

INFLUENCE OF VARIOUS COMMERCIALY AVAILABLE AND EXPERIMENTAL
FUNGICIDES AND TURFGRASS COLORANTS ON THE SUMMER STRESS
MANAGEMENT OF A CREEPING BENTGRASS PUTTING GREEN

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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 greens speed 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. Various experimental chemistries as well as spray tank additives are currently being evaluated for their ability to minimize summer stress to creeping bentgrass putting greens during extreme heat conditions. The objective of this study is to evaluate various 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. The putting green was a modified USGA specified sand construction with a pH of 7.8 and an OM of .27%. Turfgrass used for the fungicide evaluation was predominantly a stand of 'Penncross' creeping bentgrass (*Agrostis stolonifera*) with approximately 5 to 10% 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. On 28 Jul the mowing height was reduced to .090" for a 2 week period in an effort to increase plant stress. 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 2 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. Treatments were initiated on 2 Jun. On 11 Jun (9 days after treatment; DAT), plots treated with Daconil WeatherStik + Signature and Foursome had the highest turfgrass quality of any treatment. Few differences, however, existed among many of the treatments and only plots treated with A16422A + A14658A (#1), A17601A, SA-0010212, and SA-0070101 had unacceptable quality (<7.0) on

the first rating date (Table 1). Following the initial rating, the untreated control plots generally had unacceptable quality throughout the study. Throughout Jun and Jul and prior to the induction of stress by lowering mowing heights, turfgrass quality varied by treatments. Between 11 Jun and 27 Jul, plots were evaluated for the number of times they were considered equal to the greatest performing treatment on each rating date. Plots treated with the following treatments had the highest quality on 4 out of 4 ratings dates: Renown + A14658A + A14658D, SA-0010211, Daconil WeatherStik + Chipco Signature, QP Fosetyl-Al + Foursome + QP Chlorothalonil, QP Fosetyl-Al + QP Chlorothalonil NEW + Foursome, and Chipco Signature + Daconil Ultrex. Plots with the highest quality on 3 of 4 dates included: A16422A + A14658A + A14658D, A17601A + A14658A + A14658D, and SA-0010210. Plots with the highest quality on 2 of 4 dates included: Foursome and QP Fosetyl-Al + Foursome. All remaining treatments resulted in quality below treatments with the highest quality on ≤ 1 rating date, although this did not necessarily result in unacceptable quality. Approximately 2 weeks after mechanical stress was induced by lowering mowing heights, plots treated with QP Fosetyl-Al + Foursome + QP Chlorothalonil exhibited the highest quality (8.8 out of 9.0) when compared to bentgrass quality from other treatments. Good turfgrass quality (≥ 8.0) was observed within plots treated with the A16422A + A14658A + A14658D, SA-0010211, QP Fosetyl-Al + Foursome + QP Chlorothalonil NEW, and Chipco Signature + Daconil Ultrex. Few differences existed among treatments, but those plots treated with QP Fosetyl-Al and the untreated control plots generally had the lowest quality and were all considered to be unacceptable (≤ 7.0).

Turfgrass color and NDVI. Turfgrass color varied throughout the study. Data collected in mid-August following two weeks of lower mowing height stress and using visual ratings and the quantitative ratings from the NDVI TCM 500 Turf Color Meter are reported in Table 2 and 3. On the final rating dates for each color assessment, treatments providing the highest color ratings using both rating scales included plots treated with A16422A + A14658A + A14658D, Renown + A14658A + A14658D, A17601A, SA-0010211, SA-0010212, Daconil WeatherStik + Chipco Signature, QP Fosetyl-Al + Foursome + QP Chlorothalonil, QP Fosetyl-Al + Foursome + QP Chlorothalonil NEW, and Daconil Ultrex + Chipco Signature. Differences in visual color ratings among treatments were present during the study, but few treatments (including the untreated control) had unacceptable color ratings on a majority of the rating dates.

Dollar spot. Dollar spot was present within the study area when treatments were initiated on 2 Jun and continued to be severe within the first few weeks of the study. On 11 Jun, disease severity was moderate to severe and an average of 18 to 30 infection centers within the untreated control plots (Table 4). Few differences among treatments existed and no treatments resulted in a rapid and acceptable curative suppression of dollar spot.

DISCUSSION

Summer stress management is an important consideration for golf course superintendents growing creeping bentgrass in the mid-Atlantic region. While products such as Chipco Signature and those containing StressGard are often utilized, other experimental chemistries and colorants are gaining in interest for various reasons. In this study, several products appeared to improve turfgrass quality on many rating dates. Treatments receiving select experimental products including A16422A + A14658A + A14658D, Renown + A14658A + A14658D, SA-0010211, Daconil (WeatherStik or Ultrex) + Chipco Signature, and QP Fosetyl-Al + Foursome + QP Chlorothalonil (both formulations) appeared to provide consistently high quality. The turf colorant Foursome appeared to provide approximately 2 weeks of improved quality following its application and for unknown reasons provided higher turf quality when turf was under mowing stress.

Future work may seek to look at the length of improved quality from Foursome and other products following induced stresses including mechanical and environmental factors. In addition to the application of the various products in this study, studies should also seek to determine the interaction and/or influence of the products when applied with typical nitrogen spoon-feeding programs commonly performed by golf course superintendents. In this study, the goal was to keep nutrients to a minimum to help to visualize potential reductions in turf quality and color. Overall, the results of this study show that these fungicides and colorants may improve turfgrass quality. Caution, however, should be exercised with

repeated use of fungicides in the absence of disease to help to minimize the potential for resistance development.

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Table 1. Quality of a creeping bentgrass/annual bluegrass green treated with various fungicide programs for the management of summer stress, 2010.

| | Treatment and rate per 1000 sq ft | App. Code ^y | Quality (1-9) ^z | | | | |
|----|-----------------------------------|------------------------|----------------------------|---------|---------|--------|---------|
| | | | 11 Jun | 28 Jun | 13 Jul | 27 Jul | 13 Aug |
| 1 | A 16422A 3.6 fl oz | ABCDE | | | | | |
| | A14658A 6 fl oz | ABC | | | | | |
| | A14658D 6 fl oz..... | DE | 6.8 cde ^x | 7.8 ab | 7.8 ab | 8.3 a | 8.0 b |
| 2 | Renown 2.5 fl oz | ABCDE | | | | | |
| | A14658A 6 fl oz | ABC | | | | | |
| | A14658D 6 fl oz..... | DE | 7.5 abc | 8.0 a | 7.8 ab | 8.0 ab | 7.3 cde |
| 3 | A17601A 0.625 fl oz..... | ABCDE | 6.3 e | 7.3 bc | 7.5 abc | 7.5 bc | 7.5 bcd |
| 4 | A17601A 0.625 f oz | ABCDE | | | | | |
| | A14658A 6 fl oz | ABC | | | | | |
| | A14658D 6 fl oz..... | DE | 7.0 cde | 8.0 a | 7.8 ab | 8.3 a | 7.8 bc |
| 5 | SA-0010207 3.6 fl oz..... | ABCDE | 7.0 cde | 7.0 cd | 6.8 de | 8.0 ab | 7.3 cde |
| 6 | SA-0010210 5.0 fl oz..... | ABCDE | 7.3 bcd | 8.0 a | 7.5 abc | 8.0 ab | 7.8 bc |
| 7 | SA-0010211 7.0 fl oz..... | ABCDE | 7.5 abc | 8.0 a | 7.8 ab | 7.8 ab | 8.0 b |
| 8 | SA-0010212 5.0 fl oz..... | BCDE | 6.8 cde | 7.0 cd | 7.3 bcd | 8.3 a | 7.5 bcd |
| 9 | Untreated..... | ABCDE | 7.3 bcd | 6.3 e | 5.8 g | 6.0 f | 6.3 g |
| 10 | SA-0010214 3.6 fl oz..... | ABCDE | 7.3 bcd | 7.0 cd | 7.3 bcd | 7.5 bc | 7.3 cde |
| 11 | SA-0170101 1.0 oz..... | ABCDE | 6.5 de | 6.3 e | 6.0 fg | 6.3 ef | 7.0 def |
| 12 | Daconil WeatherStik 3.6 fl oz | ABCDE | | | | | |
| | Chipco Signature 4 oz..... | ABCDE | 8.3 a | 8.0 a | 7.5 abc | 8.0 ab | 7.8 bc |
| 13 | QP Fosetyl-AI 4 oz..... | ABCDE | 7.0 cde | 6.5 de | 6.5 ef | 6.3 ef | 6.5 fg |
| 14 | Foursome 16 fl oz/A..... | ABCDE | 8.3 a | 7.5 abc | 6.8 de | 6.8 de | 7.5 bcd |
| 15 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | | |
| | Foursome 16 fl oz/A..... | ABCDE | 8.0 ab | 8.0 a | 7.0 cde | 7.0 cd | 7.8 bc |
| 16 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | | |
| | Foursome 16 fl oz/A | ABCDE | | | | | |
| | QP Chlorothalonil DF 3.2 oz..... | ABCDE | 8.0 ab | 8.0 a | 7.8 ab | 8.0 ab | 8.8 a |
| 17 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | | |
| | QP Chlorothalonil NEW DF 3.2 oz | ABCDE | | | | | |
| | Foursome 16 fl oz/A..... | ABCDE | 8.0 ab | 8.0 a | 8.0 a | 8.3 a | 8.0 b |
| 18 | Chipco Signature 4.0 oz..... | ABCDE | 8.0 ab | 8.0 a | 8.0 a | 8.3 a | 8.0 b |
| | Daconil Ultrex 3.2 oz..... | ABCDE | | | | | |
| 19 | Untreated..... | - | 7.0 cde | 6.5 de | 5.5 g | 6.3 ef | 6.5 fg |
| 20 | Untreated..... | - | 7.5 abc | 6.3 e | 6.0 fg | 6.0 f | 6.3 g |
| 21 | Untreated..... | - | 7.0 cde | 7.0 cd | 6.5 ef | 6.3 ef | 6.8 efg |

^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 = 2 Jun, B = 17 Jun, C= 1 Jul, D= 15 Jul, E= 29 Jul.

^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 management of summer stress, 2010.

| | Treatment and rate per 1000 sq ft | App. Code ^y | Color (1-9) ^z | | | |
|----|-----------------------------------|------------------------|--------------------------|--------|---------|---------|
| | | | 28 Jun | 13 Jul | 27 Jul | 13 Aug |
| 1 | A 16422A 3.6 fl oz | ABCDE | | | | |
| | A14658A 6 fl oz | ABC | | | | |
| | A14658D 6 fl oz..... | DE | 7.5 def ^x | 7.8 cd | 8.5 ab | 8.0 abc |
| 2 | Renown 2.5 fl oz | ABCDE | | | | |
| | A14658A 6 fl oz | ABC | | | | |
| | A14658D 6 fl oz..... | DE | 7.5 def | 7.8 cd | 7.8 cde | 8.0 abc |
| 3 | A17601A 0.625 fl oz..... | ABCDE | 7.3 efg | 7.3 de | 7.5 def | 8.0 abc |
| 4 | A17601A 0.625 f oz | ABCDE | | | | |
| | A14658A 6 fl oz | ABC | | | | |
| | A14658D 6 fl oz..... | DE | 7.5 def | 7.8 cd | 8.0 bcd | 7.3 cde |
| 5 | SA-0010207 3.6 fl oz..... | ABCDE | 7.8 cde | 7.8 cd | 8.0 bcd | 7.8 bcd |
| 6 | SA-0010210 5.0 fl oz..... | ABCDE | 8.0 bcd | 8.0 bc | 8.8 a | 7.8 bcd |
| 7 | SA-0010211 7.0 fl oz..... | ABCDE | 8.3 abc | 8.5 ab | 8.5 ab | 8.0 abc |
| 8 | SA-0010212 5.0 fl oz..... | BCDE | 7.0 fg | 7.3 de | 8.3 abc | 8.0 abc |
| 9 | Untreated..... | ABCDE | 7.0 fg | 6.3 f | 6.8 g | 6.8 e |
| 10 | SA-0010214 3.6 fl oz..... | ABCDE | 7.8 cde | 7.8 cd | 8.0 bcd | 7.8 bcd |
| 11 | SA-0170101 1.0 oz | ABCDE | 7.0 fg | 6.5 f | 7.3 efg | 7.0 de |
| 12 | Daconil WeatherStik 3.6 fl oz | ABCDE | | | | |
| | Chipco Signature 4 oz..... | ABCDE | 8.0 bcd | 8.0 bc | 8.3 abc | 8.3 ab |
| 13 | QP Fosetyl-AI 4 oz | ABCDE | 7.0 fg | 6.8 ef | 6.8 g | 7.0 de |
| 14 | Foursome 16 fl oz/A | ABCDE | 8.8 a | 8.5 ab | 7.5 def | 8.3 ab |
| 15 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | |
| | Foursome 16 fl oz/A | ABCDE | 8.8 a | 8.5 ab | 7.8 cde | 8.0 abc |
| 16 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | |
| | Foursome 16 fl oz/A | ABCDE | | | | |
| | QP Chlorothalonil DF 3.2 oz | ABCDE | 8.5 ab | 9.0 a | 8.5 ab | 8.8 a |
| 17 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | |
| | QP Chlorothalonil NEW DF 3.2 oz | ABCDE | | | | |
| | Foursome 16 fl oz/A | ABCDE | 8.8 a | 9.0 a | 8.3 abc | 8.5 ab |
| 18 | Chipco Signature 4.0 oz..... | ABCDE | | | | |
| | Daconil Ultrex 3.2 oz | ABCDE | 8.5 ab | 8.3 bc | 8.3 abc | 8.5 ab |
| 19 | Untreated..... | - | 7.0 fg | 6.5 f | 7.0 fg | 7.0 de |
| 20 | Untreated..... | - | 7.3 efg | 6.3 f | 7.3 efg | 7.0 de |
| 21 | Untreated..... | - | 6.8 g | 6.8 ef | 7.5 def | 7.3 cde |

^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 = 2 Jun, B = 17 Jun, C = 1 Jul, D = 15 Jul, E = 29 Jul.

^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 3. NDVI ratings of a creeping bentgrass/annual bluegrass green treated with various fungicides for the management of summer stress, 2010.

| | Treatment and rate per 1000 sq ft | App. Code ^y | NDVI ^z | | | |
|----|-----------------------------------|------------------------|----------------------|---------|-----------|-----------|
| | | | 29 Jun | 9 Jul | 2 Aug | 16 Aug |
| 1 | A 16422A 3.6 fl oz | ABCDE | | | | |
| | A14658A 6 fl oz | ABC | | | | |
| | A14658D 6 fl oz..... | DE | 0.771 a ^x | 0.762 a | 0.719 a-e | 0.769 ab |
| 2 | Renown 2.5 fl oz | ABCDE | | | | |
| | A14658A 6 fl oz | ABC | | | | |
| | A14658D 6 fl oz..... | DE | 0.760 a | 0.761 a | 0.732 abc | 0.776 a |
| 3 | A17601A 0.625 fl oz..... | ABCDE | 0.753 a | 0.763 a | 0.719 a-e | 0.759 a-e |
| 4 | A17601A 0.625 f oz | ABCDE | | | | |
| | A14658A 6 fl oz | ABC | | | | |
| | A14658D 6 fl oz..... | DE | 0.756 a | 0.764 a | 0.725 a-d | 0.756 b-e |
| 5 | SA-0010207 3.6 fl oz..... | ABCDE | 0.755 a | 0.759 a | 0.731 a-d | 0.756 b-e |
| 6 | SA-0010210 5.0 fl oz..... | ABCDE | 0.758 a | 0.765 a | 0.734 abc | 0.766 abc |
| 7 | SA-0010211 7.0 fl oz..... | ABCDE | 0.756 a | 0.769 a | 0.736 ab | 0.765 a-d |
| 8 | SA-0010212 5.0 fl oz..... | BCDE | 0.753 a | 0.751 a | 0.710 def | 0.770 ab |
| 9 | Untreated..... | ABCDE | 0.751 a | 0.753 a | 0.698 ef | 0.732 fg |
| 10 | SA-0010214 3.6 fl oz..... | ABCDE | 0.754 a | 0.770 a | 0.733 abc | 0.758 a-e |
| 11 | SA-0170101 1.0 oz | ABCDE | 0.744 a | 0.759 a | 0.699 ef | 0.731 fg |
| 12 | Daconil WeatherStik 3.6 fl oz | ABCDE | | | | |
| | Chipco Signature 4 oz..... | ABCDE | 0.749 a | 0.766 a | 0.739 a | 0.767 abc |
| 13 | QP Fosetyl-AI 4 oz | ABCDE | 0.754 a | 0.770 a | 0.718 a-f | 0.745 efg |
| 14 | Foursome 16 fl oz/A | ABCDE | 0.759 a | 0.770 a | 0.712 c-f | 0.748 c-f |
| 15 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | |
| | Foursome 16 fl oz/A | ABCDE | 0.754 a | 0.763 a | 0.723 a-d | 0.746 d-g |
| 16 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | |
| | Foursome 16 fl oz/A | ABCDE | | | | |
| | QP Chlorothalonil DF 3.2 oz | ABCDE | 0.758 a | 0.763 a | 0.736 a | 0.773 ab |
| 17 | QP Fosetyl-AI 4.0 oz | ABCDE | | | | |
| | QP Chlorothalonil NEW DF 3.2 oz | ABCDE | | | | |
| | Foursome 16 fl oz/A | ABCDE | 0.757 a | 0.763 a | 0.732 a-d | 0.766 abc |
| 18 | Chipco Signature 4.0 oz..... | ABCDE | | | | |
| | Daconil Ultrex 3.2 oz | ABCDE | 0.754 a | 0.756 a | 0.723 a-d | 0.759 a-e |
| 19 | Untreated..... | - | 0.739 a | 0.749 a | 0.698 ef | 0.729 g |
| 20 | Untreated..... | - | 0.753 a | 0.760 a | 0.697 f | 0.740 efg |
| 21 | Untreated..... | - | 0.753 a | 0.762 a | 0.714 b-f | 0.742 efg |

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

^y Treatments were applied as follows: A = 2 Jun, B = 17 Jun, C= 1 Jul, D= 15 Jul, E= 29 Jul.

^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 management of summer stress, 2010.

| | Treatment and rate per 1000 sq ft | App. Code ^y | Dollar spot ^z |
|----|-----------------------------------|---------------------------|--------------------------|
| | | | 11 Jun |
| 1 | A 16422A 3.6 fl oz | ABCDE | 9.3 fg ^x |
| | A14658A 6 fl oz | ABC | |
| | A14658D 6 fl oz..... | DE | |
| 2 | Renown 2.5 fl oz | ABCDE | 9.5 efg |
| | A14658A 6 fl oz | ABC | |
| | A14658D 6 fl oz..... | DE | |
| 3 | A17601A 0.625 fl oz..... | ABCDE | 16.0 b-g |
| 4 | A17601A 0.625 f oz | ABCDE | 11.5 d-g |
| | A14658A 6 fl oz | ABC | |
| | A14658D 6 fl oz..... | DE | |
| 5 | SA-0010207 3.6 fl oz..... | ABCDE | 18.0 b-e |
| 6 | SA-0010210 5.0 fl oz..... | ABCDE | 12.5 d-g |
| 7 | SA-0010211 7.0 fl oz..... | ABCDE | 9.5 efg |
| 8 | SA-0010212 5.0 fl oz..... | BCDE | 17.0 b-f |
| 9 | Untreated..... | ABCDE | 30.0 a |
| 10 | SA-0010214 3.6 fl oz..... | ABCDE | 12.5 d-g |
| 11 | SA-0170101 1.0 oz | ABCDE | 22.0 ab |
| 12 | Daconil WeatherStik 3.6 fl oz | ABCDE | 9.5 efg |
| | Chipco Signature 4 oz..... | ABCDE | |
| 13 | QP Fosetyl-AI 4 oz | ABCDE | 21.5 abc |
| 14 | Foursome 16 fl oz/A | ABCDE | 17.3 b-f |
| 15 | QP Fosetyl-AI 4.0 oz | ABCDE | 13.3 c-g |
| | Foursome 16 fl oz/A | ABCDE | |
| 16 | QP Fosetyl-AI 4.0 oz | ABCDE | 11.0 efg |
| | Foursome 16 fl oz/A | ABCDE | |
| | QP Chlorothalonil DF 3.2 oz | ABCDE | |
| 17 | QP Fosetyl-AI 4.0 oz | ABCDE | 7.5 g |
| | QP Chlorothalonil NEW DF 3.2 oz | ABCDE | |
| | Foursome 16 fl oz/A | ABCDE | |
| 18 | Chipco Signature 4.0 oz..... | ABCDE | 11.0 efg |
| | Daconil Ultrex 3.2 oz | ABCDE | |
| 19 | Untreated..... | - | 22.0 ab |
| 20 | Untreated..... | - | 20.0 bcd |
| 21 | Untreated..... | - | 17.8 b-f |

^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 = 2 Jun, B = 17 Jun, C= 1 Jul, D= 15 Jul, E= 29 Jul.

^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.