University of Maryland

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Weed Science and Management
Research Summaries

CONTRIBUTIONS TO THE UNIVERSITY OF MARYLAND TURFGRASS PATHOLOGY AND WEED SCIENCE RESEARCH PROGRAMS IN 2012

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Fungicides Can Mitigate Summer Stress and Mechanical Injury In Creeping Bentgrass Greens, 2012

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Introduction. Summer decline of putting green turf 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 Maryland 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. Conversely, in studies conducted in 2011, Insignia regardless of rate (0.4 vs. 0.7 oz) had no impact on mechanical injury in Penn A-1 + A-4 creeping bentgrass grown on a research green in College Park, MD.

Chipco Signature contains a green pigment called StressGard®, a confidential compound that is believed 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not exhibit improved photosynthesis or more efficient respiration; and canopy temperature was unaffected (Dernoeden, unpublished).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 mitigate 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 summer in the Mid-Atlantic region is challenging. Golf course superintendents keep soil moisture relatively low to provide for more firm and fast surfaces. Both low mowing and restricted irrigation 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. As previously noted some fungicides do mitigate environmental and mechanical stress injury. This study will constitutes a search for other fungicides that also improve summer stress tolerance in creeping bentgrass golf greens.

Chipco Signature and Fore Rainshield, particularly when tank-mixed, have been consistently shown to improve the summer performance and reduce mechanical injury of mature creeping bentgrass; these fungicides were included in this study and served as standards for comparison. Appear (potassium salts of phosphorous acid and pigment) may have similar effects on turf as Chipco Signature since both fungicides are pigmented phosponates. Daconil Action contains chlorothalonil and acibenzolar. Acibenzolar is a chemical that activates natural plant defense mechanisms. Preventive applications of acibenzolar are helpful in suppressing bacterial diseases in some vegetable crops and provide for improved dollar spot control with lower rates of the chlorothalonil component of Daconil Action. Conceivably, acidenzolar could impact the summer performance of creeping bentgrass by triggering natural defense mechanisms that may provide for improved stress tolerance. As previously noted, Insignia improved quality of stressed bentgrass in a 2008 study, but not in a 2011 study, and further investigation is thus warranted. Hence, the objective of this study was to evaluate the 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.

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. Turf was a mature blend of Penn A-1 + A-4 creeping bentgrass, which was established in October 2010. Turf initially was mown to a height of 0.150 inches five days weekly, but mowing height was reduced to 0.130 inches in early July. The site received approximately 3.0 lb N/1000ft^2 between autumn and spring and was not fertilized during the study period; however, 0.25 lb N 1000 ft^2 was applied toward the end of the study on July 26, 2012 to promote recovery. 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. Dollar spot was controlled with Curalan (vinclozolin)and brown patch was controlled with Endorse (polyoxin D) since they have no known plant growth regulator properties. Wetting agents (Revolution and Aqueduct) also were applied to manage localized dry spots in the study area.

In addition to high temperature stress (daily high temperatures ≥ 90F and average night temperatures ≥ 75F), other stresses were imposed to include double mowing at 0.130 inches during the heat of the day beginning 6 July 2012. On 10 July, the study area was brushed, vertical cut in two directions, topdressed and brushed again. This mechanical stress caused significant injury, which was monitored as described below.

Fungicide treatments were applied on a 14 day interval on 13 and 28 June and 12 July 2012 to coincide with an extremely high temperature stress period. 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). Plots were 5ft by 10ft and arranged in a RCB with three 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 visually 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. All data were subjected to ANOVA and significant differences were separated using Tukey's HSD at $P \leq 0.05$.

Results. Injury ratings commenced on 6 July, about one week after double mowing was initiated, but before the mechanical injury from brushing, vertical cutting and topdressing were imposed on 10 July. On 6 July, there were few injury rating differences among treatments, except that lower injury compared to the control was observed in Signature + Fore-treated plots. Color and quality ratings also were similar at this time, but by 12 July color and quality ratings were higher in plots treated with Signature and Fore alone or tank-mixed and Appear-treated plots. Plots were subjected to mechanical injury on 10 July and the third application of fungicides was made on 12 July. Injury was rated one week after imposing mechanical injury on 16 July and least injury was observed in plots treated with Signature + Fore. Plots treated with Signature, Fore and Appear alone had injury ratings lower than those observed in the control. The aforementioned treatments also improved color and quality compared to plots treated with Daconil Action, Insignia, Insignia + Daconil Action and the untreated control.

Due to there being only three replications and some variation (i.e., less injury) in one of the untreated control plots in the study area ,few statistical differences among treatments were observed. Thus, injury (≤ 2.5), color (≥ 7.0) and quality (≥ 7.0) thresholds will be discussed in more detail, but results obtained on 18 July generally remained the trend for the remainder of the study. On 23 July, injury was greater in plots treated with Daconil Action and Appear + Daconil Action compared to the control. Plots treated with Signature, Fore and Appear alone, and Signature + Fore had injury ratings below the threshold; whereas, plots treated with Daconil Action alone or mixed with Appear, Signature or Insignia exceeded the threshold on 23 July. Similar injury data were collected on 27 July, except that Insignia-treated plots had showed some recovery and were below the injury threshold. Color and quality on 27 July were above the threshold in most plots, including the control, with the exception of those treated with Daconil

Action alone or mixed with Appear, Signature and Insignia. All plots had equal injury, color and quality by 3 August. A blue-green algal bloom appeared following overcast and rainy weather on 23 July. All fungicide treatments except Insignia alone had controlled the algae.

Conclusion. Results of this study again confirm that Signature, Fore and especially Signature + Fore mitigate environmental and mechanical stress and improve turf color and quality in the summer. Results from 2011 and 2012 suggest that Insignia does not reduce injury due to mechanical stress, but turf did recover from mechanical injury a little more rapidly when compared to the control. Data from plots treated with Appear alone indicate that this material can improve color and quality in environmentally or mechanically stressed turf, but the "paint effect" may dissipate more rapidly compared to Signature + Fore. Data also suggest that Daconil Action whether applied alone or mixed with other fungicides has no apparent impact on improving environmental or mechanical stress and may slow turf recovery.

References:

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Table 1. Mechanical injury mitigation and percent plot area covered by blue-green algae as influenced by various fungicides applied to a Penn A-1 and A-4 creeping bentgrass research green, College Park MD, 2012.

	Rate	Injury**						% Algae
Treatment*	oz/1000 ft^2	6 July	16 July	18 July	23 July	27 July	3 August	23 July
Chipco Signature 80 WP	4 oz	1.33 bcd	2.17 c	1.67 bc	2.17 cd	2.33 ab	1.17 ab	1.3 b
Fore Rainshield 80 WP	6 oz	1.17 bcd	2.00 cd	1.57 bc	2.00 cd	2.00 ab	1.67 ab	2.0 b
Daconil Action 6.1 SC	3.5 fl oz	3.17 ab	4.17 a	3.67 a	4.17 a	3.50 a	2.27 ab	3.3 b
Appear 4.1 SC	6 fl oz	1.33 bcd	2.00 cd	1.33 bc	2.50 bcd	2.23 ab	1.77 ab	2.3 b
Daconil Action + Appear	3.5 oz + 6 fl oz	1.13 cd	2.50 bc	2.83 ab	4.17 a	3.17 a	2.77 ab	0.3 b
Insignia 2.1 SC	0.4 oz	3.50 a	3.67 ab	2.67 ab	2.00 cd	2.00 ab	1.83 ab	35.0 a
Signature + Fore	4 + 4 oz	0.83 d	0.67 d	0.83 c	1.17 d	1.17 b	0.67 b	0.3 b
Signature + Daconil Action	4 oz + 3.5 fl oz	2.00 a-d	3.37 abc	3.00 ab	3.00 abc	2.83 ab	3.00 a	0.3 b
Insignia + Daconil Action	0.4 oz + 3.5 fl oz	2.67 a-d	4.33 a	3.83 a	3.67 ab	3.00 a	2.67 ab	2.3 b
Untreated		3.10 abc	3.60 ab	2.93 ab	2.50 bcd	2.50 ab	2.17 ab	25.0 a
Treatment Prob(F)		0.0004	0.0001	0.0001	0.0001	0.0091	0.0275	0.0001

* Treatments were applied on 13 and 28 June and 12 July 2012.

** Injury was rated on a 0 to 5 scale where) = green and healthy turf; 2.5 = objectionable injury and 5 = entire plot area brown or dead.

*** Means followed by same letter are not significantly different (*P*=0.05, Tukey's HSD).

Table 2. Penn A-1 and A-4 creeping bentgrass color as influenced by various fungicides and mechanical injury, College Park MD, 2012.

Treatment*	Rate oz/1000 ft^2	Color ** 6 July	12 July	16 July	18 July	27 July	3 August
Chipco Signature 80 WP	4 oz	8.50 a	7.83 a	7.10 a-d	7.27 ab	7.27 ab	7.37 a
Fore Rainshield 80 WP	6 oz	8.50 a	7.97 a	7.43 ab	7.60 ab	7.67 a	7.50 a
Daconil Action 6.1 SC	3.5 fl oz	8.10 a	5.67 c	4.17 e	5.33 c	5.67 c	7.33 a
Appear 4.1 SC	6 fl oz	8.50 a	8.27 a	7.83 a	7.77 a	6.83 abc	7.43 a
Daconil Action + Appear	3.5 oz + 6 fl oz	8.60 a	7.67 ab	7.33 abc	7.53 ab	5.60 c	7.17 a
Insignia 2.1 SC	0.4 oz	8.03 a	5.67 c	5.33 de	6.43 abc	7.70 a	7.70 a
Signature + Fore	4 + 4 oz	8.93 a	7.93 a	7.87 a	7.53 ab	7.63 a	7.60 a
Signature + Daconil Action	4 oz + 3.5 fl oz	8.60 a	7.30 abc	5.83 b-e	6.17 bc	6.00 bc	7.27 a
Insignia + Daconil Action	0.4 oz + 3.5 fl oz	8.10 a	5.83 c	4.17 e	5.00 c	5.83 c	7.60 a
Untreated		8.33 a	6.17 bc	5.50 cde	6.33 abc	7.70 a	7.60 a
Treatment Prob(F)		0.1007	0.0001	0.0001	0.0001	0.0001	0.2559

* Treatments were applied on 13 and 28 June and 12 July 2012.

** Turfgrass color was rated on 0 – 10 visual scale were 10 = optimum green color.

*** Means followed by same letter are not significantly differerent (*P*=0.05, Tukey's HSD).

Table 3. Penn A-1 and A-4 creeping bentgrass quality as influenced by various fungicides and mechanical injury, College Park MD, 2012.

	Rate	Quality**					
Treatment*	oz/1000 ft^2	6 July	12 July	16 July	18 July	27 July	3 August
Chipco Signature 80 WP	4 oz	8.83 a	7.43 ab	6.77 abc	7.10 ab	7.00 abc	7.60 a
Fore Rainshield 80 WP	6 oz	8.83 a	7.90 a	7.43 ab	7.53 a	7.43 ab	7.20 a
Daconil Action 6.1 SC	3.5 fl oz	8.60 a	6.10 c	4.50 de	5.33 bc	5.50 d	6.87 a
Appear 4.1 SC	6 fl oz	8.83 a	8.03 a	7.33 ab	7.77 a	6.93 abc	7.33 a
Daconil Action + Appear	3.5 oz + 6 fl oz	9.17 a	7.60 a	6.93 abc	6.77 abc	5.67 cd	6.37 a
Insignia 2.1 SC	0.4 oz	8.67 a	6.17 bc	5.33 cde	6.33 abc	7.27 ab	7.03 a
Signature + Fore	4 + 4 oz	9.27 a	8.53 a	8.27 a	7.70 a	7.87 a	8.03 a
Signature + Daconil Action	4 oz + 3.5 fl oz	9.00 a	7.43 ab	6.00 bcd	6.17 abc	6.10 bcd	6.27 a
Insignia + Daconil Action	0.4 oz + 3.5 fl oz	8.50 a	6.17 bc	4.00 e	5.00 c	5.33 d	6.33 a
Untreated		8.83 a	6.17 bc	5.17 cde	6.10 abc	7.27 ab	6.80 a
Treatment Prob(F)		0.1232	0.0001	0.0001	0.0005	0.0001	0.0466

* Treatments were applied on 13 and 28 June and 12 July 2012.

** Turfgrass quality was rated on 0 - 10 visual scale were 10 = optimum green color and density.

*** Means followed by same letter are not significantly different (*P*=0.05, Tukey's HSD).

Dollar Spot Control With Fungicides In Fairway Height 'Crenshaw' Creeping Bentgrass, 2012

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Procedure. Dollar spot (*Sclerotinia homoeocarpa*) is among the most common diseases of turf. Indeed, it is estimated that more money is spent managing dollar spot than any other turf disease. The disease is invariably managed with fungicides. New fungicide formulations and chemistries are continuously being developed and evaluated. The objective of this study is to compare the ability of several products to control dollar spot.

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 or 21 day interval between April 27 and June 8, 2012 as footnoted in the data table. 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 2011 and 1.0 lb N/ 1000ft^2 in the spring of 2012. 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 and eventually brown patch (*Rhizoctonia solani)* developed naturally and uniformly. Dollar spot and brown patch were evaluated visually using a linear scale of 0 to 100% where 0 = entire plot area disease-free and 100 = entire plot area blighted. Treatments with ratings exceeding 0.5 and 5.0% plot area blighted by *Sclerotinia homoeocarpa* and *Rhizoctonia solani*, respectively were subjectively considered to be unacceptable or at the threshold for re-treatment of a golf course fairway. Data were subjected to ANOVA and significantly different means were separated using Tukey's HSD at $P \leq 0.05$.

Results. Dollar spot appeared in mid-April and Daconil Ultrex (1.8 oz/1000 ft^2) was applied to stop the epidemic. Fungicide treatments were initiated on 27 April at which time there was no active dollar spot in the study site and thus treatments were applied preventively. Dollar spot did not reactivate until late May, after two-thirds of the application of fungicides had been made. Note that the 21-day Encartis treatment was corrupted by a misapplication on 25 May with a mix of Contend + Daconil Action.

From 25 May until 19 June (i.e., 11 days following the last application of fungicides) all treatments had provided complete disease control. The sharp drop in blight observed on 8 June was due to low night temperatures (< 50F). One week later (i.e., June 15), dollar spot pressure reached a severe level. Dollar spot did not develop in any of the fungicide-treated plots until 22 June. At this time (i.e., 14 days since all treatments were last applied), plots treated with

Iprodione Pro, Curalan (both timings), Daconil Action, Velista (0.3 oz), and Contend exceeded the threshold (i.e., > 0.5% dollar spot). Three days later (i.e., 25 June), plots treated with Interface (iprodione + triflozystrobin; 3.0 fl oz) had exceeded the threshold. Dollar spot pressure again dissipated by 29 June and turf was recovering. Except for plots treated with Iprodione Pro, Curalan, Velista (0.3 oz), Daconil Action (chlorothalonil + acibendolar) and Contend (cyproconazole), other fungicide-treated plots again had dollar spot levels below the threshold on 29 June. Dollar spot resurged on 3 July and then declined on 6 July. Creeping bentgrass recovery again was observed in all fungicide-treated plots. On the final rating date (i.e., 13 July or 35 days since all treatments were last applied) only plots treated with Encartis (chlorothalonil + Emerald), Honor (Insignia + Emerald) and Emerald had not exceeded the threshold. Secure (fluazinam)-treated plots maintained effectiveness as late as 6 July.

Brown patch was assessed on 10 and 13 July. While brown patch levels were low in untreated plots on 10 July, relatively higher levels of disease were observed in plots treated with Curalan. Brown patch became moderately severe by 13 July and only plots treated with Honor, Velista (all three treatments) were disease-free. Brown patch levels below the threshold were observed in plots treated with Interface (Chipco 26GT + Compass), Emerald, Daconil Action, Contend (cyproconazole) and Contend tank-mixed with Daconil Action.

Table 1. Dollar spot control in fairway height “Crenshaw’ creeping bentgrass, College Park, MD, 2012.

	Rate oz/1000 ft^2	Spray Interval (days)*	% blighting by *S. homoeocarpa* 25 May	31 May	8 Jun	15 Jun	19 Jun
Interface 24.5 SC*	3.0 fl.	14	0 b**	0 b	0 b	0 b	0 b
Interface 24.5 SC*	4.0 fl.	14	0 b	0 b	0 b	0 b	0 b
Honor 28 WG*	0.83 oz.	14	0 b	0 b	0 b	0 b	0 b
Iprodione Pro 2 SE	4.0 fl.	14	0 b	0 b	0 b	0 b	0 b
Encartis 749 SC	4.0 fl.	14	0 b	0 b	0 b	0 b	0 b
Encartis 749 SC+	4.0 fl.	21	0 b	0 b	0 b	0 b	0 b
Curalan 50 WG	1.0 oz.	14	0 b	0 b	0 b	0 b	0 b
Curalan 50 WG	1.0 oz.	21	0 b	0 b	0 b	0 b	0 b
Velista 50 WDG	0.3 oz.	14	0 b	0 b	0 b	0 b	0 b
Velista 50 WDG	0.5 oz.	14	0 b	0 b	0 b	0 b	0 b
Velista + Curalan	0.3 + 1.0 oz.	14	0 b	0 b	0 b	0 b	0 b
Emerald	0.13 oz.	14	0 b	0 b	0 b	0 b	0 b
Daconil Action 6.1 SC	2.0 fl oz.	14	0 b	0 b	0 b	0 b	0 b
Secure 4.2 SC	0.5 fl oz.	14	0 b	0 b	0 b	0 b	0 b
Contend 0.83 SL	0.96 fl oz.	21	0 b	0 b	0 b	0 b	0 b
Contend + Dac. Action	0.6 + 1.6 fl oz.	14	0 b	0 b	0 b	0 b	0 b
Untreated	—	—	10 a	22 a	6 a	32 a	40 a

*14 day treatments were applied: 27 April + 11 May + 25 May + 8 June
21 day treatments were applied: 27 April + 18 May + 8 June

**Means separated by Tukey’s HSD, P = 0.05.

***Dollar spot decline due to night temperature in mid-50’s F.

+ Encartis 21-day plots accidentally treated with Contend + Daconil Action on 25 May.

Table 1 continued. Dollar spot control in fairway height "Crenshaw' creeping bentgrass, College Park, MD, 2012.

	Rate oz/1000 ft^2	Spray Interval (days)*	% blighting by *S. homoeocarpa*				
			22 June	25 June	29 June	3 July	6 July
Interface 24.5 SC*	3.0 fl.	14	0.4 b**	0.7 b	0.1 b	2.9 cd	0.3 bc
Interface 24.5 SC*	4.0 fl.	14	0.0 b	0.2 b	0.1 b	1.2 d	0.2 c
Honor 28 WG*	0.83 oz.	14	0.0 b	0.0 b	0.0 b	0.0 d	0.0 c
Iprodione Pro 2 SE	4.0 fl.	14	1.4 b	6.0 b	2.8 b	14.0 bc	3.5 bc
Encartis 749 SC	4.0 fl.	14	0.0 b	0.0 b	0.0 b	0.0 d	0.0 c
Encartis 749 SC[+]	4.0 fl.	21	0.1 b	0.0 b	0.0 b	0.0 d	0.0 c
Curalan 50 WG	1.0 oz.	14	0.6 b	7.2 b	0.9 b	10.5 bcd	5.0 bc
Curalan 50 WG	1.0 oz.	21	0.5 b	2.4 b	0.7 b	13.8 bc	6.4 bc
Velista 50 WDG	0.3 oz.	14	2.6 b	5.5 b	1.8 b	13.8 bc	8.5 bc
Velista 50 WDG	0.5 oz.	14	0.4 b	0.4 b	0.2 b	5.0 bcd	2.6 bc
Velista + Curalan	0.3 + 1.0 oz.	14	0.0 b	0.1 b	0.0 b	1.1 d	0.6 bc
Emerald	0.13 oz.	14	0.0 b	0.0 b	0.0 b	0.0 d	0.0 c
Daconil Action 6.1 SC	2.0 fl oz.	14	3.6 b	7.2 b	4.7 b	17.2 b	11.2 b
Secure 4.2 SC	0.5 fl oz.	14	0.1 b	0.0 b	0.0 b	0.4 d	0.1 c
Contend 0.83 SL	0.96 fl oz.	21	0.7 b	4.9 b	1.9 b	8.8 bcd	4.6 bc
Contend + Dac. Action	0.6 + 1.6 fl oz.	14	0.2 b	0.4 b	0.1 b	2.6 cd	1.0 bc
Untreated	—	—	45.5 a	65.8 a	62.8 a	66.5 a	45.8 a

*14 day treatments were applied: 27 April + 11 May + 25 May + 8 June.
21 day treatments were applied: 27 April + 18 May + 8 June.
**Means separated by Tukey's HSD, P = 0.05.
[+] Encartis 21-day plots were accidentally treated with Contend + Daconil Action on 25 May.

Table 1 continued. Dollar spot and brown patch control in fairway height "Crenshaw' creeping bentgrass, College Park, MD, 2012.

	Rate oz/1000 ft^2	Spray Interval (days)*	% *S. homoeocarpa* 13 July	% *R. solani* 10 July	% *R. solani* 13 July
Interface 24.5 SC*	3.0 fl.	14	12.8 bc**	0.0 b	1.3 b
Interface 24.5 SC*	4.0 fl.	14	4.0 bc	0.5 b	1.8 b
Honor 28 WG*	0.83 oz.	14	0.0 c	0.0 b	0.0 b
Iprodione Pro 2 SE	4.0 fl.	14	21.5 b	3.3 ab	15.8 ab
Encartis 749 SC	4.0 fl.	14	0.2 bc	3.5 ab	14.0 ab
Encartis 749 SC[+]	4.0 fl.	21	0.4 c	4.0 ab	5.5 ab
Curalan 50 WG	1.0 oz.	14	18.2 bc	11.3 ab	21.5 a
Curalan 50 WG	1.0 oz.	21	22.0 b	18.3 a	28.5 a
Velista 50 WDG	0.3 oz.	14	22.5 b	0.0 b	0.0 b
Velista 50 WDG	0.5 oz.	14	18.5 bc	0.0 b	0.0 b
Velista + Curalan	0.3 + 1.0 oz.	14	15.2 bc	0.0 b	0.0 b
Emerald	0.13 oz.	14	0.2 c	0.0 b	3.3 b
Daconil Action 6.1 SC	2.0 fl oz.	14	22.2 b	0.0 b	4.0 b
Secure 4.2 SC	0.5 fl oz.	14	7.2 bc	0.0 b	8.0 ab
Contend 0.83 SL	0.96 fl oz.	21	14.5 bc	0.0 b	0.8 b
Contend + Dac. Action	0.6 + 1.6 fl oz.	14	6.5 bc	1.0 b	0.3 b
Untreated	—	—	51.0 a	1.8 b	11.3 ab

*14 day treatments were applied: 27 April + 11 May + 25 May + 8 June.
21 day treatments were applied: 27 April + 18 May + 8 June.

**Means separated by Tukey's HSD, $P = 0.05$.

[+] Encartis 21-day plots were accidentally treated with Contend + Daconil Action on 25 May.

Brown Patch Control In Colonial Bentgrass With Commercial Fungicides, 2012

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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. This field study was conducted in 2012 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 established in autumn 2010. The study area was fertilized with 2.0 lb N/1000ft^2 in the autumn of 2011 and another 1.0 lb N/1000ft^2 in the spring of 2012. Turf was mowed three times weekly to a height of 0.50 inches 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-treatment of a golf course fairway. Data were subjected to ANOVA and significantly different means were separated using Tukey's HSD at $P \leq 0.05$.

Results. Brown patch became active in early June and the study site was treated with a low rate of Daconil Ultrex (1.8 oz/1000 ft^2) to stop the epidemic. Treatments were initiated one week later on 8 June in disease-free turf; hence, treatments were applied preventively. Symptoms of a new brown patch epidemic, however, did not appear until early July. Brown patch pressure was low in early July and moderately severe after mid-July. Disease pressure became severe by 27 July (i.e., 21 and 28 days since 14-d and 21-d treatments were last applied, respectively). Between 10 and 30 July little of no brown patch was observed in any of the fungicide-treated plots. Encartis (boscalid and chlorothalonil) and Secure (fluazinam) residual effectiveness began to deteriorate on 27 and 30 July, respectively. On the final rating date (3 August), plots treated with Velsita, Contend and Tourney were nearly disease-free and thus below the threshold. In conclusion all fungicides performed extremely well given that over 28 days had elapsed before any brown patch appeared in any of the fungicide-treated plots. Velista, Contend and Tourney had longest residual effectriveness.

Table 1. Brown patch control in colonial bentgrass, College Park MD, 2012.

Fungicide	Rate oz/1000 ft^2	Spray Interval (days)	% Brown patch 10 Jul	13 Jul	16 Jul	20 Jul	23 Jul	27 Jul	30 Jul	3 Aug
Velista 50 WDG	0.5	14*	0 a***	0 a	0 a	0 a	0.0 a	0 b	0 b	0 c
Secure 4.25 SC	0.5	14	0 a	0 a	0 a	0 a	0.2 a	<1 b	2 b	9 bc
Dac. Action 6SC	3.5	14	0 a	0 a	0 a	0 a	0.0 a	0 b	0 b	8 bc
Contend 0.83 SL	0.96	21**	0 a	0 a	0 a	0 a	0.0 a	0 b	0 b	<1 bc
Tourney 50 DG	0.28	14	0 a	0 a	0 a	0 a	0.0 a	0 b	0 b	0 c
Encartis 749 SC	3.0	21	0 a	0 a	0 a	0 a	0.2 a	1b	2 b	18 b
Untreated	—	—	4 b	7 b	14 b	19 b	26 b	41a	36 a	49 a
Treatment Prob(F)			0.0015	0.0039	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Secure = fluazinam

Contend = cyproconazole

Daconil Action= Actigard + chlorothalonil

*Treatments on 14-d interval were applied 8 and 22 June and 6 July, 2012.

**Treatments on 21-d interval were applied 8 and 29 June, 2012.

*** Means followed by same letter are not significantly different (P=.05, Tukey's HSD)

Brown Patch Control In Tall Fescue Seedlings With Granular Fungicides, 2012

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Objective: Establishing tall fescue from seed in summer is difficult due to environmental stresses, weeds and diseases. In particular, brown patch (*Rhizoctonia solani*) can be very destructive to tall fescue seedlings. Lawn care organizations prefer to utilize granular products since public perception is that sprayable pesticides are harmful to the environment. Therefore, the objective of this study was to determine if fungicides formulated on granules could control brown patch in a seedbed and thus promote tall fescue establishment.

Procedure: The study site was treated with Round-up in May and disk-seeded with 'Bullseye'tall fescue at 6 lb seed per 1000 ft^2 on 2 June 2012. The site was treated with Tenacity (5.0 fl oz prod/A) twice on a 14 day interval to control weeds. Yellow foxtail was later controlled in the study site with Acclaim Extra. The fungicides evaluated were Pillar (Insignia + Trinity); Headway (Heritage + Banner MAXX); Infuse (thiophanate-methyl) and Fung-Away (Eagle). Plots were 5 ft by 10 ft and arranged in a randomized complete block with four replications. Soil was a Keyport silt loam. Fungicides were applied by shaker jar on 19 June and 16 July 2012. The site was lightly irrigated 24 hrs after each application. Plots were evaluated visually for blighting using a 0 to 100% scale where 0=no disease and 100=entire plot area blighted. Overall quality was evaluated visually using a 0 to 10 scale where 0=entire plot area brown or dead; 7.0 = minimum acceptable quality and 10= optimum green color and density. Data were subjected to ANOVA and significantly different means were separated using Tukey's HSD at $P = 0.05$.

Results: Brown patch was slow to develop and first became evident on 12 July. Between 12 and 27 July disease pressure was low, but became moderately severe in early August. No differences in blighting were observed among treatments on 12 and 18 July. On 20 July (i.e., 4 days since materials were last applied) all fungicides reduced brown patch compared to the control except Fung-Away. Pillar and Headway were the only fungicides to reduce brown patch compared to the control on 27 July and only Headway reduced the disease on 3 August (i.e., 18 days since last applied). On 3 August, turf quality only was improved by Pillar and Headway and ratings were above the acceptable threshold (> 7.0). The following three weeks were marked by frequent thunderstorm actively and brown patch became severe causing a melting-out symptomatology rather than discrete patches. Disease therefore was assessed by estimating the percentage of plot area covered with living tall fescue plants on 23 August; quality also was assessed at this time. Only Pillar and Headway were associated with superior cover and quality compared the control on the final rating date.

Table 1. Percent plot area blighted by *Rhizoctonia solani* and overall quality as impacted by granular fungicides, College Park MD, 2012.

	Rate	% plot area blighted by *R. solani*					Overall quality		% tall fescue cover
Treatment*	Prod./1000 ft^2	12 July	18 July	20 July	27 July	3 August	3 Aug	23 Aug	23 Aug
Pillar G	3 lb	0.0 a **	0.0 a	0.63 b	1.3 b	6.8 ab	7.78 ab	7.15 ab	92.3 ab
Headway G	4 lb	0.0 a	0.0 a	0.00 b	0.0 b	0.3 b	8.83 a	8.58 a	98.0 a
Infuse	3 lb	1.8 a	1.5 a	1.63 b	3.8 ab	10.3 ab	6.45 bc	4.25 c	62.5 bc
Fung-Away	6 lb	1.0 a	3.5 a	3.25 ab	5.3 ab	10.0 ab	6.75 bc	5.00 bc	71.3 abc
Untreated		1.8 a	4.5 a	6.50 a	9.0 a	16.0 a	5.75 c	3.50 c	53.8 c
Treatment Prob(F)		0.1326	0.0476	0.0077	0.0019	0.0061	0.0016	0.0003	0.0023

* Treatments were applied on 19 June and 16 July 2012.
** Means followed by the same letter are not significantly different (P=.05, Tukey's HSD).
*** Percent plot area blighted by brown patch was rated on a 0 to 100 percent scale where 0= no disease and 100= entire plot area blighted.

Annual Bluegrass Control In A 'Providence' Creeping Bentgrass Green With Methiozolin (PoaCure®), 2011-2012

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Objective. Two recently developed herbicides (i.e., methiozolin 250EC = PoaCure®) and amicarbazone 70WDG = Exonerate®) were evaluated for their ability to control of annual bluegrass (*Poa annua*) postemergence in golf green height creeping bentgrass (*Agrostis stolonifera*). Selected treatments were applied to the same plots in 2011 and 2012.

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 0.150 inches using a triplex mower.

Two application timings were assessed. The 11 April 2011 and 21 March 2012 applications were timed to coincide with full (i.e., 100%) spring 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. The second application timing (i.e., + 3 weeks of green-up) was initiated on 2 May 2011 and 11 April 2012 or three weeks after full green-up with a second application following in three weeks. 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 in 2011. In 2012, the first application rate of amicarbazone was 0.09 lb ai/A and the sequential was 0.045 lb ai/A (see Table 5).

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 = minimum 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.

2011 Results. Annual bluegrass injury ratings were obtained in 2011 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 amicarbazone 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 23 May in the first timing (i.e.,11 April start date) (i.e., 42 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 23 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.

2012 Results: The herbicides again were applied in two timings as previously described. The same herbicides were applied to the same plots treated in 2011. The second amicarbazone treatment (i.e., three weeks after green-up) was reduced to 0.045 lb ai/A since past experience indicated that later applications when air temperatures are rising can increase phytotoxicity potential with this herbicide.

Spring of 2012 was unseasonably warm and thus green-up was unusually early. The "green-up" treatments were initiated on 21 March 2012. Unlike 2011, injury to annual bluegrass was not assessed. However, there was injury to creeping bentgrass, which was assessed in terms of color and quality ratings. Amicarbazone-treated plots were injured for about one week, but data were not obtained at that time. Unlike 2011, methiozolin (except 0.45 lb ai/A rate in the "green-up" timing) did injure the creeping bentgrass for one week in early May, which was elicited by the 11 April application. Injury was mostly in the form of a bluish-purple and reddish-brown discoloration and a less dense appearance in the creeping bentgrass. This injury dissipated in 7 days and turf had completely recovered in about 12 days. Injury did persist in the form of a reduction in quality in plots treated with methiozolin at the high rate in the "+ 3weeks full green" timing. Injury did not recur among other methiozolin treatments following subsequent applications of the herbicide. Regardless of methiozolin treatment or rating date, color and quality of the creeping bentgrass remained well above the threshold (i.e., > 7.0) on all rating dates.

The annual bluegrass cover data collected 23 March reflected changes in weed cover during the autumn and winter of 2011. Data showed that annual bluegrass populations recovered in the 2011 study area with no differences in weed cover observed among treatments (Table 5). There was, however, a trend for lower annual bluegrass cover ratings in plots treated in 2011 with the high rate of methiozolin. It is likely that the re-infestation of annual bluegrass was due to coring in October 2011 and the mild winter, which would have promoted an extended period of annual bluegrass germination.

The first control rating involving herbicide activity from 2012 treatments was obtained on 4 May (i.e., 33 days after the last application of "green-up" treatments and 22 days since application of the first "+ 3 week after green-up"). All treatments had provided for lower annual bluegrass cover ratings compared to the control on 4 May. Lowest cover ratings were observed in plots treated with methiozolin at 0.90 lb ai/A in the "green-up" timing. Similar ratings were obtained on 16 May, but here was enough annual bluegrass recovery in amicarbazone-treated plots that cover data were now similar to the untreated control. On the final rating date, lowest annual bluegrass cover was observed in plots treated with the high rate of methiozolin, regardless of application timing. The low rate of methiozolin also reduced annual bluegrass cover compared to the control, but control was less in the "+ 3 week" versus the "green-up" timing.

2011 Summary. While amicarbazone caused substantial injury to annual bluegrass, and annual bluegrass did not succumb. Amicarbazone, at the rates and timings evaluated, were extremely phytotoxic to creeping bentgrass. It should be noted, however, that June 2011 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 but temporarily reduce quality. Methiozolin 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 bare spots in methiozolin-treated plots at any time. The 74% control of annual bluegrass provided 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.

2012 Summary. Amicarbazone caused only short-lived discoloration rather than the severe phytotoxicity observed with higher rates in 2011. Less phytotoxicity was attributed to using a lower amicarbazone rate and as in the past little or no reduction in annual bluegrass was observed. Unlike 2011, methiozolin did cause discoloration and thinning (i.e., reduction in verdure) in creeping bentgrass, particularly in plots treated with the high rate and in the second "+ 3 week" timing. Discoloration (i.e., purplish-reddish-brown foliage and a more open turf) dissipated within a week and creeping bentgrass cover and quality data were equivalent the control within 7 to 14 days. The high rate of methiozolin in both timings was highly effective (about 95% of the untreated control) in controlling annual bluegrass. As was observed in 2011, death of the annual bluegrass was slow and the creeping bentgrass filled the thinning and dying annual bluegrass areas and no dead spots were evident at any time.

2011-2012 Summary and Conclusions. Amicarbazone and methiozolin were applied to the same plots in 2011 and 2012. Amicarbazone rate was reduced in 2012 due to phytotoxicity problems experienced in 2011. Given the rates and timings assessed, data indicated that amicarbazone had no significant effect in reducing annual bluegrass populations and was potentially phytotoxic to creeping bentgrass.

Methiozolin applied at 0.90 lb ai/A in the "green-up" timing was the most effective treatment in 2011, providing about 74% annual bluegrass control. Due to coring in October and a mild winter annual bluegrass re-colonized the study area, but there was a trend for less annual bluegrass in spring 2012 in methiozolin plots treated with the high rate in 2011. The high rate of methiozolin in both timings provided about 95% annual bluegrass control by 1 June 2012. Methiozolin discolored and reduced verdure for a 7 to 14 day period, especially the high rate applied in the "+ 3 week" timing. It took about 21 days following the second application to observe substantial losses of annual bluegrass. The rate of annual bluegrass death was slow, allowing creeping bentgrass to infest dying annual bluegrass areas thus resulting in no dead spots in the study area in either year. It should be noted that most of the annual bluegrass in the study site developed in small spots about 1.0 to 2.0 inches in diameter. Caution should be used with methiozolin where annual bluegrass dominates, which may result in large voids in the absence of sufficient creeping bentgrass populations to spread into dying turf areas.

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

Treatment	Rate (lb ai/A)	*Poa annua* injury (0-5)					
		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, $P \leq 0.05$.

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.

Treatment*	Rate (lb ai/A)	Overall quality (0-10)					
		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.

Table 5. Postemergence annual bluegrass (*Poa annua*) control with methiozolin in a creeping bentgrass green, College Park, MD 2011 – 2012.

	Rate	% *P. annua* cover				Bentgrass Color			Bentgrass Quality			
	lb ai/A	23-Mar***	4-May	16-May	1-June	4-May	11-May	16-May	4-May	11-May	16-May	1-June****
*Methiozolin	0.45	8.5a+	3.4cd	5.9bc	8.3cd	8.1b	8.5bc	9.4ab	8.2b	8.6b	9.1b	8.2bc
*Methiozolin	0.90	6.1a	0.3d	0.6c	1.0d	7.6c	8.6bc	9.5c	7.5c	8.4bc	9.1b	9.1a
Amicarbazone	0.09 + 0.045	14.3a	8.3bc	15.0ab	20.5ab	8.8a	9.0a	9.5a	8.8a	8.9a	9.5a	7.5c
**Methiozolin	0.45	11.0a	12.3b	12.0b	12.5bc	7.7c	8.4c	9.3ab	7.9bc	8.4bc	9.1b	8.3b
**Methiozolin	0.90	9.5a	2.8cd	2.4c	1.5d	7.5c	8.1d	9.0b	7.6c	8.2c	8.8c	8.8ab
Untreated	—	12.1a	19.8a	23.3a	26.5a	8.3b	8.6b	9.4ab	8.3b	8.5b	9.3ab	7.5c

*Green-up applied: 11 Apr. + 2 May 2011; 21 Mar. + 11 Apr. 2012.
**+ 3 wks full green applied: 2 May + 23 May 2011; 11 Apr. + 4 May 2012.
***Rating at time study was initiated in 2012 and reflects re-invasion of annual bluegrass in all plots treated with the same herbicides in 2011.
****Rating considers the presence of annual bluegrass as a negative factor.
+ Means in a column followed by the same letter are not significantly different according to Fisher's LSD, $P \leq 0.05$.

Pre-Postemergence Annual Bluegrass Control On A Creeping Bentgrass Research Green, 2011-2012

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Objective and Procedure: Annual bluegrass (*Poa annua*) is the most important weed in creeping bentgrass (*Agrostis stoloniferia*) . Bensulide (Bensumec) is the industry standard for controlling annual bluegrass preemergence. Paclobutrazol (Trimmit) is used to promote creeping bentgrass competitiveness with annual bluegrass and thereby reducing its invasiveness. Research conducted at the University of Maryland in 2010 suggested that Trimmit has preemergence activity on annual bluegrass or in some way limits its ability to colonize turf in the winter (Dernoeden, 2011). Methiozolin (PoaCure) is a promising postemergence herbicide for use on creeping bentgrass golf greens, but has had limited testing of its potential preemergence activity. This study was designed to quantify the preemergence capability of Trimmit and PoaCure in the winter and their subsequent postemergence activity in the spring. Bensumec was applied as the standard for comparison.

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%. During the growing season, turf was mowed five times weekly to a height of 0.150 inches using a triplex mower.

The study site had a low to moderate population of annual bluegrass, which was primarily growing in coring holes and most infested areas grew in spots 1 to 2 inches in diameter. All treatments were initially applied on 2 September 2011. Trimmit was applied weekly throughout September and October (i.e., 8 applications) and weekly from 21 March to 28 June 2012 (i.e., 15 applications). In spring, Bensumec was applied again on 21 March and PoaCure was applied on 21 March and 11 April 2012. Hence, the September treatments were targeted for preemergence annual bluegrass control; whereas, spring applications of Trimmit and PoaCure were for postemergence control. Bensumec also was applied on 21 March 2012 to mimic a preemergence crabgrass control program, while also attempting to determine if an autumn plus spring application of all materials would impact the summer stress tolerance of the creeping bentgrass.

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). 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. Bentgrass color and quality as well as overall quality was visually assessed on a 0 to 10 scale where 0 = entire plot area brown or dead; 7.0 = minimum acceptable color and quality for a golf green and 10 = optimum green color and uniformity. Wilt injury to creeping bentgrass was assessed visually on a 0 to 5 scale where 0 = entire plot area green and healthy; 2.5 = prominent wilting (i.e., purpling or footprinting) and 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: As previously noted, annual bluegrass primarily colonized small, discrete spots 1 to 2 inches in diameter. Treatments were first applied on 2 September 2011, but initial annual bluegrass levels were not recorded. Annual bluegrass cover rating obtained 23 March 2012 constituted the preemergence effects of the materials. Trimmit had been more effective (3.5 % cover = 69% control) than Bensumec (6.5 % cover = 49% control). The level of control provided by PoaCure (5.8% cover = 49%control) was statistically equivalent to both Trimmit and Bensumec.

Annual bluegrass cover ratings obtained between 7 May and 1 June 2012 reflect primarily the postemergence activity of Trimmit and PoaCure. Both Trimmit and PoaCure provided equivalent postemergence annual bluegrass control. The average reduction in annual bluegrass was 97% for PoaCure and 88% for Trimmit on 16 May, but by 1 June both treatments were equal at about 94% control. As of 1 June, data showed that Bensumec had limited annual bluegrass cover by 60% of the control, which was inferior to either Trimmit or PoaCure.

Bentgrass color and quality and overall quality data revealed few differences among treatments. Trimmit most affected turf by causing objectionable discoloration from time to time, which usually coincided with a frost. Observations on color and quality influences of Trimmit are discussed below. One of the objectives of this study was to determine if any of the chemicals impacted summer stress tolerance of the bentgrass. Wilt was the most common observable stress and was evaluated on 29 June and 16 July. On both dates, wilt stress was greater in Bensumec-treated plots compared to the control. PoaCure-treated turf exhibited wilt stress levels equivalent to both the untreated control and Bensumec –treated plots, but Trimmit-treated plots were least affected by wilt stress.

The mechanism by which multiple Trimmit applications provided an annual bluegrass control level equivalent to the herbicide PoaCure was not determined. It is likely that annual bluegrass seedlings absorbing the growth regulator were not capable of proper development and despite a warm winter they were unable to survive. At Woodhome C.C. in Baltimore, a more aggressive use of Trimmit during the 2011 to 2012 winter was highly effective in excluding annual bluegrass on all 18 golf greens. However, the superintendent (Stephen Potter, CGCS) observed that the creeping bentgrass developed more grain and a leafy texture (i.e., wider leaves). The combination of grain and leafy texture resulted in reduced surface smoothness and green speed for several weeks in the spring. This problem was not observed in the current study presumably due in part to the fact that Trimmit was not applied between 24 October 2011 and 21 March 2012. Throughout winter, Trimmit-treated plots were darker green than all other plots. However, Trimmit applications in the spring elicited a purple or red-purple color that was highly objectionable for numerous weeks. These adverse color responses are well known to occur in the spring and autumn when applications coincide with frosts or when there are warm days followed by periods marked by very low night temperatures and/or heavy morning frosts.

Literature Cited:

Dernoeden, P.H., 2011. Preemergence annual bluegrass control in fairway height zoysiagrass. Proc. NEWSS 65: 75-76.

Preemergence and subsequent postemergence annual bluegrass control in a creeping bentgrass golf green, College Park, MD, 2011 - 2012.

		% *Poa annua* cover				Bent color		Bent quality		Overall quality		Wilt injury	
Treatment*	Rate/A	23-Mar	7-May	16-May	1-Jun	11-May	15 May	11-May	25-May	1-Jun	16 Jul	29 Jun	16 Jul
Bensumec 4 L	12.5 lb ai	6.5b[+]	4.8b	6.3b	7.5b	8.8a	9.3a	8.7a	9.1a	7.9a	7.0b	1.9a	2.1a
Trimmit 2 SC**	6.0 oz prod.	3.5c	2.3c	1.7c	0.8c	7.3c	9.1a	7.2b	8.8a	8.0a	8.3a	0.6ab	0.6b
PoaCure 250 EC***	0.9 lb ai	5.8bc	0.6c	0.5c	0.6c	8.4b	9.0a	8.4a	8.6a	8.2a	7.1ab	1.5ab	1.9ab
Untreated	—	11.3a	13.0a	14.5a	19.0a	8.7ab	9.5a	8.7a	9.3a	7.4a	8.2a	0.4b	0.6b

*All treatments were applied 2 Sept 2011 and March 21, 2012.
**Trimmit was applied weekly in Sept and Oct. 2011 and weekly from March 21 to June 28, 2012.
***PoaCure reapplied 11 April 2012.
[+]Means in a column followed by the same letter are not statistically different according to Fisher's LSD, $P = 0.05$.

Preemergence Annual Bluegrass Control in Fairway Height Zoysiagrass, 2012

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Introduction: Annual bluegrass (*Poa annua* L.) is an intractable weed in golf course turf. Annual bluegrass becomes invasive in zoysiagrass (*Zoysia japonica* L.) fairways in the late autumn and winter and dominates with the advent of warmer temperatures in spring. Preemergence herbicides offer a means of controlling the weed, but there has been little research conducted to identify effective and safe materials for zoysiagrass maintained at fairway height. It has been over a decade since research at the University of Maryland had identified prodiamine, at a rate as low as 0.38 lb ai/A, to be effective in controlling annual bluegrass preemergence in rough-height (3.0") Kentucky bluegrass (*Poa pratensis* L.) (Dernoeden,1998). Kentucky bluegrass is a cool-season grass that maintains vigor from autumn to spring and is able to compete more effectively with annual bluegrass in winter and spring when compared to zoysiagrass, which becomes dormant in winter. More recently, a 2010 Maryland study showed dithiopyr, prodiamine, pendimethalin, and oxadiazon to be safe and highly effective in controlling annual bluegrass in winter dormant zoysiagrass (Dernoeden, 2011). For decades, bensulide has been the standard annual bluegrass preemergence herbicide used on golf courses, yet its' performance was inferior to the aforementioned herbicides (Dernoeden, 2011). Paclobutrazol (Trimmit) is a plant growth regulator that has been associated with reducing the invasiveness of annual bluegrass on golf courses in the Mid-Atlantic region (S. Zontek, personal communication). In the aforementioned 2011 study, Trimmit showed promise in controlling annual bluegrass, but more research is needed to confirm these findings. Thus, the objectives of this research were to further assess bensulide (Bensumec) when targeting annual bluegrass, and to compare bensulide to more modern compounds as follows: prodiamine (Barricade 65DG), oxadiazon (RonStar 2G); dithiopyr (Dimension 40WSP), pendimethalin (Pendulum AquaCap 3.8CS), methiozolin (PoaCure) and paclobutrazol (Trimmit 2S).

Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. All treatments were applied on 2 September 2011. Trimmit was applied in two regimes: 2 times on 2 September and 3 October and 8 times weekly between 2 September and 24 October 2011(see Table for rates). Sprayable herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Granular formulation of RonStar was applied using a shaker jar. The site received rainfall or irrigation within 48 hrs of each application.

Soil was a Keyport silt loam with a pH of 5.6 and 1.4% OM. Turf was a mature stand of Zenith zoysiagrass maintained to a height of 0.5 inches. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 4 replications. Percent of plot area covered with annual bluegrass was assessed visually on a 0 to 100% scale where 0 = no annual bluegrass and 100 = entire plot area covered with annual bluegrass. Annual bluegrass developed naturally and uniformly across the study area. Data were subjected to analysis of variance and significantly different means were separated at $P \leq 0.05$ using Fisher's least significant difference (LSD) test.

Results: Annual bluegrass cover was evaluated on four dates between 14 December 2011 and 9 March 2012. Due to an unusually warm and open winter and unseasonably warm and early spring, annual bluegrass had ideal growing conditions and was highly competitive. On 14 December 2011 and 31 January 2012, all treatments had reduced annual bluegrass levels compared to the control. Plots treated with Trimmit (16 oz product/A on 2 Sept. + 3 Oct.; hereafter 2 apps) and PoaCure-treated plots had higher annual bluegrass cover ratings compared to all other chemical treatments. Substantial increases in annual bluegrass cover were evident in plots treated with Bensumec, Pendulum, PoaCure and Trimmit (2 apps) on 23 February, but levels remained lower than those observed in the control, but generally higher versus all other chemical treatments. Plots were last evaluated on 9 March due to the premature green-up of the zoysiagrass. At this time, annual bluegrass cover was statistically equivalent among plots treated with Trimmit (2 apps), PoaCure and the untreated control. Lowest annual bluegrass cover was observed in plots treated with Barricade (0.65 lb ai/A) and Ronstar (3-6%; about 91% control), but data did not statistically vary when compared to plots treated with Barricade (0.38 lb ai/A), Dimension Ultra, Pendulum AquaCap and Trimmit (8 apps) (8-14 % cover; 73-85% control). The mechanism by which multiple Trimmit applications performed at a level of control equivalent to the herbicides was not determined. It is likely that annual bluegrass seedlings absorbing the growth regulator were not capable of proper development and despite a warm winter they were unable to survive.

Literature Cited:

Dernoeden, P.H. 1998. Use of prodiamine as a preemergence herbicide to control annual bluegrass in Kentucky bluegrass. HortSci. 33:845-846.

Dernoeden, P.H., 2011. Preemergence annual bluegrass control in fairway height zoysiagrass. Proc. NEWSS 65: 75-76.

Preemergence annual bluegrass control in fairway height zoysiagrass, College Park, MD, 2011 - 2012.

				% *Poa annua* cover			
	Rate		Dates	2011	2012		
Treatment	(lb ai/A)	Timing	Applied	14-Dec	31-Jan	23-Feb	9-Mar
Bensumec 4L	12.5	Pre	2-Sep	7.3cd*	9.3cd	15.8cd	21.3cd
Barricade 65DG	0.38	Pre	2-Sep	3.5cd	3.8d	5.3de	7.8de
Barricade 65DG	0.65	Pre	2-Sep	1.4d	1.1d	1.9e	3.1e
Ronstar 2G	4	Pre	2-Sep	2.4d	2.8d	3.8de	5.5e
Dimension Ultra 40WSP	0.5	Pre	2-Sep	5.0cd	5.8d	8.0cde	9.8de
Pendulum AquaCap 3.8CS	3	Pre	2-Sep	6.5cd	7.3d	11.5cde	14.3cde
PoaCure 250EC	0.9	Pre	2-Sep	18.8b	22.0b	36.3ab	39.0ab
Trimmit 2SC	16.0 oz x 2	Pre	2-Sep, 3 Oct	11.6bc	18.8bc	33.0b	37.5ab
Trimmit 2SC	12.0 oz	Pre/weekly	2, 12, 19, 26 Sep; 3, 10, 17, 24 Oct	1.5d	1.8d	5.8cde	8.8de
Untreated	—	—	—	31.4a	41.3a	49.4a	51.6a

*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 to 2012

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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. The herbicides were applied to the same plots in 2011 and 2012 to determine if the herbicides would predispose creeping bentgrass to injury from environmental stress in the summer.

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 '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 and 1 April 2012. Spring of both 2011 and especially 2012 came early, but 2012 was considerably warmer. Thus, crabgrass emerged much earlier than ever recorded in the last 30 years.

The same plots were treated with the same herbicides on 29 March 2011 and 21 March 2012. The only treatment difference between years was Tupersan. In 2011, Tupersan was applied once at 12 lb ai/A, but in 2012 it was applied four times at 6.0 lb ai/A on 21 March, 12 April, and 2 and 23 May 2012.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 in 2011, but the site was irrigated within 24 hours in 2012. The study area was irrigated thereafter to avoid drought stress in both years.

Plots were 5 ft x 10 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. Summer stress was assessed visually on a 0 to 5 scale where 0 = entire plot area green and healthy; 2.5 objectionable wilt or turf discoloration; and 5 = >50% of the plot area brown or dead. Turf quality was rated visually using a 0 to 10 scale where 0= entire plot area brown or dead ; 7.0 = minimum acceptable quality for a golf course fairway and 10 = optimum green color and density. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Fisher's LSD or Tukey's HSD.

2011 Results. Smooth crabgrass pressure was uniform and severe across the site. Some crabgrass was observed in all herbicide-treated plots by 5 July, and it was evident that Tupersan had been ineffective by this time (data not shown). 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 in 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.

2012 Results. Smooth crabgrass pressure again was uniform and severe across the site. As was observed in 2011, it was evident that Tupersan, despite multiple applications, would not provide commercially acceptable control by mid-July (data not shown). At the height of the summer stress period, plots were evaluated visually for stress on 12 July and none of the treatments appeared to predispose the creeping bentgrass to heat and /or drought stress. By 3 August, plots treated with Bensumec, and Tupersan had crabgrass levels above the acceptable threshold (i.e., ≥ 5% crabgrass cover). On the final rating (i.e., 31 August), all herbicide treatments had significantly reduced crabgrass cover and improved overall turf quality compared to the control. Among herbicide treatments, crabgrass levels were highest in plots treated with Tupersan (56%) followed by Bensumec (23 %). All other treatments gave statistically equivalent and excellent crabgrass control. Plots treated with Dimension 2EW were marginally acceptable in terms of both control (6% cover) and overall quality (rating = 6.8). Highest quality was associated with Barricade-treated plots, which was statistically similar to plots treated with RonStar. Acceptable quality (i.e., > 7.0) also was provided by Pendulum AquaCap and Dimension 0.21G.

Summary and Conclusions. Studies seldom are conducted in which herbicides are applied to the same plots in successive years, especially in creeping bentgrass. Both crabgrass control and turf safety were monitored. It should be noted that the rates evaluated were label rates for creeping bentgrass fairways, which are lower than those for use on other cool and warm-season fairway grasses. The only problem incurred in this study was the delay of creeping bentgrass rooting from stolons in dead crabgrass skeletons in the first year by Pendulum AquaCap. The summers of both 2011 and 2012 began early and were extremely stressful. In 2011, stress dissipated in early August, but continued until early September in 2012. In 2012, there were over 35 days when air temperature exceeded 90F, making 2012 the 6th hottest summer on record. Despite the high temperature stress, there was no visual indication that the herbicides had predisposed creeping bentgrass to drought or heat stress injury. Barricade was the only herbicide to provide commercially acceptable control in both years. Subjectively, good (< 10% crabgrass cover) to excellent (< 5% crabgrass cover) crabgrass control was provided by Pendulum AquaCap in both years. Statistically, Barricade, Pendulum, RonStar and Dimension (both formulations) had provided similar levels of crabgrass control in both years. Bensumec, the industry standard for use on creeping bentgrass fairways, provided unacceptable control in both years and was inferior to all other herbicides except Tupersan on the final rating date in the second year.

Table 1. Preemergence smooth crabgrass control in fairway height creeping bentgrass, College Park, 2011 and 2012.

	Rate	Crabgrass cover (%)			Summer stress (0-5)		Quality
Treatment*	(lb/ai/A)	15 Aug '11	3 Aug '12	31 Aug '12	15 Aug '11	12 Jul '12	31 Aug ' 12
Bensumec 4LF	10.0	12.3b***	12.5bc	28c	2.0a	0.8a	5.3cd
Tupersan 50WP	12.0/6.8 x 4**	61.8a	23.5b	56b	2.8a	0.9a	4.0de
RonStar 2G	3.0	15.8b	2.0bc	3d	1.8a	1.4a	7.8ab
Pendulum AquaCap 3.8CS	2.0	6.9b	2.0bc	5d	2.1a	0.5a	7.1b
Barricade 4F	0.5	4.3b	0.1c	<1d	1.3a	0.0a	8.8a
Dimension 2EW	0.38	12.3b	0.6c	6d	2.0a	0.0a	6.8bc
Dimension 0.21G	0.38	17.0b	2.2bc	5d	1.8a	0.9a	7.1b
Untreated	–	74.0a	62.5a	80a	2.5a	1.1a	3.3e

*Treatments were applied 29 March 2011 and 21 March 2012.

**Tupersan was applied at 6.0 lb ai/A on 21 March, 12 April, and 2 and 23 May 2012.

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

Effect of Post Application Irrigation and Mowing on Premergence Herbicides Targeting Crabgrass in Tall Fescue, 2012

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Objective: Preemergence herbicides are routinely applied in spring and primarily target crabgrass (*Digitaria* spp). The performance of preemergence herbicides can vary from year to year depending on rates and methods of application, cultural inputs (e.g. mowing height) and environmental conditions. Lawn care operators (LCO's) often are baffled by the sometimes disappointing outcomes associated with these materials. What LCO's cannot control is the weather and watering-in of these herbicides by a timely rain is thought to be integral to their successful performance. Another uncontrollable factor is mowing practices; basically the lower the mowing height the more stress is placed on herbicides. It has long been pondered whether mowing and clipping removal soon after a preemergence herbicide could impact performance. Another important question is whether post application irrigation or mowing could also interact significantly depending on herbicide formulation (i.e., sprayable versus a granular formulation). This study was designed to find answers to some of these questions. The objectives were as follows: 1.) to determine if irrigating within 24 hours versus 7 days following application would impact herbicide performance ; 2.) to determine if mowing 24 hours after application and removal of clippings would influence herbicide performance ; and 3) to determine if a sprayable versus granular herbicide formulation is more impacted by post application mowing and irrigation.

Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. Turf was a mature mix of Coyote II tall fescue (95%) and Impact Kentucky bluegrass (5%) and was mowed two times weekly to a height of 1.5 inches. Soil was a Keyport silt loam with a pH of 5.7 and 2.2 % organic matter. Eight, 10 ft by 35 ft independently irrigated blocks equipped with pop-up heads were established in 2009. Four of these blocks were irrigated with 0.15 inches of water 24 hours after the application of herbicides; four blocks were not intended to be irrigated for 7days following herbicide application. The herbicides were applied on 26 March 2012. A sprayable and granular formulation of Barricade, Pendulum and Dimension were assessed. Sprayable herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Granular herbicides were applied by shaker bottle. Herbicide rates are shown in the data table. The non-irrigated blocks were covered with tarps on 28 and 30 March in anticipation of rain, which did not occur. The first substantial amount of irrigation applied to the "non-irrigated" blocks was on 12 April 2012 (i.e., 18 days after herbicide application). Each block was split lengthwise and one-half was mowed 24 hours after application to a height of 1.5 inches and clippings were removed. Due to cool nights and relatively low rainfall, not much verdure could be removed by this mowing. The granular herbicides were formulated with fertilizer (19-0-6) that delivered between 0.65 and 0.75 N/1000 ft^2. To offset this N difference, plots treated with the sprayable formulations were fertilized with 0.75 lb N/ 1000ft^2 with urea on 12 April 20102. The urea was watered-in with 0.25 inches of water and this was the first time all blocks received a substantial amount of water since the study was initiated.

Individual plot size was 5 ft x 5 ft and plots were arranged in a randomized complete split-slit block design with 4 replications. Percent of plot area covered with smooth crabgrass was assessed visually 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. Data were subjected to analysis of variance and significantly different means were separated at $P \leq 0.05$ using Tukey's LSD.

Results: Smooth crabgrass seedlings were first observed in the study site on 1 April 2012, which was about 14 days earlier than in the average year. Crabgrass developed uniformly across the site and pressure was severe. Smooth crabgrass cover was estimated on 15 August 2012. There was no apparent effect of either mowing or irrigation parameters. Plots treated with Barricade 4F had lowest crabgrass cover, but data did not differ statistically compared to Dimension 0.164G. There were no differences among the remaining treatments. In general Barricade 4F outperformed Barricade 0.38G; Pendulum AquaCap outperformed Pendulum 0.86G in irrigated blocks only; and Dimension 0.164G outperformed Dimension Ultra. Regardless of mowing or irrigation treatment, Barricade 4F had provided outstanding crabgrass control (4-6% crabgrass cover; 94% control). Barricade 0.38G, Pendulum (both formulations) and Dimension Ultra provided poor control, regardless of mowing or irrigation parameter. Relatively good control (6-19% cover; 86% control) was provided by Dimension 0.164G.

Conclusions: Mowing and irrigation parameters had no effect on the performance of the herbicides. As previously noted, little foliage was removed 24 hours after application in "mowed" plots due to slow growth of the tall fescue. Hence, amounts of herbicide remaining in the mowed plots probably were close to equivalency to non-mowed plots. Irrigation had no effect, despite 18 days of no irrigation versus irrigation 24 hours after treatment. The problem may have been two-fold. Plots irrigated 24 hours after treatment only received about 0.15 inches of water, which may not have been sufficient to effectively move herbicide active ingredient to the soil surface. Considerable amounts of condensation were observed accumulating on the underside of tarps upon removal in the morning. This amount of water appears to have been sufficient to move herbicides through the canopy and to the soil surface. This conclusion is corroborated by the observation that plots treated with granular herbicides formulated with fertilizer had greened-up at the same time, regardless of whether plots were irrigated within 24 hours of application or not irrigated and covered with tarps. This level of condensation may have been sufficient to move herbicides off foliage at a level equivalent to the 0.15 inches used in the irrigation treatment. In spite of extremely severe pressure, Barricade 4F provided outstanding crabgrass control in all blocks.

Effect of post application irrigation and mowing on preemergence herbicides targeting crabgrass in tall fescue, College Park MD, 2012.

	Rate	% crabgrass cover, 15 August 2012			
		Irrigated		Not irrigated	
Herbicide*	lb ai/A	Mowed	Not mowed	Mowed	Not mowed
Barricade 4F**	0.65	6e***	5c	4d	5c
Barricade 0.38G (19-0-6)	0.65	39bcd	37bc	28bcd	26bc
Pendulum AquaCap 3.8CS**	3.0	25cde	25bc	47bc	32bc
Pendulum 0.86 (19-0-6)	3.0	56b	60ab	50b	43b
Dimension Ultra 2EW**	0.38	40bc	59ab	34bcd	25bc
Dimension 0.164G (19-0-6)	0.38	19de	18c	14cd	6bc
Untreated	–	91a	94a	88a	84a

*Applied 27 March 2012; crabgrass seedlings observed 1 April 2012.
**Plots received 0.75 lb N/1000ft^2 on 12 April 2012.
***Means in a column followed by the same letter are not significantly different according to Tukey's HSD, *P* = 0.05.

Postemergence Smooth Crabgrass Control In Fairway Height Creeping Bentgrass, 2012

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Objectives and Procedure. Little effort has been devoted to finding new herbicide approaches to crabgrass (*Digitaria* spp.) control in creeping bentgrass (*Agrostis stolonifera*) fairways. Acclaim Extra (fenoxaprop-ethyl) and Drive (quinclorac) are standard products. To be highly effective, Acclaim Extra must be applied frequently at low rates beginning when crabgrass plants are in a 1-2 leaf stage (usually mid-to-late May). Drive can be used effectively in a mid-post timing (late June-early July in Maryland), but the herbicide causes an objectionable yellow-mottling in creeping bentgrass, which usually persists for 30 or more days. Tupersan(siduron) is safe and effective in the seedbed and has both pre and early postemergence activity on crabgrass. Multiple low rate applications of Tupersan need to be assessed for their effectiveness. Trimmit is a plant growth regulator. Weekly applications in September and October have been shown to be effective in controlling annual bluegrass in fairway height turf due to unknown mechanisms. It is not known if Trimmit has preemergence or otherwise suppressive activity on crabgrass.

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 'Backspin' creeping bentgrass 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 on 1 April 2012.

Trimmit, Accalim Extra and Tupersan were applied 6 times on a 3 week interval between 5 April and 16 July 2012. Drive was applied either once on 28 June or sequentially on 28 June and 16 July 2012.Herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) backpack sprayer equipped with an 8004E flat fan nozzle. Plots were 5 ft x 10 ft and were arranged in a randomized complete block with three 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. Foliar injury (i.e., phytotoxicity) 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. Turf quality was rated visually using a 0 to 10 scale where 0= entire plot area brown or dead; 7.0 = minimum acceptable quality for a golf course fairway and 10 = optimum green color and density. Data were subjected to ANOVA and significantly different means were separated at $P \leq 0.05$ using Tukey's HSD.

Results. Crabgrass developed uniformly across the study area and pressure was severe. Crabgrass cover was evaluated three times between 13 July and 31 August 2012.On 13 July, all treatments had reduced crabgrass cover compared to the control, but it was evident that Trimmit would not be effective at the rate and application timing assessed. The ratings obtained on 3 August are of most importance since applications of materials ceased on 16 July and it is likely that additional germination and tillering of surviving crabgrass plants would confound later season assessments. At this time, there were no crabgrass cover differences among Tupersan, Acclaim Extra, and Drive (both treatments)-treated plots. Drive-treated plots were injured significantly. Foliar injury to plots treated once on 28 June was less than in those plots treated twice on 28 June and 16 July. Injury appeared as a chlorotic mottling of leaf tissues, which was objectionable in plots of both Drive treatments. As a result, turf quality was reduced to unacceptable levels (i.e., < 7.0) in Drive-treated turf. This injury was evident on 19 July (field day-no data collected) and remained evident on 31 August (i.e., 43 days; data not shown). Tupersan-treated plots also had inferior quality due to crabgrass levels exceeding the “acceptable” threshold (i.e. ≤ 5% crabgrass cover). Only Acclaim Extra -treated bentgrass exhibited acceptable turf quality. Crabgrass cover was last rated on 31 August. As previously noted this would have been 46 days since the herbicides were last applied; thus surviving crabgrass plants would have tillered and become more invasive, and/or there would have been some additional germination that would bias results. On the final rating, lowest crabgrass cover (8%; 91% control) was observed in plots treated with Acclaim and Drive (0.5 + 0.5 lb ai/A). The poor level of control observed in plots treated with Tupersan and Drive (0.75 lb ai/A) was attributed to tillering of surviving crabgrass plants since Acclaim has no preemergence activity and crabgrass levels remained similar between the 3 and 31 August rating in Acclaim Extra-treated plots.

Summary of Key Points:

- Six applications of Acclaim Extra applied on a 21 day interval between 5 April and 16 July provided excellent crabgrass control and the herbicide caused not visual injury to creeping bentgrass.
- Drive XLR8 (0.5 + 0.5 lb ai/A) applied twice on an 18 day interval beginning in a mid-post timing (i.e., 28 June + 16 July) provided excellent crabgrass control, but the creeping bentgrass was injured to objectionable and unacceptable levels for over 40 days.
- Previous research conducted at the University of Maryland has shown that Lesco’s N Plus Micronutrients helps to mask injury elicited by Drive XLR8, but this product must be applied on a two week interval for up to 30 days following the last application of Drive XLR8 to be effective.
- Tupersan applied 6 times on the 21-day interval provided good control until 3 August. Since none of the herbicides were applied after 16 July it is likely that the high level of crabgrass cover observed on 31 August in Tupeersan-treated plots was due to tillering of surviving crabgrass plants. Future research should consider extending Tupersan applications throughout August.

- The earliest rating (i.e., 13 July) indicated that Trimmit had provided some reduction in crabgrass, presumably via suppressing weed growth and possibly by increasing attrition of plants. The 21 day spray interval was too wide and future research should consider weekly applications of Trimmit.

Postemergence crabgrass control in fairway height creeping bentgrass, College Park MD 2012.

			% crabgrass cover			8-13-12	
Treatment	Rate	Timing	13 Jul	3 Aug	31 Aug	Foliar injury	Quality
Trimmit 2SC	16 oz/A	Early/3wk*	20b***	55a	79a	0.0c	5.0b
Tupersan 50 WP	4.0 lb ai/A	Early/3 wk	1b	7b	24bc	0.0c	6.3ab
Acclaim Extra 0.57 EW	4.0 oz/A	Early/3 wk	<1b	1b	8c	0.7c	7.7a
Drive XLRB 1.5 SC	0.75 lb ai/A	Mid-Post/Once**	<1b	8b	37b	1.8b	6.2ab
Drive XLRB 1.5 SC	0.5 lb ai/A	Mid-Post + 16 Jul	1b	<1b	8c	3.2a	6.1ab
Untreated	–	–	56a	70a	89a	0.0c	5.2b

*Early / 3 week interval treatments were applied 5 and 25 April, 17 May, 7 and 28 June and 16 July 2012.
**Mid-post treatments applied once on 28 June or twice on 28 June + 16 July 2012.
***Means in a column followed by the same letter are not significantly different according to Tukey's HSD, *P* = 0.05.

Postemergence Smooth Crabgrass Control In Tall Fescue With Tenacity and Topramezone, 2012

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Procedure. This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. This study assessed the tall fescue safety and effectiveness of topramezone and Tenacity (i.e., mesotrione) in various tank- mix combinations for postemergence control of smooth crabgrass (*Digitaria ischaemum*). Turf was a mature stand of Titan II tall fescue (*Festuca arundinacea*) and 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 % organic matter.

Herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Topramezone treatments were applied twice on a 21-day interval. Tenacity treatments were applied twice on either a 21 or 42-day interval. There were two timings for Tenacity treatments: an early-post application beginning 18 June when crabgrass was in the 3 to 4 leaf stage and a mid-post timing beginning on 3 July when crabgrass was in the 3 leaf to 4 tiller (mostly 2-3 tillers) stage. Rates and dates of application are footnoted in the data table. The site received rainfall or irrigation within 24 hrs of each application. The study site was irrigated thereafter to avoid drought stress. All topramezone treatments were mixed with 5% v/v methylated seed oil (MSO); whereas, Tenacity was mixed with 0.25% v/v Activator 90 (NIS).

Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 4 replications. Tall fescue injury was assessed visually on a 0 to 5 scale where 0=no injury: 2.5 = substantial and commercially unacceptable discoloration and 5.0 = entire plot area brown or dead. Turf quality was rated visually using a 0 to 10 scale where 0 = entire plot area brown or dead; 7.0 = minimum acceptable quality and 10 = optimum green color and density. Percent of plot area covered with smooth crabgrass was assessed visually 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. Data were subjected to analysis of variance and significantly different means were separated at $P \leq 0.05$ using Tukey's LSD.

Results. Rates, dates and timings of herbicide applications are shown in the data table. On 3 (i.e., 15 days after first application) and 10 July 2012 (i.e., 21 days after first application) injury to tall fescue was severe in plots treated with topramezone alone. Significantly less injury compared to topramezone alone was observed in plots treated with topramezone tank-mixed with Drive XLR8. Injury in the acceptable range was observed in plots treated with Tenacity on 18 June. Overall quality data were obtained on 12 July and again 31 August. Quality of plots treated with topramezone alone was unacceptable on both dates particularly on 12 July. While tall fescue did recover substantially by 31 August in plots treated with topramezone alone some thinning and the presence of crabgrass is the reason for the lower quality ratings compared to other herbicide-treated plots. Plots treated with topramezone + Drive had lower than acceptable quality on 12 July due to herbicide injury, but turf had fully recovered by 31 August. Lower turf quality of plots treated with Tenacity + Turflon applied in the 3 July and 13 August (i.e., mid-post, 42 d interval) timing was due to the presence of crabgrass and not discoloration or other form of phytotoxicity.

Growing conditions were ideal (hot and wet) and smooth crabgrass pressure was uniform and severe across the site. Topramezone + Drive XLR8 provided complete crabgrass control and only trace levels of crabgrass were observed in plots treated with Tenacity + Turflon in the 18 June + 9 July timing (i.e., 21-d interval in early-post timing) and 18 June + 30 July timing (i.e., 42-d interval in early-post timing), and 3 July + 23 August (i.e., 21-d interval in mid-post timing). Tenacity + Turflon applied in the 3 July + 13 August timing (i.e., 42-d interval mid-post timing) greatly reduced crabgrass levels within two weeks, but it was not until the final rating date that crabgrass cover declined to within the threshold (i.e. $\leq$ 5% crabgrass cover). Topramezone alone also provided acceptable crabgrass control.

Summary of Key Points:

- Topramezone applied alone was phytotoxic to tall fescue, and it took months for the tall fescue to recover.
- Drive XLR8 partially safened topramezone and the combination provided complete crabgrass control.
- Tenacity + Turflon Ester provided excellent postemergence crabgrass control when applied on a 21 or 42-day interval beginning in the early and mid- post timings.
- Tenacity + Turflon Ester applied on the 42-d interval in the mid-post timing required about 21 days to effectively reduce crabgrass levels to within the acceptable range.
- Given the severe pressure and excellent crabgrass growing conditions it was concluded that all treatments had provided outstanding crabgrass control.

Table 1. Postemergence smooth crabgrass control and tall fescue injury and quality as influenced by Tenacity and topramazone tank-mixes, College Park MD, 2012.

	Rate		Overall quality		Tall fescue injury		% Crabgrass cover		
Treatment	oz/Prod./A	Timing	12 Jul	31 Aug	3 Jul	10 Jul	12 Jul	13 Aug	5 Sep
Topramezone 2.8 SC+MSO*	1.5 oz/A	18-June + 9-July[+]	4.9b	6.8b	4.0a[z]	4.9a	0.1b	4.2c	5.4bc
Topramezone + Drive x XLRS + MSO*	1.5 + 64 oz/A	18-June + 9-July[+]	6.6a	8.7a	2.2b	2.9b	0.0b	0.0c	0.0c
Tenacity 4 SC + Turflon Ester 4 EC + Activator 90**	5.0 + l6 fl. oz/A	18-June + 9-July[+]	7.5a	8.5a	0.9cd	1.5cd	0.0b	0.5c	1.1c
Tenacity 4 SC + Turflon Ester 4 EC + Activator 90	5.0 + l6 fl. oz/A	18-June + 30-July[++]	7.1a	8.5a	1.4bc	1.8bc	0.5b	0.1c	0.5c
Tenacity 4 SC + Turflon Ester 4 EC + Activator 90	5.0 + l6 fl. oz/A	3-July + 23-July[+]	7.1a	8.6a	0.0d	0.9cd	4.5b	0.1c	0.3c
Tenacity 4 SC + Turflon Ester 4 EC + Activator 90	5.0 + l6 fl. oz/A	3-July + 13-Aug.[++]	6.8a	7.5b	0.2d	1.5d	4.4b	30.0b	4.0b
Untreated	—	—	3.5c	3.0c	0.0d	0.5d	39.	91.2a	97.5a

*Methylated seed oil 0.5% v/v [+] = 21-day interval ; crabgrass 3-4L on 18 June 2012.

**Activator 90 0.25% v/v [++] = 42 day interval ; crabgrass 3L to 4T; mostly 2-3 T on 3 July 2012.

[z]Means followed by the same letter in a column are not significantly different according to Tukey's HSD, P = 0.05.

Tall Fescue Tolerance and Postemergence Smooth Crabgrass Control With Topramezone, 2012

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Procedure: This field study was conducted at the University of Maryland Paint Branch Turfgrass Research Facility in College Park, MD. This study compared topramezone alone and in tank-mix combinations with quinclorac (Drive XLR8) and triclopyr ester (Turflon Ester) for tall fescue safety and postemergence control of smooth crabgrass (*Digitaria ischaemum*). Turf was a mature stand of Titan II tall fescue (*Festuca arundinacea*) and 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 % organic matter.

Herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Rates and dates of application are footnoted in the data table. All topramezone treatments were mixed with methylated seed oil (0.5% v/v). Except for a two week period in early July, rainfall was sufficient and the site seldom required irrigation to alleviate wilt. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 4 replications. Tall fescue injury was assessed visually on a 0 to 5 scale where 0 = no injury: 2.5 = substantial and commercially unacceptable discoloration and 5.0 = entire plot area brown or dead. Turf color and quality were rated using a 0 to 10 scale where 0= entire plot area brown or dead; 7.0 = minimum acceptable color and quality; and 10 = optimum green color and density. Overall quality took into consideration density, color and the presence or absence of weeds. Percent of plot area covered with smooth crabgrass , broadleaf weeds (mostly lespedeza and ragweed) and yellow nutsedge were assessed visually on a 0 to 100% scale where 0 = no crabgrass or other weeds and 100 = entire plot area covered with smooth crabgrass or other weeds. Crabgrass ratings ≤ 5% of plot area covered subjectively were considered to have provided commercially acceptable control. Smooth crabgrass pressure was uniform and initially low, but becoming moderately severe after plants had tillered in August. Data were subjected to analysis of variance and significantly different means were separated at $P \leq 0.05$ using Tukey's HSD.

Results: Herbicide treatments were applied on a 21-day interval from 31 May and 11 July 2012. Injury caused by topramezone applied alone or tank-mixed with Drive XLR8 became evident 6 days following the second application of herbicides on 27 June. Conversely, topramezone tank-mixed with triclopyr and Acclaim + triclopyr caused no significant injury. Tall fescue color and quality better describe the level and significance of the injury. Plots treated with topramezone alone were discolored and overall quality generally was reduced to below acceptable levels between 27 June and 23 July. Remnant thinning of the stand from topramezone was evident as late as 3 August, but overall quality was in the good (i.e., > 8.0) range by this time. Topramezone + Drive XLR8-treated plots were injured for a shorter period versus topramezone applied alone from 27 June to 3 July thus resulting in lower color and quality compared to the control. Topramezone was completely safened by triclopyr. Similarly, little or no injury was associated with Acclaim Extra + triclopyr ester applications to the tall fescue.

No weeds were evident when the study was initiated on May 31. All treatments provided complete control of smooth crabgrass and broadleaf weeds. Interestingly, yellow nutsedge was the only weed to re-colonize plots in late summer (i.e., 31 August) and in particular those treated with topramezone alone (i.e., 17 % yellow nutsedge cover). It is likely that the thinning of tall fescue during most of the summer enabled yellow nutsedge to better compete in plots injured by topramezone alone.

Table 1. Tall fescue injury, quality and color as influenced by topramezone and Acclaim Extra and triclopyr ester, College Park MD, 2012.

	Rate	Injury (0-5)			Color (0-10)		Overall Quality (0-10)				
Herbicide*	(Prod./A)	27 Jun	23 Jul	3 Jul	10 Jul	23 Jul	27 Jun	3 Jul	10 Jul	23 Jul	3 Aug
Topramezone**	1.5+15+1.0 oz	2.6a[+]	2.4a	3.2a	7.4a	6.4c	2.4a	5.8b	7.4a	6.7c	8.2b
Topramezone** + Triclopyr	1.5 + 32 oz	1.6ab	0.0c	0.8bc	8.3a	8.8a	7.3abc	7.4a	8.3a	8.8a	8.8a
Topramezone**+ Drive XLR8	1.5 + 32 oz	3.0a	1.8b	1.8b	7.9a	7.9b	6.1c	6.5ab	7.9a	7.6b	8.2b
Acclaim Extra + Triclopyr	32 + 32 oz	1.1b	0.0c	0.6c	8.3a	9.1a	7.6a	7.7a	8.3a	9.1a	9.0a
Untreated	—	1.0b	0.0c	0.0c	7.8a	8.7a	7.5ab	7.8a	7.6a	6.2c	5.9c

* Applied: May 31, June 21, and July 11, 2012.
** All topramezone treatments were mixed with 0.5% v/v MSO.
[+]Means in a column followed by the same letter are not significantly different according to Tukey's HSD, $P \geq 0.05$.

Table 2. Weed control as influenced by topramezone and triclopyr ester, College Park MD, 2012.

	Rate	% broadleaf weeds		% Crabgrass		% yellow nutsedge
Herbicide*	Prod./A	23 Jul	3 Aug	3 Aug	31 Aug	31 Aug
Topramezone**	1.5+15+1.0 oz	0.0b[+]	0.0b	0.0b	0.0b	11.7a
Topramezone** + Triclopyr	1.5 + 32 oz	0.0b	0.0b	0.0b	0.0b	0.1b
Topramezone**+ Drive XLR8	1.5 + 32 oz	0.0b	0.0b	0.0b	0.0b	0.4b
Acclaim Extra + Triclopyr	32 + 32 oz	0.0b	0.0b	0.0b	0.0b	0.0b
Untreated	—	17.5a	7.0a	10.3a	31.5a	0.0b

* Applied: May 31, June 21, and July 11, 2012.
** All topramezone treatments were mixed with 0.5% v/v MSO.
[+]Means in a column followed by the same letter are not significantly different according to Tukey's HSD, $P \geq 0.05$.

Common Bermudagrass Control In A Golf Course Rough
With Topramezone and Relevant Observations, 2012

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Introduction. Common bermudagrass (*Cynodon dactylon*) is an intractable weed in golf course turfs. Herbicides such as triclopyr (Turflon Ester) and fenoxaprop-ethyl (Acclaim Extra) are effective selective herbicides for controlling bermudagrass in tall fescue, perennial ryegrass and Kentucky bluegrass. Rates of the aforementioned herbicides targeting bermudagrass, however, would severely damage or kill creeping bentgrass. Topramezone (Impact) may have applications for use in creeping bentgrass fairways. The objective of this study was simply to determine if topramezone applied alone or tank-mixed with triclopyr or quinclorac (Drive XLR8) would be as effective in controlling bermudagrass as Acclaim Extra + Turflon Ester– the current standards of the industry.

Procedure. This study was conducted in a rough at the University of Maryland Golf Course. Turf was a mix of annual bluegrass and a small population of perennial ryegrass. At the time the study was initiated on 25 May 2012, common bermudagrass had broken dormancy and was green, but was not yet growing vigorously. Common bermudagrass was uniformly distributed throughout the study area and was the dominant species present.

Herbicides were applied in 50 GPA using a CO_2 pressurized (35 psi) sprayer equipped with an 8004E flat fan nozzle. Rates and dates of application are footnoted in the data table. Plots were 5 ft x 5 ft and were arranged in a randomized complete block with 4 replications. Initially bermudagrass injury was assessed visually on a 0 to 5 scale where 0=no injury: 2.5= substantial bermudagrass discoloration and 5.0= entire plot area brown or dead. Percent of plot area covered with bermudagrass was assessed visually on a 0 to 100% scale where 0 = no bermudagrass and 100 = entire plot area covered with bermudagrass. Annual bluegrass cover was rated once on 15 June, but no more ratings were taken following high temperature stress that naturally killed the annual bluegrass. Data were subjected to analysis of variance and significantly different means were separated at $P \leq 0.05$ using Tukey's LSD.

Results. Herbicides were applied three times between 25 May and 6 July 2012 at the rates shown in Table 1. Bermudagrass pressure was uniform and severe across the site. Two weeks following the initial application of herbicides on 8 June severe injury to the bermudagrass was observed. Initial injury took the form of tissue turning white and after subsequent applications bermudagrass tissues became necrotic. Injury ratings last were recorded on 15 June since substantial losses in bermudagrass cover were evident. Thereafter, bermudagrass cover was assessed as a means of expressing the level of control. By 6 July (i.e., 21 days following the second application of herbicides), only trace amounts of bermudagrass remained in all herbicide-treated plots. The herbicides were needlessly applied a third time on 6 July. Two weeks later on 20 June, only trace levels of bermudagrass remained evident among herbicide-treated plots.

Observations. Annual bluegrass was the primary cool-season grass present when the study was initiated. Annual bluegrass cover was assessed once on 15 June (i.e., 21 days since first application of herbicides). Since there were no annual bluegrass cover differences among treatments, topramezone appeared to be safe to apply to annual bluegrass. Unfortunately, high temperature stress had debilitated the annual bluegrass by 15 June, and by 9 July 2012 all of the annual bluegrass had died due to heat stress.

There was plentiful rainfall during the study period. Topramenzone was observed to have moved downward in rain water. Indeed, the two untreated replications lost about 50% of their bermudagrass cover due to movement of the herbicide down and possibly across the slope. Topramezone also was observed to be tracked on the tires of maintenance equipment.

In a companion study, topramezone was applied at 1.5 and 3.0 oz product/A on 5 May and 15 June 2012 and rates reduced to 1.0 and 2.0 oz product/A on 1 July to Penncross creeping bentgrass maintained at 0.50 inches. The first application elicited whitening in the bentgrass that persisted about 7 days. The second application also caused whitening, which persisted about two weeks. The third application coincided with wilt stress, which caused substantial damage to the creeping bentgrass. It was at our field day on 19 July that I learned that the rate of topramezone applied to the bentgrass was too high and that the timing had begun too early in the season.

Table 1. Bermudagrass injury and cover, and annual bluegrass cover as influenced by topramezone and Acclaim Extra and Turflon Ester, University of Maryland Golf Course, College Park, 2012.

	Rate	Bermudagrass Injury (0 - 5)		% Bermudagrass cover			% *Poa annua*
Herbicide*	Prod./A	8 Jun	15 Jun	8 Jun	6 Jul	20 Jul	15 Jun
Topramezone**	1.5+1.5+1.0 oz	3.2a***	2.3b	20.7a	2.3b	0.2b	64.5a
Topramezone** + Turflon	1.5 + 32 oz	3.9a	5.0a	0.2a	0.9b	0.1b	31.8a
Topramezone**+ Drive XLR8	1.5 + 32 oz	3.0a	3.1b	24.5a	1.7b	0.2b	60.0a
Acclaim Extra + Turflon	32 + 32 oz	3.8a	0.0c	7.2a	2.5b	1.1b	46.3a
Untreated	—	0.0b	0.0c	40.5a	49.5a	48.8a	51.3a

* Applied May 25, June 15, and July 6, 2012.
** All topramezone treatments were mixed with 0.5% v/v MSO.
*** Means followed by same letter are not significantly different according to Tukey's HSD, P= 0.05.