

Impact of Bispyribac-sodium Application on Annual Bluegrass Control and Brown Patch Severity in Tall Fescue¹

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Abstract

Annual bluegrass (*Poa annua* L.) is a problematic weed in tall fescue [*Festuca arundinacea* (Schreb.) S.J. Darbyshire], with limited options available for postemergence control. Field research was conducted to evaluate bispyribac-sodium application rates (37 or 74 g ai-ha⁻¹) (0.033 or 0.066 lb ai-A⁻¹) and timings (March, April or May) as well as iron supplementation on brown patch (*Rhizoctonia solani*) severity, annual bluegrass control, and tall fescue quality. In general, applying bispyribac-sodium to tall fescue did not result in significantly more brown patch than in untreated plots in field trials. Applying bispyribac-sodium in March or April resulted in significantly higher annual bluegrass control than applications in May. In greenhouse experiments, bispyribac-sodium at 37 and 74 g ai-ha⁻¹ (0.033 or 0.066 lb ai-A⁻¹) was applied to brown patch-inoculated tall fescue plants. Under conditions of high inoculum and humidity in those greenhouse studies, applications of bispyribac-sodium increased the number of brown patch lesions relative to untreated plants. Tall fescue plant height was initially reduced after being treated with bispyribac-sodium; however, six weeks after application tall fescue plants in treated with herbicide were taller than the nontreated plants.

Index words: weed control, disease incidence.

Species used in this study: tall fescue (*Festuca arundinacea* Schreb.) S.J. Darbyshire synonym *Schedonorus phoenix* (Scop.) Holub]; annual bluegrass (*Poa annua* L.); *Rhizoctonia solani* Kuhn.

Chemicals used in this study: bispyribac sodium 2,6-bis[(4,6-dimethoxy-2-pyrimidinyl)oxy]benzoate (Velocity).

Significance to the Nursery Industry

Annual bluegrass is a troublesome weed in landscape maintenance and there currently exists no selective controls in spring for infestations in tall fescue. Bispyribac (Velocity) is a potential selective control option in established turfgrass, although previous research suggested it may increase disease levels in bentgrass (*Agrostis* spp.). Velocity applications in March or April significantly decreased annual bluegrass populations in two out of three years. Leaf chlorosis was observed in tall fescue following bispyribac application, but the injury decreased over time, with turfgrass quality occasionally exceeding the untreated. Bispyribac has a growth-regulating effect on tall fescue, temporarily decreasing height, with a darker green color observed during recovery. Although greenhouse trials indicated an increase in brown patch lesions following application of bispyribac to tall fescue, applications in field trials did not result in a significant increase in this disease.

Introduction

Annual bluegrass (*Poa annua* L.) is a troublesome weed in tall fescue [*Festuca arundinacea* (Schreb.) S.J. Darbyshire synonym *Schedonorus phoenix* (Scop.) Holub] and other cool-season grasses. Annual bluegrass is adapted to low-mowed, irrigated, well-maintained turfgrass (11, 20). The yellow-green leaf color and prominent whitish seedheads of annual bluegrass negatively impact the aesthetic value of tall fescue stands. Typically, preemergence herbicides such as prodiamine, pendimethalin, or dithiopyr are applied in late summer or early fall to control annual bluegrass (4). However, if tall fescue is overseeded in the fall then prodiamine, pendimethalin, or dithiopyr herbicides cannot be applied without damaging the tall fescue seedlings (23). Siduron is a preemergence herbicide that can be applied safely to tall fescue seedlings; however, this herbicide does not control annual bluegrass (23). Currently, no postemergence herbicides are labeled for control of annual bluegrass in tall fescue in the spring. A postemergence herbicide that has potential to control annual bluegrass in tall fescue is bispyribac-sodium. Bispyribac-sodium is in the pyrimidinyloxybenzoic acid family and is herbicidal due to its ability to inhibit the acetolactase synthetase (ALS) enzyme, which is responsible for the synthesis of the branched chain amino acids valine, leucine and isoleucine in plants (23). Bispyribac-sodium was first adopted for control of barnyardgrass (*Echinochloa crus-galli* L. Beauv) in rice production (18). Bispyribac-sodium's selectivity is based on the species' ability to detoxify the herbicide. Bispyribac-sodium is effective at controlling annual bluegrass in creeping bentgrass fairways (*Agrostis stolonifera* L.) (14). Preliminary studies have reported minimal phytotoxicity when bispyribac-sodium is applied to tall fescue. Additionally, phytotoxicity attributed to bispyribac-sodium in creeping bentgrass can be reduced by mixing chelated iron with the herbicide (19). Bispyribac-sodium has fungicidal

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properties. Application of bispyribac-sodium to creeping bentgrass has been shown to reduce dollar spot, a disease caused by the fungal pathogen *Sclerotinia homoeocarpa* Bennett (18). However, other reports indicate that applications of bispyribac-sodium may increase brown patch disease incidence in bentgrass species (*Agrostis* spp.) (12).

Brown patch is caused by the fungal pathogen *Rhizoctonia solani* Kuhn (22) and is problematic in multiple grass species including tall fescue. In turfgrass infected with *R. solani*, leaves initially appear dark and water soaked and cream-colored lesions form on the leaves; subsequently, the infected leaves dry out, wither, and turn a dark brown. Brown and black colored sclerotia may be found beneath the leaf or on roots. When no attempt is made to control brown patch, thinning of the turf can occur, resulting in the encroachment of undesirable weedy species. Upon contact with the plant, rounded *R. solani* hyphae grow over the plant surface. Actual infection begins when the hyphae flatten out and press into the epidermal cells of the plant (2, 7). Hyphal internodes shorten and form side branches at right angles, which are a distinguishing characteristic of *R. solani*. Branching of hyphae can form tightly packed dome-shaped infection cushions that adhere tightly to the surface of the plant. Infection pegs are formed from the swollen hyphal tips (10). It is believed that the hyphal tips function to find weak sites of the plant in which to initiate penetration (17). Subsequently, the thin infection peg exerts enough pressure on the outside of the plant to penetrate the cuticle. In addition to mechanized pressure, enzymatic activity aides in penetration of the host plant.

Applications of herbicides may impact the interaction between plants and plant pathogens. One study looking at the transcriptome response of *Arabidopsis thaliana* determined that 478 genes were either up or down regulated in the presence of ALS inhibiting herbicides, including genes involved in defense (8). Thus, application of bispyribac-sodium may have an impact on enzymatic defense mechanisms in tall fescue. In general, herbicide applications can impact pathogen-plant interactions by altering the morphology and physiology of the host plant (1). Changes in plants due to herbicide application that may perturb disease incidence include alteration in nitrogen, glucoside, and carbohydrate metabolism as well as reduction or stimulation in plant growth. Pathogen populations in the soil can be altered by herbicide application as well. Pathogens that use the herbicide as a food source will flourish while pathogens injured by that the herbicide will decrease in number (5).

The benefits of controlling annual bluegrass with bispyribac-sodium in overseeded tall fescue might be negated if the herbicide increased brown patch severity. If applications of bispyribac-sodium increase brown patch severity then the tall fescue stand could be thinned, which could lead to annual bluegrass and other weed infestations the following spring. If bispyribac-sodium is to be utilized in tall fescue, it is important to optimize application strategies for effective annual bluegrass control while minimizing phytotoxicity and brown patch severity.

The objectives of this research were to evaluate the impact of bispyribac-sodium rate and application timing on annual bluegrass control, brown patch severity and phytotoxicity in tall fescue field and greenhouse experiments. Optimization of these application parameters may provide information that would help determine if bispyribac-sodium should be labeled for use in tall fescue.

Materials and Methods

Field evaluation of bispyribac-sodium efficacy. Research was conducted at the Virginia Tech Hampton Roads Agricultural Research and Extension Center located in Virginia Beach, VA. The experiments were conducted using a randomized complete block with 4 replications. All studies were repeated. 'Southern Belle' tall fescue plots 2.1 by 3.0 m (7 by 10 ft) were mowed at 10 cm (4 in), received 171 kg N·ha⁻¹ (150 lb N·A⁻¹) annually using a 19N-0P-15.8K slow-release fertilizer, and irrigated weekly. Annual bluegrass control, turf quality and brown patch cover ratings were taken visually from April until the end of June. Brown patch and annual bluegrass ratings were estimated visually and reported as a percent rating for the entire plot. Turfgrass quality ratings were taken visually on a 1 to 9 scale where 1 indicates dead turf and 9 indicates lush green turf. All data were subjected to ANOVA ($\alpha = 0.05$) in SAS (Statistical Analysis Software, Cary, NC) using mixed model methodology.

Impact of bispyribac-sodium application on brown patch, annual bluegrass control, and tall fescue injury in field trials. The study was established in separate areas in the spring of 2009, 2010, and 2011. Tall fescue plots were subjected to a factorial treatment of bispyribac-sodium application rate (37 or 74 g·ha⁻¹) (0.033 or 0.066 lb ai·A⁻¹) and application timing (April 22 or May 22) with a repeat application two weeks later. These treated plots were compared to a nontreated control. In 2010 and 2011, a March 22 application date with a repeat application date was included in the study.

Impact of chelated iron with bispyribac-sodium on tall fescue injury and brown patch in field trials. The experiment was established in 2010 and repeated in an adjacent area in 2011. The treatments included a nontreated control, bispyribac-sodium applied alone at 37 g·ha⁻¹ (0.033 lb ai·A⁻¹), and bispyribac sodium applied at the same rate tank mixed with chelated-iron. The liquid Fe plus N product was tank-mixed with bispyribac-sodium to provide FeSO₄ at 1.1 kg·ha⁻¹ + N at 2.2 kg·ha⁻¹ + S at 0.7 kg·ha⁻¹ + Mn at 0.4 kg·ha⁻¹ (1.0, 2.0, 0.6, and 0.3 lb·A⁻¹, respectively). Treatments were applied March 22, April 22, or May 22 with a repeat application two weeks later in each year. The preemergence herbicide prodiamine was applied in October in order to reduce the influence of weeds on the epidemiology of brown patch in tall fescue and allow for easier visual evaluations regarding the phytotoxicity of bispyribac-sodium on tall fescue.

Impact of bispyribac-sodium on brown patch lesions and turf growth in greenhouse trials. This study evaluated the interaction between bispyribac-sodium, *Rhizoctonia solani* and 'Matador' tall fescue in a climate-controlled setting. The experimental design was a split block with 5 replications. Tall fescue plants were grown in calcined clay media consisting of 75% SiO₂ (Profile Products LLC, 750 Lake Cook Rd., Suite 440, Buffalo Grove, IL 60089) in pots 25 cm (10 in) in diameter with one pot per plot. The greenhouse had light shutters and fans in order to moderate temperature, which ranged from 25 to 30C during the day. Pots were fertilized once at 50 kg N·ha⁻¹ (45 lb N·A⁻¹) with a 15-3.9P-10K slow release fertilizer. The tall fescue plants were mowed to 8 cm (3 in) weekly and after 3 months were placed in humidity chambers that received *R. solani* inoculum or no inoculum. Plants were irrigated with an overhead mist system. A protocol developed

by Burpee et al. (1991) was followed to inoculate the plants. The *Rhizoctonia solani* isolates used were from anastomosis grouping AG2-IIIB isolate LD 312 and were collected from tall fescue (Donated by Sajeewuh Amaradasa, USDA, Beltsville, MD). Treatment design consisted of a factorial of plants receiving inoculum or no inoculum, and bispyribac sodium applied at 37 or 74 g·ha⁻¹ (0.033 or 0.066 lb ai·A⁻¹). Bispyribac-sodium was applied twice on a two week interval to plants 6, 4 or 0 weeks prior to inoculation. Non-inoculated and inoculated controls were incorporated into the study. Each treatment was replicated four times. Plant height was measured once a week, prior to the weekly mowing. Brown patch lesions were counted 14 days after inoculation. The upper 7 cm (3 in) of the tall fescue canopy were harvested and lesions greater than 0.5 cm (0.2 in) were counted for the first 75 shoots in each treatment from the upper canopy. The experiment was repeated. Tall fescue height was measured in plants receiving the initial bispyribac-sodium treatment at 6 weeks before inoculation. The plants were measured one week after the first herbicide application. Inoculation did not have a significant effect on plant height, thus the average of inoculated and non-inoculated plants is presented.

Results and Discussion

Impact of bispyribac-sodium application on brown patch, annual bluegrass control, and tall fescue injury in field trials. Herbicide timing and herbicide rate had a significant effect on annual bluegrass cover in 2009. On April 21 of the 2009 study, which was before any herbicide treatments were applied, annual bluegrass cover ranged from 26 to 29% (Table 1). The highest annual bluegrass control was achieved when bispyribac-sodium was applied at 74 g·ha⁻¹ (0.066 lb·A⁻¹) in April. Applying bispyribac-sodium in May regardless of rate resulted in unacceptable annual bluegrass cover in June of 2009. Due to the success of the April applications, an earlier application date (March) was added in the 2010 study.

In 2010, herbicide rate or timing did not have a significant effect on annual bluegrass cover. Annual bluegrass cover in the untreated plots was 46% on the first rating date, which was almost double the amount of annual bluegrass cover observed in the 2009 study. The March application of bispyribac-sodium at 74 g·ha⁻¹ initially reduced annual bluegrass cover numerically in April; however, annual bluegrass recovered by the next rating date. April applications of bispyribac-sodium in 2010 were not as effective as the 2009 study. The reduced efficacy could be due to more mature annual bluegrass plants at treatment in 2010 compared to 2009 due to more favorable growing conditions in the fall of 2009.

The differences in herbicide efficacy may be attributed to differences in annual bluegrass size between the two study years. Rainfall from October through November of 2008 was 27.0 cm (10.6 in); comparatively, rainfall from October through November of 2009 was 50.0 cm (20 in). Therefore, the annual bluegrass plants were more robust coming into the spring of 2010 compared to the spring of 2009.

In 2011, applying bispyribac-sodium, regardless of rate or timing, resulted in significantly less annual bluegrass cover when compared to untreated plots in May (Table 1). Annual bluegrass naturally transitioned out of the tall fescue stand by the June rating date in 2011. The reason for this earlier transition in the 2011 study may be due to decreased spring rainfall when compared to the other study years. In 2011, only 25 cm (10 in) of rain fell from March until June while 40 to 45 cm (16 to 18 in) of rain fell during the spring in the other studies. In all study years, annual bluegrass cover was less than 5% on the July 25 rating dates (data not shown).

The results of these studies are slightly different than other studies evaluating bispyribac-sodium timing on annual bluegrass control. In New Jersey, applications of bispyribac-sodium in July resulted in less annual bluegrass cover on a creeping bentgrass fairway than April applications (14). The differences in efficacy may be attributed to the cooler

Table 1. Impact of bispyribac-sodium rate and timing on annual bluegrass cover in tall fescue in the 2009, 2010 and 2011 trials.

Study year	Bispyribac-sodium timing	Bispyribac-sodium rate	Annual bluegrass percent cover ^a		
			April 21	May 21	June 19
2009	April 22 + May 7	37 g·ha ⁻¹	26a	8ab	4bc
	April 22 + May 7	74 g·ha ⁻¹	26a	2b	1c
	May 22 + June 6	37 g·ha ⁻¹	27a	24a	15a
	May 22 + June 6	74 g·ha ⁻¹	29a	28a	11ab
	Untreated	Untreated	26a	26a	18a
2010	March 22 + April 6	37 g·ha ⁻¹	34a	34a	38a
	March 22 + April 6	74 g·ha ⁻¹	19a	28a	33a
	April 22 + May 7	37 g·ha ⁻¹	39a	28a	31a
	April 22 + May 7	74 g·ha ⁻¹	45a	25a	26a
	May 22 + June 6	37 g·ha ⁻¹	45a	40a	35a
	May 22 + June 6	74 g·ha ⁻¹	40a	45a	24a
	Untreated	Untreated	47a	45a	40a
2011	March 22 + April 6	37 g·ha ⁻¹	10a	7b	0a
	March 22 + April 6	74 g·ha ⁻¹	7a	6b	0a
	April 22 + May 7	37 g·ha ⁻¹	18a	4b	0a
	April 22 + May 7	74 g·ha ⁻¹	7a	5b	0a
	May 22 + June 6	37 g·ha ⁻¹	9a	14a	0a
	May 22 + June 6	74 g·ha ⁻¹	18a	15a	0a
	Untreated	Untreated	23a	19a	0a

^aAll means within a column followed by the same letter in the same year are not significantly different according to Fishers protected LSD at the 0.05 level. Application rates are 0.033 and 0.066 lb ai·A⁻¹.

Table 2. Impact of bispyribac-sodium rate and timing on tall fescue quality in the 2009, 2010 and 211 trials.

Study year	Bispyribac-sodium timing	Bispyribac-sodium rate	Tall fescue quality (1–9) ²		
			April 21	May 21	June 21
2009	April 22 + May 7	37 g·ha ⁻¹	7.0a	3.8b	7.5a
	April 22 + May 7	74 g·ha ⁻¹	7.1a	2.9b	8.0a
	May 22 + June 6	37 g·ha ⁻¹	6.9a	6.6a	2.0d
	May 22 + June 6	74 g·ha ⁻¹	7.1a	6.9a	2.8c
	Untreated	Untreated	7.1a	7.1a	6.5b
2010	March 22 + April 6	37 g·ha ⁻¹	4.0b	7.1a	7.0a
	March 22 + April 6	74 g·ha ⁻¹	3.8b	7.0a	7.5a
	April 22 + May 7	37 g·ha ⁻¹	7.0a	4.0b	6.5b
	April 22 + May 7	74 g·ha ⁻¹	7.0a	2.9b	7.6a
	May 22 + June 6	37 g·ha ⁻¹	6.9a	6.5a	3.0c
	May 22 + June 6	74 g·ha ⁻¹	7.0a	6.9a	2.8c
	Untreated	Untreated	7.0a	7.0a	7.5a
2011	March 22 + April 6	37 g·ha ⁻¹	5.5b	6.7b	6.0a
	March 22 + April 6	74 g·ha ⁻¹	4.8b	7.9a	6.0a
	April 22 + May 7	37 g·ha ⁻¹	7.0a	5.9bc	6.0a
	April 22 + May 7	74 g·ha ⁻¹	7.1a	5.4c	6.0a
	May 22 + June 6	37 g·ha ⁻¹	7.1a	6.6b	6.0a
	May 22 + June 6	74 g·ha ⁻¹	7.6a	6.0bc	6.0a
	Untreated	Untreated	7.0a	6.3b	6.0a

²All means within a column followed by the same letter in the same year are not significantly different according to Fishers protected LSD at the 0.05 level. Application rates are 0.033 and 0.066 lb ai A⁻¹.

temperatures in New Jersey, where April application allowed the plants to recover, compared to the warmer Virginia Beach site. Other studies showing the effectiveness of bispyribac-sodium applied at 74 g·ha⁻¹ (0.066 lb·A⁻¹) with repeat applications in the summer on annual bluegrass control occurred in the cooler climates of Blacksburg, VA, New Jersey, and Maryland (3, 9, 16).

Study year had a significant effect on brown patch ratings as well, but herbicide timing or herbicide rate did not have a significant effect on brown patch severity during these field studies. Other studies report that applications of bispyribac-sodium may increase brown patch in bentgrass species (12), but is likely not the case in tall fescue grown in the field.

Study year and herbicide timing impacted turfgrass quality ratings ($p < 0.05$). In April and May of 2009, the untreated plots had a quality rating of 7.1 (Table 2). Initially, applications of bispyribac-sodium resulted in chlorosis in tall fescue that reduced the quality rating of the plots. However, two months after bispyribac-sodium application, treated plots were darker green than nontreated plots. Different trends for quality were observed in 2010. On April 21, the quality of tall fescue in the nontreated check was 7.0. Applying bispyribac-sodium in March at 37 and 74 g·ha⁻¹ (0.033 and 0.066 lb·A⁻¹) resulted in turfgrass quality ratings of 4.0 and 3.8, respectively on April 21. No increase in green color was observed two months after bispyribac-sodium application in the 2010 trial. On some dates in 2011, an increase in green color was observed following application of bispyribac-sodium. In 2011 a rate and timing effect ($p < 0.05$) was observed on the May 21 date. Applying bispyribac-sodium on the March application date at 74 g·ha⁻¹ (0.066 lb·A⁻¹) resulted in significantly darker green plots compared to the nontreated plots. For later application dates, increasing the rate generally led to lower quality ratings. Tall fescue quality ratings at the end of July were consistently 6.0 across all treatments all years (data not shown). No increase of green color was observed in May

treated plots on the July rating date and all phytotoxicity had subsided by the July rating date (data not shown).

Impact of chelated iron with bispyribac-sodium on tall fescue injury and brown patch in field trials. Study year, herbicide timing and iron supplements affected quality ratings ($p < 0.05$). Applications of bispyribac-sodium alone in March resulted in turfgrass quality ratings of 6.5 on April 21, 2010 (Table 3). The turfgrass quality in the untreated plots and plots treated with bispyribac-sodium plus chelated iron in March was 7.0, thus the iron masked the yellow discoloration occurring after bispyribac-sodium application. However, on some rating dates, iron supplementation resulted in lower quality ratings. In April 2011, applications of bispyribac-sodium and iron resulted in lower quality on the May rating date than plots treated with bispyribac-sodium alone.

Percent brown patch severity was minimal in April and May 2010 and throughout 2011. In spite of significant brown patch at other times in this study, bispyribac-sodium had no effect on brown patch regardless of iron treatment.

Impact of bispyribac-sodium on brown patch lesions and turf growth in greenhouse trials. One week after herbicide application, the plant height for untreated control plants was 15 cm (Fig. 1). Plants treated with bispyribac-sodium were approximately 8 cm (3 in) tall regardless of rate at one, two, and three weeks after herbicide treatment. The first symptom of ALS-inhibiting herbicides is a cessation of mitosis, thus the reduction in plant growth was expected. Four weeks after application, there were no significant differences among treatments and the range of plant height was between 8 and 10 cm (3 and 4 in). Five weeks after the initial treatment, the height of the untreated control plants was 8.5 cm (3.3 in) and plants treated with 37 g·ha⁻¹ (0.033 lb·A⁻¹) of bispyribac-sodium had increased to 13 cm (5.1 in) just prior to weekly mowing. Six weeks after application, plants treated with

Table 3. Impact of bispyribac-sodium timing and iron supplementation on visual tall fescue quality.

Study year	Bispyribac-sodium timing	Iron	Quality ratings ^z		
			April 21	May 21	June 19
2010	March 22 + April 6	No	6.5a	7.0a	7.6a
	March 22 + April 6	Yes	7.0a	7.0a	6.5ab
	April 22 + May 7	No	7.0a	6.0b	6.5ab
	April 22 + May 7	Yes	7.0a	7.0a	7.0a
	May 22 + June 6	No	7.0a	7.0a	5.3b
	May 22 + June 6	Yes	7.0a	7.0a	5.1b
	Untreated	Untreated	7.0a	7.0a	7.1a
2011	March 22 + April 6	No	6.0b	7.0a	6.0a
	March 22 + April 6	Yes	6.5b	7.0a	6.0a
	April 22 + May 7	No	8.0a	7.1a	6.0a
	April 22 + May 7	Yes	8.0a	6.1b	6.0a
	May 22 + June 6	No	8.0a	6.6a	6.0a
	May 22 + June 6	Yes	8.0a	7.0a	6.0a
	Untreated	Untreated	8.0a	7.0a	6.0a

^zAll means within a column followed by the same letter in the same year are not significantly different according to Fishers protected LSD at the 0.05 level. Bispyribac-sodium was applied at 37 g ai·ha⁻¹ (0.033 lb ai·A⁻¹).

either rate of bispyribac-sodium had grown to 13 cm (5.1 in) while plants in the untreated control were shorter than 10 cm (4 in).

All plants treated with bispyribac-sodium had more brown patch lesions compared to the nontreated check two weeks after inoculation (Table 4). Typically, a greater number of brown patch lesions were recorded on plants treated with bispyribac-sodium 6 plus 4 weeks before inoculation when compared to application timings close to the inoculation date. Application rate did not have an effect on the number of brown patch lesions. One month after inoculation, brown patch was so severe in all the plants that there was no discernible way to count individual lesions.

Optimal conditions for bispyribac-sodium application. Based on the results of the field studies, applying bispyribac-sodium twice in April at 74 g·ha⁻¹ (0.066 lb·A⁻¹) per application would maximize annual bluegrass control. Generally, there was higher quality in tall fescue on the June rating date when the herbicide was applied in April versus May. Ad-

ditionally, the increase in green color observed two months after the April application in 2009 and 2011 did not occur two months after the May applications. Applying bispyribac-sodium in April provided better annual bluegrass control when compared to May and March applications. Applying bispyribac-sodium in the cooler March temperatures, which ranged between 8 and 12C (46 to 54F) in 2010 and 2011, may allow the annual bluegrass plants to recover. Previous growth chamber experiments determined that increasing temperatures from 10 to 30C (50 to 86F) resulted in improved annual bluegrass control with bispyribac-sodium (21). If the applications must be made in March then a third application may be needed for acceptable control. In addition to the recuperative ability of annual bluegrass plants, the size of the plants should be considered as well. Applying bispyribac-sodium in May was not as effective in some years likely because the annual bluegrass was larger at herbicide application, thus harder to control.

Based on these studies, we would recommend applying bispyribac-sodium in late April at 74 g·ha⁻¹ (0.066 lb·A⁻¹) with chelated iron. Also, due to the phytotoxicity caused by the initial bispyribac-sodium application and an increase in green color in tall fescue plants seen 4 to 6 weeks after application, we would recommend only broadcast application. Spot spraying bispyribac-sodium may create a mottled

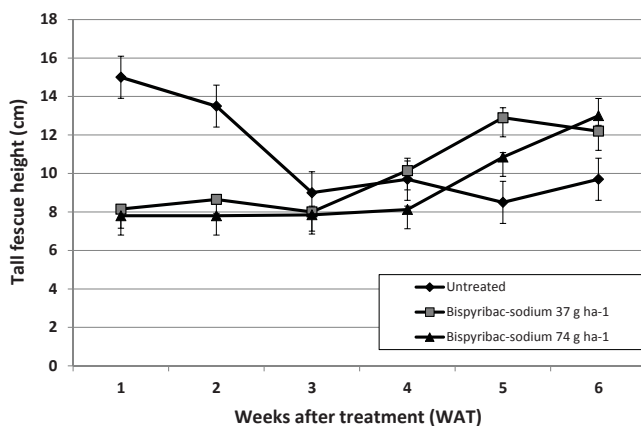


Fig. 1. Impact of bispyribac-sodium on tall fescue height (cm) 1 to 6 weeks after initial treatment (WAT) averaged across two greenhouse assays and inoculation treatment. Error bars signify LSD (0.05).

Table 4. Impact of bispyribac-sodium application timing and rate on brown patch lesion counts 14 days after inoculation.

Application timing	Herbicide rate	Brown patch lesions per 75 shoots ^z
6,4 weeks before inoculation	37 g·ha ⁻¹	24.3a
6,4 weeks before inoculation	74 g·ha ⁻¹	25.0a
4,2 weeks before inoculation	37 g·ha ⁻¹	19.3bc
4,2 weeks before inoculation	74 g·ha ⁻¹	15.5cd
0,2 weeks after inoculation	37 g·ha ⁻¹	19.0bc
0,2 weeks after inoculation	74 g·ha ⁻¹	23.5ab
Untreated check		11.3d

^zAll means with the same letter group are not significantly different according to Fishers protected LSD at the 0.05 level. Application rates are 0.033 and 0.066 lb ai·A⁻¹.

pattern in the turf stand. Caution should be exercised if bispyribac-sodium is labeled in tall fescue. Under greenhouse conditions of high humidity and inoculum increased brown patch incidence was observed in treated plants. If these conditions occur in a field situation then the turf manager might want to incorporate a fungicide program into their summer budget. Nevertheless, bispyribac-sodium would provide a useful tool for managers of tall fescue with annual bluegrass infestations.

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