	60 G AI/A	June/14 DAT	9.0	8.5	8.0	8.5	8.5
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	8.5	9.0	8.0	8.5	8.5
VELOCITY	17.6WP	30 G AI/A	June/14 DAT	8.7	8.5	8.0	8.5	8.5
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	8.0	9.5	9.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.3	9.0	9.5	9.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	8.7	8.0	8.5	8.5	8.5
VELOCITY	80WP	30 G AI/A	June					
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	9.2	8.5	8.5	8.5	8.5
VELOCITY	80WP	30 G AI/A	June	9.0	8.5	8.5	8.5	8.5
BETASAN	4EC	5.6 OZ/M	June/56 DAT	8.7	8.5	8.0	8.5	8.5
PROGRASS	1.5EC	0.75	NOV/LATE NOV	8.5	8.5	8.0	8.5	8.5
PROGRASS	1.5EC	0.75	NOV/LATE NOV	8.8	8.5	8.0	8.5	8.5
TRIMMIT	2SC	0.75	NOV/LATE NOV					
PROGRASS	1.5EC	0.375	NOV/LATE NOV	8.7	8.5	8.0	8.5	8.5
TRIMMIT	2SC	0.375	NOV/LATE NOV					
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	9.5	9.5	9.5	9.5	8.5
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT					
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	9.2	9.0	8.5	8.5	8.5
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT					
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	9.3	9.0	9.0	8.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	9.5	9.0	9.0	8.5	8.5
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT					
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT					
VELOCITY	80WP	60 G AI/A	June/14 DAT	9.2	9.5	9.0	8.5	8.5
PSU EXP (PART A)	WP	10.4 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
PSU EXP (PARTB)	WP	11.2 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT					
PSU EXP (PART A)	WP	20.8 OZ/M	June/28/56/112/140 DAT	8.5	9.5	9.0	9.0	8.5
PSU EXP (PARTB)	WP	22.4 OZ/M	June/28/56/112/140 DAT					

1 – Quality rated on a scale of 0 to 10 where 0= worst, 7 = acceptable, and 10 = excellent quality.

Table 3. Spring color of a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass in 2006.

Treatment	Form	Rate (lb ai/A)	Timing	(-------Spring Color [1]-----) 4/13/06	5/9/06
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.3	9.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.8	9.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.5	9.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.7	9.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
VELOCITY	80WP	30 G AI/A	June/14 DAT	6.3	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT		
VELOCITY	80WP	45 G AI/A	June/14 DAT	6.3	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT		
VELOCITY	80WP	60 G AI/A	June/14 DAT	6.8	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT		
VELOCITY	80WP	60 G AI/A	June/14 DAT	6.8	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT		
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	7.2	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/28/56/84/112 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	8.0	9.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
BETASAN	4EC	5.6 OZ/M	June/56 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.8	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
BETASAN	4EC	5.6 OZ/M	June/56/ DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.7	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	8.0	9.0
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
BETASAN	4EC	5.6 OZ/M	June/56 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	8.0	9.0
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	7.3	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
BETASAN	4EC	5.6 OZ/M	June/56 DAT		
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	7.3	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
BETASAN	4EC	5.6 OZ/M	June/56 DAT		
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	7.5	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	7.0	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	7.3	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
BETASAN	4EC	5.6 OZ/M	June/56 DAT		
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	7.7	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	7.2	9.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	6.5	9.0
CHECK				6.0	9.0

1 – Spring color rated on a scale of 0 to 10 where 0= worst and 10 = green spring color.

Table 3 (cont.) Spring color of a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass in 2006.

Treatment	**Form**	**Rate (lb ai/A)**	**Timing**	**(------------Spring Color [1]-----------) 4/13/06**	**5/9/06**
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	6.0	9.0
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	7.2	9.0
VELOCITY	80WP	30 G AI/A	June/14 DAT	6.3	9.0
VELOCITY	80WP	45 G AI/A	June/14 DAT	6.3	9.0
VELOCITY	80WP	60 G AI/A	June/14 DAT	7.0	9.0
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	6.3	9.0
VELOCITY	17.6WP	30 G AI/A	June/14 DAT	6.3	9.0
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	6.7	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	8.0	9.0
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	6.5	9.0
VELOCITY	80WP	30 G AI/A	June		
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	6.3	9.0
VELOCITY	80WP	30 G AI/A	June	6.3	9.0
BETASAN	4EC	5.6 OZ/M	June/56 DAT	6.7	9.0
PROGRASS	1.5EC	0.75	NOV/LATE NOV	3.0	9.0
PROGRASS	1.5EC	0.75	NOV/LATE NOV	3.0	9.0
TRIMMIT	2SC	0.75	NOV/LATE NOV		
PROGRASS	1.5EC	0.375	NOV/LATE NOV	3.3	9.0
TRIMMIT	2SC	0.375	NOV/LATE NOV		
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	7.8	9.0
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT		
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	7.5	9.0
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT		
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	7.2	9.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT		
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	7.5	9.0
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT		
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT		
VELOCITY	80WP	60 G AI/A	June/14 DAT	7.5	9.0
PSU EXP (PART A)	WP	10.4 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT		
PSU EXP (PARTB)	WP	11.2 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT		
PSU EXP (PART A)	WP	20.8 OZ/M	June/28/56/112/140 DAT	7.2	9.0
PSU EXP (PARTB)	WP	22.4 OZ/M	June/28/56/112/140 DAT		

1 – Spring color rated on a scale of 0 to 10 where 0= worst and 10 = green spring color.

Table 4. Percent annual bluegrass population change in a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass. Ratings taken on May 9, 2006.

Treatment	**Form**	**Rate (lb ai/A)**	**Timing**	**(-------Population Change [1, 2]------) 5/9/2006**
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	82.7a-d
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	91.1abc
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	74.0a-e
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	64.0a-g
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
VELOCITY	80WP	30 G AI/A	June/14 DAT	60.6b-h
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT	
VELOCITY	80WP	45 G AI/A	June/14 DAT	41.9e-l
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT	
VELOCITY	80WP	60 G AI/A	June/14 DAT	68.5a-f
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT	
VELOCITY	80WP	60 G AI/A	June/14 DAT	72.3a-e
RUBIGAN	1AS	0.75 OZ/M	June/14/42/70/98 DAT	
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	55.6c-I
RUBIGAN	1AS	0.75 OZ/M	June/14/28/56/84/112 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	83.3a-d
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
BETASAN	4EC	5.6 OZ/M	June/56 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	82.1a-d
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
BETASAN	4EC	5.6 OZ/M	June/56/ DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	79.1a-d
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	92.2abc
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
BETASAN	4EC	5.6 OZ/M	June/56 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	81.7a-d
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	-23.3rs
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
BETASAN	4EC	5.6 OZ/M	June/56 DAT	
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	-6.7o-s
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
BETASAN	4EC	5.6 OZ/M	June/56 DAT	
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	10.0l-s
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	-8.0o-s
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	21.2i-p
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
BETASAN	4EC	5.6 OZ/M	June/56 DAT	
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	10.0l-s
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	27.8h-o
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	2.3m-s
CHECK				6.7l-s

1 – Means followed by the same letter do not significantly differ (P = 0.05, Duncan's New MRT).
2 – Negative numbers indicate an increase in annual bluegrass populations.

Table 4 (cont.) Percent annual bluegrass population change in a mixed fairway height sward of 'Penneagle' creeping bentgrass and annual bluegrass. Ratings taken on May 9, 2006.

Treatment	**Form**	**Rate (lb ai/A)**	**Timing**	**(--------Population Change [1, 2]-----) 5/9/2006**
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	12.8k-r
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	-25.9s
VELOCITY	80WP	30 G AI/A	June/14 DAT	23.7i-p
VELOCITY	80WP	45 G AI/A	June/14 DAT	48.5d-k
VELOCITY	80WP	60 G AI/A	June/14 DAT	60.0b-h
VELOCITY	80WP	10 G AI/A	June/7/14/21/28/35 DAT	54.1d-j
VELOCITY	17.6WP	30 G AI/A	June/14 DAT	61.6a-h
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	76.3a-e
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	35.5f-m
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	19.4j-q
VELOCITY	80WP	30 G AI/A	June	
RUBIGAN	1AS	0.75 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	0.4m-s
VELOCITY	80WP	30 G AI/A	June	0.9m-s
BETASAN	4EC	5.6 OZ/M	June/56 DAT	29.8g-n
PROGRASS	1.5EC	0.75	NOV/LATE NOV	95.2ab
PROGRASS	1.5EC	0.75	NOV/LATE NOV	97.9a
TRIMMIT	2SC	0.75	NOV/LATE NOV	
PROGRASS	1.5EC	0.375	NOV/LATE NOV	95.0ab
TRIMMIT	2SC	0.375	NOV/LATE NOV	
TRIMMIT	2SC	0.4	June/28/56/112/140 DAT	79.3a-d
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	
SIGNATURE	80WP	8 OZ/M	June/28/56/112/140 DAT	-11.6p-s
RUBIGAN	1AS	1.5 OZ/M	June/28/56/112/140 DAT	
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	42.3e-l
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	
CUTLESS	50W	12 OZ/A	June/28/56/112/140 DAT	-16.7qrs
RUBIGAN	1AS	0.75 OZ/M	June/28/56/112/140 DAT	
18-3-1	1.8L	0.2 LB N/M	June/28/56/112/140 DAT	
VELOCITY	80WP	60 G AI/A	June/14 DAT	-3.3n-s
PSU EXP (PART A)	WP	10.4 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	
PSU EXP (PARTB)	WP	11.2 OZ/M	June/14/28/42/56/70/84/98/112/140 DAT	
PSU EXP (PART A)	WP	20.8 OZ/M	June/28/56/112/140 DAT	32.2g-n
PSU EXP (PARTB)	WP	22.4 OZ/M	June/28/56/112/140 DAT	

1 – Means followed by the same letter do not significantly differ (P = 0.05, Duncan's New MRT).
2 – Negative numbers indicate an increase in annual bluegrass populations.

Post Emergence Control of Smooth Crabgrass

J. A. Borger and M. B. Naedel[1]

Introduction

Postemergence control of smooth crabgrass (*Digitaria ischaemum*) was evaluated on a mature stand of 'Jet Elite' perennial ryegrass (*Lolium perenne* L.), at the Valentine Turfgrass Research Center, Penn State University, University Park, Pa. The objective of the study was to determine the efficacy of selected herbicides for the post emergence control of smooth crabgrass and the injury to the desired species.

Methods and Materials

This study was a randomized complete block design with three replications. All treatments were applied on July 19, 2006 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using one, flat fan, 11004E nozzle at 40 psi. The site was mowed once per week with a rotary mower at one inch with clippings returned to the site.

The test site was overseeded with a native source of smooth crabgrass seed in the fall of at least two of the pervious growing seasons. The test site had approximately 90% cover of smooth crabgrass in the non treated areas at the conclusion of the study.

Smooth crabgrass germination was first noted in the test site on April 24, 2006 and was at the two to three tiller stage at the time of application of these materials (July 19, 2006).

Results and Discussion

Turfgrass phytotoxicity was rated three times during the study (Table 1). No turfgrass phytotoxicity was found during the study.

The control of smooth crabgrass was rated on August 15, 2006 (Table 2). Turfgrass treated with Acclaim Extra alone or combined with MacroSorb Foliar at any rate provided commercially acceptable control (85% or greater) of smooth crabgrass.

Materials that contained quinclorac have not been as successful in past years in the control of smooth crabgrass when applied at the two to three tiller growth stage. Although 40% control or greater was achieved when turfgrass was treated with these product, they did not reach the commercially acceptable level of control in this study. Further research should be conducted to explore this issue.

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Table 1. Evaluations of phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity taken in 2006.

Treatment	Form	Rate	(----------Phytotoxicity----------)		
		LB AI/A	7/26	8/2	8/15
ACCLAIM EXTRA	0.57EW	39 OZ/A	10.0	10.0	10.0
ACCLAIM EXTRA	0.57EW	19.5 OZ/A	10.0	10.0	10.0
ACCLAIM EXTRA	0.57EW	19.5 OZ/A	10.0	10.0	10.0
MACROSORB FOLIAR	L	2 OZ/M			
DRIVE	75DF	0.75	10.0	10.0	10.0
MSO	L	1 % V/V			
CHECK			10.0	10.0	10.0
DRIVE	75DF	0.375	10.0	10.0	10.0
MACROSORB FOLIAR	L	2 OZ/M			
MSO	L	1 % V/V			
Q-4	1.55L	8 PT/A	10.0	10.0	10.0
Q-4	1.55L	4 PT/A	10.0	10.0	10.0
MACROSORB FOLIAR	L	2 OZ/M			

Table 2. Evaluations of the percent control of smooth crabgrass in 2006. Commercially acceptable control was considered to be 85% and above.

Treatment	Form	Rate	(----% Control----)
		LB AI/A	8/15
ACCLAIM EXTRA	0.57EW	39 OZ/A	90.0
ACCLAIM EXTRA	0.57EW	19.5 OZ/A	86.7
ACCLAIM EXTRA	0.57EW	19.5 OZ/A	85.0
MACROSORB FOLIAR	L	2 OZ/M	
DRIVE	75DF	0.75	66.7
MSO	L	1 % V/V	
CHECK			0.0
DRIVE	75DF	0.375	56.7
MACROSORB FOLIAR	L	2 OZ/M	
MSO	L	1 % V/V	
Q-4	1.55L	8 PT/A	66.7
Q-4	1.55L	4 PT/A	40.0
MACROSORB FOLIAR	L	2 OZ/M	

Preemergence Control of Smooth Crabgrass

J. A. Borger and M. B. Naedel[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. Treatments were applied on April 18, 2006 (PRE), May 18, 2006 (4 WAT), June 1, 2006 (6 WAT) and June 17, 2006 (8 WAT)) using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using one, flat fan, 11008E nozzle at 40 psi and granular treatments were applied to wet turf using a shaker jar. After each application the entire test site received approximately 0.5 inch of water. On April 27, 2006 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 plots that did not contain a fertilizer treatment. The site was mowed once per week with a rotary mower at one inch with clippings returned to the site.

The test site was overseeded with a native source of smooth crabgrass seed in the fall of at least two of the pervious growing seasons. The test site had approximately 90% cover of smooth crabgrass in the non treated areas at the conclusion of the study.

Smooth crabgrass germination was first noted in the non treated areas of the test site on April 24, 2006.

Results and Discussion

Turfgrass phytotoxicity was rated four times during the study (Table 1). No turfgrass phytotoxicity was found during the study.

Smooth crabgrass control was rated once during the study (Table 2). All treated turfgrass provided commercially acceptable control of smooth crabgrass (85% or greater) except: Betasan at 7.4 oz/M applied PRE, Betasan at 2.5 oz/M applied PRE/4/8 WAT, 19-3-5 W/Barricade 0.21G or Barricade on DG PRO 0.48DG at 0.35 lb ai/A applied PRE, Barricade on DG PRO 0.48DG at 0.75 lb ai/A, 18-2-12 W/Dimension 0.164G or Dimension on DG PRO 0.25DG at 0.08 lb ai/A or applied PRE, 18-2-12 W/Dimension 0.164G or Dimension on DG PRO 0.25DG at 0.19 lb ai/A or applied PRE, 18-2-12 W/Dimension 0.164G at 0.25 lb ai/A applied PRE, and GWN-3109 applied PRE. It should be noted that some of the materials that did not control at the commercially acceptable level were applied at very low rates of active ingredients.

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Table 1. Evaluations of phytotoxicity where 0 = worst, 7 = acceptable, and 10 = no phytotoxicity taken in 2006.

Treatment	Form	Rate	Timing	(-------------------Phytotoxicity	----------------)		
		LB AI/A		5/2	5/23	6/6	6/27
PENDULUM	3.3EC	2	PRE/8 WAT	10.0	10.0	10.0	10.0
PENDULUM	3.3EC	1.5	PRE/8 WAT	10.0	10.0	10.0	10.0
PENDULUM AQUA CAP	3.8CS	2	PRE/8 WAT	10.0	10.0	10.0	10.0
PENDULUM AQUA CAP	3.8CS	1.5	PRE/8 WAT	10.0	10.0	10.0	10.0
BARRICADE	4FL	18 OZ/A	PRE/6 WAT	10.0	10.0	10.0	10.0
BARRICADE	65WG	13.8 OZ/A	PRE/6 WAT	10.0	10.0	10.0	10.0
BETASAN	4E	7.4 OZ/M	PRE	10.0	10.0	10.0	10.0
BETASAN	4E	2.5 OZ/M	PRE/4/8 WAT	10.0	10.0	10.0	10.0
BETASAN	4E	7.4 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.125	PRE				
BETASAN	4E	4.5 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.1875	PRE				
BETASAN	4E	2.5 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.1875	PRE				
BETASAN	4E	4.5 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.125	PRE				
DIMENSION	40WP	0.1875	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.5	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.25	PRE/6 WAT	10.0	10.0	10.0	10.0
BETASAN	4E	7.4 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.1875	6 WAT				
BETASAN	4E	5.9 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.1875	6 WAT				
BETASAN	4E	4.5 OZ/M	PRE	10.0	10.0	10.0	10.0
DIMENSION	40WP	0.1875	6 WAT				
DIMENSION	40WP	0.1875	PRE/6 WAT	10.0	10.0	10.0	10.0
CHECK				10.0	10.0	10.0	10.0
19-3-5 W/ BARRICADE	0.21G	0.35	PRE	10.0	10.0	10.0	10.0
BARRICADE ON DG PRO	0.48DG	0.35	PRE	10.0	10.0	10.0	10.0
19-3-5 W/ BARRICADE	0.21G	0.65	PRE	10.0	10.0	10.0	10.0
BARRICADE ON DG PRO	0.48DG	0.65	PRE	10.0	10.0	10.0	10.0
19-3-5 W/ BARRICADE	0.21DG	0.75	PRE	10.0	10.0	10.0	10.0
BARRICADE ON DG PRO	0.48DG	0.75	PRE	10.0	10.0	10.0	10.0
19-3-5 W/ BARRICADE	0.21G	1	PRE	10.0	10.0	10.0	10.0
BARRICADE ON DG PRO	0.48DG	1	PRE	10.0	10.0	10.0	10.0
18-2-12 W/ DIMENSION	0.164G	0.08	PRE	10.0	10.0	10.0	10.0
DIMENSION ON DG PRO	0.25DG	0.08	PRE	10.0	10.0	10.0	10.0
18-2-12 W/ DIMENSION	0.164G	0.19	PRE	10.0	10.0	10.0	10.0
DIMENSION ON DG PRO	0.25DG	0.19	PRE	10.0	10.0	10.0	10.0
18-2-12 W/ DIMENSION	0.164G	0.25	PRE	10.0	10.0	10.0	10.0
DIMENSION ON DG PRO	0.25DG	0.25	PRE	10.0	10.0	10.0	10.0
18-2-12 W/ DIMENSION	0.164G	0.5	PRE	10.0	10.0	10.0	10.0
DIMENSION ON DG PRO	0.25DG	0.5	PRE	10.0	10.0	10.0	10.0
GWN-3109	4E	7.4 OZ/M	PRE	10.0	10.0	10.0	10.0

Table 2. Evaluations of the percent control of smooth crabgrass in 2006. Commercially acceptable control was considered to be 85% and above.

Treatment	Form	Rate LB AI/A	Timing	(----% Control----) 8/15
PENDULUM	3.3EC	2/1.5	PRE/8 WAT	92.7
PENDULUM	3.3EC	1.5	PRE/8 WAT	99.0
PENDULUM AQUA CAP	3.8CS	2/1.5	PRE/8 WAT	99.0
PENDULUM AQUA CAP	3.8CS	1.5	PRE/8 WAT	99.0
BARRICADE	4FL	18 OZ/A	PRE/6 WAT	96.0
BARRICADE	65WG	13.8 OZ/A	PRE/6 WAT	99.0
BETASAN	4E	7.4 OZ/M	PRE	76.7
BETASAN	4E	2.5 OZ/M	PRE/4/8 WAT	76.7
BETASAN DIMENSION	4E 40WP	7.4 OZ/M 0.125	PRE PRE	96.0
BETASAN DIMENSION	4E 40WP	4.5 OZ/M 0.1875	PRE PRE	96.0
BETASAN DIMENSION	4E 40WP	2.5 OZ/M 0.1875	PRE PRE	96.0
BETASAN DIMENSION	4E 40WP	4.5 OZ/M 0.125	PRE PRE	93.0
DIMENSION	40WP	0.1875	PRE	94.7
DIMENSION	40WP	0.5	PRE	99.0
DIMENSION	40WP	0.25	PRE/6 WAT	99.0
BETASAN DIMENSION	4E 40WP	7.4 OZ/M 0.1875	PRE 6 WAT	96.0
BETASAN DIMENSION	4E 40WP	5.9 OZ/M 0.1875	PRE 6 WAT	96.0
BETASAN DIMENSION	4E 40WP	4.5 OZ/M 0.1875	PRE 6 WAT	97.7
DIMENSION	40WP	0.1875	PRE/6 WAT	99.0
CHECK				0.0
19-3-5 W/ BARRICADE	0.21G	0.35	PRE	63.3
BARRICADE ON DG PRO	0.48DG	0.35	PRE	60.0
19-3-5 W/ BARRICADE	0.21G	0.65	PRE	90.0
BARRICADE ON DG PRO	0.48DG	0.65	PRE	80.0
19-3-5 W/ BARRICADE	0.21DG	0.75	PRE	99.0
BARRICADE ON DG PRO	0.48DG	0.75	PRE	83.3
19-3-5 W/ BARRICADE	0.21G	1	PRE	94.7
BARRICADE ON DG PRO	0.48DG	1	PRE	86.7
18-2-12 W/ DIMENSION	0.164G	0.08	PRE	50.0
DIMENSION ON DG PRO	0.25DG	0.08	PRE	40.0
18-2-12 W/ DIMENSION	0.164G	0.19	PRE	68.3
DIMENSION ON DG PRO	0.25DG	0.19	PRE	75.0
18-2-12 W/ DIMENSION	0.164G	0.25	PRE	81.7
DIMENSION ON DG PRO	0.25DG	0.25	PRE	86.7
18-2-12 W/ DIMENSION	0.164G	0.5	PRE	93.0
DIMENSION ON DG PRO	0.25DG	0.5	PRE	99.0
GWN-3109	4E	7.4 OZ/M	PRE	76.7

Evaluation of Primo Maxx and Sprayer Nozzles on Fairway Height Creeping Bentgrass

J. A. Borger and M. B. Naedel[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 varying nozzle types (droplet size) with applications of Primo MAXX and using color ratings and measurements of plant height and foliar fresh weight yield.

Methods and Materials

This study was a randomized complete block design with three replications. The plot size was 40 ft^2. All treatments were applied on June 7, June 29 and July 20, 2006 using a four foot battery powered walk behind boom sprayer calibrated to deliver 1 gpm using two nozzles of varying types/droplet size at 40 psi. The test site was maintained similar to that of a golf course fairway with respect to irrigation and mowing. The study received 0.5 lb N/M before the trial was initiated and 0.25 lb N/M every month thereafter from a liquid methylene urea source. Turfgrass height was measured using a Turfcheck 1 prism. Clipping weights were taken once a week with a John Deere walk behind reel mower bench set to 0.485" with an actual height of cut 0.500".

Results and Discussion

Turfgrass color was evaluated nine times during the study (Table 1). At no time during the study did treated or non turfgrass color ratings fall below acceptable (7.0).

Turfgrass height was evaluated nine times during the study (Table 2). On the June 14, 21, July 5, and 13, 2006 rating dates, turfgrass treated with Primo MAXX at 0.5 oz/M using the Turf Jet ¼ TT J04 (XC) nozzles or XR Tee Jet XR11004 (M) nozzles was significantly shorter than non treated turfgrass. Additionally, on the July 13, 2006 rating date, turfgrass treated with Primo MAXX at 0.125 oz/M using the M nozzles was significantly shorter than non treated turfgrass. Finally, on the last rating date, August 16, 2006, turfgrass with Primo MAXX at 0.125 oz/M using the M nozzles had significantly higher turfgrass than non treated, possibly a rebound effect of the PGR.

Turfgrass fresh clipping yield was rated nine times during the study (Table 3). On the June 14, 21, 28, July 5, 13, 19, and 26, 2006 rating dates, turfgrass treated with Primo MAXX at 0.5 oz/M using the XC or M nozzles had significantly less fresh clipping yield than non treated turfgrass. On the June 14, 2006 rating date, turfgrass treated with Primo MAXX at 0.125 oz/M using the XC nozzles also had significantly less fresh clipping yield than non treated turfgrass. Finally, on the June 21, July 13, and 26, 2006 rating dates, turfgrass treated with Primo Maxx at 0.125 oz/M using the XC or M nozzles had significantly less fresh clipping yield than non treated turfgrass.

Generally, when Primo MAXX was applied at the 0.5 oz/M rate, fresh clipping yields were not significantly different when the XC nozzles were compared to the M nozzles. There were some rating dates when the XC or M nozzles were significantly different when compared to the VC nozzles with respect to the fresh clipping yield. When Primo MAXX was applied at the 0.125 oz/M rate there were no significant differences found when XC nozzles were compared to M nozzles.

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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 2006.

Treatment	Form	Rate oz/M	6-14	6-21	6-28	7-5	7-13	7-19	7-26	8-3	8-16
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC[1]	1MEC	0.125	8.5	9.0	8.5	8.3	8.5	9.0	9.0	8.8	8.0
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.125	8.0	9.0	8.5	8.7	8.7	9.2	9.0	9.2	8.0
CHECK			7.5	8.5	8.0	8.2	8.2	8.7	8.8	8.2	8.0
PRIMO MAXX AI TEEJET AI11003 (2.0) VC	1MEC	0.125	8.2	9.0	8.7	8.5	8.7	9.5	9.2	9.0	8.0
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC	1MEC	0.5	7.7	8.5	8.5	9.2	9.0	9.3	9.3	9.3	8.0
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.5	7.8	8.8	8.8	8.8	8.8	9.3	9.3	9.3	8.0

1 – Nozzle type (ground speed mph) droplet size where XC = extra coarse, VC = very coarse and M = medium.

Table 2. Height ratings (in inches) of PGR's applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate oz/M	6-14	6-21	6-28	7-5	7-13	7-19	7-26	8-3	8-16
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC[1]	1MEC	0.125	0.46ab[2]	0.46ab	0.69a	0.59ab	0.49a	0.57a	0.53ab	0.47a	0.44ab
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.125	0.46ab	0.45ab	0.68a	0.57ab	0.43bc	0.56a	0.58a	0.48a	0.49a
CHECK			0.53a	0.53a	0.73a	0.63a	0.49a	0.61a	0.52ab	0.47a	0.42b
PRIMO MAXX AI TEEJET AI11003 (2.0) VC	1MEC	0.125	0.48ab	0.46ab	0.68a	0.57ab	0.46ab	0.56a	0.53ab	0.47a	0.46ab
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC	1MEC	0.5	0.42b	0.39b	0.60a	0.51b	0.43bc	0.52a	0.46b	0.42a	0.47ab
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.5	0.45b	0.42b	0.66a	0.52b	0.41c	0.54a	0.47b	0.40a	0.44ab

1 – Nozzle type (ground speed mph) droplet size where XC = extra coarse, VC = very coarse and M = medium.
2 - 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 2006.

Treatment	Form	Rate oz/M	6-14	6-21	6-28	7-5	7-13	7-19	7-26	8-3	8-16
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC[1]	1MEC	0.125	4.0b[2]	5.2bc	48.8ab	11.3ab	3.6bc	10.9ab	5.6b	8.5a	18.1a
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.125	3.7bc	4.1bcd	49.1ab	10.7ab	2.9bc	11.8a	4.2bc	7.1a	14.3a
CHECK			5.9a	11.9a	70.0a	16.1a	7.4a	13.9a	7.8a	7.3a	13.1a
PRIMO MAXX AI TEEJET AI11003 (2.0) VC	1MEC	0.125	4.8ab	6.3b	51.5ab	11.8ab	5.4ab	12.4a	4.8b	7.7a	13.3a
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC	1MEC	0.5	2.3c	2.3d	32.5b	6.0b	1.5c	6.8c	2.9c	3.6a	16.5a
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.5	2.4c	3.0cd	44.9b	6.7b	2.7bc	8.2bc	2.9c	4.0a	14.1a

1 – Nozzle type (ground speed mph) droplet size where XC = extra coarse, VC = very coarse and M = medium.

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

Evaluation of Primo Maxx, Sync and Sprayer Nozzles on Fairway Height Creeping Bentgrass

J. A. Borger and M. B. Naedel[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 varying nozzle types (droplet size) to apply Primo MAXX alone or in combination with Sync Fungicide Activator and using color ratings and measurements of plant height and foliar fresh weight yield.

Methods and Materials

This study was a randomized complete block design with three replications. The plot size was 40 ft^2. All treatments were applied on June 7, June 29 and July 20, 2006 using a four foot battery powered walk behind boom sprayer calibrated to deliver 1 gpm using two nozzles of varying types/droplet size at 40 psi. The test site was maintained similar to that of a golf course fairway with respect to irrigation and mowing. The study received 0.5 lb N/M before the trial was initiated and 0.25 lb N/M every month thereafter from a liquid methylene urea source. Turfgrass height was measured using a Turfcheck 1 prism. Clipping weights were taken once a week with a John Deere walk behind reel mower bench set to 0.485" with an actual height of cut 0.500".

Results and Discussion

Turfgrass color was evaluated nine times during the study (Table 1). At no time during the study did treated or non turfgrass color ratings fall below acceptable (7.0).

Turfgrass height was evaluated nine times during the study (Table 2). On the June 21, 2006 rating date, turfgrass treated with Primo MAXX plus Sync using XR Tee Jet XR11004 (M) nozzles or Turf Jet 1/4TT J04 (XC) nozzles Had significantly shorter height compared to non treated turfgrass. On the July 13, 2006 rating date, turfgrass treated with Primo MAXX alone using M nozzles had significantly shorter height than non treated turfgrass.

Turfgrass fresh clipping yield was evaluated nine times during the study (Table 3). On the June 21, 2006 rating date, turfgrass treated with Primo Maxx alone or combined with Sync using the XC nozzles and Primo Maxx plus Sync using the M nozzles had significantly less fresh clipping yield than non treated turfgrass. Turfgrass treated with Primo MAXX plus Sync using the XC or M nozzles had significantly less fresh clipping yield on both the July 5 and August 3, 2006 rating dates when compared to non treated turfgrass. On the July 13, 2006 rating date, turfgrass treated with Primo MAXX plus Sync using the XC nozzles had significantly less fresh clipping weight compared to non treated turfgrass. Turfgrass treated with Primo MAXX plus Sync using the M nozzles had significantly less fresh clipping yield on the July 26, 2006 rating date compared to non treated turfgrass. Finally, on the August 3, 2006 rating date, turfgrass treated with Primo MAXX alone using the M nozzles had significantly less fresh clipping yield than non treated turfgrass. In general, it appears that the addition of Sync to Primo MAXX and or nozzle (droplet size) had little influence on fresh clipping yield when comparing the different treated turfgrass combinations to each other.

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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 2006.

Treatment	Form	Rate oz/M	6-14	6-21	6-28	7-5	7-13	7-19	7-26	8-3	8-16
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC[1]	1MEC	0.125	8.2	9.0	8.7	8.8	8.7	9.5	9.0	9.2	8.0
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.125	7.8	8.8	8.2	8.8	8.8	9.2	9.2	9.2	8.0
CHECK			7.7	8.5	8.3	8.7	8.2	8.8	8.7	8.2	8.0
PRIMO MAXX SYNC TURF JET 1/4TT JO4 (2.8) XC	1MEC L	0.125 0.125% v/v	8.2	9.0	8.3	8.8	8.8	9.2	9.2	9.5	8.0
PRIMO MAXX SYNC XR TEEJET XR11004 (2.8) M	1MEC L	0.125 0.125% v/v	8.5	8.7	8.2	9.0	9.0	9.5	9.3	9.0	8.0

1 – Nozzle type (ground speed mph) droplet size where XC = extra coarse and M = medium.

Table 2. Height ratings (in inches) of PGR's applied to creeping bentgrass taken in 2006.

Treatment	Form	Rate oz/M	6-14	6-21	6-28	7-5	7-13	7-19	7-26	8-3	8-16
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC[1]	1MEC	0.125	0.37a[2]	0.42b	0.63b	0.57a	0.43ab	0.57a	0.54a	0.53a	0.48a
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.125	0.41a	0.47ab	0.68ab	0.57a	0.42b	0.57a	0.55a	0.50a	0.51a
CHECK			0.42a	0.51a	0.70a	0.59a	0.51a	0.56a	0.54a	0.56a	0.52a
PRIMO MAXX SYNC TURF JET 1/4TT JO4 (2.8) XC	1MEC L	0.125 0.125% v/v	0.39a	0.43b	0.71a	0.55a	0.45ab	0.56a	0.53a	0.54a	0.51a
PRIMO MAXX SYNC XR TEEJET XR11004 (2.8) M	1MEC L	0.125 0.125% v/v	0.40a	0.42b	0.68ab	0.55a	0.46ab	0.52a	0.51a	0.50a	0.50a

1 – Nozzle type (ground speed mph) droplet size where XC = extra coarse and M = medium.

2 - 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 2006.

Treatment	**Form**	**Rate oz/M**	**6-14**	**6-21**	**6-28**	**7-5**	**7-13**	**7-19**	**7-26**	**8-3**	**8-16**
PRIMO MAXX TURF JET 1/4TT JO4 (2.8) XC[1]	1MEC	0.125	3.4a[2]	5.2b	56.7a	12.2ab	7.2ab	15.7a	9.6ab	13.3ab	20.7a
PRIMO MAXX XR TEEJET XR11004 (2.8) M	1MEC	0.125	3.7a	7.7ab	61.2a	11.4ab	7.0ab	16.7a	8.7ab	10.0b	20.6a
CHECK			5.4a	10.2a	66.8a	15.3a	9.9a	18.3a	12.7a	17.4a	18.9a
PRIMO MAXX SYNC TURF JET 1/4TT JO4 (2.8) XC	1MEC L	0.125 0.125% v/v	3.4a	5.2b	52.1a	8.5b	4.7b	14.5a	7.8ab	10.0b	23.3a
PRIMO MAXX SYNC XR TEEJET XR11004 (2.8) M	1MEC L	0.125 0.125% v/v	3.4a	5.2b	52.7a	9.2b	5.6ab	13.6a	6.1b	7.4b	20.3a

1 – Nozzle type (ground speed mph) droplet size where XC = extra coarse and M = medium.

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

EVALUATION OF PROGRESSIVE TURF LLC LIQUID PRODUCTS IN PUTTING GREEN FERTILIZATION PROGRAMS

Submitted July 20, 2007 to the Pennsylvania Turfgrass Council

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Objective

To discover attributes of Turf Foundation and Greater Green liquid fertilizers when compared to urea-based liquid analogs as primary sources of a frequent, spoon-feeding nitrogen fertilization putting green protocol. Creeping bentgrass vigor, shoot density, and canopy color are the parameters to be used to base conclusions of fertility management and putting green quality.

Materials and Methods

General Methods and Data Collection

Plots were mowed 6-7 times weekly at a height of ⅛” and clippings were removed. All fertilizer treatments were applied using a CO_2–pressurized (262 kPa), single nozzle (Tee-Jet TP11008E, Spraying Systems Co., Wheaton, IL) wand sprayer (R&D Sprayers, Opelousas, LA). A digital metronome (KORG, Melville, NY) was employed to ensure precise nozzle travel rate across the plot length. Potable irrigation was applied to prevent wilt. Plant protectants and wetting agents were applied as necessary in accordance with label directions. High-resolution, JPEG-formatted plot images (2560 x 1920 pixels, 8.9–mm focal length, various shutter speeds and apertures) were collected at identical orientation to the sun and successively by experimental block, using a hand-held digital camera (Nikon E5700, Nikon Corp., Melville, NY). These plot images were used to measure green coloration (dark green color index; DGCI) of the putting green canopy[†]. On any given date (for either experiment), all observed DGCI values were divided by the maximum DGCI value observed that day. This normalization procedure controls ambient light variability, a particular nuisance in repeated measure field studies. The resulting ‘relative’ dark green color indices (relDGCI) are used to describe turfgrass canopy color response to fertilizer treatments throughout the following results and discussion.

Experiment 1:

Penn A4 creeping bentgrass (*Agrostis palustris*)/annual bluegrass (*Poa annua*) USGA green, 4-y old, low soil OM (<1.2%). PSU Joseph Valentine Turfgrass Research Center, University Park, PA.

Liquid fertilizer treatments, applied every 7-10 days (9 total applications), @ 2 gal per 1000 ft^2, were made at low (0.1 lbs N/1000 ft^2) and high rates (0.18 lbs N/1000 ft^2) using either Turf Foundation 10-3-5 (Progressive Turf LLC, Canton, GA) or urea 46-0-0 (Table 1). Experiment 1 was initiated 12 June 2006, and run for 80 days (11 weeks). The experiment was established in a randomized complete block design (3 replicates) comprising 12 plots (3 x 6 ft). Digital images of each Exp. 1 replicate plot were captured on 10 dates between 16 June and 30 Aug. 2006. Duplicate measures of 660– and 850–nm light reflectance from the canopy of each creeping bentgrass putting green plot were recorded by an ambient light-excluding FieldScout TCM–500 turf color meter

† Karcher, D.E., and M.D. Richardson. 2003. Quantifying turfgrass color using digital image analysis. Crop Sci. 43:943-951.

(Spectrum Technologies Inc., Plainfield, IL) on 21 and 25 June. Reflectance data were used to calculate normalized differential vegetative and leaf area indices (NDVI and LAI). Clipping yields were collected from Exp.1 plots 6 July 2006; 7 days following fertilizer applications. Shoot biomass was dried in a forced-air oven (70 ^{o}C) and weighed.

Experiment 2:

Penn A4 creeping bentgrass (*Agrostis palustris*) green, 2-y old, moderate soil OM (~2.2%). Penn State Univ., Joseph Valentine Turfgrass Research Center, University Park, PA.

Liquid fertilizer treatments, applied every 7-10 days (4 total applications), @ 2 gal per 1000 ft^2, were made at low (0.1 lbs N/1000 ft^2) and high rates (0.18 lbs N/1000 ft^2) using Turf Foundation 10-3-5, Greater Green 5-0-7 (Progressive Turf LLC, Canton, GA); or a compound fertilizer solution prepared in 0.1% acetic acid (Distilled White Vinegar, H.J. Heinz Co.) using urea, potassium sulfate, and technical-grade salts of Fe, Mn, and Mo (Table 1). Experiment 2 was initiated 13 July 2006, and run for 30 days. The experiment was established in a randomized complete block design (4 replicates) comprising 24 plots (3 x 6 ft). Digital images of each Exp. 2 replicate plot were captured on 5 dates between 14 and 26 July 2006.

Results and Discussion

Weather conditions over the experimental period were typical of central Pennsylvania summer months and supported cool season turfgrass growth. Daily high temperatures were observed in the range of 80 to 93 ^{o}F (84.9 ^{o}F mean daily high), while low temperatures ranged from 56 to 77 ^{o}F (65.6 ^{o}F mean daily low). Mean relative humidity ranged from 40 to 100%, and mean daily solar radiation levels between 500 and 900 W m^{-2} were observed. Weather data were collected onsite by an automated datalogging weather station (Campbell Sci. Inc., Logan UT).

Table 1. Fertilizer analysis and application and nutrient delivery rates for Exps. 1 & 2, Penn State Univ., 2006.

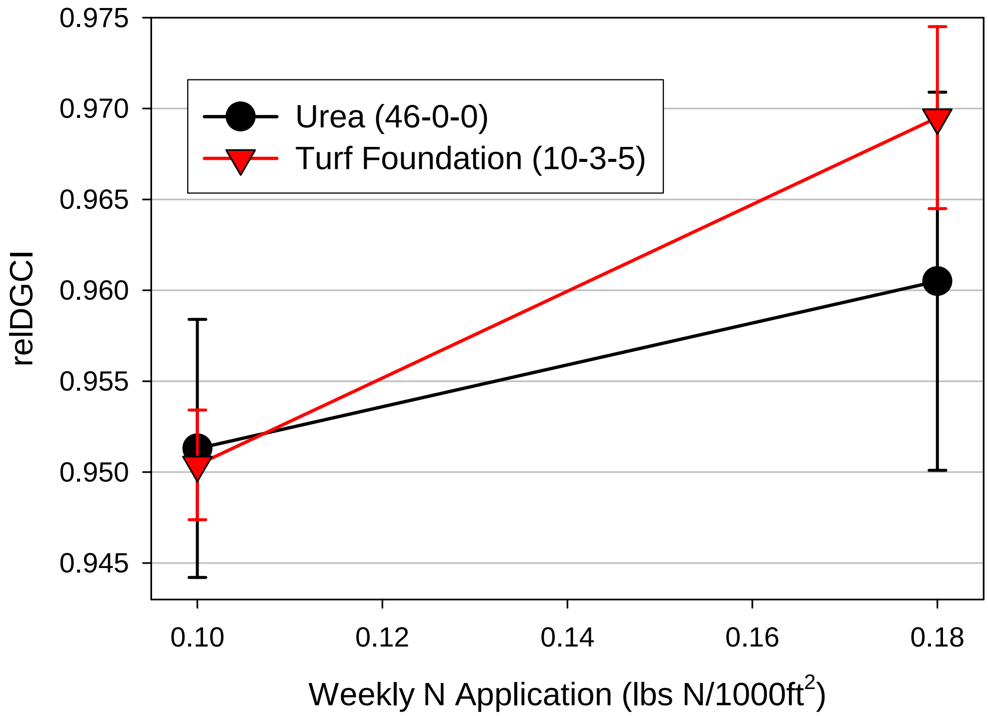
	Fertilizer Analysis							Fertilizer	Nutrient Delivery per Application						
	N	P_2O_5	K_2O	S	Fe	Mn	Mo	App. Rate	N	P_2O_5	K_2O	S	Fe	Mn	Mo
	Experiment 1: Penn A4 creeping bentgrass–annual bluegrass mixture–USGA Green														
Fertilizer	% by mass							ppm	lbs per 1000ft^2						
Urea	46	0	0.00	0.0	0.0	0.0	0.0	0.22	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.00	0.10	0.03	0.05	0.01	0.00	0.00	0.00
Urea	46	0	0.00	0.0	0.0	0.0	0.0	0.39	0.18	0.00	0.00	0.00	0.00	0.00	0.00
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.80	0.18	0.05	0.09	0.02	0.00	0.00	0.00
	Experiment 2: Penn A4 creeping bentgrass–Modified Soil Green														
Fertilizer	% by mass							ppm	lbs per 1000ft^2						
Greater Green*	5	0	7.00	1.0	1.0	0.4	5.0	2.0	0.10	0.00	0.14	0.02	0.02	0.008	<0.001
Urea-based Nutr. Sol.	1.033	0	0.58	0.1	0.1	0.0	0.5	9.7	0.10	0.00	0.06	0.01	0.01	0.004	<0.001
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.0	0.10	0.03	0.05	0.01	0.00	0.000	0.000
Greater Green*	5	0	7.00	1.0	1.0	0.4	5.0	3.6	0.18	0.00	0.25	0.04	0.04	0.014	<0.001
Urea-based Nutr. Sol.	1.033	0	0.58	0.1	0.1	0.0	0.5	17.4	0.18	0.00	0.10	0.02	0.02	0.007	<0.001
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.8	0.18	0.05	0.09	0.02	0.00	0.000	0.000

*Registered trademarks of Progressive Turf, LLC.

Experiment 1:

The relative dark green color index (relDGCI) is a highly-resolute measure of turfgrass color, and is associated with shoot chlorophyll concentrations. Putting green relDGCI responded more significantly to fertilizer rate than type (Fig. 1), as increasing N application rates increased relDGCI over the course of the study. No significant differences between the Turf Foundation and urea fertilizer products were observed at either the 0.1 or 0.18 lbs N / 1000ft^2•week rate.

Figure 1 (right). Experiment 1 mean relative dark green color index (relDGCI), by N rate and fertilizer, all dates combined. Each symbol represents the mean relDGCI of 30 independent measures (3 replications over 10 collection dates). Means with overlapping error bars are not statistically different.



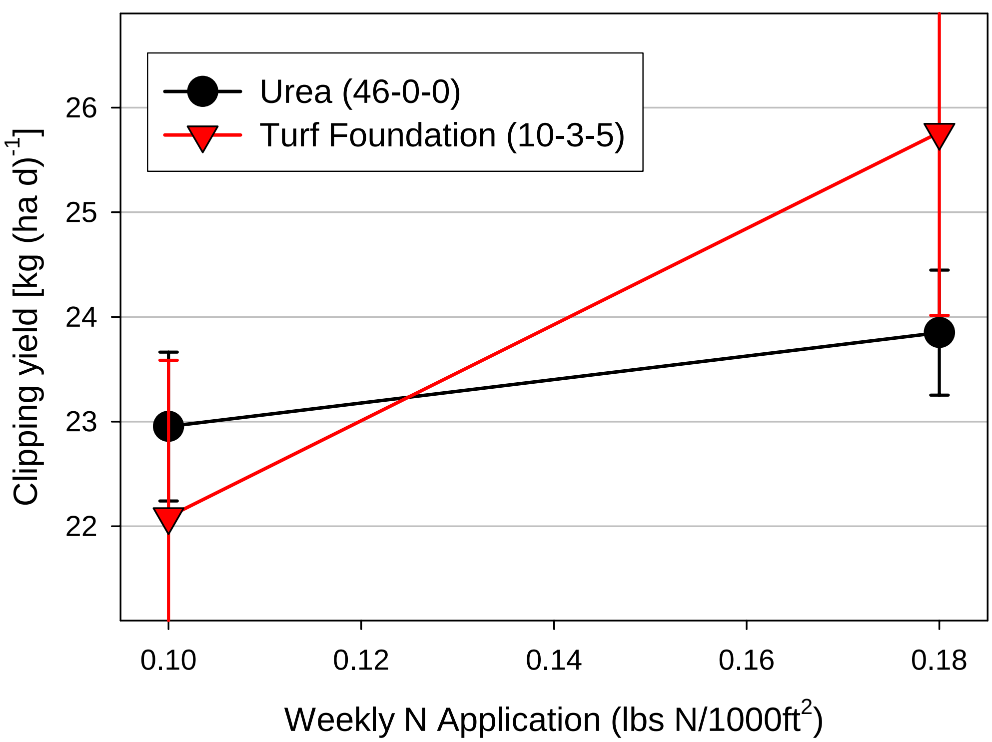


Figure 2 (left). Experiment 1 clipping yields, by N rate and fertilizer. Each symbol represents the mean clipping yield of 3 replications. Means with overlapping error bars are not statistically different.

Putting green clipping yield is a measure of turfgrass growth and vigor, and is associated with optimal growth conditions and nutrient availability. Putting green clipping yield responded more significantly to fertilizer rate than type (Fig. 2), as increasing N application rates increased creeping bentgrass/annual bluegrass growth in early July. No significant differences in shoot growth between the Turf Foundation and urea fertilizer products were observed at either the 0.1 or 0.18 lbs N / 1000ft^2•week rate.

The normalized differential vegetative index (NDVI) and leaf area index (LAI) are similarly calculated indirect measures of leaf/shoot density. During the week of 19–25 June, averaged treatment values (across both collection dates) revealed both density measures responded more significantly to fertilizer rate than type, and no differences were observed between the two fertilizers at either rate (data not shown). On a per date basis, putting green leaf/shoot density increased from 2 to 6 DAT (Figs. 3 & 4). Two DAT, every alternate fertilizer/rate showed significantly greater shoot/leaf density than the 0.1 lbs N / 1000ft^2•week Turf Foundation treatment; yet 6 DAT, the Turf Foundation treatment at the 0.18 lbs N / 1000ft^2•week rate showed the highest NDVI or LAI values (Figs. 3 & 4).

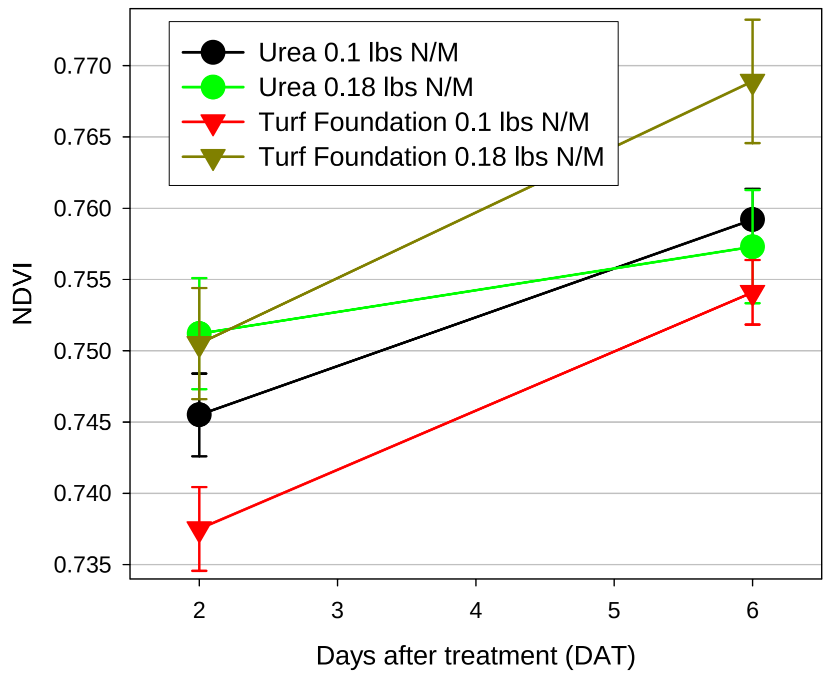


Figure 3 (above). Experiment 1 normalized differential vegetative index (NDVI), by N rate, fertilizer, and days after treatment (DAT). Each symbol represents the mean NDVI of 3 replications. Means with overlapping error bars are not statistically different.

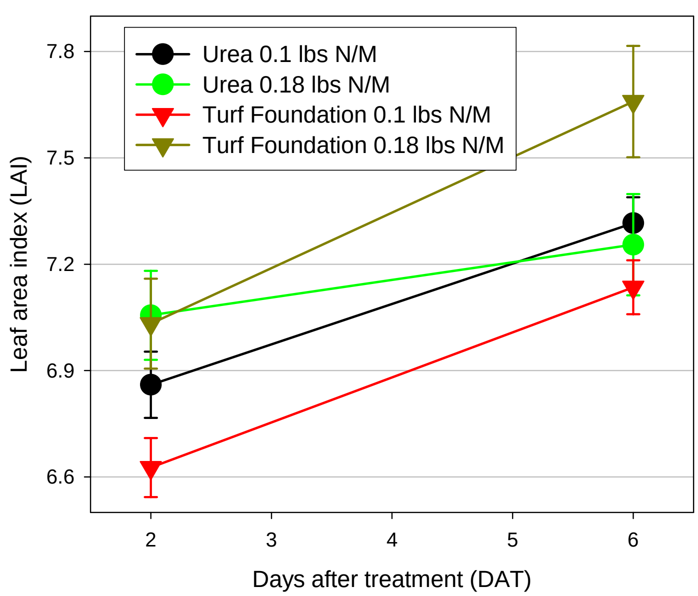


Figure 4 (left). Experiment leaf area index (LAI), by N rate, fertilizer, and days after treatment (DAT). Each symbol represents the mean LAI of 3 replications. Means with overlapping error bars are not statistically different.

<u>Experiment 2:</u>

The mean relative dark green color index (relDGCI) of the Penn A4 putting green canopy in Exp. 2 significantly responded to both fertilizer rate and type (across all collection dates). Increasing N application rates of any/all fertilizer resulted in significant increases in relDGCI over the course of Experiment 2. However, the control micronutrient fortified urea solution fostered significantly better canopy color than the Turf Foundation product at either 0.1 or 0.18 lbs N / 1000ft^2•week rates (Fig. 5). The same was true for the control nutrient solution compared to the Greater Green product at the 0.18 lbs N/ 1000ft^2•week rate (Fig. 5), and at both rates averaged (data not shown).

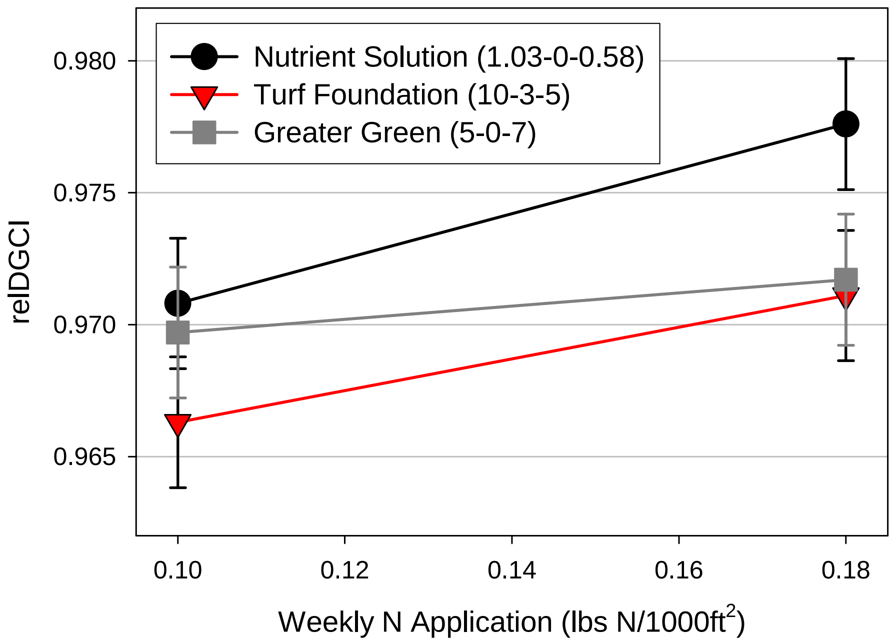


Figure 5 (left). Experiment 2 mean relative dark green color index (relDGCI), by N rate and fertilizer, all dates combined. Each symbol represents the mean relDGCI of 20 independent measures (4 replications over 5 collection dates). Means with overlapping error bars are not statistically different.

Summary

Increasing N rates from 0.1 to 0.18 lbs N/ 1000ft^2•week resulted in greater growth, leaf/shoot density, and color of Penn A4 creeping bentgrass/annual bluegrass putting greens and Penn A4 bentgrass putting greens, regardless of fertilizer type. Despite the inclusion of soybean extract in the Progressive Turf Liquid Products (Turf Foundation and Greater Green), equal N fertilization practice using simple urea solutions provided identical color and growth of Penn A4 creeping bentgrass/annual bluegrass putting greens at either rate (Exp. 1). In only one brief occasion did Turf Foundation (0.18 lbs N rate) significantly enhance Penn A4 creeping bentgrass/annual bluegrass putting green density compared to urea (Exp. 1; June 25), likely the result of greater comparative potassium and/or phosphorous fertilizer concentration in Turf Foundation (Table 1). On the five dates of the Penn A4 bentgrass putting green evaluation (Exp. 2), the control micronutrient fortified urea solution significantly increased canopy color compared to both Progressive Turf products at the 0.18 lbs N/ 1000ft^2 rates, and the Turf Foundation product at the 0.1 lbs N/ 1000ft^2 rates. The favorable performance observed of the fortified urea control nutrient solution occurred despite lesser micronutrient concentrations compared to the Greater Green product (Exp. 2; Table 1).

Acknowledgements

The author recognizes the generous in-kind donation of fertilizers provided by Mr. Ricky Bradshaw, President–Progressive Turf LLC; and thanks the Pennsylvania Turfgrass Council for supporting maintenance & analytical costs associated with the described experiments.

KENTUCKY BLUEGRASS RESPONSE TO SLOW-RELEASE FERTILIZER TREATMENTS: COMPARISONS OF NITROGEN & POTASSIUM AVAILABILITY, NUTRITIONAL QUALITY, AND COLOR

Submitted November 20, 2006 to the Pennsylvania Turfgrass Council

Prepared by: Max Schlossberg, Ph.D., Asst. Prof. of Turfgrass Nutrition & Soil Fertility
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<u>Introduction</u>:

More slow-release fertilizer products are currently available to turfgrass mangers than ever before. Fertilizer producers employ one or two general mechanisms to regulate nutrient availability following application of their product. The first is use of slowly-degradable coatings to encapsulate immediately available nutrient forms (e.g. sulfur-coated urea N). The second is synthesis of urea, formaldehydes, and/or salts into polymers of various length, solubility, and stability/persistence (e.g. methylene urea N).

Though simplistic, disadvantages of using coats to regulate quickly-available fertilizers are stark. Foremost, coatings add weight to the prill, diluting nutrient content and increasing requisite material application rates. Likewise, coating integrity can be compromised by ‘rough handling’ inherent to bulk fertilizer transport and application. These undesirable traits of coated fertilizers continue to increase interest in homogenous, organic N fertilizer formulations. Considering claims of consistent N-release over an entire season, it has become increasingly important to verify fertilizer performance through replicated and statistically-scrutinized field research.

<u>Experimental Objective:</u>

To evaluate and compare the release patterns of several commercially-available fertilizers over an 85-day (~12 week) field trial by measuring canopy color, growth rate, and nutrient uptake; following a typical, one-time application (1.8 lbs N per 1000 ft^2) to an intensively-maintained Kentucky bluegrass sports turf field (or showcase home lawn).

<u>Field Experimentation and Methods:</u>

<u>Treatments:</u> On April 20, 2006, six similar fertilizer products [Exalt, Expo, MethEx, IBDU, PCU/SCU (coated), and StaGreen (coated)] were applied at a rate of 1.8 lbs N per 1000 ft^2 to four replicated plots (4 x 8 ft, 32 ft^2) of ‘Park’ Kentucky bluegrass, in a randomized complete block design. A control plot was maintained in each block to calculate N recoveries. Associated nutrient delivery rates are presented in Table 1 below.

							Fertilizer					
	N	P_2O_5	K_2O	Fe	S	Fertilizer	N	WIN*	P_2O_5	K_2O	Fe	S
	Fertilizer % mass					lbs applied / 1000 ft^2						
Exalt	25	0	12	0	10.2	7.20	1.8	0.41	0.0	0.86	0.00	0.73
Expo	20	0	25	0	8.5	9.00	1.8	0.59	0.0	2.25	0.00	0.77
IBDU	31	0	0	0	0.0	5.81	1.8	1.61	0.0	0.00	0.00	0.00
MethEx	40	0	0	0	0.0	4.50	1.8	0.56	0.0	0.00	0.00	0.00
PCU/SCU	39	0	0	0	12.0	4.62	1.8	1.71	0.0	0.00	0.00	0.55
StaGreen	29	2	5	1	1.2	6.21	1.8	0.45	0.1	0.31	0.06	0.08

*WIN, water insoluble N

Figure 1. The 2006 Slow-Release Granular Fertilizer Field Trial conducted at the Joseph Valentine Turfgrass Research Center, Penn State University, University Park, PA. Image captured 8 days following experiment initiation (April 28).

Data Collection: Clipping yields (CY) were collected 12, 20, 27, 34, 41, 48, 55, 62, 69, 77 and 85 days after treatment (DAT). Relative clipping yield (RCY; 0-1) was calculated for each plot CY by dividing the observed CY by the maximum CY reported for any given DAT. Tissue collected from plots at 12 and 20 DAT were pooled, ground, and analyzed for nutrient content (henceforth referred to as 16 DAT). This process was repeated on pooled tissue samples from the 41 and 48 DAT yields, and the 69 and 77 DAT yields (henceforth referred to as 44 and 73 DAT, respectively). Clippings collected 55 or 85 DAT were analyzed for tissue N only. Nitrogen uptake (NUP) was calculated as the product of biomass production and mean tissue N (when available). Tissue N was estimated for 27 and 34 DAT clipping yields, and NUP estimated for inclusion in total net NUP estimates. Potassium uptake (KUP) was calculated from data for the 16, 44, and 73 DAT CYs only (KUP estimates were not calculated). High resolution digital images were collected 5, 14, 18, 20, 24, 31, 34, 41, 57, 62, 70, 77 and 85 DAT. Turfgrass color index ratings were calculated using the dark green color index (DGCI) method (Karcher and Richardson, 2003). Relative DGCI (rDGCI) was calculated as described for RCY above.

Field Results:

Initial Nutrient Content, Growth, and Quality:

Nutritional status of Kentucky bluegrass tissue collected 12 to 20 days after treatment (DAT) generally resided within established ranges of sufficiency (data not shown). In the first 3 weeks of the study, nutrients showing the greatest variability in tissue by fertilizer treatment were potassium (K) and sulfur (S). This is not surprising considering IBDU was the only fertilizer devoid of S, while only Exalt, Expo, and StaGreen contained K_2O (Table 1).

Bluegrass Shoot Growth (i.e. Clipping Yield/Biomass Production):
Because several environmental factors (other than nutrient availability) influence shoot growth (e.g. light intensity/quality, soil water availability, temperature), repeated measures of shoot growth over time are best standardized on a per-date basis. Thus, relative clipping yield (RCY) data are used to most clearly represent shoot growth patterns observed over the study. Experiment-wide mean relative clipping yield (RCY) data are shown below (Figure 2).

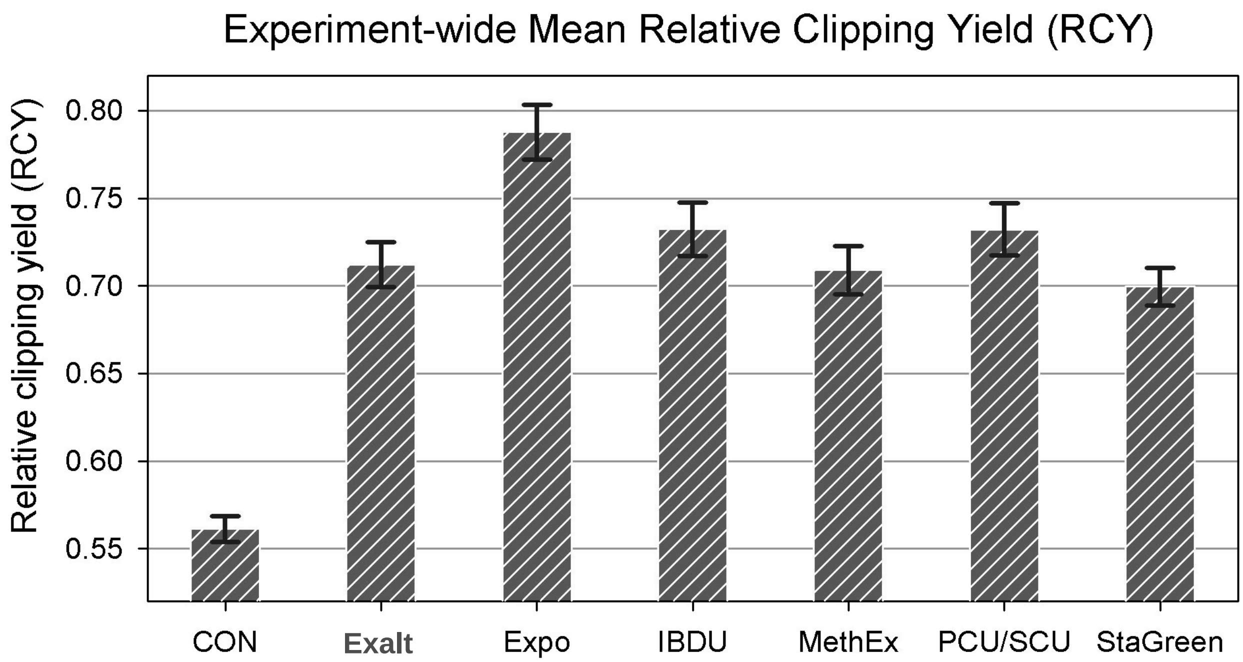


Figure 2. Relative clipping yields (RCY) shown by fertilizer over the 85-day study. Error bars represent the statistically significant range of RCY response for each fertilizer treatment (alpha level = 0.05).

Obvious differences in shoot growth are observed in the mean RCY values. Plots fertilized with Expo demonstrated significantly more growth than all other treatments. Plots treated with IBDU or PCU/SCU demonstrated statistically similar RCY, while a significantly greater rate of shoot growth than StaGreen. Regarding mean RCY across the study, all fertilizer treatments fostered significantly more vigorous shoot growth than the control plots (Fig. 2).

Relative clipping yields (RCY) by DAT are displayed in Figure 3 (next page). In the 12-days following fertilizer application (1.8 lbs N / 1000 ft^2); N release from IBDU or PCU/SCU fertilizers was relatively limited. All other treatments resulted in shoot growth significantly greater than the unfertilized control plots (Fig. 3). MethEx and StaGreen showed identical growth rate 12 and 20 DAT. Shoot growth in all fertilized plots (except IBDU) statistically exceeded that observed in the control plots, 20 DAT. Exalt and Expo plots demonstrated significant growth increases (Fig. 3), a desirable early-season response to N fertilization. Once turfgrass has broken dormancy, shoot growth thickens the canopy, increases area-based photosynthetic assimilation, and facilitates early season weed resistance. Growth-induced canopy thickening and enhanced aesthetic appeal are important late spring season management goals.

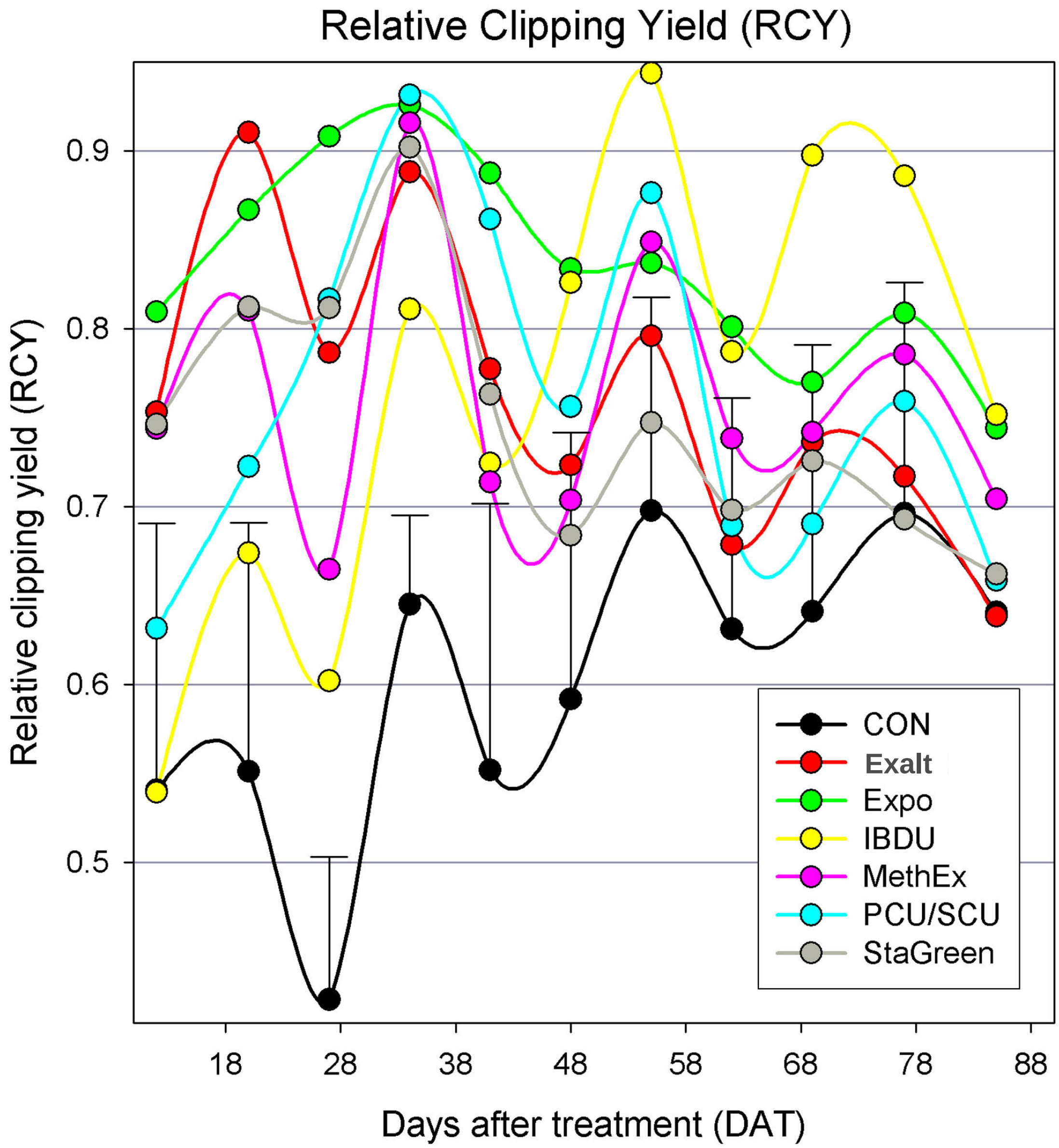


Figure 3. Relative clipping yield (RCY) by fertilizer and day after treatment (DAT). Error bars on control (0 lbs N) symbols represent a range of RCY response NOT significantly different from the control RCY response, for any DAT (alpha level = 0.05). No fertilizer treatment RCY was significantly different from the control RCY at 85 DAT (far right).

In the 25 to 40-days following treatment, all fertilized plots show significantly greater growth than the control plots. Most fertilizers are supplying more N to the Kentucky bluegrass in this period than at any other throughout the study (excepting MethEx and IBDU). Though StaGreen treatment showed identical RCY to MethEx at 12 & 20 DAT, shoot growth of StaGreen treated plots exceeds MethEx at 27 DAT. Between 34 and 40 DAT, availability of N from the Exalt and StaGreen fertilizers appear to wane (Fig. 3). Over the next 45-days, shoot growth in the Exalt and StaGreen treated plots were not significantly different than the control plots; indicating very little N availability from those fertilizers 6 weeks following a 1.8 lbs N / 1000 ft^2 application.

From 48 to 62 DAT, only Expo and IBDU demonstrate significantly greater shoot growth than the control. Compared to Exalt and StaGreen, both PCU/SCU and MethEx treatments demonstrate improved slow-release formulation (delayed N release) during this period, but not with as consistent growth as the Expo and IBDU treatments (Fig. 3). At 68 and 78 DAT, only the IBDU treatment delivers significant levels of N to the Kentucky bluegrass plots, as all other fertilizer treatments fail to stimulate greater growth than no fertilizer treatment at all.

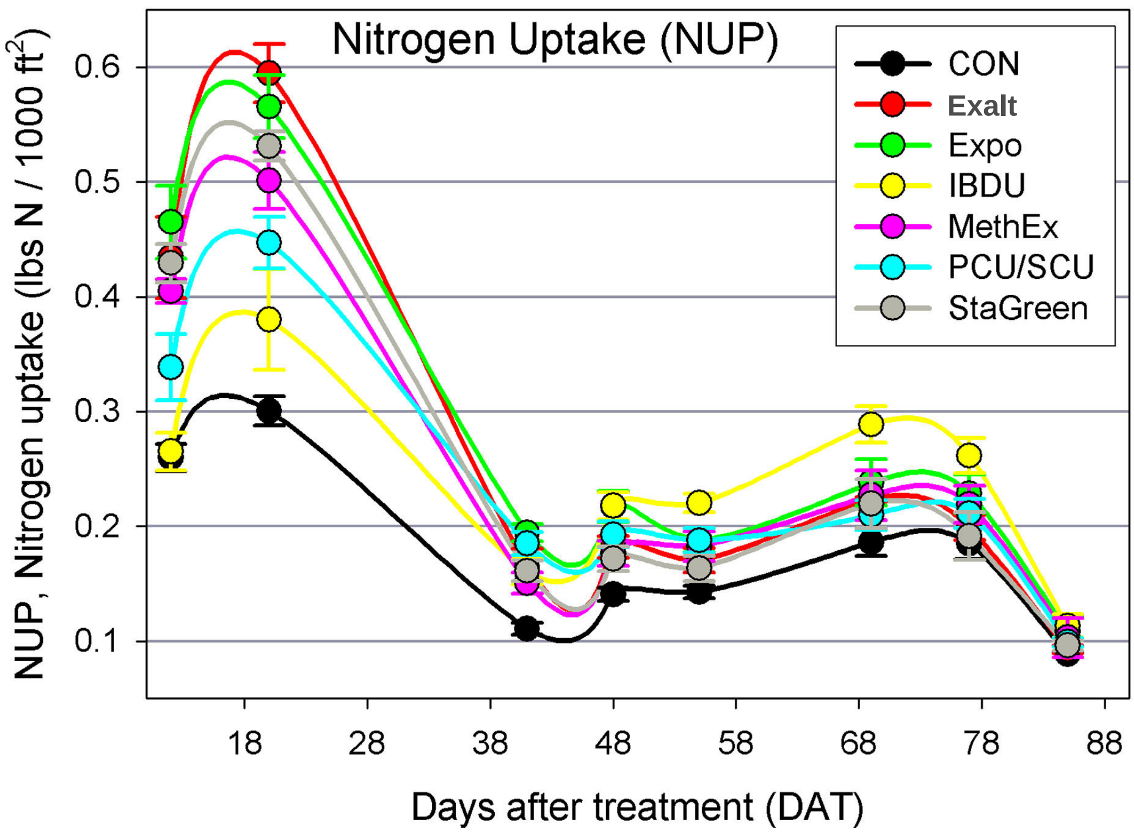


Figure 4. Nitrogen uptake (NUP) by fertilizer and days after treatment (DAT). Error bars represent the statistically significant range of NUP response for each fertilizer treatment (alpha level = 0.05), at any given collection date.

<u>Kentucky Bluegrass Nitrogen Uptake (NUP):</u>
The critical objective of a fertilizer program is consistent, metered N availability through the post application interval. Although most fertilizers demonstrated twice the N availability and uptake during the first 40 days of the trial than in the next 40 days, IBDU was the only fertilizer that demonstrated nearly equally-metered uptake over the 85-day experimental period (Figure 5b).

The fertilizers showing the most NUP (0.65 to 0.85 lbs N / 1000 ft^2) in the first 41 DAT were Exalt, Expo, and StaGreen. This NUP demonstrated by Exalt and StaGreen correlate well with their water-soluble N (WSN) fractions of 77.2 and 75 % (of total N), respectively. However, the comparatively lesser NUP of MethEx at 12 and 20 DAT (Figure 4) did not result in much lesser RCY, yet will likely result in greater N recovery later.

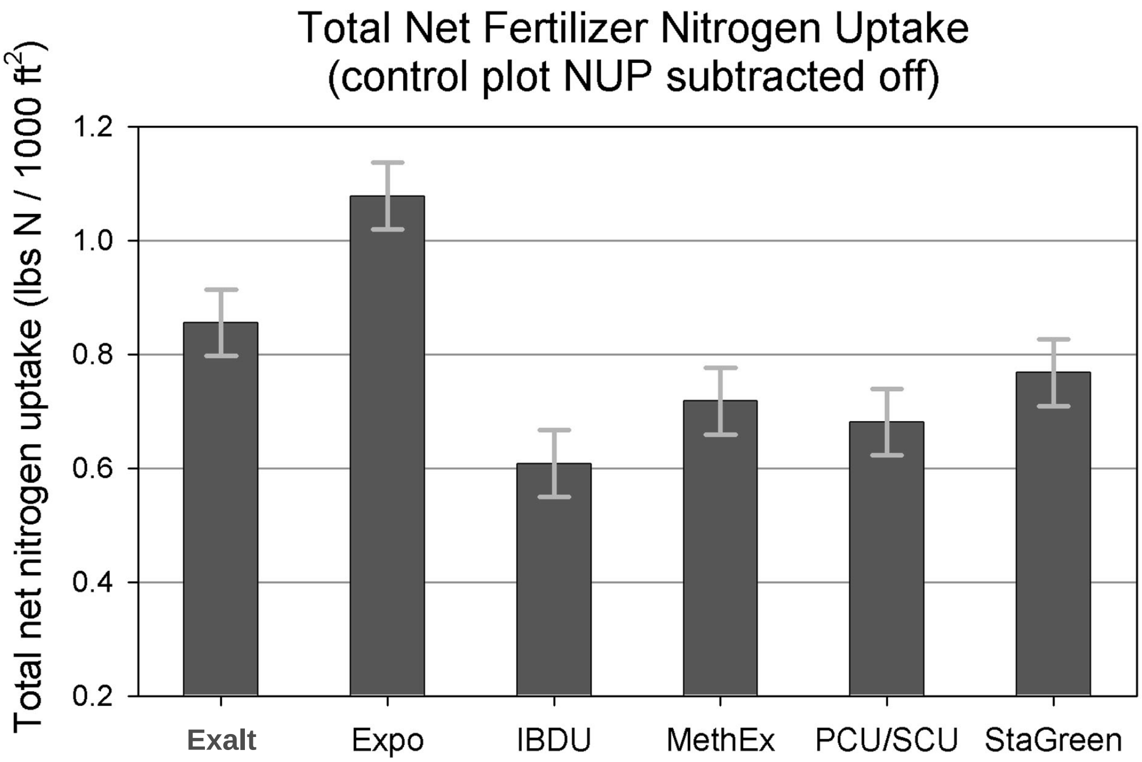
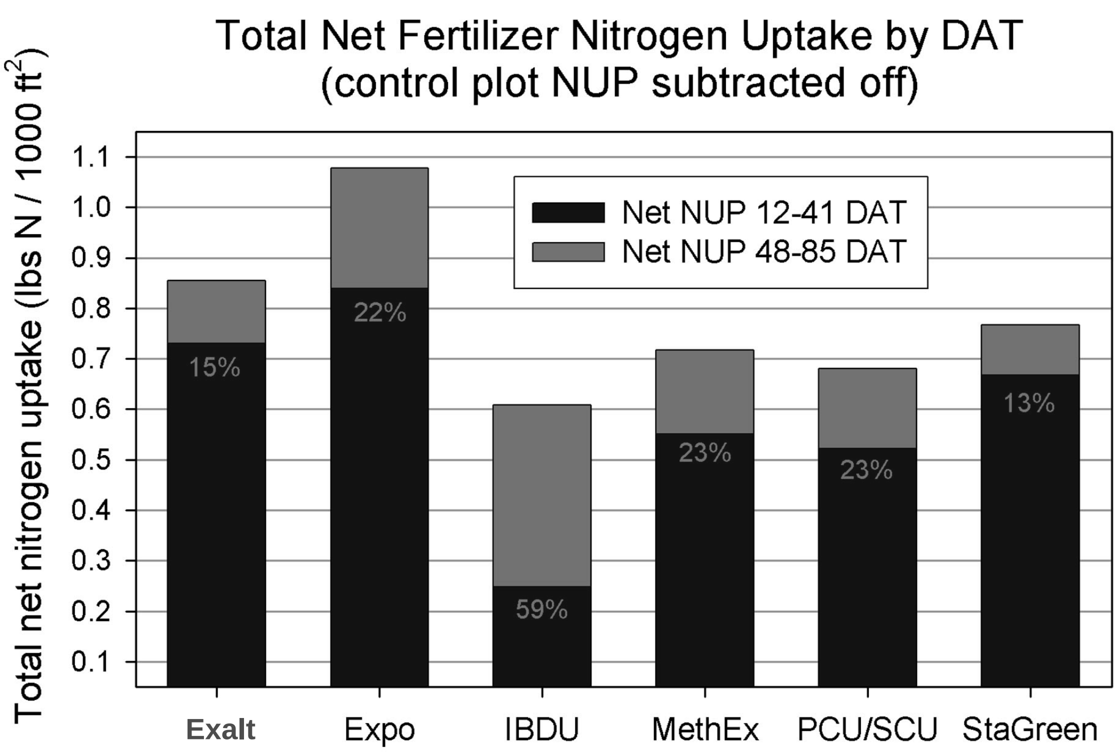


Figure 5. (a; above) Total (experiment-wide) net nitrogen uptake (net NUP) by fertilizer treatment. Error bars represent the statistically significant range of NUP response for each fertilizer treatment (alpha level = 0.05). (b; below) Total NUP by fertilizer by experimental period; where percent NUP occurring 48 to 85 DAT relative to total is shown in light blue.



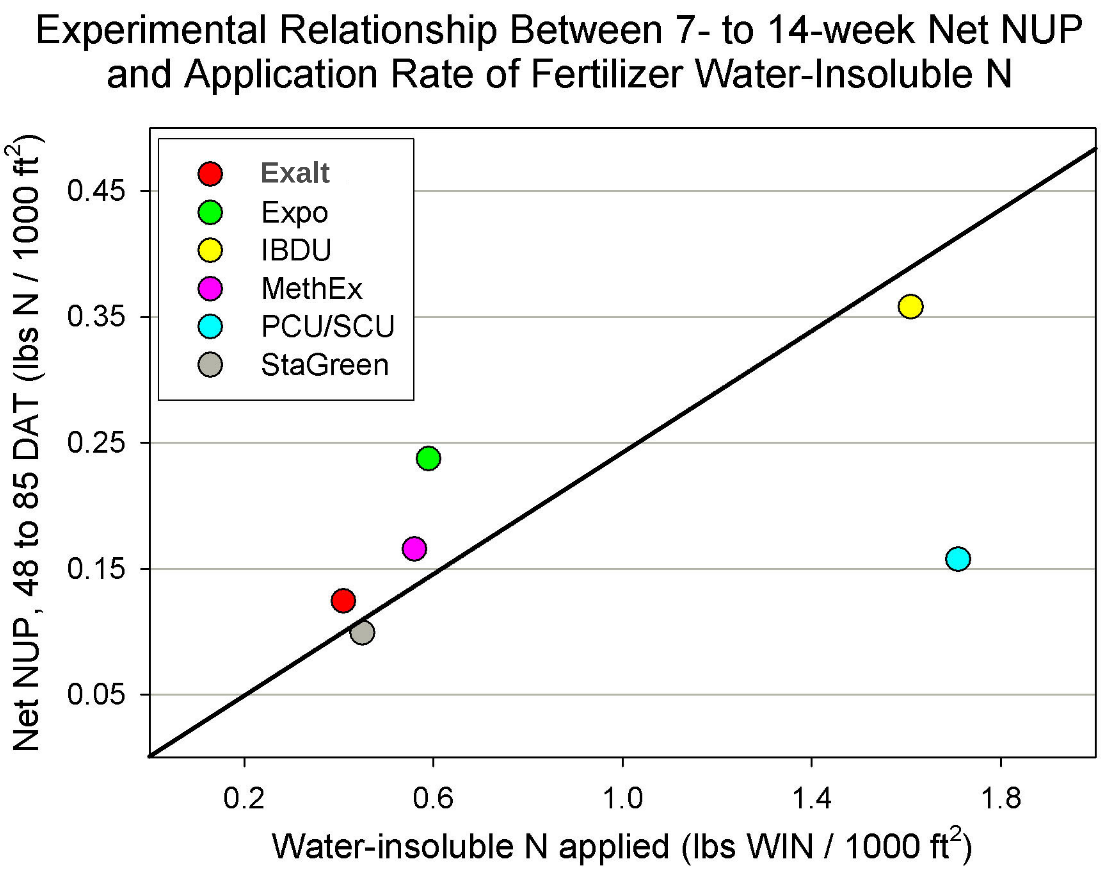


Figure 6. Net nitrogen uptake (NUP, control subtracted) by fertilizer treatment in the 48- to 85-DAT experimental period as related to lbs of water-insoluble N (WIN) applied per 1000 ft^2. The solid black line statistically predicts 48- to 85-day NUP by label WIN (48- to 85-DAT NUP = [0.24314 X lbs WIN applied], r^2=0.737). Fertilizers reporting 'controlled-release N' instead of WIN were not used to calculate the prediction (PCU/SCU and StaGreen).

Although total levels of NUP were similar for PCU/SCU, MethEx, and StaGreen (over the 85-d experiment duration), NUP from the PCU/SCU and MethEx fertilized plots in the 2nd half of the study accounted for 23% of their total, whereas StaGreen treatment resulted in significantly greater 1st half NUP (87%) and lesser N recovery in the 2nd half of the study (Fig. 5b).

Data shown in Figure 6 clearly demonstrates the trend between fertilizer WIN and NUP in the 48 to 85 days after fertilizer application. Kentucky bluegrass recovered 29.5, 30.3, or 40.2 % of WIN from the MethEx, Exalt, or Expo fertilizer applications 48 to 85 DAT, respectively. Only 9 % of PCU/SCU-'controlled release N (CRN)', or 22 % of either IBDU-WIN or StaGreen-CRN was recovered over identical time periods. Net total 85-d recovery of the Expo and Exalt fertilizer treatments are impressive (Figure 5a). Significantly greater fertilizer N was recovered (net NUP) from Expo than any other fertilizer treatment. Exalt fertilization resulted in significantly higher experiment-wide net NUP than IBDU, MethEx, or PCU/SCU (Figure 5a).

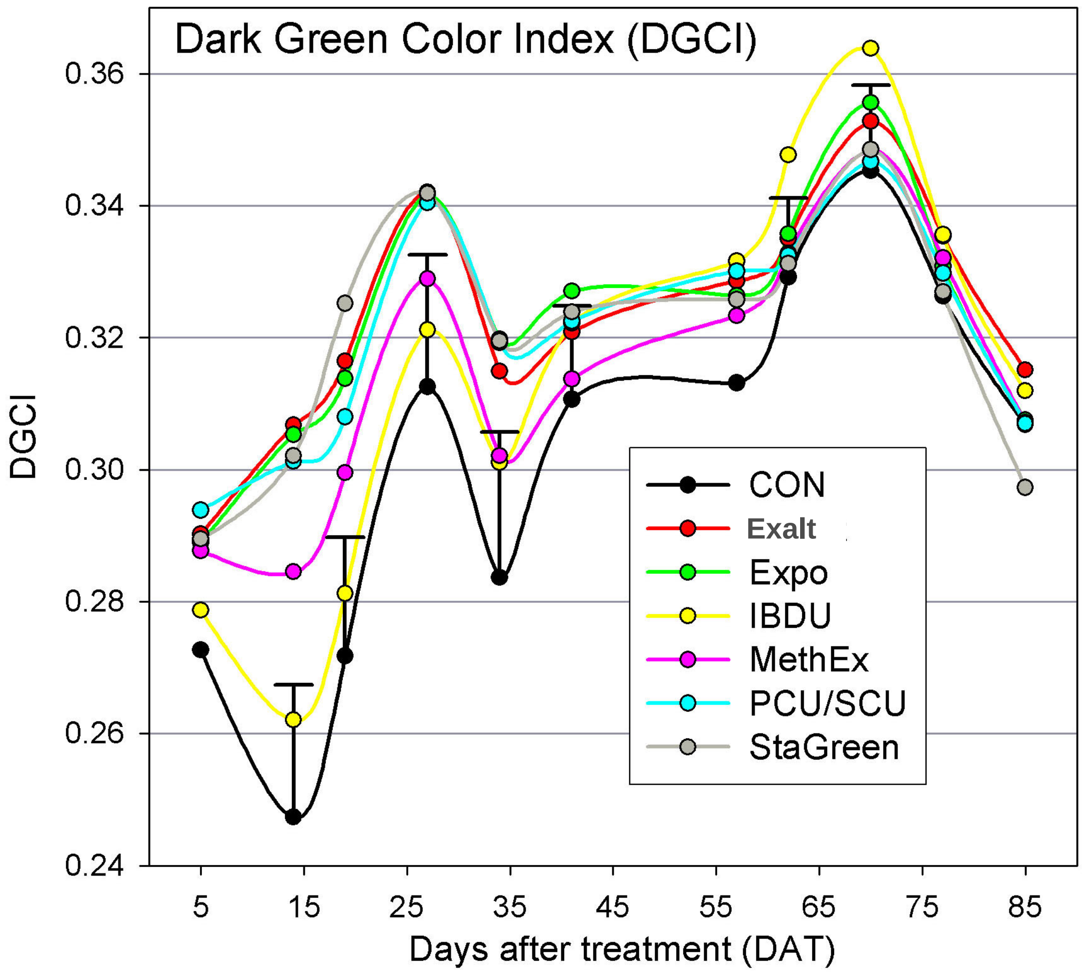


Figure 7. Dark green color index (DGCI) by fertilizer and day after treatment (DAT). Error bars on control (0 lbs N) symbols represent a range of DGCI response NOT significantly different from the control DGCI response, for any DAT (alpha level = 0.05). No fertilizer treatment DGCI significantly differed from the control at 5, 57, 77 or 85 DAT.

<u>Dark Green Color Index (DGCI):</u>

While 13 digital image collections were made over the 12 week study, statistical analysis of DGCI data showed no significant experiment-wide differences between treatments. Daily significant differences in dark green leaf coloration from 5 to 62 DAT are summarized briefly:

- 14 DAT; Exalt, Expo, PCU/SCU, and StaGreen showed significantly better DGCI than IBDU and MethEx.
- 19 DAT; Exalt and StaGreen showed significantly better DGCI than IBDU, MethEx, and PCU/SCU.
- 27 DAT; Exalt, Expo, PCU/SCU, and StaGreen had significantly better DGCI than IBDU.
- 27 DAT; Only PCU/SCU and StaGreen had significantly better DGCI than MethEx.
- 41 DAT; Exalt, Expo, IBDU, PCU/SCU, and StaGreen all showed significantly better DGCI than the MethEx fertilizer treatment.

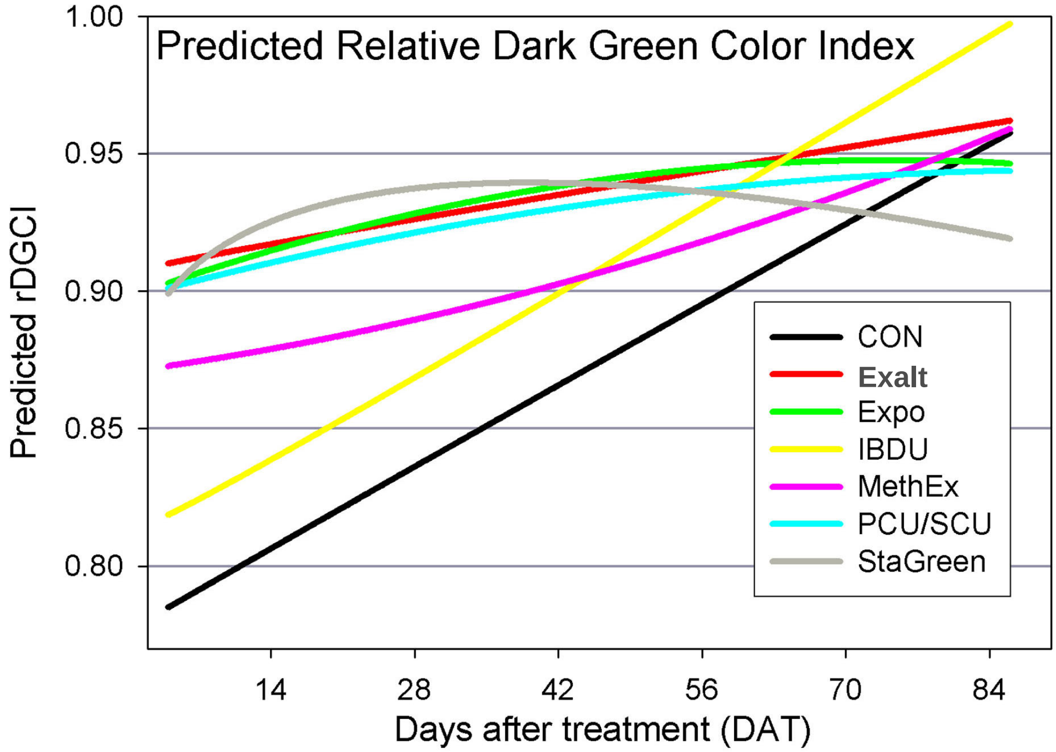
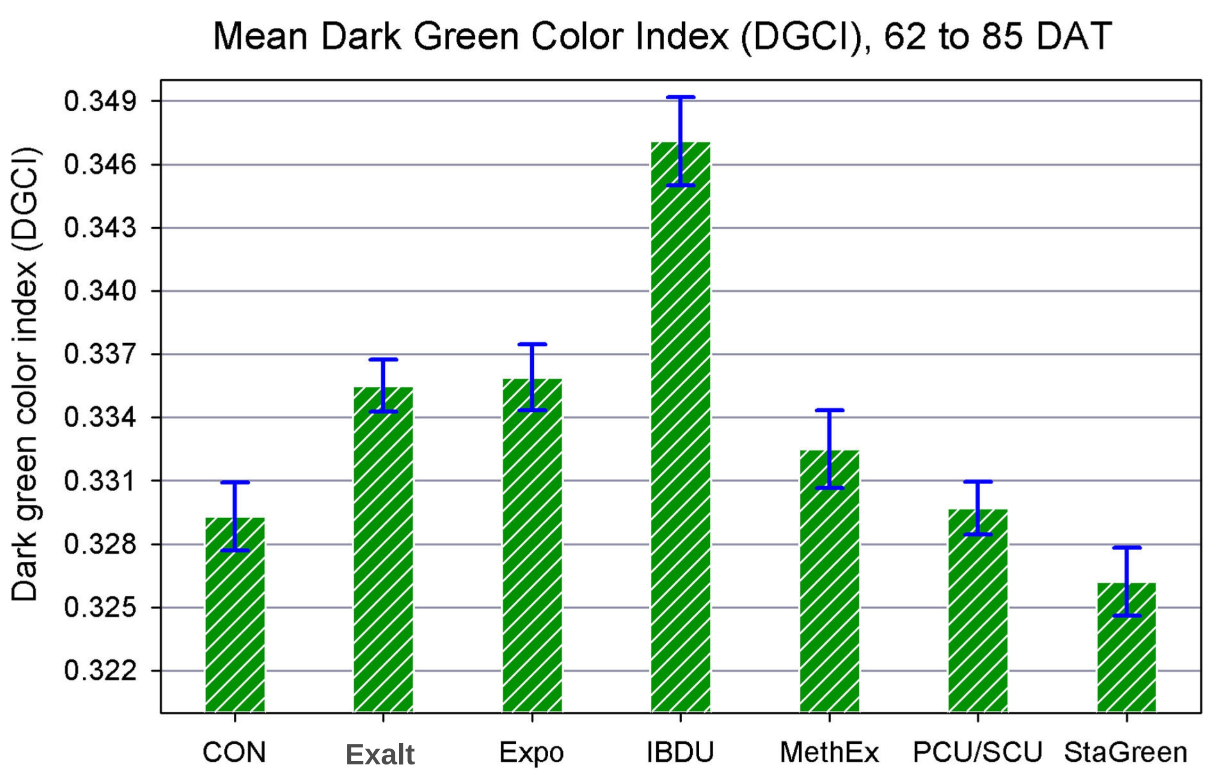


Figure 8. (a; above) Predicted relative dark green color index (rDGCI) by fertilizer and days after treatment (DAT). (b; below) Mean DGCI by fertilizer over the last 3 weeks of the 12 week study (62 to 85 DAT). Error bars represent the statistically significant range of DGCI response for each fertilizer treatment (alpha level = 0.05).



While StaGreen treatment demonstrated significant color improvement over IBDU and MethEx in the 14 to 41 DAT period, the resulting DGCI decreased rapidly over the experimental remainder (Figure 7). Relative DGCI can be a more useful tool for comparing fertilizer treatments over time. The data in Figure 8a shows predictive rDGCI (relative to all fertilizers, for 5-85 DAT) over the experiment period. All fertilizers but PCU/SCU and IBDU show a rapid response to the fertilizer application (5 DAT). However, StaGreen shows a maximum rDGCI near 40 DAT, followed by an exponential decrease in rDGCI. From this data it can be inferred that N availability in the plots treated by StaGreen has significantly decreased compared to all other fertilizer treatments. Expo and PCU/SCU treatments show an asymptotic increase in the second half, with predicted rDGCI falling below the control plots only in the last week of the 85-day trial. Exalt, IBDU, and MethEx were the only fertilizer treatments that demonstrated continual relative DGCI improvement, fostering darker green color than the control plots over the entire trial (Figure 8a).

Statistical evaluation of fertilizer treatment effects on DGCI across all dates can sometimes obscure significant differences that would be apparent over pooled dates. Data in Figure 7 show few significant differences between fertilizer treatments 62, 70, 77, or 85 DAT. However, Figure 8b shows DGCI levels of fertilizer treatments pooled across the last 4 dates (final 3 weeks). The data from this period show DGCI of MethEx, PCU/SCU, and StaGreen treatments to be statistically equivalent to plots receiving no fertilizer treatment at all (control). In this same period, DGCI levels in IBDU treated plots were significantly greater than the control plots as well as all other fertilizer treatments (Figure 8b). Likewise, DGCI of Exalt and Expo treatments were significantly darker in green color than all fertilized and control plots, except IBDU and MethEx (Figure 8b).

Nutrient Concentration and Uptake:

General nutritional status of Kentucky bluegrass was maximized in the initial weeks of the study (data not shown). Tissue N, P, Ca, S, Fe, Mn, and Zn levels decreased over the course of the study for all fertilizer treatments. From 69 to 85 DAT, leaf N levels rapidly decreased from a range of 3.6–4.0 % tissue N to levels generally considered inadequate for optimal bluegrass performance (3.1–3.3 % tissue N). Most micronutrient tissue levels were also comparatively depleted, with iron deficiencies pending.

Leaf potassium (K), the essential nutrient accumulation second only to nitrogen in necessary turfgrass tissue abundance, has been highly correlated to NUP by turfgrass researchers in recent period. Leaf K increased in Kentucky bluegrass with time only in plots fertilized with IBDU, MethEx, or PCU/SCU. Regardless, leaf K levels remained above 2.4 % in all fertilized plots over the course of the study. Leaf K levels in plots fertilized with Expo were significantly greater than all fertilizers except Exalt (16 DAT), and IBDU (73 DAT). At 16 DAT, leaf K levels in Exalt treated plots were significantly greater than all other plots except Expo and StaGreen.

Of greater application than evaluation of tissue K levels by time, is evaluation of total K uptake (KUP) over the experimental period (Figure 9). Potassium sufficiency is an integral component of stress resistant turfgrass, and K_2O application equivalent to N rate (e.g. 5-1-5 analysis ratio) is a recommended practice for maximizing K availability in low organic matter mineral soils and/or low CEC, porous, sand rootzones.

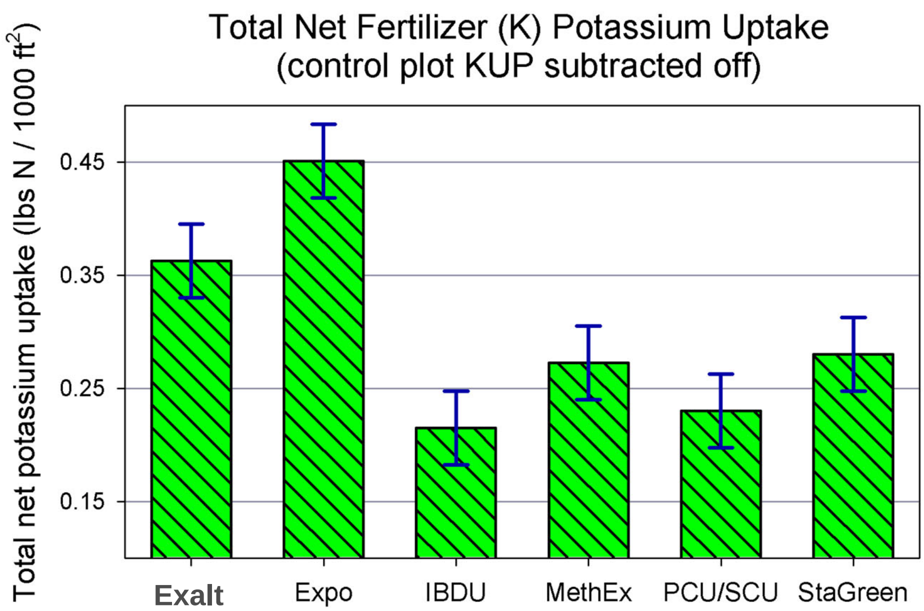


Figure 9. Total (experiment-wide) net potassium uptake (net KUP) by fertilizer treatment. Error bars represent the statistically significant range of KUP response for each fertilizer treatment (alpha level = 0.05).

Data shown in Figure 9 above illustrate significant enhancement of KUP with treatment by fertilizers containing K_2O (Exalt and Expo). A more specific examination of KUP by DAT is presented in Figure 10 (below), and shows the majority of the experiment-wide differences in KUP were gained by Expo and Exalt in the first 3 weeks of the study (Figures 9 and 10). Because K plays an osmoregulative role in turfgrass leaf tissue, it is not found in the more recalcitrant components of leaf clippings. This is significant because the elevated KUP in the early season resulting from the Exalt and Expo fertilizer treatments would be liberated from returned leaf clippings, and cycle in the upper soil profile over the course of the season. However, this nutrient-cycling benefit was not observed in our experimentation, as all leaf clippings were collected and disposed off site.

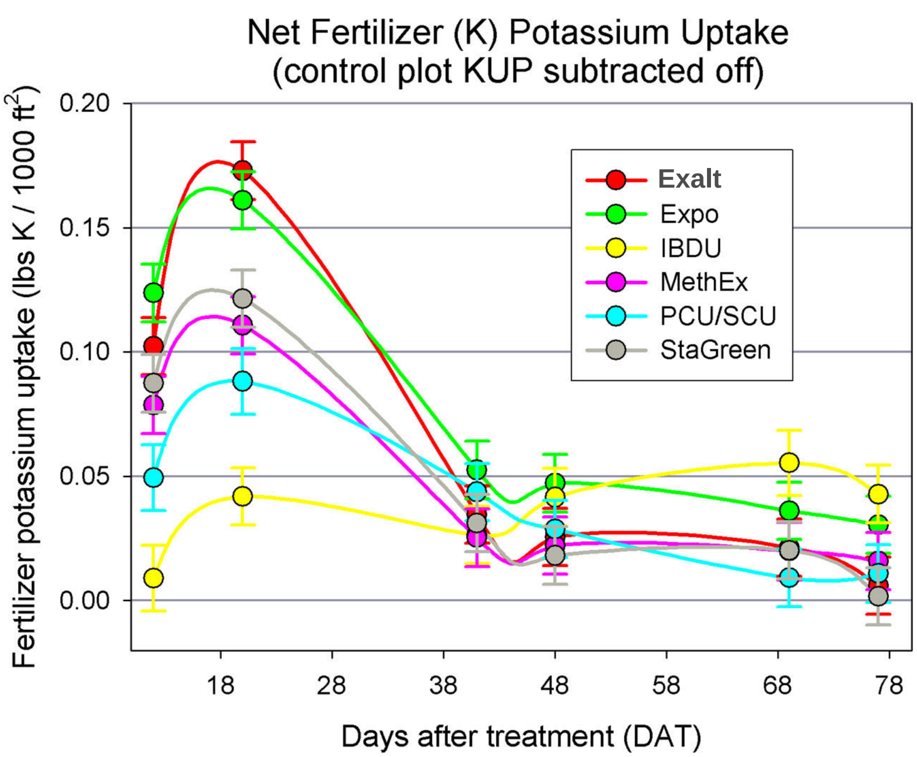


Figure 10. Net potassium uptake (KUP) by fertilizer and days after treatment (DAT). Error bars represent the statistically significant range of KUP response for each fertilizer treatment (alpha level = 0.05), at any given collection date.

Summary of Kentucky Bluegrass Field Study:

Recent research has shown frequent, yet light application of plant-available nitrogen to optimize turfgrass growth/recuperation, stress resistance, and overall plant health; when compared to turfgrasses receiving equal N rates in greater doses on a less frequent basis (Bowman, 2003). Turfgrasses that cycle through alternate periods of nitrogen feast or famine demonstrate short periods of unabated shoot growth, followed by subsequent chlorosis and stunting. In conjunction with proper turfgrass culture, consistent maintenance of N sufficiency in Kentucky bluegrass (3.6-4.6 % leaf N) is likely to facilitate maximum carbohydrate reserves, root-to-shoot ratios, leaf chlorophyll concentrations, and photosynthetic efficiencies.

There are at least two ways to achieve this objective: One is to fertilize turfgrass with available N forms every 3 to 4 days, while the second is to apply a proven slow-release fertilizer product on a pre-determined interval that reliably releases plant-available N forms as they are needed. In management of a showcase home or commercial lawn system, the second is the more cost-effective option. The reported data show variously-formulated fertilizers demonstrate various N release patterns, but one thing that can be agreed upon is the fertilizer treatment that maximizes color and supports moderate growth, consistently over a 3-month period, is the best fertilizer for periodic application to showcase home or commercial lawn systems.

The fertilizers that performed best in this study did not show signs of rapid, intense N release; often indicated by unsustainable, short-term, nitrogen-stimulated shoot growth. The more-effective fertilizer treatments showed total net NUP levels in excess of 0.6 lbs N / 1000 ft^2, yet also resulted in 48-85 DAT NUP levels exceeding 15 % of the total measured net NUP. Moreover, the fertilizer treatments that resulted in elevated RCY and DGCI values in the last month of this study indicate a reliable slow-release formulation compared to those which did not.

These things considered, Expo and Exalt are identified as the primary outperforming fertilizers evaluated. These two fertilizers fostered significantly greater Kentucky bluegrass lawn quality than common alternatives in the 12-weeks following application. Plots treated with StaGreen did show excellent color response in the first month, yet subsequent decreases in growth and color response indicated an abrupt depletion of N supply. While MethEx and IBDU demonstrated consistent growth and NUP across the study duration, the canopy color of the bluegrass treated with these fertilizers fell below acceptable levels in the first 6 weeks of the study.

The top performer of the trial, residing within the top statistical grouping for experiment-wide RCY, NUP, KUP, DGCI (all dates, yet most importantly 62-85 DAT), and having released 40 % of fertilizer WIN between 48 and 85 DAT, was the Expo (20-0-25) granular fertilizer (LebanonTurf Products, Lebanon Seaboard Corp.).

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