University of Maryland

Department of Plant Science
and Landscape Architecture

2011
Turfgrass Pathology,
Weed Science and Management
Research Summaries

Contributions To The University of Maryland Turfgrass Pathology, Weed Science, and General Management Research Programs in 2011

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Dollar Spot Control With Commercial and Experimental Fungicides In Fairway Height Crenshaw Creeping Bentgrass, 2011

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Procedure. This study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Treatments were applied with a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle and calibrated to deliver 1.1 gal. water per 1000 ft^2 (50 GPA). Fungicides were applied on a 14 day interval between April 28 and May 26, 2011. Turf was a mature stand of 'Crenshaw' creeping bentgrass grown on Keyport silt loam with a pH of 6.0 and 1.8% OM. Turf was mowed two to three times weekly to a height of 0.50" using a triplex mower. Turf received 2.0 lb N/1000 ft^2 in the autumn of 2010 and 1.0 lb N/ 1000ft^2 in the spring of 2011. No N was applied to the site during the study period. Plots were 5 ft by 5 ft, and were arranged in a randomized complete block with four replications. Dollar spot developed naturally and uniformly. Dollar spot was evaluated by counting the number of infection centers (IC's) in each plot. On the final rating date, plots were rated on a visual linear scale of 0 to 100% where 0 = entire plot area disease-free and 100 = entire plot area blighted. Plots also were assessed for foliar color and overall quality using a visual 0 to 10linear scale where 0 = entire plot area brown or dead and 10 = optimum green color and quality. Data were subjected to ANOVA and significantly different means were separated using Fisher's LSD at $P \leq 0.05$.
Dollar Spot Control. Dollar spot appeared on 27 April 2011, which was one of the earliest known outbreaks of dollar spot in central Maryland. As such, the fungicides were applied curatively on 28 April when there were between 9 and 21 infection centers in each plot.By 5 May, all treatments had reduced dollar spot compared to the control. There were few differences among treatments, which followed a trend similar to the starting number of IC's. Between 12 May (i.e., 14 days after the initial application) and 19 May all treatments again had similar levels of dollar spot suppression. On 16 May (day of last application of treatments) and 2 June plots treated with Tourney (both rates) Concert II + Primo and A9898A + Primo had less than 1 IC/plot. Regardless, all treatments had similar levels (0 to 4 IC's/plot). On 10 June (i.e., 14 days since treatments last were applied) plots treated with Velista (0.3 oz), Renown + Primo and A16422A + Primo had an increase in disease compared to the 2 June rating indicating that their residual effectiveness had diminished. All treatments (except Velista 0.5 oz) had less dollar spot compared to Velsita (0.3 oz); Renown + Primo and A16422A + Primo on 17 June. Dollar spot had increased in all plots one week later on 22 June. At this time only plots treated with Emerald, Concert II + Primo and A9898A + Primo had less than 10 IC's/plot., but data did not vary significantly compared to most other treatments (except Velista 0.3 oz; Renown, and A16422A + Primo).On the final rating date (29 June; percent area blighted) relatively good control (i.e., ≤ 5% blight) as still being provided by Emerald, Tourney (0.37 oz), Concert II, Headway, and A9898A + Primo.

Turf Color and Overall Quality. Turf color generally was improved by all treatments. Highest color ratings were consistently associated with all Primo MAXX tank-mixes with fungicides.

Table 1. Dollar spot control with commercial and experimental fungicides in Crenshaw creeping bentgrass in College Park, MD, 2011.

	Rate	Infection Centers/plot									% blighted
Treatment*	oz/1000ft^2	27-Apr	5-May	12-May	19-May	26-May	2-Jun	10-Jun	17-Jun	22-Jun	29-Jun
Emerald 70WG	0.13	10.3bc**	7.5cde	2.8bc	3.8b	1.5bc	1.0bc	0.5de	2.5c	7.3d	2.8d
Tourney 50WDG	0.28	11.0bc	6.0de	2.8bc	0.3b	0.0c	0.0c	0.0e	4.0c	16.5cd	7.3cd
Tourney 50WDG	0.37	13.8bc	7.0cde	1.8c	0.3b	0.3c	0.3c	0.0e	2.3c	14.8cd	5.0d
Velista 50WDG	0.3	10.5bc	4.8e	1.8c	2.3b	2.5bc	4.3b	8.5b	15.8b	29.5bc	15.0bcd
Velista 50WDG	0.5	21.3a	14.0b	4.0bc	3.0b	2.5bc	3.3bc	3.5b-e	7.5bc	21.5bcd	5.8d
Renown + Primo M.	3.25+0.2	16.5ab	10.8bcd	6.0b	2.5b	2.8bc	4.3b	6.5bc	15.8b	42.8b	20.5bc
Concert II + Primo M.	4.0+0.2	13.0bc	7.5cde	4.3bc	0.3b	0.0c	0.0c	0.0e	2.5c	8.3cd	4.5d
Headway + Primo M.	1.5+0.2	12.3bc	8.0cde	4.5bc	1.5b	1.3bc	1.5bc	1.3cde	5.3c	17.3cd	4.5d
A9898A + Primo M.	0.96+0.2	9.0c	5.3e	1.8c	1.0b	0.3c	0.3c	0.0e	1.5c	4.8d	2.8d
A16422A + Primo M.	2.6+0.2	15.0abc	11.5bc	5.0bc	4.5b	4.3b	4.3b	5.8bcd	17.0b	39.5b	24.5b
Untreated	–	14.8abc	19.1a	11.3a	33.4a	37.1a	44.0a	51.5a	62.8a	81.4a	54.8a

*Fungicides were applied on a 14-d interval on April 28 and 12 and 26 May 2011.
**Means separated by Fisher's LSD, $P = 0.05$.

Table 2. Crenshaw creeping bentgrass color as influenced by fungicides and Primo MAXX, in College Park, MD, 2011.

Treatment*	Rate oz/1000ft^2	Color (0-10 scale) 1-Jun	10-Jun	17-Jun	24-Jun
Emerald 70WG	0.13	8.4cde**	8.0cd	8.0c	7.9b
Tourney 50WDG	0.28	8.4cde	8.1bc	8.0c	7.9b
Tourney 50WDG	0.37	8.1def	8.0cd	7.9c	7.6b
Velista 50WDG	0.3	8.0ef	8.0cd	8.0c	7.6b
Velista 50WDG	0.5	8.4cde	8.3bc	8.0c	7.5bc
Renown + Primo M.	3.25+0.2	9.0a	8.8a	8.5b	8.4a
Concert II + Primo M.	4.0+0.2	8.9ab	8.9a	8.9a	8.8a
Headway + Primo M.	1.5+0.2	8.8abc	8.8a	8.8ab	8.4a
A9898A + Primo M.	0.96+0.2	8.5bcd	8.5ab	8.6ab	8.8a
A16422A + Primo M.	2.6+0.2	8.8abc	8.8a	8.8ab	8.4a
Untreated	−	7.9f	7.6d	7.4d	7.1c

*Fungicides were applied on a 14-d interval on April 28 and 12 and 26 May 2011.
**Means separated by Fisher's LSD, *P* = 0.05.

Table 3. Overall Crenshaw creeping bentgrass quality as influenced by fungicides and Primo MAXX in College Park, MD, 2011.

	Rate	Quality (0-10 scale)			
Treatment*	oz/1000ft^2	1-Jun	10-Jun	17-Jun	24-Jun
Emerald 70WG	0.13	8.6ab**	8.3ab	8.3a	8.0a
Tourney 50WDG	0.28	8.6ab	8.4ab	7.6ab	7.1abc
Tourney 50WDG	0.37	8.6ab	8.3ab	7.8ab	7.1abc
Velista 50WDG	0.3	7.9c	7.9b	7.1b	6.0cde
Velista 50WDG	0.5	8.3abc	8.4ab	7.8ab	6.6b-e
Renown + Primo M.	3.25+0.2	8.1bc	8.1ab	7.1b	5.6e
Concert II + Primo M.	4.0+0.2	8.9a	8.6a	8.3a	7.8ab
Headway + Primo M.	1.5+0.2	8.5abc	8.4ab	7.6ab	7.0a-d
A9898A + Primo M.	0.96+0.2	8.6ab	8.3ab	8.1a	7.6ab
A16422A + Primo M.	2.6+0.2	7.9c	7.9b	7.1b	5.8de
Untreated	–	5.3d	5.3c	4.8c	4.2f

*Fungicides were applied on a 14-d interval on April 28 and 12 and 26 May 2011.
**Means separated by Fisher's LSD, $P = 0.05$.

Brown Patch Control With BAS 640 and CX-42, 2011

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Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. The purpose of this study was to evaluate the performance of two experimental fungicides on control of brown patch (*Rhizoctonia solani).* The experimental BAS 640 was a pre-packaged mix of boscalid and chlorothalonil; whereas the active ingredient in CX-42 was not disclosed. Daconil Ultrex served as a standard for comparison.

Fungicides were applied with a CO_2 pressurized (34psi) sprayer equipped with an 8004E flat-fan nozzle and calibrated to deliver 1.1 gal water per 1000 sq ft (50 GPA). Treatments were applied on the dates footnoted in the data table. Soil was a Keyport silt loam with a pH of 5.7 and 2.6% OM. Turf was 'Revere' colonial bentgrass (*Agrostis capilaris*) planted in the fall of 2010. Upon seeding, an 18-24-12 starter fertilizer was applied to deliver 1.0 lb N/1000ft^2. Another 1.0 lb N/1000ft^2 application of urea was made on 7 April, 2011. The study area was mowed three times weekly to a height of 0.5 in. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with four replications. Percent of plot area blighted was assessed visually on a linear 0 to 100% scale where 0 = entire plot area green and healthy, and 100 = entire plot area blighted. Treatments with ratings exceeding 5.0% plot area blighted by *Rhizoctonia solani* were subjectively considered to be unacceptable or at the threshold for retreatment of a golf course fairway.

Results. Treatments were initiated on 17 June with the exception of CX-42 20SC, which was first applied 21 June. Disease pressure increased between 17 and 21 June, and the late-treated CX-42 20SC plots were sprayed with a mix of CX-42 and Daconil Ultrex (chlorothalonil;1.0 oz/1000ft^2) on 21 June. Brown patch pressure was ephemeral due to constantly changing weather conditions in late July and throughout August. For example, blight levels were in the moderately severe range on 6 and 12 July, but declined to a low level on 22 July. Thereafter, disease pressure increased slowly until reaching a severe level by mid-August.

When plots were first rated for brown patch severity on 6 July, disease only was present in plots treated with Curalan (both timings) and the untreated control. Brown patch was equally severe in the control plots and 21-day Curalan-treated plots. . By 12 July, brown patch had appeared in all plots except those treated with BAS 640 in the 21 day interval. At this time plots treated with Curalan were above the threshold (i.e., > 5% blighting) and all other treatments were both statistically similar and within the threshold. Weather shifted from extremely hot to cool and dry and brown patch pressure declined as the bentgrass recovered throughout the study area on 22 July. On 22 July, only plots treated with Curalan (both timings) had blight levels equivalent to the control. Plots treated with BAS 640 (both timings), Daconil Ultrex and CX-42 had little or no disease and statistically similar levels of brown patch between 26 July and 9 August. Conversely, brown patch intensified in Curalan-treated plots (both timings). It is interesting to note that there was more blighting in Curalan plots treated on the 14-day versus the

21-day interval. Both of the aforementioned were last applied on 29 July and it cannot be explained why plots treated every 14 days were more severely blighted. On the final rating date, 12 August, brown patch severity was greatest in all Curalan-treated plots and the control, and there were no differences among other treatments. At no time did plots treated with BAS 640, Daconil Ultex or CX-42 exceed the threshold.

Table 1. Brown patch blight levels in colonial bentgrass as influenced by fungicides, 2011.

Treatment	Rate (oz/1000ft^2)	Spray interval (days)*	Brown patch/plot (%) 6-Jul	12-Jul	22-Jul	26-Jul	2-Aug	4-Aug	9-Aug	12-Aug
Curalan 50WG	1.0	14	9.0b**	10.3b	4.3ab	8.3b	12.8a	20.0a	36.8a	42.0a
BAS 640 749SC	3.0 fl	14	0.0c	1.3c	2.0bcd	1.0c	0.0c	0.0c	0.0c	0.0b
Curalan 50WG	1.0	21	16.5ab	7.3b	5.3a	16.3a	7.5b	11.3b	24.5b	32.5a
BAS 640 749SC	3.0 fl	21	0.0c	0.0c	0.0d	0.5c	0.0c	0.3c	0.8c	3.0b
Daconil Ultrex	3.2	14	0.0c	2.5c	0.8cd	0.0c	0.0c	0.0c	0.0c	0.0b
CX-42 20SC	0.5	14	0.0c	2.3c	1.5cd	1.8c	0.5c	1.0c	1.8c	4.3b
Untreated	-	-	24.5a	16.8a	3.3abc	12.3ab	13.8a	24.3a	31.3a	45.5a

*Treatments on 14-day interval were applied 17 June, 1, 15 and 29 July. Treatments on 21-day interval were applied 17 June, 8 and 29 July.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Brown Patch Control with Syngenta Experimental Fungicides, 2011

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Procedure. The purpose of this study was to evaluate the performance of several experimental fungicide rates and timings for their ability to control brown patch. BAS 640 is a pre-packaged mix of boscalid and chlorothalonil and was included as a standard. This field study was conducted in 2011 at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Fungicides were applied with a CO_2 pressurized (34 psi) sprayer equipped with an 8004E flat-fan nozzle and calibrated to deliver 1.1 gal water per 1000 sq ft (50 GPA). Treatments were applied on the dates footnoted in the data table. Soil was a Keyport silt loam with a pH of 5.7 and 2.6% OM. Turf was 'Revere' colonial bentgrass (*Agrostis capillaris*) that was planted in autumn 2010. The study area was fertilized with 1.0 lb N/1000ft^2 in the autumn of 2010 and another 1.0 lb N/1000ft^2 in the spring of 2011. Turf was mowed three times weekly to a height of 0.50 in using a triplex mower. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with four replications. Percent of plot area blighted was assessed visually on a linear 0 to 100% scale where 0 = entire plot area green and healthy, and 100 = entire plot area blighted. Treatments with ratings exceeding 5.0% plot area blighted by *Rhizoctonia solani* were subjectively considered to be unacceptable or at the threshold for re-streatment of a golf course fairway. Data were subjected to ANOVA and significantly different means were separated using Fisher's LSD at $P \leq 0.05$.

Brown Patch. Treatments were initiated on 10 June in response to unusually warm and humid weather, but symptoms of brown patch did not appear until early July. While July was marked by prolonged periods of heat stress, it was relatively dry, which lowed progression of the disease. In late July and throughout the remainder of the summer temperatures moderated and there was plentiful rainfall. Throughout August the disease achieved a stasis in response to alternating periods of unusually cool and low humidity conditions. This may be the first time in 31 years that brown patch pressure did not achieve a level that overwhelmed the ability of most fungicides to control the disease.

The study was initiated on 20 June and applications ceased on 1 August for 14-and 21-day treatments and on 25 July for 35-day treatments. With few exceptions, all fungicide treatments provided for almost complete control of brown patch from 6 July to 19 August. When plots were first rated for disease on 6 July, brown patch was present in plots treated with Contend (A9898A) applied at 28 and 35-day intervals, A18281A applied at 35-day intervals, and the control. On 12 July, brown patch appeared in several other treatments, but disease severity was highest in the control. On 22 July, disease severity had declined in the control and there were several treatments in which brown patch levels were equal to that of the control but the differences were small. By 26 July, all plots had received a second or third fungicide application, and brown patch was restricted to the control. Thereafter, no brown patch developed in fungicide-treated plots until 19 August, which was about 3 weeks since all treatments had been last applied. On 19 August, brown patch appeared again in plots treated with A17386B (both timings) while brown patch severity in the control also was increasing. On 22 August, brown patch appeared at low levels in plots treated with A18281A (both timings) and BAS 640. Finally, on 6 September (i.e., 30-35 days since treatments were last applied) brown patch resurgence (i.e., more disease in a fungicide-treated plot versus the control) was observed in plots treated with A17386B (0.37 oz 28-d). Numerically high blight levels versus the control were recorded in plots treated with A18281A (2.0 fl. oz, 28-d and 35-d) and A17386B (0.37 oz, 35-d). Plots treated with A18847A (0.51 fl oz, 21-d); A18847A (0.69 fl oz, 35-d) and A13703G (0.5 oz) remained disease-free on the final rating date. All other treatments had only a trace to 2.5% blighting on 22 August.

Table 1. Brown patch blight ratings in colonial bentgrass as influenced by experimental fungicides, 2011.

Treatment*	Rate (oz/1000ft^2)	Spray Interval (days)	Brown patch (%) 6-Jul	12-Jul	22-Jul	26-Jul	2-Aug	4-Aug	9-Aug	12-Aug	16-Aug	19-Aug	22-Aug	6-Sep
Contend 100SL	0.96 fl.	21	0.0b**	1.5b	1.5ab	2.0b	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	1.8de
A18847A 378CS	0.51 fl.	21	0.0b	1.8b	1.0ab	1.0bc	2.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	0.0e
A18124A 645SC	4.0 fl.	21	0.0b	0.0b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	1.0e
A13705S 200SC	1.26 fl.	21	0.0b	1.0b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	0.8e
Contend 100SL	1.3 fl.	28	1.0b	2.0b	1.3ab	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	2.5de
Contend 100SL	1.3 fl.	35	1.0b	0.5b	0.5b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	1.8de
A18281A 202SC	2.0 fl.	28	0.0b	0.8b	1.0ab	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	1.1bc	12.0bc
A18281A 202SC	2.0 fl.	35	0.5b	2.0b	0.5b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	1.3bc	9.8bc
A17386B 50WG	0.37	28	0.0b	0.0b	0.8ab	0.0c	0.0c	0.0b	0.1b	0.0b	0.0b	1.0b	3.0b	26.8a
A17386B 50WG	0.37	35	0.0b	0.0b	0.5b	0.0c	0.0c	0.0b	0.3b	0.0b	0.0b	0.8b	1.0bc	14.3bc
A18847A 378CS	0.69 fl.	28	0.0b	0.0b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	0.8e
A18847A 378CS	0.69 fl.	35	0.0b	1.3b	2.5a	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	0.0e
BAS 640 749SC	3.0 fl.	14	0.0b	0.0b	0.5b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	1.0bc	16.0b
A13703G	0.31 fl.	14	0.0b	0.5b	0.5b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	1.8de
A13703G	0.31 fl.	21	0.0b	0.0b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	1.3de
A13703G	0.50 fl.	21	0.0b	0.0b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	0.0e
A13703G	0.62 fl.	21	0.0b	0.3b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0b	0.0b	0.0c	0.5e
Untreated	-	-	4.5a	4.5a	1.9ab	7.0a	7.3a	11.5a	16.5a	18.5a	18.3a	19.5a	21.8a	8.3cd

*14-day treatments were applied 20 June, 5 and 18 July, and 1 Aug; 21-day treatments were applied 20 June, 11 July, and 1 Aug; 28-day treatments were applied 20 June and 18 July; 35-day treatments were applied 20 June and 25 July.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Evaluation of BASF Spray Program for Summer Disease Control In Providence Creeping Bentgrass Green, 2011

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In addition to providing disease control some fungicides improve plant heath and can help mitigate some types of mechanical injury. This study was designed to evaluate the effects of four separate fungicide programs for their ability to control dollar spot (*Sclerotinia homoeocarpa*) control, as well as to assess their effects on overall turf quality and root length. Each fungicide program is shown in Table 1. Basically, each program involved a different strobilurin fungicide. Only the first, second, fifth and eighth spray of each program was different among the treatments. The first and last spray for each program was a combination product that included a strobilurin fungicide, and the second spray for each program was the strobilurin fungicide alone. In the first program, Honor 14.3WDG (pyraclostrobin + boscalid) was applied initially, followed by Insignia 2.1SC (pyraclostrobin). This program was the only program that did not contain a DMI fungicide. A second application of Insignia 2.1SC was made for the fifth application, and the final application again was Honor 14.3WDG. In the second fungicide program, Headway 1.4ME (azoxystrobin + propiconazole) was applied for the first and last applications, while Heritage TL 0.8ME (azoxystrobin) was applied for the second and fifth sprays. In program number three, Disarm M SC (fluoxastrobin + myclobutanil) was applied initially and lastly, while Disarm 480SC (fluoxastrobin) was applied for the second and fifth sprays. Finally, in the fourth program, Tartan 2.4SC (trifloxystrobin + triadimefon) was applied for the first and last sprays while Compass (trifloxystrobin) was applied for the second and fifth sprays.

Procedure. This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. The study area was a mature stand of 'Providence' creeping bentgrass grown on a sand-based rootzone (97% sand, 2% silt and clay, 1% OM; pH =6.5) and maintained as a putting green. Turf was mowed five times weekly to a height of 0.150" using a triplex mower. Treatments were applied on a 14 day interval beginning on 3 May and ending on 9 August, 2011 totaling 8 fungicide applications. Only trace amounts of dollar spot were present when treatments were initiated. To prevent severe loss of turf the untreated control plots were treated with Curalan (1.0 oz/1000 sq ft) on 22 July and 10 August 2011.

Treatments were applied with a CO_2 pressurized sprayer (35 psi) equipped with an 8004E flat fan nozzle and calibrated to deliver 1.1 gallons of water per $1000ft^2$ (50 GPA). Dates of application are noted below and footnoted in the data tables. Plots were 5 ft by 5 ft and arranged in a randomized complete block with four replications. Turfgrass quality was rated visually on a 0 to 10 scale where 0 = brown or dead turf, 7.0 = minimal acceptable quality for creeping bentgrass putting green, 8.0 = good summer quality and 10 = optimum green color and density. Dollar spot developed naturally and uniformly. Dollar spot was rated on a visual linear scale of 0 to 100% where 0 = entire plot area disease-free and 100 = entire plot area blighted. An acceptable level of control was considered ≤ 0.5 %. Plots were rated weekly for dollar spot levels and overall quality beginning on 2 July and ending on 26 August. Area Under the Disease Progress Curve (AUDPC) and Area Under the Quality Curve (AUQC) were also calculated to more easily compare disease levels over the course of the study. Rooting was assessed at the end of the study by obtaining soil plus root cores 0.75 inches in diameter and to rooting depth on 22 Aug. 2011. Twelve (12) root sub- samples (4 reps x 3 samples/rep) were collected for each treatment. Each core was placed in an individual plastic bag and identified. After all cores were collected they were placed immediately in a Styrofoam cooler with cold packs and shipped overnight express to Illinois for analysis. In Illinois, individual root samples were placed in a water bath and soil was gently removed from the roots using an artist's brush. Cleaned root samples then were placed on a flat-bed scanner and subjected to WinRhizo analysis to quantify root parameters (i.e., root length and root surface area). For the statistical analysis of root data the average of the three sub-samples per plot was used. All data were subjected to analysis of variance and significantly different means were separated using Fisher's least significant difference (LSD) test at $P \leq 0.05$.

Dollar Spot. Trace levels of dollar spot were present when treatments were initiated on 3 May. Dollar spot pressure remained low (≤0.1%) in all fungicide-treated plots when rating began on 2 July (Table 2). Thereafter, the epidemic proceeded to a severe level in mid-July and maintained a stasis until 12 Aug. at which time it increased in severity. Acceptable control (≤0.5%) was achieved in Programs 1(pyraclostrobin) and Program 4(trifloxystrobin) throughout the course of the study. The threshold of 0.5% blighting was surpassed when plots were rated on 13 July. This was the only time at which Program 2 (azoxystrobin) exceeded 0.5% blighting, while Program 3 (fluoxastrobin) remained above the 0.5% threshold for the remainder of the study. There were, however, no AUDPC differences among the programs.

Turf Quality. Programs 1(pyraclostrobin) and Program 4 (trifloxystrobin) maintained acceptable levels of overall turf quality throughout the study (Table 3). Programs 2(azoxystrobin) and 3(fluoxastrobin) fell below acceptable levels of quality on several rating dates throughout the study period. The AUQC values showed that the highest turf quality was achieved using Program 1(pyraclostrobin), and that there were no differences in AUQC among the other fungicide-treated plots.

Root Length. Bentgrass from plots treated with Program 1 (pyraclostrobin) had longer root lengths than those from Program 3 (fluoxastrobin) and the untreated control (Table 3). There were no differences in rooting among Programs 2, 3 and 4 compared to the control.

Summary and Conclusions. All Programs reduced dollar spot and improved overall quality compared to the control on all dates. Acceptable dollar spot control was maintained by fungicide Programs 1 (pyraclostrobin) and Program 4 (trifloxystrobin) throughout this study. Plots treated with Program 1 were disease-free except for one rating date (13 July). Disease control levels in plots treated with Program 2 (azoxystrobin) were satisfactory on all but one rating date (13 July). Plots in Program 3 (fluoxastrobin) exceeded the acceptable threshold on all but the first two rating dates. There were, however, no AUDPC differences among programs. Program 1 (pyraclostrobin) provided for good or better summer quality on all 9 rating dates and over the season (i.e., AUQC). All other Programs were associated with good summer quality on the first two rating dates only. Program 4 (trifloxystrobin) provided acceptable quality levels throughout the study period., but was inferior to Program 1 on all rating dates between 13 July and 19 August. Program 1 (pyraclostrobin) was the only program in which creeping bentgrass root length exceeded those from the control as well as bentgrass in plots from Program 3(fluoxastrobin). Hence, Program 1 (pyraclostrobin) was superior in all respects and was the only one not containing a DMI fungicide.

Table. 1 Fungicide program products, rates and dates applied, 2011.

Program	Fungicide	Rate (oz/1000ft^2)	Dates Applied
Program1:			
1st Spray	Honor 14.3 WDG	1.1 oz	3-May
2nd Spray	Insignia 2.1 SC	0.9 oz	17-May
3rd Spray	Spectro 90	5.75 oz	31-May
4th Spray	Signature + Daconil Ultrex	4 + 3.2 oz	14-Jun
5th Spray	Insignia 2.1 SC	0.9 oz	28-Jun
6th Spray	Signature + Daconil Ultrex	4 + 3.2 oz	12-Jul
7th Spray	Chipco 26GT 2 SC	4 oz	26-Jul
8th Spray	Honor 14.3 WDG	1.1 oz	9-Aug
Program2:			
1st Spray	Headway 1.4 ME	3 oz	3-May
2nd Spray	Heritage TL 0.8 ME	2 oz	17-May
3rd Spray	Spectro 90	5.75 oz	31-May
4th Spray	Signature + Daconil U.	4 + 3.2 oz	14-Jun
5th Spray	Heritage TL 0.8 ME	2 oz	28-Jun
6th Spray	Signature + Daconil U.	4 + 3.2 oz	12-Jul
7th Spray	Chipco 26GT 2 SC	4 oz	26-Jul
8th Spray	Headway 1.4 ME	3 oz	9-Aug
Program3:			
1st Spray	Disarm M SC	1 oz	3-May
2nd Spray	Disarm 480 SC	0.36 oz	17-May
3rd Spray	Spectro 90	5.75 oz	31-May
4th Spray	Signature + Daconil U.	4 + 3.2 oz	14-Jun
5th Spray	Disarm 480 SC	0.36 oz	28-Jun
6th Spray	Signature + Daconil U.	4 + 3.2 oz	12-Jul
7th Spray	Chipco 26GT	4 oz	26-Jul
8th Spray	Disarm M	1 oz	9-Aug
Program4:			
1st Spray	Tartan 2.4 SC	2 oz	3-May
2nd Spray	Compass	0.25 oz	17-May
3rd Spray	Spectro 90	5.75 oz	31-May
4th Spray	Signature + Daconil U.	4 + 3.2 oz	14-Jun
5th Spray	Compass	0.25 oz	28-Jun
6th Spray	Signature + Daconil U.	4 + 3.2 oz	12-Jul
7th Spray	Chipco 26GT	4 oz	26-Jul
8th Spray	Tartan 2.4 SC	2 oz	9-Aug
Untreated 5	–	–	–

Table 2. Dollar spot levels in 'Providence' CBG green as influenced by BASF fungicide programs, 2011.

	Plot area blighted by dollar spot (%)									AUDPC
Treatment*	2-Jul	7-Jul	13-Jul	21-Jul	28-Jul	4-Aug	12-Aug	19-Aug	26-Aug	disease x time
Program 1	0.0b**	0.0b	0.1b	0.0b	0.0b	0.0b	0.0b	0.0b	0.0b	0.6b*
Program 2	0.0b	0.4b	0.9b	0.4b	0.4b	0.4b	0.3b	0.4b	0.4b	24.2b
Program 3	0.1b	0.4b	1.1b	0.8b	0.6b	0.6b	0.7b	0.6b	0.9b	37.3b
Program 4	0.0b	0.4b	0.5b	0.3b	0.3b	0.3b	0.3b	0.3b	0.3b	16.3b
Untreated	8.5a	7.3a	13.5a	11.8a	11.5a	12.5a	14.0a	15.3a	17.9a	692.3a

*Treatments were applied 3, 17 and 31 May; 14 and 28 June; 12 and 26 July; and 9 August.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.

Table 3. Overall turf quality of 'Providence' CBG green as influenced by BASF fungicide programs, 2011.

	Overall quality (1-10)									AUQC	Root length(cm)
Treatment*	2-Jul	7-Jul	13-Jul	21-Jul	28-Jul	4-Aug	12-Aug	19-Aug	26-Aug	(quality x time)	22-Aug
Program 1	8.9a**	9.0a	9.0a	8.9a	8.9a	8.9a	8.9a	8.8a	8.6a	505.8a	372.7a*
Program 2	8.6ab	8.3a	6.8b	6.9b	6.9b	6.9b	7.0b	7.1b	7.4b	410.5b	361.3ab
Program 3	8.3b	8.3a	6.5b	7.0b	7.0b	7.0b	6.6b	6.5b	6.3c	399.1b	286.7b
Program 4	8.5ab	8.6a	7.0b	7.3b	7.3b	7.3b	7.3b	7.5b	7.8ab	428.3b	335.4ab
Untreated	5.8c	5.4b	4.4c	4.5c	4.5c	4.5c	4.5c	4.6c	4.3d	265.7c	282.5b

*Treatments were applied 3, 17 and 31 May; 14 and 28 June; 12 and 26 July; and 9 August.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.

Can Fungicides Mitigate Summer Stress and Mechanical Injury In An Immature Creeping Bentgrass Green?

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Introduction: Summer decline of putting green turf generally is caused by a combination of biotic and abiotic stress factors. Some fungicides have been shown to improve summer quality in creeping bentgrass (*Agrostis stolonifera)* maintained as putting greens in the absence of disease. For example, previous field studies have documented improved summer performance of creeping bentgrass putting green turf treated with fosetyl-aluminum (Chipco Signature), especially when tank-mixed with either chlorothalonil (Daconil Ultrex) or pigmented mancozeb (Fore Rainshield) (Dernoeden, 2002). Other field studies revealed that mancozeb (Fore Rainshield and Protect = non-pigmented) alone was very effective in reducing mechanical injury due to scalping and vertical cutting in a creeping bentgrass green (Dernoeden and Fu, 2008). In those studies, Chipco Signature improved creeping bentgrass quality, but was not as effective as mancozeb in ameliorating vertical cutting injury. Pyraclostrobin (Insignia) applied at the high label rate (0.9 oz/1000 ft^2), but not the low rate (0.5 oz/1000ft^2), improved creeping bentgrass quality and mitigated injury from scalping.

Chipco Signature contains a green pigment called StressGard®, a confidential compound that is said to improve stress tolerance. Previous Maryland field studies with Chipco Signature have shown that field grown creeping bentgrass treated with this fungicide did not have elevated chlorophyll or nutrient levels; did not exhibit improved photosynthesis or more efficient respiration; and canopy temperature was unaffected (Dernoeden, unpublished). Research conducted at Virginia Tech, however, has shown that Chipco Signature promotes the production of antioxidants in treated turf (Dr. E. Ervin, personal communication). Antioxidants improve heat stress tolerance in plants and delay tissue senescence. Insignia is thought to enhance plant health and thus reduce stress injury in creeping bentgrass. According to BASF (Raleigh, NC) literature, Insignia induces the production of nitric oxide (NO) in plants. Nitric oxide is known to reduce the production of the senescence hormone ethylene. It is believed that NO acts as a primer in plants, which induces systemic acquired resistance (i.e., the ability of plants to trigger their own defense mechanisms and thus protect tissues from pathogens). This priming is further believed to provide systemic cross resistance to abiotic stresses. Unpublished data suggest that Insignia can increase leaf water content; reduce canopy temperature; increase antioxidant production; improve drought resistance; and increase rooting in creeping bentgrass.

The mechanism(s) enabling Chipco Signature, Fore Rainshield and Insignia to ameliorate mechanical injury in the studies by Dernoeden and Fu (2008) is unknown. Improved color of turf treated with Chipco Signature and Fore Rainshield in part is due to a "paint effect." As previously noted, StressGard and Insignia presumably induce biochemical reactions in plants that improve stress tolerance, and conceivably assist in reducing mechanical injury. Perhaps these fungicides also may modify plant morphology, structure, and growth habit or growth rate. For example, bentgrass leaves treated with these fungicides may develop thicker cuticles and/or cell walls or possibly they slow growth or in some way reduce puffiness in creeping bentgrass.

Finally, it has been suggested that the pigment in Chipco Signature reduces the harmful effects of UV light in the summertime (much like a sunscreen-effect in humans). Regardless, there is reproducible, field-generated evidence that Chipco Signature and Fore Rainshield improve the summer quality of creeping bentgrass maintained under putting green conditions in the absence of disease.

Managing creeping bentgrass greens during their first summer in the Mid-Atlantic region is challenging. Younger plants are more succulent and are more susceptible to environmental stress and mechanical injury. Indeed, studies have shown that injury from drought stress and coring is much more problematic during the first versus the second summer of creeping bentgrass establishment (Fu and Dernoeden, 2009a,b,c). Although greens may be young, golfers will demand an acceptable green speed that only can be provided by relatively low mowing and/or rolling. Golf course superintendents also will keep soil moisture relatively low to provide for a more firm surface. Both low mowing and restricted irrigating can be debilitating summer stress factors. Since management of the thatch-mat layer is important, even in the first year of establishment, there is a need to topdress greens to dilute the growing organic layer with sand during summer. Angular topdressing sand is abrasive and causes injury in summer even to mature bentgrass greens. Since Chipco Signature, Fore Rainshield and Insignia have been shown to improve the summer performance and reduce mechanical injury of mature creeping bentgrass, it would be prudent to determine if they could also mitigate similar injury in immature creeping bentgrass. Hence, the objective of this study was to evaluate the three aforementioned fungicides alone or in combination for their impact on summer injury, turf color and overall turf quality in an immature creeping bentgrass stand maintained as a putting green. The treatments were follows: Chipco Signature 4.0 oz; Fore Rainshield 4.0 oz; Fore Rainshield 6.0 oz; Insignia 0.5 oz; and Insignia 0.9 oz/ 1000 ft^2 applied alone or tank mixed with Fore Rainshield (4.0 oz/1000 ft^2).

Procedure. This field study was performed at the University of Maryland Paint Branch Turfgrass Research Facility in College Park. The study was conducted on an 80/20 sand/sphagnum peat moss (v/v) creeping bentgrass putting green constructed using USGA recommendations in 2000. The existing creeping bentgrass was treated with glyphosate several weeks prior to seeding. A blend of Penn A-1 + A-4 creeping bentgrass was disk-seeded with 2.0 lb seed per 1000 ft^2 on October 16, 2010. Mowing to a height of 0.150 inches began on November 1, 2010. The site received approximately 3.0 lb N/1000ft^2 prior to winter. In the spring and summer of 2011 the turf was fertilized with N (how much?) and topdressed using a schedule recommended by Mid-Atlantic USGA Agronomists.

In addition to high temperature stress, other stresses were imposed to include double mowing while reducing mowing height during the heat of the day; vertical-cutting; sand topdressing; and brushing as outlined in Table 1. Diseases were controlled curatively throughout the study period since injury from environmental and mechanical stresses, and not disease, were the primary parameters assessed. Dollar spot (*Sclerotinia homoeocarpa*) and brown patch (*Rhizoctonia solani*) were the only disease problems and they were addressed with the fungicide treatments to the entire study site as outlined in Table 2. Attempts were made to impose drought stress, but due to the close juxtaposition of other studies that were irrigated resulted in water equilibrating throughout the entire sand-based rootzone of the research green. Wetting agents also were applied to manage localized dry spots in the study area.

Fungicide treatments were initiated on 31 May to coincide with extremely high temperature stress period. Applications continued on a 14-day interval and ended on 10 Aug. 2011. Plots were 5ft by 10ft and arranged in a RCB with four replications. Overall quality and turf color were assessed visually on a 0 to 10 scale where 0 = entire plot area brown or dead; 7 =minimum acceptable color and quality; 8= very good summer color and quality; and 10 =optimum green color, density and uniformity. Plots also were rated for stress and injury on a 0 to 5 scale where 0 = no stress or injury; 2.5 = objectionable injury; 5 = entire plot area brown or dead. Rooting was assessed by obtaining soil plus root cores 0.75 inches in diameter and to rooting depth on 22 Aug.2011. Twelve (12) root sub- samples (4 reps x 3 samples/rep) were collected for each treatment. Each core was placed in an individual plastic bag and identified. After all cores were collected they were placed immediately in a Styrofoam cooler with cold packs and shipped overnight express to Illinois for analysis. In Illinois, individual root samples were placed in a water bath and soil was gently removed from the roots using an artist's brush. Cleaned root samples then were placed on a flat-bed scanner and subjected to WinRhizo analysis to quantify root parameters (i.e., root length and root surface area). For the statistical analysis of root data the average of the three sub-samples per plot was used. All data were subjected to ANOVA and significant differences were separated using Fisher's LSD at $P \leq 0.05$. Area under the color, quality and injury curves was computed using the trapezoidal method. Area under the curve data provide a "one number" seasonal assessment of the parameters evaluated over all rating dates.

Results:

Color. Area under the color curve (AUCC) data show that plots treated with Fore (6.0 oz) alone and Signature + Fore had significantly better color than all other treatments, except Fore (4.0 oz) (Table 3). Insignia alone (both rates) did not improve turf color compared to the control. Bentgrass treated with Signature alone and Insignia + Fore- had better color than the untreated control. Plots treated with Signature + Fore had very good summer color ratings (rating ≥ 8.0) on all rating dates. Plots treated alone with Insignia and the untreated control did not achieve a very good color rating on any date, but these plots were always above the minimum acceptable color level (rating ≥ 7.0). Plots treated with Fore (both rates) and Insignia (0.4 oz) + Fore had very good color on 6 to 7 of 8 rating dates. Insignia (0.7 oz.) + Fore had very good color on only 3 of 8 rating dates.

Overall Quality. Area under the quality curve (AUQC) data was the best indicator of how the treatments responded to the severe heat stress incurred in July (Fig. 1). The AUQC showed that over the season plots treated with Signature alone, Fore alone (both rates) and Signature + Fore had equivalent quality (Table 4). Plots treated with Insignia alone (0.4 oz), Insignia (both rates) + Fore had better quality than the untreated control. Plots treated with Fore alone (6.0 oz) and Signature + Fore had very good to excellent quality (rating ≥ 9.0) on all rating dates. Plots treated with Insignia alone (both rates) had very good summer quality on 4 to 5 out of 9 rating dates. Plots treated with Insignia (0.4 oz) + Fore exhibited very good summer quality on 8 of 9 ratings, however, plots treated with Insignia (0.7) + Fore had very good summer quality on only 4 of 9 rating dates. Statistically, there were no differences in quality among plots treated with Insignia alone (both rates) versus Insignia (both rates) + Fore.

Environmental Stress and Mechanical Injury. Stress rating obtained on 29 July reflected heat stress injury. All treatments, except Insignia alone (0.7 oz) and Insignia alone (both rates), exhibited less stress versus the untreated control (Table 5). There was a hail storm in early August, and injury was observed and rated on 9 and 12 Aug. Injury appeared as tan or brown spots and speckles. On 9 Aug. Signature + Fore was the only treatment that exhibited less damage versus the control. After a few days of recovery, less damage compared to the control was observed in plots treated with Signature, Fore alone (both rates) and Signature + Fore. The improvement in these plots likely was a paint-effect since treatments were last applied two days prior to the 10 Aug. rating.

Area under the injury curve (AUIC) data reflect damage incurred in late Aug. and early Sept. following the imposition of the various stress treatments imposed as shown in Table 1.The AUIC data show that injury was greatest in the control and all plots treated with Insignia alone or mixed with Fore (Table 5). Plots treated with Signature + Fore and Fore alone (6.0 oz) had lower AUIC ratings compared to the control. Conversely, plots treated with the high rate of Insignia alone or mixed with Fore were the only treatments with injury ratings equivalent to the control..

Roots. No root length or root surface area differences were observed among the treatments (Table 6). Although not significant, numerically highest root length and surface area data were associated with bentgrass grown in plots treated with Signature + Fore. Lack of significance was due to variation in samples and transforming data did not affect the outcome.

Blue-green Algae. Overcast weather in late Aug. through early Sept. promoted a blue-green algal bloom. Plots treated with Signature alone or Fore (including tank-mixes) contained less blackening from algae versus the control (Table 6). Only plots treated with Insignia alone had algal-blackening levels equivalent to the control.

Discussion and Conclusions:

This study was conducted on an immature (i.e., < one year old) stand of an A-1/A-4 blend maintained under putting green conditions. The daily high and low temperatures and precipitation data for most of the 2011 study period are presented in Figure 1. June and particularly July were very stressful with daily temperatures often exceeding 90 F and night temperatures frequently above 70 F. It also was this period when plots were frequently double cut during the heat of the day. Temperatures moderated in mid-Aug. and particularly following hurricane Irene on Aug. 28. September was very cool and rainy and there was no heat stress during the period plots were vertical cut on 22 and 24 Aug. The AUQC for the period of 15 July and 19 Aug. were most descriptive of the appearance, and therefore the visual stress tolerance, of the putting surface. These and all other data showed that Fore alone (6.0 oz.) and especially Signature + Fore were the most beneficial performance treatments during the period of excessive heat stress.

The AUIC data reflect the effectiveness of treatments in ameliorating the effect of brushing, topdress and vertical cutting (i.e., the mechanical stresses). As previously noted this was performed during a period of little or no environmental stress. These data also showed that Fore (6.0 oz) alone and Signature + Fore were the most effective treatments in minimizing the effects of mechanical stress.

Insignia alone did improve overall quality during the period of environmental stress, but had minimal effects when subjected to mechanical stress. For unknown reasons, plots treated with the low rate of Insignia (0.4 oz) + Fore tended to out-perform the high rate of Insignia (0.7 oz.) + Fore during the period that the mechanical stresses were imposed. None of the treatments influenced root length and root surface area significantly, which was attributed to variability in sampling. Signature, Fore and Signature + Fore reduced algal colonization, but Insignia alone did not.

It was assumed that an immature stand would be damaged more by environmental and mechanical stress than a more mature stand. The resiliency of the A-1/A-4 blend was much greater than anticipated and as such efforts were made to inflict stress such as reducing mowing heights while double cutting on afternoons when air temperatures exceeded 90 F and in some cases 100 F. Plots even were topdressed and rolled on one occasion (27 July) while being double cut at 0.130 and lowered to 0.125 inches two to three days prior and after application of the sand. Despite these and other efforts, it was difficult to injure the stand. Hence, vertical cutting was performed in two directions in late Aug. to inflict more injury, but at this time temperatures moderated and there was frequent overcast weather and rain. Unlike what normally would be expected, little additional data could be collected since environmental stress did not return in Sept.

In conclusion, this study confirms previous field studies conducted in Maryland, which demonstrated that Fore RainShield, Signature and particularly Signature + Fore Rainshield effectively ameliorated environmental and mechanical stress injury as well as suppressed algal growth in an immature creeping bentgrass stand maintained under putting green conditions.

Summary of Key Points:

- Selected fungicides can mitigate environmental and mechanical stress injury in the absence of disease. The objective of this study was to assess the performance of three fungicides applied alone or in combination for their impact on golf green stress tolerance in the summer of 2011.
- Chipco Signature, Insignia, and Fore Rainshield were applied alone and in tank-mix combination on a 14-day interval to an immature stand of A-1/A-4 creeping bentgrass maintained as a golf green beginning in late May.
- The study area was kept disease-free since quantifying visual turf reactions to stress was the objective of the study.
- In addition to high temperature stress various mechanical stresses were imposed including reducing mowing height and double cutting during the heat of the day; sand topdressing and brushing during the heat of the day; and vertical cutting in two directions in August.

- June and July 2011 were marked by extended periods of heat stress with daily air temperatures typically ≥90^{o}F and night temperatures ≥ 70^{o} F. August was relatively cool and rainy.
- All fungicide treatments exhibited improved turfgrass quality versus the control in June and July during periods of heat stress and double cutting.
- Fore Rainshield alone and especially the tank-mix of Chipco Signature + Fore Rainshield provided the best combination of improved turf color and overall quality in response to heat stress as well as the mechanical stresses imposed.
- No differences in root length or root surface area were detected among the treatments.
- Chipco Signature and Fore Rainshield reduced blue-green algal colonization, but Insignia did not.

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Table 1. Mowing and other stress-inducing treatment schedule.

July 5-6 walk mow @ 0.150''
July 7-8 walk mow @ 0.145''
July 11 walk mow @ 0.140''
July 12 double cut @ 0.140''
July 13 double cut and brush
July 14 double cut and double brush
July 15 double cut @ 0.135''
July 18-July 22 double cut @ 0.130''
July 25-26 double cut @ 0.130''
July 27 topdressed and rolled
July 28 double cut
Aug 1 double cut @ 0.125''
Aug 2 brush and double cut
Aug 3-5 double cut
Aug 8 double cut
Aug 10-12 double cut
Aug 17, 19 double cut
Aug 22 topdress, brush and vertical cut
Aug 24 vertical cut at right angle to that performed Aug. 22

Table 2. Fungicide application schedule targeting dollar spot and brown patch in the study site.

May 27 Daconil Ultrex @ 3oz + Banner Maxx @ 0.5 oz/M
July 6 Curalan @ 1 oz/M
July 13 Prostar @ 2.2 oz/M
July 14 Curalan @ 1 oz/M
July 29 Curalan @ 1 oz/M
Aug 9 Curalan @ 1 oz/M
Aug 23 Curalan @ 1 oz/M
Aug 24 Prostar @ 2.2 oz/M + 0.15 lb N via urea
Sept 9 Curalan @ 1 oz/M + Daconil Ultrex @ 4 oz/M + Prostar @ 2.2 oz

Table 3. Color ratings of A1/A4 CBG putting green as influenced by fungicides, 2011.

Treatment*	Rate oz/1000ft^2	Color ratings (0-10) 15-Jul	22-Jul	29-Jul	3-Aug	9-Aug	12-Aug	19-Aug	AUCC color x time
Chipco Signature 80WP	4.0	8.0b**	7.8bc	8.2abc	7.7abc	8.2abc	8.0b	8.9ab	279cd
Fore Rainshield 80WP	4.0	8.5ab	7.8bc	8.5ab	8.0ab	8.4ab	8.3ab	8.0ab	286bc
Fore Rainshield 80WP	6.0	8.5ab	8.0ab	8.8a	8.2a	8.3ab	8.5ab	8.1a	291ab
Insignia 2.1SC	0.4	7.3c	7.3c	7.4d	7.7bc	8.0bcd	7.5c	7.6bc	263ef
Insignia 2.1SC	0.7	7.3c	7.3c	7.9bcd	7.7bc	7.8cd	7.4c	7.3c	264ef
Chipco Signature + Fore	4.0 + 4.0	8.9a	8.5a	8.6a	8.0ab	8.6a	8.5ab	8.4a	297a
Insignia + Fore	0.4 + 0.4	8.3b	7.7bc	8.4ab	7.8abc	8.0bcd	8.1ab	8.0ab	280cd
Insignia + Fore	0.7 + 0.4	8.4ab	7.8bc	7.6cd	7.3c	7.8cd	8.1ab	8.0ab	273de
Untreated	-	7.2c	7.6bc	7.6cd	7.6bc	7.6d	7.4c	7.3c	262f

*Treatments were applied 31 May; 14 and 28 June; 12 and 26 July; and 10 August.

**Means in a column followed by the same letter are not significantly different according to Fisher’s LSD, $P \leq 0.05$.

Table 4. Overall quality and Area Under the Quality Curve (AUQC) of A1/A4 CBG putting green as influenced by fungicides, 2011.

Treatment*	Rate (oz/1000ft^2)	Overall quality (0-10) 5-Jul	15-Jul	22-Jul	29-Jul	3-Aug	9-Aug	12-Aug	19-Aug	12-Sep	AUQC (quality x time)
Chipco Signature 80WP	4.0	9.0ab**	8.4abc	8.4bc	8.3ab	7.7abc	8.7ab	8.1abc	8.1b	8.4ab	565a-d
Fore Rainshield 80WP	4.0	9.4a	9.0a	8.1bcd	8.5ab	7.9ab	9.0ab	8.3ab	8.0b	8.0ab	569abc
Fore Rainshield 80WP	6.0	9.4a	8.8ab	8.5b	8.8a	8.5a	9.0ab	8.6a	8.2ab	8.3ab	581ab
Insignia 2.1SC	0.4	9.0ab	8.2bc	7.9cd	7.8bc	8.0ab	8.2bc	7.7bcd	7.4cd	8.7a	547cd
Insignia 2.1SC	0.7	8.8bc	8.0cd	7.8d	8.1ab	7.2bc	7.8c	7.5cd	7.4cd	8.1ab	532de
Chipco Signature + Fore	4.0 + 4.0	9.4a	8.7ab	9.1a	8.7a	8.3a	9.3a	8.2abc	8.7a	8.3ab	591a
Insignia + Fore	0.4 + 0.4	9.0ab	8.7ab	8.2bcd	8.1ab	7.6abc	8.2bc	8.2abc	8.0bc	8.1ab	557bcd
Insignia + Fore	0.7 + 0.4	9.5a	8.7ab	7.9bcd	7.9bc	7.1bc	7.8c	8.2abc	8.1b	7.6b	547cd
Untreated	-	8.4c	7.5d	8.0bcd	7.2c	7.0c	7.6c	7.2d	7.2d	7.6b	508e

*Treatments were applied 31 May; 14 and 28 June; 12 and 26 July; and 10 August.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.

Table 5. Stress, injury and Area Under the Injury Curve (AUIC) ratings of A1/A4 CBG putting green as influenced by fungicides, 2011.

	Rate	Stress (0-5)	Hail injury (0-5)		Injury(0-5)					AUIC
Treatment*	oz/1000ft^2	29-Jul	9-Aug	12-Aug	24-Aug	26-Aug	31-Aug	6-Sep	12-Sep	(injury x time)
Chipco Signature 80WP	4.0	0.3bc**	1.8abc	0.9c	2.7abc	2.9bc	3.0abc	2.8ab	1.0c	85bc
Fore Rainshield 80WP	4.0	0.5bc	1.5bc	1.0bc	2.6abc	2.9bc	3.0abc	2.9ab	1.6abc	88bc
Fore Rainshield 80WP	6.0	0.0c	1.5bc	0.8c	2.1bc	2.6c	2.8bc	2.8ab	1.1bc	75c
Insignia 2.1SC	0.4	0.6bc	2.1abc	1.5abc	2.8abc	2.9bc	2.7bc	2.8ab	1.3bc	94abc
Insignia 2.1SC	0.7	0.8abc	2.5a	2.1a	3.1a	3.4ab	3.3abc	3.1ab	1.5abc	112ab
Chipco Signature + Fore	4.0 + 4.0	0.4bc	1.4c	1.0bc	2.0c	2.7c	2.5c	2.6b	1.1bc	75c
Insignia + Fore	0.4 + 0.4	0.8abc	2.3abc	1.5abc	3.0ab	3.3ab	3.5ab	3.2ab	1.5abc	106abc
Insignia + Fore	0.7 + 0.4	1.0ab	2.4ab	2.0ab	2.9ab	3.4ab	3.5ab	3.5ab	2.2a	115ab
Untreated	-	1.6a	2.5ab	2.3a	3.4a	3.8a	3.7a	3.7a	1.9ab	128a

*Treatments were applied 31 May; 14 and 28 June; 12 and 26 July; and 10 August.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

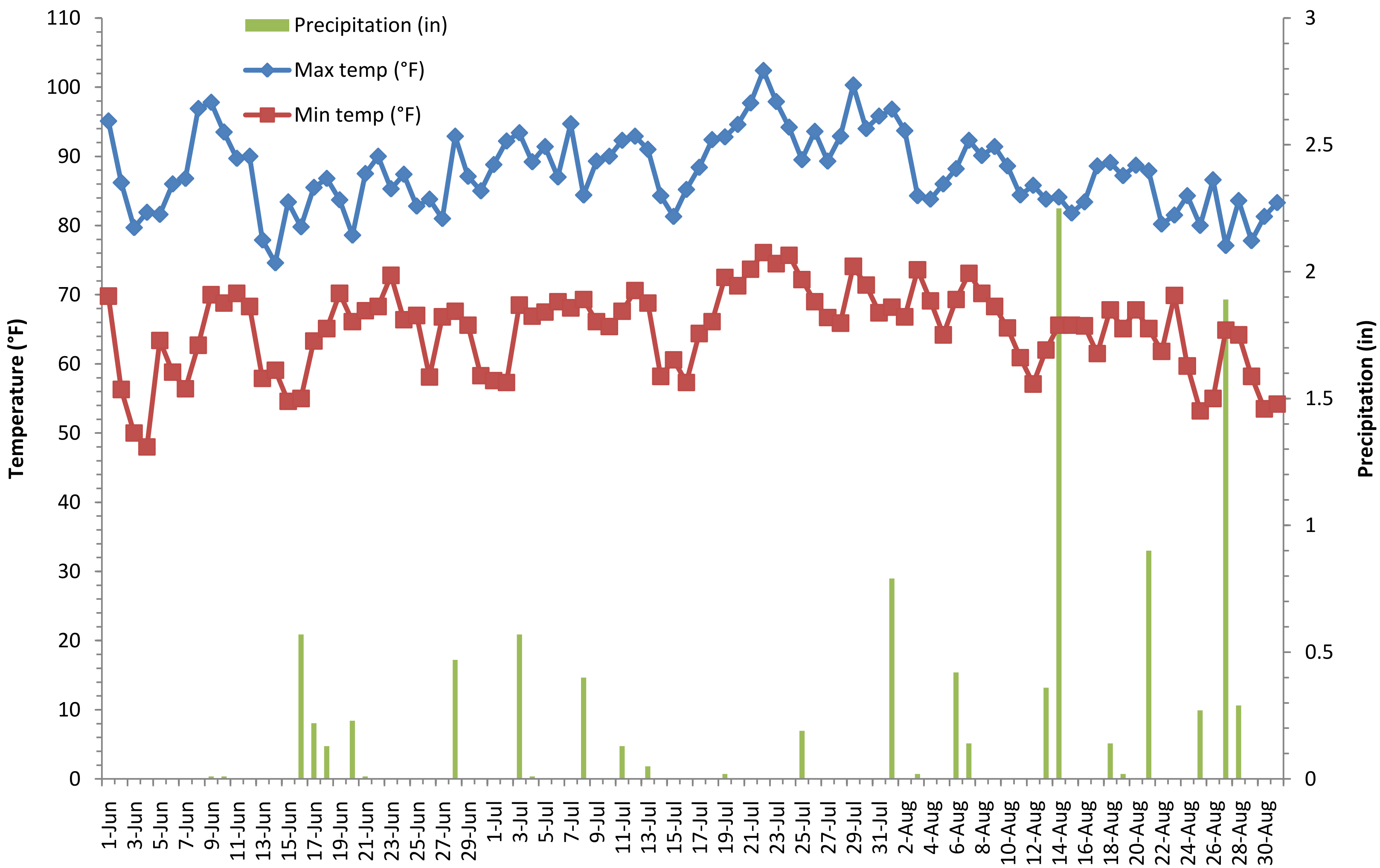
Table 6. Root length, root surface and algae ratings of A1/A4 putting green as influenced by fungicides, 2011.

Treatment*	Rate oz/1000ft^2	Root length (cm) 22-Aug	Root surface area (cm^2) 22-Aug	Algae (%) 6-Sep
Chipco Signature 80WP	4.0	181a	18.4a	1.4c
Fore Rainshield 80WP	4.0	184a	19.2a	3.8bc
Fore Rainshield 80WP	6.0	148a	15.5a	2.6bc
Insignia 2.1SC	0.4	189a	20.6a	11.0a
Insignia 2.1SC	0.7	163a	17.2a	6.9ab
Chipco Signature + Fore	4.0 + 4.0	200a	21.2a	0.3c
Insignia + Fore	0.4 + 0.4	157a	18.2a	2.0c
Insignia + Fore	0.7 + 0.4	134a	15.7a	1.8c
Untreated	-	126a	15.3a	10.3a

*Treatments were applied 31 May; 14 and 28 June; 12 and 26 July; and 10 August.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Figure 1. Daily maximum and minimum temperature (°F) and daily precipitation (in) 1 June to 31 August, 2011.



Annual Bluegrass Control in Providence Creeping Bentgrass Green, 2011

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Objective. Two recently developed herbicides (i.e., methiozolin 250EC and amicarbizone 70WDG) were evaluated for their ability to control of annual bluegrass (*Poa annua*) postemergence in golf green height creeping bentgrass (*Agrostis stolonifera*).

Procedure. This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Turf was a mature stand of 'Providence' creeping bentgrass grown on a sand-based rootzone with a pH of 6.5 and OM content of 1.0%. Turf was mowed five times weekly to a height of 0.15 inches using a triplex mower. The area was treated preventively with fungicides and spoon-feed with urea every two weeks at 0.15 lb N/1000ft^2.

Herbicides were applied with a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat-fan nozzle and calibrated to deliver 1.1 gal water per 1000 ft^2 (50 GPA). Amicarbazone treatments were applied with 0.25% v/v of non-ionic surfactant. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with four replications. Percent of plot area covered with annual bluegrass was assessed visually on a linear 0 to 100% scale where 0 = no annual bluegrass, and 100 = entire plot area covered with annual bluegrass. Overall quality was visually assessed on a 0 to 10 scale where 0 = entire plot area brown or dead; 7.0 = acceptable quality for a green and 10 = optimum green color and uniformity. Herbicide injury to annual bluegrass and creeping bentgrass was assessed visually on a 0 to 5 scale where 0 = entire plot area green and healthy; 2.5 = objectionable turf discoloration; and 5 = >50% of the plot area brown or dead. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD.

Results. Two application timings were assessed. The 11 April application was timed to coincide with full (i.e., 100%) green-up of the creeping bentgrass (i.e., after having been mowed a few times and all winter dormant tissue removed) followed in three weeks by a second application on 2 May. The second timing was initiated on 2 May or three weeks after full green-up with a second application on 23 May. The rate of amicarbazone was reduced from 0.18 lb/A in the first timing to 0.09 lb/A in the second timing due to phytotoxicity issues. The second application of amicarbazone in the first timing also was reduced to 0.09 lb/A due to phytotoxicity problems with the higher rate.

Injury ratings to the annual bluegrass were obtained to define a time line for herbicide activity. All herbicides applied in the first timing showed an appreciable injurious effect on annual bluegrass on 13 May (i.e., 32 days after study was initiated) (Table 1). Methiozolin injury to annual bluegrass in the first timing dissipated on 10 June and remained static thereafter. Conversely, injury to the annual bluegrass intensified in amicarbazone-treated plots on all dates. As previously noted in the second timing, amicarbazone rate was reduced to 0.09 lb ai/A. All second timing treatments were initiated on 2 May and substantial injury was noted in all plots by 25 May (2 days after second application). The injury to annual bluegrass again dissipated in methiozolin-treated plots, but intensified to severe levels in amicarbazone-treated plots.

Although there was significant injury to annual bluegrass in April and early May (Table 1), there was no apparent effect of any herbicide treatment on annual bluegrass levels until 25 May in the first timing (i.e.,11 April start date) (i.e., 44 days after first application) (Table 2). At this time and thereafter the high rate of methiozolin had reduced annual bluegrass cover compared to the control. The low rate of methiozolin applied in the first timing reduced annual bluegrass cover on 1 June, but there were no differences between this rate and the control thereafter. Indeed only the high rate of methiozolin applied in the full green-up timing on 11 April and 2 May had a significant effect on annual bluegrass control. Annual bluegrass populations naturally began to decline with the advent of a prolonged period of extreme heat stress beginning in late May. The percent of annual bluegrass control for the high rate of methiozolin in the first timing between 25 May and 29 June 2011 averaged 74%.

None of the methiozolin treatments caused any perceptible injury to the creeping bentgrass (Table 3). However, both amicarbazone rates caused substantial and unacceptable injury to the creeping bentgrass from 13 May until data collection ceased on 1 July. The high rate of methiozolin applied in the first timing reduced quality slightly and temporarily (i.e., 13 and 25 May), which was within the acceptable range on both dates. No other methiozolin treatments reduced quality at any other time. Conversely, both rates of amicarbazone reduced quality significantly and to an unacceptable level on nearly all rating dates until the study was ended on 1 July.

Summary and Conclusions. While amicarbazone caused substantial injury to annual bluegrass, the weed did not succumb. Amicarbazone, at the rates and timings evaluated, were extremely phytotoxic to creeping bentgrass. It should be noted however that June was marked by a prolonged period of high temperature stress, which may have impacted the performance of amicarbazone. Methiozolin was safe to apply to creeping bentgrass and provided a good level of annual bluegrass control, but only when applied at the high rate in the first timing. The effect of methiozolin was very slow. Affected annual bluegrass plants developed a yellow-green to watersoaked appearance 21 days after the first application. Death of the annual bluegrass was so slow, that creeping bentgrass was able to fill voids and there were no bares spots in methiozolin-treated plots at any time. The 74% control of annual bluegrass by the high methiozolin rate in the first timing was judged to be very good in view of the lack of any perceptible phytotoxicity to the creeping bentgrass golf green.

Table 1. Annual bluegrass injury as influenced by amicarbazone and methiozolin, College Park MD, 2011.

		Poa annua injury (0-5)					
Treatment	Rate (lb ai/A)	28-Apr	13-May	25-May	10-Jun	20-Jun	1-Jul
*Methiozolin 250EC	0.45	0.0b***	2.6b	2.5b	1.5c	1.3b	1.0b
*Methiozolin 250EC	0.9	0.0b	3.4ab	3.5ab	1.8c	1.7b	1.2b
*Amicarbazone 70WDG	0.18/0.09	1.9a	3.6a	4.0a	3.8a	4.0a	4.0a
**Methiozolin 250EC	0.45	0.0b	1.1c	2.0b	2.5b	1.5b	1.5b
**Methiozolin 250EC	0.9	0.0b	1.0c	2.2b	2.8b	1.8b	1.7b
**Amicarbazone 70WDG	0.09	0.0b	1.4c	3.1ab	3.3ab	4.2a	4.3a
Untreated	–	0.0b	0.0d	0.0c	0.0d	0.0c	0.0c
LSD Value		1.0	0.5	1.5	0.8	0.5	0.8

*Treatments were applied 11 April and 2 May.
**Treatments were applied 2 and 23 May.
***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 2. Annual bluegrass control in 'Providence' creeping bentgrass with amicarbazone and methiozolin, College Park, MD, 2011.

	Rate	*Poa annua*/plot (%)								
Treatment	(lb ai/A)	15-Apr	25-Apr	5-May	13-May	23-May	1-Jun	10-Jun	20-Jun	29-Jun
*Methiozolin 250EC	0.45	8.0a***	8.3a	7.8a	9.0ab	8.8ab	7.5bc	7.8ab	7.5ab	7.0ab
*Methiozolin 250EC	0.90	8.5a	9.0a	7.0a	6.0b	4.0b	3.0c	3.5b	3.0b	3.0b
*Amicarbazone 70WDG	0.18/.09	8.5a	9.8a	10.8a	11.5ab	9.5ab	9.5abc	9.8ab	9.0ab	9.8a
**Methiozolin 250EC	0.45	7.8a	8.5a	9.0a	10.3ab	10.0ab	11.3ab	10.8a	10.8a	10.0a
**Methiozolin 250EC	0.90	9.5a	9.5a	9.3a	10.0ab	9.8ab	9.0abc	8.8ab	7.0ab	5.9ab
**Amicarbazone 70WDG	0.09	10.5a	11.5a	11.5a	15.5a	13.8a	13.3ab	12.3a	9.0ab	7.8ab
Untreated	–	8.3a	9.3a	10.1a	10.8ab	12.5a	14.5a	13.5a	11.6a	11.3a
LSD Value		7.6	7.1	6.3	6.5	6.5	6.9	6.6	6.5	6.5

*Treatments were applied 11 April and 2 May.
**Treatments were applied 2 and 23 May.
***Means in a column followed by the same letter are not significantly different according to Fisher’s LSD, P ≤0.05.

Table 3. Providence creeping bentgrass injury as influenced by amicarbazone and methiozolin, College Park, MD 2011.

Treatment	Rate (lb ai/A)	Creeping bentgrass injury (0-5)				
		13-May	25-May	10-Jun	20-Jun	1-Jul
*Methiozolin 250EC	0.45	0.2bc***	0.1b	0.0b	0.0b	0.0b
*Methiozolin 250EC	0.9	0.3bc	0.2b	0.1b	0.0b	0.0b
*Amicarbazone 70WDG	0.18/0.09	3.5a	3.8a	4.0a	3.3a	3.3a
**Methiozolin 250EC	0.45	0.2bc	0.1b	0.0b	0.0b	0.0b
**Methiozolin 250EC	0.9	0.5bc	0.3b	0.2b	0.1b	0.0b
**Amicarbazone 70WDG	0.09	3.3a	3.5a	4.0a	3.5a	3.5a
Untreated	–	0.0c	0.0b	0.0b	0.0b	0.0b
LSD Value		0.5	0.4	0.5	0.3	0.2

*Treatments were applied 11 April and 2 May.

**Treatments were applied 2 and 23 May.

***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 4. Providence creeping bentgrass quality as influenced by amicarbazone and methiozolin, College Park, MD, 2011.

		Overall quality (0-10)					
Treatment*	Rate (lb ai/A)	13-May	25-May	1-Jun	10-Jun	20-Jun	1-Jul
*Methiozolin 250EC	0.45	8.0a	8.3a	8.3ab	8.3a	8.5a	8.5a
*Methiozolin 250EC	0.90	7.0b	7.3b	8.5a	8.5a	8.5a	8.5a
*Amicarbazone 70WDG	0.18/0.09	4.4c	5.3c	5.6c	6.0c	6.3c	6.5b
**Methiozolin 250EC	0.45	7.9a	7.5b	7.5ab	7.8ab	8.0ab	8.1a
**Methiozolin 250EC	0.90	7.9a	7.4b	7.8ab	7.8ab	8.1ab	8.3a
**Amicarbazone 70WDG	0.09	7.8ab	4.4d	4.6c	4.5d	5.0d	5.0c
Untreated	–	8.5a	8.3a	7.5ab	7.8ab	8.3a	8.1a
LSD Value		0.8	0.8	1.0	0.7	0.5	0.4

*Treatments were applied 11 April and 2 May.

**Treatments were applied 2 and 23 May.

***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Annual Bluegrass Control In A Creeping Bentgrass Fairway At Hampshire Greens G.C., 2011

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Objective: Three postemergence herbicides targeting annual bluegrass (*Poa annua*) were evaluated. The three products tested were methiozolin 250EC, amicarbazone 70WDG and bispyribac-sodium (Velocity 17.6EC). Currently, methiozolin and amicarbazone are under development. Velocity was accidentally applied at one-third (i.e., 2.0 oz/A) its recommended rate (i.e., 6.0 oz/A). Similarly, the rate of methiozolin evaluated was a low rate intended for golf greens. Hence, there is no standard for comparison in this study and the Velocity and methiozolin data are of little value.

Procedure: This field study was conducted on a fairway at Hampshire Greens Golf Course in Cloverly, MD. Herbicides were applied with a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat-fan nozzle and calibrated to deliver 1.1 gal water per 1000 ft^2 (50 GPA). Turf was a mature blend of 'Providence' and 'SR1020' creeping bentgrass (*Agrostis stolonifera*) and was mowed two to three times weekly to a height of about 0.5 inches using a triplex mower. Soil was a silt loam.

Plots were 5 ft x 5 ft and were arranged in a randomized complete block with four replications. Percent of plot area covered with annual bluegrass was assessed visually on a linear 0 to 100% scale where 0 = no weeds, and 100 = entire plot area covered with annual bluegrass. Overall quality was visually assessed on a 0 to 10 scale where 0 = entire plot area brown or dead; 7.0 = minimum acceptable quality for a golf green and 10 = optimum green color and uniformity. Herbicide-induced injury to annual bluegrass and creeping bentgrass were assessed visually on a 0 to 5 scale where 0 = entire plot area green and healthy; 2.5 = objectionable turf discoloration; and 5 = >50% of the plot area brown or dead. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD.

Results. All herbicides were applied four times either on a 7 or 14-day interval on the dates footnoted in the data tables. After it was discovered that errors had been made in rate selection, the rate of methiozolin (0.9 lb ai/A) and Velocity (6.0 oz/A) were increased on the last application date (i.e., 9 June).

All herbicides appeared to injure annual bluegrass (ABG) when data first were collected on 19 May (35 days since study was initiated) (Table 1). All five applications of amicarbazone had been applied by 19 May and injury to ABG declined overtime in this treatment and most plants recovered. The 2.0 and 3.0 oz rates of amicarbazone caused a severe level of ABG injury throughout the study. No treatment had reduced ABG cover between 15 April and 5 May (Table 2). On 19 May reduced levels ABG were noted in all amicarbazone-treated plots. Between 19 May and 2 June, ABG appeared to have recovered in plots treated with the two lower rates of amicarbazone. Conversely, in plots treated with the high rate of amicarbazone the ABG was completely eliminated by 2 June and little or no ABG recovered by the last rating date. ABG began to senesce naturally in response to increasing heat stress from late May through June and thus ABG cover ratings generally declined naturally in all plots (except methiozolin) by 17 June. While some reductions in ABG were observed in Velocity-treated plots on 10 and 17 June, the ABG had recovered by 24 June. By the final two rating dates (i.e., 17 and 24 June) only trace amounts of ABG were observed in plots treated with the 2.0 and 3.0 oz rates of amicarbazone. All other herbicide-treated plots had ABG cover ratings statistically equivalent to the untreated control at the end of the study.

Herbicide-induced injury to the creeping bentgrass first was observed on 19 May (i.e., 35 days after study was initiated) in plots treated with the high rate of amicarbazone (Table 3). Injury slowly and rapidly increased in plots treated with 2.0 and 3.0 oz rates of amicarbazone, respectively. Unacceptable injury was noted in plots treated with the 3.0 oz rate of amicarbazone on 26 May and plots retained unacceptable injury until data collection ceased on 2 July. Plots treated with the 2.0 oz rate of amicarbazone also elicited unacceptable injury by 10 June, which increased in severity until the final rating (i.e., 2 July). No other treatment elicited any injury to the creeping bentgrass. Overall quality ratings mirror injury ratings. Plots treated with the 2.0 and 3.0 oz rates exhibited unacceptable quality on all rating dates (Table 4). No other treatment reduced quality compared to the control.

Summary and Conclusions. Velocity and methiozolin had no impact on annual bluegrass control or creeping bentgrass quality because the rates evaluated were too low for fairway height turf. The 1.0 oz rate of amicarbazone was safest to use on creeping bentgrass, but did not provide any level of ABG control. Conversely, the two higher rates of amicarbazone nearly eliminated the ABG, but were too phytotoxic to creeping bentgrass. It should be noted that a prolonged high temperature stress period began in late May and continued throughout June. This earlier than normal period of heat stress may have influenced results.

Table 1. Annual bluegrass injury as influenced by herbicides at Hampshire Greens G.C, 2011.

Treatment	Rate (Prod./A)	*Poa annua* injury (0-5) 19-May	26-May	2-Jun	10-Jun	17-Jun	2-Jul
*Amicarbazone 70WDG	1.0 oz	2.0b***	2.0b	1.1c	1.8b	1.1c	0.5c
**Amicarbazone 70WDG	2.0 oz	1.9b	3.5a	4.0a	2.5b	5.0a	5.0a
**Amicarbazone 70WDG	3.0 oz	3.5a	4.5a	4.8a	5.0a	5.0a	5.0a
**Methiozolin 250EC	0.45 lb a.i./A	1.1c	0.5c	1.0c	2.3b	1.4c	0.8b
**Velocity 17.6EC	2.0 oz	1.1c	1.4bc	2.0b	2.4b	2.4b	0.6bc
Untreated	–	0.1d	0.5c	1.1b	2.2b	1.6c	0.4c
LSD Value		0.7	1.2	0.8	1.0	0.6	0.2

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.
**Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 2. Annual bluegrass control in a creeping bentgrass fairway with amicarbazone at Hampshire Greens G.C., 2011.

Treatment	Rate (Prod./A)	*Poa annua*/plot (%) 15-Apr	21-Apr	29-Apr	5-May	19-May	26-May	2-Jun	10-Jun	17-Jun	24-Jun
*Amicarbazone 70WDG	1.0 oz	12.5a***	27.8a	33.3a	32.8a	6.3b	5.5b	10.3a	9.5b	9.5ab	6.3a
**Amicarbazone 70WDG	2.0 oz	11.3a	19.5a	26.0a	32.3a	7.5b	15.0a	14.3a	2.8c	1.0c	0.3b
**Amicarbazone 70WDG	3.0 oz	10.5a	19.0a	25.3a	28.5a	9.8b	9.5ab	0.0b	0.0c	0.0c	0.3b
**Methiozolin 250EC	0.45 lb a.i./A	11.3a	18.8a	28.8a	31.0a	24.3a	13.0a	12.8a	11.8ab	12.8a	9.0a
**Velocity 17.6EC	2.0 oz	13.3a	21.8a	27.5a	31.5a	23.0a	12.8a	11.3a	8.8b	7.8b	10.0a
Untreated	–	11.a	24.9a	33.1a	34.4a	22.0a	13.1a	14.9a	15.3a	12.3a	9.9a
LSD Value		5.3	18.0	18.3	26.6	9.4	5.7	6.4	5.1	4.1	4.8

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.
**Treatments were applied on21 day intervals on 14 and 29 April, 19 May and 9 June.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 3. Creeping bentgrass injury as influenced by herbicides targeting annual bluegrass at Hampshire Greens G.C., 2011.

		Creeping bentgrass injury (0-5)					
Treatment	Rate (Prod./A)	19-May	26-May	2-Jun	10-Jun	17-Jun	2-Jul
*Amicarbazone 70WDG	1.0 oz	0.4b***	0.0c	0.0c	0.0c	0.0c	0.1c
**Amicarbazone 70WDG	2.0 oz	0.6b	1.1b	1.5b	2.6b	3.8a	3.8b
**Amicarbazone 70WDG	3.0 oz	1.5a	3.5a	3.4a	4.1a	4.3a	4.5a
**Methiozolin 250EC	0.45 lb a.i./A	0.3b	0.0c	0.0c	0.0c	0.1c	0.0c
**Velocity 17.6EC	2.0 oz	0.0b	0.0c	0.0c	0.0c	1.0b	0.0c
Untreated	–	0.0b	0.0c	0.0c	0.0c	0.0c	0.0c
LSD Value		0.8	0.4	0.5	0.4	0.5	0.2

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.

** Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 4. Creeping bentgrass quality as influenced by herbicides targeting annual bluegrass at Hampshire Greens G.C., 2011.

		Quality ratings (0-10)					
Treatment	Rate (Prod./A)	19-May	26-May	2-Jun	10-Jun	17-Jun	2-Jul
*Amicarbazone 70WDG	1.0 oz	8.0a***	7.9a	8.4a	8.5a	8.4a	8.1a
**Amicarbazone 70WDG	2.0 oz	5.8b	5.6b	5.9b	4.5b	5.1c	4.6b
**Amicarbazone 70WDG	3.0 oz	3.1c	3.0c	2.9c	2.8c	3.3d	3.0c
**Methiozolin 250EC	0.45 lb a.i./A	8.1a	7.9a	8.5a	8.0a	8.1ab	8.3a
**Velocity 17.6EC	2.0 oz	8.1a	7.9a	8.5a	8.5a	8.1ab	8.3a
Untreated	–	7.8a	7.4a	8.3a	8.0a	7.8b	7.8a
LSD Value		0.5	0.8	0.6	0.5	0.4	0.6

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.

**Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Annual Bluegrass Control in Fairway Height Creeping Bentgrass Fairway In College Park, 2011

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Objective: Three postemergence herbicides targeting annual bluegrass (*Poa annua*) were evaluated. The three products tested were methiozolin 250EC, amicarbazone 70WDG and bispyribac-sodium (Velocity 17.6EC). Currently, methiozolin and amicarbazone are under development. Velocity was accidentally applied at one-third (i.e., 2.0 oz/A) its recommended rate (i.e., 6.0 oz/A). Similarly, the rate of methiozolin evaluated was a low rate intended for golf greens. Hence, there is no standard for comparison in this study and the Velocity and methiozolin data are of little value.

Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Herbicides were applied with a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat-fan nozzle and calibrated to deliver 1.1 gal water per 1000 ft^2 (50 GPA). Amicarbazone treatments were applied with 0.25% v/v of non-ionic surfactant. Turf was a mature stand of 'Penncross' creeping bentgrass (*Agrostis stolonifera*) and was mowed three times weekly to a height of 0.5 inches using a triplex mower. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM.

Plots were 5 ft x 5 ft and were arranged in a randomized complete block with three replications. Percent of plot area covered with annual bluegrass was assessed visually on a linear 0 to 100% scale where 0 = no weeds, and 100 = entire plot area covered with annual bluegrass. Overall quality was visually assessed on a 0 to 10 scale where 0 = entire plot area brown or dead; 7.0 = minimum acceptable quality for a green and 10 = optimum green color and uniformity. Herbicide-induced injury to annual bluegrass and creeping bentgrass were assessed visually on a 0 to 5 scale where 0 = entire plot area green and healthy; 2.5 = objectionable turf discoloration; and 5 = >50% of the plot area brown or dead. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD.

Results. All herbicides were applied four times either on a 7- or 14-day interval on the dates footnoted in the data tables. After it was discovered that errors had been made in rate selection, the rate of methiozolin (0.9 lb ai/A) and Velocity (6.0 oz/A) were increased on the last application date (i.e., 9 June).

Only the two highest rates of amicarbazone injured the annual bluegrass severely (injury = 3.5 to 5.0) on all rating dates (Table 1). On the first three rating dates in late April and early May there was no indication that the annual bluegrass was being controlled (Table 2). On 16 May (32 days after treatments had been initiated and after most applications had been applied) annual bluegrass cover was reduced by all three amicarbazone rates compared to all other treatments including the control. On 26 May, following an additional application of the two higher rates of amicarbazone, all treated plots exhibited additional reductions in annual bluegrass cover. Annual bluegrass cover continued to decline on 2 June and complete control was observed in plots treated with the high rate of amicarbazone at this time. Annual bluegrass populations began to decline naturally in response to high temperature stress throughout June. By 10 June annual bluegrass levels in plots treated with 1.0 oz rate of amicarbazone had stabilized and were statistically equivalent to annual bluegrass levels in the control. Some recovery of annual bluegrass was noted in plots treated with the 2.0 oz rate of amicarbazone on 17 and 24 June, but levels remained lower compared to the control. No annual bluegrass recovered in plots treated with the 3.0 oz. rate of amicarbazone. Methiozolin and Velocity did not reduce annual bluegrass levels on any date.

Amicarbazone applied at 2.0 oz elicited severe and unacceptable injury to the creeping bentgrass following the second application; this injury persisted until 10 June (Table 3). The 3.0 rate of amicarbazone was very phytotoxic and unacceptable injury remained evident until data collection ceased on 1 July. All other herbicide treatments had been non-injurious to the creeping bentgrass. Overall quality data reflect injury elicited by the 2.0 and 3.0 oz rates of amicarbazone. Plots treated with the 3.0 oz rate of amicarbazone exhibited unacceptable quality on all rating dates; however, plots treated with the 2.0 oz rate were unacceptable between 18 May and 17 June and had recovered by 24 June. The quality of plots treated with the low amicarbazone rate, methiozolin and Velocity were equivalent to the control on all rating dates.

Summary and Conclusions. Velocity and methiozolin had no impact on annual bluegrass or creeping bentgrass quality because the rates evaluated were too low for fairway height turf. While the 3.0 oz rate of amicarbazone effectively controlled annual bluegrass, both the 2.0 and 3.0 oz rates were too phytotoxic to the fairway height creeping bentgrass. Plots treated with the 2.0 oz. rate on amicarbazone , however, had recovered by late June. It should be noted that a prolonged high temperature stress period began in late May and continued throughout June. This earlier than normal period of heat stress may have influenced results.

Table 1. Annual bluegrass injury as influenced by three herbicides in creeping bentgrass, College Park MD, 2011.

	Rate	*Poa annua* injury (0-5)						
	(AMT/A)	18-May	25-May	2-Jun	10-Jun	17-Jun	24-Jun	1-Jul
*Amicarbazone 70WDG	1.0 oz	1.3b***	1.0b	0.8b	1.3b	0.7d	1.0c	0.8c
**Amicarbazone 70WDG	2.0 oz	3.5a	3.5a	3.3a	3.5a	4.0b	4.7a	4.7a
**Amicarbazone 70WDG	3.0 oz	4.5a	4.5a	4.5a	4.5a	4.5a	5.0a	5.0a
**Methiozolin 250EC	0.45 lb a.i./A	0.7b	0.8b	0.8b	0.0c	0.7d	1.0c	1.2c
**Velocity 17.6EC	2.0 oz	0.8b	0.8b	1.0b	0.2c	1.3c	1.8b	2.0b
Untreated	–	0.0b	0.0b	0.0b	0.0c	0.5d	0.7c	0.7c
LSD Value		1.3	1.1	1.2	1.0	0.4	0.5	0.5

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.
**Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.
***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 2. Annual bluegrass control in a creeping bentgrass fairway with three herbicides, College Park, MD, 2011.

	Rate	*Poa annua*/plot (%)								
Treatment	(AMT/A)	15-Apr	25-Apr	5-May	16-May	26-May	2-Jun	10-Jun	17-Jun	24-Jun
*Amicarbazone 70WDG	1.0 oz	26.3a***	28.7a	28.0a	12.7b	8.3b	6.3b	6.3a	6.7a	7.0ab
**Amicarbazone 70WDG	2.0 oz	34.0a	33.0a	30.3a	9.0b	6.0b	0.3c	0.3b	2.7b	2.7bc
**Amicarbazone 70WDG	3.0 oz	32.0a	30.3a	25.7a	8.7b	3.3b	0.0c	0.0b	0.0b	0.0c
**Methiozolin 250EC	0.45 lb a.i./A	27.3a	30.3a	34.0a	29.3a	23.0a	13.7a	11.0a	9.3a	8.7a
**Velocity 17.6EC	2.0 oz	26.0a	27.7a	28.7a	25.3a	20.7a	15.3a	12.0a	10.7a	8.3a
Untreated	–	28.0a	31.0a	36.0a	28.7a	24.7a	15.0a	11.7a	9.7a	6.7ab
LSD Value		13.0	13.6	17.1	12.0	10.0	7.6	6.2	5.2	4.7

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.
**Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.
***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 3. Creeping bentgrass injury as influenced by three herbicides targeting annual bluegrass, College Park MD, 2011.

Treatment	Rate (AMT/A)	Creeping bentgrass injury (0-5)						
		19-May	25-May	2-Jun	10-Jun	17-Jun	24-Jun	1-Jul
*Amicarbazone 70WDG	1.0 oz	0.8b***	0.7b	0.8b	0.3bc	0.3c	0.0b	0.0c
**Amicarbazone 70WDG	2.0 oz	3.3a	3.5a	3.3a	0.8b	1.7b	2.3a	2.2b
**Amicarbazone 70WDG	3.0 oz	4.0a	4.3a	4.0a	2.7a	2.8a	2.5a	2.8a
**Methiozolin 250EC	0.45 lb a.i./A	0.8b	1.0b	0.8b	0.0c	0.0c	0.0b	0.0b
**Velocity 17.6EC	2.0 oz	0.7b	0.8b	1.0b	0.0c	0.0c	0.0b	0.0b
Untreated	–	0.0b	0.0b	0.0b	0.0c	0.0c	0.0b	0.0b
LSD Value		0.8	1.0	1.1	0.6	0.8	0.4	0.5

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.
**Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.
***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 4. Creeping bentgrass quality as influenced by three herbicides targeting annual bluegrass, College Park MD, 2011.

Treatment	Rate (AMT/A)	Quality ratings (0-10)						
		18-May	25-May	2-Jun	10-Jun	17-Jun	24-Jun	1-Jul
*Amicarbazone 70WDG	1.0 oz	8.3a***	8.2a	8.3a	8.1a	8.2a	7.5a	8.0a
**Amicarbazone 70WDG	2.0 oz	5.2b	5.3b	5.5b	5.2b	6.0b	8.0a	8.0a
**Amicarbazone 70WDG	3.0 oz	2.8c	3.0c	2.8c	3.0c	4.2c	5.5b	6.0b
**Methiozolin 250EC	0.45 lb a.i./A	7.8a	7.8a	7.5a	7.8a	7.8a	7.8a	8.2a
**Velocity 17.6EC	2.0 oz	7.8a	7.8a	7.7a	7.8a	7.8a	8.0a	8.2a
Untreated	–	8.0a	7.8a	7.7a	8.0a	7.8a	7.8a	8.0a
LSD Value		0.5	0.8	0.8	0.5	0.6	0.5	0.4

*Treatment was applied on 7 day intervals on 14, 21, 29 April and 5 May.
**Treatments were applied on 21 day intervals on 14 and 29 April, 19 May and 9 June.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Preemergence Smooth Crabgrass Control In A Creeping Bentgrass Fairway With Herbicides, 2011

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Objective. The purpose of the study was to compare various preemergence herbicides targeting smooth crabgrass (*Digitaria ischaemum*) in creeping bentgrass maintained under fairway conditions.

Procedure. This field study was conducted at the University of Maryland Paint Branch Research Facility in College Park, MD. Turf was a mature stand of ‘Backspin’ creeping bentgrass (*Agrostis stolonifera*) and was mowed 2 to 3 times weekly to a height of 0.5 inches. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM. Crabgrass seedlings were first observed in the study site 19 April 2011.

Sprayable herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) backpack sprayer equipped with an 8004E flat fan nozzle. Granular formulations were applied using a shaker jar. The study site received rainfall or irrigation within 36 hours of treatment application, and was irrigated thereafter to avoid drought stress. Plots were 10 ft x 5 ft and were arranged in a randomized complete block with four replications. Percent of plot area covered with smooth crabgrass was visually assessed on a 0 to 100% scale where 0 = no crabgrass and 100 = entire plot area covered with smooth crabgrass. Crabgrass ratings ≤ 5% of plot area covered subjectively were considered to have provided commercially acceptable control. Smooth crabgrass pressure was uniform and severe across the site. Summer stress was assessed visually on a 0 to 5 scale where 0 = entire plot area green and healthy; 2.5 objectionable turf discoloration; and 5 = >50% of the plot area brown or dead. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher’s LSD.

Results: Some crabgrass was observed in all herbicide-treated plots by 5 July, and it was evident that Tupersan had been ineffective by this time (Table 1). Plots were last evaluated 15 August and all herbicides except Tupersan had reduced crabgrass levels compared to the control. While there were no significant differences among treatments that reduced crabgrass, only Pendulum AquaCap and Barricade had provided commercially acceptable control. None of the herbicides discolored turf or appeared to reduce the summer stress tolerance of the creeping bentgrass. Pendulum, however, delayed recovery of creeping bentgrass into patches of dead crabgrass plants remaining from the previous year. On close inspection, it was observed that Pendulum, but none of the other herbicides, had delayed rooting from stolons in the dead crabgrass voids. Roots emanating from stolons in Pendulum-treated plots were not clubbed, but they also were not rooting into the dead crabgrass debris from the previous year. Stolons eventually were able to cover and root into the dead crabgrass skeletons in the summer, but the effect on spring quality of the creeping bentgrass was objectionable and unacceptable.

Table 1. Preemergence smooth crabgrass control in fairway height creeping bentgrass, College Park, 2011.

Treatment*	Rate (lb/ai/A)	Crabgrass (%) 5-Jul	Crabgrass (%) 15-Aug	Summer stress (0-5) 15-Aug
Bensumec 4LF	10.0	0.5b**	12.3b	2.0a
Tupersan 50WP	12.0	10.3a	61.8a	2.8a
Ronstar 2G	3.0	0.9b	15.8b	1.8a
Pendulum AquaCap 3.8CS	2.0	0.1b	6.9b	2.1a
Barricade 4F	0.5	0.1b	4.3b	1.3a
Dimension 2EW	0.38	0.7b	12.3b	2.0a
Dimension 0.21G	0.38	0.9b	17.0b	1.8a
Untreated		19.3a	74.0a	2.5a

*Treatments were applied 30 March 2011.

**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.

Postemergence Yellow Foxtail Control with Tenacity, 2011

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Objective. This study compared the effectiveness of Tenacity (mesotrione) and Acclaim Extra (fenoxaprop-ethyl) for postemergence yellow foxtail (*Setaria glauca*) control. Two timings (i.e., 1 June and 17 June) were evaluated to determine if foxtail were more susceptible to Tenacity when smaller and less mature or vice versa. Tenacity 4SC was applied at two rates sequentially (4 and 8 oz prod. /A). Acclaim Extra 0.57EW was applied at one rate (15 oz prod. /A) in each timing and served as the standard for comparison.

Procedure. This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Turf was a mature stand of 'Coyote II' tall fescue (*Festuca arundinacea*) and was mowed 2 to 3 times weekly to a height of 2.5 inches. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM.

Plots were 5 ft x 5 ft and were arranged in a randomized complete block with four (n=4) replications. The site contained a heavy pressure mixture of yellow foxtail and smooth crabgrass (*Digitaria ischaemum*), which made estimating yellow foxtail populations extremely difficult. In general, the yellow foxtail had a distinctively more yellow canopy color whereas crabgrass was darker-green. By 14 Sept., however, yellow foxtail seedheads were present and this provided the most accurate evaluation. Percent of plot area covered with yellow foxtail was assessed visually on a 0 to 100% scale where 0 = no yellow foxtail and 100 = entire plot area covered with yellow foxtail. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD.

Results. It is unclear whether yellow foxtail or crabgrass was first to emerge, but it would have been at about the same time. Initiation of the study was delayed so that the annual grass weeds were tall enough to intercept the herbicides through the tall fescue canopy. Applications were initiated on either 1 June when yellow foxtail seedlings were in the 3 to 4-leaf stage or 17 July when foxtail seedlings were in the 4-leaf to 2-tiller stage. Plots were not rated until 5 July, which was after the second application of treatments beginning in the 1 June timing. Only one Tenacity application had been made at this time in plots involved in the second timing (i.e., 17 June). On 5 July, it was clear that Acclaim had provided rapid and almost complete control of yellow foxtail in both timings (Table 1). On 12 July, it remained evident that Acclaim had been highly effective, but statistically similar control was provided by the high Tenacity rate in both timings. Crabgrass seedlings continued to emerge throughout July and by 22 July all herbicide-treated plots were re-invaded making accurate foxtail assessments difficult. On Sept 14, however, yellow foxtail seedheads were abundant and clearly evident. These data showed that only Acclaim Extra had provided effective yellow foxtail control and that Tenacity had not. The very high yellow foxtail ratings in Tenacity-treated plots reflect the ability of this herbicide to control crabgrass, which in turn released and allowed the yellow foxtail to dominate. Low yellow foxtail levels in the untreated control were due to competition for space between yellow foxtail and crabgrass. As would be expected, crabgrass was much more competitive.

Table 1. Postemergence yellow foxtail control with Tenacity, College Park, MD, 2011.

Treatment*	Rate (oz/A)	Timing	Yellow foxtail/plot (%) 5-Jul	12-Jul	22-Jul	14-Sep**
Tenacity 4SC	4.0 + 4.0	1-Jun + 17-Jun	25.3b[+]	44.7b	80.0b	61.7a
Tenacity 4SC	8.0 + 8.0	1-Jun + 17-Jun	4.2c	18.7c	30.7c	47.7a
Acclaim Extra 0.57EW	15	1-Jun	1.5c	9.3c	25.0c	6.7b
Tenacity 4SC	4.0 + 4.0	17-Jun + 1-Jul	22.3b	2.3cd	9.3d	47.7a
Tenacity 4SC	8.0 + 8.0	17-Jun + 1-July	12.7bc	3.7cd	7.3d	51.0a
Acclaim Extra 0.57EW	15	17-Jun	0.0c	0.0d	4.7d	5.7b
Untreated	–	–	65.0a	85.0a	96.0a	18.0b

*Treatments were initiated 1 June, 2011.

** Assessment of yellow foxtail cover was based on presence of seedheads.

[+]Means in a column followed by the same letter are not significantly different according to Fisher’s LSD, $P \leq 0.05$.

Postemergence Field Paspalum Control With Fusilade, 2011

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Objective. The purpose of this study was to evaluate postemergence field paspalum (*Paspalum laeve*) control using Fusilade (fluazifop) and Tenacity (mesotrione) applied at various combinations, rates and timings.

Procedure. This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Turf was a mature stand of tall fescue (*Festuca arundinacea*). Turf was mowed two times weekly to a height of 2.5 inches. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM. Drive (quinclorac; 0.75 lb ai/A) was applied on 29 June, 21 July and 31 August to control smooth crabgrass (*Digitaria ischaemum*).

Treatments were applied with a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle and calibrated to deliver 1.1 gal water per 1000 ft^2 (50 GPA). All treatments were mixed with 0.25% v/v using a non-ionic surfactant (Activator 90). Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 4 replications. Percent of plot area covered with field paspalum, tall fescue, and bare ground were assessed visually on a 0 to 100% scale where 0 = no paspalum, tall fescue or bare ground and 100 = entire plot area covered with paspalum, tall fescue or bare ground. Paspalum ratings ≤ 5% of plot area covered subjectively were considered to have provided excellent control; ratings ≤ 10% were considered to be commercially acceptable. Turf quality was assessed using a 0 to 10 scale where 0 = entire plot area brown or dead and 10 = optimum green color and density. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$.

Results. . Treatment timings and rates are listed in Table 1. Field paspalum pressure was uniform and severe across the site. It was not determined when mature paspalum began to break winter dormancy or when additional seed would have begun to germinate in the study site. High levels of the weed first became apparent in early July and these levels increased to early August and thereafter naturally declined, perhaps in response to the applications of Drive to control crabgrass. All treatments reduced paspalum levels statistically equally on all dates except Treatment 2 (Table 2). In Treatment 2 there had been a severe phytotoxic response in the tall fescue following the second application of Fusilade and the third application therefore was omitted. Injury remained evident in Treatment 2 plots as late as 13 Sept. (75% tall fescue cover). In fact, all treatments involving the 8.0 oz prod./A rate of Fusilade were injurious.

As previously noted most treatments provided an equivalent level of paspalum control on nearly all rating dates. Since the highest levels of paspalum were noted in the control plots between 5 July and 15 Aug. (40 to 61% paspalum cover), these would appear to be the critical dates for discussion. During this period, plots treated with Fusilade at both 5 and 8 prod. oz/A beginning 1 June always had paspalum levels ≤ 7% paspalum cover. Plots treated with Tenacity alone (18 to 23% paspalum cover) or in combination with Fusilade at 5.0 oz prod. /A (15 to 21% paspalum cover) had unacceptable levels of field paspalum. Numerically higher bare ground ratings (3 to 8% bare) were noted in plots treated with Fusilade at 5.0 oz prod. /A beginning 2 May, which were numerically larger than the same rate initiated on1 June (1 to 2% bare). Furthermore, quality ratings remained above the acceptable threshold (≥ 7.0) on all dates for both Fusilade treatments initiated on 1 June. Hence, Fusilade was more injurious to tall fescue when applied in the earlier timing (i.e., beginning 1 May) when air temperatures would have been cooler. Finally, the small changes in paspalum populations after 15 July in Fusilade-treated plots would suggest that most of the control was provided by the first two applications. Future research should compare one versus two versus three applications of Fusilade at 5.0 oz. prod/A in two timings beginning 1 June and 1 July.

Table 1. Treatments and timings for postemergence field paspalum control, College Park, MD, 2011.

		Herbicide	Rate lb prod./A	Timing
1.	a.	Tenacity + Fusilade*	8.0 + 5.0 oz	2 May
	b.	Fusilade + 3 wk	5.0 oz	23 May
	c.	Fusilade + 3 wk	5.0 oz	13 June
2.	a.	Tenacity + Fusilade	8.0 + 8.0 oz	2 May
	b.	Fusilade + 3 wk	8.0 oz	23 May
	c.	Fusilade + 3 wk	8.0 oz	Not applied**
3.	a.	Tenacity	8.0 oz	2 May
	b.	Tenacity + 3 wk	8.0 oz	23 May
	c.	Tenacity + 3 wk	8.0 oz	16 June
4.	a.	Fusilade	5.0 oz	2 May
	b.	Fusilade + 3 wk	5.0 oz	23 May
	c.	Fusilade + 3 wk	5.0 oz	16 June
5.	a.	Fusilade	8.0 oz	2 May
	b.	Fusilade + 3 wk	8.0 oz	23 May
	c.	Fusilade + 3 wk	8.0 oz	16 June
6.	a.	Fusilade	5.0 oz	1 June
	b.	Fusilade + 3 wk	5.0 oz	22 June
	c.	Fusilade + 3 wk	5.0 oz	13 July
7.	a.	Fusilade	8.0 oz	1 June
	b.	Fusilade + 3 wk	8.0 oz	22 June
	c.	Fusilade + 3 wk	8.0 oz	13 July
8.		Untreated	–	–
9.		Untreated	–	–
10.		Untreated	–	–

*Tank-mixed with 0.25% v/v = 2.5 ml/L Activator 90

**Not applied due to too much injury

Table 2. Postemergence field paspalum control in tall fescue, College Park, MD, 2011.

		Rate		Field Paspalum/plot (%) ***							Bare ground (%)		Tall fescue/plot (%)
	Treatment*	product/A	Timing	5-Jul	15-Jul	25-Jul	5-Aug	15-Aug	1-Sep	13-Sep	5-Jul	15-Jul	13-Sep
1.	a. Tenacity + Fusilade*	8.0 + 5.0 oz	2-May	0.5c†	9.3cd	15.0cd	21.5bc	19.5bc	14.5b	8.8b	6.0b	3.3b	86.3a
	b. Fusilade+3 wk	5.0 oz	23-May										
	c. Fusilade+3 wk	5.0 oz	16-Jun										
2.	a. Tenacity + Fusilade	8.0 + 8.0 oz	2-May										
	b. Fusilade+3 wk	8.0 oz	23-May	7.8c	27.5b	36.3b	49.3a	40.5a	26.8a	16.0a	3.8b	1.3b	75.0b
	c. Fusilade+3 wk	8.0 oz	Not applied**										
3.	a. Tenacity	8.0 oz	2-May										
	b. Tenacity+3 wk	8.0 oz	23-May	21.0b	18.3bc	22.3c	28.3b	23.0b	13.8bc	8.8b	0.0b	0.3b	87.3a
	c. Tenacity+3 wk	8.0 oz	16-Jun										
4.	a. Fusilade	5.0 oz	2-May										
	b. Fusilade+3 wk	5.0 oz	23-May	0.0c	4.8d	7.5d	11.0bc	8.0bc	5.8bc	3.5b	8.5b	3.0b	92.5a
	c. Fusilade+3 wk	5.0 oz	16-Jun										
5.	a. Fusilade	8.0 oz	2-May										
	b. Fusilade+3 wk	8.0 oz	23-May	0.0c	3.0d	5.5d	10.0bc	7.8bc	5.8bc	2.5b	30.5a	22.0a	92.8a
	c. Fusilade+3 wk	8.0 oz	16-Jun										
6.	a. Fusilade	5.0 oz	1-Jun										
	b. Fusilade+3 wk	5.0 oz	22-Jun	0.0c	2.8d	4.3d	7.3c	6.3bc	5.8bc	4.5b	2.3b	1.3b	92.3a
	c. Fusilade+3 wk	5.0 oz	13-Jul										
7.	a. Fusilade	8.0 oz	1-Jun										
	b. Fusilade+3 wk	8.0 oz	22-Jun	0.0c	1.3d	2.3d	4.0c	3.5c	3.5c	3.0b	4.5b	3.5b	95.3a
	c. Fusilade+3 wk	8.0 oz	13-Jul										
8.	Untreated	–	–	40.2a	50.1a	56.3a	60.6a	51.9a	35.6a	20.5a	0.0b	0.3b	71.3b

*Tank-mixed with 0.25% v/v=2.5mL/L Activator 90

**Not applied due to too much injury

***Crabgrass treated with Drive (0.75 lb ai/A) on 29 June, 21 July and 31 August, which may have impacted data collection.

†Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 3. Quality of tall fescue as influenced by Fusilade and Tenacity, College Park, MD, 2011.

	Treatment*	Rate product/A	Timing	Quality Ratings (0-10)*** 15-Jul	25-Jul	5-Aug	15-Aug	1-Sep	13-Sep
1.	a. Tenacity + Fusilade*	8.0 + 5.0 oz	2-May						
	b. Fusilade + 3 wk	5.0 oz	23-May	5.9cd†	6.1bc	6.9abc	7.0bc	7.6a	8.3a
	c. Fusilade + 3 wk	5.0 oz	16-Jun						
2.	a. Tenacity + Fusilade	8.0 +8.0 oz	2-May						
	b. Fusilade + 3 wk	8.0 oz	23-May	5.6cd	5.5cd	4.9de	5.6de	6.6bc	7.1b
	c. Fusilade + 3 wk	8.0 oz	Not applied**						
3.	a. Tenacity	8.0 oz	2-May						
	b. Tenacity + 3 wk	8.0 oz	23-May	6.3bc	6.3b	6.0cd	6.4cd	7.5ab	8.4a
	c. Tenacity + 3 wk	8.0 oz	16-Jun						
4.	a. Fusilade	5.0 oz	2-May						
	b. Fusilade + 3 wk	5.0 oz	23-May	6.1bc	6.4b	7.1abc	7.3abc	7.9a	8.5a
	c. Fusilade + 3 wk	5.0 oz	16-Jun						
5.	a. Fusilade	8.0 oz	2-May						
	b. Fusilade + 3 wk	8.0 oz	23-May	3.4e	4.4e	6.5bc	6.9bc	7.5ab	7.9ab
	c. Fusilade + 3 wk	8.0 oz	16-Jun						
6.	a. Fusilade	5.0 oz	1-Jun						
	b. Fusilade + 3 wk	5.0 oz	22-Jun	7.4a	7.4a	7.5ab	7.8ab	8.3a	8.5a
	c. Fusilade + 3 wk	5.0 oz	13-Jul						
7.	a. Fusilade	8.0 oz	1-Jun						
	b. Fusilade + 3 wk	8.0 oz	22-Jun	7.0ab	7.4a	8.3a	8.3a	8.3a	8.5a
	c. Fusilade + 3 wk	8.0 oz	13-Jul						
8.	Untreated	–	–	5.0d	4.9de	4.4e	5.1e	6.4c	8.1a

*Tank-mixed with 0.25% v/v=2.5mL/L Activator 90

**Not applied due to too much injury

***Crabgrass treated with Drive (0.75 lb ai/A) on 21 June and 31 August, which may have impacted data collection.

†Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P≤0.05.

Preemergence Field Paspalum Control In Spring Seeded Tall Fescue , 2011

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Objective. The purpose of this study was to evaluate Tenacity (mesotrione) and Tupersan (siduron) applied at various rates and timings for preemergence control of field paspalum (*Paspalum laeve*).

Procedure. This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Field paspalum seed was collected in the autumn of 2010 at Paint Branch. The study area was treated with glyphosate to kill existing vegetation. The area then was broadcast seeded with field paspalum at 1.5 lbs seed/1000 ft^2 on 7 April 2011. The area then was disk-seeded with 'Winning Colors' tall fescue (*Festuca arundinacea*) at 5.0 lb/1000 ft^2 on 14 April, 2011. A starter fertilizer (18-24-12) was applied at the time of seeding to deliver 1.0 lbs N/1000ft^2. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM. Turf was mowed two times weekly to a height of 2.5 inches. The site was treated with Drive (quinclorac; 0.75 lb ai/A) on 29 June, 21 July and 31 August to control smooth crabgrass (*Digitaria ischaemum*), which was especially severe in the untreated control plots. The Drive applications were intended to remove enough crabgrass so that the paspalum could be estimated more accurately. It is possible that Drive injured the paspalum and influenced results. This explains in part why paspalum levels were lowest on the final rating (13 Sept.).

Treatments were applied with a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle and calibrated to deliver 1.1 gal water per 1000 ft^2 (50 GPA). Treatment timings and rates are listed on Table 1. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 4 replications. Percent of plot area covered with field paspalum was assessed visually on a 0 100% scale where 0 = no paspalum and 100 = entire plot area covered with paspalum. Paspalum ratings $\leq$ 5% of plot area covered subjectively were considered to have provided commercially acceptable control. Turf quality was rated using a 0 to 10 scale where 0 = entire plot area brown or dead and 10 = optimum green color and density. Area under the weed curve (AUWC) and area under the quality curve (AUQC) were computed using the trapezoid method and give a seasonal summery perspective. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$. Excellent control was considered to be $\leq$ 5% paspalum cover and $\leq$ 10% was considered acceptable control.

Results. Field paspalum pressure was uniform and severe across the site, but the weed did not become recognizable until early July. During July, most treatments had reduced paspalum levels compared to the control (Table 1). However, it was immediately apparent that little control was to be provided by Tenacity (0.25 lb/A) applied once on 14 April or Tupersan

(6.0 lb/A) applied once on 2 May. Treatments expressed clear differences numerically by 25 July. Between 25 July and 15 Aug. high levels of paspalum were noted in the untreated control (62 to 75% paspalum cover). This period appears to represent the most important time of data collection since paspalum levels sharply declined from 15 July to 15 Aug. Numerically lowest levels (3 to 8% paspalum cover) were observed in plots treated once or sequentially with Tenacity at 0.25 lb/A beginning on 2 May. Statistically equivalent levels of paspalum control (7 to 13 % paspalum cover)were provided by Tenacity applied sequentially at 0.25 lb/A on 14 April and 12 May and Tupersan applied sequentially at 6.0 lb/A on 14 April and 12 May.

The single application of Tupersan at either 6.0 or 12 lb/A on 14 April reduced the weed and provided equivalent control, but both rates were judged unacceptable since there was over 23% paspalum cover by 25 July (Table 1). Similarly, single applications of Tupersan applied on 2 May were ineffective. Only Tupersan applied sequentially at 6.0 lb/A on 2 and 24 May were as effective as Tenacity.

Tall fescue cover was rated on 13 Sept. and plots treated with Tenacity sequentially on 2 and 24 May had highest cover (Table 2). Statistically similar levels of tall fescue cover were provided by Tenacity applied once on 2 May and sequential treatments with Tupersan on 14 April and 12 May. Due to both lower paspalum and crabgrass levels and good tall fescue cover plots treated with Tenacity once or sequentially on 2 May exhibited best turf quality over the season (i.e., AUCC) compared to most other treatments. Similar AUCQ data were associated with Tenacity and Tupersan applied sequentially on 14 April and 12 May.

It is unknown when field paspalum germinates in Maryland. Since the single 14 April application of Tenacity at 0.25 lb/A failed to control the weedy grass, while the 2 May application was effective, it would appear that field paspalum germinates closer to the aforementioned date. The relatively high level of control provided by the sequential treatments of Tenacity and Tupersan on 14 April and 12 May suggest that germination probably began in early May.

Table 1. Preemergence field paspalum control in tall fescue, College Park, MD, 2011.

	Rate		Field paspalum/plot (%)							
Treatment	(lb ai/A)	Timing	2-Jul	9-Jul	25-Jul	5-Aug	15-Aug	29-Aug	13-Sep	AUWC
Tenacity 4SC	0.25	14 Apr	38.3b*	41.3b	56.5b	58.5ab	51.3ab	37.5a	18.0a	3319 a
Tenacity 4SC	0.25+0.25	14 Apr + 12 May	8.3c	7.3c	9.0de	11.0de	12.0e	13.3bc	16.0a	796 cde
Tupersan 50WP	6	14 Apr	7.0c	12.3c	26.3c	41.3bc	32.5cd	19.0b	4.0bc	1658 bc
Tupersan 50WP	6.0+6.0	14 Apr + 12 May	3.8c	8.3c	12.8cde	12.8de	10.8e	7.8bc	1.0c	681 de
Tupersan 50WP	12	14 Apr	5.5c	12.3c	22.8cd	26.8cd	21.3cde	14.8bc	4.3bc	1293 bcd
Tenacity 4SC	0.25	2 May	8.3c	6.8c	7.0de	7.5de	8.0e	8.3bc	10.0ab	558 de
Tenacity 4SC	0.25+0.25	2 May + 24 May	3.6c	3.5c	3.3e	4.3e	4.5e	4.3c	4.8bc	291 e
Tupersan 50WP	6	2 May	43.8b	52.5b	67.5ab	77.5a	60.0a	37.5a	10.3ab	3888 a
Tupersan 50WP	6.0+6.0	2 May + 24 May	8.5c	8.8c	13.5cde	18.5de	14.5de	9.5bc	5.3bc	858 b-e
Tupersan 50WP	12	2 May	15.5c	16.0c	28.8c	43.3bc	33.8bc	18.8b	5.3bc	1785 b
Untreated	–	–	72.8a	72.5a	74.4a	75.0a	61.9a	40.0a	7.8bc	4270 a

*Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.

Table 2. Tall fescue quality as influenced by Tenacity and Tupersan treatments, College Park, MD, 2011.

Treatment	Rate (lb ai/A)	Timing	Quality ratings (0-10) 2-Jul	15-Jul	25-Jul	5-Aug	13-Aug	% TF Cover 13 Sep	AUQC (Quality x Time)
Tenacity 4SC	0.25	14 Apr	5.1ef*	5.1de	4.9efg	4.8fg	4.9fg	50cd	208ef
Tenacity 4SC	0.25+0.25	14 Apr + 12 May	6.6abc	7.0ab	6.9ab	7.0abc	6.9abc	79ab	290ab
Tupersan 50WP	6	14 Apr	6.8abc	6.0c	5.8cde	5.6def	5.6def	74 abc	249cd
Tupersan 50WP	6.0+6.0	14 Apr + 12 May	7.4a	6.3bc	6.4bc	6.5bcd	6.4bcd	84ab	274abc
Tupersan 50WP	12	14 Apr	7.0ab	5.9cd	5.9cd	6.3cde	6.0cde	68abc	258bcd
Tenacity 4SC	0.25	2 May	6.6abc	7.4a	7.4a	7.8a	7.4ab	87ab	308a
Tenacity 4SC	0.25+0.25	2 May + 24 May	6.1bcd	6.9ab	7.3ab	7.6ab	7.5a	91a	297a
Tupersan 50WP	6	2 May	5.3def	4.6e	4.5fg	4.1g	4.4g	16e	191f
Tupersan 50WP	6.0+6.0	2 May + 24 May	5.1ef	5.8cd	5.4def	5.3efg	5.4d-g	62bc	227def
Tupersan 50WP	12	2 May	5.9cde	6.0c	5.5cde	5.3efg	5.3efg	65abc	236cde
Untreated	–	–	4.5f	4.4e	4.4g	4.4g	4.4g	32de	256bcd

*Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Evaluation of Organic Selective and Non-Selective Herbicides, 2011

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Objective: The purpose of this study was to evaluate the effectiveness of several commercially available organic selective and non-selective herbicides. The selective products evaluated were Fiesta Lawn Weed Killer (Iron HEDTA) and Garden Weasel AG Crabgrass Killer (cinnamon bark). Fiesta Lawn Weed Killer is labeled for control of the following weeds: black medic (*Medicago lupulina*), broadleaf plantain (*Plantago major*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), common chickweed (*Stellaria media*), creeping buttercup (*Ranunculus repens*), dandelion (*Taraxicum officinale*) , narrow-leaved plantain (*Plantago lanceolata*), shepherd's-purse (*Capsella bursa-pastoris*), silverweed cinquefoil (*Potentilla anserina*), slender speedwell (*Veronica filiformis)*, white clover (*Trifolium repens*), as well as moss, liverworts, algae and lichens. Garden Weasel AG Crabgrass Killer is labeled for the control the following weeds: large crabgrass (*Digitaria sanguinalis*), smooth crabgrass (*Digitaria ischaemum*), common chickweed (*Stellaria media*), nutsedge (*Cyperus* spp.), dollarweed (*Hydrocotyle* spp.), dallisgrass (*Paspalum dilatatum*), yellow woodsorrel (*Oxalis stricta*), Virginia buttonweed (*Diodia virginiana*) and other. The remaining herbicides evaluated were all non-selective: All Down Concentrate (acetic acid, citric acid, *Allium sativum* extract), Scythe (pelargonic acid, related fatty acids), Green Match EX (lemon grass oil), Safer Brand Fast Acting Weed and Grass Killer (potassium salts of fatty acids), and Avenger Weed Killer (d-limonene).

Procedure: This study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park. Turf was a mature and weedy stand of 'Coyote II' tall fescue (*Festuca arundinacea*) and was mowed 2-3 times weekly to a height of 2.5 inches. The dominant broadleaf weed species was white clover, but woodsorrel and dandelion also were present in low populations. Smooth crabgrass and yellow foxtail were the annual grass weeds present. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM.

All treatments were applied 17 June 2011. Liquid herbicides were applied using a CO_2 pressurized (35 psi) backpack sprayer equipped with an 8004E flat fan nozzle. Dilutions rates and spray volumes were adjusted according to label recommendations, and can be found in Table 1. Granular formulations were applied using a shaker jar, and according to label recommendations, were applied to moistened turf. Turf was moistened by applying 60 GPA of water via the aforementioned backpack sprayer prior to application. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with three replications. Plant injury (weeds and tall fescue) was assessed visually on a 0 to 100% scale where 0 = no injury and 100 = entire plot area brown or dead. White clover and annual grass control (mostly crabgrass and some yellow foxtail) also were assessed visually using a 0 to 100% scale where 0 = no weeds and 100 = entire plot area covered by weeds. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD.

Results: Within three days of application all products had caused a burn-down of foliage. Scythe had been most effective, having damaged 95% of the plot area (Table 1). Safer was least effective having damaged only 22% of the plot area. Other non-selective herbicides provided an intermediate level of burn-down ranging from 45 to 62%. The selective herbicide Fiesta damaged mostly white clover and other broadleaf weeds that were present (62 % injury) and was significantly more injurious than Garden Weasel (36%) injury. Both Fiesta and Garden Weasel also injured the tall fescue, but separate ratings were not obtained. Nine days later on 29 June, nearly all of the vegetation had recovered in all herbicide-treated plots except Scythe. In Scythe-treated plots 46% of the plot area remained damaged. None of the herbicides reduced white clover levels significantly compared to the control. Only Scythe had reduced annual grasses (mostly non-tillered crabgrass seedlings) significantly (i.e., 81% control) compared to the untreated control. The large spray volumes required for Fiesta (400 GPA) and Scythe (200 GPA) would be logistically difficult to achieve for most professional applicators. Regardless, the herbicides evaluated appear to have little or no utility for use in turf.

Table 1. Performance of selective and non-selective organic herbicides, College Park, 2011.

					Cover (%)	
	Dilution rate		Plant injury (%)		W. Clover	Crabgrass
Treatment*	(if applicable)	Spray volume	20-Jun	29-Jun	29-Jun	29-Jun
Fiesta/ Selective	24:1	400 gal/A	61.7b**	5.3b	7.3a	38.3a
All Down / Non-selective	2:1	50 gal/A	45.0bc	4.3b	19.3a	39.3a
Scythe / Non-selective	10% v/v	200 gal/A	94.7a	46.0a	14.3a	9.3b
Green Match / Non-selective	15% v/v	100 gal/A	61.7b	7.3b	18.0a	42.3a
Safer Brand /Non-selective	–	50 gal/A	21.7d	2.3b	19.7a	47.7a
Avenger / Non-selective	–	50 gal/A	61.0b	9.0b	16.7a	25.0ab
Garden Weasel/ Selective	2 lb/100 sq ft	–	36.0cd	9.7b	22.0a	29.0ab
Untreated	–	–	0.0e	0.7b	16.0a	49.7a

*Treatments were applied 17 June.

**Means in a column separated by Fisher's LSD. 5%.

Fairway Height Penncross and Providence Creeping Bentgrass Tolerance to Freehand, 2011

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Freehand 1.75G (0.75% dimethenamid-P and 1% pendimethalin) is a new herbicide formulation that features preemergence activity on annual grassy weeds and some small-seeded broadleaf weeds. The objective of this study was to evaluate the potential phytotoxicity of Freehand 1.75G, when applied at three rates on two cultivars of fairway height creeping bentgrass. Pendulum AquaCap 3.8ME served as a standard for comparison.

Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Freehand 1.75G was applied at three rates (100, 200 and 300 lb/A) using a shaker jar, while Pendulum AquaCap (2.0 lb a.i./A) was applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. The study site was mowed three times a week to a height of 0.5" and irrigated as needed to prevent drought stress. Treatments were applied on 1 July, 2011 and were watered-in 30 minutes after application.

This study was conducted on mature stands of 'Penncross'and 'Providence' creeping bentgrass. Soil was a Keyport silt loam with a pH of 5.7 and 2.2% OM. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 3 replications. Turf injury and quality were rated from 8 July to 12 August 2011. Quality was rated using a 0 to 10 scale where 0 = entire plot area brown or dead and 10 = optimum green color and density. Injury to turf was rated visually on a 0 to 5 scale where 0 = no injury; 2.5 = objectionable and probably unacceptable injury; 5 = >50% plot area brown or dead. Area Under the Quality Curve (AUQC) also was calculated. All data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD.

Penncross Results. Plots were first evaluated one week following application (i.e., 8 July), at which time there was only slight injury to Penncross in Freehand-treated plots (Table 1). On 12 July, and for the remainder of the study, there was significant injury to turf in Freehand-treated plots. Plots treated with the highest two rates exhibited objectionable injury. It took another two weeks for plots treated with the low Freehand rate to exhibit objectionable injury. All Freehand-treated plots exhibited significant and mostly unacceptable injury for the remainder of the study. Pendulum generally was non-injurious to Penncross.

Turf quality rating reflected injury and followed the same pattern as described for injury. One week after application, plots treated with Freehand had reduced, but acceptable quality (Table 2). Two weeks after treatment and thereafter quality ratings of Freehand-treated plots, regardless of rate, were extremely poor and unacceptable.

Providence Results. Providence was more tolerant of Freehand than Penncross for the 100 and 200 lb, but not the 300 lb rate. One week after treatment the 200 and 300 lb rates had caused injury that was in the acceptable range (Table 3). By 12 July, plots treated with the two higher rates were injured to an unacceptable level and injury increased slightly through 29 July before leveling off. The low rate of Freehand did not elicit significant injury until 15 July (i.e., 2 weeks after treatment). The low rate, however, did not cause an objectionable level of injury throughout the study and these plots had recovered by 12 August. Pendulum did not cause significant injury to Providence.

The low rate of Freehand reduced quality between 15 and 29 July, but ratings remained in the acceptable range on all rating dates (Table 4). Turf quality was reduced to the unacceptable range 14 days after application in plots treated with the 200 and 300 lb rates of Freehand. Plots treated with the 300 lb rate deteriorated greatly thereafter. Plots treated with Pendulum had numerically lower quality than the untreated control throughout the study, but the differences were not significant.

Conclusion: Freehand was too phytotoxic to creeping bentgrass. It should be noted, however, that the herbicide treatments were applied at a time of sustained high temperature stress (days > 90^{o} F nights > 70 ^{o} F). Perhaps results would have been much different if Freehand had been applied in early spring.

Table 1. Injury to fairway height 'Penncross' creeping bentgrass, 2011.

		Injury Ratings (0-5)					
Treatment*	Rate	8-Jul	12-Jul	15-Jul	22-Jul	29-Jul	12-Aug
Freehand	100 lb/A	1.0a**	2.0b	2.3b	3.0b	2.7b	2.2b
Freehand	200 lb/A	1.0a	3.0a	3.1ab	3.8a	3.8a	3.2ab
Freehand	300 lb/A	1.0a	3.5a	3.8a	4.3a	4.5a	4.2a
Pendulum AquaCap	2 lb ai/A	0.0b	0.0d	0.5c	0.7c	0.8c	0.5c
Untreated	-	0.7ab	1.0c	0.0c	0.0d	0.2c	0.3c

*Treatments were applied July 1, 2011.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 2. Quality ratings in fairway height 'Penncross' creeping bentgrass, 2011.

		Quality Ratings (0-10)					AUQC
Treatment*	Rate	8-Jul	15-Jul	22-Jul	29-Jul	12-Aug	(quality x time)
Freehand	100 lb/A	7.6b**	6.3b	5.2c	5.5b	6.2b	208b
Freehand	200 lb/A	7.8ab	5.9bc	4.0d	4.3b	5.0b	177b
Freehand	300 lb/A	7.7b	5.0c	3.0e	2.3c	3.2c	130c
Pendulum AquaCap	2 lb ai/A	8.3a	7.9a	8.2b	7.7a	8.2a	279a
Untreated	-	7.9ab	8.2a	8.6a	8.8a	8.5a	296a

*Treatments were applied July 1, 2011.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 3. Injury to fairway height 'Providence' creeping bentgrass, 2011.

		Injury Ratings (0-5)					
Treatment*	Rate	8-Jul	12-Jul	15-Jul	22-Jul	29-Jul	12-Aug
Freehand	100 lb/A	0.0c**	0.8c	1.0c	1.2b	1.5b	0.7c
Freehand	200 lb/A	1.0b	2.5b	2.7b	3.2a	3.4a	2.6b
Freehand	300 lb/A	2.2a	4.0a	4.0a	4.3a	4.3a	4.3a
Pendulum AquaCap	2 lb ai/A	0.3c	0.7c	0.7cd	0.7b	0.8bc	0.3c
Untreated	-	0.0c	0.0c	0.0d	0.0b	0.0c	0.0c

*Treatments were applied July 1, 2011.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Table 4. Quality ratings in fairway height 'Providence' creeping bentgrass, 2011.

		Quality Ratings (0-10)					AUQC
Treatment*	Rate	8-Jul	15-Jul	22-Jul	29-Jul	12-Aug	(quality x time)
Freehand	100 lb/A	9.0a**	8.1b	8.1b	7.4b	8.4a	282b
Freehand	200 lb/A	8.5b	6.3c	5.3c	4.7c	5.7b	200c
Freehand	300 lb/A	7.8c	5.0d	2.5d	2.2d	3.5c	127d
Pendulum AquaCap	2 lb ai/A	8.9a	8.5ab	8.5b	8.2ab	8.8a	298ab
Untreated	-	9.1a	9.7a	9.6a	9.4a	9.2a	329a

*Treatments were applied July 1, 2011.
**Means in a column followed by the same letter are not significantly different according to Fisher's LSD, P ≤0.05.

Summer Stress Protection In An A1/A4 Creeping Bentgrass Green With TurfScreen , Nano Argentum and Fore Rainshield

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Objective: The purpose of this study was to evaluate TurfScreen, a new product being marketed for summer stress management of golf greens. TurfScreen contains 30% titanium dioxide and 9% zinc oxide, which are the same ingredients found in suntan lotion. TurfScreen is said to provide turfgrasses protection from the harmful effects of UV radiation. Nano Argentum (silver in osmolized water) also is marketed as a material that reduces stress tolerance of golf greens and was applied here for comparative purposes. Since there was no response from the first application of Nano Argentum, the pigmented fungicide Fore Rainshield was applied to the untreated control plots to serve as a more appropriate comparison to the pigment in TurfScreen.

Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. All products were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Turf was a 50/50 blend of A1/A4 creeping bentgrass (*Agrostis stolonifera*) grown on a sand-based rootzone, and maintained as a putting green. The site was seeded in the autumn of 2010. The study site received 2.0 lb N/1000ft^2 in the fall of 2010; 1.0 lb of N/1000 ft2 in winter 2010-2011 and 3.5 lb N/1000ft^2 in the spring of 2011. The high nitrogen fertility was required to establish and provide for full bentgrass cover by summer 2011. Turf was mowed five times weekly to a height of 0.15" using a triplex mower and the study areas was syringed or otherwise irrigated to prevent wilt.

Plots were 5 ft x 10 ft and were arranged in a randomized complete block with four replications. Turf color and quality were assessed visually using a 0-10 scale where 0 = entire plot area brown or dead, 8.0 = acceptable quality for a green, and 10 = optimum green color and uniformity. On 10 August, canopy temperatures were measured a Raytek Raynger ST2 and soil temperatures were measured using a Delta-T Moisture Meter HH2. Data were subjected to ANOVA and significantly different means were separated using Fisher's LSD test at $P \leq 0.05$.

Results: Treatments were initially applied on 29 July and plots were first evaluated on 3 August. Both rates of TurfScreen provided improved color via a paint effect from pigments in the product (Table 1). Since there was no color response from Nano A. the untreated control was sprayed with the pigmented fungicide Fore Rainshield on 3 and 9 August to provide a standard of comparison for the paint effect provided by TurfScreen. On 11 August, bentgrass color in plots treated with Fore Rainshield was improved compared to Nano A, and was equivalent to TurfScreen. By 16 Aug, TurfScreen (both rates)-treated bentgrass had color superior to Nano A. and better than that provided by Fore R. Overall quality ratings reflect the pigment or paint affect of the products. On the final two rating dates, overall quality was equivalent among TurfScreen and Fore treatments. The improvement in quality versus color ratings in Fore-treated plots was due to less blue-green algae development in Fore-treated plots compared to TurfScreen. Canopy and soil temperature data collected 10 August revealed no differences among treatments. Shortly thereafter hurricane Irene arrived and brought cooler less stressful conditions to the area and the study was terminated due to lack of heat stress.

Table 1. Color and creeping bentgrass quality as influenced by TurfScreen, College Park, 2011.

Treatment	Rate (product/M)	Color ratings (0-10) 3-Aug	11-Aug	16-Aug	Quality ratings (0-10) 3-Aug	11-Aug	16-Aug	Soil temp (°F) 10-Aug	Canopy temp (°F) 10-Aug
*TurfScreen	2.0 oz	8.9a***	9.1a	9.3a	8.9a	9.3a	9.2a	87.8a	88.3a
*TurfScreen	3.6 oz	9.0a	9.0a	9.5a	9.0a	9.3a	9.5a	87.9a	88.5a
*Nano Argentum	0.032	7.9b	7.7b	7.8c	8.1b	8.1b	7.9b	87.6a	89.1a
**Untreated/Fore R.	0.0/4.0 oz	7.8b	8.6a	8.7b	8.1b	9.0a	9.1a	87.6a	89.1a

*Treatments were applied 29 July and 8 August 2011.

** Fore Rainshield (4.0 oz) was applied to untreated control plots on 3 and 9 August 2011.

***Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.