

INFLUENCE OF VARIOUS FUNGICIDE PROGRAMS ON THE PREVENTION OF SUMMER STRESS

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INTRODUCTION

Putting green summer stress management is of particular interest in the mid-Atlantic region and other areas in which turfgrass managers must maintain cool-season turfgrass in the area known as the transition-zone. In this region, golf course superintendents must be able to provide acceptable green speeds and turfgrass quality in the heat of the summer when growing conditions are suboptimal for creeping bentgrass. Previous research has shown that certain fungicides (Chipco Signature) may assist in the putting green stress management during these periods of intense heat. Although the mechanism remains unclear or poorly understood, the inclusion of StressGuard® in Signature appears to assist in this stress reduction when applied preventively. The objective of this study is to evaluate other turfgrass colorants, fungicides, and/or experimental compounds for their ability to improve turfgrass quality during the summer months.

MATERIALS & METHODS

This study was initiated at the Valentine Turfgrass Research Center located in University Park, PA. Soil was a loamy sand with a pH of 7.8 and an OM of .27%. Turfgrass used for the fungicide evaluation was predominantly a stand of creeping bentgrass (*Agrostis stolonifera*) with approximately 10% to 15% annual bluegrass (*Poa annua*). The area was maintained as a bentgrass green and mowed six days per week to a height of 0.125 in. All fungicide treatments were applied with a CO₂ pressurized (40 psi) sprayer equipped with an air-induction flat fan nozzle, and calibrated to deliver 2.0 gal water per 1000 ft². Treatments were initiated on 12 June and applied every 14 days for a total of five applications. All treatments and application dates are listed in the data tables.

Plots measured 3 ft x 6 ft and were arranged in a randomized complete block with four replications. Plots were visually rated for quality and color. Quality was rated on a 1 to 9 scale where 1 = brown or dead turf, 7 = minimum acceptable quality for a bentgrass putting green and 9 = optimum turfgrass density and texture. Color was rated using two methods including visual ratings and the TCM 500 NDVI turf color meter (Spectrum Technologies, Inc.). Visual color ratings were evaluated on a similar scale to turfgrass quality where 1 = brown or dead turf, 7 = minimum acceptable green color and 9 = dark green turf. In addition to quality and color, dollar spot infections were rated by counting the number of infection centers per plot or by visually assessing the percent plot area affected by the pathogen on a 0 to 100% scale.

RESULTS

Turfgrass quality. Visual quality of the creeping bentgrass putting green was first assessed 2 weeks after the initial treatment. On this rating date, few differences in turf quality were observed among the treatments (Table 1). On 10 Jul (~2 weeks after the second application), the highest turfgrass quality was observed within plots treated with Daconil Ultrex + Chipco Signature. No statistical differences, however, were observed among the aforementioned treatment and plots treated with SA-0011201, SA-0011301, Chipco 26GT + Chipco Signature, QP Fosetyl-AI + Match Play, QP Fosetyl-AI + Green Lawnger, Chipco Signature, or SA-0010207 + Phyte-Off. Over the course of the study, plots treated with Daconil Ultrex + Chipco Signature, Chipco 26GT + Chipco Signature, QP Fosetyl-AI + Match Play, and QP Fosetyl-AI + Green Lawnger provided the greatest and/or statistically similar turf quality on all rating dates. Except in a few cases, turfgrass quality within the untreated control study was considered unacceptable (< 7.0) throughout the study. When compared to plots with the highest quality rating on each date, the following treated plots had reduced quality on ≥ 67% of the rating dates: Vitalonil + Banner MAXX + Disarm, SA-0010204 + Phyte-Off, SA-0011101 + Phyte-Off, SA-0170101, QP Fosetyl-AI, QP Fosetyl-AI + Quali-Gard, QP Fosetyl-AI + Fore, and QP Fosetyl-AI + Turf Mark.

Turfgrass color. Creeping bentgrass color was rated visually on a 0 to 9 scale and also using the NDVI color meter. Visual color ratings varied throughout the study, but plots treated with QP Fosetyl-AI + Green Lawnger had the highest color ratings on all dates (Table 2). Color ratings within these plots were at or near the highest rating of 9.0 on all rating dates. Only when plots were rated 3 weeks after the final treatment did color ratings within these plots fall to 8.0. Plots treated with Daconil Ultrex + Chipco Signature also rated among the best in color and was statistically similar to the aforementioned treatment on 67% of the rating dates. On no date did any treatment reduce visual color ratings when compared to the untreated control. In addition to the visual ratings, the NDVI index was used to determine differences in color. However, no statistical differences in color were exhibited when measured by the NDVI meter (Table 3).

Dollar spot. Aside from fungicides within the planned treatments of this study, no disease control measures were imparted during the experiment. Dollar spot symptoms became visible within the study site in mid-August and when plots were rated on 24 August, the untreated control plots had an average of 64 to 75 infection centers per plot. The fewest number of dollar spot infection centers were observed within plots treated with either SA-0190101 + Phyte-Off and Chipco 26GT + Chipco Signature. There were, however, no statistical differences in dollar spot infection centers among those providing the best control and those plots treated with Vitalonil + Banner MAXX + Disarm, SA-0010205 + Phyte-Off, SA-0011101 + Phyte-Off, SA-0011201, SA-0011301, Daconil Ultrex + Chipco Signature, QP Fosetyl-Al + Fore, QP Fosetyl-Al + Match Play, and SA-0010207 + Phyte-Off. When compared to the untreated controls, moderate suppression of dollar spot was observed within plots treated with SA-0010204 + Phyte-Off, QP Fosetyl-Al + Turf Mark and QP Fosetyl-Al + Green Lawnger. No differences in the number of dollar spot infection centers were observed within plots treated with SA-0170101, QP Fosetyl-Al, QP Fosetyl-Al + Quali-Gard, or Chipco Signature, when compared to the untreated control.

DISCUSSION

Turfgrass quality and management of bentgrass summer stress was the primary objective of this study. Summer stress in 2009 would have been considered low in this study to unusually optimum growing conditions and an overall mild summer. Despite this limiting factor, difference in turf quality and color as well as dollar spot activity was observed among treatments. In general, plots treated with Chipco Signature (alone or in combination) tended to rank among the highest in terms of turfgrass quality. Although not apparent when applied alone, QP Fosetyl-Al also was rated among the highest in turf quality on all rating dates when tank-mixed with the turf colorants Match Play or Green Lawnger.

When turfgrass color was visually rated, the addition of the colorant Green Lawnger provided a dark green appearance and consistently ranked among the highest in color ratings. However, this color would likely be deemed excessively green by many and not likely be utilized by turfgrass managers. On the other hand, plots treated with QP Fosetyl-Al + Match Play exhibited an excellent and natural green color that, although not ranking highest in color, provided acceptable color ratings on all rating dates and likely contributed to the improved quality ratings throughout the study. Excellent color was also observed within plots treated with Daconil Ultrex + Chipco Signature. Results of the color ratings were interesting in that no differences in color ratings were found on any rating dates when evaluated with the NDVI Turf Color Meter. This color meter is designed to measure reflected light within the red and near infrared spectral bands. No significant differences among treatments in this study, despite significant visual differences, may indicate that color differences are not associated with changes in plant chlorophyll content from the treatments.

In terms of disease suppression, dollar spot control was achieved within plots treated with traditional Sclerotinia fungicides including Banner MAXX and Chipco 26GT. Excellent control was also achieved within plots treated with the experimental compound SA-0190101 tank-mixed with Phyte-Off. Based on the results of other tank-mix combinations involving Phyte-Off, it would appear as if much of the suppression was the result of SA-0190101. Unfortunately, this numbered compound was not applied alone, so its ability to suppress dollar spot needs further evaluation. In this study, plots received QP Fosetyl-Al or Chipco Signature did not effectively suppress dollar spot when used alone. However, moderate to good suppression was achieved when used in combination with other fungicides including Daconil Ultrex, Chipco 26GT, Fore, as well as several turf colorants. The exact mechanism of dollar spot suppression from the turf colorants is unknown and warrants further investigation.

Overall, differences in turfgrass quality, color and dollar spot activity were observed in this study. Future research, however, is essential to assess the ability of these products to provide improved summer stress tolerance and turf quality under typical summer conditions.

Table 1. Quality of a creeping bentgrass/annual bluegrass green treated with various fungicide programs for the control of summer stress, 2009.

Treatment and rate per 1000 sq ft	Application	Quality (0-9) ^z					
	Code ^y	26 Jun	10 Jul	24 Jul	10 Aug	24 Aug	8 Sep
Vitalonil 5.2F 7.0 fl oz w/ Banner MAXX 1.24MEC 1.0 fl oz w/ Disarm 4SC 0.36 fl oz	A-E BC D	7.3 abc ^x	6.5 ef	7.0 b-e	6.8 cd	6.5 cde	6.8 bcd
SA-0010204 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.0 abc	7.0 c-f	6.8 c-f	6.8 cd	7.0 bcd	7.0 abc
SA-0010205 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.3 abc	7.3 b-e	7.0 b-e	6.8 cd	7.5 abc	7.0 abc
SA-0011101 3.25 fl oz + Phyte-Off 2.0 fl oz.....	A-E	6.8 bc	6.8 def	6.5 d-g	6.3 cde	7.0 bcd	7.0 abc
SA-0011201 7.0 fl oz.....	A-E	7.0 abc	7.5 a-d	7.3 a-d	6.8 cd	7.5 abc	6.8 bcd
SA-0011301 7.0 fl oz.....	A-E	7.0 abc	7.8 abc	7.3 a-d	7.0 bc	7.8 ab	6.8 bcd
SA-0190101 5.0 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.5 ab	7.0 c-f	6.8 c-f	6.8 cd	7.5 abc	7.0 abc
Daconil Ultrex 82.5WDG 3.25 oz + Chipco Signature 80WDG 4.0 oz	A-E	7.5 ab	8.3 a	8.0 a	8.0 a	8.3 a	7.0 abc
Chipco 26 GT 2SC 4.0 fl oz + Chipco Signature 80WDG 4.0 oz	A-E	7.8 a	7.8 abc	7.5 abc	7.8 ab	8.5 a	7.5 a
SA-0170101 1.0 oz.....	A-E	6.8 bc	6.3 f	5.8 g	6.0 de	6.3 de	6.0 ef
QP Fosetyl-AI 4.0 fl oz.....	A-E	7.0 abc	6.8 def	6.5 d-g	6.3 cde	6.0 de	6.5 cde
QP Fosetyl-AI 4.0 fl oz + Quali-Gard 0.36 oz	A-E	7.0 abc	6.3 f	6.0 fg	6.0 de	6.3 de	6.3 def
QP Fosetyl-AI 4.0 fl oz + Fore 80WP 4.0 oz.....	A-E	7.3 abc	7.0 c-f	6.3 efg	6.8 cd	7.0 bcd	7.0 abc
QP Fosetyl-AI 4.0 fl oz + Match Play Turf Colorant 850.0 fl oz.....	A-E	7.5 ab	7.8 abc	7.3 a-d	8.0 a	7.8 ab	7.0 abc
QP Fosetyl-AI 4.0 fl oz + Turf Mark Green Spray 10.0 fl oz	A-E	7.3 abc	7.0 c-f	5.8 g	6.0 de	6.3 de	6.0 ef
QP Fosetyl-AI 4.0 fl oz + Green Lawnger 15.0 fl oz.....	A-E	7.5 ab	8.0 ab	7.8 ab	8.0 a	7.8 ab	7.3 ab
Chipco Signature 80WDG 4.0 oz	A-E	7.8 a	7.8 abc	8.0 a	8.0 a	7.8 ab	6.5 cde
SA-0010207 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.3 abc	7.8 abc	7.3 a-d	6.8 cd	7.5 abc	7.5 a
Untreated.....	-	6.5 c	6.8 def	6.3 efg	5.8 e	6.3 de	5.8 f
Untreated.....	-	7.3 abc	6.5 ef	5.8 g	6.0 de	5.8 e	6.5 cde
Untreated.....	-	6.5 c	7.0 c-f	6.8 c-f	6.3 cde	6.0 de	5.8 f

^z Turfgrass quality was rated visually on a 0 to 9 scale where 1 = brown or dead turf; 9 = optimum density.

^y Treatments were applied as follows: A = 12 Jun, B = 26 Jun, C = 21 Jul, D = 5 Aug, E = 19 Aug.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ level according to the Fisher's protected least significant difference t-test.

Table 2. Color of a creeping bentgrass/annual bluegrass green treated with various fungicide programs for the control of summer stress, 2009.

Treatments and rate per 1000 sq ft	Application Code ^y	Color (0-9) ^z					
		26 Jun	10 Jul	24 Jul	10 Aug	24 Aug	8 Sep
Vitalonil 5.2F 7.0 fl oz w/ Banner MAXX 1.24MEC 1.0 fl oz w/ Disarm 4SC 0.36 fl oz	A-E BC D	7.3 cd ^x	6.8 fgh	6.3 hi	7.0 d-g	6.8 efg	7.0 bc
SA-0010204 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.5 bc	7.0 efg	6.5 ghi	7.0 d-g	7.0 def	7.8 ab
SA-0010205 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.5 bc	7.3 def	6.8 fgh	7.5 cde	7.3 cde	7.3 abc
SA-0011101 3.25 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.3 cd	6.8 fgh	6.0 ij	7.3 c-f	7.0 def	7.3 abc
SA-0011201 7.0 fl oz.....	A-E	7.3 cd	7.8 cde	7.5 cde	7.0 d-g	6.8 efg	7.3 abc
SA-0011301 7.0 fl oz.....	A-E	7.3 cd	8.3 abc	7.5 cde	7.8 bcd	7.8 bc	7.8 ab
SA-0190101 5.0 fl oz + Phyte-Off 2.0 fl oz.....	A-E	6.5 de	7.3 def	6.8 fgh	6.8 e-h	7.0 def	7.3 abc
Daconil Ultrex 82.5WDG 3.25 oz + Chipco Signature 80WDG 4.0 oz	A-E	8.3 ab	8.8 ab	8.3 b	8.5 ab	8.0 b	7.8 ab
Chipco 26 GT 2SC 4.0 fl oz + Chipco Signature 80WDG4.0 oz	A-E A-E	7.5 bc 7.3 cd	8.0 bcd 6.0 h	7.8 bcd 6.5 ghi	7.5 cde 6.5 fgh	8.0 b 6.0 hi	7.3 abc 6.5 c
SA-0170101 1.0 oz.....	A-E	7.3 cd	6.8 fgh	6.0 ij	6.3 gh	5.8 i	6.5 c
QP Fosetyl-AI 4.0 fl oz + Quali-Gard 0.36 oz	A-E	7.0 cde	6.3 gh	6.0 ij	6.5 fgh	5.8 i	6.5 c
QP Fosetyl-AI 4.0 fl oz + Fore 80WP 4.0 oz.....	A-E	7.5 bc	7.3 def	7.0 efg	7.3 c-f	7.3 cde	7.0 bc
QP Fosetyl-AI 4.0 fl oz + Match Play Turf Colorant 850.0 fl oz.....	A-E	7.8 bc	7.8 cde	8.3 b	8.0 abc	7.8 bc	7.3 abc
QP Fosetyl-AI 4.0 fl oz + Turf Mark Green Spray 10.0 fl oz	A-E	7.3 cd	7.0 efg	6.0 ij	6.3 gh	6.0 hi	6.5 c
QP Fosetyl-AI 4.0 fl oz + Green Lawnger 15.0 fl oz.....	A-E	9.0 a	9.0 a	9.0 a	8.8 a	8.8 a	8.0 a
Chipco Signature 80WDG 4.0 oz	A-E	7.8 bc	8.3 abc	8.0 bc	8.0 abc	7.5 bcd	6.8 c
SA-0010207 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	7.8 bc	7.3 def	7.3 def	7.5 cde	7.8 bc	7.8 ab
Untreated.....	-	6.3 e	6.3 gh	5.5 j	6.0 h	6.3 ghi	6.8 c
Untreated.....	-	7.0 cde	6.3 gh	6.5 ghi	6.3 gh	6.0 hi	7.0 bc
Untreated.....	-	7.0 cde	6.8 fgh	6.5 ghi	6.0 h	6.5 fgh	6.8 c

^z Turfgrass color was rated visually on a 0 to 9 scale where 1 = brown or dead turf; 9 = dark green turf.

^y Treatments were applied as follows: A = 12 Jun, B = 26 Jun, C = 21 Jul, D = 5 Aug, E = 19 Aug.

^x Means in a column followed by the same letter are not significantly different at P ≤ 0.05 level according to the Fisher's protected least significant difference t-test.

Table 3. NDVI ratings of a creeping bentgrass/annual bluegrass green treated with various fungicides for the control of summer stress, 2009.

Treatments and rate per 1000 sq ft	Application Code ^y	NDVI ^z	
		12 Jun	26 Jun
Vitalonil 5.2F 7.0 fl oz w/ Banner MAXX 1.24MEC 1.0 fl oz w/ Disarm 4SC 0.36 fl oz	A-E BC D	0.7340 a ^x	0.7140 a
SA-0010204 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	0.7170 a	0.7150 a
SA-0010205 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	0.7113 a	0.7170 a
SA-0011101 3.25 fl oz + Phyte-Off 2.0 fl oz.....	A-E	0.7433 a	0.7128 a
SA-0011201 7.0 fl oz.....	A-E	0.7460 a	0.7083 a
SA-0011301 7.0 fl oz.....	A-E	0.7320 a	0.7220 a
SA-0190101 5.0 fl oz + Phyte-Off 2.0 fl oz.....	A-E	0.7685 a	0.7723 a
Daconil Ultrex 82.5WDG 3.25 oz + Chipco Signature 80WDG 4.0 oz	A-E	0.7410 a	0.7205 a
Chipco 26 GT 2SC 4.0 fl oz + Chipco Signature 80WDG4.0 oz	A-E	0.7083 a	0.7088 a
SA-0170101 1.0 oz.....	A-E	0.7400 a	0.7063 a
QP Fosetyl-AI 4.0 fl oz.....	A-E	0.7445 a	0.7065 a
QP Fosetyl-AI 4.0 fl oz + Quali-Gard 0.36 oz	A-E	0.7440 a	0.7078 a
QP Fosetyl-AI 4.0 fl oz + Fore 80WP 4.0 oz.....	A-E	0.7405 a	0.7160 a
QP Fosetyl-AI 4.0 fl oz + Match Play Turf Colorant 850.0 fl oz.....	A-E	0.7403 a	0.6860 a
QP Fosetyl-AI 4.0 fl oz + Turf Mark Green Spray 10.0 fl oz	A-E	0.7468 a	0.7120 a
QP Fosetyl-AI 4.0 fl oz + Green Lawnger 15.0 fl oz.....	A-E	0.7358 a	0.0686 a
Chipco Signature 80WDG 4.0 oz	A-E	0.7505 a	0.7153 a
SA-0010207 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	0.7318 a	0.7158 a
Untreated.....	-	0.7355 a	0.6888 a
Untreated.....	-	0.7533 a	0.6975 a
Untreated.....	-	0.7650 a	0.7075 a

^z Turfgrass was rated using a NDVI TCM 500 Turf Color Meter.

^y Treatments were applied as follows: A = 12 Jun, B = 26 Jun, C= 21 Jul, D= 5 Aug, E= 19 Aug.

^x Means in a column followed by the same letter are not significantly different at P ≤ 0.05 level according to the Fisher's protected least significant difference t-test.

Table 4. Dollar spot incidence of a creeping bentgrass/annual bluegrass green treated with various fungicides for the control of summer stress, 2009.

Treatments and rate per 1000 sq ft	Application Code ^y	Dollar spot ^z	
		24 Aug (No. inf. cent.)	8 Sep (%)
Vitalonil 5.2F 7.0 fl oz w/ Banner MAXX 1.24MEC 1.0 fl oz w/ Disarm 4SC 0.36 fl oz	A-E BC D	6.5 gh ^x	1.0 fgh
SA-0010204 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	31.0 d-g	1.8 d-h
SA-0010205 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	15.3 fgh	1.3 e-h
SA-0011101 3.25 fl oz + Phyte-Off 2.0 fl oz.....	A-E	17.8 e-h	1.5 e-h
SA-0011201 7.0 fl oz.....	A-E	20.5 e-h	1.3 e-h
SA-0011301 7.0 fl oz.....	A-E	18.0 e-h	2.0 d-g
SA-0190101 5.0 fl oz + Phyte-Off 2.0 fl oz.....	A-E	2.5 h	0.2 gh
Daconil Ultrex 82.5WDG 3.25 oz + Chipco Signature 80WDG 4.0 oz	A-E	14.3 fgh	1.5 e-h
Chipco 26 GT 2SC 4.0 fl oz + Chipco Signature 80WDG4.0 oz	A-E	1.3 h	0.1 h
SA-0170101 1.0 oz.....	A-E	59.5 abc	4.4 abc
QP Fosetyl-Al 4.0 fl oz.....	A-E	44.8 b-e	3.0 cde
QP Fosetyl-Al 4.0 fl oz + Quali-Gard 0.36 oz	A-E	41.0 b-f	3.6 cd
QP Fosetyl-Al 4.0 fl oz + Fore 80WP 4.0 oz.....	A-E	22.0 d-h	1.7 e-h
QP Fosetyl-Al 4.0 fl oz + Match Play Turf Colorant 850.0 fl oz.....	A-E	25.0 d-h	1.1 e-h
QP Fosetyl-Al 4.0 fl oz + Turf Mark Green Spray 10.0 fl oz	A-E	33.5 c-g	3.0 cde
QP Fosetyl-Al 4.0 fl oz + Green Lawnger 15.0 fl oz.....	A-E	30.3 d-g	2.5 c-f
Chipco Signature 80WDG 4.0 oz	A-E	47.8 bcd	2.9 c-f
SA-0010207 3.6 fl oz + Phyte-Off 2.0 fl oz.....	A-E	13.8 gh	1.0 fgh
Untreated.....	-	75.3 a	6.3 a
Untreated.....	-	67.8 ab	4.3 bc
Untreated.....	-	64.0 ab	5.8 ab

^z The number of dollar spot infection centers were counted and the numbers represent the average of infection centers per plot.

^y Treatments were applied as follows: A = 12 Jun, B = 26 Jun, C= 21 Jul, D= 5 Aug, E= 19 Aug.

^x Means in a column followed by the same letter are not significantly different at P≤0.05 level according to the Fisher's protected least significant difference t-test.