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SAFETY OF BISPYRIBAC-SODIUM ON COLONIAL BENTGRASS AND INFLUENCE ON BROWN PATCH SEVERITY

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ABSTRACT

Bispyribac-sodium can be used to selectively control ABG in stands of perennial ryegrass and creeping bentgrass. However, its safety is unknown when applied to CoBG, which can be found on golf course fairways in the Northeastern United States and other parts of the world. The primary objectives of this field study were to determine if the chlorosis elicited by BPS could be masked by tank-mixing the herbicide with a chelated iron (Fe) plus nitrogen (N) product and determine the effect of the herbicide on brown patch. Bispyribac-sodium was applied to mature, fairway-height CoBG two or three times at 49 or 74 g ai/ha on a two week interval. In 2005, BPS caused significant injury to 'SR7100' CoBG, but BPS+Fe+N did provide some respite from chlorosis. When applied to 'Allister' CoBG in 2007, BPS injury was less pronounced and BPS+Fe+N continued to provide near complete masking of chlorosis. In both years, BPS caused moderate to severe increases in brown patch, regardless of rate. Plots receiving two applications of BPS or BPS+Fe+N resulted in the least amount of brown patch when compared to other treated plots and had higher disease levels than the untreated control on the 2 or 3 to 4 rating dates, respectively. Plots receiving three applications of BPS or BPS and Fe+N generally had significantly greater percent brown patch on 4 of 5 rating dates when compared to the untreated control. Based on the results of this study, BPS may cause unacceptable injury to certain cultivars of CoBG, and is likely to increase brown patch severity.

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INTRODUCTION

Annual bluegrass (*Poa annua* L.) is a common and persistent weed on golf courses throughout the Northern United States and in many other parts of the world. While bentgrasses (*Agrostis* spp.) are considered desirable for use on golf course fairways, annual bluegrass can be an aggressive competitor and can rapidly dominate swards (McDonald et al., 2006).

Annual bluegrass is also susceptible to winter damage and summer heat stress (Vargas, 2005) as well as common diseases such as anthracnose basal rot caused by *Colletotrichum cereale* Manns [sensu lato Crouch, Clarke and Hillman]), summer patch caused by *Magnaporthe poae* Landschoot and Jackson, and others (Smiley et al., 2005).

Colonial bentgrass (*A. capillaris* L.; CoBG) is another *Agrostis* species used on golf courses in Europe and to a lesser extent the United States (Ruemmele, 2003). Interest in utilizing CoBG as a fairway turf in the Northern US is increasing due to its relatively low management requirements and lower susceptibility to dollar spot when compared to other species such as creeping bentgrass (*Agrostis stolonifera* L.) (Koeritz et al., 2005, Plumley et al., 2000). A major limitation to the use of CoBG in many parts of the country is its high susceptibility to brown patch (*Rhizoctonia solani* Kühn). Brown patch is a foliar disease that can become severe during hot, rainy, or humid weather (Smiley et al., 2005). While conditions favoring the development of brown patch can occur in the Northeastern US, they generally arise for a limited period of time during the summer months and can be effectively suppressed with fungicides (Kaminski, 2006; Kaminski and Putman, 2007; Kaminski and Putman 2008a).

Bispyribac-sodium (sodium 2,6-bis(4,6-dimethoxypyrimidin-2-yloxy) benzoic acid; BPS) is a relatively new herbicide labeled for the selective control of annual bluegrass in mixed stands of creeping bentgrass or perennial ryegrass (*Lolium perenne* L.) (Velocity label, online). Effective suppression of annual bluegrass requires multiple applications of BPS which generally elicits an objectionable chlorosis referred to as the "yellow flash" (Branham and Calhoun, 2005, Lycan et al., 2003; McCullough and Hart, 2006a; McDonald et al., 2006). Previous research, however, has shown that the yellowing caused by BPS as well as quinclorac (3,7-dichloro-8-quinolinecarboxylic acid) can be partially masked with chelated iron and nitrogen (Dernoeden et al., 2003; McDonald et al., 2006). To maximize efficacy on annual bluegrass, current recommendations state that BPS should be applied during the summer months (Lycan and Hart, 2005; McCullough and Hart, 2006b), when several turf diseases reach their peak activity (Smiley et al., 2005). BPS has been shown to reduce dollar spot severity (Askew et al., 2004; Branham and Calhoun, 2005; McCarty and Estes, 2005), but an increase in severity of Pythium blight due to BPS has been reported (Askew, 2006). While BPS has been reported to reduce brown patch severity in creeping bentgrass (Rimelspach et al., 2006), the influence of BPS on the disease in CoBG is unknown.

The ability to utilize BPS as a selective postemergent control of annual bluegrass in stands of CoBG would be beneficial to turf managers. However, the safety of BPS on CoBG and the influence of BPS on brown patch in CoBG are unknown. The objectives of this study were to: 1) evaluate the safety of repeated applications of BPS to CoBG, 2) determine the impact of BPS on brown patch, and 3) evaluate the ability of an Fe + N product to mask any chlorosis to BPS-treated CoBG.

MATERIALS AND METHODS

This study was conducted in 2005 and 2007 at the University of Connecticut Plant Science Research and Education Facility located in Storrs, CT USA. Soil was a Woodbridge fine sandy loam with a pH of 6.4 and 2.7% organic matter. The site used for the 2005 study was seeded to 'SR7100' CoBG at a rate of 50 kg seed/ha in October 2004. The area received N from a starter fertilizer (19-25-5) at a rate of 74 kg/ha prior to winter and received an additional 123 kg N/ha in the spring prior to initiation of treatments. 'Allister' CoBG was seeded at a rate of 50 kg seed per ha in August 2006 for use as the 2007 study site. This study site received 95 kg N per ha from various complete fertilizers (18-24-12, 20-20-20, or 22-3-11) prior to winter, and 83 kg N per ha from urea (46-0-0) in 2007 prior to the initiation of treatments. In both years, turf was mowed three to four times per week to a height of 1.3 cm, and clippings were removed. In 2005, irrigation was provided only to prevent drought stress. To encourage brown patch in 2007, the study site was occasionally irrigated in the early evening (1700 to 1900 hours) to maximize leaf wetness.

Bispyribac-sodium was applied twice at 74 g ai/ha, or three times at 49 g ai/ha or 74 g ai/ha. All BPS treatments were applied either alone or tank-mixed with an Fe + N product (Lesco's 12-0-0 Chelated Iron Plus Micronutrients, Troy, MI USA). The Fe + N product was applied at 19.1 L/ha and provided $FeSO_4$, N, S, and Mn at 1.1, 2.2, 0.7, and 0.4 kg/ha, respectively. Plots measured 1.5 x 1.5 m (2005) or 0.9 x 1.8 m (2007), and were arranged in a randomized complete block design with four replications. All treatments were applied with a CO_2 pressurized (276 kPa) backpack sprayer equipped with a flat-fan nozzle, and calibrated to deliver 467 liters of water per ha. All treatments and application dates are listed in the data tables.

Percent of plot area blighted by *R. solani* was visually estimated on a 0 to 100 scale where 0 = entire plot healthy and 100 = entire plot area affected by brown patch. Injury to CoBG was assessed visually on a 0 to 5 scale where 0 = entire plot healthy; ≥2 = unacceptable chlorosis for a golf course fairway; and 5 = entire plot brown or dead. Data were subjected to analysis of variance

Table 1. Colonial bentgrass (*Agrostis capillaris*) injury following applications of bispyribac-sodium, Storrs, CT, 2005.

Treatment and rate	App. timing‡	Injury†				
		20 Jun	27 Jun	3 Jul	9 Jul	18 Jul
Bispyribac-sodium 49 g ai/ha	ABC	3.0 a§	0.4 b	3.0 a	3.0 abc	2.9 a
Bispyribac-sodium 74 g ai/ha	ABC	3.3 a	1.0 a	2.3 b	3.4 ab	3.1 a
Bispyribac-sodium 74 g ai/ha	AB	2.9 a	1.1 a	3.0 a	3.5 a	0.0 d
Bispyribac-sodium 49 g ai/ha + Fe + N 19.1 L/ha	ABC	1.5 b	0.0 b	1.5 c	2.3 c	1.6 b
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	ABC	1.8 b	0.0 b	1.4 c	2.5 bc	1.6 b
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	AB	1.6 b	0.0 b	1.3 c	2.8 abc	0.8 c
Untreated		0.0 c	0.0 b	0.0 d	0.0 d	0.0 d
P ≤ F¶		***	***	***	***	***

†Colonial bentgrass injury was assessed visually on a 0 to 5 scale where 0 = entire plot healthy; ≥2 = unacceptable chlorosis; and 5 = entire plot brown or dead.

‡Treatments were applied as follows: A = 13 June; B = 27 June; C = 9 July.

§Means in a column followed by the same letter are not significantly different ($P \leq 0.05$) according to Fisher's protected significant difference test.

¶*, **, and *** indicate statistical differences at P ≤ 0.05, 0.01, and 0.001, respectively. NS = not significant.

Table 2. Percent brown patch (*Rhizoctonia solani*) in a colonial bentgrass (*Agrostis capillaris*) fairway following applications of bispyribac-sodium, Storrs, CT, 2005.

Treatment and rates	App. timing‡	Percent brown patch†				
		3 Jul	18 Jul	25 Jul	2 Aug	26 Aug
Bispyribac-sodium 49 g ai/ha	ABC	38 ab§	46 bc	66 ab	67 ab	55 b
Bispyribac-sodium 74 g ai/ha	ABC	44 a	68 a	79 a	84 a	73 a
Bispyribac-sodium 74 g ai/ha	AB	25 b	21 d	37 c	24 cd	19 c
Bispyribac-sodium 49 g ai/ha + Fe + N 19.1 L/ha	ABC	22 bc	45 bc	66 ab	58 b	52 b
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	ABC	29 ab	58 ab	80 a	81 a	75 a
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	AB	26 b	28 cd	49 bc	39 c	25 c
Untreated		6 c	2 d	11 d	6 d	9 c
P ≤ F¶		*	***	***	***	***

†Percent plot area blighted by *R. solani* was visually estimated on a linear 0 to 100 scale where 0 = entire plot area healthy and 100 = entire plot area blighted.

‡Treatments were applied as follows: A = 13 June; B = 27 June; C = 9 July.

§Means in a column followed by the same letter are not significantly different ($P \leq 0.05$) according to Fisher's protected significant difference test.

¶* and *** indicate statistical differences at P ≤ 0.05 and 0.001, respectively. NS = not significant.

using the MIXED procedure in SAS (SAS Institute, Version 9.1, Cary, NC USA), and means were separated ($P \leq 0.05$) using Fisher's protected least significant difference test.

RESULTS

In 2005, one week after treatments were initiated, BPS applied alone resulted in unacceptable chlorosis (2.9 to 3.3) to the CoBG regardless of application rate (Table 1). Two weeks after the first application, only minor yellowing remained in plots treated with BPS alone. On 20 Jun, 7 days after the first application, only minor chlorosis was observed in plots treated with BPS+Fe+N, and no discoloration was observed by 27 Jun. On 3 July (1 week after the second application), unacceptable (2.3 to 3.0) and minor (1.3 to 1.5) chlorosis appeared within plots treated with BPS alone and BPS tank-mixed with Fe+N, respectively. Unlike the first application, however, all plots receiving BPS alone or in combination with Fe+N resulted in moderate to severe chlorosis (2.3 to 3.5) when rated on 9 July (2 weeks after the second application). On the final rating date (18 July), plots receiving 2 applications of BPS exhibited no discoloration. Although plots receiving only 2 applications of BPS+ Fe+N had significantly more chlorosis than the untreated control plots, the discoloration was not unacceptable.

Although chlorosis varied from minor to severe, percent plot area affected by brown patch was generally severe in BPS-treated plots during the study. Between 3 July and 26 August, percent brown patch within the untreated control plots and the six treatments receiving BPS ranged from 2% to 11% and 19% to 84%, respectively (Table 2). Plots receiving three applications of BPS or BPS+Fe+N had significantly greater percent brown patch on at least 4 of 5 rating dates when compared to the untreated control. When BPS+Fe+N were applied twice, percent brown patch increased to 49% on 25 July (approximately one month after last treatment) and was significantly greater than the untreated control on 3 of 5 rating dates. Percent plot area affected by brown patch ranged from 19 to 37% within plots receiving BPS alone applied twice; however, these levels were similar to brown patch within the untreated control on 60% of the rating dates.

Table 3. Colonial bentgrass (*Agrostis capillaris*) injury and turf quality following applications of bispyribac-sodium, Storrs, CT, 2007.

Treatment and rate	App. timing‡	Injury†		
		6 Aug	14 Aug	21 Aug
Bispyribac-sodium 49 g ai/ha	ABC	0.8 ab§	1.5 b	0.8 a
Bispyribac-sodium 74 g ai/ha	ABC	0.8 ab	2.0 a	0.5 a
Bispyribac-sodium 74 g ai/ha	AB	1.3 a	0.3 c	0.0 a
Bispyribac-sodium 49 g ai/ha + Fe + N 19.1 L/ha	ABC	0.0 c	0.0 c	0.0 a
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	ABC	0.0 c	0.0 c	0.0 a
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	AB	0.5 bc	0.0 c	0.0 a
Untreated		0.0 c	0.0 c	0.0 a
P ≤ F¶		***	***	NS

†Colonial bentgrass injury was assessed visually on a 0 to 5 scale where 0 = entire plot healthy; ≥2 = unacceptable chlorosis; and 5 = entire plot brown or dead.

‡Treatments were applied as follows: A = 10 July; B = 24 July; C = 7 August.

§Means in a column followed by the same letter are not significantly different ($P \leq 0.05$) according to Fisher's protected least significant difference test.

¶** and *** indicate statistical differences at P ≤ 0.01 and 0.001, respectively. NS = not significant.

In 2007, chlorosis to the 'Allister' CoBG was minimal during the study. On 6 August (2 weeks after the second application), only minor chlorosis was observed within plots treated with BPS alone (Table 3). Limited to no discoloration was observed within plots treated with BPS+Fe+N on any rating date. Unacceptable chlorosis to the CoBG was observed on a single rating date and occurred 1 week after the third application of BPS (74 g ai/ha), but dissipated to an acceptable level within 2 weeks following treatment.

Trace levels of brown patch were observed at the initiation of the study on 10 July. One week after the initial treatment, brown patch incidence was moderate (19% to 25%) in plots treated with bispyribac-sodium alone when compared to the untreated control (11%) (Table 4). The trend for increasing brown patch within

Table 4. Percent brown patch (*Rhizoctonia solani*) in a colonial bentgrass (*Agrostis capillaris*) fairway following applications of bispyribac-sodium, Storrs, CT, 2007.

Treatment and rate	App. timing‡	Percent brown patch†				
		17 Jul	24 Jul	6 Aug	14 Aug	21 Aug
Bispyribac-sodium 49 g ai/ha	ABC	25 a§	23 ab	23 b	31 ab	18 abc
Bispyribac-sodium 74 g ai/ha	ABC	21 ab	24 ab	29 ab	31 ab	25 a
Bispyribac-sodium 74 g ai/ha	AB	19 b	19 bc	27 ab	16 cd	4 d
Bispyribac-sodium 49 g ai/ha + Fe + N 19.1 L/ha	ABC	12 c	23 ab	24 b	28 b	9 cd
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	ABC	14 c	28 a	30 ab	38 a	22 ab
Bispyribac-sodium 74 g ai/ha + Fe + N 19.1 L/ha	AB	21 ab	28 a	34 a	24 bc	12 bcd
Untreated		11 c	16 c	11 c	10 d	8 cd
P ≤ F¶		***	*	***	***	*

†Percent plot area blighted by *R. solani* was visually estimated on a linear 0 to 100 scale where 0 = entire plot area healthy and 100 = entire plot area blighted.

‡Treatments were applied as follows: A = 10 Jul; B = 24 Jul; C = 7 August.

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

¶*, **, and *** indicate statistical differences at P ≤ 0.05, 0.01, and 0.001, respectively. NS = not significant.

BPS-treated plots continued and by 6 August, two weeks following the second application, all treated plots had a greater percentage of brown patch (23 to 34%) than the untreated plots (11%). Between 6 and 14 August, brown patch increased within plots treated a third time with BPS or BPS+Fe+N, whereas,, CoBG within plots receiving only 2 applications of BPS or BPS and Fe+N began to recover. On the final rating date (21 August), only plots treated three times with 74 g ai/ha of BPS (regardless of Fe+N) had percentages of brown patch greater than the untreated control plots.

DISCUSSION

Although tank-mixing Fe+N with BPS resulted in a general reduction in CoBG chlorosis, multiple applications of BPS caused unacceptable levels of discoloration to 'SR7100' CoBG. When the study was repeated in 2007 on a different cultivar, chlorosis to the CoBG was generally minor and Fe+N appeared to mask discoloration during the study. Differences in cultivar susceptibility to applications of BPS may have played an important role in the overall phytotoxicity observed in this study. Although Kentucky bluegrass (*Poa pratensis* L.) has previously exhibited unacceptable injury from applications of BPS, a wide range of injury has been observed among cultivars (Shortell et al., 2006).

Increased levels of brown patch were observed following application of BPS applied alone or tank mixed with Fe+N. Under severe disease pressure in 2005, percent of the plot area affected by brown patch in plots treated twice with BPS or BPS and Fe+N was greater than the untreated control on 40% to 60% of the rating dates. Under moderate disease pressure and on a different cultivar in 2007, this trend was less apparent and percent plot area affected by brown patch within plots treated twice with BPS alone was similar to the untreated control on 60% of the rating dates. When compared to the untreated control plots, all other treatments in 2007 exhibited greater percent brown patch on 60% to 100% of the rating dates.

Results of this study suggest that bispyribac-sodium may increase the severity of brown patch in CoBG. These results are consistent with previous research in which an increase in brown patch was observed when repeated applications of BPS were applied to tall fescue (*Schedonorus phoenix* (Scop.) Holub) (Kaminski and Putman, 2008b). Although brown patch on CoBG increased in this study following the application of BPS, future evaluation of the tolerance of CoBG cultivars to the herbicide may be warranted. It would also be helpful to determine if the use of plant protectants would be useful in reducing the increase in brown patch when BPS is applied.

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