CHAPTER FOUR

SULFOSULFURON AND BISPYRIBAC-SODIUM COMBINED WITH OVERSEEDING CREEPING BENTGRASS FOR FAIRWAY CONVERSION

Abstract

Roughstalk bluegrass (*Poa trivialis* L.) contamination is problematic on golf course fairways from the Midwest to the Mid-Atlantic. Bispyribac-sodium and sulfosulfuron have potential to selectively control roughstalk bluegrass. Our objective was to determine the most effective herbicide treatments for short- and long-term roughstalk bluegrass control and to determine if overseeding with creeping bentgrass after herbicide treatments will improve long-term control of roughstalk bluegrass or conversion to creeping bentgrass. Studies were conducted in Indiana in 2006 and 2007. Plots were treated with bispyribac-sodium or sulfosulfuron and then half of each plot was overseeded with creeping bentgrass in early August, two weeks after the final herbicide application. The most effective herbicide treatments for roughstalk bluegrass appear to be sulfosulfuron at 27 g a.i. ha^{-1} applied three times or bispyribac-sodium at 37, 56, or 74 g a.i. ha^{-1} applied four times, while sulfosulfuron at 13 g a.i. ha^{-1} applied two or three times and at 27 g a.i. ha^{-1} applied two times were the least effective herbicide treatments. Overseeding with creeping bentgrass improved long-term roughstalk bluegrass control and quickened conversion to creeping bentgrass.

Introduction

Roughstalk bluegrass (*Poa trivialis* L.) contamination is problematic on golf course fairways from the Midwest to the Mid-Atlantic. Roughstalk bluegrass has poor drought and heat tolerance, thus turf areas with substantial roughstalk bluegrass populations thin in late summer, decreasing aesthetic and functional quality (Christians, 2004). Selective herbicide control is valuable since cultural management of roughstalk bluegrass has not been effective. However, bare areas remain after large patches of roughstalk bluegrass are eliminated. Overseeding with the desired turf species shortly after herbicide application could help fill-in bare areas and introduce species that will potentially compete with surviving roughstalk bluegrass.

Two selective herbicides in controlling roughstalk bluegrass are bispyribac-sodium (2,6-bis[(4,6-dimethoxypyrimidin-2-yl)oxy] benzoic acid) and sulfosulfuron (1-(4,6-dimethoxypyrimidin-2-yl)-3-[2-ethanesulfonyl-imidazo[1,2-a]pyridine-3-yl) sulfonyl]urea). Bispyribac-sodium is labeled for use in turfgrass as Velocity^{TM} (Valent U.S.A. Corp., Walnut Creek, CA) and sulfosulfuron is labeled for use in turfgrass as Certainty^{TM} (Monsanto, St. Louis, MO). Our previous research has shown that sulfosulfuron and bispyribac-sodium are effective for controlling roughstalk bluegrass (Morton et al., 2007). For instance, bispyribac-sodium at 56 and 74 g a.i. ha^{-1} applied four times on a two week interval decreased cover by > 85% 12 WAIT (weeks after initial treatment) at one location while sulfosulfuron at 27 g a.i. ha^{-1} applied three times on a two week interval reduced roughstalk bluegrass cover by 34% 8 WAIT at another location (Morton et al., 2007). In a two-year Virginia study, three applications of bispyribac-sodium at 37 g a.i. ha^{-1} starting in June, August, or September reduced roughstalk bluegrass at 10 WAIT by 88, 48, and 11%, respectively, and increasing the rate to 74 g ha^{-1} resulted in 93, 95 and 31% control, respectively (Askew et al., 2004). Since seeding creeping bentgrass after bispyribac-sodium or sulfosulfuron applications can be safely done within two weeks of application (Lycan and Hart, 2005 and 2006), our objective was to determine the most effective

herbicide treatments for short- and long-term roughstalk bluegrass control and to determine if overseeding with creeping bentgrass after herbicide treatments will improve long-term control of roughstalk bluegrass and conversion to creeping bentgrass.

Materials and Methods

Treatments were initiated in June 2006 and 2007 at the W.H. Daniel Turfgrass Research and Diagnostic Center, West Lafayette, IN. Experimental area was 'Laser' roughstalk bluegrass originally seeded at 98 kg ha^{-1} in Aug 2004, with < 10% contamination of creeping bentgrass at initiation of study. Soil type was a Starks-Fincastle silt loam (Fine-silty, mixed, mesic Aeric Ochraqualfs) with a pH of 7.2 and organic matter content of 3.8%. Treatments were arranged in a split plot design with eight herbicide treatments as main plots and two seeding treatments as subplots. Main plots were 3 x 1.5 m with 0.5 m untreated alleyways between each main plot and subplots were 1.5 x 1.5 m. Herbicide applications are listed in Table 4-1. All herbicide applications were applied in 814 L ha^{-1} water with a CO_2-pressurized backpack sprayer using a three-nozzle (TeeJet XR8001.5VS, Spraying Systems Co., Wheaton, IL) boom at 207 kPa. Throughout the experiment, turf received 196 kg N ha^{-1} yr^{-1} and was irrigated to ensure optimal growth before seeding and to encourage germination after seeding. Turf was mowed three times per week at 1.25 cm and clippings were returned. Experimental areas were on a preventative greens fungicide program, mainly targeting dollar spot, brown patch, and pythium, applied every ten to fourteen days in June, July, and August in both years.

One half of each main plot was seeded with 'L 93' creeping bentgrass at 49 kg ha^{-1} in early August, two weeks after the final herbicide application (Table 4-2). Sixty four grams of 6-0-2 organic fertilizer was added to the seed as a bulking material. The seedbed was prepared by aerating the entire experimental area with 0.64 cm diameter solid tines using a ride-on aerifier with 5 x 5 cm spacing. After emergence, the plots were mowed three times per week at 1.25 cm

and clippings were returned. Initial seeding was not successful in 2007 due to above average heat and disease pressure, and the area was reseeded on 5 Sept 2007 in the same manner as previously described. Plots initially treated in 2006 were re-treated and re-seeded in 2007 following the same procedure as stated above and plots initially treated in 2007 will be retreated and reseeded in 2008.

Percent cover of creeping bentgrass and roughstalk bluegrass were rated visually every two weeks from mid-June to mid-November in both years. Cover at 0 WAIS (weeks after initial seeding) is presented as an indication of short-term herbicide effects prior to germination, 14 WAIS was prior to winter, and 42 WAIS was prior to initiation of the second year of herbicide applications. Data were analyzed using PROC GLM (SAS Institute, Cary, NC). An arcsin transformation was performed on the data and a two-tailed F-test was performed on the transformed data to test homogeneity of errors. Error variances were not homogenous, and thus data were not combined across years. Analysis of roughstalk bluegrass cover in 2007 revealed 0% cover and zero variance for sulfosulfuron at 27 g a.i. ha^{-1} applied three times at 14 WAIS, thus this treatment was removed from the analysis.

Results and Discussion

Study 1: Averaged over herbicide treatments, seeded plots had 29% roughstalk bluegrass at 42 WAIS compared to 53% roughstalk bluegrass in the unseeded plots (Figure 4-1), but there was no seeding affect at 14 WAIS (Table 4-3). This indicates overseeding with creeping bentgrass is advantageous for long-term roughstalk bluegrass control. All herbicide treatments reduced roughstalk bluegrass cover to ≤ 50% at 0 WAIS compared to the untreated control, which retained 83% cover (Table 4-3 and Figure 4-2). Sulfosulfuron at 27 g a.i. ha^{-1} applied three times and bispyribac-sodium at 37, 56, and 74 g a.i. ha^{-1} were the most effective in controlling roughstalk bluegrass, resulting in ≤ 1% cover 0 WAIS. Even though a similar trend was observed

at 14 WAIS, plots that received sulfosulfuron at 27 g a.i. ha^{-1} applied three times and bispyribac-sodium at 37 g a.i. ha^{-1} recovered significantly. Recovery was likely due to spread from uncontrolled stolons and indicates the need for long-term control data on roughstalk bluegrass. This trend continued through 42 WAIS where sulfosulfuron at 27 g a.i. ha^{-1} and all three bispyribac-sodium treatments reduced roughstalk bluegrass cover to ≤ 27% compared to 87% in the untreated control.

Averaged over herbicide treatments, seeded plots had 51% creeping bentgrass cover compared to 18% in the unseeded plots by 14 WAIS (Figure 4-1). Seeded plots had 69% creeping bentgrass cover by 42 WAIS compared to 39% creeping bentgrass in the unseeded plots. Creeping bentgrass in unseeded plots was most likely due to prior contamination, which spread quickly with reduced competition from roughstalk bluegrass after herbicide applications. Averaged over seeding treatments, plots treated with sulfosulfuron at 27 g a.i. ha^{-1} applied three times or bispyribac-sodium at 37, 56, or 74 g a.i. ha^{-1} had ≥ 43% creeping bentgrass at 14 WAIS compared to the untreated control with 5% creeping bentgrass (Figure 4-2). The remaining sulfosulfuron treatments and the untreated control had equivalent creeping bentgrass cover at 14 WAIS. Plots that received sulfosulfuron at 27 g a.i. ha^{-1} or bispyribac-sodium at 37, 56, or 74 g a.i. ha^{-1} had ≥ 71% creeping bentgrass compared to 12% creeping bentgrass in the untreated control by 42 WAIS (Figure 4-2).

Combining overseeding with herbicide treatments improved short- and long-term cover and thus minimized disruption. Averaged over herbicide treatment, seeded plots had 97% total cover at 14 WAIS compared to 77% in the unseeded plots, which increased to 100% and 96% cover at 42 WAIS, respectively (Figure 4-1). Over 52% of the cover in the unseeded plots at 42 WAIS was roughstalk bluegrass compared to 29% roughstalk bluegrass cover in the seeded plots. This suggests that creeping bentgrass seeded after sulfosulfuron or bispyribac-sodium

applications fills in bare areas left after removing roughstalk bluegrass and competes with any remaining roughstalk bluegrass.

Study 2: All herbicide treatments reduced roughstalk bluegrass cover to ≤ 13% by 0 WAIS compared to the untreated control with 50% roughstalk bluegrass cover (Figure 4-3). This was markedly different from 2006 due to irrigation malfunctions causing the experimental areas to dry out early in the season and then become saturated later in the season. This is consistent with our anecdotal observations where roughstalk bluegrass herbicides are more effective when the roughstalk bluegrass is environmentally stressed following applications. All herbicide treatments reduced roughstalk bluegrass cover to ≤ 6% compared to 41% in the untreated control by 14 WAIS.

A significant seed x herbicide interaction occurred in creeping bentgrass and total cover at 14 WAIS in 2007 (Table 4-3). Though there were some minor differences between herbicide treatments with and without overseeding, the interaction was primarily due to the untreated control. Little creeping bentgrass established in untreated plots regardless of overseeding (Figure 4-4), likely due to competition from roughstalk bluegrass which retained 41% cover in the untreated control (Figure 4-3). These results are similar to the seen by Gaussoin and Branham (1989) where there was little to no change in creeping bentgrass cover after overseeding 'Penncross' creeping bentgrass without a previous herbicide application in a mixed annual bluegrass/creeping bentgrass stand.

Conclusions

The most effective herbicide treatments for roughstalk bluegrass appear to be sulfosulfuron at 27 g a.i. ha^{-1} applied three times or bispyribac-sodium at 37, 56, or 74 g a.i. ha^{-1} applied four times.

Though these herbicides control roughstalk bluegrass and will allow creeping bentgrass already present in the treated areas to spread, overseeding with creeping bentgrass will improve long-term roughstalk bluegrass control and speed conversion to creeping bentgrass.

Literature Cited

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Table 4-1. Herbicide application dates for 2006 and 2007.

Herbicide	Rate (g a.i. ha^{-1} app^{-1})[y]	2006	2007
Sulfosulfuron[z]	13	13 July, 27 July	12 July, 27 July
Sulfosulfuron	13	29 June, 13 July, 27 July	29 June, 12 July, 27 July
Sulfosulfuron	27	13 July, 27 July	12 July, 27 July
Sulfosulfuron	27	29 June, 13 July, 27 July	29 June, 12 July, 27 July
Bispyribac-sodium	37	15 June, 29 June, 13 July, 27 July	15 June, 29 June, 12 July, 27 July
Bispyribac-sodium	56	15 June, 29 June, 13 July, 27 July	15 June, 29 June, 12 July, 27 July
Bispyribac-sodium	74	15 June, 29 June, 13 July, 27 July	15 June, 29 June, 12 July, 27 July
Untreated control	--	--	--

[y]Applied every two weeks.

[z]All sulfosulfuron treatments included MON 0818 surfactant at 0.25% v/v.

Table 4-2. Seeding dates for Studies 1[x] and 2 in 2006, 2007, and 2008.

	2006	2007	2008
Study 1	10 Aug	10 Aug/5 Sept[y]	--
Study 2	--	10 Aug/5 Sept	*10 Aug*[z]

[x]Study 1 was initiated in June, 2006 and Study 2 was initiated in June, 2007.
[y]2007 seedings were unsuccessful because of intense heat and disease pressure, and were reseeded.
[z]Study 2 will be re-treated and re-seeded in 2008.

Table 4-3. ANOVA for percent cover of roughstalk bluegrass and creeping bentgrass in 2006 and 2007. An arcsin transformation was performed on the data.

	2006			2007	
	0 WAIS[z] 10 Aug	14 WAIS 17 Nov	42 WAIS 14 June	0 WAIS 8 Aug	14 WAIS 13 Nov
Roughstalk bluegrass					
Seed	--	ns	**	--	ns
Herbicide	**	*	**	**	**
Seed x Herbicide	--	ns	ns	--	ns
Creeping bentgrass					
Seed	--	**	**	--	**
Herbicide	ns	*	**	ns	ns
Seed x Herbicide	--	ns	ns	--	**
Total cover					
Seed	--	**	**	--	**
Herbicide	--	*	*	--	ns
Seed x Herbicide	--	ns	ns	--	*

[z]WAIS = weeks after initial seeding

[ns, *, **] Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively

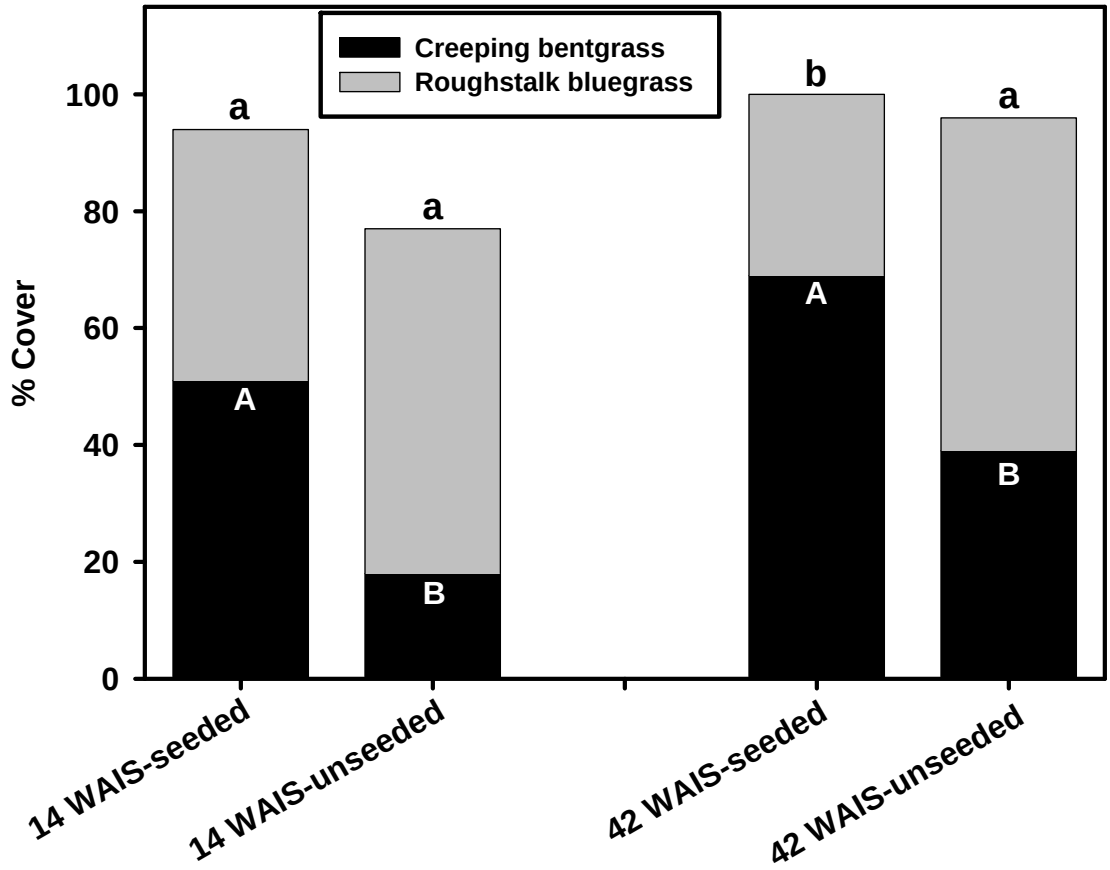

Figure 4-1. Roughstalk bluegrass and creeping bentgrass cover at 14 and 42 WAIS (weeks after initial seeding) as a result of seeding treatments in 2006. Means are back-transformed and averaged over eight herbicide treatments and three replications. Lower case letters are used to compare roughstalk bluegrass cover while upper case letter are used to compare creeping bentgrass cover. Bars with the same letter and case, and within the same rating date are not significantly different ($P < 0.05$).

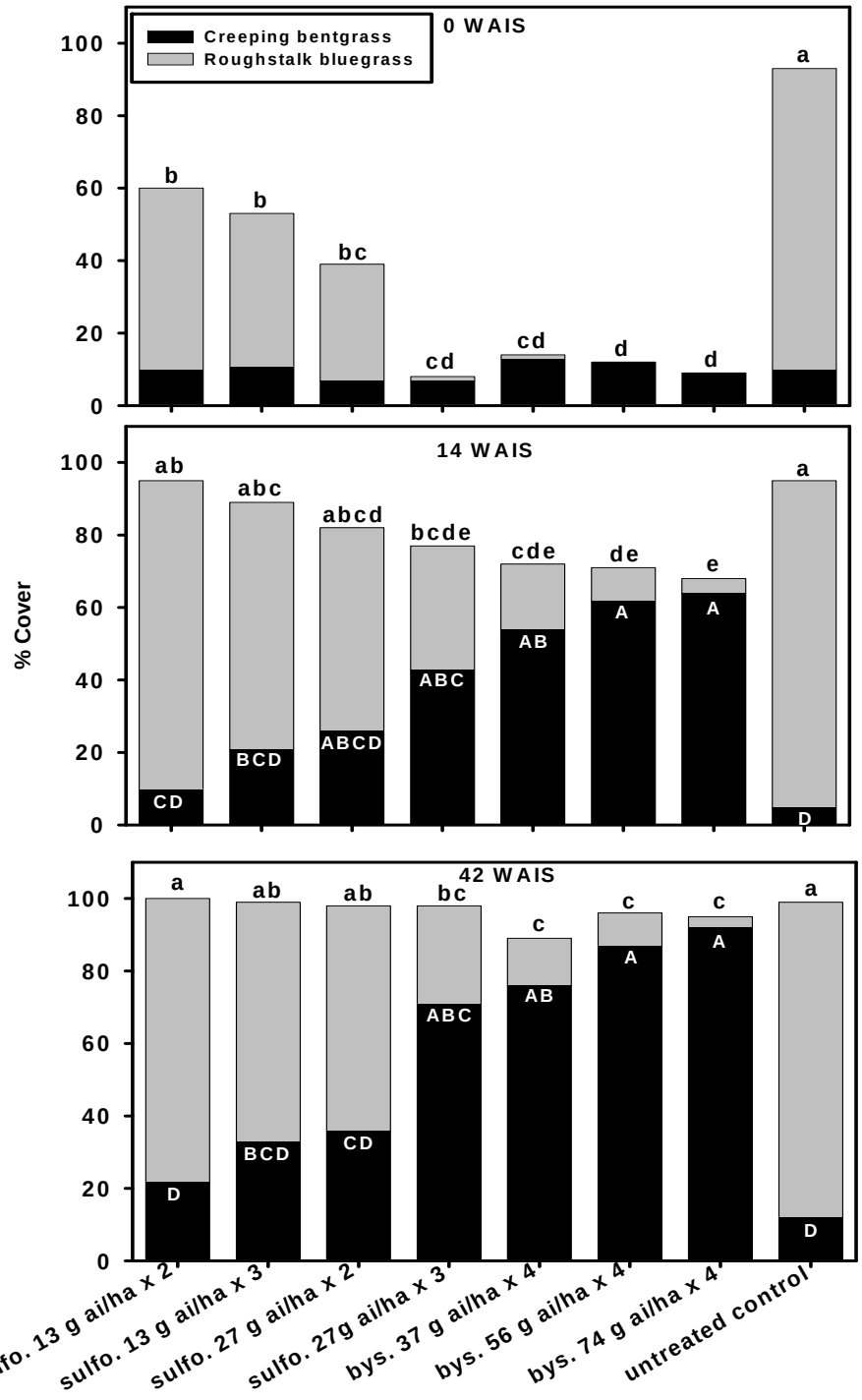

Figure 4-2. Roughstalk bluegrass and creeping bentgrass cover as a result of sulfosulfuron (sulfo.) and bispyribac-sodium (bys) 0 , 14, and 42 WAIS (weeks after initial seeding) in 2006. Means are back-transformed and averaged over two seeding treatments and three replications. Lower case letters are used to compare roughstalk bluegrass cover while upper case letter are used to compare creeping bentgrass cover. Bars with the same letter and case, and within the same rating date are not significantly different ($P < 0.05$).

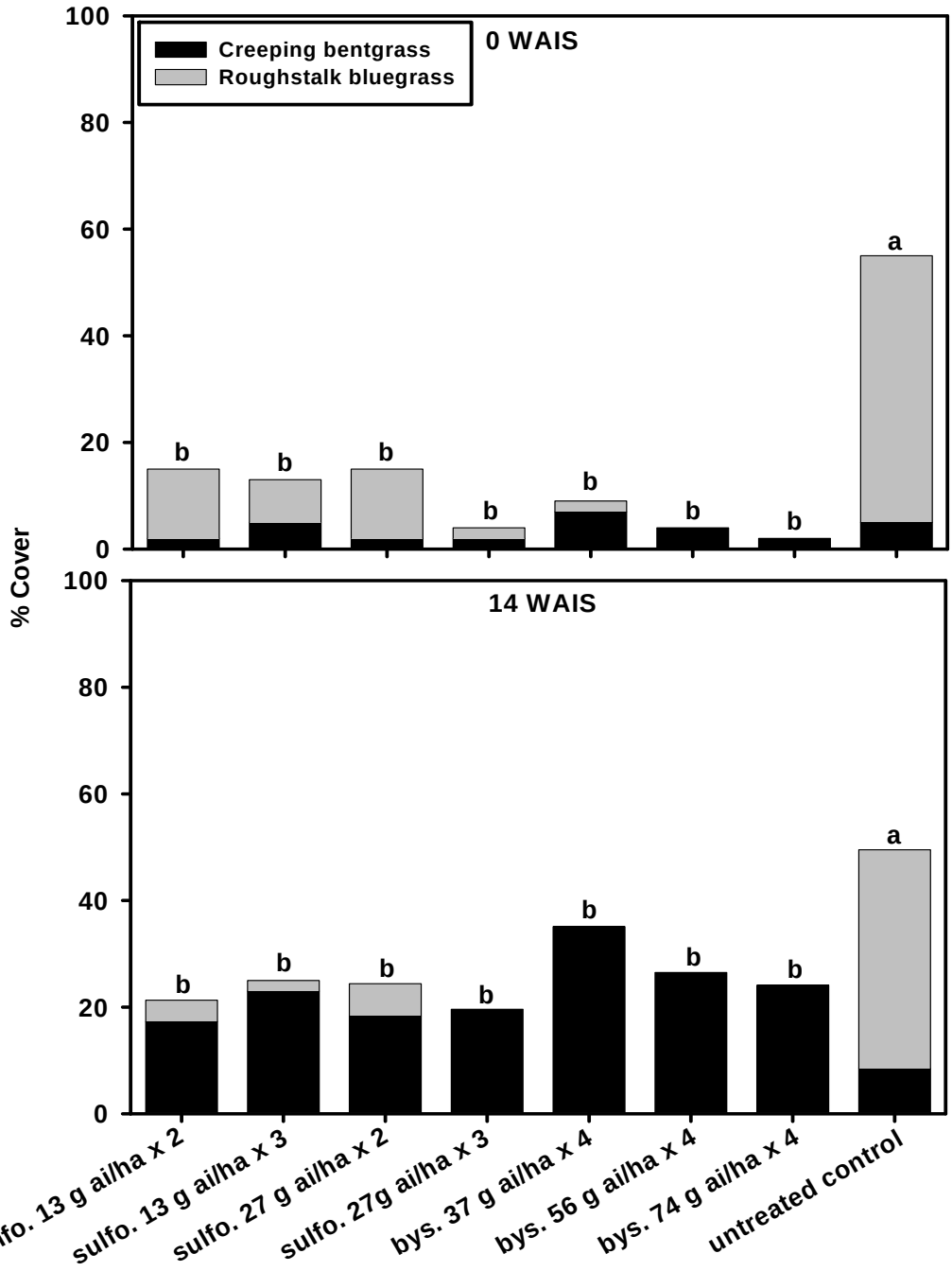

Figure 4-3. Roughstalk bluegrass and creeping bentgrass cover as a result of sulfosulfuron (sulfo.) and bispyribac-sodium (bys.) 0 and 14 WAIS (weeks after initial seeding) in 2007. Means are back-transformed and averaged over two overseeding treatments and three replications. Lower case letters are used to compare roughstalk bluegrass cover while upper case letter are used to compare creeping bentgrass cover. Bars with the same letter and case, and within the same rating date are not significantly different ($P < 0.05$).

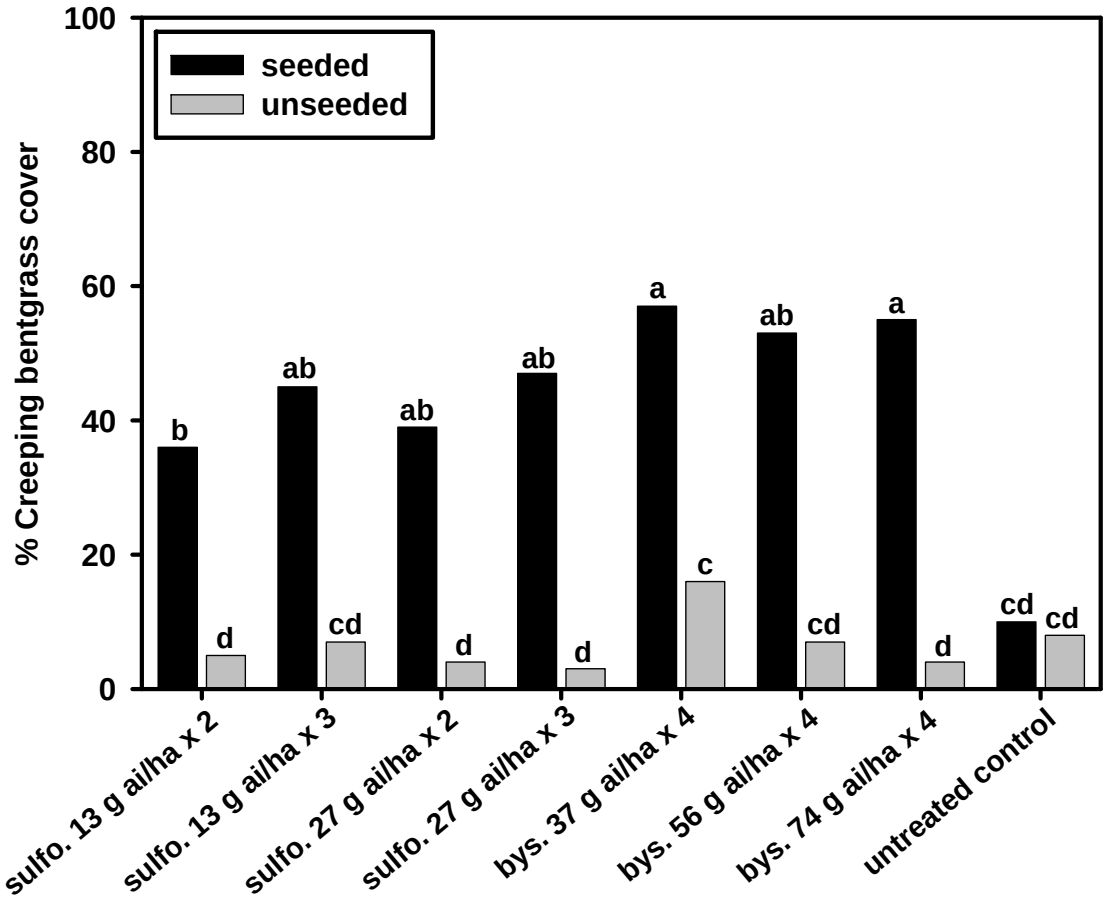

Figure 4-4. Creeping bentgrass cover as a result of sulfosulfuron (sulfo.) and bispyribac-sodium (bys.) and two seeding treatments 14 WAIS (weeks after initial seeding) in 2007. Means are back-transformed and averaged over three replications. Bars with the same letter are not significantly different ($P < 0.05$).