ANNUAL BLUEGRASS SEEDHEAD SUPPRESSION AND AMELIORATION OF PHYTOTOXICITY TO THE TURFGRASS WITH CIVITAS, 2010

J.E. Kaminski and T. Lulis

Department of Crop and Soil Science
The Pennsylvania State University, University Park

INTRODUCTION

Annual bluegrass (Poa annua) is a prolific producer of seed during the spring and early summer months. Even at low mowing heights, annual bluegrass seedheads can be produced thus creating an uneven playing surface on golf course putting greens. On fairways, seedhead production can continue to increase the seedbank in the soil and may be able to spread to nearby putting greens continuing the cycle of seedhead production and disruption of the playing surface quality. While two chemical management regimes are available, they are often met with injury or discoloration or lack of efficacy due to timing difficulties. The objectives of this study were to evaluate the ability of various growth regulators in combination with Civitas for their ability to mask or eliminate negative phytotoxic effects while still suppressing annual bluegrass seedheads.

MATERIALS & METHODS

Two field studies were initiated on either a golf course putting green or fairway at the Pennsylvania State University Golf Course. The green at the Pennsylvania State University Golf Course had a soil that was a sandy loam with a pH 5.7 and an OM of 7.7%. Turfgrass used for evaluation was a mixed stand of creeping bentgrass and annual bluegrass. The area was maintained as a bentgrass fairway and mowed three times per week to a height of 0. 5in. For the fairway site, soil was a loamy clay with a pH 6.7 and an OM of 3.4%. The fairway trial was comprised of a mixed stand of perennial ryegrass (Lolium perenne) and annual bluegrass. For the putting green, turf was a mixed stand of creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass. The putting green and fairway areas were maintained at a height of 0.125 in and 0.5 in, respectively.

Plots in both studies measured 3 ft x 6 ft and were arranged in a randomized complete block with four replications. All treatments were applied with a CO_2 pressurized (40 psi) sprayer equipped with an air-induction flat fan nozzle (AI9508E), and calibrated to deliver 2.0 gal water per 1000 ft^2. Treatments were applied on 1 Apr and all treatments and rates are listed in the data tables.

Poa seedhead severity was assessed by estimating the seedhead coverage on a 0 to 10 scale where 0 = no seedhead present and 10 = maximum seedhead production. Turfgrass quality was visually rated on a 1 to 9 scale where 1 = entire plot brown or dead and 9 = optimum greenness and density. Turfgrass injury was rated on a scale of 0 to 5 where 0 = no injury visible, ≥ 3.0 = unacceptable injury for a golf course fairway or putting green, and 5.0 = entire plot area brown or dead. Color measurements (NDVI) were taken using a FieldScout TCM 500 Turf Color Meter. Canopy temperatures were measured using a handheld infrared thermometer. All data were subjected to analysis of variance and means were separated at $P \leq 0.05$ according to Fisher's Protected Least Significant Difference Test.

RESULTS

Fairway Trial.

Seedhead severity. Treatments were initiated on 1 Apr (47 and 481 growing degree days based on base temp 50 and 32, respectively) and seedheads began to appear within the study within 7 days of treatment. On 8 Apr, only plots receiving Embark (both rates) or Embark (8.0 fl oz) + Civitas resulted in a significant seedhead reduction when compared to the untreated control plots (Table 1). Seedhead production continued through the month and peaked in late April to early May. During this period, only plots treated with Embark or Embark + Civitas reduced annual bluegrass seedheads and no differences among plots treated with Embark existed when compared to plots which also received Civitas. On May 14, annual bluegrass seedheads began to become less severe and the aforementioned treatments and those treated with Civitas + Proxy or Civitas + Proxy + Primo reduced seedheads when compared to the untreated control. By 31 May, no differences in seedhead severity existed among any treatment.

Injury. Although Embark treatments provided the best seedhead suppression during the study, injury to the perennial ryegrass fairway was moderate to severe during the study. While little to no injury was observed in other treated plots, those plots received Embark (both rates) alone or in combination with Civitas resulted in injury levels between 1.3 to 3.0 throughout the month of April. On a single rating date (30 Apr), Civitas was able to reduce the turfgrass injury caused by a single application of 8.0 fl oz of Embark.

Putting Green Trial.

Seedhead severity. Treatments were initiated on 1 Apr (47 and 481 growing degree days based on base temp 50 and 32, respectively) and but few seedheads were observed in the study site until late April or early May. Seedhead severity appeared very abruptly and peaked on 7 May. On this rating date, excellent seedhead suppression (≤ 3) was observed within plots treated with both rates of Embark applied alone or in combination with Civitas and no differences existed among any of these treatments (Table 4). Seedhead production was also moderately reduced within plots treated with Civitas + Proxy + Primo (both rating dates), Proxy + Primo (14 May), and Civitas + Proxy (7 May). No other treatment resulted in a reduction in seedheads when compared to the untreated control plots on either rating date.

Injury. Similar to the fairway study, turfgrass injury was limited to plots treated with Embark alone or in combination with Civitas. Initial injury observed 1 week after treatments were initiated was moderate to severe (1.8 to 3.0) within plots treated with Primo MAXX and all Embark treatments. Although plots treated with Primo MAXX appeared to cause an initial discoloration, the addition of Civitas appeared to mask these symptoms. By 23 April, little to no injury was apparent in plots treated with Primo MAXX. Injury to the bentgrass putting green continued to be observed within plots treated with Embark throughout April and early May. By 30 Apr, however, the addition of Civitas resulted in a reduction in injury caused by similar rates of Embark.

DISCUSSION

The suppression of annual bluegrass seedheads is an important agronomic practice in mixed stands of turfgrass. While Embark has been shown to reduce seedhead development, it is often met with an increased risk of injury to the desirable turfgrass species. Primo + Proxy has been shown to be efficacious at reducing annual bluegrass seedheads, but the timing of the application is much more difficult to target and therefore suppression may not be achieved. In this study, Embark provided the greatest suppression of annual bluegrass seedheads, but was

also met with injury to the turfgrass stands on both the putting green and the fairway trials. When tank-mixed with Civitas, the severe discoloration of turf on the putting green was able to be masked within approximately 4 weeks of application. The benefits of Civitas were less noticeable in the fairway trial which consisted of predominantly perennial ryegrass as the desirable turf species.

While the ability to mask the injury resulting in Embark applications has been to occur with Fe and other micronutrient treatments, this is the first time in which a horticultural-based oil fungicide has been shown to reduce injury. In this study, injury was masked approximately 4 weeks after a single application of Civitas. Future research should seek to determine if multiple applications of Civitas following single and sequential applications of various seedhead suppression products would provide additional reductions in injury without compromising seedhead suppression.

ACKNOWLEDGEMENTS

We thank David Livingston and the staff at the Valentine Turfgrass Research Facility for assisting in the maintenance of the research plots. This research was funded by Suncor and the Pennsylvania Turfgrass Council.

Table 1. Severity of annual bluegrass seedheads on a golf course fairway following the application of various plant growth regulators and Civitas, 2010.

	Seedhead severity[z]					
Treatment and rate per 1000 sq ft[y]	8 Apr	23 Apr	30 Apr	7 May	14 May	31 May
2P Civitas 16 fl oz	3.0 abc[x]	6.0 a	7.3 a	6.0 ab	6.8 a	2.3 a
2P Civitas 16 fl oz + Primo Maxx 0.125 fl oz	1.8 bcd	4.0 abc	6.0 a	7.0 ab	6.0 ab	2.0 a
Primo Maxx 0.125 fl oz	1.3 bcd	4.0 abc	6.3 a	8.0 a	7.0 a	2.0 a
Embark 2S IVM 4 fl oz	0.5 d	0.0 d	0.0 c	0.3 d	0.0 e	1.3 a
Embark 2S IVM 8 fl oz	0.0 d	0.0 d	0.0 c	0.0 d	0.0 e	1.0 a
Embark 2S IVM 4 fl oz + 2P Civitas 16 fl oz	1.0 cd	0.0 d	0.0 c	0.3 d	0.3 e	1.3 a
Embark 2S IVM 8 fl oz + 2P Civitas 16 fl oz	0.8 d	1.5 cd	2.0 bc	2.0 cd	2.0 de	1.3 a
Proxy 5 fl oz	4.5 a	4.8 ab	5.5 a	7.0 ab	4.0 bcd	1.5 a
Proxy 5 fl oz + Primo Maxx 0,125 fl oz	1.8 bcd	3.0 bc	5.0 ab	7.0 ab	5.0 abc	1.5 a
2P Civitas 16 fl oz w/ Proxy 5 fl oz w/ Primo Maxx 0.125 fl oz	3.3 ab	3.8 abc	5.3 a	4.8 bc	3.0 cd	1.8 a
2P Civitas 16 fl oz + Proxy 5 fl oz	4.3 a	3.5 abc	5.0 ab	4.5 bc	2.3 de	1.8 a
Untreated	3.0 abc	6.0 a	7.3 a	7.5 ab	5.8 ab	2.3 a

[z] Annual bluegrass seedhead severity was assessed by estimating the seedhead coverage on a 0 to 10 scale where 0 = no seedhead present and 10 = maximum annual bluegrass seedhead production.

[y] Treatments were applied on 1 Apr 2010.

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

Table 2. Turfgrass injury, color (NDVI), and canopy temperature on a golf course fairway following the application of various plant growth regulators and Civitas, 2010.

	Injury (0-5)[z]			Color[y]	Infrared Temp[x]
Treatment and rate per 1000 sq ft[w]	8 Apr	23 Apr	30 Apr	19 Apr	30 Apr
2P Civitas 16 fl oz	0.3 cd[v]	0.0 b	0.0 c	0.728 a	76.65 a
2P Civitas 16 fl oz + Primo Maxx 0.125 fl oz	0.0 d	0.0 b	0.0 c	0.745 a	78.65 a
Primo Maxx 0.125 fl oz	0.0 d	0.0 b	0.0 c	0.748 a	76.65 a
Embark 2S IVM 4 fl oz	1.5 ab	2.0 a	1.8 b	0.751 a	78.58 a
Embark 2S IVM 8 fl oz	2.0 a	2.8 a	3.0 a	0.725 a	78.63 a
Embark 2S IVM 4 fl oz + 2P Civitas 16 fl oz	1.3 abc	2.3 a	1.5 b	0.717 a	78.30 a
Embark 2S IVM 8 fl oz + 2P Civitas 16 fl oz	2.0 a	2.0 a	1.8 b	0.696 a	80.13 a
Proxy 5 fl oz	0.0 d	0.0 b	0.0 c	0.733 a	76.35 a
Proxy 5 fl oz + Primo Maxx 0,125 fl oz	0.5 bcd	0.0 b	0.0 c	0.754 a	76.33 a
2P Civitas 16 fl oz w/ Proxy 5 fl oz w/ Primo Maxx 0.125 fl oz	0.5 bcd	0.0 b	0.0 c	0.742 a	78.73 a
2P Civitas 16 fl oz + Proxy 5 fl oz	1.0 a-d	0.5 b	0.0 c	0.725 a	77.40 a
Untreated	0.5 bcd	0.0 b	0.0 c	0.729 a	78.73 a

[z] Turfgrass injury to perennial ryegrass and annual bluegrass was rated visually on a 0 to 5 scale where 0 = no injury; 3 = unacceptable injury for a golf course putting green; and 5 = entire plot area brown or dead.

[y] Turfgrass color was rated using a NDVI TCM 500 Turf Color Meter.

[x] Infrared temperatures were measure using a handheld infrared thermometer.

[w] Treatments were applied on 1 Apr 2010.

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

Table 3. Overall turfgrass quality of a golf course fairway following the application of various plant growth regulators and Civitas, 2010.

	Quality (0-9)[z]					
Treatment and rate per 1000 sq ft[y]	8 Apr	23 Apr	30 Apr	7 May	14 May	31 May
2P Civitas 16 fl oz	7.5 abc[x]	7.3 ab	7.0 ab	7.0 bc	6.5 de	6.8 bc
2P Civitas 16 fl oz + Primo Maxx 0.125 fl oz	8.3 a	8.0 a	7.3 a	7.3 bc	6.8 cde	7.8 a
Primo Maxx 0.125 fl oz	8.0 ab	7.3 ab	7.5 a	7.0 bc	6.3 e	7.8 a
Embark 2S IVM 4 fl oz	6.5 c	6.3 cd	6.3 bc	8.8 a	8.5 a	7.5 ab
Embark 2S IVM 8 fl oz	6.8 c	5.3 e	5.3 d	6.5 c	7.0 cde	7.3 abc
Embark 2S IVM 4 fl oz + 2P Civitas 16 fl oz	6.8 c	6.0 cde	7.0 ab	8.8 a	8.3 ab	7.5 ab
Embark 2S IVM 8 fl oz + 2P Civitas 16 fl oz	6.5 c	5.5 de	6.0 cd	7.0 bc	7.0 cde	6.5 c
Proxy 5 fl oz	7.5 abc	7.5 ab	7.0 ab	7.0 bc	6.5 de	6.5 c
Proxy 5 fl oz + Primo Maxx 0,125 fl oz	7.0 bc	7.8 a	7.3 a	7.3 bc	6.8 cde	7.0 abc
2P Civitas 16 fl oz + Proxy 5 fl oz + Primo Maxx 0.125 fl oz	7.5 abc	7.5 ab	7.5 a	7.8 b	7.5 bc	6.5 c
2P Civitas 16 fl oz + Proxy 5 fl oz	6.8 c	6.8 bc	7.0 ab	7.5 b	7.3 cd	6.8 bc
Untreated	7.0 bc	7.3 ab	7.0 ab	7.0 bc	6.5 de	7.0 abc

[z] Turfgrass quality was rated on a 1 to 9 scale where 1 = entire plot area brown or dead; 7 = minimum acceptable quality for a golf course putting green; and 9 = optimum greenness and density.

[y] Treatments were applied on 1 Apr 2010.

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

Table 4. Annual bluegrass seedhead severity, color (NDVI), and canopy temperature on a golf course putting green following the application of various plant growth regulators and Civitas, 2010.

	Seedhead severity[z]		Color[y]	Canopy temp[x]
Treatment and rate per 1000 sq ft[w]	7 May	14 May	19 Apr	30 Apr
2P Civitas 16 fl oz	6.8 ab[v]	5.0 abc	0.693 a	77.88 a
2P Civitas 16 fl oz + Primo Maxx 0.125 fl oz	6.5 bc	5.3 ab	0.692 a	79.20 a
Primo Maxx 0.125 fl oz	8.3 a	6.3 a	0.697 a	77.28 a
Embark 2S IVM 4 fl oz	2.3 f	1.8 ef	0.621 c	79.35 a
Embark 2S IVM 8 fl oz	1.3 f	1.5 ef	0.587 e	78.85 a
Embark 2S IVM 4 fl oz + 2P Civitas 16 fl oz	2.5 ef	2.0 def	0.615 cd	78.18 a
Embark 2S IVM 8 fl oz + 2P Civitas 16 fl oz	1.3 f	0.8 f	0.595 de	79.50 a
Proxy 5 fl oz	5.0 cd	4.8 abc	0.692 a	79.30 a
Proxy 5 fl oz + Primo Maxx 0,125 fl oz	6.3 bc	3.5 cd	0.701 a	78.18 a
2P Civitas 16 fl oz w/ Proxy 5 fl oz w/ Primo Maxx 0.125 fl oz	4.0 de	2.5 de	0.685 ab	78.58 a
2P Civitas 16 fl oz + Proxy 5 fl oz	4.5 d	4.3 bc	0.669 b	80.55 a
Untreated	6.5 bc	5.5 ab	0.693 a	78.30 a

[z] Annual bluegrass seedhead severity was assessed by estimating the seedhead coverage on a 0 to 10 scale where 0 = no seedhead present and 10 = maximum annual bluegrass seedhead production.

[y] Turfgrass color was rated using a NDVI TCM 500 Turf Color Meter.

[x] Infrared temperatures were measure using a handheld infrared thermometer.

[w] Treatments were applied on 1 Apr 2010.

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

Table 5. Turfgrass injury on a golf course putting green following the application of various plant growth regulators and Civitas, 2010.

	Injury (0-5)[z]			
Treatment and rate per 1000 sq ft[y]	8 Apr	23 Apr	30 Apr	7 May
2P Civitas 16 fl oz	0.5 c[x]	0.25 d	0.0 e	0.0 e
2P Civitas 16 fl oz + Primo Maxx 0.125 fl oz	0.8 c	0.25 d	0.0 e	0.0 e
Primo Maxx 0.125 fl oz	1.8 b	0.25 d	0.0 e	0.0 e
Embark 2S IVM 4 fl oz	2.3 ab	3.00 bc	2.8 c	1.3 c
Embark 2S IVM 8 fl oz	3.0 a	4.13 a	4.0 a	3.0 a
Embark 2S IVM 4 fl oz + 2P Civitas 16 fl oz	1.8 b	2.50 c	1.8 d	0.5 de
Embark 2S IVM 8 fl oz + 2P Civitas 16 fl oz	2.3 ab	3.63 ab	3.5 b	2.3 b
Proxy 5 fl oz	0.0 c	0.25 d	0.0 e	0.5 de
Proxy 5 fl oz + Primo Maxx 0,125 fl oz	0.5 c	0.00 d	0.0 e	0.0 e
2P Civitas 16 fl oz w/ Proxy 5 fl oz w/ Primo Maxx 0.125 fl oz	0.3 c	0.50 d	0.0 e	0.0 e
2P Civitas 16 fl oz + Proxy 5 fl oz	0.0 c	0.25 d	0.0 e	0.8 cd
Untreated	0.3 c	0.50 d	0.0 e	0.0 e

[z] Turfgrass injury to creeping bentgrass and annual bluegrass was rated visually on a 0 to 5 scale where 0 = no injury; 3 = unacceptable injury for a golf course putting green; and 5 = entire plot area brown or dead.

[y] Treatments were applied on 1 Apr 2010.

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

Table 6. Overall turfgrass quality of a golf course putting green following the application of various plant growth regulators and Civitas, 2010.

	Quality (0-9)[z]					
Treatment and rate per 1000 sq ft[y]	8 Apr	23 Apr	30 Apr	7 May	14 May	31 May
2P Civitas 16 fl oz	8.0 a[x]	7.5 a	8.3 a	7.0 a	7.3 a	8.0 a
2P Civitas 16 fl oz + Primo Maxx 0.125 fl oz	7.3 ab	7.5 a	8.0 a	7.0 a	7.3 a	7.8 a
Primo Maxx 0.125 fl oz	6.5 bc	7.8 a	8.0 a	7.0 a	6.5 a	7.8 a
Embark 2S IVM 4 fl oz	5.8 cd	5.0 bc	4.8 c	7.3 a	7.3 a	7.5 a
Embark 2S IVM 8 fl oz	5.0 d	3.5 d	3.3 d	5.5 c	6.5 a	8.0 a
Embark 2S IVM 4 fl oz + 2P Civitas 16 fl oz	6.0 c	5.5 b	6.3 b	7.5 a	7.8 a	7.8 a
Embark 2S IVM 8 fl oz + 2P Civitas 16 fl oz	5.8 cd	4.3 cd	4.3 c	6.3 b	7.3 a	7.5 a
Proxy 5 fl oz	7.3 ab	7.0 a	7.5 a	7.0 a	7.0 a	8.0 a
Proxy 5 fl oz + Primo Maxx 0,125 fl oz	7.3 ab	7.8 a	7.8 a	7.0 a	7.0 a	7.5 a
2P Civitas 16 fl oz w/ Proxy 5 fl oz w/ Primo Maxx 0.125 fl oz	7.3 ab	7.3 a	7.5 a	7.5 a	7.5 a	7.5 a
2P Civitas 16 fl oz + Proxy 5 fl oz	7.5 a	7.0 a	7.8 a	7.0 a	7.3 a	7.8 a
Untreated	7.3 ab	7.3 a	7.8 a	7.0 a	7.0 a	7.8 a

[z] Turfgrass quality was rated on a 1 to 9 scale where 1 = entire plot area brown or dead; 7 = minimum acceptable quality for a golf course putting green; and 9 = optimum greenness and density.

[y] Treatments were applied on 1 Apr 2010.

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