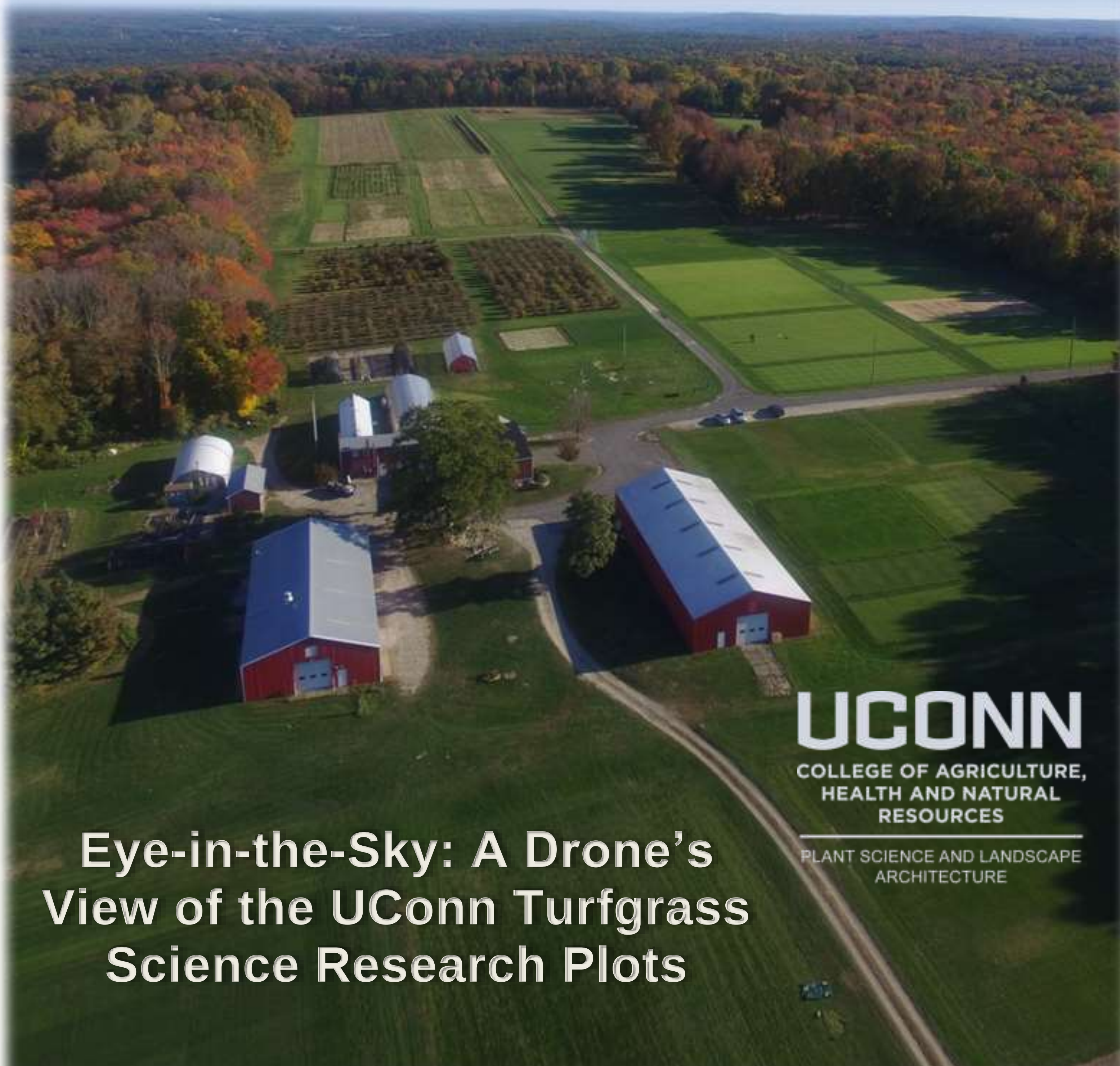
University of Connecticut

College of Agriculture, Health and Natural Resources

2015 Annual Turfgrass Research Report



Eye-in-the-Sky: A Drone's View of the UConn Turfgrass Science Research Plots

Cover photo: Looking south across the University of Connecticut, Department of Plant Science and Landscape Architecture's Research and Teaching Facility as seen from a remote-controlled drone that is being used for imaging research plots and landscape features.

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PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

2015 Annual Turfgrass Research Report Summary

University of Connecticut
College of Agriculture, Health and Natural Resources
Department of Plant Science and Landscape Architecture
Storrs, Connecticut

The University of Connecticut's Annual Turfgrass Research Report is published to provide timely dissemination of current research findings. The purpose of this report is to encourage the exchange of ideas and knowledge between university researchers and members of the turfgrass industry. Research summaries included within this report are designed to provide turfgrass managers, extension specialists, research scientists, and industry personnel with information about current topics related to managing turfgrass.

This report is divided into various sections and includes original research results in the fields of turf pest control (pathology and entomology), athletic field and golf turf maintenance, fertility and nutrient management, and cultivar evaluation and improvement. Additionally, abstracts and citations of scientific publications and presentations published in calendar year 2015 by University of Connecticut turfgrass researchers are included. This information is presented in the hopes of providing current information on relevant research topics for use by members of the turfgrass industry.

Special thanks are given to those individuals, companies, and agencies that provided support to the University of Connecticut's Turfgrass Research, Extension, and Teaching Programs.

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The University of Connecticut Turfgrass Science Program appreciates the support of the turfgrass industry, state and federal agencies, private foundations, and university units and departments. Without your contributions, we would be unable to conduct many of the research projects included in this report. We extend our thanks to all of the individuals and companies who supported turfgrass research and education at the University of Connecticut.

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The University of Connecticut Turfgrass Science Program

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PREVENTIVE ANTHRACNOSE CONTROL ON AN ANNUAL BLUEGRASS PUTTING GREEN TURF, 2015

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INTRODUCTION

Anthracnose (caused by *Colletotrichum cereale*) is a devastating disease of annual bluegrass putting green turf. An integrated disease control program including cultural management and fungicides is required to minimize turf loss due to this disease. Rotational fungicide programs utilizing different chemical modes of action and multi-site fungicides have been found to be most effective in providing season-long anthracnose control. Identifying new fungicides with unique modes of action effective against anthracnose is important to continued control of this disease and resistance management. The objective of this study was to examine the efficacy of experimental and commonly used fungicides for anthracnose control on an annual bluegrass putting green turf.

MATERIALS & METHODS

A field study was conducted on an annual bluegrass (*Poa annua*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed five days wk^{-1} at a bench setting of 0.125-inches. Minimal nitrogen was applied to the study area to encourage anthracnose development. A total of 2.1 lb N $1000\text{-}ft^{-2}$ was applied as water soluble sources from April through 1 August. Overhead irrigation and hand-watering was applied as needed to prevent drought stress. A rotation of Curalan (1.0 oz.) and Emerald (0.18 oz.) was applied 3 times between 13 June and 25 July to prevent dollar spot development; Subdue MAXX (1.0 fl.oz.) was applied preventively for Pythium blight on 9 July. Acelepryn was applied on 6 June for control of annual bluegrass weevil.

Treatments consisted of currently available and developmental fungicides applied individually, or as tank mixes and rotational programs. Initial applications were made on 26 May prior to disease developing in the trial area. Subsequent applications were made every 14-d through 4 August. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9508E flat fan nozzle calibrated to deliver 2 gal $1000\text{-}ft^{-2}$ at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Anthracnose was determined visually as the percent area blighted by *C. cereale* from 14 July through 7 August. Turf quality was visually assessed on a 1 to 9 scale; where 9 represented the best quality turf and 6 was the minimum acceptable level. Phytotoxicity was also assessed visually on a 0 to 5 scale, where 0 was equal to no discoloration and 2 represented the maximum acceptable level of injury. All data were subjected to an analysis of variance and means were separated using Fisher's Protected Least Significant Difference Test. Anthracnose severity data were arcsine, square root, or log-transformed for ANOVA and mean separation tests, means were de-transformed for presentation.

RESULTS AND DISCUSSION

Anthracnose Severity

Anthracnose symptoms were first observed uniformly throughout the trial on 14 July, developing from a natural infestation (Table 1). Disease progressed in untreated control plots reaching ~30% plot area blighted by mid-July and ~60% by early-August. Plots treated with rotational programs 1 through 7, as well as Daconil Action + Appear + Primo Maxx, provided near complete control of disease symptoms for the entirety of the trial, as did plots treated with Autilis or AMV4820G (alone or with the addition of Harrell's Par, a green turf colorant).

Torque and Velista provided good control until late in the trial, when plots reached nearly 20% blighted area. Secure offered some suppression relative to untreated plots, with 20% blighted area in late July compared to over 30% on untreated plots. It was not, however, able to reduce disease to acceptable levels, especially during the peak of the epidemic in early August when blighted area on these plots reached 46%.

Xzemplar, Insignia Intrinsic and Lexicon Intrinsic provided no control of disease at any point in the trial, with plots reaching over 80% blighted area by early August.

Turf Quality and Phytotoxicity

Turf quality was primarily influenced by anthracnose severity and phytotoxicity. Plots treated with Autilis, a PCNB-based fungicide, displayed slight chlorosis (i.e., phytotoxicity) in the days immediately following application, however this effect faded a few days later. No phytotoxicity was observed in Autilis + Harrell's Par, indicating that the phytotoxic effect was minor enough to be hidden by a green pigment.

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Table 1. Anthracnose severity influenced by various fungicides applied preventatively to annual bluegrass putting green turf at the Plant Science Research Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	App Codes[z]	Anthracnose Severity 14 Jul	19 Jul	24 Jul	30 Jul	7 Aug
			---------------------------% plot area blighted-------------------------				
Rotation 1: Signature Xtra	4.0 oz.	ACEGIK	0.0[y] d[x]	0.0[w] d	0.0[v] e	0.0[w] f	0.6 e
-Mirage	1.0 fl.oz.	AEI					
-Daconil Ultrex	3.2 oz.	CGK					
Rotation 2: Chipco Signature	4.0 oz.	ACEGIK	0.0 d	0.1 cd	0.4 e	0.1 f	1.6 e
-Mirage	1.0 fl.oz.	AEI					
-Daconil Ultrex	3.2 oz.	CGK					
Rotation 3: Signature Xtra	4.0 oz.	ACEGIK	0.0 d	0.0 d	0.2 e	0.0 f	0.3 e
-Daconil Ultrex	3.2 oz.	AEI					
-Mirage	1.0 fl.oz.	CK					
-Insignia SC	0.7 fl.oz.	G					
Rotation 4: Signature Xtra	4.0 oz.	ACEGIK	0.0 d	0.0 d	0.0 e	0.0 f	0.9 e
-Daconil Ultrex	3.2 oz.	AEI					
-Exteris Stressguard	1.0 fl.oz.	CK					
-Insignia SC	0.7 fl.oz.	G					
Daconil Action	3.5 fl.oz.	ACEGIK	0.0 d	0.0 d	0.0 e	0.0 f	0.0 e
+Appear	6.0 fl.oz.						
+Primo Maxx	0.125 fl.oz.						
Rotation 5: Appear	6.0 fl.oz.	ACEGIK	0.0 d	0.0 d	0.1 e	0.0 f	0.0 e
+Primo Maxx	0.125 fl.oz.	ACEGIK					
-Daconil Action	3.5 fl.oz.	AEI					
-Velista	0.5 oz.	CGK					
Rotation 6: Appear	6.0 fl.oz.	ACEGIK					
+Daconil Action	3.5 fl.oz.	ACEGIK	0.0 d	0.0 d	0.0 e	0.0 f	0.0 e
+Primo Maxx	0.125 fl.oz.	ACEGIK					
-Velista	0.5 oz.	AEI					
-Briskway	0.5 fl.oz.	CGK					
Xzemplar	0.21 fl.oz.	ACEGIK	3.4 a	30.3 a	47.2 ab	53.1 b	80.0 a
Insignia Intrinsic	0.5 fl.oz.	ACEGIK	1.1 bc	30.1 a	58.3 a	70.3 a	86.3 a
Lexicon Intrinsic	0.375 fl.oz.	ACEGIK	3.9 a	28.9 a	44.2 ab	59.5 ab	85.0 a
Secure	0.5 fl.oz.	ACEGIK	1.1 bc	10.1 b	19.9 c	27.6 c	46.3 c

Continued on following page.

Continued from Table 1.

Treatment	Rate per 1000ft^2	App Codes	Anthracnose Severity 14 Jul	19 Jul	24 Jul	30 Jul	7 Aug
			--------------------------% plot area blighted------------------------				
Autilus	6.0 fl.oz.	ACEGIK	0.0 d	0.0 d	0.0 e	0.0 f	0.5 e
+Harrell's Par	0.37 fl.oz.						
AMV4820G	4.0 fl.oz.	ACEGIK	0.0 d	0.0 d	0.0 e	0.0 f	0.3 e
+Harrell's Par	0.37 fl.oz.						
AMV4820G	6.0 fl.oz.	ACEGIK	0.0 d	0.0 d	0.2 e	0.8 ef	0.5 e
+Harrell's Par	0.37 fl.oz.						
AMV4820G	8.0 fl.oz.	ACEGIK	0.0 d	0.0 d	0.1 e	0.2 f	0.3 e
+Harrell's Par	0.37 fl.oz.						
Torque	0.6 fl.oz.	ACEGIK	0.1 d	0.7 cd	2.4 de	7.9 d	18.5 d
Velista	0.5 oz.	ACEGIK	0.3 cd	1.9 c	7.0 d	7.5 d	18.8 d
Rotation 7: AMV4820G	8.0 fl.oz	AK	0.0 d	0.0 d	0.0 e	0.3 ef	0.3 e
-Harrell's Par	0.37 fl.oz.	AK					
-Daconil Ultrex	3.25 oz.	CG					
-Chipco Signature	4.0 oz.	EI					
-Velista	0.5 oz.	E					
-Affirm	4.0 oz.	G					
-Medallion	0.33 oz.	I					
Autilus	6.0 fl.oz.	ACEGIK	0.0 d	0.0 d	1.4 e	3.3 de	6.3 de
Untreated			1.3 b	26.1 a	34.2 b	53.3 b	66.3 b
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001	0.0001
Most Recent Application			G	G	I	I	K
Days Since Application			6	11	2	8	3

[z]Treatments were initiated on 26 May, prior to disease development. Application dates and corresponding letter codes were as follows: A=26 May; C=10 June; E=24 June; G=8 July; I=22 July; K=4 August.

[y]Data were log-transformed, means are back-calculated for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

[w]Data were arc-sin transformed, means are back-calculated for presentation.

[v]Data were square-root transformed, means are back-calculated for presentation.

Table 2a. Turf quality affected by various fungicides applied preventatively to annual bluegrass putting green turf at the Plant Science Research Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	App Codes[z]	Turf Quality 29 May	5 Jun	13 Jun	19 Jun	26 Jun
			-------------------------0-9; 6=min acceptable------------------------				
Rotation 1: Signature Xtra	4.0 oz.	ACEGIK	7.5 ab[y]	8.5 ab	8.5 ab	8.3 abc	9.0 a
-Mirage	1.0 fl.oz.	AEI					
-Daconil Ultrex	3.2 oz.	CGK					
Rotation 2: Chipco Signature	4.0 oz.	ACEGIK	6.5 c-f	7.8 cde	7.5 cde	7.5 def	8.3 bc
-Mirage	1.0 fl.oz.	AEI					
-Daconil Ultrex	3.2 oz.	CGK					
Rotation 3: Signature Xtra	4.0 oz.	ACEGIK	7.8 a	8.0 bcd	8.8 a	8.8 a	9.0 a
-Daconil Ultrex	3.2 oz.	AEI					
-Mirage	1.0 fl.oz.	CK					
-Insignia SC	0.7 fl.oz.	G					
Rotation 4: Signature Xtra	4.0 oz.	ACEGIK	6.8 b-e	8.5 ab	8.5 ab	8.5 ab	8.8 ab
-Daconil Ultrex	3.2 oz.	AEI					
-Exteris Stressguard	1.0 fl.oz.	CK					
-Insignia SC	0.7 fl.oz.	G					
Daconil Action	3.5 fl.oz.	ACEGIK	7.0 a-d	8.8 a	7.5 cde	8.0 bcd	7.8 cd
+Appear	6.0 fl.oz.						
+Primo Maxx	0.125 fl.oz.						
Rotation 5: Appear	6.0 fl.oz.	ACEGIK	6.3 def	7.8 cde	8.0 abc	8.5 ab	8.8 ab
+Primo Maxx	0.125 fl.oz.	ACEGIK					
-Daconil Action	3.5 fl.oz.	AEI					
-Velista	0.5 oz.	CGK					
Rotation 6: Appear	6.0 fl.oz.	ACEGIK	6.5 c-f	8.3 abc	7.8 bcd	8.0 bcd	8.5 ab
+Daconil Action	3.5 fl.oz.	ACEGIK					
+Primo Maxx	0.125 fl.oz.	ACEGIK					
-Velista	0.5 oz.	AEI					
-Briskway	0.5 fl.oz.	CGK					
Xzemplar	0.21 fl.oz.	ACEGIK	6.8 b-e	7.3 efg	6.8 efg	7.0 f	7.0 e
Insignia Intrinsic	0.5 fl.oz.	ACEGIK	6.5 c-f	7.3 efg	7.3 c-f	7.8 cde	7.3 de
Lexicon Intrinsic	0.375 fl.oz.	ACEGIK	6.5 c-f	7.5 def	6.8 efg	7.3 ef	7.3 de
Secure	0.5 fl.oz.	ACEGIK	6.5 c-f	6.8 g	7.0 d-g	7.3 ef	7.0 e
Autilus	6.0 fl.oz.	ACEGIK	7.5 ab	8.8 a	8.8 a	8.8 a	8.8 ab
+Harrell's Par	0.37 fl.oz.						
AMV4820G	4.0 fl.oz.	ACEGIK	7.5 ab	8.3 abc	8.5 ab	8.5 ab	8.8 ab
+Harrell's Par	0.37 fl.oz.						
AMV4820G	6.0 fl.oz.	ACEGIK	7.3 abc	8.3 abc	8.8 a	8.0 bcd	8.8 ab
+Harrell's Par	0.37 fl.oz.						
AMV4820G	8.0 fl.oz.	ACEGIK	7.0 a-d	7.5 def	8.5 ab	7.5 def	8.5 ab
+Harrell's Par	0.37 fl.oz.						
Torque	0.6 fl.oz.	ACEGIK	5.8 f	7.0 fg	6.5 fg	7.0 f	7.3 de
Velista	0.5 oz.	ACEGIK	6.5 c-f	7.0 fg	7.0 d-g	7.3 ef	7.8 cd
Rotation 7: AMV4820G	8.0 fl.oz.	AK	7.0 a-d	8.3 abc	7.3 c-f	8.0 bcd	8.3 bc
-Harrell's Par	0.37 fl.oz.	AK					
-Daconil Ultrex	3.25 oz.	CG					
-Chipco Signature	4.0 oz.	EI					
-Velista	0.5 oz.	E					
-Affirm	4.0 oz.	G					
-Medallion	0.33 oz.	I					
Autilus	6.0 fl.oz.	ACEGIK	6.0 ef	7.8 cde	6.3 g	7.3 ef	7.3 de
Untreated			6.8 b-e	7.3 efg	7.3 c-f	7.0 f	7.3 de
ANOVA: Treatment (P > F)			0.0010	0.0001	0.0001	0.0001	0.0001
Most Recent Application			A	A	C	C	E
Days Since Application			3	9	3	9	2

[z]Treatments were initiated on 26 May, prior to disease development. Application dates and corresponding letter codes were as follows: A=26 May; C=10 June; E=24 June; G=8 July; I=22 July; K=4 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2b. Turf quality affected by various fungicides applied preventatively to annual bluegrass putting green turf at the Plant Science Research Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	App Codes[z]	Turf Quality			
			14 Jul	17 Jul	24 Jul	7 Aug
			0-9; 6=min acceptable			
Rotation 1: Signature Xtra	4.0 oz.	ACEGIK	8.2 ab[y]	8.5 abc	8.5 abc	7.3 cd
-Mirage	1.0 fl.oz.	AEI				
-Daconil Ultrex	3.2 oz.	CGK				
Rotation 2: Chipco Signature	4.0 oz.	ACEGIK	6.5 de	7.0 efg	8.0 bc	6.8 d
-Mirage	1.0 fl.oz.	AEI				
-Daconil Ultrex	3.2 oz.	CGK				
Rotation 3: Signature Xtra	4.0 oz.	ACEGIK	8.7 ab	9.0 a	9.0 a	8.5 ab
-Daconil Ultrex	3.2 oz.	AEI				
-Mirage	1.0 fl.oz.	CK				
-Insignia SC	0.7 fl.oz.	G				
Rotation 4: Signature Xtra	4.0 oz.	ACEGIK	8.2 ab	9.0 a	9.0 a	9.0 a
-Daconil Ultrex	3.2 oz.	AEI				
-Exteris Stressguard	1.0 fl.oz.	CK				
-Insignia SC	0.7 fl.oz.	G				
Daconil Action	3.5 fl.oz.	ACEGIK	7.7 bc	8.5 abc	8.8 ab	8.5 ab
+Appear	6.0 fl.oz.					
+Primo Maxx	0.125 fl.oz.					
Rotation 5: Appear	6.0 fl.oz.	ACEGIK	8.0 ab	8.8 ab	8.3 abc	9.0 a
+Primo Maxx	0.125 fl.oz.	ACEGIK				
-Daconil Action	3.5 fl.oz.	AEI				
-Velista	0.5 oz.	CGK				
Rotation 6: Appear	6.0 fl.oz.	ACEGIK	8.0 ab	8.8 ab	8.3 abc	8.5 ab
+Daconil Action	3.5 fl.oz.	ACEGIK				
+Primo Maxx	0.125 fl.oz.	ACEGIK				
-Velista	0.5 oz.	AEI				
-Briskway	0.5 fl.oz.	CGK				
Xzemplar	0.21 fl.oz.	ACEGIK	5.2 fg	3.8 i	2.8 fg	1.8 h
Insignia Intrinsic	0.5 fl.oz.	ACEGIK	5.2 fg	4.5 hi	3.0 fg	1.5 h
Lexicon Intrinsic	0.375 fl.oz.	ACEGIK	4.7 g	4.5 hi	2.5 g	1.5 h
Secure	0.5 fl.oz.	ACEGIK	5.2 fg	5.3 h	5.0 e	3.3 g
Autilus	6.0 fl.oz.	ACEGIK	9.0 a	8.8 ab	9.0 a	9.0 a
+Harrell's Par	0.37 fl.oz.					
AMV4820G	4.0 fl.oz.	ACEGIK	8.5 ab	7.8 cde	8.5 abc	8.3 ab
+Harrell's Par	0.37 fl.oz.					
AMV4820G	6.0 fl.oz.	ACEGIK	7.7 bc	8.0 bcd	7.8 c	8.0 bc
+Harrell's Par	0.37 fl.oz.					
AMV4820G	8.0 fl.oz.	ACEGIK	8.7 ab	7.5 def	8.3 abc	7.8 bc
+Harrell's Par	0.37 fl.oz.					
Torque	0.6 fl.oz.	ACEGIK	6.0 ef	6.3 g	5.5 de	3.5 g
Velista	0.5 oz.	ACEGIK	6.0 ef	6.5 g	5.5 de	4.5 f
Rotation 7: AMV4820G	8.0 fl.oz.	AK	7.0 cd	7.8 cde	7.8 c	8.0 bc
-Harrell's Par	0.37 fl.oz.	AK				
-Daconil Ultrex	3.25 oz.	CG				
-Chipco Signature	4.0 oz.	EI				
-Velista	0.5 oz.	E				
-Affirm	4.0 oz.	G				
-Medallion	0.33 oz.	I				
Autilus	6.0 fl.oz.	ACEGIK	6.5 de	6.8 fg	6.3 d	5.5 e
Untreated			5.7 ef	4.5 hi	3.5 f	2.3 h
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001
Most Recent Application			G	G	I	K
Days Since Application			6	9	2	3

[z]Treatments were initiated on 26 May, prior to disease development. Application dates and corresponding letter codes were as follows: A=26 May; C=10 June; E=24 June; G=8 July; I=22 July; K=4 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

Table 3a. Phytotoxicity affected by various fungicides applied preventatively to annual bluegrass putting green turf at the Plant Science Research Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	App Codes[z]	Phytotoxicity 29 May	5 Jun	13 Jun	19 Jun	26 Jun
			------------------0-5; 2=max acceptable-----------------				
Rotation 1: Signature Xtra	4.0 oz.	ACEGIK	0.0	0.0	0.0 b[y]	0.0	0.0
-Mirage	1.0 fl.oz.	AEI					
-Daconil Ultrex	3.2 oz.	CGK					
Rotation 2: Chipco Signature	4.0 oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
-Mirage	1.0 fl.oz.	AEI					
-Daconil Ultrex	3.2 oz.	CGK					
Rotation 3: Signature Xtra	4.0 oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
-Daconil Ultrex	3.2 oz.	AEI					
-Mirage	1.0 fl.oz.	CK					
-Insignia SC	0.7 fl.oz.	G					
Rotation 4: Signature Xtra	4.0 oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
-Daconil Ultrex	3.2 oz.	AEI					
-Exteris Stressguard	1.0 fl.oz.	CK					
-Insignia SC	0.7 fl.oz.	G					
Daconil Action	3.5 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Appear	6.0 fl.oz.						
+Primo Maxx	0.125 fl.oz.						
Rotation 5: Appear	6.0 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Primo Maxx	0.125 fl.oz.	ACEGIK					
-Daconil Action	3.5 fl.oz.	AEI					
-Velista	0.5 oz.	CGK					
Rotation 6: Appear	6.0 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Daconil Action	3.5 fl.oz.	ACEGIK					
+Primo Maxx	0.125 fl.oz.	ACEGIK					
-Velista	0.5 oz.	AEI					
-Briskway	0.5 fl.oz.	CGK					
Xzemplar	0.21 fl.oz.	ACEGIK	0.3	0.0	0.0 b	0.0	0.0
Insignia Intrinsic	0.5 fl.oz.	ACEGIK	0.5	0.0	0.0 b	0.0	0.0
Lexicon Intrinsic	0.375 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
Secure	0.5 fl.oz.	ACEGIK	0.3	0.0	0.1 b	0.0	0.0
Autilus	6.0 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Harrell's Par	0.37 fl.oz.						
AMV4820G	4.0 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Harrell's Par	0.37 fl.oz.						
AMV4820G	6.0 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Harrell's Par	0.37 fl.oz.						
AMV4820G	8.0 fl.oz.	ACEGIK	0.0	0.0	0.0 b	0.0	0.0
+Harrell's Par	0.37 fl.oz.						
Torque	0.6 fl.oz.	ACEGIK	0.5	0.0	0.1 b	0.1	0.0
Velista	0.5 oz.	ACEGIK	0.3	0.0	0.0 b	0.0	0.0
Rotation 7: AMV4820G	8.0 fl.oz.	AK	0.0	0.0	0.0 b	0.0	0.0
-Harrell's Par	0.37 fl.oz.	AK					
-Daconil Ultrex	3.25 oz.	CG					
-Chipco Signature	4.0 oz.	EI					
-Velista	0.5 oz.	E					
-Affirm	4.0 oz.	G					
-Medallion	0.33 oz.	I					
Autilus	6.0 fl.oz.	ACEGIK	0.8	0.0	1.3 a	0.3	0.3
Untreated			0.0	0.0	0.3 b	0.1	0.0
ANOVA: Treatment (P > F)			0.0708	1.0000	0.0001	0.5527	0.4750
Most Recent Application			A	A	C	C	E
Days Since Application			3	9	3	9	2

[z]Treatments were initiated on 26 May, prior to disease development. Application dates and corresponding letter codes were as follows: A=26 May; C=10 June; E=24 June; G=8 July; I=22 July; K=4 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

Table 3b. Phytotoxicity affected by various fungicides applied preventatively to annual bluegrass putting green turf at the Plant Science Research Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	App Codes[z]	Phytotoxicity 14 Jul	17 Jul	24 Jul
			----------0-5; 2=max acceptable--------		
Rotation 1: Signature Xtra	4.0 oz.	ACEGIK	0.0 c[y]	0.0	0.0 c
-Mirage	1.0 fl.oz.	AEI			
-Daconil Ultrex	3.2 oz.	CGK			
Rotation 2: Chipco Signature	4.0 oz.	ACEGIK	0.0 c	0.0	0.0 c
-Mirage	1.0 fl.oz.	AEI			
-Daconil Ultrex	3.2 oz.	CGK			
Rotation 3: Signature Xtra	4.0 oz.	ACEGIK	0.0 c	0.0	0.3 b
-Daconil Ultrex	3.2 oz.	AEI			
-Mirage	1.0 fl.oz.	CK			
-Insignia SC	0.7 fl.oz.	G			
Rotation 4: Signature Xtra	4.0 oz.	ACEGIK	0.0 c	0.0	0.0 c
-Daconil Ultrex	3.2 oz.	AEI			
-Exteris Stressguard	1.0 fl.oz.	CK			
-Insignia SC	0.7 fl.oz.	G			
Daconil Action	3.5 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Appear	6.0 fl.oz.				
+Primo Maxx	0.125 fl.oz.				
Rotation 5: Appear	6.0 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Primo Maxx	0.125 fl.oz.	ACEGIK			
-Daconil Action	3.5 fl.oz.	AEI			
-Velista	0.5 oz.	CGK			
Rotation 6: Appear	6.0 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Daconil Action	3.5 fl.oz.	ACEGIK			
+Primo Maxx	0.125 fl.oz.	ACEGIK			
-Velista	0.5 oz.	AEI			
-Briskway	0.5 fl.oz.	CGK			
Xzemplar	0.21 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
Insignia Intrinsic	0.5 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
Lexicon Intrinsic	0.375 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
Secure	0.5 fl.oz.	ACEGIK	0.1 b	0.0	0.0 c
Autilus	6.0 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Harrell's Par	0.37 fl.oz.				
AMV4820G	4.0 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Harrell's Par	0.37 fl.oz.				
AMV4820G	6.0 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Harrell's Par	0.37 fl.oz.				
AMV4820G	8.0 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
+Harrell's Par	0.37 fl.oz.				
Torque	0.6 fl.oz.	ACEGIK	0.0 c	0.0	0.0 c
Velista	0.5 oz.	ACEGIK	0.0 c	0.0	0.0 c
Rotation 7: AMV4820G	8.0 fl.oz.	AK	0.0 c	0.0	0.0 c
-Harrell's Par	0.37 fl.oz.	AK			
-Daconil Ultrex	3.25 oz.	CG			
-Chipco Signature	4.0 oz.	EI			
-Velista	0.5 oz.	E			
-Affirm	4.0 oz.	G			
-Medallion	0.33 oz.	I			
Autilus	6.0 fl.oz.	ACEGIK	1.0 a	0.0	2.0 a
Untreated			0.0 c	0.0	0.0 c
ANOVA: Treatment (P > F)			0.0001	1.0000	0.0001
Most Recent Application			G	G	I
Days Since Application			6	9	2

[z]Treatments were initiated on 26 May, prior to disease development. Application dates and corresponding letter codes were as follows: A=26 May; C=10 June; E=24 June; G=8 July; I=22 July; K=4 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

PHYTOSAFETY OF VARIOUS PHOSPHITE SALTS APPLIED WITH AND WITHOUT A DMI FUNGICIDE ON A CREEPING BENTGRASS PUTTING GREEN TURF, 2015

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INTRODUCTION

Phosphite fertilizers and fungicides are routinely applied to golf course putting greens throughout the summer months. Fertilizer formulations are marketed to enhance tolerance to abiotic stress; whereas fungicide formulations have been demonstrated to help reduce severity of Pythium, anthracnose, and Microdochium patch.

All phosphites are derived from phosphorous acid, which is neutralized with an alkali metal salt (e.g., potassium hydroxide, sodium hydroxide) to increase the pH to a level safe for application to turfgrass and other plant foliage. Fosetyl-Al is also derived from phosphorous acid, however, its manufacturing process and the active ingredient produced differ from phosphites.

Phosphite applications have been reported to cause phytotoxicity at times, particularly when applied during mid- to late-afternoon, on sunny days with warm temperatures. Turf managers have also reported phytotoxicity occurring when phosphites are tank-mixed with emulsifiable concentrate formulations of plant protectants. Phosphite manufacturer claims suggest that difference among the alkali metal salts, and other inert ingredients contained within commercially available phosphite products make them safer to apply compared to others. The objective of this study was to evaluate phytosafety of various commercially available phosphite salts applied with and without an emulsifiable concentrate formulation of a DMI fungicide on a creeping bentgrass putting green turf.

MATERIALS & METHODS

A field study was conducted on a 'Penn A-4' creeping bentgrass (*Agrostis stolonifera*) putting green turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed five days wk^{-1} at a bench setting of 0.125-inches. A total of 2.75 lb N 1000-ft^{-2} was applied as water soluble sources from April through August. Acelepryn was applied on 6 June to control white grubs. Revolution was applied on 11 July and 8 August to aid in water infiltration. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of various commercially available phosphite salts and a non-pigmented formulation of fosetyl-Al all applied at an equivalent rate of phosphorous acid. Phosphites and fosetyl-Al were applied with and without Banner MAXX at 1.0 fl.oz. 1000-ft^{-2}. Initial applications were made on 29 May, and subsequent applications were made every 14-d through 7 August. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9508E flat fan nozzle calibrated to deliver 2.0 gal 1000-ft^{-2} at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Turf quality was visually assessed on a 1 to 9 scale; where 9 represented the highest quality turf and 6 was the minimum acceptable level. Phytotoxicity was also assessed visually on a 0 to 5 scale; where 0 was equal to no discoloration and 2 represented the maximum acceptable level of injury. Normalized difference vegetative index was determined using a TCM500 (Spectrum Technologies) and recorded as the average of 10 readings per plot. Dollar spot incidence was assessed as a count of individual disease foci within each plot. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Turf Quality , Phytotoxicity, and NDVI

Phosphites applied in the absence of Banner MAXX generally increased turf quality or had no effect compared to the untreated control throughout the duration of the trial (Tables 1a & 1b). Few statistical differences among phosphite treatments applied alone were observed. Similarly, very little phytotoxicity was observed in phosphite treatments without Banner MAXX throughout the trial, and no statistical differences were observed among these treatments (Table 2). NDVI of phosphite treatments without Banner MAXX were generally among the highest throughout the trial (Table 3). However, these treatments only differed from the untreated control on one observation date (19 June) when they increased NDVI.

When Banner MAXX was tank-mixed with phosphites, turf quality was generally reduced compared to phosphites applied alone, and the untreated control (Tables 1a & 1b). However, this effect was not evident until late-July through August, after 5 applications (Table 1b). During this same period of time, Banner MAXX applied alone also had lower, albeit acceptable, turf quality (≥ 6) and minor phytotoxicity (Table 2). DMI fungicides are known to induce growth regulation, and repeat applications on putting greens, particularly during hot summer temperatures, are known to result in purplish-gray discoloration and thinning of the turf canopy. Thus, the reduction in turf quality observed in this study with the phosphite + Banner MAXX treatments appears to be due to the growth regulation effects/phytotoxicity associated with repeat applications of a DMI fungicide rather than phytotoxicity associated with the phosphites. Few subtle differences in turf quality and phytotoxicity between phosphites tank-mixed with Banner MAXX were observed. The most consistent effect observed was that QP fosetyl-Al + Banner MAXX often had lower turf quality and phytotoxicity compared to phosphites treated with Banner MAXX (Tables 1a, 1b, and 2).

Dollar Spot Incidence

As expected, plots treated with Banner MAXX, a DMI fungicide with known activity against dollar spot, contained less disease relative to the untreated control (Table 4). Interestingly, phosphite-only treated plots also demonstrated some dollar spot suppression relative to untreated controls. The level of dollar spot control observed among any of the treatments included in this study would be considered unacceptable for putting green turf. However, it does appear that phosphites may provide some limited disease suppression of dollar spot, but should not be expected to control the disease without being tank-mixed with a dedicated dollar spot fungicide.

SUMMARY

Phosphites applied with and without Banner MAXX throughout the summer months were evaluated for their effect on turf quality and phytosafety. Turf quality of phosphite treated turf, without Banner MAXX, was generally greater or equal to untreated controls. No meaningful level of phytotoxicity was observed in this study when phosphites were applied alone. When phosphites were tank-mixed with Banner MAXX, lower turf quality was observed, after 5 applications, however this is most likely due to the negative growth regulation effects of summer applied DMI's rather than a negative interaction, between phosphites and the fungicide. These results are contradictory to reports from practitioners in the field that phosphites may cause injury to turf when tank-mixed with emulsifiable concentrate formulations of plant protectants. Previous studies conducted at this site have also observed, phytotoxicity associated with phosphites applied alone. However, none was observed this year. It is likely that phytotoxicity attributable to phosphite applications, with or without an emulsifiable concentrate, maybe dependent on prevailing environmental conditions, turf health at the time of application, and the rate of phosphite applied. Despite the results presented here from this one year study, superintendents should be cautious about applying phosphites alone, or tank-mixed with other products, when turf is stressed, and when temperatures are expected to be in excess of 90°F.

Table 1a. Turf quality influenced by various phosphite salts applied with and without a DMI fungicide on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Turf Quality 5 Jun	13 Jun	19 Jun	26 Jun	10 Jul
			1-9; 6=min acceptable				
PK Plus	6.0 fl.oz.	14-d	7.0	8.3	7.8 abc[y]	8.0	8.5 ab
Magellan	2.6 fl.oz.	14-d	7.0	8.0	7.8 abc	7.8	8.8 a
Prudent 42CW	1.95 fl.oz.	14-d	7.5	7.5	7.8 abc	7.8	8.5 ab
Phosphite 30	2.55 fl.oz.	14-d	6.8	7.8	7.5 bc	7.5	8.3 ab
QP Fosetyl-Al	2.58 oz.	14-d	7.3	7.5	8.0 ab	7.8	7.8 bc
PK Plus +Banner MAXX	6.0 fl.oz. 1.0 fl.oz.	14-d	7.8	7.8	8.0 ab	8.0	8.8 a
Magellan +Banner MAXX	2.6 fl.oz. 1.0 fl.oz.	14-d	6.8	8.3	8.3 a	8.5	8.3 ab
Prudent 42CW +Banner MAXX	1.95 fl.oz. 1.0 fl.oz.	14-d	7.0	8.0	7.8 abc	7.8	7.8 bc
Phosphite 30 +Banner MAXX	2.55 fl.oz. 1.0 fl.oz.	14-d	7.0	7.8	7.5 bc	8.0	8.0 abc
QP Fosetyl-Al +Banner MAXX	2.58 oz. 1.0 fl.oz.	14-d	7.0	7.3	7.5 bc	7.3	7.8 bc
Banner MAXX	1.0 fl.oz.	14-d	6.8	8.0	7.3 cd	7.0	7.3 c
Untreated			7.3	7.5	6.8 d	7.3	8.0 abc
ANOVA: Treatment (P > F)			0.1896	0.2778	0.0248	0.0864	0.0499
Days Since Application		14-d	6	2	8	1	1

[z]Treatments were initiated on 29 May, prior to disease development. Subsequent applications were made on a 14-d basis on 11 June, 25 June, 9 July, 23 July , and 7 August

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 1b. Turf quality influenced by various phosphite salts applied with and without a DMI fungicide on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Turf Quality 17 Jul	24 Jul	3 Aug	7 Aug	14 Aug
			1-9; 6=min acceptable				
PK Plus	6.0 fl.oz.	14-d	8.3	8.5 a[y]	8.0 b	8.5 a	7.8 abc
Magellan	2.6 fl.oz.	14-d	8.0	8.3 ab	8.8 a	8.5 a	8.8 a
Prudent 42CW	1.95 fl.oz.	14-d	7.8	8.3 ab	8.3 ab	8.5 a	8.0 ab
Phosphite 30	2.55 fl.oz.	14-d	8.0	8.5 a	8.5 ab	8.5 a	8.5 ab
QP Fosetyl-Al	2.58 oz.	14-d	7.5	8.0 ab	8.3 ab	8.3 a	7.8 abc
PK Plus +Banner MAXX	6.0 fl.oz. 1.0 fl.oz.	14-d	7.8	7.5 bc	7.0 cd	7.3 b	6.0 d
Magellan +Banner MAXX	2.6 fl.oz. 1.0 fl.oz.	14-d	7.0	6.8 cd	6.8 cd	6.8 b	6.3 d
Prudent 42CW +Banner MAXX	1.95 fl.oz. 1.0 fl.oz.	14-d	7.5	6.8 cd	6.8 cd	6.5 b	6.8 cd
Phosphite 30 +Banner MAXX	2.55 fl.oz. 1.0 fl.oz.	14-d	7.0	6.8 cd	7.3 c	6.5 b	6.0 d
QP Fosetyl-Al +Banner MAXX	2.58 oz. 1.0 fl.oz.	14-d	6.5	6.5 d	6.5 d	6.5 b	6.3 d
Banner MAXX	1.0 fl.oz.	14-d	6.8	6.8 cd	6.8 cd	6.8 b	6.3 d
Untreated			7.5	8.3 ab	8.0 b	8.3 a	7.5 bc
ANOVA: Treatment (P > F)			0.0509	0.0001	0.0001	0.0001	0.0001
Days Since Application		14-d	8	1	11	15	7

[z]Treatments were initiated on 29 May, prior to disease development. Subsequent applications were made on a 14-d basis on 11 June, 25 June, 9 July, 23 July , and 7 August

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2. Phytoxicity affected by various phosphite salts applied with and without a DMI fungicide on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Phytotoxicity 5 Jun	13 Jun	19 Jun	26 Jun	10 Jul	24 Jul	7 Aug
			------ 0-5; 2=max acceptable ------						
PK Plus	6.0 fl.oz.	14-d	0.0	0.0	0.0	0.1	0.0 c[y]	0.0 c	0.0 c
Magellan	2.6 fl.oz.	14-d	0.0	0.0	0.0	0.1	0.0 c	0.0 c	0.0 c
Prudent 42CW	1.95 fl.oz.	14-d	0.0	0.0	0.0	0.0	0.0 c	0.3 bc	0.0 c
Phosphite 30	2.55 fl.oz.	14-d	0.0	0.0	0.0	0.0	0.0 c	0.0 c	0.0 c
QP Fosetyl-Al	2.58 oz.	14-d	0.0	0.0	0.0	0.0	0.0 c	0.0 c	0.0 c
PK Plus +Banner MAXX	6.0 fl.oz. 1.0 fl.oz.	14-d	0.0	0.0	0.0	0.5	0.0 c	0.3 bc	1.3 b
Magellan +Banner MAXX	2.6 fl.oz. 1.0 fl.oz.	14-d	0.0	0.0	0.0	0.1	0.4 b	1.3 a	1.5 ab
Prudent 42CW +Banner MAXX	1.95 fl.oz. 1.0 fl.oz.	14-d	0.0	0.0	0.0	0.3	0.5 ab	0.8 ab	1.8 ab
Phosphite 30 +Banner MAXX	2.55 fl.oz. 1.0 fl.oz.	14-d	0.0	0.0	0.0	0.1	0.4 b	0.5 bc	1.8 ab
QP Fosetyl-Al +Banner MAXX	2.58 oz. 1.0 fl.oz.	14-d	0.0	0.0	0.0	0.1	0.4 b	1.3 a	2.0 a
Banner MAXX	1.0 fl.oz.	14-d	0.0	0.0	0.0	0.5	0.8 a	0.3 bc	1.5 ab
Untreated			0.0	0.0	0.0	0.0	0.0 c	0.0 c	0.0 c
ANOVA: Treatment (P > F)			1.0000	1.0000	1.0000	0.1634	0.0006	0.0004	0.0001
Days Since Application		14-d	6	2	8	1	1	1	15

[z]Treatments were initiated on 29 May, prior to disease development. Subsequent applications were made on a 14-d basis on 11 June, 25 June, 9 July, 23 July , and 7 August

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 3. NDVI affected by various phosphite salts applied with and without a DMI fungicide on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	NDVI 19 Jun	26 Jun	17 Jul	24 Jul
			------ Vegetation Index ------			
PK Plus	6.0 fl.oz.	14-d	0.786 ab[y]	0.766	0.788 a	0.804 a
Magellan	2.6 fl.oz.	14-d	0.782 ab	0.772	0.786 ab	0.799 ab
Prudent 42CW	1.95 fl.oz.	14-d	0.782 ab	0.768	0.779 a-d	0.799 ab
Phosphite 30	2.55 fl.oz.	14-d	0.754 ab	0.770	0.786 ab	0.798 abc
QP Fosetyl-Al	2.58 oz.	14-d	0.775 bc	0.769	0.773 cd	0.791 b-e
PK Plus +Banner MAXX	6.0 fl.oz. 1.0 fl.oz.	14-d	0.786 a	0.769	0.775 bcd	0.791 b-e
Magellan +Banner MAXX	2.6 fl.oz. 1.0 fl.oz.	14-d	0.789 a	0.772	0.785 abc	0.788 b-e
Prudent 42CW +Banner MAXX	1.95 fl.oz. 1.0 fl.oz.	14-d	0.787 a	0.772	0.770 d	0.782 de
Phosphite 30 +Banner MAXX	2.55 fl.oz. 1.0 fl.oz.	14-d	0.788 a	0.773	0.780 a-d	0.786 cde
QP Fosetyl-Al +Banner MAXX	2.58 oz. 1.0 fl.oz.	14-d	0.782 ab	0.765	0.772 cd	0.779 e
Banner MAXX	1.0 fl.oz.	14-d	0.783 ab	0.764	0.769 d	0.786 cde
Untreated			0.767 c	0.757	0.781 a-d	0.793 a-d
ANOVA: Treatment (P > F)			0.0089	0.1162	0.0424	0.0055
Days Since Application		14-d	8	1	8	1

[z]Treatments were initiated on 29 May, prior to disease development. Subsequent applications were made on a 14-d basis on 11 June, 25 June, 9 July, 23 July , and 7 August

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 4. Dollar spot incidence influenced by various phosphite salts applied with and without a DMI fungicide on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int[z]	Dollar Spot Incidence 13 Jun	19 Jun	26 Jun
			---------------- # of foci 18ft^{-2}		-----------------
PK Plus	6.0 fl.oz.	14-d	0.9 bc[y]	8.4 bc	14.7 bcd
Magellan	2.6 fl.oz.	14-d	2.9 b	14.1 b	28.1 b
Prudent 42CW	1.95 fl.oz.	14-d	1.6 bc	7.8 bc	24.0 bc
Phosphite 30	2.55 fl.oz.	14-d	1.5 bc	14.0 b	23.9 bc
QP Fosetyl-Al	2.58 oz.	14-d	1.5 bc	8.9 bc	18.4 bcd
PK Plus +Banner MAXX	6.0 fl.oz. 1.0 fl.oz.	14-d	0.2 c	3.0 cd	11.7 cd
Magellan +Banner MAXX	2.6 fl.oz. 1.0 fl.oz.	14-d	1.7 bc	3.4 cd	12.3 cd
Prudent 42CW +Banner MAXX	1.95 fl.oz. 1.0 fl.oz.	14-d	0.4 c	1.2 d	9.5 d
Phosphite 30 +Banner MAXX	2.55 fl.oz. 1.0 fl.oz.	14-d	0.9 bc	3.4 cd	15.9 bcd
QP Fosetyl-Al +Banner MAXX	2.58 oz. 1.0 fl.oz.	14-d	1.6 bc	3.6 cd	16.1 bcd
Banner MAXX	1.0 fl.oz.	14-d	0.2 c	3.3 cd	19.4 bcd
Untreated			14.7 a	38.8 a	53.6 a
ANOVA: Treatment (P > F)			0.0010	0.0001	0.0006
Days Since Application		14-d	2	8	3

[z]Treatments were initiated on 29 May, prior to disease development. Subsequent applications were made on a 14-d basis on 11 June, 25 June, 9 July, 23 July , and 7 August

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

PREVENTIVE BROWN PATCH CONTROL WITH FUNGICIDES AND BIORATIONALS ON A COLONIAL BENTGRASS FAIRWAY TURF, 2015

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INTRODUCTION

Brown patch, caused by *Rhizoctonia solani* is characterized by round patches of diffusely-blighted, thinned turf. It is a summer disease that is most active under warm (nighttime temps ≥ 65° F) and humid conditions. On golf course fairways it is commonly controlled using cultural practices such as avoiding excess nitrogen and improving air movement, as well as through the use of preventative fungicides. The objective of this study was to evaluate the effectiveness of new and existing fungicides and biorational materials at controlling brown patch in a colonial bentgrass fairway turf.

MATERIALS & METHODS

A field study was conducted on an 'SR-7150' colonial bentgrass (*Agrostis capillaris*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed three days wk^{-1} at a bench setting of 0.5-inches. Nitrogen was applied to the study area to encourage brown patch development. A total of 2.75 lb N 1000-ft^{-2} was applied as water soluble sources from April through July. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of fungicides applied individually, or as tank mixes. Initial applications were made on 10 June prior to disease developing in the trial area. Subsequent applications were made at specified treatment intervals through 12 August. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal 1000-ft^{-2} at 40 psi.

Brown patch was assessed visually as a percentage of the plot area blighted by *Rhizoctonia solani*. Turf quality was visually assessed on a 1 to 9 scale; where 9 represented the best quality turf and 6 was the minimum acceptable level. Phytotoxicity was also assessed visually where 0 was equal to no discoloration and 2 represented the maximum acceptable level. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Brown Patch Incidence

Disease severity was slow to begin, but by mid-July it escalated quickly in affected plots as conditions conducive to disease developed (Table 1a + b). However, disease was not uniformly distributed throughout the field. This reduced the ability for statistics to separate some treatment means.

As of 10 July, untreated plots contained about 10 % disease, and Impulse + Omega + Phosphite 30 had 46% disease. Impulse + Omega + Phosphite 30 performed poorly throughout the trial, with severity peaking at nearly 60% at the end of July.

Kabuto (0.4 oz) + UC15-9 (3.75 oz) applied on a 21-d treatment performed better than Kabuto (0.4 oz) + UC15-9 (1.875 oz), with disease only reaching above 10% at the end of August. Disarm-T, Heritage Action, and Heritage WG (all rates and intervals) provided near complete control throughout the trial. There was no difference observed between Heritage formulations.

By mid-August the disease had largely run its course, with sporadic resurgences as conditions allowed. Rating continued through the end of the month to assess residual protection. Several treatments performed quite well even over a week after their reapplication interval, including Velista + Primo Maxx, Kabuto + UC15-8 (14-d), and Heritage WG, all of which were at or close to 0% disease on 28 Aug (23 DAT).

Turf Quality and Phytotoxicity

Turf quality (Table 2) was primarily affected by disease severity and phytotoxicity (Table 3). Primo Maxx-treated plots initially exhibited slight phytotoxicity after the initial application. However, Primo Maxx actually enhanced turf quality on thereafter, as the PGR increased turf density and color relative to other treatments. No phytotoxicity was observed for any of the other treatments. Turf quality was very poor by mid-July on Kabuto + UC15-9 (14-d), Impulse + Omega + Phosphite 30, and untreated plots due to increased disease.

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Table 1a. Brown Patch severity influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015

Treatment	Rate per 1000ft^2	Int[z]	Brown Patch Severity					
			19 Jun	26 Jun	10 Jul	17 Jul	21 Jul	24 Jul
			%					
Velista	0.3 oz.	14-d	0.0	1.1[y] bc[x]	0.0 d	0.3 bc	0.0 e	0.0 d
+Primo Maxx	0.125 fl.oz.							
Secure	0.5 fl.oz.	14-d	0.0	0.0 c	0.6 cd	0.2 bc	0.6 de	0.6 d
+Primo Maxx	0.125 fl.oz.							
Velista	0.3 oz.	14-d	0.0	0.0 c	0.0 d	0.4 bc	0.0 e	0.0 d
-Secure	0.5 fl.oz.							
+Primo Maxx	0.125 fl.oz.							
Kabuto	0.4 fl.oz.	14-d	0.0	0.3 c	0.0 d	0.0 c	0.0 e	0.0 d
+UC15-8	0.15 oz.							
Kabuto	0.4 fl.oz.	21-d	0.8	0.0 c	0.5 cd	0.2 bc	0.3 e	0.0 d
+UC15-8	0.15 oz.							
Kabuto	0.5 fl.oz.	21-d	0.0	0.0 c	0.0 d	0.0 c	0.0 e	0.0 d
+UC15-8	0.1875.oz.							
UC15-8	0.1875 oz.	14-d	0.0	0.0 c	0.3 cd	0.0 c	0.0 e	0.0 d
Kabuto	0.4 fl.oz.	14-d	0.0	0.6 c	15.1 b	18.9 a	17.2 ab	23.7 a
+UC15-9	1.875 fl.oz.							
Kabuto	0.4 fl.oz.	21-d	0.0	1.5 bc	2.5 c	2.2 bc	6.1 bc	7.5 b
+UC15-9	1.875 fl.oz.							
Kabuto	0.5 fl.oz.	21-d	0.0	0.0 c	0.0 d	1.1 bc	2.6 cd	5.1 bc
+UC15-9	3.75 fl.oz.							
UC15-9	3.75 fl.oz.	14-d	0.0	0.6 c	2.2 c	0.4 bc	0.3 e	1.5 cd
Impulse	2.0 fl.oz.	14-d	0.0	7.3 a	46.4 a	40.7 a	44.7 a	58.8 a
+Omega	0.36 fl.oz.							
+Phosphite 30	2.0 fl.oz.							
Disarm T	0.33 fl.oz.	21-d	0.3	0.0 c	0.0 d	0.8 bc	0.7 de	1.0 d
Disarm T	0.44 fl.oz.	21-d	0.0	0.5 c	0.5 cd	0.0 c	0.0 e	0.0 d
Disarm T	0.89 fl.oz.	21-d	0.0	0.0 c	0.0 d	0.0 c	0.0 e	0.0 d
Heritage WG	0.2 oz.	21-d	0.8	0.5 c	0.0 d	0.0 c	0.0 e	0.0 d
Heritage Action	0.2 oz.	21-d	0.5	0.0 c	0.0 d	0.0 c	0.0 e	0.0 d
Heritage WG	…0.3 oz.	28-d	1.0	0.0 c	0.0 d	0.6 bc	0.0 e	0.3 d
Heritage Action	0.3 oz.	28-d	1.3	0.0 c	0.6 cd	0.0 c	0.0 e	0.0 d
Untreated			1.3	5.6 ab	9.8 b	16.4 a	17.2 ab	32.8 a
ANOVA: Treatment ($P > F$)			0.1851	0.0112	0.0001	0.0001	0.0001	0.0001
Days after treatment		14-d	9	1	3	10	14	1
		21-d	9	16	8	15	19	1
		28-d	9	16	3	10	14	17

[z]Treatments were initiated on 10 June, prior to disease development. Subsequent 14-d treatments were made on 10 June, 25 June, 7 July, 23 July, and 5 Aug. Subsequent 21-d treatments were made on 10 June, 2 July, 23 July, and 12 Aug. Subsequent 28-d treatments were made on 10 June, 7 July, and 5 Aug.

[y]Brown Patch data were log transformed; means presented are de-transformed for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

Table 1b. Brown Patch severity influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015

Treatment	Rate per 1000ft²	Int[z]	Brown Patch Severity 14 Aug	21 Aug	28 Aug
			---------- % ----------		
Velista	0.3 oz.	14-d	0.8[y] de[x]	4.2 bcd	0.6 c
+Primo Maxx	0.125 fl.oz.				
Secure	0.5 fl.oz.	14-d	6.2 bc	2.8 cde	16.1 b
+Primo Maxx	0.125 fl.oz.				
Velista	0.3 oz.	14-d	0.0 e	2.6 cde	1.4 c
-Secure	0.5 fl.oz.				
+Primo Maxx	0.125 fl.oz.				
Kabuto	0.4 fl.oz.	14-d	0.0 e	0.0 e	0.0 c
+UC15-8	0.15 oz.				
Kabuto	0.4 fl.oz.	21-d	0.0 e	0.7 de	0.0 c
+UC15-8	0.15 oz.				
Kabuto	0.5 fl.oz.	21-d	0.0 e	0.0 e	0.0 c
+UC15-8	0.1875 oz.				
UC15-8	0.1875 oz.	14-d	0.0 e	0.7 de	0.0 c
Kabuto	0.4 fl.oz.	14-d	16.3 b	25.5 a	53.1 a
+UC15-9	1.875 fl.oz.				
Kabuto	0.4 fl.oz.	21-d	15.2 b	15.6 ab	32.0 ab
+UC15-9	1.875 fl.oz.				
Kabuto	0.5 fl.oz.	21-d	0.6 de	7.8 abc	16.1 b
+UC15-9	3.75 fl.oz.				
UC15-9	3.75 fl.oz.	14-d	2.1 cd	5.1 bcd	24.3 ab
Impulse	2.0 fl.oz.	14-d	48.9 a	14.0 ab	48.8 a
+Omega	0.36 fl.oz.				
+Phosphite 30	2.0 fl.oz.				
Disarm T	0.33 fl.oz.	21-d	0.0 e	0.0 e	0.0 c
Disarm T	0.44 fl.oz.	21-d	0.0 e	0.0 e	0.0 c
Disarm T	0.89 fl.oz.	21-d	0.0 e	0.0 e	0.0 c
Heritage WG	0.2 oz.	21-d	0.0 e	0.0 e	0.0 c
Heritage Action	0.2 oz.	21-d	0.0 e	0.8 de	0.0 c
Heritage WG	…0.3 oz.	28-d	0.0 e	0.0 e	0.0 c
Heritage Action	0.3 oz.	28-d	0.0 e	0.0 e	0.0 c
Untreated			9.2 b	18.9 ab	38.8 ab
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001
Days after treatment		14-d	9	16	23
		21-d	2	9	16
		28-d	9	16	23

[z]Treatments were initiated on 10 June, prior to disease development. Subsequent 14-d treatments were made on 10 June, 25 June, 7 July, 23 July, and 5 Aug. Subsequent 21-d treatments were made on 10 June, 2 July, 23 July, and 12 Aug. Subsequent 28-d treatments were made on 10 June, 7 July, and 5 Aug.

[y]Brown patch data were log transformed; means are de-transformed for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2. Turf Quality influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015

Treatment	Rate per 1000ft²	Int[z]	Turf Quality				
			19 Jun	26 Jun	10 Jul	17 Jul	24 Jul
			------------------------ 0-9; 6=min acceptable ------------------------				
Velista	0.3 oz.	14-d	7.8 de[y]	8.8 ab	8.3 ab	8.3 a	8.5 a
+Primo Maxx	0.125 fl.oz.						
Secure	0.5 fl.oz.	14-d	8.0 cde	9.0 a	7.8 bcd	8.0 ab	8.5 a
+Primo Maxx	0.125 fl.oz.						
Velista	0.3 oz.	14-d	7.5 e	8.8 ab	9.0 a	8.3 a	8.5 a
-Secure	0.5 fl.oz.						
+Primo Maxx	0.125 fl.oz.						
Kabuto	0.4 fl.oz.	14-d	8.8 ab	8.0 a-d	7.8 bcd	7.3 ab	7.3 bcd
+UC15-8	0.15 oz.						
Kabuto	0.4 fl.oz.	21-d	8.8 ab	8.0 a-d	7.8 bcd	7.3 ab	7.8 abc
+UC15-8	0.15 oz.						
Kabuto	0.5 fl.oz.	21-d	9.0 a	8.0 a-d	7.8 bcd	7.3 ab	7.5 a-d
+UC15-8	0.1875 oz.						
Heritage WG	0.1875 oz.	14-d	8.8 ab	8.3 abc	7.8 bcd	7.5 ab	7.8 abc
Kabuto	0.4 fl.oz.	14-d	9.0 a	7.3 cd	5.8 e	5.0 c	5.0 fg
+UC15-9	1.875 fl.oz.						
Kabuto	0.4 fl.oz.	21-d	9.0 a	8.0 a-d	7.0 cd	7.0 b	6.0 ef
+UC15-9	1.875 fl.oz.						
Kabuto	0.5 fl.oz.	21-d	9.0 a	8.0 a-d	7.5 bcd	7.3 ab	6.5 de
+UC15-9	3.75 fl.oz.						
UC15-9	3.75 fl.oz.	14-d	8.3 bcd	7.5 cd	7.3 bcd	7.5 ab	6.8 cde
Impulse	2.0 fl.oz.	14-d	9.0 a	5.8 e	4.0 f	3.8 d	3.3 h
+Omega	0.36 fl.oz.						
+Phosphite 30	2.0 fl.oz.						
Disarm T	0.33 fl.oz.	21-d	8.0 ab	8.0 a-d	6.8 de	7.3 ab	7.0 b-e
Disarm T	0.44 fl.oz.	21-d	9.0 a	7.8 bcd	7.8 bcd	7.8 ab	7.3 bcd
Disarm T	0.89 fl.oz.	21-d	8.8 ab	7.8 bcd	7.8 bcd	7.3 ab	7.3 bcd
Heritage WG	0.2 oz.	21-d	8.8 ab	7.8 bcd	7.8 bcd	7.0 b	7.3 bcd
Heritage Action	0.2 oz.	21-d	8.0 cde	8.0 a-d	7.5 bcd	7.3 ab	7.8 abc
Heritage WG	0.3 oz.	28-d	8.8 ab	8.0 a-d	8.0 abc	7.3 ab	7.5 a-d
Heritage Action	0.3 oz.	28-d	8.5 abc	8.0 a-d	7.8 bcd	7.5 ab	8.0 ab
Untreated			8.3 bcd	7.0 d	6.0 e	5.0 c	4.8 g
ANOVA: Treatment (P > F)			0.0002	0.0002	0.0001	0.0001	0.0001
Days after treatment		14-d	9	1	3	10	1
		21-d	9	16	8	15	1
		28-d	9	16	3	10	17

[z]Treatments were initiated on 10 June, prior to disease development. Subsequent 14-d treatments were made on 10 June, 25 June, 7 July, 23 July, and 5 Aug. Subsequent 21-d treatments were made on 10 June, 2 July, 23 July, and 12 Aug. Subsequent 28-d treatments were made on 10 June, 7 July, and 5 Aug.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

Table 3. Phytotoxicity influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015

Treatment	Rate per 1000ft²	Int[z]	Phytotoxicity 19 Jun	26 Jun	10 Jul	24 Jul
			---------------- 0-5; 2=max acceptable	-----------------		
Velista	0.3 oz.	14-d	0.8 a[y]	0.0	0.0	0.0
+Primo Maxx	0.125 fl.oz.					
Secure	0.5 fl.oz.	14-d	1.0 a	0.0	0.0	0.0
+Primo Maxx	0.125 fl.oz.					
Velista	0.3 oz.	14-d	0.8 a	0.0	0.0	0.0
-Secure	0.5 fl.oz.					
+Primo Maxx	0.125 fl.oz.					
Kabuto	0.4 fl.oz.	14-d	0.0 b	0.0	0.0	0.0
+UC15-8	0.15 oz.					
Kabuto	0.4 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
+UC15-8	0.15 oz.					
Kabuto	0.5 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
+UC15-8	0.1875 oz.					
UC15-8	0.1875 oz.	14-d	0.0 b	0.0	0.0	0.0
Kabuto	0.4 fl.oz.	14-d	0.0 b	0.0	0.0	0.0
+UC15-9	1.875 fl.oz.					
Kabuto	0.4 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
+UC15-9	1.875 fl.oz.					
Kabuto	0.5 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
+UC15-9	3.75 fl.oz.					
UC15-9	3.75 fl.oz.	14-d	0.0 b	0.0	0.0	0.0
Impulse	2.0 fl.oz.	14-d	0.0 b	0.0	0.0	0.0
+Omega	0.36 fl.oz.					
+Phosphite 30	2.0 fl.oz.					
Disarm T	0.33 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
Disarm T	0.44 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
Disarm T	0.89 fl.oz.	21-d	0.0 b	0.0	0.0	0.0
Heritage WG	0.2 oz.	21-d	0.0 b	0.0	0.0	0.0
Heritage Action	0.2 oz.	21-d	0.0 b	0.0	0.0	0.0
Heritage WG	0.3 oz.	28-d	0.0 b	0.0	0.0	0.0
Heritage Action	0.3 oz.	28-d	0.0 b	0.0	0.0	0.0
Untreated			0.0 b	0.0	0.0	0.0
ANOVA: Treatment (P > F)			0.0001	0.0002	0.0001	0.0001
Days after treatment		14-d	9	1	3	1
		21-d	9	16	8	1
		28-d	9	16	3	17

[z]Treatments were initiated on 10 June, prior to disease development. Subsequent 14-d treatments were made on 10 June, 25 June, 7 July, 23 July, and 5 Aug. Subsequent 21-d treatments were made on 10 June, 2 July, 23 July, and 12 Aug. Subsequent 28-d treatments were made on 10 June, 7 July, and 5 Aug.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

PREVENTIVE BROWN PATCH CONTROL WITH FUNGICIDES ON A TALL FESCUE LAWN TURF, 2015

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INTRODUCTION

Brown patch of turfgrass, caused by *Rhizoctonia solani* is characterized by round patches of diffusely-blighted, thinned turf. It is a summer disease that is most active under warm (nighttime temperatures ≥ 65° F) and humid conditions. It is commonly controlled using cultural practices such as avoiding excess nitrogen and improving air movement, as well as through the use of preventative fungicides. The objective of this study was to evaluate the effectiveness of new and existing fungicides at controlling brown patch in a tall fescue lawn turf.

MATERIALS & METHODS

A field study was conducted on a 'Crossfire 3' tall fescue (*Lolium arundinaceum*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed two days wk^{-1} at a cutting height of 3-inches. Nitrogen was applied to the study area to encourage brown patch development. A total of 4.0 lb N $1000\text{-}ft^{-2}$ was applied as water soluble sources from April through July. Overhead irrigation was applied as needed to prevent drought stress.

Initial applications were made on 10 June prior to disease developing in the trial area. Subsequent applications were made at specified treatment intervals through 12 August. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal $1000\text{-}ft^{-2}$ at 40 psi.

Brown patch was assessed visually as a percentage of the plot area blighted by *Rhizoctonia solani*. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Brown Patch Incidence

Disease developed to low levels throughout the trial. was sparse during the beginning months of the trial. Disease differences were greatest among treatments on 14 August. Heritage, Headway, Armada, and Disarm T (all rates and intervals) provided excellent disease control throughout the trial. There was no difference in control between Heritage formulations.

QP Tebuconazole (0.6 oz) as well as Velista (0.3 oz) performed better applied every 14-d than equivalent rates applied on a 21-d interval. Even at higher rates (i.e., 0.5 oz), Velista was less effective at extended intervals (i.e., 21-d) compared to 14-d intervals.

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Table 1. Brown Patch severity influenced by various fungicides applied preventatively on a tall fescue lawn turf at the Plant Science Research and Education Facility in Storrs, CT during 2015

Treatment	Rate per 1000ft^2	Int[z]	Brown Patch Severity 19 Jul	Brown Patch Severity 14 Aug	Brown Patch Severity 28 Aug
			---------------------- % ----------------------		
QP Tebuconazole...........	0.6 fl.oz.	14-d	0.8[y] cde[x]	1.3 bcd	0.0 c
QP Tebuconazole...........	0.6 fl.oz.	21-d	5.2 b	9.7 a	5.0 ab
Headway........................	1.5 fl.oz.	14-d	0.2 de	0.0 d	0.0 c
Headway........................	1.5 fl.oz.	21-d	0.0 e	0.6 bcd	0.0 c
Headway......................	2.25 fl.oz.	21-d	0.0 e	0.0 d	0.0 c
Headway......................	2.25 fl.oz.	28-d	0.2 de	0.2 bcd	0.3 c
Headway........................	3.0 fl.oz.	28-d	0.6 cde	0.0 d	0.0 c
Heritage WG......................	0.4 oz.	28-d	0.0 e	0.0 d	0.0 c
Heritage Action	0.4 oz.	28-d	0.0 e	0.0 d	0.0 c
Heritage WG......................	0.2 oz.	14-d	0.3 de	0.0 d	0.0 c
Heritage Action	0.2 oz.	14-d	0.0 e	0.0 d	0.0 c
Armada WDG..................	0.75 oz.	21-d	0.9 cde	0.1 cd	0.6 c
Armada WDG..................	0.75 oz.	21-d	1.9 bcd	1.0 bcd	0.0 c
Armada WDG....................	1.5 oz.	28-d	1.6 b-e	0.1 cd	0.3 c
Disarm T......................	0.89 fl.oz.	28-d	0.0 e	0.0 d	0.0 c
Velista................................	0.3 oz.	14-d	3.2 bc	2.7 b	0.8 c
Velista................................	0.3 oz.	21-d	0.5 de	15.8 a	3.7 ab
Velista................................	0.5 oz.	21-d	0.2 de	12.1 a	3.5 b
Velista................................	0.5 oz.	28-d	0.0 e	1.6 bc	0.0 c
Untreated			18.8 a	13.2 a	9.2 a
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001
Days after treatment		14-d	10	16	23
		21-d	15	9	16
		28-d	10	16	23

[z]Treatments were initiated on 10 June, prior to disease development. Subsequent 14-d treatments were made on 10 June, 25 June, 7 July, 23 July, and 5 Aug. Subsequent 21-d treatments were made on 10 June, 2 July, 23 July, and 12 Aug. Subsequent 28-d treatments were made on 10 June, 7 July, and 5 Aug.

[y]Brown Patch data were log transformed; means presented are de-transformed for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

PREVENTIVE DOLLAR SPOT CONTROL USING NEW AND EXISTING FUNGICIDE FORMULATIONS ON A CREEPING BENTGRASS FAIRWAY TURF, 2015

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INTRODUCTION

Dollar spot is a common disease of cool-season turfgrasses caused by the fungal pathogen *Sclerotinia homoeocarpa*. On golf course fairways it is characterized by light, straw-colored spots that may coalesce into larger irregularly shaped areas. It is particularly active during periods of warm daytime temperatures (80°F), warm nighttime temperatures (60°F), and high humidity. It can be managed in part with cultural practices such as maintaining moderate nitrogen fertility and reducing leaf wetness period. However, the use of fungicides is often still necessary on high priority areas such as greens, tees and fairways. The objective of this study was to evaluate the efficacy of new and existing fungicides in controlling dollar spot on a creeping bentgrass fairway turf.

MATERIALS & METHODS

A field study was conducted on a 'Putter' creeping bentgrass (*Agrostis stolonifera*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed three days wk^{-1} at a bench setting of 0.5-inches. Minimal nitrogen was applied to the study area to encourage dollar spot development. A total of 1.75 lb N $1000\text{-}ft^{-2}$ was applied as water soluble sources from April through October. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of new fungicide formulations, currently available products applied individually, as tank mixes, and/or in rotational programs, and nutritional programs. Initial applications were made on 21 May prior to disease developing in the trial area. Subsequent applications were made at specified intervals through 10 September. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal $1000\text{-}ft^{-2}$ at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Dollar spot incidence was assessed as a count of individual disease foci within each plot from 29 May to 21 September. Turf quality was visually assessed on a 1 to 9 scale; where 9 represented the best quality turf and 6 was the minimum acceptable level. Phytotoxicity was also assessed visually where 0 was equal to no discoloration and 2 represented the maximum acceptable level. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test. Dollar spot incidence data were square-root transformed for ANOVA and mean separation tests, although means presented are de-transformed values.

RESULTS AND DISCUSSION

Dollar Spot Incidence

Dry conditions throughout the growing season were not conducive to the development of *Sclerotinia homoeocarpa*. Therefore, disease incidence throughout the study area was limited for the duration of the trial (Table 1). While untreated plots had some minor disease during late August and September, the epidemic never reached unacceptable levels on any of the treated plots.

Turf Quality and Phytotoxicity

A relatively dry and disease-free summer resulted in moderate to good turf quality in nearly all plots through the duration of the trial (Table 2). A few treatments, such as UC15-7 + Harrell's Par, stood out as particularly high quality, especially soon after application (such as on 19 June or 14 August) due to the inclusion of a green pigment (Par). Plant Food programs 1 and 2 also had particularly high quality, likely due to the inclusion of nitrogen and iron fertilizer in the mixes causing enhanced green color.

Treatments that included Primo Maxx, a PGR, displayed some minor phytotoxicity (Table 3), especially earlier in the trial (June 8; June 19) that resulted in low, albeit acceptable turf quality. This phytotoxicity disappeared with subsequent applications, and turf quality increased to good to excellent levels.

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Table 1. Dollar spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int[z]	Dollar Spot Incidence			
			14 Aug	21 Aug	28 Aug	21 Sep
			------------------- # of spots 18ft^{-2} -------------------			
Velista	0.3 oz.	14-d	0.0 e	0.0 d	0.0 f	0.2 ef
+Primo Maxx	0.125 fl.oz.					
Secure	0.5 fl.oz.	14-d	0.0 e	0.0 d	0.0 f	0.0 f
+Primo Maxx	0.125 fl.oz.					
Velista	0.3 oz.	pgm[y]	0.0 e	0.0 d	0.4 ef	0.0 f
-Secure	0.5 oz.					
-Primo Maxx	0.125 fl.oz.					
Xzemplar	0.21 fl.oz.	21-d	0.0 e	0.0 d	0.0 f	0.0 f
Xzemplar	0.21 fl.oz.	28-d	0.0 e	0.0 d	0.0 f	0.0 f
Xzemplar	0.26 fl.oz.	28-d	0.0 e	0.0 d	0.0 f	0.0 f
Velista	0.3 oz.	14-d	0.0 e	0.0 d	0.0 f	0.0 f
Velista	0.3 oz.	21-d	0.0 e	0.0 d	0.2 f	0.5 ef
Velista	0.5 oz.	21-d	0.0 e	0.0 d	0.0 f	0.5 ef
Velista	0.5 oz.	28-d	0.0 e	0.0 d	0.0 f	0.9 c-f
Emerald	0.13 oz.	21-d	0.0 e	0.0 d	0.0 f	0.4 ef
Emerald	0.13 oz.	28-d	0.0 e	0.0 d	0.0 f	0.7 def
Emerald	0.18 oz.	28-d	0.2 de	0.0 d	0.4 f	0.2 ef
Kabuto	0.4 fl.oz.	14-d	0.0 e	0.0 d	1.0 def	0.3 ef
+UC15-8	0.15 oz.					
Kabuto	0.4 fl.oz.	21-d	1.1 bc	0.7 c	5.6 ab	3.5 bc
+UC15-8	0.15 oz.					
Kabuto	0.5 fl.oz.	21-d	0.3 cde	0.0 d	0.9 def	0.3 ef
+UC15-8	0.1875 oz.					
UC15-8	0.1875 oz.	14-d	1.6 b	1.9 b	5.6 ab	6.0 ab
Kabuto	0.4 fl.oz.	14-d	0.0 e	0.0 d	0.4 ef	0.2 ef
+UC15-9	1.875 fl.oz.					
Kabuto	0.4 fl.oz.	21-d	1.8 b	0.2 cd	1.9 cde	2.9 bcd
+UC15-9	1.875 fl.oz.					
Kabuto	0.5 fl.oz.	21-d	0.0 e	0.0 d	0.5 ef	0.0 f
+UC15-9	3.75 fl.oz.					
UC15-9	3.75 fl.oz.	14-d	0.4 cde	0.2 cd	0.6 ef	1.8 cde
Kabuto	0.4 fl.oz.	14-d	0.0 e	0.0 d	0.3 ef	0.4 ef
Kabuto	0.5 fl.oz.	14-d	0.0 e	0.0 d	0.0 f	0.0 f
Emerald	0.13 oz.	14-d	0.0 e	0.0 d	0.0 f	0.0 f
Torque	0.6 fl.oz.	21-d	0.0 e	0.0 d	0.2 f	0.6 ef
Banner MAXX	0.5 fl.oz.	14-d	0.2 de	0.0 d	1.1 def	0.6 ef
Banner MAXX	0.5 fl.oz.	21-d	0.8 bcd	0.3 cd	3.9 bc	1.9 b-e
Banner MAXX	1.0 fl.oz.	21-d	0.0 e	0.0 d	0.0 f	0.0 f
Banner MAXX	1.5 fl.oz.	21-d	0.0 e	0.0 d	0.2 f	0.0 f

Continued...

Table 1 *(continued).* Dollar spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int^t	Dollar Spot Incidence 14 Aug	21 Aug	28 Aug	21 Sep
			-------------------- # of spots 18ft^{-2}	--------------------		
UC15-7	4.0 fl.oz.	21-d	0.0^w e^v	0.2^w cd	2.7^w bcd	1.0^w c-f
+Harrell's Par	0.37 fl.oz.					
UC15-7	6.0 fl.oz.	21-d	0.0 e	0.0 d	0.6 ef	0.2 ef
+Harrell's Par	0.37 fl.oz.					
UC15-7	8.0 fl.oz.	21-d	0.0 e	0.0 d	0.0 f	0.0 f
+Harrell's Par	0.37 fl.oz.					
UC15-7	8.0 fl.oz.	pgm^x	0.0 e	0.0 d	0.2 f	0.0 f
+Harrell's Par	0.37 fl.oz.					
+26GT	3.0 fl.oz.					
+Daconil Ultrex	3.25 oz.					
Plant Food Program 1	pgm	14-d	0.6 cde	0.3 cd	1.7 cde	1.4 c-f
+ 20-3-3; 20% SRN	6.0 fl. oz.					
+ Phosphite 30	2.0 fl. oz.					
+ Impulse	3.0 fl. oz.					
+ Green Blade	0.36 fl. oz.					
+ Daconil Weather Stik	2.0 fl. oz.					
Plant Food Program 2	pgm	14-d	0.0 e	0.0 d	0.4 ef	0.0 f
+ Cal Nitrate	9.0 fl. oz.					
+ Impulse	3.0 fl. oz.					
+ Omega	0.36 fl. oz.					
+ Kelp Iron, 8-0-0	3.0 fl. oz.					
+ Torque	0.36 fl. oz.					
Untreated			8.8 a	6.5 a	12.2 a	12.0 a
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001
Days after treatment		14-d	1	9	2	11
		21-d	1	9	16	21
		28-d	1	9	16	11

^{z}Treatments were initiated on 21 May, prior to disease development. Subsequent 14-d treatments were applied on 3 June, 16 June, 30 June, 15 July, 28 July, 13 Aug, 26 Aug, and 10 Sept. Subsequent 21-d treatments were applied on 10 June, 30 June, 23 July, 13 Aug, 1 Sept. Subsequent 28-d treatments were applied on 16 June, 15 July, 13 Aug, 10 Sept.

^{y}Velista and Primo Maxx were applied on 21 May, 16 June, 15 July, 13 Aug, and 10 Sept.. Secure and Primo Maxx were applied on 3 June, 30 June, 28 July, and 26 August.

^{x}UC14-7 and Harrell's Par were applied on 21 May, 30 June, 13 August. 26GT and Daconil Ultrex were applied on 10 June, 23 July, and 1 Sept.

^{w}Data were log transformed; means presented are de-transformed for presentation.

^{v}Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2. Turf Quality influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int[z]	Turf Quality 29 May	8 Jun	19 Jun	10 Jul	17 Jul	14 Aug	28 Aug	21 Sep
			------ 1-9; 6=min acceptable ------							
Velista	0.3 oz.	14-d	6.0 g	6.0 g	6.5 d	6.7 ef	6.8 ef	8.5 abc	8.5 a	7.8 abc
+Primo Maxx	0.125 fl.oz.									
Secure	0.5 fl.oz.	14-d	6.0 h	6.0 g	6.5 d	7.0 def	7.3 c-f	8.0 bcd	8.0 ab	7.8 abc
+Primo Maxx	0.125 fl.oz.									
Velista	0.3 oz.	pgm[y]	6.3 fg	6.0 g	7.0 bcd	6.7 ef	6.5 f	7.3 def	7.8 abc	8.0 ab
-Secure	.0.5 oz.									
-Primo Maxx	0.125 fl.oz.									
Xzemplar	0.21 fl.oz.	21-d	6.8 def	6.8 ef	7.0 bcd	7.5 bcd	8.0 bc	7.5 def	7.0 cde	7.0 cde
Xzemplar	0.21 fl.oz.	28-d	6.5 efg	6.8 ef	6.8 cd	6.7 ef	6.8 ef	7.0 ef	7.8 abc	7.0 cde
Xzemplar	0.26 fl.oz.	28-d	6.3 fg	7.3 cde	7.5 abc	7.5 bcd	6.8 ef	7.0 ef	7.5 bcd	7.3 b-e
Velista	0.3 oz.	14-d	6.5 efg	7.3 cde	7.8 ab	7.2 b-e	7.5 b-e	7.5 def	8.0 ab	7.5 bcd
Velista	0.3 oz.	21-d	6.8 def	7.8 bc	7.5 abc	7.0 c-f	7.0 def	7.0 ef	7.8 abc	7.5 bcd
Velista	0.5 oz.	21-d	6.8 def	7.5 bcd	7.5 abc	7.2 b-e	7.5 b-e	8.0 bcd	7.8 abc	7.5 bcd
Velista	0.5 oz.	28-d	6.3 dg	7.5 bcd	7.5 abc	7.0 c-f	7.3 c-f	7.8 cde	7.5 bcd	6.8 de
Emerald	0.13 oz.	21-d	6.5 efg	6.5 fg	7.0 bcd	7.0 c-f	6.5 f	6.8 f	7.0 cde	7.5 bcd
Emerald	0.13 oz.	28-d	6.5 efg	7.0 def	7.3 a-d	6.5 f	6.8 ef	7.5 def	7.8 abc	7.3 b-e
Emerald	0.18 oz.	28-d	6.5 efg	6.8 ef	7.5 abc	7.2 b-e	7.5 b-e	7.0 ef	7.5 bcd	7.0 cde
Kabuto	0.4 fl.oz.	14-d	7.0 cde	7.0 def	7.5 abc	7.2 b-e	7.3 c-f	7.8 cde	8.0 ab	7.5 bcd
+UC15-8	0.15 oz.									
Kabuto	0.4 fl.oz.	21-d	6.0 g	7.5 bcd	7.3 a-d	7.0 c-f	7.3 c-f	7.0 ef	6.8 de	6.8 de
+UC15-8	0.15 oz.									
Kabuto	0.5 fl.oz.	21-d	6.5 efg	7.0 def	7.5 abc	7.7 bc	7.8 bcd	7.3 def	7.0 cde	7.5 bcd
+UC15-8	0.1875 oz.									
UC15-8	0.1875 oz.	14-d	6.3 fg	7.0 def	7.5 abc	7.0 c-f	7.5 b-e	7.0 ef	6.8 de	6.5 e
Kabuto	0.4 fl.oz.	14-d	6.8 def	7.3 cde	7.3 a-d	8.0 b	7.3 c-f	7.5 def	7.3 b-e	7.8 abc
+UC15-9	1.875 fl.oz.									
Kabuto	0.4 fl.oz.	21-d	6.8 def	7.5 bcd	7.5 abc	7.5 bcd	8.0 bc	7.5 def	7.5 bcd	7.0 cde
+UC15-9	1.875 fl.oz.									
Kabuto	0.5 fl.oz.	21-d	6.8 def	7.5 bcd	7.3 a-d	7.2 b-e	7.3 c-f	7.3 def	7.3 b-e	7.5 bcd
+UC15-9	3.75 fl.oz.									
UC15-9	3.75 fl.oz.	14-d	6.5 efg	7.3 cde	7.3 a-d	7.7 bc	7.0 def	7.3 def	7.0 cde	7.5 bcd
Kabuto	0.4 fl.oz.	14-d	6.8 def	6.8 ef	7.0 bcd	7.0 def	6.8 ef	7.3 def	7.5 bcd	7.0 cde
Kabuto	0.5 fl.oz.	14-d	6.8 def	7.0 def	7.5 abc	6.7 ef	6.5 f	7.3 def	7.3 b-e	6.8 de
Emerald	0.13 oz.	14-d	6.8 def	7.3 cde	7.5 abc	7.2 b-e	7.5 b-e	7.3 def	7.5 bcd	7.3 b-e
Torque	0.6 fl.oz.	21-d	6.8 def	7.5 bcd	7.8 ab	7.0 def	7.5 b-e	7.0 ef	7.3 b-e	7.0 cde
Banner MAXX	0.5 fl.oz.	14-d	7.0 cde	7.0 def	7.3. a-d	7.0 c-f	7.3 c-f	7.5 def	7.5 bcd	6.8 de
Banner MAXX	0.5 fl.oz.	21-d	6.5 efg	7.3 cde	7.0 bcd	6.7 ef	7.0 def	7.5 def	6.8 de	7.0 cde
Banner MAXX	1.0 fl.oz.	21-d	6.5 efg	6.8 ef	7.5 abc	6.7 ef	7.5 b-e	7.3 def	7.8 abc	7.3 b-e
Banner MAXX	1.5 fl.oz.	21-d	6.5 efg	7.0 def	7.0 bcd	6.5 f	6.8 ef	6.8 f	7.3 b-e	7.0 cde

Continued...

Table 2 *(continued).* Dollar spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[t]	Turf Quality 29 May	8 Jun	19 Jun	10 Jul	17 Jul	14 Aug	28 Aug	21 Sep
			1-9; 6=min acceptable							
UC15-7	4.0 fl.oz.	21-d	7.8 ab[w]	8.0 b	8.0 a	7.5[v] bcd	7.8 bcd	8.8 ab	7.3 b-e	7.3 b-e
+Harrell's Par	0.37 fl.oz.									
UC15-7	6.0 fl.oz.	21-d	7.5 bc	8.0 b	8.0 a	7.0 c-f	7.8 bcd	9.0 a	7.5 bcd	7.5 bcd
+Harrell's Par	0.37 fl.oz.									
UC15-7	8.0 fl.oz.	21-d	6.8 def	7.5 bcd	8.0 a	7.2 b-e	7.3 c-f	9.0 a	7.3 b-e	6.8 de
+Harrell's Par	0.37 fl.oz.									
UC15-7	8.0 fl.oz.	pgm[x]	7.0 cde	7.5 bcd	7.0 bcd	7.2 b-e	7.5 b-e	9.0 a	7.5 bcd	7.8 abc
+Harrell's Par	0.37 fl.oz.									
+26GT	3.0 fl.oz.									
+Daconil Ultrex	3.25 oz.									
Plant Food Program 1	pgm	14-d	7.8 a	9.0 a	7.8 ab	9.0 a	9.0 a	8.8 ab	7.8 abc	8.0 ab
+ 20-3-3; 20% SRN	6.0 fl. oz.									
+ Phosphite 30	2.0 fl. oz.									
+ Impulse	3.0 fl. oz.									
+ Green Blade	0.36 fl. oz.									
+ Daconil Weather Stik	2.0 fl. oz.									
Plant Food Program 2	pgm	14-d	7.3 bcd	8.0 b	7.8 ab	7.7 bc	8.3 ab	8.0 bcd	7.3 b-e	8.5 a
+ Cal Nitrate	9.0 fl. oz.									
+ Impulse	3.0 fl. oz.									
+ Omega	0.36 fl. oz.									
+ Kelp Iron, 8-0-0	3.0 fl. oz.									
+ Torque	0.36 fl. oz.									
Untreated			6.8 def	7.3 cde	7.5 abc	7.2 b-e	7.0 def	7.0 ef	6.5 e	5.5 f
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Days after treatment		14-d	8	5	3	10	2	1	2	11
		21-d	8	18	9	10	17	1	16	21
		28-d	8	18	3	24	2	1	16	11

[z]Treatments were initiated on 21 May, prior to disease development. Subsequent 14-d treatments were applied on 3 June, 16 June, 30 June, 15 July, 28 July, 13 Aug, 26 Aug, and 10 Sept. Subsequent 21-d treatments were applied on 10 June, 30 June, 23 July, 13 Aug, 1 Sept. Subsequent 28-d treatments were applied on 16 June, 15 July, 13 Aug, 10 Sept.

[y]Velista and Primo Maxx were applied on 21 May, 16 June, 15 July, 13 Aug, and 10 Sept.. Secure and Primo Maxx were applied on 3 June, 30 June, 28 July, and 26 August.

[x]UC14-7 and Harrell's Par were applied on 21 May, 30 June, 13 August. 26GT and Daconil Ultrex were applied on 10 June, 23 July, and 1 Sept.

[w]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

[v]Data were arc-sin transformed; means presented are de-transformed for presentation.

Table 3. Phytotoxicity influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

			Phytotoxicity				
Treatment	Rate per 1000ft^2	Int[z]	29 May	8 Jun	19 Jun	17 Jul	21 Aug
			---------------------- 0-5; 2=max acceptable --------------------				
Velista	0.3 oz.	14-d	0.0	0.8 b	0.7[t] a	0.0	0.0 d
+Primo Maxx	0.125 fl.oz.						
Secure	0.5 fl.oz.	14-d	0.0	1.0 a	1.0 a	0.0	0.0 d
+Primo Maxx	0.125 fl.oz.						
Velista	0.3 oz.	pgm[y]	0.0	0.8 b	1.0 a	0.0	0.0 d
-Secure	.0.5 oz.						
-Primo Maxx	0.125 fl.oz.						
Xzemplar	0.21 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Xzemplar	0.21 fl.oz.	28-d	0.0	0.3 c	0.0 b	0.3	0.3 cd
Xzemplar	0.26 fl.oz.	28-d	0.0	0.0 d	0.0 b	0.0	0.5 c
Velista	0.3 oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Velista	0.3 oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Velista	0.5 oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Velista	0.5 oz.	28-d	0.0	0.0 d	0.0 b	0.0	0.3 cd
Emerald	0.13 oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Emerald	0.13 oz.	28-d	0.0	0.0 d	0.0 b	0.0	0.3 cd
Emerald	0.18 oz.	28-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Kabuto	0.4 fl.oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
+UC15-8	0.15 oz.						
Kabuto	0.4 fl.oz.	21-d	0.0	0.0 d	0.2 b	0.0	0.0 d
+UC15-8	0.15 oz.						
Kabuto	0.5 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.3 cd
+UC15-8	0.1875 oz.						
UC15-8	0.1875 oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Kabuto	0.4 fl.oz.	14-d	0.0	0.0 d	0.2 b	0.3	0.0 d
+UC15-9	1.875 fl.oz.						
Kabuto	0.4 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
+UC15-9	1.875 fl.oz.						
Kabuto	0.5 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
+UC15-9	3.75 fl.oz.						
UC15-9	3.75 fl.oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Kabuto	0.4 fl.oz.	14-d	0.0	0.0 d	0.2 b	0.3	0.0 d
Kabuto	0.5 fl.oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Emerald	0.13 oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Torque	0.6 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Banner MAXX	0.5 fl.oz.	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Banner MAXX	0.5 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.0 d
Banner MAXX	1.0 fl.oz.	21-d	0.0	0.0 d	0.2 b	0.0	0.0 d
Banner MAXX	1.5 fl.oz.	21-d	0.0	0.3 c	0.0 b	0.0	0.3 cd

Continued...

Table 3 *(continued).* Phytotoxicity influenced by various fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int[t]	Phytotoxicity 29 May	8 Jun	19 Jun	17 Jul	21 Aug
			---------------------- 0-5; 2=max acceptable ----------------------				
UC15-7	4.0 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	0.3 cd
+Harrell's Par	0.37 fl.oz.						
UC15-7	6.0 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.0	1.3 b
+Harrell's Par	0.37 fl.oz.						
UC15-7	8.0 fl.oz.	21-d	0.0	0.0 d	0.0 b	0.3	0.0 d
+Harrell's Par	0.37 fl.oz.						
UC15-7	8.0 fl.oz.	pgm[x]	0.0	0.0 d	0.0 b	0.0	0.0 d
+Harrell's Par	0.37 fl.oz.						
+26GT	3.0 fl.oz.						
+Daconil Ultrex	3.25 oz.						
Plant Food Program 1	pgm	14-d	0.0	0.0 d	0.0 b	0.0	0.0 d
+ 20-3-3; 20% SRN	6.0 fl. oz.						
+ Phosphite 30	2.0 fl. oz.						
+ Impulse	3.0 fl. oz.						
+ Green Blade	0.36 fl. oz.						
+ Daconil Weather Stik	2.0 fl. oz.						
Plant Food Program 2	pgm	14-d	0.0	0.0 d	0.2 b	0.3	0.0 d
+ Cal Nitrate	9.0 fl. oz.						
+ Impulse	3.0 fl. oz.						
+ Omega	0.36 fl. oz.						
+ Kelp Iron, 8-0-0	3.0 fl. oz.						
+ Torque	0.36 fl. oz.						
Untreated			0.0	0.0 d	0.0 b	0.0	0.0 d
ANOVA: Treatment (P > F)			1.0000	0.0001	0.0001	0.6407	0.0001
Days after treatment		14-d	8	5	3	2	9
		21-d	8	18	9	17	9
		28-d	8	18	3	2	9

[z]Treatments were initiated on 21 May, prior to disease development. Subsequent 14-d treatments were applied on 3 June, 16 June, 30 June, 15 July, 28 July, 13 Aug, 26 Aug, and 10 Sept. Subsequent 21-d treatments were applied on 10 June, 30 June, 23 July, 13 Aug, 1 Sept. Subsequent 28-d treatments were applied on 16 June, 15 July, 13 Aug, 10 Sept.

[y]Velista and Primo Maxx were applied on 21 May, 16 June, 15 July, 13 Aug, and 10 Sept.. Secure and Primo Maxx were applied on 3 June, 30 June, 28 July, and 26 August.

[x]UC14-7 and Harrell's Par were applied on 21 May, 30 June, 13 August. 26GT and Daconil Ultrex were applied on 10 June, 23 July, and 1 Sept.

[w]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

INFLUENCE OF FOLIAR NITROGEN FERTILITY ON BIOFUNGICIDE AND CONVENTIONAL FUNGICIDE EFFICACY FOR PREVENTIVE DOLLAR SPOT CONTROL ON A CREEPING BENTGRASS FAIRWAY TURF, 2015

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INTRODUCTION

Dollar spot is a common disease of cool-season turfgrasses caused by the fungal pathogen *Sclerotinia homoeocarpa*. On golf course fairways it is characterized by light, straw-colored spots that may coalesce into larger irregularly shaped areas. It is particularly active during periods of warm daytime temperatures (80°F), warm nighttime temperatures (60°F), and high humidity. It can be managed in part with cultural practices such as maintaining moderate nitrogen fertility and reducing leaf wetness period. However, the use of fungicides is often still necessary on high priority areas such as greens, tees and fairways. The objective of this study was to evaluate whether foliar fertility could enhance the efficacy of biofungicides and a conventional fungicide for dollar spot control in a creeping bentgrass fairway turf.

MATERIALS & METHODS

A field study was conducted on a ‘MacKenzie’ creeping bentgrass (*Agrostis stolonifera*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed three days wk^{-1} at a bench setting of 0.5-inches. Nitrogen was applied to the study area at a total of 1.5 lb N $1000\text{-}ft^{-2}$ as water soluble sources from April through August. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of Nitro 30 (foliar fertilizer) with and without Companion (biofungiicde) and/or Velista (conventional fungicide). Initial applications were made on 7 May prior to disease developing in the trial area. Subsequent applications were made at specified intervals through 27 August. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal $1000\text{-}ft^{-2}$ at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Dollar spot incidence was assessed as a count of individual disease foci within each plot from 10 July to 28 August. Turf quality was visually assessed on a 1 to 9 scale; where 9 represented the best quality turf and 6 was the minimum acceptable level. Phytotoxicity was also assessed visually where 0 was equal to no discoloration and 2 represented the maximum acceptable level. Copper spot incidence was assessed as a count of individual disease foci within each plot. All data were subjected to an analysis of variance and means were separated using Fisher’s protected least significant difference test.

RESULTS AND DISCUSSION

Dollar Spot Incidence

Disease was slow to develop in the trial area due to dry conditions during the spring. Dollar spot was first observed on 10 July (Table 1). The epidemic progressed slowly over the course of the month. As of 30 July, only 4 to 7 disease foci were present on plots treated with Nitro 30 alone, Urea, and untreated plots. There was little to no disease present on plots treated with Velista, either alone or part of a tank mix and/or rotational program, including plots treated with Companion + Nitro 30 (14-d) + Velista (21-d), Nitro 40 (14-d) + Velista (21-d), Companion + Nitro 30 + Velista (21-d), and Nitro 30 + Velista (21-d). These treatments continued to provide similar dollar spot control throughout the remainder of the season as disease progressed to moderate levels in untreated control plots.

Turf Quality, Copper Spot Incidence, and Phytotoxicity

Few differences in turf quality were observed prior to mid to late August when disease incidence increased (Table 2). As of 14 August, turf quality was good in plots treated with Companion + Nitro 30 (14-d) + Velista (21-d), Nitro 40 (14-d) + Velista (21-d), Companion + Nitro 30 + Velista (21-d), and Nitro 30 + Velista (21-d). However quality was reduced, albeit acceptable, in Nitro 30 alone and Urea, and unacceptable in untreated control plots by this date due to increased disease incidence.

Beginning in late July and continuing through late August, several of the treatments developed a severe copper spot outbreak (Table 4). Only plots treated with Companion + Nitro 30 (14-d) + Velista (21-d) remained free of the disease; whereas Companion + Nitro 30 + Velista (21-d), Nitro 30 + Velista (21-d), Urea, and untreated control plots showed over 40 disease foci per plot. This, in addition to dollar spot on some of these plots, contributed to poor turf quality on these plots as of 28 August. Companion + Nitro 30 (14-d) + Velista (21-d), Nitro 30 (14-d) + Velista (21-d), and Velista applied alone retained acceptable turf quality. It is possible that the combination of more frequent applications of fertilizer-containing biofungicides in addition to the regular application of Velista helped to keep turf quality acceptable for these treatments.

There was little to no phytotoxicity (Table 3) observed for any of the treatments.

Table 1. Dollar spot incidence influenced by various biological and traditional fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Dollar Spot Incidence 10 Jul	17 Jul	24 Jul	30 Jul	7 Aug	14 Aug	21 Aug	28 Aug
			# of spots 18ft⁻²							
Companion	6.0 fl.oz.	14-d	0.0[x]	0.0 b[y]	1.0[w] bc	0.0[w] b	0.0[x] b	0.0[w] b	0.0[w] b	0.0[w] c
+ Nitro 30	5.2 fl.oz.	14-d								
- Velista	0.3 oz.	21-d								
Nitro 30	5.2 fl.oz.	14-d	0.1	0.0 b	1.7 abc	0.0 b	0.0 b	0.0 b	0.0 b	0.8 bc
- Velista	0.3 oz.	21-d								
Companion	6.0 fl.oz.	21-d	0.0	0.0 b	0.4 bc	0.2 b	0.0 b	0.0 b	0.2 b	1.8 b
+ Nitro 30	10.3 fl.oz.	21-d								
+ Velista	0.3 oz.	21-d								
Nitro 30	5.2 fl.oz.	21-d	0.1	0.0 b	0.2 c	0.2 b	0.0 b	0.0 b	0.0 b	0.6 bc
- Velista	0.3 oz.	21-d								
Nitro 30	10.3 fl.oz.	21-d	0.1	0.0 b	2.3 abc	5.3 a	9.9 a	12.8 a	12.4 a	19.1 a
Urea	0.25 lb/N	21-d	0.1	1.3 a	2.7 ab	4.4 a	9.9 a	10.8 a	10.3 a	14.4 a
Velista	0.3 oz.	21-d	0.1	0.0 b	0.3 bc	0.2 b	0.0 b	0.0 b	0.3 b	0.3 bc
Untreated			0.8	1.5 a	6.2 a	7.1 a	15.1 a	13.5 a	13.6 a	25.0 a
ANOVA: Treatment (P > F)			0.5654	0.0385	0.0234	0.0001	0.0001	0.0001	0.0001	0.0001
Days after treatment		14-d	8	1	8	14	8	15	7	1
		21-d	1	8	15	21	8	15	1	8

[z]Treatments were initiated on 7-May, prior to disease development. Subsequent 14-d treatments were applied on 21 May, 4 June, 18 June, 2 July, 16 July, 30 July, 14 August, and 27 August. Subsequent 21-d treatments were applied on 28 May, 18 June, 9 July, 30 July, and 20 August.
[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).
[x]Data were arc-sin transformed. Means are de-transformed for presentation.
[w]Data were log transformed. Means are de-transformed for presentation.

Table 2. Turf Quality affected by various biological and traditional fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Turf Quality 29 May	19 Jun	26 Jun	10 Jul	17 Jul	24 Jul	14 Aug	28 Aug
			1-9; 6=min acceptable							
Companion	6.0 fl.oz.	14-d	7.8	7.5	6.5 b[y]	7.0	6.3	6.5	7.5 a	8.5 a[x]
+ Nitro 30	5.2 fl.oz.	14-d								
- Velista	0.3 oz.	21-d								
Nitro 30	5.2 fl.oz.	14-d	7.5	7.3	6.8 ab	6.3	5.8	5.8	7.5 a	7.0 ab
- Velista	0.3 oz.	21-d								
Companion	6.0 fl.oz.	21-d	7.3	7.3	7.5 a	6.8	6.3	6.8	7.3 a	5.3 cd
+ Nitro 30	10.3 fl.oz.	21-d								
+ Velista	0.3 oz.	21-d								
Nitro 30	5.2 fl.oz.	21-d	7.5	7.8	7.5 a	7.0	6.8	7.0	7.3 a	5.3 cd
- Velista	0.3 oz.	21-d								
Nitro 30	10.3 fl.oz.	21-d	7.3	7.5	6.8 ab	6.8	6.3	6.8	6.0 bc	4.8 cd
Urea	0.25 lb/N	21-d	7.5	8.0	7.5 a	6.5	6.5	6.0	6.0 bc	5.0 cd
Velista	0.3 oz.	21-d	7.3	7.0	6.0 b	5.8	4.8	5.0	6.8 ab	6.0 bc
Untreated			6.8	7.0	6.8 ab	6.5	5.8	5.8	5.3 c	4.0 d
ANOVA: Treatment (P > F)			0.5269	0.4616	0.0232	0.5002	0.1800	0.1946	0.0016	0.0003
Days after treatment		14-d	8	1	8	8	1	8	15	1
		21-d	1	1	8	1	8	15	15	8

[z]Treatments were initiated on 7-May, prior to disease development. Subsequent 14-d treatments were applied on 21 May, 4 June, 18 June, 2 July, 16 July, 30 July, 14 August, and 27 August. Subsequent 21-d treatments were applied on 28 May, 18 June, 9 July, 30 July, and 20 August.
[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).
[x]Data were square-root transformed. Means are de-transformed for presentation.

Table 3. Phytotoxicity affected by various biological and traditional fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Phytotoxicity 29 May	Phytotoxicity 19 Jun	Phytotoxicity 17 Jul
			------- 0-5; 2=max acceptable --------		
Companion	6.0 fl.oz.	14-d	0.0	0.0	0.0 b
+ Nitro 30	5.2 fl.oz.	14-d			
- Velista	0.3 oz.	21-d			
Nitro 30	5.2 fl.oz.	14-d	0.0	0.0	0.0 b
- Velista	0.3 oz.	21-d			
Companion	6.0 fl.oz.	21-d	0.0	0.0	0.0 b
+ Nitro 30	10.3 fl.oz.	21-d			
+ Velista	0.3 oz.	21-d			
Nitro 30	5.2 fl.oz.	21-d	0.0	0.0	0.0 b
- Velista	0.3 oz.	21-d			
Nitro 30	10.3 fl.oz.	21-d	0.0	0.0	0.0 b
Urea	0.25 lb/N	21-d	0.0	0.0	0.0 b
Velista	0.3 oz.	21-d	0.0	0.3	0.5 a
Untreated			0.0	0.0	0.0 b
ANOVA: Treatment (P > F)			1.0000	0.4616	0.0239
Days after treatment		14-d	8	1	1
		21-d	1	1	8

[z]Treatments were initiated on 7-May, prior to disease development. Subsequent 14-d treatments were applied on 21 May, 4 June, 18 June, 2 July, 16 July, 30 July, 14 August, and 27 August. Subsequent 21-d treatments were applied on 28 May, 18 June, 9 July, 30 July, and 20 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

Table 4. Copper spot incidence influenced by various biological and traditional fungicides applied preventatively on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Int[z]	Copper Spot 30 Jul	Copper Spot 14 Aug	Copper Spot 28 Aug
			------------ # of spots 18ft^{-2} -----------		
Companion	6.0 fl.oz.	14-d	1.9[y]	8.5[y]	0.0[x] c[w]
+ Nitro 30	5.2 fl.oz.	14-d			
- Velista	0.3 oz.	21-d			
Nitro 30	5.2 fl.oz.	14-d	0.6	4.8	22.2 b
- Velista	0.3 oz.	21-d			
Companion	6.0 fl.oz.	21-d	2.9	10.9	40.1 ab
+ Nitro 30	10.3 fl.oz.	21-d			
+ Velista	0.3 oz.	21-d			
Nitro 30	5.2 fl.oz.	21-d	3.6	11.7	43.7 ab
- Velista	0.3 oz.	21-d			
Nitro 30	10.3 fl.oz.	21-d	3.4	5.6	30.7 b
Urea	0.25 lb/N	21-d	8.5	19.9	55.1 ab
Velista	0.3 oz.	21-d	1.3	5.6	37.9 ab
Untreated			4.8	15.7	73.2 a
ANOVA: Treatment (P > F)			0.2638	0.3958	0.0009
Days after treatment		14-d	14	15	1
		21-d	21	15	8

[z]Treatments were initiated on 7-May, prior to disease development. Subsequent 14-d treatments were applied on 21 May, 4 June, 18 June, 2 July, 16 July, 30 July, 14 August, and 27 August. Subsequent 21-d treatments were applied on 28 May, 18 June, 9 July, 30 July, and 20 August.

[y]Data were log transformed. Means are de-transformed for presentation.

[x]Data were square root transformed. Means are de-transformed for presentation.

[w]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

CURATIVE DOLLAR SPOT CONTROL USING NEW AND EXISTING FUNGICIDE FORMULATIONS ON A CREEPING BENTGRASS FAIRWAY TURF, 2015

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INTRODUCTION

Dollar spot (caused by *Sclerotinia homoeocarpa*) is a common disease of golf course fairway turf occurring from May to October throughout New England. Control of this disease is achieved through integrated management plans utilizing improved bentgrass varieties, cultural, and chemical approaches. However, when environmental conditions are particularly favorable for dollar spot development, the disease may occur despite preventive management. In these cases, curative fungicide applications are required to arrest the disease and prevent further turf loss. The objective of this study was to evaluate the curative efficacy of new and commonly used fungicides against *S. homoeocarpa.*

MATERIALS & METHODS

A field study was conducted on a 'MacKenzie' creeping bentgrass (*Agrostis stolonifera*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed three days wk^{-1} at a bench setting of 0.5-inches. Minimal nitrogen was applied to the study area to encourage dollar spot development. A total of 1.5 lb N 1000-ft^{-2} was applied as water soluble sources from April through October. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of various fungicides applied curatively. Initial applications were made on 7 October after a severe epidemic had established in the trial area. A subsequent application of all treatments was made on 21 October. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal 1000-ft^{-2} at 40 psi. Nitrogen was applied at a rate of 0.5 lbs 1000-ft^{-2} on 8 October to assist with turf recovery. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Dollar spot incidence was assessed as a count of individual disease foci within each plot from 7 October to 3 November. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Dollar Spot Incidence

A severe epidemic of dollar spot was evident throughout the trial area at the beginning of the study. Likely due to the severity of the infestation, treatment differences were not apparent until 18 October, 11 days after initial treatments and 10 days after nitrogen was applied to the study area (Table 1). At this date, all fungicide-treated plots showed a reduction in dollar spot relative to the untreated control. Secure was particularly effective at reducing dollar spot, with a 62% reduction since the start of the trial.

A second application of treatments was made on 21 October. Following this, dollar spot incidence continued to decline in all treated plots even as disease pressure remained high with >100 disease foci per plot in the untreated control for the duration of the study. Xzemplar, Encartis, Secure, Kabuto, Velista, and Lexicon Intrinsic returned plots to acceptable levels of dollar spot (<18 disease foci per plot) by 3 November.

Table 1. Dollar spot incidence influenced by curative applications of various fungicides on a creeping bentgrass fairway turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int[z]	7 Oct	9 Oct	12 Oct	18 Oct	22 Oct	28 Oct	3 Nov
			Dollar Spot Incidence						
			# of spots 18ft^{-2}						
Xzemplar	0.26 fl.oz.	14-d	171.5	162.8	112.0	70.5 bc[y]	49.5 b	24.0 b	11.3 cd
Encartis	4.0 fl.oz.	14-d	160.8	159.8	121.3	75.0 bc	40.8 b	25.3 b	16.3 bcd
Secure	0.5 fl.oz.	21-d	145.5	137.5	92.3	56.0 c	37.0 b	19.0 b	8.0 d
Daconil WeatherStik	4.0 fl.oz.	14-d	140.8	138.0	109.3	67.8 bc	41.5 b	29.0 b	21.8 b
Velista	0.5 oz.	21-d	164.0	163.3	118.3	79.0 bc	48.5 b	26.0 b	18.5 bc
Kabuto	0.5 fl.oz.	21-d	139.3	138.0	99.3	70.3 bc	43.8 b	25.5 b	17.0 bcd
Lexicon Intrinsic	0.46 fl.oz.	21-d	135.8	130.8	115.9	85.8 b	57.5 b	33.5 b	15.3 bcd
Untreated		21-d	155.0	153.0	106.9	110.5 a	109.3 a	113.3 a	105.8 a
ANOVA: Treatment (P > F)			0.4616	0.4335	0.6899	0.0048	0.0001	0.0001	0.0001
Days after treatment		14-d	0	2	5	11	1	7	13

[z]Treatments were initiated on 7-October, prior to disease development. A subsequent application of all treatments was made on 21 October.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

PREVENTIVE DOLLAR SPOT CONTROL USING BIOFUNGICIDES AND FUNGICIDES APPLIED USING THE SMITH-KERNS DOLLAR SPOT MODEL ON A CREEPING BENTGRASS FAIRWAY TURF, 2015

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INTRODUCTION

Dollar spot is perhaps the most common disease on golf course fairways in the Northeastern United States. It is favored by warm daytime (80°F) and nighttime temperatures (60°F) with high humidity, which are common throughout much of the growing season in the region. To manage the disease, a combination of cultural practices and routine fungicide applications are used throughout the season. Typically fungicides are applied on a fixed interval every 14 to 21 d from May through October, resulting in 7 to 10 fungicide applications annually.

Recently, a dollar spot forecasting model known as the Smith-Kerns Model was developed by Drs. Damon Smith and Jim Kerns. The model calculates the potential risk of dollar spot symptoms to develop, based on average air temperature and relative humidity. Use of an effective dollar spot forecasting model could help turf managers time fungicide applications to go out only when the likelihood for disease is high. The model provides a risk value that turf managers would use as a predetermined action threshold for timing fungicide applications. Lower risk values would result in more frequent fungicide applications; whereas higher values would have fewer applications, but incur a greater potential for disease breakthrough.

Various biofungicides have been evaluated for dollar spot control with mixed results. Generally, these materials are not effective replacements for conventional fungicides for disease control on fairways, but in some cases, may enhance efficacy of conventional fungicides.

The objectives of this study were to determine whether fungicides applied based on the Smith-Kerns dollar spot model could provide comparable disease control as conventional 21-d fungicide timings, and whether biofungicides could help improve disease control of fungicides applied at high risk forecast model thresholds on creeping bentgrass fairway turf throughout the season.

MATERIALS & METHODS

A field study was conducted on a 'MacKenzie' creeping bentgrass (*Agrostis stolonifera*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed three days wk^{-1} at a bench setting of 0.5-inches. Nitrogen was applied to the study area as water soluble sources totaling 1.5 lb N 1000-ft^{-2} from April through August. Overhead irrigation was applied as needed to prevent drought stress.

Treatments were arranged in a 4 × 4 factorial with main effect factors being fungicide application interval and biofungicide. Fungicide application intervals consisted of Smith-Kerns dollar spot forecast model risk action thresholds of 30% (high risk) or 20% (moderate risk), 21-d calendar based, or a non-fungicide treated control. Biofungicides evaluated included TurfShield Plus (1.5 oz 1000 ft^{-2} initial application and 0.5 oz thereafter), Companion (6.0 oz 1000 ft^{-2}), Rhapsody (10.0 fl oz 1000 ft^{-2}) + experimental adjuvant (0.2% v/v), and a non-biofungicide control.

Initial applications of biofungicides were made preventively on 11 May when average soil temperatures reached 50F. Biofungicides were reapplied every 14-d through 6 October, except TurfShield Plus which was reapplied every 21-d. Conventional fungicide application intervals initiated for 21-d calendar-based fungicide treatment and 20% risk action threshold treatments on 14 May, and 30% risk action threshold on 1 June. Model-based treatments were reapplied when specified risk thresholds were reached; although re-applications were withheld for 21-d following fungicide application regardless of model forecast. Treatments were reapplied at specified intervals through 6 October.

All treatments were applied using a hand held CO_2 pressurized spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal 1000-ft^{-2} at 40 psi. TurfShield Plus treated plots received 0.5 inches of post-application irrigation following the first application and 0.1 inches following each application thereafter. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications. Dollar spot incidence was assessed as a count of individual disease foci within each plot from 26 June to 28 August. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Dollar Spot Incidence

Dollar spot pressure was relatively low throughout the duration of the study likely due to below average precipitation for the year. Symptoms were first observed in untreated controls on 26 June, however disease incidence remained low, increasing to a maximum of 21 spots per plot by 28 August (Table 1). No fungicide treated plots contained more than 1 dollar spot per plot throughout the duration of the study. Unfortunately, the limited disease pressure in this study did not provide for a rigorous evaluation of the Smith-Kerns model this year.

All conventional fungicide application interval treatments reduced disease compared to the untreated control, regardless of interval on all evaluation dates. Generally, few differences were observed between application intervals during the year. Small differences were apparent on the last rating date (28 August); however all intervals had ≤ 1 dollar spot on these dates. Indicating that in practice, under low disease severity, all intervals may provide acceptable disease control.

Biofungicides evaluated had little effect on dollar spot, regardless of whether they were applied with or without conventional fungicides. Companion and Rhapsody did provide a statistical disease reduction compared to non-biofungicide treated turf on 26 June; however the average dollar spot incidence among all treatments on this date was less than one spot per 18 ft^{-2}. No differences were observed on the remaining dates in the study.

While few differences in disease control among application intervals were observed, differences in the total number of fungicide applications occurred. A total of 7 applications on a 21-d interval were made from 15 May to 6 October. Fungicides applied based on the model at a moderate risk forecast (i.e., 20%) resulted in 7 total applications. Higher risk thresholds of 30% reduced the total number of applications to 5 for the year. Since all application intervals maintained disease at < 1 dollar spot per 18 ft^{-2}, it appears that the model does have the potential to reduce the number of fungicide applications required. This is particularly true during years with low disease pressure. While the results of the model from this year seem promising for providing guidance on fungicide timing for effective disease control, it is important to consider that disease pressure in this study was very low. This study must be repeated to determine whether use of risk action thresholds as high as 30% would provide reliable disease control during years with greater dollar spot pressure.

Table 1. Fungicide interval and biofungicide effects on dollar spot incidence on a 'MacKenzie' creeping bentgrass (*Agrostis stolonifera*) turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

	Dollar Spot Incidence		
Main Effect	26 Jun	24 Jul	28 Aug
Fungicide Interval[z]	------- # of foci per 18ft^{-2}-------		
30% risk threshold (high)[y]	0.1 b	0.4 b	0.0 c
20% risk threshold (moderate)[x]	0.1 b	0.3 b	0.4 b
every 21-d[w]	0.0 b	0.1 b	0.0 c
no fungicide	0.5 a	2.5 a	21.3 a
Biofungicide[v]			
TurfShield Plus[u]	0.1 ab	0.8	4.4
Companion[t]	0.0 b	0.5	4.9
Rhapsody[s]	0.1 b	0.9	5.1
None	0.4 a	1.1	7.3
Source of Variation	-------------- *P > F* --------------		
Fungicide Timing	*	***	***
Biofungicide	*	NS	NS
Fungicide Timing × Biofungicide	NS	NS	NS

[z]Velista (0.5 oz 1000 ft^{-2}) and Secure (0.5 fl oz 1000 ft^{-2}) were applied as a tank mix at each of the specified application intervals.
[y]Treatments were made prior to disease development beginning on 1 and 25 June; 19 July; 20 Aug; and 15 Sep.
Treatments were made prior to disease development beginning on 14 May; 13 June; 3 and 28 July; 20 Aug; 15 Sep and 6 Oct.
[w]Treatments were made prior to disease development beginning on 14 May. Subsequent applications were made on a 21-d basis on 3 June, 22 June, 14 July, 7 August, 26 August, 15 September, 6 October.
[v]Biofungicides were initially applied on 11 May when average soil temperatures reached 50F.
[u]TurfShield Plus was initially applied at 1.5 oz 1000 ft^{-2} and at 0.5 oz 1000 ft^{-2} every 21 days thereafter. Following application 0.5 inches of irrigation were applied after the initial application, and 0.1 inches for subsequent applications.
[t]Companion was applied at 6 fl oz 1000 ft^{-2} every 14 days.
[s]Rhapsody was applied at 10 fl oz 1000 ft^{-2} with an experimental adjuvant at 0.2% v/v every 14 days.

PREVENTIVE DOLLAR SPOT CONTROL USING THE SMITH-KERNS FORECAST MODEL ON A CREEPING BENTGRASS FAIRWAY TURF, 2015

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INTRODUCTION

Dollar spot is perhaps the most common disease on golf course fairways in the Northeastern United States. It is favored by warm daytime (80°F) and nighttime temperatures (60°F) with high humidity, which are common throughout much of the growing season in the region. To manage the disease, a combination of cultural practices and routine fungicide applications are used throughout the season. Typically fungicides are applied on a fixed interval every 14 to 21 d from May through October, resulting in 7 to 10 fungicide applications annually.

Recently, a dollar spot forecasting model known as the Smith-Kerns Model was developed by Drs. Damon Smith and Jim Kerns. The model calculates the potential risk of dollar spot symptoms to develop, based on average air temperature and relative humidity. Use of an effective dollar spot forecasting model could help turf managers time fungicide applications to go out only when the likelihood for disease is high. The model has been preliminarily tested in several states throughout the country, however it has not been evaluated in New England. Moreover, additional evaluation of regionally appropriate forecast action thresholds are needed to make recommendations about for the model in New England. Thus, the objectives of this study were to evaluate dollar spot incidence achieved when fungicides are applied at various risk thresholds determined by the Smith-Kerns dollar spot model, and compare the model to conventional calendar based fungicide timings.

MATERIALS & METHODS

A field study was conducted on a 'MacKenzie' creeping bentgrass (*Agrostis stolonifera*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed three days wk^{-1} at a bench setting of 0.5-inches. Nitrogen was applied to the study area as water soluble sources totaling 1.5 lb N $1000\text{-}ft^{-2}$ from April through August. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of various fungicide application intervals including: 5 dollar spot forecast model risk thresholds (10, 15, 20, 25, and 30% risk thresholds), calendar-based every 14-d, every 28-d, and an untreated control. A tank mix of Secure (0.5 fl.oz.) and Velista (0.3 oz.) were applied at each of the specified risk thresholds, or specified calendar-based intervals. Initial applications for calendar-based and model-based treatments were made on 14-May, except the highest risk treatment which was first applied on 1 June. Model-based treatments were reapplied when specified risk thresholds were reached; although re-applications were withheld for 21-d following fungicide application regardless of model forecast. Treatments were reapplied at specified intervals through 6 October.

All treatments were applied using a hand held CO_2 pressurized spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal $1000\text{-}ft^{-2}$ at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with 9 replications.

Dollar spot incidence was assessed as a count of individual disease foci within each plot every 7 days from 26 June to 28 August. However, only monthly dollar spot data are presented here for brevity. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Dollar Spot Incidence

Dollar spot pressure was relatively low throughout the duration of the study likely due to below average precipitation for the year. Symptoms were first observed in untreated controls on 26 June, however disease incidence remained low, increasing to a maximum of 35 spots per plot by 25 September (Table 1). No fungicide treated plots contained more than 1 dollar spot per plot throughout the duration of the study. Unfortunately, the limited disease pressure in this study did not provide for a rigorous evaluation of the Smith-Kerns model this year.

All treatments reduced disease compared to the untreated control, regardless of application interval on all evaluation dates. Generally, few differences were observed between application intervals during the year. Small differences were apparent on the last two rating dates (28 August & 25 September); however all intervals had ≤ 1 dollar spot on these dates, and no consistent trend among intervals on these dates was apparent. Indicating that in practice, under low disease severity, all intervals may provide acceptable disease control.

While few differences in disease control among application intervals were observed, considerable differences in the total number of fungicide applications occurred. As many as 10 applications were made on a 14-d interval and 7 applications on a 21-d interval from 15 May to 6 October. Fungicides applied based on the model at conservative risk forecasts (i.e., 10 to 20%) resulted in 7 total applications. Moderate to higher risk thresholds of 25 or 30% reduced the total number of applications to 6 and 5 for the year, respectively. Since all application intervals maintained disease at < 1 dollar spot per

18 ft^{-2}, it appears that the model does have the potential to reduce the number of fungicide applications required. This is particularly true during years with low disease pressure. While the results of the model from this year seem promising for providing guidance on fungicide timing for effective disease control, it is important to consider that disease pressure in this study was very low. This study must be repeated to determine whether use of risk action thresholds as high as 30% would provide reliable disease control during years with greater dollar spot pressure.

Table 1. Dollar spot incidence influenced by fungicide application intervals based on the Smith-Kerns dollar spot forecast model or calendar based timings on a 'MacKenzie' creeping bentgrass (*Agrostis stolonifera*) turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Application Dates[z]	Total Number of Applications	Dollar Spot Incidence 26 Jun	24 Jul	28 Aug	25 Sep
			---------------- # of foci per 18ft^{-2} ----------------			
Risk Threshold 10%	ACGJLMN	7	0.0 b	0.0 b	0.0 c	0.6 bc
Risk Threshold 15%	ADHKLMN	7	0.0 b	0.0 b	0.0 c	0.4 bc
Risk Threshold 20%	AEIKLMN	7	0.0 b	0.0 b	0.0 c	0.4 bc
Risk Threshold 25%	AEIKLM	6	0.0 b	0.1 b	0.0 c	0.7 b
Risk Threshold 30%	BFJLM	5	0.0 b	0.2 b	0.0 c	0.9 b
Calendar-based (14-d)	14-d interval[y]	10	0.0 b	0.2 b	0.0 c	0.0 c
Calendar-based (21-d)	21-d interval[x]	7	0.0 b	0.0 b	0.6 b	0.0 c
Untreated			0.9 a	2.4 a	15.1 a	34.7 a
ANOVA: Treatment (P > F)			0.0270	0.0001	0.0001	0.0001

[z]A=14 May; B=1 June; C=6 June; D=9 June; E=13 June; F=25 June; G=26 June; H=2 July; I=3 July; J=19 July, K=28 July; L=20 August; M=15 September; N=6 October.

[y]Treatments were made prior to disease development beginning on 14 May. Subsequent applications were made on a 14-d basis on 26 May, 9 June, 22 June, 7 July, 22 July, 7 August, 20 August, 1 September, 15 September, 29 September.

[x]Treatments were made prior to disease development beginning on 14 May. Subsequent applications were made on a 21-d basis on 3 June, 22 June, 14 July, 7 August, 26 August, 15 September, 6 October.

PREVENTIVE DOLLAR SPOT CONTROL USING ROTATIONAL FUNGICIDE PROGRAMS ON A CREEPING BENTGRASS PUTTING GREEN TURF, 2015

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INTRODUCTION

Dollar spot is a common disease of cool-season turfgrasses caused by the fungal pathogen *Sclerotinia homoeocarpa*. On golf course fairways it is characterized by light, straw-colored spots that may coalesce into larger irregularly shaped areas. It is particularly active during periods of warm daytime temperatures (80°F), cool nighttime temperatures (60°F), and high humidity. It can be managed in part with cultural practices such as maintaining moderate nitrogen fertility, reducing leaf wetness period. However, the use of fungicides is often still necessary on high priority areas such as greens, tees and fairways. The objective of this study was to evaluate the efficacy of rotational fungicide programs using new and exisiting DMI and phosphate-based fungicides with a green pigment in controlling dollar spot on a creeping bentgrass fairway turf.

MATERIALS & METHODS

A field study was conducted on a 'Penn A-4' creeping bentgrass (*Agrostis stolonifera*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed five days wk^{-1} at a bench setting of 0.125-inches. Nitrogen was applied at a total of 1.6 lb N $1000\text{-}ft^{-2}$ as water soluble sources from April through October. Acelepryn was applied on 6-June for control of white grubs. Revolution, a wetting agent, was applied on 11 July and 8 August due to dry surface conditions. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of new fungicide formulations and currently available products applied individually, as tank mixes, and/or in rotational program. Initial applications were made on 7 May prior to disease developing in the trial area and when soil temperatures reached 55° F over 5 days at a 2-inch depth. The following application took place on 4 June, and subsequent applications were made on a 14-d interval through 10 September. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9508E flat fan nozzle calibrated to deliver 2.0 gal $1000\text{-}ft^{-2}$ at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Dollar spot incidence was assessed as a count of individual disease foci within each plot from 29 May to 21 September. Turf quality was visually assessed on a 1 to 9 scale; where 9 represented the best quality turf and 6 was the minimum acceptable level. Phytotoxicity was also assessed visually where 0 was equal to no discoloration and 2 represented the maximum acceptable level. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test. Dollar spot incidence data were square-root transformed for ANOVA and mean separation tests, although means presented are de-transformed values.

RESULTS AND DISCUSSION

Dollar Spot Incidence

Dollar spot pressure was moderate to severe throughout the study area, with untreated plots reaching 17 infection centers per plot by 19 June, and peaking at nearly 90 infection centers by mid-August (Tables 1abc). Virtually all treatments provided good to excellent disease control for the duration of the trial, with the exception of Daconil Ultrex applied alone, which peaked at over 30 infection centers in late-August and frequently did not differ from untreated plots.

Chipco Signature + Daconil Ultrex, Signature Xtra + Daconil Ultrex, and Appear + Daconil Ultrex all provided good dollar spot control throughout the trial. These treatments consisted of a fosetyl-Al or phosphite, + chlorothalonil and a green pigment. Signature Xtra is a new fosetyl-Al fungicide containing 60% a.i. and a new formulation of inert ingredients. There was no difference in disease control between the two Signature formulations.

The rotational fungicide programs consisted of an early season DMI fungicide application (7 May), followed by a rotation of various types of fungicides. Rotations 1, 2, and 3 contained a green pigment, whereas rotation 4 contained no pigment. All four rotations provided excellent control of dollar spot, with no difference caused by the presence or absence of pigment.

Phytotoxicity and Turf Quality

Turf quality (Tables 2 a+b) was primarily influenced by disease incidence and phytotoxicity. Following the initial application of Tartan (Rotations 1-3) or Bayleton (Rotation 4), plots displayed slight, albeit acceptable, phytotoxicity as of 22 May (Tables 3 a+b). This effect subsided by 29 May (22 DAT). The following application (4 June) of Mirage (Rotations 1-3) or QP Tebuconazole also yielded a moderate phytotoxic effect that dissipated by 14-28 DAT. Turf quality in late May through mid-June was poor due to this discoloration, though it returned to above acceptable levels by mid-July and remained high for the duration of the trial. Subsequent DMI applications in July and September on these plots did not yield a phytotoxic response.

Chipco Signature + Daconil Ultrex treated plots temporarily displayed unacceptable levels of phytotoxicity beginning 22 days after initial treatment (DAIT), reappearing following all subsequent applications through mid-July. A similar pattern was evident in Appear + Daconil Ultrex. Signature and Appear are phosphonate-based fungicides, and it is possible that the turf was sensitive to this active ingredient. Lower levels of discoloration were apparent in Signature Xtra + Daconil Ultrex, which contains less a.i. than Chipco Signature, as well as Daconil Ultrex + Par and Daconil Ultrex alone. The fact that these tank-mixes contain less (or no) fosetyl-Al or phosphite may partly explain the lesser phytotoxic response.

Copper Spot and Algae Intensity

Copper Spot (Table 5) developed in mid-July and persisted throughout the growing season. All treatments reduced copper spot compared to the untreated control. All of the treatments were successful in total suppression of the disease. Algae formation (Table 5) was also apparent following a couple of dates with heavy rainfall. Plots treated with phosphites had little to no algae.

Table 1a. Dollar spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Application Dates[z]	Dollar Spot Incidence 29 May	8 Jun	19 Jun	26 Jun	10 Jul
			# of spots 18ft^{-2}				
Rotation Program 1			0.0	1.3[y]	1.1 c[x]	0.0 b	0.3 c
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Chipco Signature	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 2			0.0	1.2	0.9 c	0.0 b	0.2 c
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 3			0.0	0.3	0.6 c	0.0 b	0.0 c
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
-UC15-10.	0.2 fl.oz.	EI					
Rotation Program 4			0.0	0.6	2.1 c	0.0 b	0.0 c
-Bayleton	0.95 fl.oz.	A					
-Compass	0.2 oz.	A					
-QP Tebucnazole	0.55 fl.oz.	EIS					
-QP Fosetyl-Al	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Chipco Signature	4.0 oz.	AEGIKMOQS	0.0	2.7	0.6 c	1.7 b	1.2 bc
+Daconil Ultrex	3.2 oz.						
Signature Xtra	4.0 oz.	AEGIKMOQS	0.0	0.4	3.0 bc	2.0 b	2.7 b
+Daconil Ultrex	3.2 oz.						
Appear	6.0 fl.oz.	AEGIKMOQS	0.0	0.2	1.6 c	0.9 b	1.3 bc
+Daconil Ultrex	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.0	0.4	0.6 c	0.2 b	0.5 c
+Par	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.0	0.7	11.5 ab	14.4 a	12.6 a
Untreated			0.0	3.0	16.8 a	19.6 a	24.1 a
ANOVA: Treatment (P > F)			1.0000	0.2778	0.0015	0.0001	0.0001
Most Recent Application			A	E	G	G	I
Days Since Application			22	4	1	8	8

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Dollar spot data beginning on 8 June were log-transformed; means are back-calculated for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 1b. Dollar spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Application Dates^z	Dollar Spot Incidence				
			17 Jul	21 Jul	24 Jul	7 Aug	14 Aug
			# of spots 18ft^{-2}				
Rotation Program 1			0.5^y bcd^x	1.2 bc	0.0 e	0.0 d	0.0 d
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Chipco Signature	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 2			0.7 bcd	0.0 c	0.3 de	0.0 d	0.0 d
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ	0.0 d	0.2 c	0.0 e	0.0 d	0.0 d
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 3							
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
-UC15-10.	0.2 fl.oz.	EI					
Rotation Program 4			0.3 cd	0.4 c	0.0 e	0.0 d	0.2 d
-Bayleton	0.95 fl.oz.	A					
-Compass	0.2 oz.	A					
-QP Tebucnazole	0.55 fl.oz.	EIS					
-QP Fosetyl-Al	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Chipco Signature	4.0 oz.	AEGIKMOQS	3.5 bc	4.0 b	3.0 c	2.0 c	7.8 bc
+Daconil Ultrex	3.2 oz.						
Signature Xtra	4.0 oz.	AEGIKMOQS	4.0 b	3.6 b	2.0 cd	0.8 cd	5.2 c
+Daconil Ultrex	3.2 oz.						
Appear	6.0 fl.oz.	AEGIKMOQS	2.8 bc	1.0 bc	0.8 cde	1.0 cd	3.6 c
+Daconil Ultrex	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	3.7 bc	1.9 bc	0.5 de	0.6 cd	5.1 c
+Par	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	20.0 a	14.5 a	13.7 b	11.9 b	21.4 ab
Untreated			36.2 a	40.8 a	43.0 a	50.6 a	47.1 a
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001	0.0001
Most Recent Application			K	K	K	M	M
Days Since Application			1	5	8	8	15

^{z}Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

^{y}Dollar spot data beginning on 8 June were log-transformed; means are back-calculated for presentation.

^{x}Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

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Table 1c. Dollar spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Application Dates[z]	Dollar Spot Incidence 21 Aug	28 Aug	10 Sep
			-------------- # of spots 18ft⁻² --------------		
Rotation Program 1			0.0[y] d[x]	0.0 d	0.4 de
-Tartan	2.0 fl.oz.	A			
-Mirage SC	1.0 fl.oz.	EIS			
-Chipco Signature	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
Rotation Program 2			0.0 d	0.0 d	0.0 e
-Tartan	2.0 fl.oz.	A			
-Mirage SC	1.0 fl.oz.	EIS			
-Signature Xtra	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
Rotation Program 3			0.0 d	0.3 d	0.0 e
-Tartan	2.0 fl.oz.	A			
-Mirage SC	1.0 fl.oz	EIS			
-Signature Xtra	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
-UC15-10.	0.2 fl.oz.	EI			
Rotation Program 4			0.0 d	0.0 d	0.0 e
-Bayleton	0.95 fl.oz.	A			
-Compass	0.2 oz.	A			
-QP Tebucnazole	0.55 fl.oz.	EIS			
-QP Fosetyl-Al	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
Chipco Signature	4.0 oz.	AEGIKMOQS	3.3 bc	10.6 bc	6.0 bc
+Daconil Ultrex	3.2 oz.				
Signature Xtra	4.0 oz.	AEGIKMOQS	2.2 cd	6.4 c	2.1 cde
+Daconil Ultrex	3.2 oz.				
Appear	6.0 fl.oz.	AEGIKMOQS	2.1 cd	5.9 c	4.7 cd
+Daconil Ultrex	3.2 oz.				
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.6 cd	7.4 c	2.7 cde
+Par	3.2 oz.				
Daconil Ultrex	3.2 oz.	AEGIKMOQS	11.5 b	32.7 ab	25.6 ab
Untreated			89.6 a	87.8 a	64.1 a
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001
Most Recent Application			O	Q	Q
Days Since Application			5	1	14

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Dollar spot data beginning on 8 June were log-transformed; means are back-calculated for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

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Table 2a. Turf Quality influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Application Dates[z]	Turf Quality 22 May	29 May	8 Jun	19 Jun	26 Jun	10 Jul
			------------------------ 0-9; 6=min acceptable --------------------------					
Rotation Program 1			6.8 cd[y]	6.3	4.3 c	6.0 bc	5.8	6.5 bc
-Tartan	2.0 fl.oz.	A						
-Mirage SC	1.0 fl.oz.	EIS						
-Chipco Signature	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
Rotation Program 2			7.0 bcd	6.5	4.8 bc	6.8 abc	5.5	6.8 bc
-Tartan	2.0 fl.oz.	A						
-Mirage SC	1.0 fl.oz.	EIS						
-Signature Xtra	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
Rotation Program 3			7.3 bcd	6.8	4.8 bc	7.0 abc	6.3	7.0 abc
-Tartan	2.0 fl.oz.	A						
-Mirage SC	1.0 fl.oz	EIS						
-Signature Xtra	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
-UC15-10.	0.2 fl.oz.	EI						
Rotation Program 4			6.8 cd	6.0	4.5 c	5.8 c	5.8	6.5 bc
-Bayleton	0.95 fl.oz.	A						
-Compass	0.2 oz.	A						
-QP Tebucnazole	0.55 fl.oz.	EIS						
-QP Fosetyl-Al	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
Chipco Signature	4.0 oz.	AEGIKMOQS	6.5 d	5.8	5.3 bc	6.0 bc	6.3	6.0 cd
+Daconil Ultrex	3.2 oz.							
Signature Xtra	4.0 oz.	AEGIKMOQS	8.8 a	8.3	7.3 a	8.0 a	7.3	8.3 a
+Daconil Ultrex	3.2 oz.							
Appear	6.0 fl.oz.	AEGIKMOQS	6.5 d	5.8	4.8 bc	5.8 c	5.8	6.8 bc
+Daconil Ultrex	3.2 oz.							
Daconil Ultrex	3.2 oz.	AEGIKMOQS	7.5 bcd	7.0	6.3 ab	7.3 ab	6.8	7.5 ab
+Par	3.2 oz.							
Daconil Ultrex	3.2 oz.	AEGIKMOQS	8.0 ab	7.8	6.3 ab	7.5 a	6.0	6.5 bc
Untreated			7.8 abc	7.3	5.8 abc	7.0 abc	5.3	5.0 d
ANOVA: Treatment (P > F)			0.0111	0.0529	0.0161	0.0226	0.0669	0.0090
Most Recent Application			A	A	E	G	G	I
Days Since Application			15	22	4	1	8	8

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2b. Turf Quality influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Application Dates[z]	Turf Quality 17 Jul	24 Jul	14 Aug	21 Aug	28 Aug
			------------------------ 0-9; 6=min acceptable	--------------------------			
Rotation Program 1			6.3 bcd[y]	6.8 c	8.3 ab	7.8 bc	8.0 ab
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Chipco Signature	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 2			7.3 ab	7.3 bc	8.8 a	8.5 ab	8.3 ab
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 3			7.8 a	8.3 a	9.0 a	8.8 a	9.0 a
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
-UC15-10.	0.2 fl.oz.	EI					
Rotation Program 4			6.0 cd	6.8 c	8.0 abc	7.8 bc	7.8 abc
-Bayleton	0.95 fl.oz.	A					
-Compass	0.2 oz.	A					
-QP Tebucnazole	0.55 fl.oz.	EIS					
-QP Fosetyl-Al	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Chipco Signature	4.0 oz.	AEGIKMOQS	5.8 d	7.8 ab	6.8 cd	7.5 cd	6.8 cd
+Daconil Ultrex	3.2 oz.						
Signature Xtra	4.0 oz.	AEGIKMOQS	7.0 abc	8.3 a	7.0 bcd	8.0 abc	7.0 bcd
+Daconil Ultrex	3.2 oz.						
Appear	6.0 fl.oz.	AEGIKMOQS	6.3 bcd	7.8 ab	6.8 cd	7.3 cd	6.8 cd
+Daconil Ultrex	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	7.0 abc	8.5 a	7.3 bc	7.8 bc	7.3 bc
+Par	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	5.5 d	6.8 c	5.8 d	6.8 d	5.8 d
Untreated			3.3 e	4.0 d	3.5 e	2.8 e	2.8 e
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001	0.0001
Most Recent Application			K	K	M	O	Q
Days Since Application			1	8	15	5	1

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 3a. Phytotoxicity influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Application Dates[z]	Phytotoxicity 21 May	26 May	29 May	4 Jun	8 Jun	19 Jun
			------------------------ 0-5; 2=max acceptable					---------------------------
Rotation Program 1			1.0 a[y]	1.0[x] a	0.1 cd	0.0 d	1.8 bc	0.7 bcd
-Tartan	2.0 fl.oz.	A						
-Mirage SC	1.0 fl.oz.	EIS						
-Chipco Signature	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
Rotation Program 2			1.0 a	1.0 a	0.1 cd	0.0 d	1.8 bc	0.2 de
-Tartan	2.0 fl.oz.	A						
-Mirage SC	1.0 fl.oz.	EIS						
-Signature Xtra	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
Rotation Program 3			1.0 a	1.0 a	0.0 d	0.0 d	2.0 abc	0.0 e
-Tartan	2.0 fl.oz.	A						
-Mirage SC	1.0 fl.oz	EIS						
-Signature Xtra	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
-UC15-10.	0.2 fl.oz.	EI						
Rotation Program 4			1.0 a	1.0 a	0.6 bc	0.0 d	2.3 abc	1.0 bc
-Bayleton	0.95 fl.oz.	A						
-Compass	0.2 oz.	A						
-QP Tebucnazole	0.55 fl.oz.	EIS						
-QP Fosetyl-Al	4.0 oz.	GKMOQS						
-Daconil Ultrex	3.2 oz.	GMQ						
-Insignia SC	0.7 fl.oz.	KO						
Chipco Signature	4.0 oz.	AEGIKMOQS	0.6 a	1.3 a	2.2 a	1.8 ab	3.3 a	2.9 a
+Daconil Ultrex	3.2 oz.							
Signature Xtra	4.0 oz.	AEGIKMOQS	0.0 b	0.0 c	0.4 bcd	0.9 bc	0.3 d	1.2 b
+Daconil Ultrex	3.2 oz.							
Appear	6.0 fl.oz.	AEGIKMOQS	1.1 a	1.4 a	1.6 ab	2.1 a	3.0 ab	2.5 a
+Daconil Ultrex	3.2 oz.							
Daconil Ultrex	3.2 oz.	AEGIKMOQS	1.0 a	0.6 ab	0.0 d	0.2 d	1.0 cd	0.0 e
+Par	3.2 oz.							
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.0 b	0.0 c	0.0 d	0.4 cd	1.3 cd	0.2 de
Untreated			0.3 ab	0.1 bc	0.0 d	0.2 d	1.0 cd	0.4 cde
ANOVA: Treatment (P > F)			0.0040	0.0009	0.0004	0.0001	0.0044	0.0001
Most Recent Application			A	A	A	A	E	G
Days Since Application			14	19	22	28	4	1

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

[x]Phytotoxicity data were arc-sin transformed on 26 May, 29 May, and 10 July. Data were log-transformed on 4 June and 19 June. Means are back-calculated for presenation.

Table 3b. Phytotoxicity influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Application Dates[z]	Phytotoxicity 26 Jun	10 Jul	17 Jul	21 Aug
			------------- 0-5; 2=max acceptable	---------------		
Rotation Program 1			0.2 de[y]	0.0[x] b	0.0 c	0.5 abc
-Tartan	2.0 fl.oz.	A				
-Mirage SC	1.0 fl.oz.	EIS				
-Chipco Signature	4.0 oz.	GKMOQS				
-Daconil Ultrex	3.2 oz.	GMQ				
-Insignia SC	0.7 fl.oz.	KO				
Rotation Program 2			0.0 e	0.0 b	0.0 c	0.0 c
-Tartan	2.0 fl.oz.	A				
-Mirage SC	1.0 fl.oz.	EIS				
-Signature Xtra	4.0 oz.	GKMOQS				
-Daconil Ultrex	3.2 oz.	GMQ				
-Insignia SC	0.7 fl.oz.	KO				
Rotation Program 3			0.0 e	0.0 b	0.0 c	0.0 c
-Tartan	2.0 fl.oz.	A				
-Mirage SC	1.0 fl.oz	EIS				
-Signature Xtra	4.0 oz.	GKMOQS				
-Daconil Ultrex	3.2 oz.	GMQ				
-Insignia SC	0.7 fl.oz.	KO				
-UC15-10.	0.2 fl.oz.	EI				
Rotation Program 4			0.2 de	0.0 b	0.1 bc	0.3 bc
-Bayleton	0.95 fl.oz.	A				
-Compass	0.2 oz.	A				
-QP Tebucnazole	0.55 fl.oz.	EIS				
-QP Fosetyl-Al	4.0 oz.	GKMOQS				
-Daconil Ultrex	3.2 oz.	GMQ				
-Insignia SC	0.7 fl.oz.	KO				
Chipco Signature	4.0 oz.	AEGIKMOQS	2.5 a	1.5 a	0.6 a	0.5 abc
+Daconil Ultrex	3.2 oz.					
Signature Xtra	4.0 oz.	AEGIKMOQS	1.2 bc	0.2 b	0.0 c	0.5 abc
+Daconil Ultrex	3.2 oz.					
Appear	6.0 fl.oz.	AEGIKMOQS	2.1 ab	1.0 a	0.4 ab	1.0 a
+Daconil Ultrex	3.2 oz.					
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.0 e	0.0 b	0.0 c	0.0 c
+Par	3.2 oz.					
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.7 cd	0.1 b	0.0 c	0.8 ab
Untreated			0.9 c	0.0 b	0.0 c	0.3 bc
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0056	0.0386
Most Recent Application			G	I	K	O
Days Since Application			8	8	1	7

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

[x]Phytotoxicity data were arc-sin transformed on 26 May, 29 May, and 10 July. Data were log-transformed on 4 June and 19 June. Means are back-calculated for presenation.

Table 4a. NDVI influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft²	Application Dates[z]	NDVI 7 May	29 May	4 Jun	19 Jun	26 Jun
			------------------------ Vegetation Index	--------------------------			
Rotation Program 1			0.703	0.740	0.745	0.771	0.777 bcd[y]
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Chipco Signature	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 2			0.707	0.750	0.747	0.774	0.782 abc
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 3			0.694	0.737	0.746	0.770	0.777 bcd
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
-UC15-10.	0.2 fl.oz.	EI					
Rotation Program 4			0.692	0.743	0.746	0.766	0.779 a-d
-Bayleton	0.95 fl.oz.	A					
-Compass	0.2 oz.	A					
-QP Tebucnazole	0.55 fl.oz.	EIS					
-QP Fosetyl-Al	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Chipco Signature	4.0 oz.	AEGIKMOQS	0.701	0.734	0.726	0.766	0.784 ab
+Daconil Ultrex	3.2 oz.						
Signature Xtra	4.0 oz.	AEGIKMOQS	0.703	0.758	0.735	0.782	0.788 a
+Daconil Ultrex	3.2 oz.						
Appear	6.0 fl.oz.	AEGIKMOQS	0.694	0.739	0.741	0.765	0.780 abc
+Daconil Ultrex	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.693	0.736	0.724	0.770	0.773 cd
+Par	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.699	0.749	0.752	0.777	0.781 abc
Untreated			0.701	0.740	0.741	0.775	0.769 d
ANOVA: Treatment (P > F)			0.4475	0.2033	0.1773	0.0580	0.0435
Most Recent Application			--	A	A	G	G
Days Since Application			--	22	28	1	8

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

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Table 4b. NDVI influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Application Dates[z]	NDVI 17 Jul	24 Jul	14 Aug
			------------ Vegetation Index	-----------	
Rotation Program 1			0.791 ab[y]	0.783 ab	0.808 abc
-Tartan	2.0 fl.oz.	A			
-Mirage SC	1.0 fl.oz.	EIS			
-Chipco Signature	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
Rotation Program 2			0.788 abc	0.784 ab	0.804 a-d
-Tartan	2.0 fl.oz.	A			
-Mirage SC	1.0 fl.oz.	EIS			
-Signature Xtra	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
Rotation Program 3			0.781 a-d	0.783 ab	0.802 a-d
-Tartan	2.0 fl.oz.	A			
-Mirage SC	1.0 fl.oz	EIS			
-Signature Xtra	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
-UC15-10.	0.2 fl.oz.	EI			
Rotation Program 4			0.787 abc	0.788 ab	0.813 a
-Bayleton	0.95 fl.oz.	A			
-Compass	0.2 oz.	A			
-QP Tebucnazole	0.55 fl.oz.	EIS			
-QP Fosetyl-Al	4.0 oz.	GKMOQS			
-Daconil Ultrex	3.2 oz.	GMQ			
-Insignia SC	0.7 fl.oz.	KO			
Chipco Signature	4.0 oz.	AEGIKMOQS	0.781 a-d	0.794 a	0.809 ab
+Daconil Ultrex	3.2 oz.				
Signature Xtra	4.0 oz.	AEGIKMOQS	0.793 a	0.784 ab	0.807 abc
+Daconil Ultrex	3.2 oz.				
Appear	6.0 fl.oz.	AEGIKMOQS	0.768 d	0.787 ab	0.797 bcd
+Daconil Ultrex	3.2 oz.				
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.776 bcd	0.779 bc	0.794 cd
+Par	3.2 oz.				
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.774 cd	0.788 ab	0.793 d
Untreated			0.768 d	0.769 c	0.790 d
ANOVA: Treatment ($P > F$)			0.0083	0.0269	0.0276
Most Recent Application			K	K	M
Days Since Application			1	8	15

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

Table 5. Copper spot incidence influenced by various fungicides applied preventatively on a creeping bentgrass putting green turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Application Dates[z]	Copper Spot Incidence 17 Jul	Copper Spot Incidence 21 Aug	Algae Intensity 26 Jun	Algae Intensity 21 Jul	Algae Intensity 21 Aug
			------- # of spots 18ft^{-2} ------		---------------- 0-5; 0=none ----------------		
Rotation Program 1			0.0[y] b[x]	0.0 b	3.0 b	1.9 b	0.0 b
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Chipco Signature	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 2			0.0 b	0.0 b	3.0 b	1.2 c	0.0 b
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz.	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Rotation Program 3			0.0 b	0.0 b	2.5 b	0.7 d	0.0 b
-Tartan	2.0 fl.oz.	A					
-Mirage SC	1.0 fl.oz	EIS					
-Signature Xtra	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
-UC15-10.	0.2 fl.oz.	EI					
Rotation Program 4			0.0 b	0.0 b	2.5 b	1.2 c	0.0 b
-Bayleton	0.95 fl.oz.	A					
-Compass	0.2 oz.	A					
-QP Tebucnazole	0.55 fl.oz.	EIS					
-QP Fosetyl-Al	4.0 oz.	GKMOQS					
-Daconil Ultrex	3.2 oz.	GMQ					
-Insignia SC	0.7 fl.oz.	KO					
Chipco Signature	4.0 oz.	AEGIKMOQS	0.0 b	0.0 b	0.3 de	0.0 e	0.0 b
+Daconil Ultrex	3.2 oz.						
Signature Xtra	4.0 oz.	AEGIKMOQS	0.3 b	0.0 b	0.5 de	0.0 e	0.0 b
+Daconil Ultrex	3.2 oz.						
Appear	6.0 fl.oz.	AEGIKMOQS	0.3 b	0.0 b	0.0 e	0.0 e	0.0 b
+Daconil Ultrex	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.0 b	0.0 b	1.5 c	0.0 e	0.0 b
+Par	3.2 oz.						
Daconil Ultrex	3.2 oz.	AEGIKMOQS	0.0 b	0.0 b	1.0 cd	0.0 e	0.0 b
Untreated			3.5 a	79.7 a	4.0 a	4.2 a	2.0 a
ANOVA: Treatment (P > F)			0.0001	0.0001	0.0001	0.0001	0.0001
Most Recent Application			K	O	G	K	O
Days Since Application			1	7	8	5	7

[z]Treatments were initiated on 7 May, prior to disease development and when mean soil temperature reached 55 °F for 5 days at a 2-inch depth. Application dates and corresponding letter codes were as follows: A=7 May; E=4 June; G= 18 June; I=2 July; K=16 July; M=30 July; O=14 August; Q= 27 August; S=10 September.

[y]Copper spot data were log transformed on 17 July, data were square-root transformed on 21 August. Means are back-calculated for presentation.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

TOLERANCE OF ONE-YEAR-OLD PERENNIAL RYEGRASS VARIETIES TO GRAY LEAF SPOT IN CONNECTICTUT, 2015

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INTRODUCTION

Gray leaf spot (GLS) is the most devastating disease of perennial ryegrass (*Lolium perenne* L.) turf. The disease is caused by the fungus *Magnaporthe oryzae*, and periodically affects perennial and annual ryegrass during August and September in the Northeast. Initially, symptoms may appear similar to drought stress, with dried, twisted leaf tips. However, symptoms can rapidly progress to thinning of the turf stand and complete collapse of affected areas. In the past 2-3 years, an increase of this disease has been observed in the region wherever ryegrass is grown (e.g., athletic fields, golf courses, residential and commercial lawns).

Perennial ryegrass breeding programs have greatly improved our ability to manage GLS through the development of new tolerant varieties. However, the degree of GLS tolerance of new varieties can vary. The objective of this trial was to evaluate GLS tolerance of several new commercially available varieties and developmental accessions.

MATERIALS & METHODS

A field study was established as lawn turf on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT in 2014. New commercially available cultivars or developmental accessions of perennial ryegrass were seeded on 8 July at 8.0 lbs 1000-ft^{-2}. The study was inoculated in 2014 on 9 August, however the disease did not over-winter in the trial area.

In 2015, the trial area was inoculated on 10 August using a solution of *Magnaporthae oryzae* at a total concentration of 49,969 conidia mL^{-1} applied in a carrier volume of 2 gal 1000-ft^{-2} using a backpack sprayer. Following inoculation, the trial area was covered overnight with a plastic tarp to increase relative humidity and temperatures to promote infection.

2.3 lb N 1000-ft^{-2} was applied to the study area as urea for the duration of the 2015 trial. Velista was applied on 4 August for control of other foliar diseases. The field was mowed at 2.75 inches twice per week. The trial area was irrigated 3 times per day to maintain leaf wetness and encourage disease development.

Gray leaf spot severity was visually assessed on a 1-9 scale; where 9 represented disease-free turf and 5 was the minimum acceptable level, throughout September. Data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Gray leaf spot symptoms first started to appear on 18 August, 8 days after inoculation. Disease progressed slowly however and differences between treatments were only observed on 27 September (Table 1).

Gray Leaf Spot Severity on Single Varieties

Newly seeded perennial ryegrass is more susceptible to gray leaf spot than older, established stands of turf. As such, all varieties provided acceptable levels of disease resistance. A few treatments were completely or nearly disease free (GLS severity of 8.0 or greater, 1=completely blighted and 9=no disease), including 10-LpS96, 11-LpC106, LpS12, BAR Lp10969, Karma, and Karma + RPR. Other varieties that performed very well (GLS severity of 7.0 or greater) include 10-LpS98, 10-LpS113, 11-Lp107, 11-LpC106, BAR Lp10972, and Pirouette II.

GLS Severity on a Susceptible + Resistant Blend

A blend of Karma (4.0 lbs/seed/M) and RPR (8.0 lbs/seed/M) initially provided very good disease tolerance (GLS severity of 8.0) as of 27 September. Karma has excellent resistance to gray leaf spot, whereas RPR is susceptible to the disease. While not totally disease free, this result indicates that it may be possible to use a lesser proportion of GLS resistant grass when creating a blend of various varieties.

Turf Quality Prior to Disease Outbreak

Turf quality was generally very good to excellent in for all varieties as of 21 August with the exception of 12-(06-Lp1 E+) which was established with poor quality seed in 2014.

Table 1. Turf Quality and Gray Leaf Spot incidence in various newly seeded cultivars of perennial ryegrass turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment[z]	Rate per 1000ft^2	Turf Quality 10 Aug	Turf Quality 21 Aug	Gray Leaf Spot Severity 27 Sept
		-- 1-9; 6=min acceptable --		-- 1-9; 9 = no disease --
10-LpS96	8.0 lbs	7.3	7.7 cde	8.7 a
10-LpS97	8.0 lbs	6.3	8.0 bcd	6.3 c-f
10-LpS98	8.0 lbs	7.3	7.7 cde	7.0 bcd
11-LpS113	8.0 lbs	8.7	8.0 bcd	7.3 bc
11-Lp107	8.0 lbs	7.7	8.3 abc	7.0 bcd
12-(06-Lp1 E+)	8.0 lbs	7.3	4.7 g	6.3 c-f
11-LpC106	8.0 lbs	7.7	8.3 abc	8.0 ab
11-LpC108	8.0 lbs	7.7	8.3 abc	7.3 bc
11-LpS126	8.0 lbs	6.7	8.7 ab	6.7 cde
LpS12	8.0 lbs	6.7	8.0 bcd	8.0 ab
LpS12	8.0 lbs	7.7	8.3 abc	6.0 d-g
Lp8	8.0 lbs	7.3	8.3 abc	5.7 efg
BAR Lp10969	8.0 lbs	7.3	9.0 a	7.3 bc
BAR Lp10969	8.0 lbs	7.3	8.7 ab	8.0 ab
BAR Lp10972	8.0 lbs	6.7	8.7 ab	6.7 cde
BAR Lp10972	8.0 lbs	7.3	8.7 ab	7.0 bcd
Pirouette II	8.0 lbs	6.0	8.7 ab	7.0 bcd
Pirouette II	8.0 lbs	8.0	9.0 a	6.7 cde
Barlennium	8.0 lbs	7.7	8.3 abc	6.0 d-g
Barlennium	8.0 lbs	6.3	9.0 a	5.7 efg
Premier II	8.0 lbs	7.3	8.3 abc	6.0 d-g
Premier II	8.0 lbs	7.7	8.3 abc	5.3 fg
Remington	8.0 lbs	5.7	6.0 f	6.7 cde
Remington NEA2	8.0 lbs	8.0	6.0 f	6.7 cde
Bargold	8.0 lbs	7.7	7.3 de	5.0 g
Bargold	8.0 lbs	7.3	7.0 e	5.7 efg
Barblack	8.0 lbs	7.3	8.3 abc	5.3 fg
Barblack	8.0 lbs	8.0	8.0 bcd	6.7 cde
Karma	8.0 lbs	6.0	9.0 a	9.0 a
Karma	4.0 lbs	7.0	9.0 a	8.0 ab
+RPR	8.0 lbs			
ANOVA: Treatment (P > F)		0.5683	0.0001	0.0001
Days after inoculation		0	11	48

[z]Treatments were inoculated on 10 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

TOLERANCE OF JUVINILE PERENNIAL RYEGRASS VARIETIES TO GRAY LEAF SPOT IN CONNECTICTUT, 2015

K. Miele, J. Dunnack, A. Switz, S. Vose, and J. Inguagiato

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INTRODUCTION

Gray leaf spot (GLS) is the most devastating disease of perennial ryegrass (*Lolium perenne* L.) turf. The disease is caused by the fungus *Magnaporthe oryzae*, and periodically affects perennial and annual ryegrass during August and September in the Northeast. Initially, symptoms may appear similar to drought stress, with dried, twisted leaf tips. However, symptoms can rapidly progress to thinning of the turf stand and complete collapse of affected areas. In the past 2-3 years, an increase of this disease has been observed in the region wherever ryegrass is grown (e.g., athletic fields, golf courses, residential and commercial lawns).

Perennial ryegrass breeding programs have greatly improved our ability to manage GLS through the development of new tolerant varieties. However, the degree of GLS tolerance of new varieties can vary. The objective of this trial was to evaluate GLS tolerance of several new commercially available varieties and developmental accessions.

MATERIALS & METHODS

A field study was established as lawn turf on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT in 2015. New commercially available cultivars or developmental accessions of perennial ryegrass were seeded on 17 June at 8.0 lbs 1000-ft^{-2} unless otherwise noted in Table 1.

The trial area was inoculated on 10 August using a solution of *Magnaporthae oryzae* at a total concentration of 49,969 conidia mL^{-}applied in a carrier volume of 2 gal 1000-ft^{-2} using a backpack sprayer. Following inoculation, the trial area was covered overnight with a plastic tarp to increase relative humidity and temperatures to promote infection.

Nitrogen was applied at 1.0 lb 1000-ft^{-2} at seeding as 18-25-5 (14% water soluble N). An additional 2.3 lb N 1000-ft^{-2} was applied as urea over the duration of the trial. Velista was applied on 4 August for control of brown patch. The field was mowed at 2.75 inches twice per week. The trial area was irrigated 3 times per day to maintain leaf wetness and encourage disease development.

Gray leaf spot severity was visually assessed on a 1-9 scale from 4-27 September; where 9 represented disease-free turf and 5 was the minimum acceptable level. Data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Gray leaf spot symptoms first started to appear on 18 August, 8 days after inoculation. Disease progressed slowly but was severe enough to discern meaningful differences between varieties by early September (Table 1).

Gray Leaf Spot Severity on Single Varieties

All varieties showed gray leaf spot symptoms by 4 September with the exception of Karma which was completely free of disease. Despite showing symptoms, several varieties still provided very good control including 10-LpS98, Barlennium, Pirouette II, Remington, Bartrace, 15RAB12, 14LpGLS160, 14-LpGLS163, 14-LpGLS166, and 14-LpGLS167. Most other varieties provided an acceptable level of control at this date with the exception of 12-(06-Lp1 E+).

Many varieties which were providing good or acceptable control earlier in the month began to show worsening symptoms as the epidemic progressed, with a few notable exceptions. As of 27 September, Karma remained disease free. 14-LpS160 maintained the same level of control as before, and 14-LpGLS166 actually improved in terms of disease tolerance. Several varieties no longer provided acceptable disease control, including Barblack, Bargold, Remington NEA2, 15RAE4, 15RAE12, 15RAF2, RAPY8-1, 14LPS172, and RPR.

GLS Severity on a Susceptible + Resistant Blend

A blend of Karma (2.0 lbs/seed/M) and RPR (12.0 lbs/seed/M) initially provided very good disease tolerance as of 4 September. By 27 September, however, disease control was reduced to barely acceptable levels. This suggests that a higher proportion of GLS tolerant varieties may be needed in blends that mix varieties with varying degrees of disease tolerance in order to achieve acceptable levels of control.

Turf Quality Prior to Disease Outbreak

Turf quality was generally acceptable following establishment and prior to disease outbreak on 21 August (Table 2). Exceptions include Remington, Remington NEA2, and 14-LpGLS163, all of which had unacceptable turf quality at this date.

Table 1. Gray leaf spot in various newly seeded cultivars of perennial ryegrass turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

		Gray Leaf Spot Severity	
Treatment[z]	Rate per 1000ft^2	4 Sep	27 Sep
		-- 1-9; 9 = no disease --	
12-(06-Lp1 E+)	8.0 lbs	4.7 g[y]	2.0 n
10-LpS97	8.0 lbs	6.7 b-f	6.0 efg
10-LpS98	8.0 lbs	8.0 ab	6.7 de
12-LpS126	8.0 lbs	7.0 b-e	5.7 fgh
Barblack	8.0 lbs	6.7 b-f	4.7 ijk
Bargold	8.0 lbs	5.3 efg	4.3 jkl
Barlennium	8.0 lbs	7.3 a-d	5.0 hij
Pirouette II	8.0 lbs	7.7 abc	5.3 ghi
Premier II	8.0 lbs	7.0 b-e	5.0 hij
Remington	8.0 lbs	7.7 abc	5.3 ghi
Remington NEA2	8.0 lbs	7.0 b-e	4.0 klm
Bartrace	8.0 lbs	8.0 ab	7.3 cd
15RAE4	8.0 lbs	6.0 c-g	3.7 lm
15RAB12	8.0 lbs	7.3 a-d	3.7 lm
15RAF2	8.0 lbs	7.0 b-e	3.7 lm
RAPY8-1	8.0 lbs	5.0 fg	3.3 m
14-LpGLS160	8.0 lbs	8.0 ab	8.0 bc
14-LpGLS163	8.0 lbs	7.3 a-d	6.3 ef
14-LpGLS166	8.0 lbs	7.3 a-d	8.7 ab
14-LpS172	8.0 lbs	5.7 d-g	4.3 jkl
14-LpGLS167	8.0 lbs	8.0 ab	7.3 cd
Karma	8.0 lbs	9.0 a	9.0 a
RPR	16.0 lbs	6.3 b-g	4.3 jkl
Karma	2.0 lbs	8.0 ab	5.3 ghi
+RPR	12.0 lbs		
ANOVA: Treatment (P > F)		0.0006	0.0001
Days after inoculation		25	48

[z]Treatments were seeded on 17 June and inoculated on 10 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2. Turf quality in various newly seeded cultivars of perennial ryegrass turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

		Turf Quality	
Treatment[z]	Rate per $1000 ft^2$	10 Aug	21 Aug
		-- 1-9; 6=min acceptable--	
12-(06-Lp1 E+)	8.0 lbs	5.0	6.0 def[y]
10-LpS97	8.0 lbs	7.7	6.7 b-e
10-LpS98	8.0 lbs	7.0	6.7 b-e
12-LpS126	8.0 lbs	7.0	7.7 ab
Barblack	8.0 lbs	6.7	7.0 a-d
Bargold	8.0 lbs	5.3	6.0 def
Barlennium	8.0 lbs	7.7	7.3 abc
Pirouette II	8.0 lbs	7.3	7.7 ab
Premier II	8.0 lbs	7.0	7.0 a-d
Remington	8.0 lbs	7.0	5.3 f
Remington NEA2	8.0 lbs	6.3	5.3 f
Bartrace	8.0 lbs	7.3	7.3 abc
15RAE4	8.0 lbs	6.7	7.7 ab
15RAB12	8.0 lbs	8.0	6.7 b-e
15RAF2	8.0 lbs	7.3	7.0 a-d
RAPY8-1	8.0 lbs	7.0	6.7 b-e
14-LpGLS160	8.0 lbs	6.0	6.3 c-f
14-LpGLS163	8.0 lbs	5.0	5.7 ef
14-LpGLS166	8.0 lbs	7.0	7.3 abc
14-LpS172	8.0 lbs	6.7	7.3 abc
14-LpGLS167	8.0 lbs	7.7	8.0 a
Karma	8.0 lbs	7.3	8.0 a
RPR	16.0 lbs	6.7	6.3 c-f
Karma	2.0 lbs	7.0	7.0 a-d
+RPR	12.0 lbs		
ANOVA: Treatment ($P > F$)		0.0944	0.0001
Days after inoculation			

[z]Treatments were seeded on 17 June and inoculated on 10 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

TOLERANCE OF PERENNIAL RYEGRASS VARIETIES TO GRAY LEAF SPOT IN CONNECTICTUT, 2015

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INTRODUCTION

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Perennial ryegrass breeding programs have greatly improved our ability to manage GLS through the development of new tolerant varieties. However, the degree of GLS tolerance of new varieties can vary. The objective of this trial was to evaluate GLS tolerance of several new commercially available varieties and developmental accessions.

MATERIALS & METHODS

A field study was established as lawn turf on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT in 2015. New commercially available cultivars or developmental accessions of perennial ryegrass were seeded on 17 June at 8.0 lbs 1000-ft^{-2} unless otherwise noted in Table 1.

The trial area was inoculated on 10 August using a solution of *Magnaporthae oryzae* at a total concentration of 49,969 conidia mL^{-}applied in a carrier volume of 2 gal 1000-ft^{-2} using a backpack sprayer. Following inoculation, the trial area was covered overnight with a plastic tarp to increase relative humidity and temperatures to promote infection.

Nitrogen was applied at 1.0 lb 1000-ft^{-2} at seeding as 18-25-5 (14% water soluble N). An additional 2.25 lb N 1000-ft^{-2} was applied as urea over the duration of the trial. Velista was applied on 4 August for brown patch control. The field was mowed at 2.75 inches twice per week. The trial area was irrigated 3 times per day to maintain leaf wetness and encourage disease development.

Gray leaf spot severity was visually assessed on a 1-9 scale throughout September; where 9 represented disease-free turf and 5 was the minimum acceptable level. Data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Gray Leaf Spot Severity

All varieties showed gray leaf spot symptoms by 4 September with the exception of 14-LpSGLS164 which was completely free of disease. Despite showing symptoms, several varieties still provided very good to excellent control including 12-12-11-Lp117, 14-12-LpS131, 14-LpSGLS158, 14-LpSGLS159, 14-Lp(4x)GLS162, 14-LpS173, 14-LpSGLS157, 14-LpSGLS161, 14-LpSGLS170, 14-LpSGLS165, BAR Lp10969, BARLp10970, Bargamma, LpS9, Parkside, and Karma. All other varieties provided an acceptable level of control at this date.

Most varieties maintained acceptable levels of control through 27 September, however almost all of them displayed worsening symptoms compared to earlier in the month, with a few notable exceptions. 14-LpSGLS158, 14-LpSGLS157, 14-LpSGLS161, 14-LpGLS165, Parkside, and Karma all maintained very good to excellent levels of disease control through this date. Varieties that no longer provided acceptable levels of control included 14-13-LpSNa145, 14-LpSGLS168, 14-LpSGLS169, 14-12-06LpS2, Barbeta, Bargamma, and LpS9.

Turf Quality Prior to Disease Outbreak

Turf quality was generally acceptable following establishment and prior to disease outbreak on 21 August (Table 2). The sole exception was Grassology (both rates), which established poorly resulting in poor turf quality.

Table 1. Gray leaf spot in various newly seeded cultivars of perennial ryegrass turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

		Gray Leaf Spot Severity	
Treatment[z]	Rate per 1000ft^2	4 Sep	27 Sep
		-- 1-9; 9 = no disease --	
14-12-11-Lp117	8.0 lbs	8.0 abc[y]	5.0 fgh
14-12-LpS131	8.0 lbs	8.0 abc	6.3 cde
14-13-LpSNa145	8.0 lbs	6.0 d	3.0 j
14-LpSGLS158	8.0 lbs	7.7 abc	8.0 ab
14-LpGLS159	8.0 lbs	8.0 abc	7.0 bcd
14-Lp(4x)GLS162	8.0 lbs	8.0 abc	6.0 def
14-LpS173	8.0 lbs	8.0 abc	5.3 e-h
14-LpSGLS157	8.0 lbs	8.3 ab	7.3 abc
14-LpSGLS168	8.0 lbs	7.3 bcd	3.7 ij
14-LpSGLS161	8.0 lbs	8.7 ab	7.3 abc
14-LpSGLS169	8.0 lbs	7.3 bcd	4.7 ghi
14-LpSGLS164	8.0 lbs	9.0 a	7.0 bcd
14-LpSGLS170	8.0 lbs	8.7 ab	5.0 fgh
14-LpSGLS165	8.0 lbs	8.7 ab	7.7 ab
14-12-06LpS2	8.0 lbs	7.3 bcd	3.7 ij
BAR Lp 10969	8.0 lbs	8.3 ab	6.0 def
Barbeta	8.0 lbs	6.7 cd	3.7 ij
BAR Lp10970	8.0 lbs	8.3 ab	6.0 def
Bargamma	8.0 lbs	8.0 abc	4.7 ghi
LpS9	8.0 lbs	7.7 abc	4.3 hi
Parkside	8.0 lbs	8.3 ab	8.0 ab
Karma	8.0 lbs	8.7 ab	8.3 a
Grassology	1.5 lbs	6.7 cd	5.7 efg
Grassology	12.0 lbs	6.7 cd	5.7 efg
ANOVA: Treatment (P > F)		0.0061	0.0001
Days after innoculation			

[z]Treatments were seeded on 17 June and inoculated on 10 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test (α = 0.05).

Table 2. Turf quality in various newly seeded cultivars of perennial ryegrass turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

		Turf Quality	
Treatment[z]	Rate per $1000ft^2$	10 Aug	21 Aug
		-- 1-9; 6=min acceptable--	
14-12-11-Lp117	8.0 lbs	7.3 ab[y]	7.7 a
14-12-LpS131	8.0 lbs	6.7 b	6.3 b
14-13-LpSNa145	8.0 lbs	7.3 ab	7.0 ab
14-LpSGLS158	8.0 lbs	7.3 ab	7.3 ab
14-LpGLS159	8.0 lbs	7.7 ab	7.3 ab
14-Lp(4x)GLS162	8.0 lbs	7.3 ab	7.3 ab
14-LpS173	8.0 lbs	7.3 ab	7.0 ab
14-LpSGLS157	8.0 lbs	7.7 ab	7.7 a
14-LpSGLS168	8.0 lbs	7.3 ab	7.3 ab
14-LpSGLS161	8.0 lbs	8.0 ab	7.3 ab
14-LpSGLS169	8.0 lbs	7.7 ab	7.3 ab
14-LpSGLS164	8.0 lbs	8.3 a	7.7 a
14-LpSGLS170	8.0 lbs	7.0 ab	7.7 a
14-LpSGLS165	8.0 lbs	7.7 ab	7.0 ab
14-12-06LpS2	8.0 lbs	6.7 b	7.3 ab
BAR Lp 10969	8.0 lbs	7.7 ab	7.7 a
Barbeta	8.0 lbs	7.3 ab	7.7 a
BAR Lp10970	8.0 lbs	7.3 ab	7.7 a
Bargamma	8.0 lbs	7.7 ab	7.0 ab
LpS9	8.0 lbs	7.0 ab	7.0 ab
Parkside	8.0 lbs	7.7 ab	7.0 ab
Karma	8.0 lbs	7.7 ab	8.0 a
Grassology	1.5 lbs	1.3 c	3.0 c
Grassology	12.0 lbs	2.0 c	4.0 c
ANOVA: Treatment (P > F)		0.0001	0.0001
Days after treatment			

[z]Treatments were seeded on 17 June and inoculated on 10 August.

[y]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

PREVENTIVE PYTHIUM BLIGHT CONTROL USING NEW AND EXISTING FUNGICIDE FORMULATIONS ON A PERENNIAL RYEGRASS LAWN TURF, 2015

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INTRODUCTION

Pythium blight is a common disease of lawn turf characterized by irregularly shaped spots of reddish-brown turf that may coalesce into larger areas. A dense, gray-white mycelium can be seen in these patches during periods of high humidity. It is particularly active during periods of hot daytime temperatures (> 90°F) and nighttime temperatures ≥ 68°F with high humidity. Some grasses, particularly newly established stands of perennial ryegrass and creeping bentgrass are particularly susceptible to the disease. It can be managed in part with cultural practices such as improving drainage, reducing leaf wetness period and maintaining moderate (but not excessive) nitrogen fertility. However, the use of fungicides is often still necessary on sites with poor drainage, with a history of the disease. The objective of this study was to evaluate the efficacy of new and existing fungicides in controlling Pythium blight on a perennial ryegrass lawn turf.

MATERIALS & METHODS

A field study was conducted on a 6 week old 'Karma' perennial ryegrass (*Lolium perenne*) turf grown on a Paxton fine sandy loam at the Plant Science Research and Education Facility in Storrs, CT. Turf was mowed two days wk^{-1} at a height of 3 inches. Nitrogen was applied to the study area to encourage disease development. A total of 2.75 lb N $1000\text{-}ft^{-2}$ was applied as water soluble sources from May through August. Overhead irrigation was applied as needed to prevent drought stress.

Treatments consisted of new and currently available fungicide formulations and biostimulants. Initial applications were made on 24 June prior to disease developing in the trial area. Treatments were reapplied on 8 and 22 July. Plots were inoculated by pouring 100 mL of grass leaf water cultures infested with *Pythium aphanidermatum* in two separate spots per plot on 13 July. The study area was covered with a germination blanket and watered to encourage disease development. All treatments were applied using a hand held CO_2 powered spray boom outfitted with a single AI9504E flat fan nozzle calibrated to deliver 1.0 gal $1000\text{-}ft^{-2}$ at 40 psi. Plots measured 3 x 6 ft and were arranged in a randomized complete block design with four replications.

Pythium incidence was assessed as a percentage of each plot that was blighted by disease. All data were subjected to an analysis of variance and means were separated using Fisher's protected least significant difference test.

RESULTS AND DISCUSSION

Pythium Incidence

Disease developed inconsistently throughout the trial area, and never reached severe levels for any of the treatments. There were however some differences among treatments. Plots treated with Disarm, Heritage Action, Heritage WG, and Kabuto were not statistically different from an untreated control, which as of 4 August (3 weeks after inoculation), showed 2.5% disease.

Plots treated with Segway or Subdue MAXX (all rates) displayed virtually no disease on any of the rating dates.

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Table 1. Pythium incidence influenced by various fungicides applied preventatively on a perennial ryegrass lawn turf at the Plant Science Research and Education Facility in Storrs, CT during 2015.

Treatment	Rate per 1000ft^2	Int[y]	Pythium Incidence 21 Jul	4 Aug
			---------- % -----------	
Segway	0.9 fl.oz.	14-d	0.7	0.3 bcd[x]
Segway	0.675 fl.oz.	14-d	0.0	0.2 cd
Segway	0.45 fl.oz.	14-d	0.0	0.0 d
Kabuto	0.5 fl.oz.	14-d	1.0	2.6 ab
Kabuto	0.5 fl.oz.	14-d	0.1	1.6 a-d
+Heritage WG	0.1875 oz.			
Impulse	2.0 fl.oz.	14-d	0.3	1.5 a-d
+Omega	0.36 fl.oz.[z]			
+Phosphite 30	0.36 fl.oz.			
Subdue MAXX	0.5 fl.oz.	14-d	0.0	0.2 cd
Subdue MAXX	1.0 fl.oz.	14-d	0.0	0.0 d
Heritage WG	0.2 oz.	14-d	0.5	2.5 abc
Heritage Action	0.2 fl.oz.	14-d	0.1	2.1 abc
Disarm	0.27 fl.oz.	14-d	0.9	3.5 a
Untreated			3.0	2.5 ab
ANOVA: Treatment (P > F)			0.3720	0.0332
Days after treatment		14-d	13	13

[z]Water carrier was adjusted to a pH of 5.5 with Harrell's pH Buffer prior to addition of Omega.

[y]Treatments were initiated on 24 June, prior to disease development. Treatments were reapplied on 8 July and 22 July.

[x]Treatment means followed by the same letter, within each column, are not significantly different based on Fisher's protected least significant difference test ($\alpha = 0.05$).

SURVIVAL OF ADULT JAPANESE BEETLE *POPILLIA JAPONICA* EXPOSED TO *METARHIZIUM BRUNNEUM* (PETCH) F52

Ana Legrand

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INTRODUCTION

Several scarab beetle species are important turfgrass pests in a number of settings such as public landscapes, school grounds and home lawns throughout the Northeast region. The larval stages of these scarab beetles, also known as white grubs, are the most damaging turf insect pests (Villani et al. 1992, Vittum et al. 1999, Koppenhöfer and Fuzy 2008). For example, the Japanese beetle *Popillia japonica* Newman (Coleoptera: Scarabaeidae) is an exotic scarab that has spread gradually and now it is well established in most states east of the Mississippi River (Vittum et al. 1999). This beetle is considered to be the most widespread and destructive insect pest of turf and landscape plants in eastern United States (Potter and Held, 2002).

There are few biological control options commercially available for management of Japanese beetles. The goal of this study was to understand the pathogenicity of *Metarhizium brunneum* (Petch) (Hypocreales: Clavicipitaceae) F52 strain against Japanese beetle adults. *M. brunneum* occurs world-wide and it has been isolated from many insect species in particular from the Coleopteran families Curculionidae, Elateridae and Scarabaeidae (Zimmerman 1993). This fungus infects both larval and adult stages of scarabs such as the Japanese beetle (Lacey et al. 1994) and research has shown the potential for augmentative use against this insect (Krueger et al. 1991, 1992). The safety in the use of this fungus as a mycoinsecticide has been shown to be very acceptable. No toxicological or pathological symptoms have been observed in studies with mammals and there have been no harmful effects on honey bees, earthworms, and Collembola (Zimmerman 1993).

The formulations of typical mycoinsecticides use live conidia as active ingredient. The conidia germinate on the insect cuticle and establish an infection which kills the insect host in 7-21 days depending on temperature and dose (Milner 2000). Entomopathogenic fungi require certain time to initiate infection and succeed in killing the target pests. Thus, it is of interest to understand how dosage and time interact in affecting the survival of the target host. Previous work had examined the impact of the *M. brunneum* F52 strain on Japanese beetle larvae (Ramoutar et al. 2010). However, questions remained on the degree of activity of the F52 strain on the Japanese beetle adults. The objective of this study was to provide information on median lethal times (LT_{50}) for five *M. brunneum* dosages applied to Japanese beetle adults. The LT_{50} is a useful measure in terms of understanding the impact of entomopathogenic fungi on overall survival while considering time and dose effects.

MATERIALS & METHODS

Bioassays were conducted to test the pathogenicity of *M. brunneum* F52 strain on adult Japanese beetles. Technical grade powder was obtained from Novozymes Biologicals, Inc at a concentration of 5 x 10^{10} conidia/g. Japanese beetles were collected using pheromone traps and kept in cages until use in experiments. Beetle survival was examined after exposing insects to the following five *M. brunneum* dosages: 0.5, 1, 2.5, 5, and 10mg/100 beetles. Control sets consisted each of 100 beetles kept with food and under the same environmental conditions as treated beetles. In bioassay A, the survival of 100 beetles per dosage was monitored daily for 11 days. In bioassay B, 100 beetles per dosage were monitored for 30 days at regular intervals. Treated and control beetles were kept in growth chambers at 25^{o}C and under a 16:8 L:D photoperiod. Humidity could not be controlled but was monitored to have a range of 20 - 60% relative humidity. Japanese beetles were fed apple pieces for the duration of the experiments.

Survival analysis was carried out using PROC LIFETEST (SAS 9.4) followed by a Log-rank test of the estimated survival functions. Bonferroni multiple comparisons adjustments were done to compare treatments and the log-log transformation was used in 95% C.L computation for the LT_{50}.

RESULTS & DISCUSSION

The results indicated a difference in survival rates of Japanese beetle when exposed to the treatment doses. The survival functions were significantly different for each bioassay (bioassay A: log-rank test P <.0001, Chi-square = 295.7, D.F. = 5; bioassay B: log-rank test P <.0001, Chi-square = 250.2, D.F. = 5). Table 1 presents Bonferroni-adjusted P values for comparisons between survival functions for each dose and control. There is agreement in most of the treatment comparison results for both bioassays except in comparisons involving the 5mg/100 beetles dose.

The LT_{50} values obtained for the 10 mg dose were the shortest times in number of days leading to 50% survival. Under lab conditions, LT_{50} values of 3 and 5 days were observed for the 10 mg/100 beetles dose (Table 2). The shorter LT_{50} is the most desirable for pest management so the doses below 10 mg are not as effective in producing a quick effect on survival. Field conditions may change these values considering temperature and humidity level fluctuations and their impact on fungal pathogens. The control LT_{50} could only be estimated from the 30 day observation period. In this analysis, observations were right-censored for beetles that were still alive when the experiment was terminated.

The 30 day duration is an appropriate set up to capture information on survival as a function of dose and time. By the end of the 30 day bioassay only 2 treated beetles and 44 control beetles were alive out of a total of 600 tested. However, one could potentially reduce the bioassay time length and capture the relevant information. The 11 day bioassay LT_{50} values were for the most part in agreement with the 30 day test results. Further work will need to be done to verify some of the confidence limit values and to test higher dosages.

Table 1. Survival function comparisons for Japanese beetle adults exposed to *Metarhizium brunneum* F52 and maintained at 25° C.

Multiple Comparisons for the Log-rank Test on Survival Functions			
Treatment Comparison		Adjusted *P* Values[1]	
Dose	Dose	Bioassay A 11 days	Bioassay B 30 days
0.5	1	1.0000	1.0000
0.5	10	<.0001	0.0005
0.5	2.5	1.0000	1.0000
0.5	5	0.2340	0.1449
0.5	Control	<.0001	<.0001
1	10	<.0001	0.0330
1	2.5	1.0000	0.1365
1	5	0.0338	1.0000
1	Control	<.0001	<.0001
10	2.5	<.0001	<.0001
10	5	0.0026	1.0000
10	Control	<.0001	<.0001
2.5	5	1.0000	0.0005
2.5	Control	<.0001	<.0001
5	Control	<.0001	<.0001

[1] Bonferroni multiple comparison adjustment.

Table 2. LT_{50} values for Japanese beetle adults exposed to *Metarhizium brunneum* F52 and maintained at 25° C.

	Bioassay A 11 days		Bioassay B 30 days	
Treatment Dose mg/100 beetles	LT_{50}	95% CL	LT_{50}	95% CL
0.5	7[1]	7-8	8	n.c.[2]
1	7	7-8	8	n.c.
2.5	7	6-7	10	8-10
5	6	6-7	8	3-8
10	5	n.c.	3	n.c.
Control	n.c.	n.c.	30	n.c.

[1] Median survival time in days when 50% of beetles did not survive.
[2] Values not computed. Log-log transformation employed.

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ACKNOWLEDGEMENTS

Support for this study was provided through the Multistate Hatch Project NE-1026 (Discovery of entomopathogens and their integration and safety in pest management systems) funding to A. Legrand. We are grateful to Novozymes Biologicals Inc. for providing *Metarhizium brunneum* F52 and to Michelle Gelinas and Dan Galtieri for technical assistance.

EVALUATING ALTERNATIVE PESTICIDE-FREE ATHLETIC FIELD MANAGEMENT STRATEGIES FOR NEW ENGLAND, 2015

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INTRODUCTION

As of July 1, 2010, the state of Connecticut banned the use of all lawn care pesticides on athletic fields at public and private schools that service pre-K through 8th grades. This legislation has caused great concern for athletic field managers due to the traffic athletic fields endure and the liability associated with their use. However, very little research based information is available regarding managing athletic fields without the use of pesticides.

Athletic fields are in a constant state of re-establishment due to their high use and intensity of traffic. This persistent turfgrass wear and reduction in turfgrass cover creates a competitive environment. Turfgrass diseases and/or insects may turn a well-established turfgrass stand into an unstable playing surface. Biological controls for turfgrass diseases and insects have shown promise, but maintaining a sufficient population of the beneficial organisms to be effective can be challenging. This combined with the prohibitive cost of application has reduced the turfgrass managers' confidence in these types of pest control strategies.

The best turfgrass species for a cool-season athletic field has traditionally been a mixed stand of Kentucky bluegrass and perennial ryegrass. The rhizomatous growth habit of Kentucky bluegrass combined with the fast germination and development of perennial ryegrass has been considered ideal. However, excessive wear and subsequent weed competition during periods of low recuperative growth for cool-season grasses can negatively impacted athletic field quality. The genetic improvements of several warm-season turfgrass species merit revisiting the question of the best turfgrass species for cool-season athletic fields, most notably the use of bermudagrass. Bermudagrass spreads by both rhizomes and stolons and is extremely aggressive during its active growth period (i.e. summer). In previous experiments, Japanese beetles have shown a preference to laying their eggs in some cool-season grasses compared to common and hybrid bermudagrasses (Wood et al., 2009). Bermudagrass offers a number of desirable qualities that could be potentially beneficial under environmental conditions in Southern New England.

Topdressing natural turfgrass playing surfaces with crumb rubber has been researched since the mid-1990s. Previous research has revealed significant advantages to adding crumb rubber to a turfgrass system such as improving traffic tolerance, preserving soil physical properties, and maintaining surface playing characteristics. Benefits have included increased turfgrass density, faster spring greenup, greater root mass, lower surface hardness and lower soil bulk density values (Rogers et al., 199; Baker et al., 2001; and Goddard et al., 2008). However, the potential synergistic effects of alternative athletic field turfgrass species and crumb rubber topdressing on turfgrass cover, weed population and playing surface characteristics have not been researched in New England. Crumb rubber located at the playing surface may likely increase surface temperatures, potentially extending the growing season for bermudagrass; warming soils sooner in the spring and keeping them warm later in the fall. Additionally, the stoloniferous/rhizomatous growth habit of the bermudagrass can help form a dense contiguous community with the crumb rubber layer at the surface potentially suppressing competing weeds.

The objectives of this research were to determine the effect of turfgrass species and crumb rubber topdressing on; 1) turfgrass color, quality, cover and weed populations and, 2) playing surface characteristics (surface hardness and traction) for athletic fields subjected to simulated traffic.

MATERIALS AND METHODS

The research was separated into two separate studies (warm-season and cool-season grasses). A randomized complete block design arranged in a 4 x 2 x 2 factorial with three replications was utilized for each study. The first factor in each study was turfgrass species. The warm-season study consisted of three bermudagrass cultivars; 'Riviera', 'Yukon', and 'Latitude 36' (seeded/sprigged June 20, 2013) and one perennial ryegrass cultivar, 'Fiesta 4' perennial ryegrass (seeded on September 13, 2013). The cool-season study consisted of 'Supranova', supina bluegrass, 'Granite' Kentucky bluegrass,' Mustang 4' tall fescue and 'Fiesta 4' perennial ryegrass (seeded on May 30, 2013).

Figure 1. 'Latitude 36' bermudagrass was established via sprigs while two other varieties, 'Yukon' and 'Rivera' were seeded.

The second factor, crumb rubber topdressing had two levels; 1) yes, 2) none and was the same for both studies. In late September, 2013, crumb rubber (10/20 mesh) was applied to the cool-season study at a rate of 0.75 inch per plot and to the warm-season study at a rate of 0.5 inch per plot. The perennial ryegrass in the warm-season study was seeded at a later date than the bermudagrass and was therefore less established at the date of the crumb rubber application and only received half the application of rubber required in the fall of 2013. The additional half application of rubber was added in the May of 2014.

The third factor, management had two levels; 1) minimal pesticides applied, and 2) no pesticides and was the same for both studies. The cool-season, minimal pesticide treatments received Tupersan 470 granules at a rate of 3lbs/1000ft^2 at seeding for pre-emergent crabgrass control. SpeedZone (5pts/acre) and Drive 75 DF (1lb/acre) were applied to the minimal pesticide plots each year for post-emergent control of seasonal grassy and broadleaf weeds. The cool-season study received an application of Compass 50WDG (0.25 oz/1000ft^2) on 15 June, 2013 to all plots as a curative for pythium foliar blight. Heritage TL (1 fl oz/1000ft^2) and Daconil Ultrex (3.2 oz/1000ft^2) was applied on 19 September, 2013 to the cool-season minimal pesticide plots to control gray leaf spot. Velista (0.5 oz/1000ft$^{2)}$ was applied to the cool-season plots on 19 June, 2015 as a broad spectrum fungicide. The warm-season study required no fungicide or herbicide applications during the establishment phase. Acelepryn G (1.15lbs/1000ft^2) was applied each year of the study as a preventative insecticide treatment to the minimal pesticide plots to both the cool and warm-season studies.

Figure 2. Modified greens aerator used to simulate traffic on athletic playing fields.

Both studies were maintained as an irrigated athletic field and mowed three days a week. The warm-season study was mowed at a height of 1.25 inches and the cool-season study was mowed at 2.5 inches. The warm and cool season study areas received a starter fertilizer (18-24-12for a total of 0.72lbs of N) application when initially seeded/sprigged and every 14-30 days throughout the growing season (May-October). Urea (45-0-0) was applied at a rate to achieve 0.5lbs N 1000ft^{-2} per application for a total of 4.22 lbs. N 1000ft^{-2} in 2013 and 4.0 lbs. N 1000ft^{-2} in 2014 for each study. All plots had simulated traffic applied two times a week during from mid-May through mid-November each year.

Digital image analysis was utilized in assessing turfgrass color and cover. Controlled light conditions were provided through the use of a light box. Images were scanned using Sigma Scan Software using the following threshold values; hue=55-125 and saturation=10-100. The Dark Green Color Index (DGCI) was calculated based on hue, saturation and brightness values. Color and quality data were collected on a biweekly basis.

RESULTS AND DISCUSSION

Warm-Season Study

All varieties of bermudagrass were initially aggressive in their growth. Bermudagrass species went into dormancy earlier in the fall than cool-season grasses. The 'Yukon' variety went into and came out of dormancy earlier than the other two varieties.

After two harsh winters, the bermudagrass plots were unable to completely recover to a functional playing surface (Figure 3). Plots receiving rubber did regenerate more quickly than plots without rubber (Figure 4). However, the level of recovery was still unacceptable for an athletic field playing surface. The use of rubber also increased density and slightly reduced the percentage of weeds found in plots during the summer months. However, crumb rubber should not be considered a method of weed control. The use of pesticides decreased weeds and increased density during the summer months.

Bermudagrass was unable to maintain sufficient cover during the majority of the season in New England when athletic fields would be most used. Therefore, bermudagrass with the varieties that are currently available is unlikely to be recommended as a stand-alone turfgrass for athletic field surfaces in Connecticut. Cold and wear tolerance are still a major concern. However more research is warranted for the possibility of using mixtures of bermudagrass with cool-season grasses for overseeding each year.

Figure 3. Warm-season plots on June 24, 2015. The bermudagrass had significantly less cover compared to the perennial ryegrass plots. Due to early dormancy and poor winter recovery, a bermudagrass monostand would likely not be considered acceptable aesthetically in Southern New England.

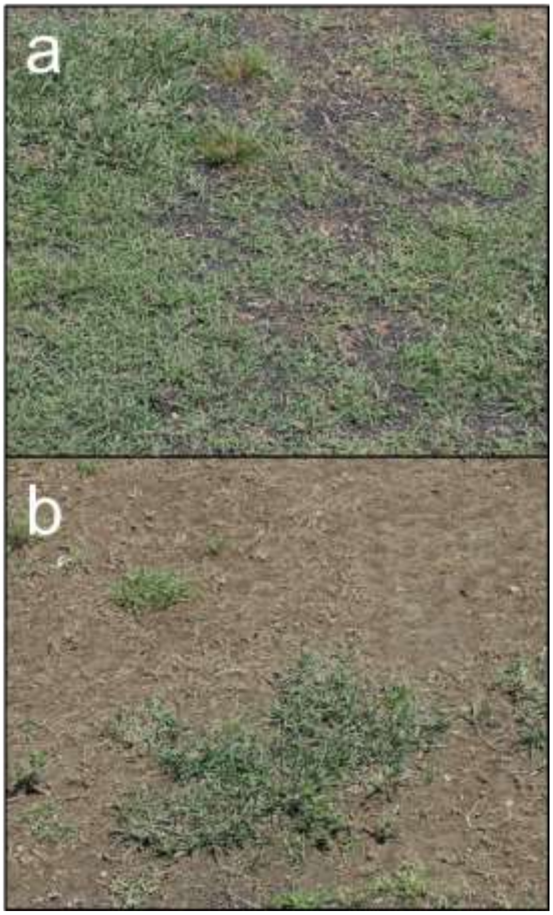

Figure 4. 'Yukon' bermudagrass a) with rubber and b) without on June 24, 2015. Due to the inablility of bermudagrass to recover it is not likely to be uitilzed as a monostand in Southern New England.

Cool-Season Study

The cool-season plots required two curative fungicide applications and two post emergent herbicide applications during the establishment phase. The use of pesticides decreased weed pressure throughout the season and crumb rubber reduced weeds during the hottest summer months for all grasses

Supina bluegrass showed increased cover and quality compared to the other cool-season grasses throughout the growing season. However, plots did show drought stress without additional water during periods of insufficient rainfall, when other cool-season plots were not as affected. Supina bluegrass plots showed increased weed pressure and decreased color without applications of pesticides or crumb rubber; but, showed excellent wear tolerance and retained cover throughout the entire experiment.

Perennial ryegrass preformed much better visually than the other grasses with regards to initial establishment and was able to maintain acceptable color and quality throughout the experiment. Kentucky bluegrass also maintained acceptable color and quality throughout the growing season.

Tall fescue had the least percent cover after two years of trafficking regardless of pesticide use (Figure 5). Weed encroachment was significantly greater in tall fescue compared to the other three turfgrasses. Cool-season turfgrasses required more chemical applications than the warm-season turfgrasses. Neither study was overseeded during the duration of the experiment.

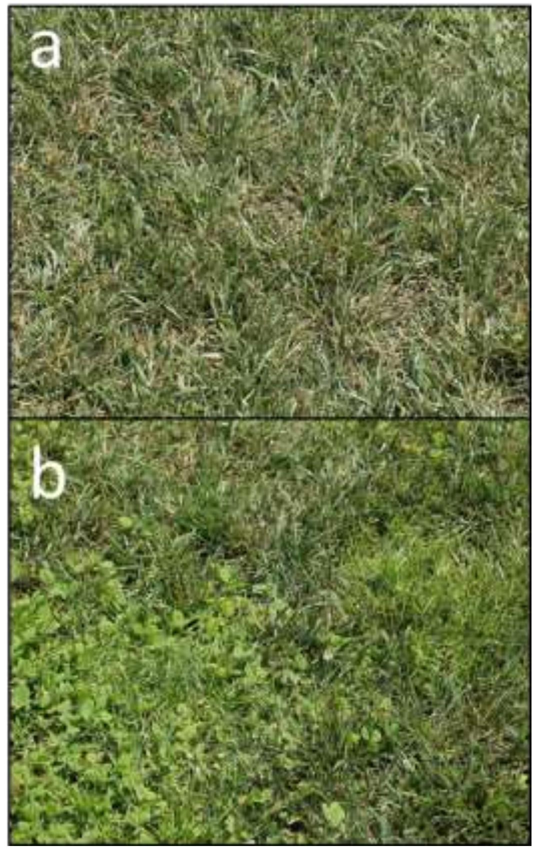

Figure 5. Tall fescue with minimal pesticides and without pesticides on June 24, 2015. Percent cover is reduced compared to monostands of other cool-season grasses.

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THE EFFECT OF NITROGEN SOURCE AND TOTAL NITROGEN ON COLOR AND QUALITY OF KENTUCKY BLUEGRASS, 2015

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INTRODUCTION

Each year an estimated 13 million tons of nitrogen fertilizer are applied in the United States (USDA-ERS, 2011). While the vast majority of this fertilizer is used for agricultural purposes, suburban landscapes are a significant portion of the fertilizer industry. Homeowners are often given general nitrogen recommendations with little regard to source or application timing. Currently standardized nitrogen testing methods are not readily available to homeowners and therefore, soil is not commonly tested for nitrogen content. Improper application can lead to inefficient use of nutrients and nitrogen loss via volatilization or runoff. Excess nitrogen can cause a number of environmental problems such as: contaminated drinking water and eutrophication.

Slow release technologies have been shown to improve nitrogen use and effectiveness in turfgrasses (Guillard and Kopp, 2004; Knight Huckaby et al., 2012). It also has been shown that as solubility of nitrogen increases, so does the potential for leaching (Easton and Petrovic, 2004).

This study was designed to examine seven nitrogen sources with varying solubility applied at 0.45 to 1.81kg nitrogen per year, and determine color and quality of the turfgrass stands throughout the growing season. The objective of this study was to maintain turfgrass color and quality throughout the growing season while minimizing the total nitrogen applied each year.

MATERIALS AND METHODS

A two year old sward of Kentucky bluegrass (Poa pratensis) was maintained as an irrigated athletic field and mowed three days a week at 3.5 inches. A randomized complete block design arranged in a 7 x 4 factorial with three replications was utilized with six additional control plots. The first factor in each study was fertilizer source (Table 1). Nitrogen fertilizers were selected to maximize variation in source and solubility. The second factor was the rate of nitrogen received (Table 2). Plots received either 1, 2, 3 or 4 lbs. N/1000ft2/Year over a growing season. Nitrogen was applied at a rate of 1lb. of nitrogen per year for each application date.

Digital image analysis was utilized in assessing turfgrass color and cover. Controlled light conditions were provided through the use of a light box. Images were scanned using Sigma Scan Software using the following threshold values; hue=55-125 and saturation=10-100. The Dark Green Color Index (DGCI) was calculated based on hue, saturation and brightness values. Color and quality data was collected on a biweekly basis. Plots were evaluated for color and quality using a 1 to 9 rating scale: where 9=outstanding turfgrass, 6=acceptable turfgrass, and 1=brown or dead turfgrass.

RESULTS AND DISCUSSION

Fertilizers that contained slow release nitrogen showed a more consistent color response over the entire season (Figure 1). This is most likely due to a more efficient use of nitrogen throughout the season. Given these results, incorporating a fertilizer that contained a form of slow release nitrogen when fertilizing a home lawn would be recommended.

Plots that received only one or two applications of nitrogen per year (1 or 2 lbs. N/1000ft2/Year) were not able to sustain sufficient color or quality over the growing season (Figure 2). However, plots receiving 3 lbs. N/1000ft2/Year produced acceptable quality throughout the season. Therefore, an additional application of nitrogen to 4 lbs. N/1000ft2/Year may not be necessary.

More education about proper fertilization rates and practices needs to be communicated to homeowners. Information about various release technologies and application rates needs to be made more readily available. UCONN Turfgrass is currently in the process of building and launching a new smart phone application targeted specifically to help consumers with fertilizer selection and calibration. The application will be ready for launch by summer 2016.

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Table 1. Products utilized in this study along with their Nitrogen Analysis, source and availability.

Product	Analysis	Nitrogen Source	Slowly Available
Loveland Urea	46-0-0	Urea	0%
Scotts Turf Builder	32-0-4	Methylene Ureas, Urea, Ammonium sulfate	9%
Lesco SCU	25-0-6	Polymer Coated Sulfur Coated Urea and Urea	11.25%
Hart's Polycoat	30-0-6	Polymer Coated Urea and Urea	15%
Lebanon ProScape MESA	30-0-0	Ammonium Sulfate, Methylene Ureas, Urea	17%
Harrells Polyon	30-0-10	Polymer Coated Urea	18%
AGWAY Corn Gluten	9-0-0	Corn Gluten Meal	100%

Table 2. Dates of application for each level of nitrogen utilized in this study. Nitrogen was applied at 1 lb. N/1000ft2/Year for each application date.

Rate of Nitrogen		Application Date
0 lb/1000ft2	(0 kg/ha)	None
1 lb/1000ft2	(49 kg/ha)	May 30
2 lb/1000ft2	(98 kg/ha)	May 30, Aug. 30
3 lb/1000ft2	(147 kg/ha)	May 30, July 15, Aug. 30
4 lb/1000ft2	(196 kg/ha)	May 30, July 15, Aug. 30, Oct. 15

Figure 1. DGCI measurements for all fertilizer sources broken down by season. Bars with the same lettering are not significantly different according to Fisher's Protected LSD test (P=0.05). CG=Corn Gluten, HT=Hart's Polycoat, JD=Lesco Sulfer Coated Urea, ME=Lebanon ProScape MESA, PY=Harrells Polyon, SC=Scotts Turf Builder, and UR=Loveland Urea.

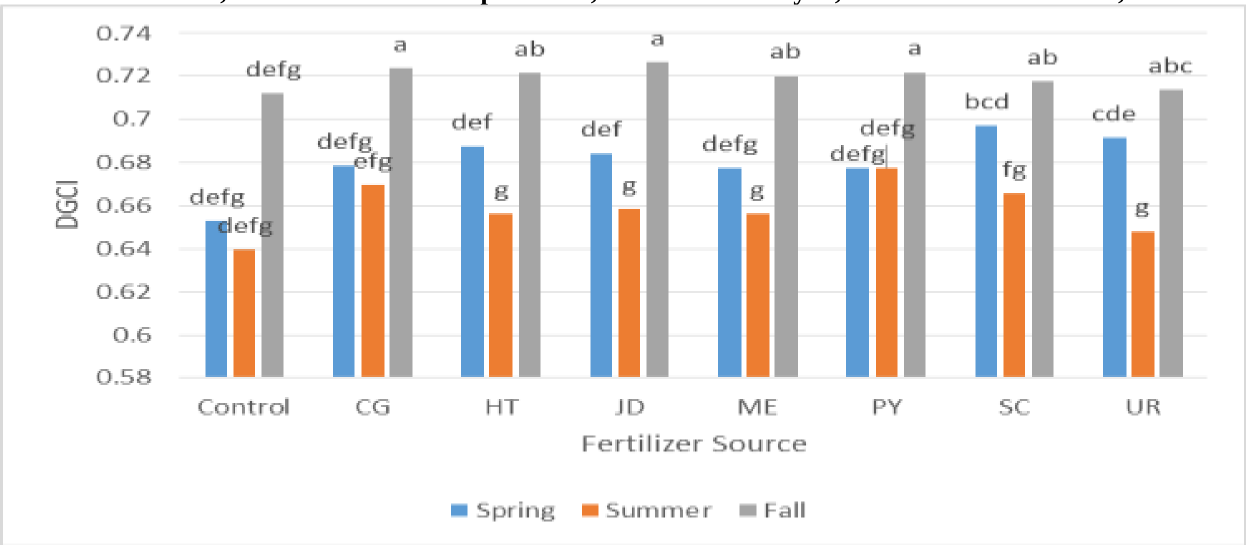

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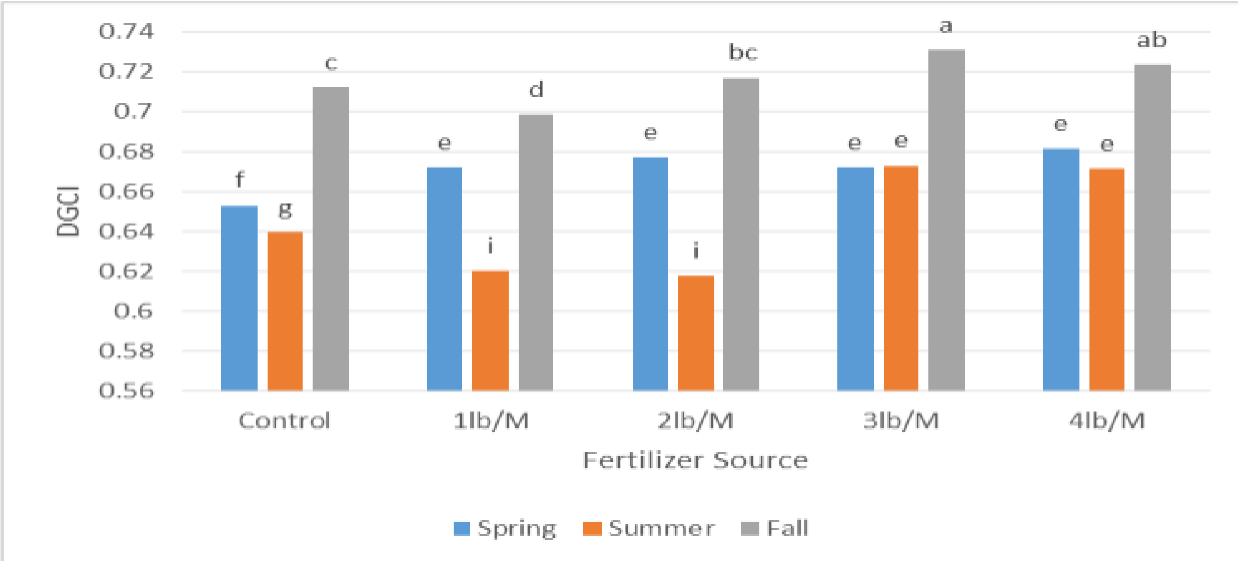
Figure 2. DGCI measurements for all fertilizer sources broken down by application. Bars with the same lettering are not significantly different according to Fisher's Protected LSD test (P=0.05). CG=Corn Gluten, HT=Hart's Polycoat, JD=Lesco Sulfer Coated Urea, ME=Lebanon ProScape MESA, PY=Harrells Polyon, SC=Scotts Turf Builder, and UR=Loveland Urea.



SOLVITA® SOIL TEST KITS TO CATEGORIZE TURFGRASS SITE RESPONSIVENESS TO NITROGEN FERTILIZATION – 2015 RESULTS

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INTRODUCTION

The ability to predict the nitrogen mineralization potential of any turfgrass site would be a valuable tool in nutrient management. Guiding nitrogen fertilization based on an objective soil test should help to avoid too little or too much nitrogen applied to turf that often occurs when using subjective criteria to determine how much nitrogen a turf needs. Insufficient or excessive nitrogen applications can lead to poor aesthetic and functional turf performance, increases in certain diseases and insects, and water quality problems when excess N is applied. The Solvita® company offers two field test kits that have been developed to measure the biologically-active C and N fractions in soil organic matter: the Soil CO_2-Burst and Soil Labile Amino Nitrogen (SLAN) Test Kits, respectively (http://solvita.com/soil). These kits are designed for on-site use, without the need to send soil samples to a laboratory. There is some preliminary evaluation of these kits for field crops that looks promising as guides to N fertilization, but currently there has been no evaluation of these kits on turfgrass soils. The Soil CO_2-Burst Test kit measures the amount of CO_2 that is presumably released from microbial respiration and degradation of the labile-C fraction of the soil organic matter. Soil microbial respiration is positively correlated to soil fertility and crop yield response. It should also function as the same indicator in turf soils with respect to turf growth and quality. The SLAN Test kit presumably measures the labile amino-N fraction of the soil organic matter which should indicate the mineralization potential of the soil. The objective of this research is to determine if these new commercially-available field test kits can categorize turf soils as to their responsiveness to N fertilization.

MATERIALS & METHODS

In September of 2007, an organic composted fertilizer (Suståne 5-2-4, all natural fine grade) was incorporated into the 15-cm depth of 1 × 1 m plots at two adjacent sites at 23 different rates ranging from 0 to 392 kg available N/ha/year. After compost incorporation, one site was seeded to tall fescue (*Festuca arundinacea* cvs. Shortstop II, Dynasty, Crossfire II), and the other was seeded to Kentucky bluegrass (*Poa pratensis* cv. America). The experiments were set out as randomized complete block designs with three replicates. In November of 2008, 2009, 2010, 2012, 2013, and 2014, plots were solid-tined aerified and compost was applied again to the same plots using the same rates, and brushed into the aerification holes. Additional treatments in each year include urea in split applications (May, June, Sept., Oct.) at 49, 98, 147, and 196 kg N/ha/year. The synthetic urea treatments were included so that response of the compost treatments could be matched to that of the synthetic N rate. Urea plots also received 98 kg of K_2O and P_2O_5 at the first urea application in the form of potassium sulfate and triple super phosphate. In early May of 2015 before urea application, soil samples were collected from each plot to a depth of 10-cm below the thatch layer, air-dried, then sieved to pass a 2-mm screen. These samples were analyzed with the Solvita® Soil CO_2-Burst and SLAN test kits. Four grams of soil were used for the SLAN test and 40 grams of soil were used for the CO_2-Burst test. Soils for the CO_2-Burst test were rewetting with 20 mls of deionized water, and incubated at room temperature for 24 hrs. At approximately every two weeks during the growing season, turf color quality was measured using Spectrum CM1000 Chlorophyll and TCM500 NDVI Turf Color meters (Spectrum Technologies, Inc., Aurora, IL). Typically, greener turf is related to higher reading values with these meters. Turf growth (yield of clippings) was collected monthly.

Linear regression models were applied to determine the response of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N as a function of organic fertilizer rates. Linear and linear-response and plateau regression models were used to determine the relationship of mean NDVI readings, mean CM1000 readings and the sum of the clippings yields as a function of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N. The REG procedure of SAS 9.4 (SAS Institute, Cary, NC) was used for the linear models, and the NLIN procedure was used for the linear-response and plateau models. Logistic curves of binary responses for the probabilities of organic fertilizer plot NDVI, CM1000, and clippings yield values equaling or exceeding the mean responses obtained from the 150 and 200 kg N ha^{-1} urea treatments (which would typically be the maximum recommended rates of N for lawns in our climate) in relation to Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations were determined with linear binary logistic models ($a + bx = \{\ln[\pi/(1-\pi)]\}$, where π is the probability of the organic fertilizer response being equal to or exceeding the mean response from the 150 and 200 kg N ha^{-1} urea treatments) using the LOGISTIC procedure of SAS 9.4.

RESULTS

Soil CO_2-C and NH_3-N Concentrations as a Function of Organic Fertilizer Rate

Increasing organic fertilizer rates were generally well correlated with increasing Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations in a significant ($P < 0.001$) linear response (Fig. 1, panels A and B; and Fig. 2, panels A and B). The model fits were better for Kentucky bluegrass than for tall fescue, and better for SLAN NH_3-N than for CO_2-Burst CO_2-C.

Turfgrass Color as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass color, as measured by NDVI and CM1000 meters, was significantly (P < 0.001) and linearly associated with Solvita® CO_2-Burst CO_2-C concentrations (Fig. 1, panels C, D, E, and F). In response to increasing SLAN NH_3-N concentrations, NDVI for both Kentucky bluegrass and tall fescue increased linearly before plateauing at 190 and 157 mg NH_3-N kg^{-1}, respectively (P < 0.001) (Fig. 2, panels C and D). Relative chlorophyll index (CM1000) increased linearly (P < 0.001) with increasing SLAN NH_3-N concentrations (Fig. 2, panels E and F). The model fits were better for Kentucky bluegrass than for tall fescue, and better for SLAN NH_3-N than for CO_2-Burst CO_2-C.

Turfgrass Clipping Yield as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass clippings yield was significantly (P < 0.001) and linearly associated with Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for Kentucky bluegrass and tall fescue (Figs. 1 and 2, panels G and H). The model fits were better for Kentucky bluegrass than for tall fescue, and better for SLAN NH_3-N than for CO_2-Burst CO_2-C.

Predicting Turfgrass Response as a Function of Soil CO_2-C and NH_3-N Concentrations

Inclusion of the urea treatments provide a convenient way to determine an equivalent response obtained from the organic fertilizer treatments, and to predict turfgrass response based on these equivalent responses. Using binary logistic regression, we were able to calculate the probability of equaling or exceeding the mean response of that obtained from the urea 150 and 200 kg N ha^{-1} yr^{-1} rates. These urea rates are typically the maximum recommended seasonal N loading amounts for cool-season turfgrass lawns in our climate; N rates above 200 kg N ha^{-1} yr^{-1} generally would not be recommended for established lawns.

Estimates of the binary logistic regression coefficient parameters and their associated P-values are given in Table 1. As a guide for the reader, the Wald P-values are used to determine the significance of the slope for the logistic regression (considered significant when P < 0.05). The Hosmer-Lemeshow P-value indicates the significance of the goodness-of-fit test. The model is considered a good fit for the data when the Hosmer-Lemeshow P-value >0.05.

Significant (P < 0.001) logistic regression models were found for all variables (NDVI, CM1000, and clippings yield) for both Kentucky bluegrass and tall fescue, and when both species were combined as a function of soil CO_2-Burst CO_2-C concentrations (Table 1). Probability curves indicated that when mean soil CO_2-Burst CO_2-C concentrations were ≤ 66 and ≤ 77 mg kg^{-1}, there was a low probability (P ≤ 0.33) of response equal to or exceeding that of 150-200 kg N ha^{-1} from urea for Kentucky bluegrass and tall fescue, respectively, across the three measured variables (Fig. 3 panels A and B, and Table 2). When mean CO_2-C concentrations were > 66 to 81 mg kg^{-1} for Kentucky bluegrass and > 77 to 112 mg kg^{-1} for tall fescue, there was a moderate probability (P > 0.33 to 0.67) of equaling or exceeding the response obtained from the 150-200 kg N ha^{-1} urea treatments. Mean soil CO_2-C concentrations were ≥ 97 and ≥ 151 mg kg^{-1} were associated with a high probability (P ≥ 0.90) of Kentucky bluegrass and tall fescue responses equaling or exceeding that of 150-200 kg N ha^{-1} from urea, respectively.

Probability curves indicated that when mean SLAN NH_3-N concentrations were ≤ 144 and ≤ 132 mg kg^{-1}, there was a low probability (P ≤ 0.33) of response equal to or exceeding that of 150-200 kg N ha^{-1} from urea for Kentucky bluegrass and tall fescue, respectively (Fig.3 panels D and E, and Table 2). When mean NH_3-N concentrations were >144 to 158 mg kg^{-1} for Kentucky bluegrass and > 132 to 159 mg kg^{-1} for tall fescue, there was a moderate probability (P > 0.33 to 0.67) of equaling or exceeding the response obtained from the 150-200 kg N ha^{-1} urea treatments. Mean soil CO_2-C concentrations ≥ 172 and ≥ 196 mg kg^{-1} were associated with a high probability (P ≥ 0.90) of Kentucky bluegrass and tall fescue responses equal to or exceeding that of 150-200 kg N ha^{-1} from urea, respectively.

When responses from both species were combined, there was a high probability (P ≥ 0.90) of Kentucky bluegrass and tall fescue responses equaling or exceeding that of the 150-200 kg N ha^{-1} urea treatments when mean soil CO_2-Burst CO_2-C concentrations were ≥ 126 mg kg^{-1} and when mean SLAN NH_3-N concentrations were ≥ 198 mg kg^{-1} (Fig. 3 panels C and F, and Table 2).

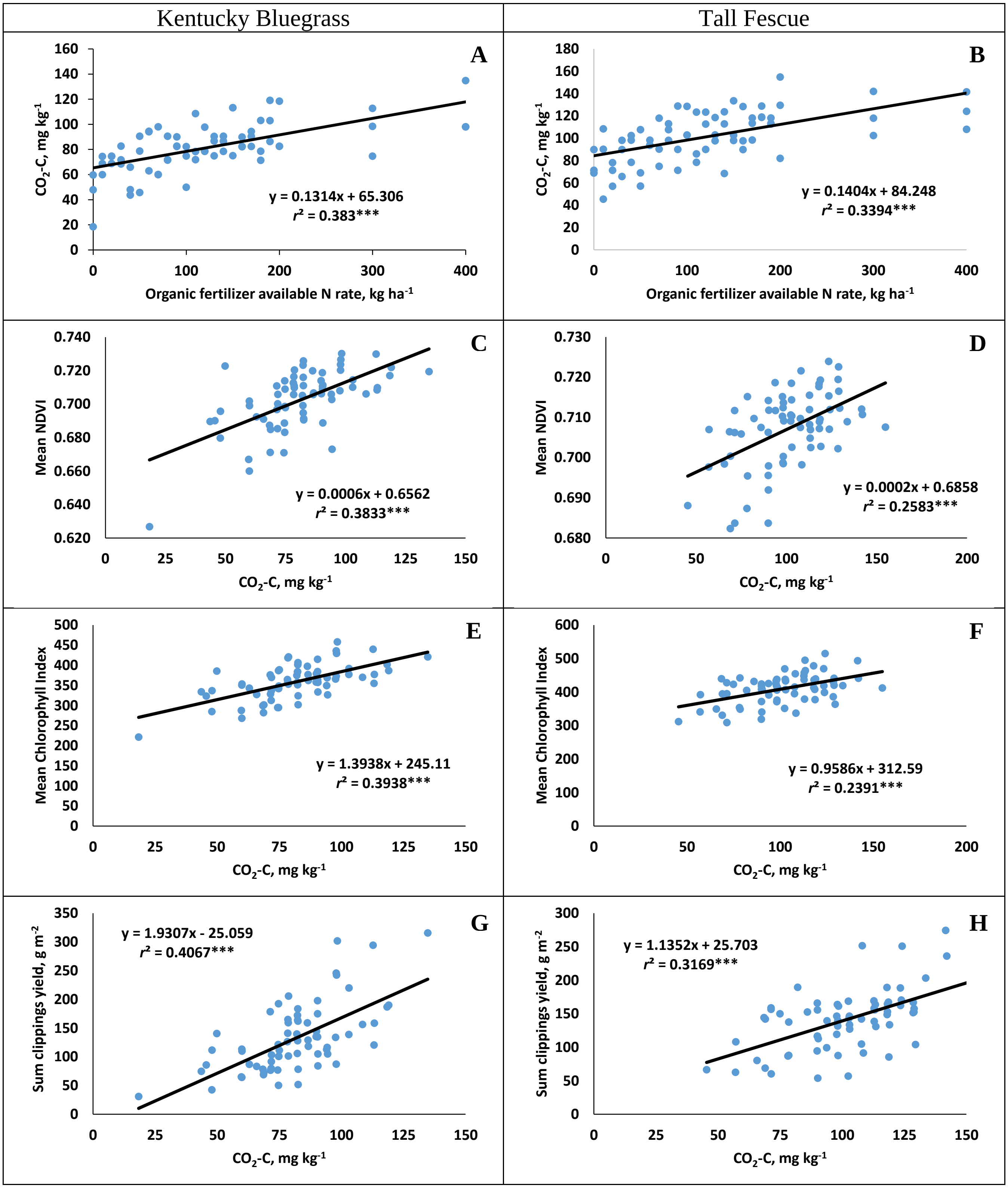

Fig. 1. Effects of organic fertilizer rate (panels A and B) on the production of CO_2-C as measured with the Solvita® CO_2-Burst Test Kit, and relationship between Solvita® CO_2-Burst Test CO_2-C and: NDVI readings from organic fertilizer plots (panels C and D); CM1000 readings from organic fertilizer plots (panels E and F); and clippings yield from organic fertilizer plots (panels G and H). The first column of panels correspond to Kentucky bluegrass (*Poa pratensis*), and the second column of panels correspond to tall fescue (*Festuca arundinacea*). Significance of coefficient of determination (r^2) for the linear response: *** ($P < 0.001$).

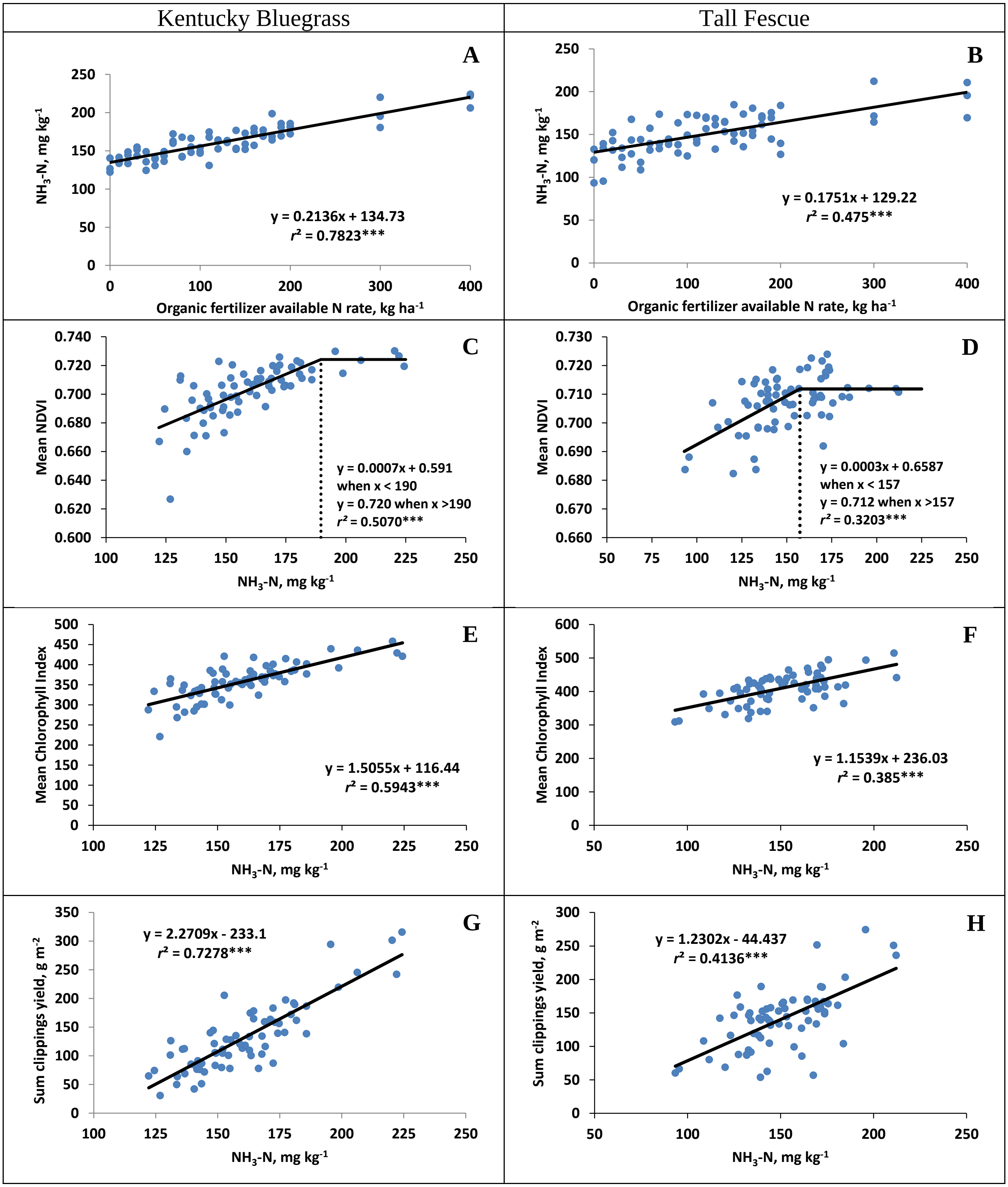

Fig. 2. Effects of organic fertilizer rate (panels A and B) on the production of NH_3-N as measured with the Solvita® Soil Labile Amino Nitrogen (SLAN) Test Kit, and relationship between Solvita® SLAN Test NH_3-N and: NDVI readings from organic fertilizer plots (panels C and D); CM1000 readings from organic fertilizer plots (panels E and F); and clippings yield from organic fertilizer plots (panels G and H). The first column of panels correspond to Kentucky bluegrass (*Poa pratensis*), and the second column of panels correspond to tall fescue (*Festuca arundinacea*). Significance of coefficient of determination (r^2) for the linear or linear plateau response: *** ($P < 0.001$).

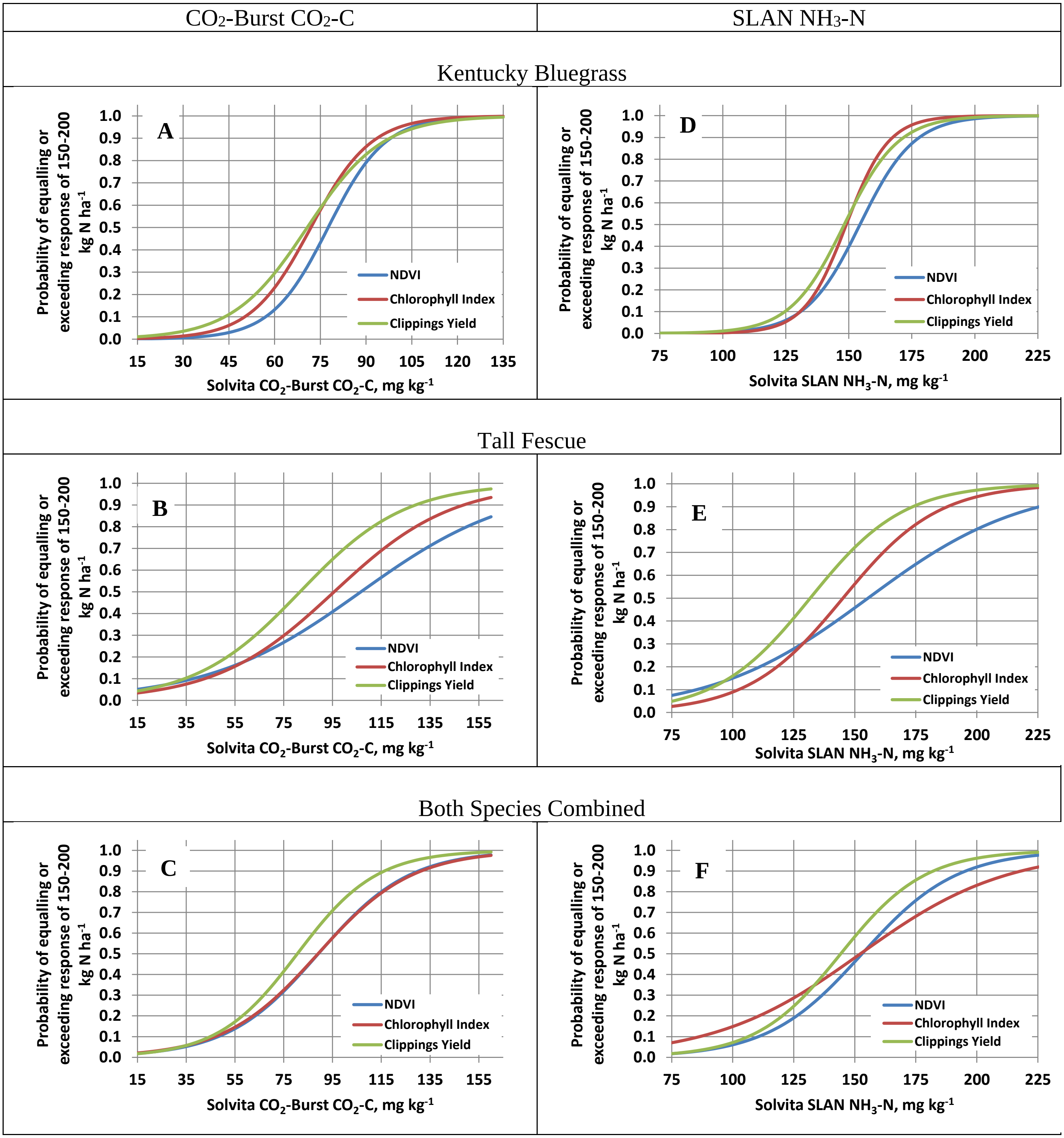

Fig. 3. Probability curves of equaling or exceeding the NDVI, CM1000, and clippings yield values of that obtained from the mean response of urea at the 150 and 200 kg N ha^{-1} rates in relation to Solvita® Soil CO_2-Burst CO_2-C concentrations (panels A, B, and C) and SLAN NH_3-N concentrations (panels D, E, and F) for the 2014 growing season. Mean urea response at the 150 and 200 kg N ha^{-1} rates for NDVI, CM1000, and sum of the monthly clippings yield (g m^{-2}) values were 0.706, 349, and 105 for Kentucky bluegrass, respectively; 0.710, 411, and 129 for tall fescue, respectively; and 0.708, 380, and 117 across both species combined, respectively.

Table 1. Logistic regression coefficients for binary response of NDVI, Chlorophyll Index (CM1000), and clippings yield values being equal to or exceeding the mean response for the urea 150 and 200 kg ha^{-1} treatments for Kentucky bluegrass and tall fescue lawns in relation to Solvita® Soil CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for the 2015 growing season.

	CO_2-Burst Test CO_2-C Concentrations									
	Kentucky bluegrass					Tall fescue				
Variable	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value
NDVI	-8.3070	0.1071	0.0002	0.4675	0.2213	-3.4016	0.0319	0.0114	0.1360	0.3504
CM1000	-7.2832	0.1013	0.0002	0.4438	0.2909	-3.9600	0.0414	0.0023	0.2062	0.9922
Yield	-5.7404	0.0812	0.0005	0.3632	0.2560	-3.789	0.0464	0.0015	0.2361	0.7855

	SLAN NH_3-N Concentrations									
	Kentucky bluegrass					Tall fescue				
Variable	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value
NDVI	-14.409	0.0933	<0.0001	0.4731	0.6073	-4.8640	0.0313	0.0108	0.1412	0.7354
CM1000	-17.824	0.1196	<0.0001	0.5491	0.7660	-7.4608	0.0514	0.0006	0.2847	0.0796
Yield	-13.813	0.0932	0.0001	0.4486	0.8692	-6.8893	0.0523	0.0012	0.2747	0.2808

	CO_2-Burst Test CO_2-C Concentrations					SLAN NH_3-N Concentrations				
	Kentucky bluegrass + Tall fescue combined					Kentucky bluegrass + Tall fescue combined				
Variable	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value
NDVI	-4.7788	0.0536	<0.0001	0.3041	0.3293	-7.924	0.0518	<0.0001	0.2804	0.3022
CM1000	-4.6299	0.0520	<0.0001	0.2925	0.9284	-5.0858	0.0334	0.0002	0.1524	0.3513
Yield	-4.9621	0.0616	<0.0001	0.3467	0.4631	-8.3650	0.0580	<0.0001	0.3087	0.8860

Table 2. Concentrations of Solvita CO_2-Burst CO_2-C and SLAN NH_3-N at selected probabilities of equaling or exceeding the response of 150-200 kg N ha^{-1} using urea for NDVI, Chlorophyll Index (CM1000), and clippings yield (ClipYield) for 2015.

CO_2-Burst CO_2-C concentrations, mg kg^{-1}

	Kentucky bluegrass				Tall fescue				Both species			
P	NDVI	CM1000	ClipYield	Mean	NDVI	CM1000	ClipYield	Mean	NDVI	CM1000	ClipYield	Mean
0.33	71	65	62	66	85	79	67	77	76	76	69	74
0.67	84	79	79	81	128	112	97	112	102	102	92	99
0.90	98	94	98	97	176	149	129	151	130	131	116	126
0.95	105	101	107	104	199	167	145	170	144	146	128	139

SLAN NH_3-N concentrations, mg kg^{-1}

	Kentucky bluegrass				Tall fescue				Both species			
P	NDVI	CM1000	ClipYield	Mean	NDVI	CM1000	ClipYield	Mean	NDVI	CM1000	ClipYield	Mean
0.33	147	143	141	144	133	145	118	132	140	132	132	135
0.67	162	155	156	158	178	153	145	159	166	173	156	165
0.90	178	167	172	172	226	188	174	196	195	218	182	198
0.95	186	174	180	180	249	202	188	213	210	240	195	215

SUMMARY AND CONCLUSIONS

The second-year results of this study suggest that the Solvita® CO_2-Burst and SLAN Test kits show promise in estimating cool-season turfgrass lawn response as a function of CO_2-C and NH_3-N concentrations in soil samples collected in the spring prior to fertilization. Better fits of the data were obtained with the SLAN test kit compared to the results of the CO_2-Burst test kit, but both did reasonably well. The second-year results for SLAN were similar to 2014 results, but 2015 results for the CO_2-Burst test were much better than 2014.

One objective of the research is to establish response categories (Low, Moderate, or High) to guide N fertilization of turfgrass lawns based on concentrations of CO_2-Burst CO_2-C and SLAN NH_3-N concentrations. Concentrations presented in Table 2 can be used as starting benchmark values for these categories for equaling or exceeding the response of 150-200 kg N ha^{-1} urea treatments. When concentrations have $P \leq 0.33$, then the category would be considered 'Low'; when concentrations have $P > 0.33$ to 0.67, then the category would be 'Moderate'; and when concentrations have $P > 0.67$, then the category would be 'High'.

Using Kentucky bluegrass NDVI response for turfgrass color as an example, it would be unlikely that much N fertilizer would be needed when soil CO_2-C concentrations are ≥ 84 mg kg^{-1}, or when SLAN NH_3-N concentrations are ≥ 162 mg kg^{-1} ($P \geq 0.67$, Table 2). When CO_2-C and NH_3-N concentrations exceed 98 and 178 mg kg^{-1}, respectively, there would be only a 10% chance or less that the Kentucky bluegrass NDVI would increase in a response equivalent to 150-200 kg N ha^{-1} to added N fertilization. In these cases, supplemental N should be withheld and applied only in special cases where turf response is less than optimum after growth is monitored before applying N. Application of supplemental N in areas when soil CO_2-Burst and SLAN test kits read high increases the likelihood of N losses from the system and more problems with insect and disease pests.

The 2015 CO_2-Burst SLAN responses are very similar to the trends obtained in previous research on these same plots when predicting turfgrass response to the soil permanganate-oxidizable carbon (POXC) and Illinois Soil N Test (ISNT)-N concentrations obtained from a spring soil sample across 5 years (2008-2012; Geng et al., 2014). SLAN NH_3-N concentrations obtained from archived soil samples from the Geng et al., 2014 study are highly correlated ($P < 0.01$) with the respective ISNT-N concentrations (data not shown). This suggests that the Solvita® SLAN test may have similar predictive power in guiding N fertilization as does the ISNT.

The 2015 data showed consistent results with 2014 data for SLAN NH_3-N concentrations, but CO_2-Burst CO_2-C concentrations were different between 2014 and 2015, with better fits of the data for 2015. As more data are collected, different conclusions and delineation ranges may come forth. However, we are encouraged with the results across two years, and think that the Solvita® tests (especially the SLAN) could provide an objective guide for N fertilization of cool-season turfgrass lawns.

ACKNOWLEDGEMENTS

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KENTUCKY BLUGRASS AND TALL FESCUE LAWN RESPONSE TO SEAWEED EXTRACTS - 2015 RESULTS

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INTRODUCTION

Seaweed (*Ascophyllum* and related species) extracts applied to horticulturally-important plants have been reported to act as biostimumlants for root and shoot growth, increase stress abiotic tolerance, and to act as inducers of plant defenses against pathogens and insect pests (reviewed in Sangha et al., 2014). Several previous research reports have suggested that seaweed extracts applied to turfgrass prior to stress periods reduces stress severity and incidence, and may shorten the recovery period compared to turfgrass that did not receive seaweed extracts (Zhang et al., 2003a,b,c; Zhang and Ervin, 2004, 2008;. Koske and Gemma, 2005; Butler and Hunter, 2007; Xu and Huang, 2010; Zhang et al., 2010).

There is little published information available on turfgrass lawn response to seaweed extracts in southern New England. This research was conducted to determine effects of several commercially-available seaweed extract products, and one experimental product, on the quality of Kentucky bluegrass (*Poa pratensis*) and turf-type tall fescue (*Festuca arundinacea*) lawns.

MATERIALS & METHODS

This was a continuation of studies initiated in 2013. Separate, but adjacent, field plot experiments were conducted on established stands of Kentucky bluegrass and turf-type tall fescue in 2015 on a fine sandy-loam soil. The experiments were set out as randomized complete block designs with three replicates. Treatments consisted of the following seaweed extract products, rates (of the concentrate), and frequency of applications: Sea Green Organics at 1, 2, 3, 4, 5, and 6 fl. oz. per 1000ft^2 every week, and 1, 2, 3, 4, 5, and 6 fl. oz. per 1000ft^2 every two weeks; Ocean Organics Guarantee Organic 0-0-1 and experimental EXP DRX at 3 fl. oz. per 1000ft^2 every week, and 6 fl. oz. per 1000ft^2 every two weeks; Neptune's Harvest Plant Food 0-0-1 at 3 fl. oz. per 1000ft^2 every week, and 6 fl. oz. per 1000ft^2 every two weeks; Sarkli/Repêchage Ltd. AgriForce Standard and AgriForce 50 at 3 fl. oz. per 1000ft^2 every week, and 6 fl. oz. per 1000ft^2 every two weeks; and a tap water control at 3 fl. oz. per 1000ft^2 every week, and 6 fl. oz. per 1000ft^2 every two weeks. The extract concentrate was applied in tap water by using a CO_2-backpack sprayer calibrated to deliver a total volume of 2 gals per 1000ft^2. The same plots used in 2013 and 2014 received the same treatments in 2015. Treatment application was initiated on May 19, 2015. Thereafter, treatments were applied every week or every two-weeks depending on treatment regime through Oct. 1, 2015. The turf was managed as medium to high quality lawn; mowed at a 3-inch cutting height as needed throughout the growing season. Across the growing season in 2015, 1 lb N per 1000ft^2 was applied in May and another 1 lb N per 1000ft^2 was applied in October, using urea (45-0-0) as the N source. Pest control was applied as needed.

Turfgrass color, as indicated by Normalized Difference Vegetative Index (NDVI) was measured with a Spectrum FieldScout CM 1000 NDVI Chlorophyll Meter (Spectrum Technologies, Inc., Aurora, IL) at approximately biweekly intervals, beginning on May 27, 2015 and ending on Oct. 15, 2015. The meter malfunction on 10/15/15 for the Kentucky bluegrass plots; no data were recorded. In general, higher NDVI readings with this meter indicate the more greener the turf. NDVI was chosen to detect effects of seaweed extracts on turf quality, since turf color is sensitive to changes in environmental conditions, especially stress. The nitrogen fertility regime was selected to remove nutrient deficiencies as a limiting factor for turfgrass color. We assumed any changes in turfgrass color would, therefore, be related to abiotic stress conditions.

Mean NDVI readings across all sampling dates were calculated for each individual plot, and the data were analyzed for treatment differences by using analysis of variance with the GLM procedure of SAS 9.4 (SAS Institute, Cary, NC). The MIXED procedure was used to determine differences in species and treatments across dates.

RESULTS

Weather Conditions

No temperature stress was present in the 2015 growing season. Mean maximum monthly temperatures only exceeded 80ºF for one month (August; Table 1). Across the 6 months of the study (May through Oct.) there were only 2 days where maximum temperatures were ≥90ºF; the highest temperature recorded being 92ºF on Sept. 9, 2015. All monthly precipitation amounts were below normal, except for June. Even though supplemental irrigation was not provided, no visual observation of turf drought stress was noted in any month.

Table 1. Mean monthly maximum and minimum temperatures, and precipitation totals during the study period in 2015.

	Temperature			Precipitation	
Month	Mean max. ºF	Mean min.º F	Number of. days ≥90ºF	Sum, inches	Normal, inches
May	73.0	49.3	0	0.66	3.98
June	72.7	55.6	0	7.80	4.45
July	79.7	61.5	1	1.83	3.94
August	80.4	60.8	0	2.96	3.82
September	77.7	56.5	1	3.77	4.09
October	60.3	40.5	0	3.86	4.61

NDVI

Overall, analysis of variance indicated no significant differences in treatment mean NDVI differences within each of the species across the growing season (Fig. 1). Out of 12 sampling dates, only one date in each species showed significant treatment differences in biweekly NDVI, but no consistent treatment effects were seen across the two species at those two dates.

Pooled across the sampling dates (May through October), there was no NDVI differences between species, among the seaweed extract treatments, and no significant interaction between species and treatments. Mean NDVI response for the two species are shown in Fig. 1.

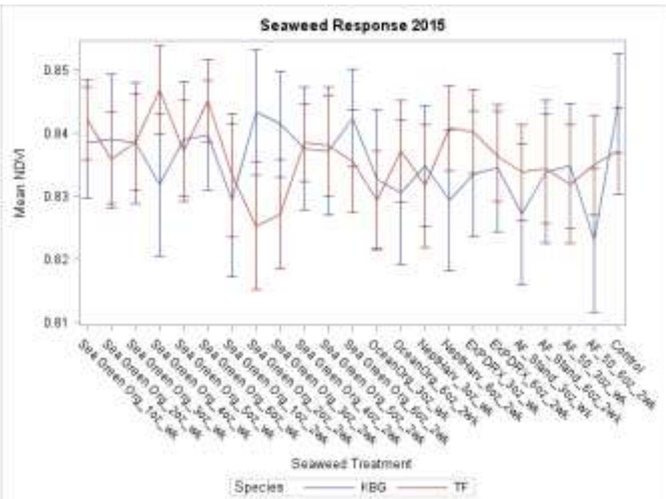

Fig. 1. Mean NDVI across the sampling dates in the 2015 growing season (May through October) for each species (KBG=Kentucky bluegrass; TF=tall fescue) and seaweed extract treatments. Vertical bars for each mean represent the standard errors.

Mean NDVI differences across sampling dates were observed, but this was expected since turfgrass color changes with season (Fig. 2).

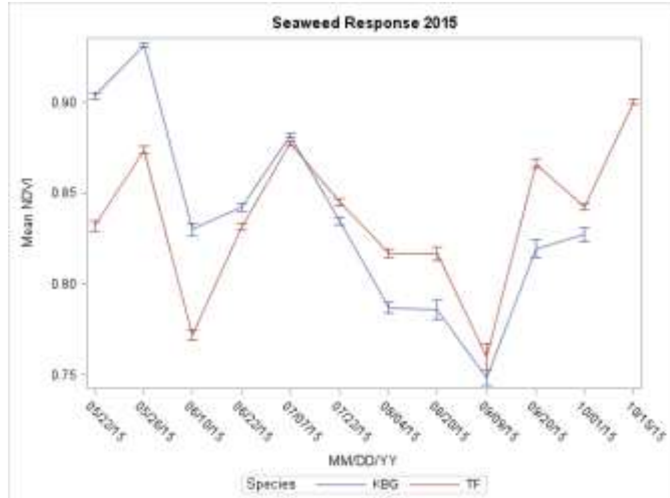

Fig. 2. Mean NDVI across the seaweed extract treatments in the 2015 growing season (May through October) for each species (KBG=Kentucky bluegrass; TF=tall fescue) and sampling date. Vertical bars for each mean represent the standard errors. (note: meter malfunctioned on 10/15/15 for KBG).

SUMMARY

No significant differences in turf color, as measured by NDVI, was observed for either species or between seaweed extract treatments. All products performed equally well, and no better than a tap-water control treatment. We observed no positive or negative effects of seaweed extracts applied to high-cut (3-inch) turfgrass lawns at our location.

ACKNOWLEDGEMENTS

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NATIONAL TURFGRASS EVALUATION PROGRAM (NTEP)
2014 NATIONAL FINELEAF FESCUE ANCILLARY TEST – 2015 RESULTS

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INTRODUCTION

Fineleaf fescues are fine leaf grasses that are medium to dark green in color. The leaves are narrow and "needle like". Fine leaf fescues are often utilized for turf that is grown under low input (fertility, water, etc.) conditions. A few areas/locations where they are often planted would be home lawns, parks, commercial properties, golf course roughs, and roadsides. Desirable characteristics of fineleaf fescues are that they have fine leaf texture, high leaf density, good to excellent drought resistance, low fertility needs, and they exhibit good to excellent shade tolerance. Some of the disadvantages of fine leaf fescues are that they exhibit moderate to poor wear tolerance, become thatchy, and they are slow to recuperate from injury. Fine leaf fescues are typically maintained at mowing heights between 1 to 3 inches. Fine leaf fescues include hard fescue, sheep fescue, creeping red fescue and chewings fescue. Hard, sheep, and chewings fescues are considered bunch type grasses (without rhizomes) while the creeping red fescues (both strong and slender) are both rhizomatous.

Golf course managers continue to face government restrictions and regulations regarding water and pesticide use on their golf course properties. An average eighteen hole golf course may have anywhere from 25 to 40 acres of fairways. Fairways are often irrigated and treated with pesticides. Most golf course fairways are maintained at mowing heights of one half inch. Typical grasses grown on fairways in northern climates are creeping bentgrass, perennial ryegrasses, and compact bluegrasses. The purpose of this study is to investigate the quality of fineleaf fescues maintained at lower mowing heights and subjected to simulated golf cart traffic. Cultivars or species of fineleaf fescues that can be successfully grown at fairway mowing heights, and that can survive under traffic conditions may be a good alternative to the conventional grasses that have higher water and fertilizer requirements.

The National Turfgrass Evaluation Program (NTEP) is sponsored by the Beltsville Agriculture Research Center and the National Turfgrass Federation Inc. NTEP works with breeders and testing sites throughout the United States in evaluating turfgrass species and cultivars. Results from turfgrass evaluations can aid professionals in their selection of turfgrass species/cultivars that best meet their needs. Results also aid breeders in selecting new cultivars that they may put into production, as well as helping in marketing their varieties. In 2014 NTEP selected ten standard testing sites and eleven ancillary test locations for their 2014 National Fineleaf Fescue Test. The University of Connecticut, Plant Science Teaching and Research Facility in Storrs CT, was selected as an ancillary test site investigating traffic tolerance of fineleaf fescue entries maintained at 0.5"mowing height. Evaluations will be made to both trafficked and non-trafficked test plots that are maintained with minimal inputs including supplemental water and fertility.

MATERIALS AND METHODS

Forty two fineleaf fescue plots were seeded on September 4, 2014 in Storrs Connecticut. Of the forty two fine fescue entries: 12 were hard fescues, 10 were strong creeping red fescues, 10 were chewings fescues, 6 were creeping red fescues, 3 were slender creeping red fescues, and 1 was a sheep fescue. A complete randomized block design with 3 replicates of each cultivar was utilized for this study. Plot size is 5' X 5'. Sponsors and entries are listed in Table 1.

As agreed upon by the cooperators, traffic was not applied to plots during the 2015 growing season. This was to allow plots to mature for one growing season before applying traffic.

Management Practices

Since establishment, all plots and cultivars received the same management protocol throughout the study. Management practices for the 2014 grow in and 2015 focused on establishment for the entire season and were as follows:

<u>Fertilizer and pesticide applications establishment 2014</u>
09/04/14 Plots seeded
09/29/14 Starter fertilizer applied 18-24-5 0.1 lb. N/1,000 ft^2
10/30/14 25-0-12 fertilizer 1 lb. N/1,000 ft^2 (60%SCU)
<u>Fertilizer and pesticide applications 2015</u>
05/05/15 Pre-emergent 0.54 oz./1,000 ft^2 Prodiamine 65 WDG
05/12/15 30-0-10 fertilizer 1 lb. N/1,000 ft^2 (60% polyon)
05/30/15 Trimec Bentgrass formula rate 1.5 fl. oz./1,000 ft^2
06/04/15 Acelepryn, 0.367 fl. oz./1,000 ft^2
07/18/15 Heritage TL rate of 1 fl. oz. /1,000 ft^2
11/05/15 25-0-12 fertilizer 1 lb. N/1,000 ft^2 (60% SCU)
<u>Mowing</u> – Plots were maintained at a mowing height of 0.5 inches and mowed three times per week. Clippings were returned.
<u>Irrigation</u> – Irrigation was applied only to prevent severe drought stress.

Establishment Ratings

Establishment ratings were taken and recorded (Table 2) on September 30, 2014, four weeks after seeding. Ratings were based on percent ground cover.

Spring Green-up Ratings

Spring green-up ratings were taken and recorded (Table 2) on April 16, 2015. Green-up measures the transition from winter dormancy to active spring growth. Ratings were based on a scale of 1-9, with 1 equaling brown turf and 9 equaling dark green turf.

Quality Ratings

Turfgrass quality ratings were taken on a monthly basis for overall turf quality (color / leaf texture / density) during the 2015 growing season. Overall turfgrass quality was determined using a visual rating system of 1-9. A score of 1 illustrates the poorest quality turf and 9 the highest quality. Monthly quality and mean quality ratings are provided in table 2.

Percent Living Ground Cover

Ratings were taken and recorded (Table 2) on July 9, 2015. Ratings were based on percent living ground cover. Ratings were taken one time in 2015. Once a traffic regime is established in 2016, percent ground cover ratings will be taken three times per growing season.

Genetic Color Ratings

Genetic color ratings (Table 2) were taken on July 9, 2015 while the grass was actively growing and not under stress conditions. Ratings were based on visual color with 1 being light green and 9 being dark green. Areas of plots that contained browning tissue (chlorosis or necrotic) from outside factors such as disease were not considered for genetic color (Table 2).

RESULTS & DISCUSSION

Results for percent emergence after seeding, spring green up, genetic color, percent living ground cover (mid-summer) and monthly quality ratings, are provided in Table 2.

The University of Connecticut was chosen as a site for the 2014 Fineleaf fescue ancillary trial that will be investing the effect of simulated golf cart traffic (Figure 2) on fineleaf fescue species and cultivars that are maintained at 0.5”. For the entire 2015 growing season, simulated golf cart traffic was withheld to allow for turf to mature. All turfgrass ratings in table 2 are taken without traffic effects. Beginning in April 2016 simulated golf cart traffic will begin. Future ratings will be taken from both, non-trafficked plots and trafficked plots.

Notable differences in the quality and density were observed between species and cultivars during the 2015 season. The hard and sheep fescues, as a group, exhibited the poorest turfgrass quality and lowest percent living ground cover. This could be due to a couple of different factors. One being that sheep and hard fescues take longer to mature when compared to the creeping red or chewings fescue. The second reason for poorer quality and density could be related to mowing height. Sheep and hard fescue typically are grown at higher mowing heights than 0.5”.

Statically there was no significance in mean quality ratings for the top 15 species/cultivars in table 2. Of the top 15 cultivars, there were more chewings fescues than any of the other fine leaf fescue species. Rounding out the top fifteen were, five strong creeping red fescues and two slender creeping red fescues.

Table 1 – Sponsors, Entries, and Species		
SPONSOR	**ENTRY**	**SPECIES**
Landmark Turf and Native Seed	Minimus	Hard Fescue
Landmark Turf and Native Seed	Marvel	Strong Creeping Red
Brett Young Seeds Ltd	7C34	Strong Creeping Red
DLF Pickseed USA	DLFPS-FL/3066	Hard Fescue
DLF Pickseed USA	DLFPS-FRC/3060	Hard Fescue
DLF Pickseed USA	DLFPS-FL/3060	Hard Fescue
DLF Pickseed USA	DLFPS-FRR/3069	Strong Creeping Red
University of Minnesota	MNHD-14	Hard Fescue
DLF Pickseed USA	DLFPS-FRR/3068	Strong Creeping Red
Standard Entry	Quatro	Sheep
Standard Entry	Boreal	Strong Creeping Red
Columbia River Seed	TH456	Hard Fescue
John Deere Landscapes	7H7	Hard Fescue
Columbia River Seed	Sword	Hard Fescue
Standard Entry	Seabreeze GT	Slender Creeping Red
Standard Entry	Radar	Chewings
Standard Entry	Beacon	Hard Fescue
Standard Entry	Navigator II	Strong Creeping Red
Mountain View Seeds	PPG-FL 106	Hard Fescue
The Scotts Company	PPG-FRC 114	Chewings
Mountain View Seeds	PPG-FRT 101	Slender Creeping Red
Mountain View Seeds	PPG-FRR 111	Strong Creeping Red
Mountain View Seeds	PPG-FRC 113	Chewings
Columbia Seeds	Kent	Strong Creeping Red
Columbia Seeds	RAD-FC32	Chewings
Barenbrug USA	BAR FRT 5002	Slender Creeping Red
Barenbrug USA	BAR VV-VP3-CT	Chewings
Barenbrug USA	BAR 6FR126	Chewings
The Scotts Company	C14-OS3	Strong Creeping Red
Brett-Young Seed LTD	RAD-FR33R	Strong Creeping Red
Bailey Seed Company	RAD-FC44	Chewings
Bailey Seed Company	RAD-FR47	Creeping Red Fescue
Pure Seed Testing Inc.	PST-4DR4	Creeping Red Fescue
Pure Seed Testing Inc.	PST-4RUE	Creeping Red Fescue
Pure Seed Testing Inc.	PST-4BEN	Creeping Red Fescue
Pure Seed Testing Inc.	PST-4BND	Hard Fescue
Pure Seed Testing Inc.	PST-4ED4	Creeping Red Fescue
DLF Pickseed USA	DLFPS-FRC/3057	Chewings
Standard Entry	Cascade	Chewings
DLF Pickseed USA	DLF-FRC 33388	Chewings
DLF Pickseed USA	DLF-FRR 6162	Creeping Red Fescue
DLF Pickseed USA	Beudin	Hard Fescue

Figure 1 – 2014 NTEP Fineleaf fescue ancillary low cut/traffic Trials, University of Connecticut (photo- July 2015)

Figure 2 – Golf cart traffic simulator
Design plans courtesy of University of Minnesota, Constructed by the University of Connecticut Technical Services Department
Funded by the New England Regional Turfgrass Foundation

Table 2. Fine Fescue NTEP results 2014 and 2015 for: percent emergence, spring green-up (ratings 1-9, where 9 equals darker green -up, percent living ground cover, genetic color (ratings 1-9, where 9 equals darker green), and turfgrass quality (rating 1-9, where 9 equals the highest turf quality). Table is listed with highest mean quality cultivars listed first

		% Emergence	Spring green up	Percent Living cover	Genetic color	Quality						
Entry no.	Entry	9/30/14	04/16/15	07/09/15	07/09/15	05/13/15	06/11/15	07/15/15	08/12/15	09/16/15	10/12/15	mean
20	PPG-FRC-114	46.0	5.3	85.0	7.3	7.0	6.0	7.0	7.0	8.3	7.7	7.2
38	DLFPS-FRC/3057	50.0	5.3	91.7	7.0	7.0	6.7	7.3	7.0	8.0	7.0	7.2
40	DLF-FRC 3338	41.7	6.0	93.3	7.3	6.7	6.7	7.0	7.0	8.0	7.7	7.2
3	7C34	55.0	5.0	93.3	7.0	7.0	6.3	6.7	7.0	8.0	7.7	7.1
23	PPG-FRC 113	45.0	5.7	88.3	6.7	7.3	6.7	6.3	6.7	7.7	7.0	6.9
29	C14-OS3	50.0	5.0	90.0	6.7	7.3	5.3	6.7	6.7	7.7	8.0	6.9
16	Radar	45.0	5.3	86.7	7.3	7.0	6.3	5.3	6.0	7.7	7.7	6.7
26	BAR FRT 5002	43.3	4.0	85.0	5.7	6.3	6.0	6.3	6.0	7.0	7.3	6.5
31	RAD-FC44	55.0	5.7	80.0	8.0	6.7	6.0	6.0	6.0	6.3	7.0	6.3
9	DLFPS-FRR/3068	38.3	4.3	91.7	7.0	5.3	5.7	6.3	6.0	7.7	6.7	6.3
28	BAR 6FR 126	65.0	5.7	75.0	6.3	7.0	6.0	5.7	6.0	6.3	6.7	6.3
21	PPG-FRT-101	51.7	5.7	80.0	6.3	6.3	5.7	5.7	6.3	6.7	6.7	6.2
41	DLF-FRR-6162	41.7	4.7	93.3	7.0	5.3	5.3	6.7	5.7	7.3	6.7	6.2
27	BAR VV-VP3-CT	51.7	5.7	76.7	6.7	7.0	5.7	5.3	5.7	6.3	6.3	6.1
32	RAD-FR47	43.3	5.7	91.7	7.7	5.3	5.7	6.3	6.0	6.7	6.0	6.0
2	Marvel	51.7	5.7	88.3	6.3	5.7	4.7	6.0	5.7	6.3	7.0	5.9
7	DLFPS-FRR/3069	45.0	4.7	86.7	6.3	5.3	5.0	6.0	5.3	6.3	5.7	5.6
5	DLFPS-FRC/3060	48.3	5.0	70.0	6.7	7.0	5.3	4.7	4.7	5.7	5.7	5.5
30	RAD-FR33R	36.7	4.0	85.0	7.0	5.3	5.0	5.3	5.0	6.0	6.0	5.4
37	PST-4ED4	48.3	5.3	90.0	8.0	5.0	3.7	6.3	5.7	6.3	5.7	5.4
25	RAD-FC32	46.7	5.0	78.3	7.3	7.7	5.3	4.7	4.3	5.0	5.3	5.4
22	PPG-FRC-111	40.0	4.3	83.3	8.0	4.3	5.0	5.3	5.0	5.7	6.0	5.2
18	Navigator II	58.3	4.7	78.3	7.3	5.3	4.7	5.0	5.3	5.3	5.3	5.2
24	Kent	51.7	4.7	90.0	6.7	4.7	4.3	5.3	5.0	5.3	5.0	4.9
35	PST-4BEN	40.0	5.0	85.0	7.3	4.0	3.7	5.0	4.7	5.7	6.3	4.9
11	Boreal	55.0	5.7	71.7	5.3	5.3	4.3	4.7	4.7	5.0	5.0	4.8
39	Cascade	58.3	5.0	71.7	6.0	5.7	3.7	4.0	4.7	5.3	5.3	4.8
42	Beudin	35.0	4.7	71.7	5.3	5.7	4.7	4.0	4.7	4.7	4.7	4.7

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10	Quatro	38.3	5.7	60.0	7.3	5.7	5.0	4.7	3.3	4.0	4.3	4.5
34	PST-4RUE	40.0	5.0	78.3	8.0	4.3	3.7	4.7	4.3	4.7	4.7	4.4
17	Beacon	43.3	4.7	70.0	6.0	5.7	5.3	4.3	3.3	3.3	4.0	4.3
8	MNHD-14	38.3	4.3	63.3	7.0	5.0	5.0	4.7	3.0	3.7	4.3	4.3
13	7H7	31.7	4.7	65.0	7.3	5.3	5.0	4.3	4.0	3.0	3.7	4.2
4	DLFPS-FL/3066	31.7	4.7	78.3	7.3	5.3	5.0	4.7	3.3	3.0	3.7	4.2
33	PST-4DR4	36.7	5.0	75.0	8.0	3.7	2.7	4.0	4.7	5.3	4.7	4.2
6	DLFPS-FL/3060	35.0	4.3	68.3	7.3	4.7	4.0	4.3	3.3	2.7	4.3	3.9
12	TH456	35.0	4.7	70.0	6.3	4.7	4.3	4.0	3.0	3.0	3.7	3.8
15	Seabreeze GT	20.0	5.0	73.3	7.3	3.0	2.3	4.0	4.3	4.7	4.3	3.8
36	PST-4BND	48.3	5.3	46.7	7.3	6.0	4.3	2.7	2.7	3.0	3.7	3.7
14	Sword	28.3	4.7	56.7	7.3	4.3	3.3	3.3	2.7	2.7	3.3	3.3
19	PPG-FL-106	25.0	4.3	61.7	7.3	3.0	3.0	4.0	3.3	2.7	3.7	3.3
1	Minimus	43.3	4.0	41.7	7.3	4.0	3.0	2.7	2.0	2.0	3.0	2.8
	$LSD_{0.05}$	10.72	1.27	13.26	1.00	1.44	1.71	1.57	1.61	1.53	1.57	1.22
	CV%	15.1	15.7	10.5	8.8	15.9	21.5	18.6	20.1	17.2	17.3	14.2

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NATIONAL TURFGRASS EVALUATION PROGRAM (NTEP)
2012 NATIONAL TALL FESCUE TEST – 2015 RESULTS

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INTRODUCTION

Turf-type tall fescue has gained in popularity over the last decade. Characteristics that make turf-type tall fescue desirable are: it maintains a dense, dark green color, lower fertility requirements than conventional Kentucky bluegrass/ryegrass home lawns, and it has good traffic tolerance and shade tolerance. Turf-type tall fescue also exhibits excellent drought avoidance characteristics. When trying to reduce inputs such as fertilizer and water, turf-type tall fescue can be a good alternative.

The National Turfgrass Evaluation Program (NTEP) is sponsored by the Beltsville Agriculture Research Center and the National Turfgrass Federation Inc. NTEP works with breeders and testing sites throughout the United States in evaluating turfgrass species and cultivars. Results from turfgrass evaluations can aid professionals in their selection of turfgrass species/cultivars that best meet their needs. Results also aid breeders in selecting new cultivars that they may put into production, as well as helping in marketing their varieties. In 2012 NTEP selected fifteen standard testing sites and eleven ancillary test locations for their 2012 Turf-type Tall Fescue Test. The University of Connecticut, Plant Science Teaching and Research Facility in Storrs CT, was selected as a standard site for the 2012 Turf-type tall Fescue Test.

MATERIALS AND METHODS

One hundred and sixteen cultivars of Turf-type tall fescue were seeded on September 11, 2012 in Storrs Connecticut. A complete randomized block design with 3 replicates of each cultivar was utilized for this study. Plot size is 5’ X 5’. Sponsors and entries are listed in Table 1.

Management Practices

Since establishment, all plots and cultivars received the same management protocol throughout the study. Management practices for 2015 were as follows:

<u>Mowing</u> - Plots were maintained at a mowing height of 2.75 inches and mowed three times per week. Clippings were returned.

<u>Irrigation</u> – Irrigation was applied only to prevent severe drought stress. In 2015 irrigation was applied on one occasion.

<u>Fertilizer and pesticide applications</u>

05/05/15	Pre-emergent 0.54 oz./1,000 ft^2 Prodiamine 65 WDG
05/08/15	1 lb. N/1,000 ft^2, 25-0-12 (60% SCU)
06/04/15	Acelepryn, 0.367 fl. oz./1,000 ft^2
11/05/15	1 lb. N/1,000 ft^2, 25-0-12 (60% SCU)

Spring Green-up Ratings

Spring green-up ratings were taken and recorded (Table 2) on April 24 2015. Green-up measures the transition from winter dormancy to active spring growth. Ratings were based on a scale of 1-9, with 1 equaling brown turf and 9 equaling dark green turf.

Quality Ratings

Turfgrass quality ratings were taken on a monthly basis for overall turf quality (color / leaf texture / density) during the 2015 growing season. Overall turfgrass quality was determined using a visual rating system of 1-9. A score of 1 illustrates the poorest quality turf and 9 the highest quality. Monthly quality and mean quality ratings are provided in table 2.

Leaf Texture Ratings

Visual leaf texture ratings were taken in the late spring (May 27, 2015) while the grass was actively growing and not under stress conditions. Texture ratings were made using a visual scale with 1 equaling coarse turf and 9 equaling fine (Table 2).

Genetic Color Ratings

Genetic color ratings (Table 2) were taken in the late spring (May 27, 2015) while the grass was actively growing and not under stress conditions. Ratings were based on visual color with 1 being light green and 9 being dark green. Areas of plots that contained browning tissue (chlorosis or necrotic) from outside factors such as disease were not considered for genetic color (Table 2).

RESULTS & DISCUSSION

Results for spring green up, genetic color, leaf texture, and monthly quality ratings, are provided in Table 2.

A few general observations noted were: mean quality values showed a lesser degree of diversity between plots in overall quality ratings when compared with the previous year (2014). Perhaps this was due to the fact that the growing season for 2015 was more favorable for turfgrass growth than in 2014. In 2015 there was less disease pressure when compared to 2014. In 2015 all plots exhibited excellent drought avoidance characteristics. Plots where irrigated one time during the late spring when there was an extended period of dry weather. All plots received a total of 2 pounds of nitrogen per 1,000 ft^2 divided into two applications. One in the late spring and the other in late fall.

Table 1- Sponsors and Entries			
SPONSOR	**ENTRY**	**SPONSOR**	**ENTRY**
Semillas Fito S.A.	Terrano	DLF International Seed	IS-TF-272
Standard Entry	Ky-31	Pennington Seed	ATF 1736
Landmark Turf and Native Seed	Regenerate	Brett-Young Seeds	ATF 1754
Semillas Fito S.A	Fesnova	Burlingham Seeds	Hemi
Z Seeds	ZW 44	Burlingham Seeds	Firebird 2
Turf Merchants Inc.	W45	Standard Entry	Bullseye
Turf Merchants Inc.	U43	Pure-Seed Testing, Inc	PST-5EV2
Turf Merchants Inc.	LSD	Pure-Seed Testing, Inc	PST-5GRB
Turf Merchants Inc.	Aquaduct	Pure-Seed Testing, Inc	PST-5SALT
Standard Entry	Catalyst	Pure-Seed Testing, Inc	PST-5SDT
Ledeboer Seed LLC	Marauder	Pure-Seed Testing, Inc	PST-5DZP
Ledeboer Seed LLC	Warhawk	Pure-Seed Testing, Inc	PST-5RO5
Ledeboer Seed LLC	Annihilator	Pure-Seed Testing, Inc	PST-5BPO
Ledeboer Seed LLC	Comp.Res. SST	Pure-Seed Testing, Inc	PST-5BRK
Ledeboer Seed LLC	204 Res.Blk4	John Deere Landscapes	DB1
Jacklin Seed by Simplot	JS 819	John Deere Landscapes	RZ2
Jacklin Seed by Simplot	JS 818	Columbia Seeds LLC	TD1
Jacklin Seed by Simplot	JS 809	Columbia Seeds LLC	DZ1
Jacklin Seed by Simplot	JS 916	Landmark Turf and Native Seed	T31
Jacklin Seed by Simplot	JS 825	Pickseed West Inc.	PSG-GSD
The Scotts Company	MET 1	Pickseed West Inc.	PSG-8BP2
The Scotts Company	F711	Pickseed West Inc.	PSG-TT4
DLF International Seed	IS-TF 291	Standard Entry	Faith
DLF International Seed	IS-TF 276 M2	The Scotts Company	K12-13
DLF International Seed	IS-TF 305 SEL	The Scotts Company	K12-05
DLF International Seed	IS-TF 269 SEL	Peak Plant Genetics	PPG-TF-156

Table 1 (continued) - Sponsors and Entries			
SPONSOR	**ENTRY**	**SPONSOR**	**ENTRY**
DLF International Seed	IS-TF 282 M2	Columbia Seeds LLC	PPG-TF-157
DLF International Seed	IS-TF 284 M2	Columbia Seeds LLC	PPG-TF-169
Great Basin Seed	OR-21	Columbia Seeds LLC	PPG-TF-170
Great Basin Seed	TY 10	Lewis Seed Company	PPG-TF-137
Great Basin Seed	EXP TF-09	Ampac Seed Company	PPG-TF-135
Seed Research Oregon	SRX-TPC	Lewis seed Company	PPG-TF-115
Pickseed West Inc.	PSG-WEI	Lewis seed Company	PPG-TF-105
Pickseed West Inc.	Pick-W43	Peak Plant Genetics	PPG-TF-172
Pickseed West Inc.	Grade 3	Grassland Oregon	PPG-TF-151
Pickseed West Inc.	PSG-PO1	Peak Plant Genetics	PPG-TF-152
Landmark Turf and Native Seed	U45	Peak Plant Genetics	PPG-TF-148
Pennington Seed	B23	Columbia Seeds	PPG-TF-150
Pennington Seed	ATF 1612	Semillas Fito S.A.	Bizem
Peennington Seed	ATF 1704	Proseeds Marketing	CCR2
Burlingham Seed	Burl TF-2	Proseeds Marketing	Met-3
Burlingham Seed	Burl TF-136	The Scotts Company	W41
Lebanon Turf Products	LTP-FSD	Peak Plant Genetics	PPG-TF-145
Lebanon Turf Products	LTP-TWUU	.Ampac Seed Company	PPG-TF-138
Lebanon Turf Products	LTP-F5DPDR	Landmark Turf and Native Seed	PPG-TF-139
DLF International Seed	IS-TF-289	Landmark Turf and Native Seed	PPG-TF-142
DLF International Seed	MET 6 SEL	Columbia Seeds LLC	RAD-TF-89
Columbia Seeds LLC	IS-TF-330	Radix Reasearch	RAD-TF-92
Columbia Seeds LLC	TF-287	Grasslands Oregon	GO-DFR
Columbia Seeds LLC	IS-TF-307 SEL	The Scotts Company	K12-MCD
Columbia Seeds LLC	IS-TF 308 SEL	Pure-Seed Testing Inc.	PST-5EX2
Brett-Young Seeds	IS-TF-311	Pure-Seed Testing Inc.	PST-5MVD
Brett-Young Seeds	IS-TF-285	Oak Park Farms	RAD-TF-83
Brett-Young Seeds	IS-TLF 310 SEL	Grassland Oregon	RAD-TF 88
Barenbrug USA	BAR Fa 120878	Pure-Seed testing Inc.	PST-R5NW
Barenbrug USA	BAR Fa 121089	Burlingham Seeds	Burl TF 69
Barenbrug USA	BAR Fa 121091	Standard Entry	Falcon IV
Barenbrug USA	BAR Fa 121095	Standard Entry	Falcon V

Figure 1 – 2012Turf-Type Tall Fescue NTEP Trial, University of Connecticut (photo- July 2014)

Table 2. Tall Fescue NTEP results 2015 for spring green-up, genetic color (ratings 1-9, where 9 equals darker green), leaf texture (rating 1-9, where 9 equals the finest texture leaf blade, turfgrass quality (rating 1-9, where 9 equals the highest turf quality). Table is listed with highest mean quality cultivars listed first.

	Spring green up	Genetic color	Texture	Quality						
Entry	04/24/15	05/27/15	05/27/15	05/13/15	06/12/15	07/15/15	08/12/15	09/16/15	10/12/15	mean
PPG-TF-152	5.3	7.0	7.0	6.3	7.3	7.3	7.0	7.0	7.7	7.1
B23	5.0	7.7	6.3	6.3	7.0	7.0	6.3	7.7	8.0	7.1
PPG-TF-135	4.3	6.7	6.3	6.3	7.0	7.0	6.3	7.7	8.0	7.1
PPG-TF-170	5.0	7.3	6.3	5.7	7.0	7.3	7.0	7.3	8.0	7.1
IS-TF 305 SEL	4.3	7.7	7.0	7.0	8.0	6.7	6.0	7.0	7.3	7.0
Pick-W43	5.7	7.3	6.7	6.3	7.7	6.3	6.0	8.0	7.7	7.0
IS-TF 311	4.7	7.0	7.0	5.7	7.3	7.7	6.0	7.0	7.7	6.9
IS-TF 285	5.0	8.0	7.3	6.7	7.3	7.3	6.0	6.7	7.0	6.8
IS-TF 291	5.3	7.7	7.0	6.0	7.3	6.7	6.3	7.0	7.7	6.8
PSG-PO1	4.7	7.0	6.7	6.3	6.3	7.0	6.3	7.3	7.7	6.8
U45	4.7	7.7	6.0	6.3	7.0	6.7	6.0	7.7	7.3	6.8
IS-TF 310 SEL	4.0	8.0	7.3	6.0	7.3	6.3	5.7	7.0	8.3	6.8
PPG-TF-142	5.0	8.7	6.3	7.0	7.0	7.3	5.3	6.7	7.3	6.8
T31	5.3	6.7	6.7	6.3	7.0	6.7	6.7	7.0	7.0	6.8
W41	5.0	7.3	6.7	6.0	7.0	7.3	5.7	7.3	7.3	6.8
PPG-TF-105	4.7	7.3	7.0	5.3	7.3	7.0	6.3	7.3	7.0	6.7
PPG-TF-157	4.7	7.7	7.0	5.7	7.3	7.0	6.0	6.3	8.0	6.7
U43	5.3	7.3	6.3	5.3	6.3	6.3	6.3	8.3	7.7	6.7
MET 1	5.7	6.0	6.7	5.7	6.3	7.0	6.0	7.7	7.3	6.7
PPG-TF-151	4.7	7.0	6.3	6.3	7.3	6.7	6.0	6.7	7.0	6.7
PPG-TF-156	4.7	7.0	6.7	5.3	6.3	7.0	6.0	7.7	7.7	6.7
LTP-TWUU	5.3	6.3	6.3	6.0	6.7	6.3	6.0	7.0	7.7	6.6
PPG-TF-150	4.3	7.0	6.7	6.3	6.7	6.3	5.7	7.0	7.7	6.6
PSG-WE1	5.3	7.0	6.7	6.0	6.3	7.0	6.0	7.7	6.7	6.6
Regenerate	5.0	7.0	7.0	6.0	6.3	6.7	5.7	7.3	7.7	6.6
F711	4.7	7.3	6.0	6.0	6.7	6.0	6.0	6.7	8.0	6.6
Fesnova	4.7	6.7	6.0	6.0	7.0	6.7	5.3	6.7	7.7	6.6
Hemi	4.3	6.7	6.7	5.7	6.7	6.7	6.3	6.7	7.3	6.6
IS-TF 307 SEL	5.0	7.7	7.0	5.7	7.0	6.7	6.0	6.3	7.7	6.6

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LTP-F5DPDR	5.3	7.3	6.3	6.0	6.7	5.7	6.3	7.3	7.3	6.6
ZW44	3.7	6.0	7.0	6.0	6.7	6.3	6.0	7.3	7.0	6.6
IS-TF 289	4.7	8.0	6.7	6.0	7.0	7.0	5.7	7.0	6.3	6.5
Falcon IV	5.0	6.3	6.0	6.3	6.7	6.7	5.7	6.7	6.7	6.4
IS-TF 330	4.7	7.7	6.3	6.3	7.3	6.3	5.7	6.0	7.0	6.4
K12-MCD	5.0	7.0	6.3	5.3	5.7	7.0	5.7	7.0	8.0	6.4
PPG-TF-137	5.7	7.0	6.3	6.0	6.3	6.3	5.7	7.3	7.0	6.4
Bizem	4.0	7.0	6.7	5.7	6.0	6.3	6.3	7.3	6.7	6.4
Burl TF-2	5.7	5.7	6.3	5.7	6.0	5.7	6.3	7.3	7.3	6.4
CCR2	5.3	7.3	6.3	5.3	6.3	6.3	5.7	7.0	7.7	6.4
Faith	5.0	7.3	5.7	5.3	7.0	7.0	5.7	6.0	7.3	6.4
IS-TF 284 M2	4.3	8.0	7.0	5.7	6.7	6.7	5.3	6.3	7.7	6.4
PST-5BRK	5.0	6.7	5.3	6.0	6.0	6.3	5.7	7.0	7.3	6.4
RZ2	5.0	6.0	7.0	5.7	6.7	6.7	6.0	6.7	6.7	6.4
DB1	3.7	7.7	6.3	6.3	7.3	5.7	4.7	6.7	7.3	6.3
MET 6 SEL	4.3	6.3	5.7	5.7	6.3	6.3	6.0	6.7	7.0	6.3
MET-3	5.0	6.7	7.0	5.7	7.0	6.0	5.7	6.3	7.3	6.3
PPG-TF-148	5.0	6.3	6.7	5.3	6.3	6.3	6.0	7.3	6.7	6.3
Catalyst	5.7	6.0	6.7	5.7	6.3	6.3	6.0	6.3	7.0	6.3
Firebird 4	4.7	7.0	6.7	5.3	7.0	6.3	5.3	6.3	7.3	6.3
IS-TF 308 SEL	4.3	6.7	6.3	5.0	6.7	6.7	5.7	6.7	7.0	6.3
LSD	4.0	6.3	6.3	5.0	6.7	6.0	6.0	7.0	7.0	6.3
PPG-TF-115	4.3	7.7	5.7	5.7	6.3	6.7	6.0	6.0	7.0	6.3
PPG-TF-138	5.3	7.0	6.3	6.0	6.7	6.3	5.3	6.3	7.0	6.3
TD1	3.7	7.7	7.0	5.7	7.7	6.7	5.0	5.7	7.0	6.3
TF-287	5.0	7.0	7.0	6.0	7.0	5.7	5.7	6.3	7.0	6.3
Grade 3	4.7	7.3	6.0	5.0	6.3	6.0	6.0	6.7	7.3	6.2
ATF 1612	5.3	6.7	6.0	5.3	6.3	6.0	5.3	7.0	7.0	6.2
ATF 1704	5.0	6.0	5.7	5.3	5.3	7.0	6.3	6.3	6.7	6.2
Burl TF-69	3.7	7.3	7.0	5.7	6.7	5.7	5.0	6.3	7.7	6.2
IS-TF 269 SEL	4.7	7.3	6.3	6.0	6.7	6.0	6.0	5.7	6.7	6.2
LTP-FSD	4.0	6.7	6.0	5.7	6.0	6.0	6.3	6.3	6.7	6.2
SRX-TPC	4.3	6.7	6.7	5.3	6.7	6.7	5.3	6.3	6.7	6.2

Bullseye	5.3	7.3	6.0	5.7	6.0	6.3	5.7	6.3	6.7	6.1
Falcon V	4.7	5.7	7.0	5.3	6.7	5.7	5.3	6.3	7.3	6.1
PPG-TF-169	5.3	6.0	6.3	5.3	6.0	6.0	5.3	7.3	6.7	6.1
PPG-TF-172	4.3	6.7	6.3	5.7	6.3	5.7	5.0	6.7	7.3	6.1
PST-5EV2	4.7	7.0	5.7	5.7	6.0	6.0	5.7	6.3	7.0	6.1
PST-5MVD	4.7	6.0	6.0	5.3	6.0	6.7	5.3	6.3	7.0	6.1
W45	4.7	6.7	7.3	5.7	6.0	5.7	5.3	6.7	7.3	6.1
Burl TF-136	5.3	6.3	7.0	5.7	6.0	5.3	5.3	6.7	7.3	6.1
IS-TF 282 M2	5.0	7.3	6.3	6.0	6.3	6.0	5.7	6.0	6.3	6.1
RAD-TF-88	3.3	7.7	7.0	4.7	7.0	6.3	5.0	6.3	7.0	6.1
PSG-TT4	5.0	7.0	5.3	5.3	6.0	5.3	5.7	6.7	7.0	6.0
PST-5BPO	5.0	5.7	5.7	5.7	6.0	6.0	5.3	6.3	6.7	6.0
IS-TF 276 M2	5.3	6.7	5.7	5.0	6.7	6.3	4.7	6.7	6.3	5.9
PSG-8BP2	5.3	7.0	5.7	5.3	6.0	6.7	5.7	6.0	6.0	5.9
PSG-GSD	5.0	6.7	5.0	5.7	6.0	6.0	5.7	6.0	6.3	5.9
PST-5EX2	4.3	5.0	5.0	5.0	5.7	6.0	6.0	6.3	6.7	5.9
PST-5SALT	4.7	6.3	6.3	5.7	6.0	6.0	5.3	6.3	6.3	5.9
PPG-TF-145	4.7	7.3	6.0	5.3	6.3	5.7	5.0	6.3	6.7	5.9
TY 10	6.3	7.7	6.3	6.0	6.3	6.3	5.0	5.7	6.0	5.9
ATF 1736	5.7	6.3	6.0	5.3	6.3	5.0	5.3	6.3	6.7	5.8
GO-DFR	4.7	7.7	6.0	5.3	7.0	6.0	5.0	5.3	6.3	5.8
IS-TF 272	3.7	8.0	7.3	5.0	6.0	5.0	5.3	6.3	7.3	5.8
JS818	5.3	7.7	7.0	6.0	6.3	6.0	5.0	5.7	6.0	5.8
K12-05	3.7	7.7	6.7	5.3	7.0	6.0	5.0	5.0	6.7	5.8
PST-5R05	5.0	7.0	5.7	5.3	5.7	5.7	5.7	6.0	6.7	5.8
DZ1	3.7	7.3	6.0	5.0	6.0	6.0	5.0	6.3	6.3	5.8
JS916	4.7	7.3	6.3	5.0	5.3	5.3	5.3	6.3	7.3	5.8
PST-57DT	4.3	6.0	5.7	5.0	5.0	7.0	5.3	5.7	6.7	5.8
PST-5DZP	5.0	7.0	6.3	5.3	5.7	5.7	5.0	6.7	6.3	5.8
PPG-TF-139	3.7	6.3	6.3	5.0	6.3	5.0	5.0	6.0	7.0	5.7
ATF 1754	3.7	5.3	5.3	5.0	5.7	5.3	5.3	6.0	6.7	5.7
Terrano	4.3	7.3	6.0	5.3	5.7	6.0	5.3	5.3	6.3	5.7
Annihilator	5.0	6.7	7.3	5.7	5.7	5.3	4.3	5.7	7.0	5.6

OR-21	4.3	8.3	6.0	5.3	6.3	5.7	5.0	5.3	6.0	5.6
JS819	4.0	7.0	6.0	5.3	5.7	5.7	5.0	5.3	6.3	5.6
RAD-TF-83	4.7	7.7	7.0	4.7	6.0	4.7	5.0	6.0	7.0	5.6
BAR Fa 121095	2.7	7.7	6.0	5.0	6.7	5.3	5.0	5.0	6.0	5.5
PST-R5NW	4.7	6.3	5.0	5.3	5.3	5.3	5.0	6.3	5.7	5.5
RAD-TF-89	3.3	8.0	6.0	4.3	5.3	5.7	5.0	6.0	6.7	5.5
BAR Fa 121089	4.0	6.7	6.0	5.3	5.7	6.0	5.0	5.3	5.3	5.4
PST-5GRB	5.3	5.7	7.0	5.0	5.7	5.0	5.0	5.7	6.3	5.4
204 Res. Blk4	4.0	5.3	7.3	5.0	6.0	4.0	4.7	6.0	6.7	5.4
BAR Fa 121091	4.3	8.0	5.7	6.0	5.7	4.3	4.0	6.0	6.3	5.4
RAD-TF-92	3.0	7.3	6.7	4.7	5.7	5.3	4.7	5.3	6.3	5.3
JS809	4.7	6.7	6.7	5.3	5.7	5.3	4.7	5.0	5.7	5.3
JS825	4.0	6.7	6.0	4.7	6.0	6.0	4.7	5.0	5.0	5.2
Warhawk	4.7	7.0	7.0	6.0	5.7	4.3	4.3	5.3	5.7	5.2
Aquaduct	5.3	6.0	6.0	4.7	5.0	5.7	4.7	4.7	6.3	5.2
Comp. Res. SST	3.7	6.0	7.0	4.7	6.0	4.7	3.7	5.7	6.3	5.2
Exp TF-09	5.7	7.0	5.7	5.3	6.3	4.7	4.7	4.7	5.3	5.2
K12-13	2.7	7.3	7.3	4.7	6.3	5.3	4.0	4.3	5.3	5.0
Marauder	4.0	6.0	7.0	5.3	5.7	4.0	4.0	5.7	5.3	5.0
BAR Fa 120878	5.0	4.7	4.0	4.3	4.0	5.3	5.0	5.0	5.3	4.8
Ky-31	5.7	3.0	2.0	2.0	2.7	2.0	3.0	3.3	4.0	2.8
$LSD_{0.05}$	1.31	1.15	0.94	1.14	1.25	1.37	1.16	1.29	1.09	0.76
CV%	17.4	10.3	9.2	12.8	12.3	14.0	13.2	12.5	9.9	7.7

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2015 COOPERATIVE TURFGRASS BREEDERS FIELD EVALUATION OF PERENNIAL RYEGRASS CULTIVARS

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INTRODUCTION

The 'Cooperative Turfgrass Breeders' Test (CTBT) is a variety evaluation trial program initiated by turfgrass breeders of commercial seed companies to support additional data on experimental cultivars considered for commercial production. Six plant breeding groups contribute to the CTBT program: DLF International Seeds, Peak Genetics, The Pickseed Group, Pure Seed Testing, NexGen Turf Research, and Rutgers' University.

The 2013 Perennial Ryegrass Cooperator Trial has 10 locations throughout the United States. The University of Connecticut is one of the chosen locations (figure 1). Site cooperators collect data on turf quality, color and density. Turfgrass injury as related to insect, disease, drought, wear, and shade is also noted. Cultivars are evaluated for two years from the date of establishment.

MATERIALS AND METHODS

One hundred-seven cultivars of perennial ryegrasses were established on September 27, 2013 in Storrs Connecticut. A complete randomized block design with 3 replicates of each cultivar was utilized for this study. Plot size is 3' X 5'. Cultivars, species, and sponsors are listed in Table 1.

Establishment & Management Practices

All cultivars received the same management protocol during establishment and throughout the study. Plots were planted on September 27, 2013 and were fertilized at the time of seeding at the rate of 1 pound of nitrogen per 1,000 ft^2. Once seeding was completed, the plots were protected with a turf cover until germination was evident. Plots were treated in April 2014 with a pre-emergent crabgrass control (prodiamine) product. Tenacity was applied in two applications late May/early June 2014. Plots were fertilized at the rate of 1#N/m in May 2014. Broadleaf weed control was applied June 2014. Tenacity and Speedzone were applied again in September 2014. In October, plots were fertilized at the rate of 1#N/m. Plots were maintained at a mowing height of 2" height of cut and are mowed approximately 2 times per week. Irrigation was applied as needed.

Establishment ratings

Establishment ratings were made on October 22, 2013. Establishment ratings were based on a scale of 1-9. Ratings were based on percent germination and seedling vigor. A rating of 1 had the lowest percent germination/vigor and 9 the highest.

Quality ratings

Turfgrass quality ratings were taken on a monthly basis for overall turf quality (color / leaf texture / density) beginning April 2014 through October 2014. Overall turfgrass quality was determined using a visual rating system of 1-9. A score of 1 illustrates the poorest quality turf and 9 the highest quality.

RESULTS & DISCUSSION

During 2014 growing season, ambient air temperatures and rainfall was consistent with normal spring conditions. However, rainfall mid-summer through October was limited and supplemental irrigation was applied as needed to the ryegrass plots. In general, the perennial ryegrasses persisted season-long without loss of color, due to the supplemental irrigation. Throughout the first growing season, there was no evidence of significant disease expression. Red thread was observed on some plots early fall.

Figure 1 - Cooperative Turfgrass Breeders Perennial Ryegrass Test, University of Connecticut

Table 1 – Perennial Rye Grass, Cultivars and Sponsors

PLOT	CULTIVAR	SPONSOR	PLOT	CULTIVAR	SPONSOR
1	PPG-PR 196	Peak Genetics	45	Monsieur	DLF
2	APR2687	NexGen	46	PST-2ED1	PST
3	PSG-21-10	PSG	47	PST-2BD1	PST
4	Thrive	DLF	48	APR2154	NexGen
5	PST-2SHRP	PST	49	APR2397	NexGen
6	Linn	PSG	50	APR2320	NexGen
7	DLF-PR-569	DLF	51	DLF-PR-561	DLF
8	PST-2FIND-13	PST	52	Brightstar SLT	PST
9	PSG-HLTY	PSG	53	PST-3IP	PST
10	PST-Gray Fox	PST	54	APR2659	NexGen
11	DLF-PR-575	DLF	55	DLF-PR-521	DLF
12	DLF-PR-523	DLF	56	PST-2MG7	PST
13	DLF-PR-583	DLF	57	APR2394	NexGen
14	PPG-PR 197	Peak Genetics	58	PSG-20-10	PSG
15	PR-09-6	PSG	59	Silver Dollar	PST
16	DLF-PR-579	DLF	60	PPG-PR 229	Peak Genetics
17	Penguin	NexGen	61	Harrier	PSG
18	Homerun	Peak Genetics	62	Fiesta 4	PSG
19	GSI-3-12	PSG	63	Apple GL	Peak Genetics
20	APR2790	NexGen	64	APR2540	NexGen
21	PS 10	Peak Genetics	65	DSL5B1	PSG
22	Aspire	DLF	66	APR2554	NexGen
23	PST-2SURV	PST	67	Allstar 3	DLF
24	PSG-HLY	PSG	68	APR2524	NexGen
25	4JPR	PSG	69	Soprano	NexGen
26	PPG-PR 234	Peak Genetics	70	PPG-PR 171	Peak Genetics
27	PPG-PR 228	Peak Genetics	71	DLF-PR-578	DLF
28	APR2680	NexGen	72	PPG-PR 222	Rutgers
29	Gator 3	DLF	73	APR2385	NexGen
30	Pop	NexGen	74	PPG-PR 227	Peak Genetics
31	PPG-PR 231	Peak Genetics	75	APR2662	NexGen
32	APR2344	NexGen	76	Diligent	DLF
33	Manhattan 6 GLR	PST	77	PPG-PR 168	Peak Genetics
34	PST-2RDY	PST	78	Banfield	DLF
35	PST-2LTD	PST	79	DLF-PR-565	DLF
36	PST-2PDA	PST	80	APR2688	NexGen
37	PST-2MPX1	PST	81	PST-2A2	PST
38	Stamina	DLF	82	DLF-PR-553	DLF
39	PSG-HLT	PSG	83	PST-2A12	PST
40	PST-2TPR	PST	84	APR2399	NexGen
41	DLF-PR-580	DLF	85	DLF-PR-564	DLF
42	DLF-PR-563	DLF	86	PPG-PR 232	Peak Genetics
43	PST-2ETS	PST	87	PST-224	PST
44	Esquire	DLF	88	PST-2TFC	PST

Table 1 – Perennial Rye Grass, Cultivars and Sponsors cont.

PLOT	CULTIVAR	SPONSOR	PLOT	CULTIVAR	SPONSOR
89	DLF-PR-537	DLF	99	APR2237	NexGen
90	APR2445	NexGen	100	Line Drive GLS	NexGen
91	DLF-PR-562	DLF	101	PS 9	Peak Genetics
92	PST-2CITM	PST	102	PST-2REB	PST
93	PSG1037-12K	PSG	103	APR2477	NexGen
94	PPG-PR 172	Rutgers	104	Karma	PSG
95	APR2104	NexGen	105	APR2679	NexGen
96	PST-2BDT	PST	106	PST-3MP3	PST
97	PPG-PR 167	Peak Genetics	107	Bandalore	DLF
98	Zoom	PSG			

Table 2 - Turfgrass Quality Ratings

CULTIVAR	AVERAGE QUALITY RATING 2104	CULTIVAR	AVERAGE QUALITY RATING 2014
PPG-PR-196	5.72	Manhattan 6 GLR	5.24
APR2687	5.14	PST-2RDY	5.33
PST-21-10	5.67	PST-2LTD	5.09
Thrive	5.19	PST-2PDA	6.00
PST-2SHRP	5.24	PST-2MPX1	5.43
Linn	4.76	Stamina	6.09
DLF-PR-569	5.57	PSG-HLT	5.52
PST-2FIND-13	5.81	PST-2TPR	5.81
PSG-HLTY	5.38	DLF-PR-580	5.29
PST-Gray Fox	5.48	DLF-PR-563	5.81
DLF-PR-575	5.38	PST-2ETS	5.52
DLF-PR-523	5.43	Esquire	5.76
DLF-PR-583	5.76	Monsieur	6.00
PPG-PR-197	5.24	PST-2ED1	5.19
PR-09-6	5.19	PST-2BD1	5.04
DLF-PR-579	5.34	APR2154	5.48
Penguin	5.90	APR2397	5.76
Homerun	5.91	APR2320	5.67
GSI-3-12	4.86	DLF-PR-561	4.95
APR2790	6.14	Brightstar SLT	5.91
PS 10	6.00	PST-3IP	4.81
Aspire	6.00	APR2659	6.19
PST-2-SURV	4.91	DLF-PR-521	4.91
PST-HLY	5.67	PST-2MG7	4.81
4JPR	5.67	APR2394	5.33
PPG-PR-234	5.76	PSG-20-10	5.52
PPG-PR-228	6.14	Silver Dollar	5.14
APR2680	**5.86**	PPG-PR-229	6.14
Gator 3	5.19	Harrier	5.34
Pop	5.19	Fiesta 4	5.91
PPG-PR-231	6.00	Apple GL	6.00
APR2344	4.81	APR2540	5.71

Table 2 - Turfgrass Quality Ratings cont.

CULTIVAR	AVERAGE QUALITY RATING 2104	CULTIVAR	AVERAGE QUALITY RATING 2014
DSL5B1	4.71	APR2445	5.14
APR2554	6.29	DLF-PR-562	6.00
Allstar 3	5.10	PST-2CITM	5.62
APR2524	5.76	PSG1037-12K	6.24
Soprano	5.76	PPG-PR-172	6.29
PPG-PR-171	6.00	APR2104	6.57
DLF-PR-578	5.00	PST-2BDT	5.52
PPG-PR-222	6.19	PPG-PR-167	6.10
APR2385	5.48	Zoom	6.14
PPG-PR-227	6.38	APR2237	5.76
APR2662	6.48	Line Drive GLS	6.24
Diligent	5.95	PS 9	6.10
PPG-PR-168	5.28	PST-2REB	5.86
Banfield	5.29	APR2477	5.67
DLF-PR-565	5.67	Karma	6.38
APR2688	5.76	APR2679	6.43
PST-2A2	5.57	PST-3MP3	5.52
DLF-PR-553	5.62	Bandalore	6.09
PST-2A12	5.28	**GRAND MEAN**	**5.65**
APR2399	5.91	**CV%**	**9.42**
DLF-PR-564	5.76	**$LSD_{0.05}$**	**0.72**
PPG-PR-232	5.90	**MIN. MEAN**	**4.71**
PST-224	5.57	**MAX. MEAN**	**6.57**
PST-2TFC	5.86	**MIN. MEAN**	**4.71**
DLF-PR-537	6.00	**MAX. MEAN**	**6.57**

PRODUCTION OF A DWARF, PROSTRATE PERENNIAL RYEGRASS (*LOLIUM PERENNE* L.) MUTANT THROUGH MUTATION BREEDING

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INTRODUCTION

Mutation breeding is a powerful technique for producing novel plant cultivars. It involves large-scale mutagenesis of a seed population followed by successive rounds of screening for a phenotype of interest. Creating new varieties of perennial ryegrass (Lolium perenne L.) through mutation breeding is challenging because of the species self-incompatibility. As such, only phenotypes that are caused by dominant mutations can be isolated in this manner. One candidate phenotype is dwarfism, which can sometimes be caused by dominant mutation is the gibberellic acid (GA) signaling pathway.

During 2013 we began a mutation breeding program for perennial ryegrass with the intention of creating a dwarf mutant. Once the plants had developed more than 10 tillers, we discovered that around 10% of all dwarf mutants displayed a prostrate secondary phenotype. One such individual (named Lowboy I) was taken for further characterization. Prostrate turf varieties are desirable because of their increased low-mowing tolerance, heat resistance, traffic resistance, and ground coverage compared to upright varieties.

Lowboy I had significant physiological differences from wild type, including a significantly shorter canopy, shorter leaf blades, and shorter internode lengths (Fig 1). Lowboy I also exhibited greater tolerance to low mowing stress than wild type.

Figure 1. Comparisons of Lowboy I and wild type 'Fiesta 4' perennial ryegrass (WT). Lowboy I plants (right) had dwarf and prostrate phenotypes compared to WT (left).

Lowboy I plants were completely restored to a wild type phenotype following the application of GA to plant leaves (Fig 2), indicating that both the dwarf and prostrate phenotypes were caused by a deleterious mutation in the GA pathway. We were also able to verify that the mutation found in Lowboy I was dominant and could be stably inherited through sexual reproduction.

Figure 2. GA3 treatment of Lowboy I M2 and wild type (WT) 'Fiesta 4' perennial ryegrass. GA3 treatment was able to restore Lowboy I mutant plants to a WT phenotype (from left to right: Untreated WT, WT treated with GA3, untreated Lowboy I, and Lowboy I treated with GA3).

MATCHING SUBJECTIVE ASSESSMENTS OF SOD STRENGTH TO QUANTITATIVE MEASUREMENTS OF PEAK SHEAR FORCE WITH PREDOMINATELY KENTUCKY BLUEGRASS SOD

Guillard, K., R.J.M Fitzpatrick, and H. Burdett. 2015. Matching subjective assessments of sod strength to quantitative measurements of peak shear force with predominately Kentucky bluegrass sod. HortScience 50:1248–1251.

ABSTRACT

Adequate turfgrass sod strength for harvesting and handling is typically determined by the producer's past experience and subjective appraisal. This study was conducted to determine the relationship between producer subjective sod-strength assessments and quantitative shear-strength measurements with predominantly Kentucky bluegrass (*Poa pratensis* L.) turf. Across three consecutive growing seasons, 93 samples were collected from sod fields in Rhode Island and assessed for sod strength by subjective and quantitative methods. Producer subjective ratings of sod strength were significantly ($P < 0.0001$) associated with quantitative measurements of peak force required to shear a sod strip. Minimally-acceptable strength occurred most frequently when peak-shear force was between 55 and 85 kg m^{-1} width of sod; whereas preferred sod strength occurred most frequently when peak shear-force was between 70 and 140 kg m^{-1} width of sod. Once peak force exceeded 58 and 86 kg m^{-1}, there was a > 50% probability that sod strength would be judged at least adequate and at preferred strength, respectively, up to a peak force of 140 kg m^{-1}. The results suggest that quantitative measurements of shear strength can be related to producer subjective assessments, and provide unbiased benchmark values to guide management decisions for Kentucky bluegrass sod production.

THE EFFECT OF NITROGEN RELEASE TECHNOLOGIES AND TOTAL NITROGEN ON COLOR AND QUALITY OF KENTUCKY BLUEGRASS

Campbell J.H., J.J. Henderson, T.F. Morris, K. Guillard, J.C. Inguagiato, S.Rackliffe, V.H. Wallace, and A. Legrand. 2015. The effect of nitrogen release technologies and total nitrogen on color and quality of Kentucky bluegrass. Presentation 48–22. In ASA-CSSA-SSSA Abstracts. Madison, WI.
https://scisoc.confex.com/scisoc/2015am/webprogram/Paper95490.html

ABSTRACT

Nitrogen recommendations to homeowners are often given as standard pounds of nitrogen per 1000ft^2 with little to no regard to the nitrogen source. This project examines various sources of nitrogen with multiple levels of total nitrogen applied over a growing season. The objective of this project was to maximize turfgrass color and quality while minimizing the total nitrogen applied for the growing season. The research was conducted using Kentucky bluegrass (*Poa pratensis*). A randomized complete block design arranged in a 7 x 4 factorial with three replications was utilized with six additional control plots. The first factor was fertilizer release rates: 1) 18% slowly available (30-0-10), 2) 17% slowly available (30-0-0), 3) 15% slowly available (30-0-6), 4) 11.25% slowly available (25-0-6), 5) 9% slowly available (32-0-4) 6) 8% slowly available (9-0-0),and 7) 0% slowly available (45-0-0). Nitrogen fertilizers were selected to maximize variation in source and solubility. The second factor was rate of nitrogen. Plots received either 49kg ha^{-1}, 98kg ha^{-1}, 146kg ha^{-1} or 195kg ha^{-1} nitrogen over a growing season. Potassium levels were standardized for each fertilizer with appropriate applications of muriate of potash. Plots receiving higher rates of nitrogen performed better overall for turfgrass color and quality. The 8% and 18% slowly available treatments consistently had the lowest color and quality ratings over the spring season regardless of rate applied. Summer color ratings plateaued at 146kg ha-^{1} with the exception of the 15% slowly available treatment, which continued to show improvement at the 195kg ha^{-1} level. Plots receiving 49kg ha^{-1} or less nitrogen ranked below acceptable for fall color and quality on a visual 1-9 scale, with the only exception being the 8% slowly available treatment, which was above the acceptable level at the 49kg ha^{-1} treatments.

PROTECTING QUALITY AND INTEGRITY OF TURFGRASS SURFACES DURING NON-SPORTING EVENTS WITH PORTABLE ROADWAYS

Tencza, B., J. Henderson, and K. Guillard. 2015. Protecting quality and integrity of turfgrass surfaces during non-sporting events with portable roadways. Crop, Forage & Turfgrass Manage. 1(1). doi:10.2134/cftm2014.0030

ABSTRACT

Many current sports venues routinely host non-sporting events that require vehicular traffic over playing surfaces. These events often occur during the season of play and are a challenge to sports turf managers to protect the playing surface. The objectives of this study were to determine the effects of portable roadways on: (i) turfgrass performance (percent cover, color, and quality), (ii) playing surface characteristics (surface hardness and rotational traction), (iii) soil physical properties (volumetric soil moisture, bulk density, total porosity), and (iv) soil displacement. Six protection systems were evaluated for multiple cover periods (three, six, and nine days): (i) 0.75 inch plywood (two layers), (ii) Enkamat Plus and plywood (two layers), (iii) Enkamat Flatback and plywood (two layers), (iv) Supa-Trac, (v) Terratrak Plus, and (vi) none. An untrafficked uncovered control was also included. This study was conducted on a mixed stand of Kentucky bluegrass (Poa pratensis L.) and perennial ryegrass (Lolium perenne L.) during year 1 and on a monostand of Kentucky bluegrass during year 2. Vehicular traffic was imposed using a truck that would be similar in weight to those used in preparing for a non-sporting event (gross vehicle weight rating [GVWR] of 20,000 lbs). Minimal differences in percent cover were observed after the three day cover period. As the cover duration increased, Terratrak Plus and Supa-Trac retained better color and cover than all the plywood treatments. Terratrak Plus retained the best color after six and nine days. The plywood treatments provided the best protection against displacement and compaction given the load range tested.

FACTORS AFFECTING SCHOOL GROUNDS AND ATHLETIC FIELD QUALITY AFTER PESTICIDE BANS: THE CASE OF CONNECTICUT

Bartholomew C., B.L. Campbell, and V. Wallace. 2015. Factors affecting school grounds and athletic field quality after pesticide bans: The case of Connecticut. HortScience 50:99–103.

ABSTRACT

Pesticide laws focused on school grounds/athletic fields are beginning to take shape around the United States. A body of literature has examined the health implications of pesticides on school children and faculty and staff. However, little research has examined the impact of changing pesticide regulations on grounds/field quality and expenses. Our research indicate that school grounds/field managers have perceived decreased quality after the Connecticut kindergarten to eighth grade pesticide ban went into effect in 2010. Furthermore, we find that educational sessions or increased expenditures on school grounds/fields can increase the probability of maintaining field quality at integrated pest management levels. However, we see that lower income areas are more likely to experience decreased grounds/field quality after the lawn care pesticide ban took effect.

INFLUENCE OF SEEDBED PREPARATION AND SEEDING METHOD ON CREEPING BENTGRASS ESTABLISHMENT IN MIXED SPECIES FAIRWAY TURF

Inguagiato, J.C., J.J. Henderson, and K.M. Miele. 2015. Influence of seedbed preparation and seeding method on creeping bentgrass establishment in mixed species fairway turf. Presentation 418-23 Poster 807. In ASA-CSSA-SSSA Abstracts, Madison, WI.
https://scisoc.confex.com/crops/2015am/webprogram/Paper95594.html

ABSTRACT

Recently developed turfgrass varieties provide golf courses an excellent opportunity to reduce pesticide and water inputs. However, fairway renovation is challenging due to the large area involved and disruption to play, therefore efficient and rapid renovation practices are required. Research to optimize fairway renovation practices was initiated on a mature golf course fairway in Wethersfield, CT with a mixed creeping bentgrass (*Agrostis stolonifera* L.) and annual bluegrass (ABG; *Poa annua* L.) turf in September 2014. The study used a split-split plot design with three blocks arranged in a 3 x 4 x 2 factorial. The main plot was seedbed preparation (none, verticut, or core cultivation), sub-plot was seeder type (no seed, drop, spike, or slit seeder), and sub-sub plot was non-selective herbicide (glyphosate only vs glyphosate + dazomet). Creeping bentgrass was seeded at a rate of 49 kg ha^{-1} except in the no seed plots. All treatments were completed within 4 days of the initiation of the study. Dark green color index was used to assess early germination differences among treatments 17 days after seeding (DAS). All seeders resulted in equivalent germination when the seedbed was prepared with verticutting or core cultivation. However, drop and spike seeders had lower germination in plots not verticut or core cultivated; whereas slit seeding had good germination regardless of seedbed preparation. Annual bluegrass contamination was assessed 39 DAS. Verticutting resulted in the greatest ABG contamination. Core cultivation had similar or lower ABG contamination as non-cultivated plots. Core cultivation followed by slit or drop seeding resulted in the least ABG contamination 39 DAS. The following June, all seeded plots contained approximately 40% ABG regardless of seedbed preparation or seeder type. Non-selective herbicide treatments had no effect on germination or ABG contamination throughout this study. Future studies will evaluate these practices during months less favorable for ABG establishment.