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Herbicides Applied at or Shortly after Seeding Are Effective for Weed Control in Seedling Buffalograss

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RESEARCH

Herbicides Applied at or Shortly after Seeding Are Effective for Weed Control in Seedling Buffalograss

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Abstract

Herbicides applied shortly after seeding of buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.] can help reduce weed pressure and maximize establishment of buffalograss. This study evaluated 12 relatively recently developed herbicides for turf safety and weed control when applied at seeding or 0 or 2 weeks after emergence (WAE) of 'Bowie' or 'Sundancer' buffalograss. Primary weed species on the site were common purslane (*Portulaca oleracea* L.), redroot pigweed (*Amaranthus retroflexus* L.), and/or yellow foxtail [*Setaria lutescens* (Weigel ex Stuntz) F.T. Hubb.]. Regardless of cultivar, untreated checks had <15% buffalograss cover and >53% weed cover by 6 WAE, whereas most of the herbicide treatments resulted in >80% buffalograss cover and <20% weed cover. Mesotrione, sulfentrazone, quinclorac, carfentrazone, simazine, amicarbazone, sulfentrazone + quinclorac, carfentrazone + quinclorac, or sulfentrazone + prodiamine applied either at seeding or 0 WAE are safe on Bowie or Sundancer buffalograss, effectively minimize weed pressure, and maximize buffalograss establishment. Herbicides applied at 2 WAE were less effective than earlier applications at minimizing weed pressure and resulted in lower buffalograss establishment.

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Abbreviations: AS, at seeding; WAE, weeks after emergence; WAT, weeks after treatment.

WEED CONTROL DURING BUFFALOGRASS ESTABLISHMENT

Buffalograss is a warm-season grass native to the North American Great Plains (Wenger, 1943). Buffalograss requires low inputs after establishment, with its relatively low growth habit, drought tolerance, and natural competitiveness (Browning et al., 1994; McCarty and Colvin, 1992; Qian et al., 1997; Wenger, 1941, 1943).

Previous reports suggest differential herbicide tolerance among buffalograss cultivars as well as differences in the ability of individual cultivars to recover from initial damage. Five out of 13 postemergence herbicides caused significant injury to 'Sharp's Improved' buffalograss 1 or 2 weeks after treatment (WAT) when applied at 1- to 3-leaf or 2- to 4-tiller stage, and four of these herbicides were phenoxy or benzoic

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Table A. Useful conversions.

To convert Column 1 to Column 2, multiply by	Column 1 Suggested Unit	Column 2 SI Unit
0.304	foot, ft	meter, m
2.54	inch	centimeter, cm (10^{-2} m)
0.405	acre	hectare, ha
9.29×10^{-2}	square foot, sq ft	square meter, sq m
3.78	gallon, gal	liter, L (10^{-3} m^3)
0.454	pound, lb	kilogram, kg
1.12	pound per acre, lb/acre	kilogram per hectare, kg/ha
5/9 (°F – 32)	Fahrenheit, °F	Celsius, °C
1.0	parts per million, ppm	extractable ions, milligram per kilogram, mg/kg
	Plant Nutrient Conversion	
	Oxide	Elemental
0.437	P_2O_5	P

acid herbicides (Fry and Upham, 1994). However, damaged buffalograss recovered from the early injury by 6 WAT. On newly seeded ‘Comanche’ buffalograss, the benzoic acid herbicide dicamba applied within 24 h of seeding reduced cover up to 100% at 4 WAT and up to 85% at 16 WAT compared with the untreated control (Dotray and McKeney, 1996). Goss et al. (2006) evaluated the tolerance of newly seeded ‘Cody’ buffalograss to various pre- and postemergence herbicides in Arkansas and Nebraska, and reported adequate seedling tolerance to a majority of the herbicides labeled for use on other warm-season grasses, including benefin, simazine, oxadiazon, pendimethalin, prodiamine, and bensulide. Pendimethalin and prodiamine did not cause injury to Cody buffalograss (Goss et al., 2006). However, seedling injury occurred in Sharp’s Improved buffalograss with the same herbicides, and was not able to recover in similar studies at the same location in Nebraska (Fry et al., 1997). Goss et al. (2006) summarized the research up to 2004 on herbicides for use in seedling buffalograss and created useful recommendations for practitioners. However, numerous herbicides have been introduced since then with documented seedling safety in cool-season grasses, and it is important to evaluate the feasibility of these newer herbicides applied over newer cultivars of buffalograss. Our objective was to evaluate 12 herbicides for turf safety and weed control when applied at or shortly after seeding of Bowie or Sundancer buffalograss.

EVALUATING HERBICIDES OVER NEWLY SEEDED BOWIE OR SUNDANCER BUFFALOGRASS

Research was conducted at the John Seaton Anderson Turfgrass Research Facility near Mead, NE, in 2012 and 2013. Soil type was a Tomek silt loam (fine, smectitic, mesic Pachic Argiudoll) with pH 6.5, 4.1% organic matter, and 103 ppm phosphorus. Experimental areas were tilled to 4 inches, compacted slightly with the Brillion culti-packer (Marysville, KS), and raked level before seeding. Bowie or Sundancer buffalograss was seeded in separate but immediately adjacent areas at 3.0 lb pure live burrs/1000 sq ft on 23 May 2012 and 24 May 2013. Following seeding, plots were lightly raked with a leaf rake to maximize seed–soil contact, and starter fertilizer (11–52–0) was applied at 1 lb P_2O_5/1000 sq ft. All plots were irrigated two to four times daily based on evapotranspiration with a total of 0.25 inch of water per day until seedlings were in 1- to 3-leaf stage, then 0.25 inch was applied every other day as needed based on evapotranspiration. Areas were mowed at 2 inches weekly with a 21-inch walk-behind rotary mower (John Deere jx85). Urea (46–0–0) was applied at 0.5 lb N/1000 sq ft on 23 May, 20 June, and 18 July 2012; and on 24 May, 22 June, and 19 July 2013. Primary weed species on the site were common purslane and redroot pigweed in 2012, and redroot pigweed and yellow foxtail in 2013.

Treatments were arranged in a randomized complete block with three replications of 5-ft by 5-ft plots. A 3 × 12 factorial design was used with three application timings and 12 herbicides plus an untreated check. Herbicides were applied using a CO_2–powered backpack sprayer at 30 lb/sq inch in 2 gal water/1000 sq ft through a spray boom with three 8002VS flat fan nozzles (TeeJet Spraying Systems, Wheaton, IL) (Table 1). Application timings were at seeding (AS), at emergence (0 weeks after emergence [WAE]), and 2 WAE. Emergence was defined as 50% emergence in the control plots. Buffalograss was in the 1- to 2-leaf stage by 0 WAE and 2- to 3-leaf stage by the 2-WAE application. Application dates were on 23 May 2012 and 24 May 2013 (AS), 13 June in 2012 and 2013 (0 WAE), and 26 June in 2012 and 2013 (2 WAE). Percent cover of buffalograss or weeds was rated visually every 2 weeks through 6 WAE. Data were analyzed as a general linear model, which assumes homogeneous variance. Variance between years was heterogeneous, thus variances were fit separately for each year using PROC GLIMMIX in SAS (Version 9.3, SAS Institute Inc., Cary, NC). Analysis of variance was performed over years to determine the main and interaction effects. Mean separation was performed using Fisher’s least significant difference at $P < 0.05$. The untreated check was not included in the factorial analysis, but those means are presented for reference.

Table 1. Herbicides applied at seeding, 0 weeks after emergence, or 2 weeks after emergence of 'Bowie' or 'Sundancer' buffalograss.

Common name	Brand name(s)	Manufacturer	Formulation rate/acre	Rate
				lb a.i./acre
Amicarbazone	Xonerate	Arysta	5 fl oz/acre	0.36
Carfentrazone	Quicksilver	FMC	1 fl oz/acre	0.02
Imazapic	Plateau	BASF	4 fl oz/acre	0.06
Mesotrione	Tenacity	Syngenta	5 fl oz/acre	0.16
Prodiamine	Barricade 4FL	Syngenta	10 fl oz/acre	0.31
Pronamide	Kerb SC T&O	Dow AgroSciences	1.25 pt/acre	0.62
Quinclorac	Drive XLR8	BASF	64 fl oz/acre	0.75
Simazine	Princep Caliber 90	Syngenta	1.1 lb/acre	1.00
Sulfentrazone	Dismiss	FMC	8 fl oz/acre	0.25
Carfentrazone + quinclorac	SquareOne	FMC	12 oz/acre	0.03 + 0.51
Sulfentrazone + prodiamine	Echelon	FMC	18 fl oz/acre	0.19 + 0.38
Sulfentrazone + quinclorac	Solitaire	FMC	16 oz/acre	0.21 + 0.63

EFFECTS OF HERBICIDES ON CULTIVARS AT DIFFERENT APPLICATION TIMINGS

Though weed and buffalograss cover were recorded throughout the study, we will focus on the final cover data at 6 WAE for brevity. All data presented are pooled over years. Occasionally, interactions with year occurred (Table 2), and these were always due to the warmer spring of 2012 vs. 2013 (Fig. 1) speeding maturation of buffalograss and decreasing weed pressure.

When rated at 2 WAE, few herbicides applied at seeding or at emergence inhibited buffalograss establishment, and the majority of treatments resulted in >20% cover (data not shown). The exceptions were imazapic, prodiamine, or sulfentrazone + prodiamine applied AS, which resulted in <10% cover of both Bowie and Sundancer, and imazapic, simazine, amicarbazone, or mesotrione applied 0 WAE, which resulted in <15% cover (data not shown). The damage caused by prodiamine was similar to that reported by Fry et al. (1997) on Sharp's Improved buffalograss with a higher rate at the same location in Nebraska. There were no differences in weed cover at 2 WAE (3–30%, data not shown) among the treatments, and thus differences in buffalograss cover due to herbicides were primarily due to herbicide injury. Though no differences in weed cover were detected due to herbicides, it is important to note that weed cover in the untreated check was double that in the worst-performing herbicide treatment. Herbicide use at or shortly after seeding of buffalograss can reduce weed competition early in the establishment phase, increasing the chances for seeding success.

Seven herbicides applied AS and five herbicides applied 0 WAE resulted in the highest cover of Bowie at 6 WAE (Fig. 2). However, none of the herbicides applied 2 WAE were in the top-performing statistical group, suggesting again the importance of weed control at or shortly after seeding. Mesotrione, sulfentrazone + quinclorac, sulfentrazone, simazine, amicarbazone,

Table 2. Analysis of variance for percent 'Bowie' or 'Sundancer' buffalograss or weed cover after 12 herbicides were applied at seeding, 0 weeks after emergence, or 2 weeks after emergence of Bowie or Sundancer buffalograss over 2 years and rated at 6 weeks after emergence.

		Bowie		Sundancer	
	df	Buffalo-grass	Weed	Buffalo-grass	Weed
		% cover			
Year (Y)	1	***	**	NS†	NS
Herbicides (H)	11	***	***	***	***
Y × H	11	**	**	NS	NS
Timing (T)	2	***	**	***	**
Y × T	2	NS	NS	NS	NS
H × T	22	**	***	**	NS
Y × H × T	22	NS	NS	NS	NS

** Significant at $P = 0.01$.

*** Significant at $P = 0.001$.

† NS, not significant.

quinclorac, or carfentrazone applied AS resulted in >72% cover of Bowie (Fig. 2) and 2 to 25% weed cover (Fig. 3). Low cover (<10% at 2 WAE) caused by AS application of prodiamine or imazapic remained low at 6 WAE (<45%), but the low cover at 2 WAE caused by sulfentrazone + prodiamine also applied AS reached 63% by 6 WAE. When applied 0 WAE, sulfentrazone + quinclorac, sulfentrazone, quinclorac, carfentrazone + quinclorac, or sulfentrazone + prodiamine also produced >72% buffalograss cover (Fig. 2), and ≤20% weed cover rated at 6 WAE (Fig. 3). Our results agree with previous research where treatments that produce the highest turf cover at 6 WAE also reduced weed cover the most (Gannon et al., 2004). There were few differences in Bowie cover among the herbicides applied at 2 WAE, but averaged over herbicides, this application timing produced the lowest buffalograss cover, probably due to weed competition.

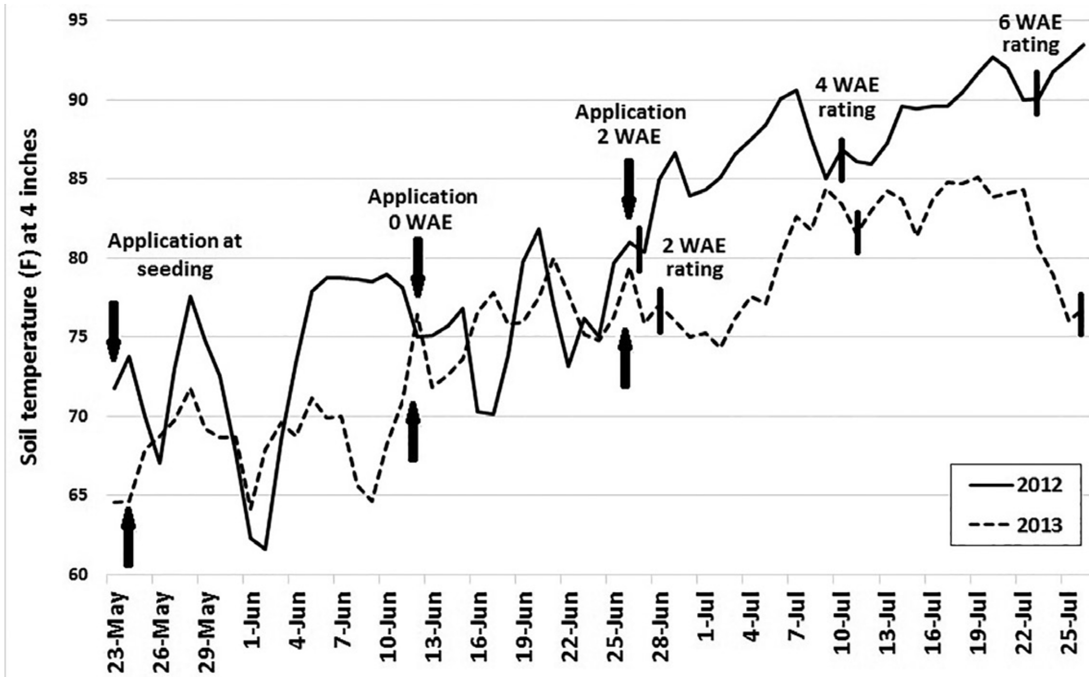

Figure 1. Average soil temperature (°F) at 4 inches during 2 years of studies at John Seaton Anderson Turfgrass Research Facility near Mead, NE, in 2012 and 2013. Buffalograss was treated with 12 herbicides applied at seeding, at emergence (0 WAE), 2 weeks after emergence (2 WAE), 4 weeks after emergence (4 WAE), or 6 weeks after emergence (6 WAE).

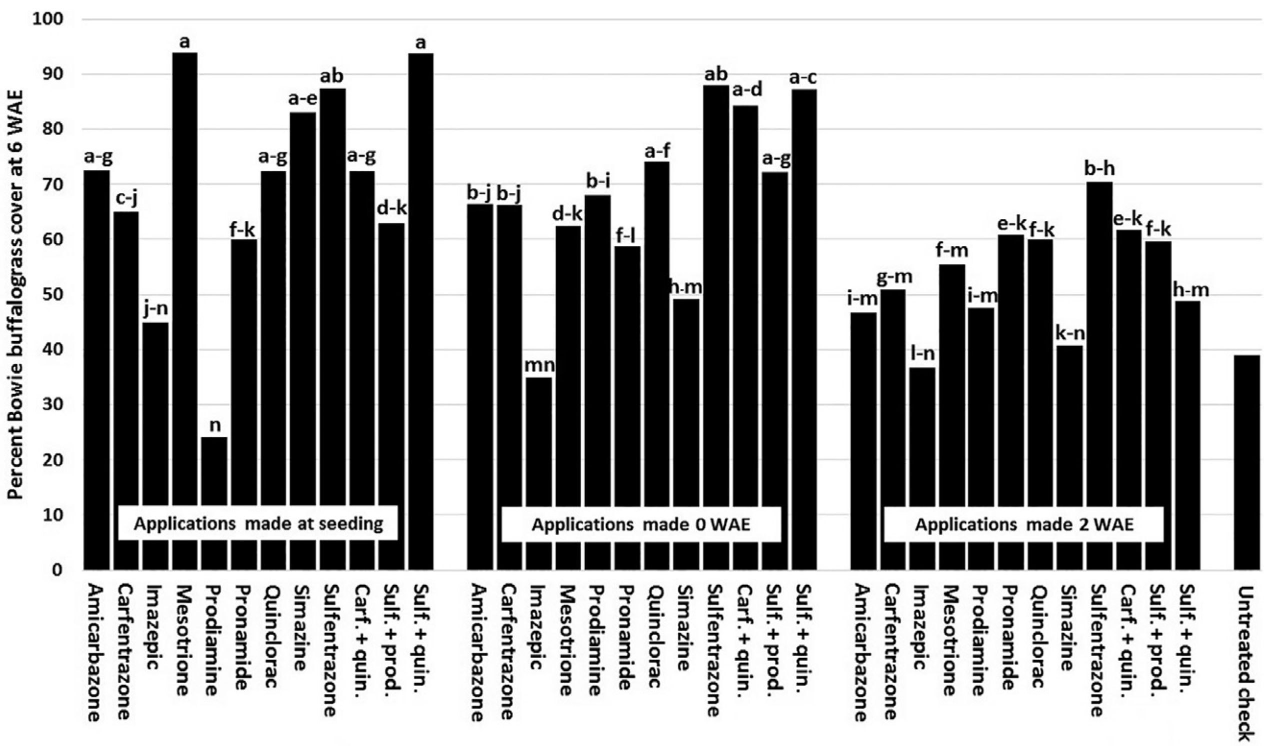

Figure 2. Percent 'Bowie' buffalograss cover rated 6 weeks after emergence (6 WAE). Buffalograss was treated with 12 herbicides applied at seeding, at emergence (0 WAE), or 2 weeks after emergence (2 WAE). Buffalograss means with a different letter are significantly different at $P = 0.05$. Means are over three replications in each of two years. Untreated check means were not included in the factorial analysis and are shown for reference only. Carf. + quin. = carfentrazone + quinclorac; Sulf. + prod. = sulfentrazone + prodiamine; Sulf. + quin. = sulfentrazone + quinclorac.

In Sundancer rated at 6 WAE, the top-performing treatments included five herbicides applied AS, three herbicides applied 0 WAE, and one herbicide applied 2 WAE (Fig. 4), again suggesting the importance of weed control shortly after seeding. Sulfentrazone, sulfentrazone + quinclorac, mesotrione, simazine, or amicarbazone

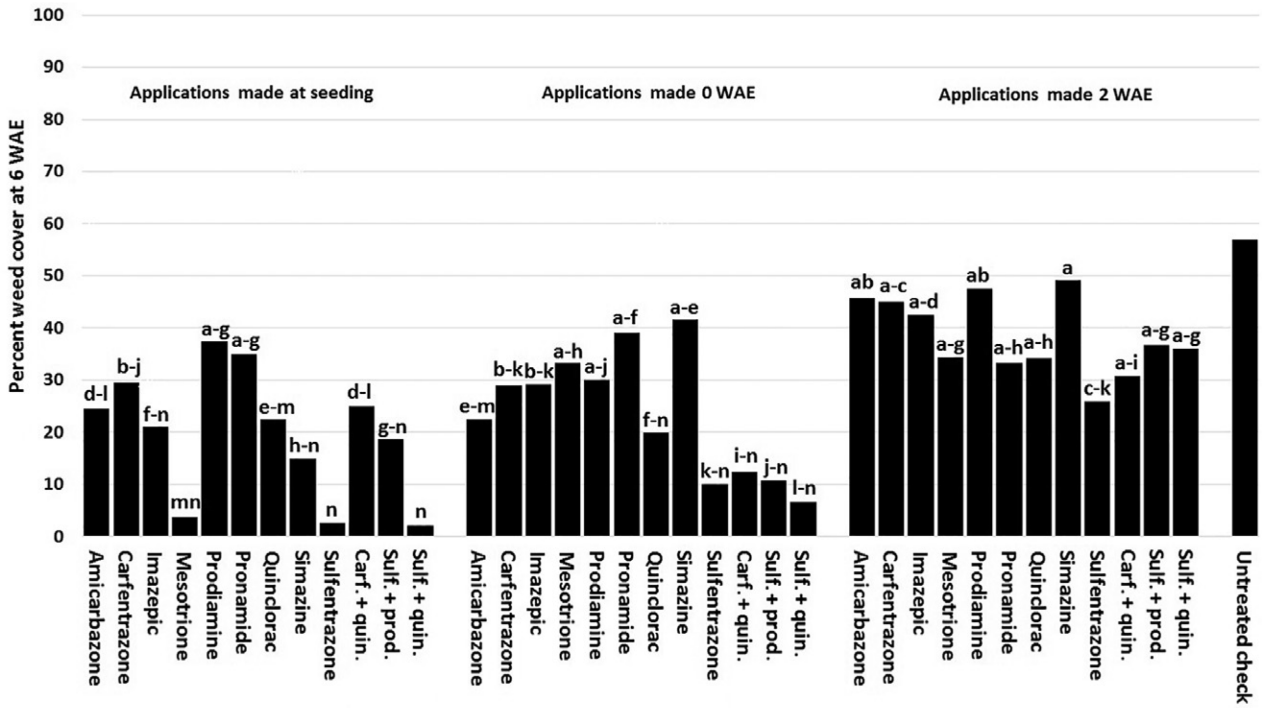

Figure 3. Percent weeds (primarily common purslane, redroot pigweed, and/or yellow foxtail) cover in 'Bowie' buffalograss rated 6 weeks after emergence (6 WAE). Buffalograss was treated with 12 herbicides applied at seeding, at emergence (0 WAE), or 2 weeks after emergence (2 WAE). Means with a different letter are significantly different at $P = 0.05$. Means are over three replications in each of two years. Untreated check means were not included in the factorial analysis and are shown for reference only. Carf. + quin. = carfentrazone + quinclorac; Sulf. + prod. = sulfentrazone + prodiamine; Sulf. + quin. = sulfentrazone + quinclorac.

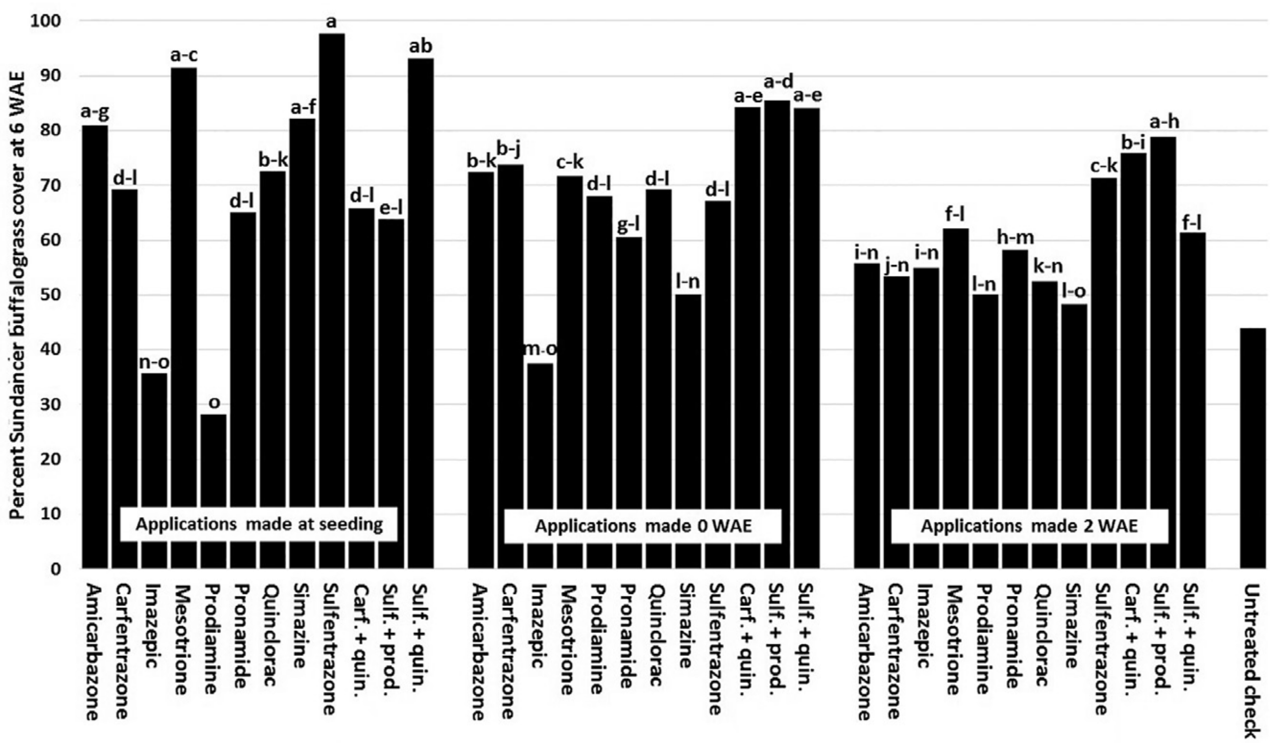

Figure 4. Percent 'Sundancer' buffalograss cover rated 6 weeks after emergence (6 WAE). Buffalograss was treated with 12 herbicides applied at seeding, at emergence (0 WAE), or 2 weeks after emergence (2 WAE). Means with a different letter are significantly different at $P = 0.05$. Means are over three replications in each of two years. Untreated check means were not included in the factorial analysis and are shown for reference only. Carf. + quin. = carfentrazone + quinclorac; Sulf. + prod. = sulfentrazone + prodiamine; Sulf. + quin. = sulfentrazone + quinclorac.

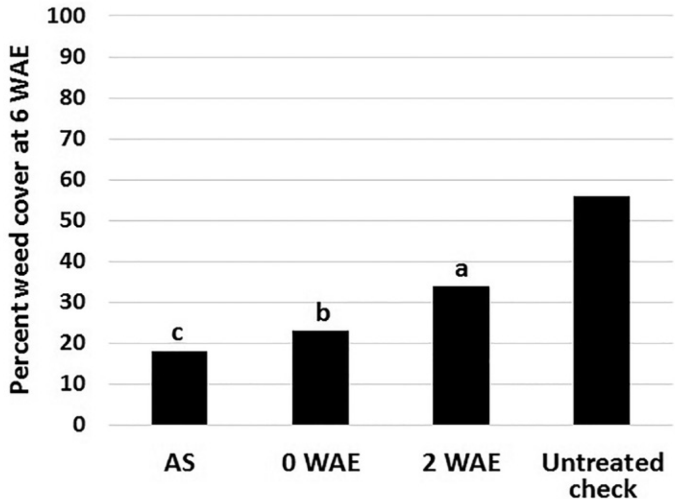

Figure 5. Percent weeds (primarily common purslane, redroot pigweed, and/or yellow foxtail) cover in 'Sundancer' buffalograss rated 6 weeks after emergence (6 WAE). Buffalograss was treated with 12 herbicides applied at seeding (AS), at emergence (0 WAE), or 2 weeks after emergence (2 WAE). Means with a different letter are significantly different at *P* = 0.05. Means are over 12 herbicides with three replications in each of two years. Untreated check means were not included in the factorial analysis and are shown for reference only.

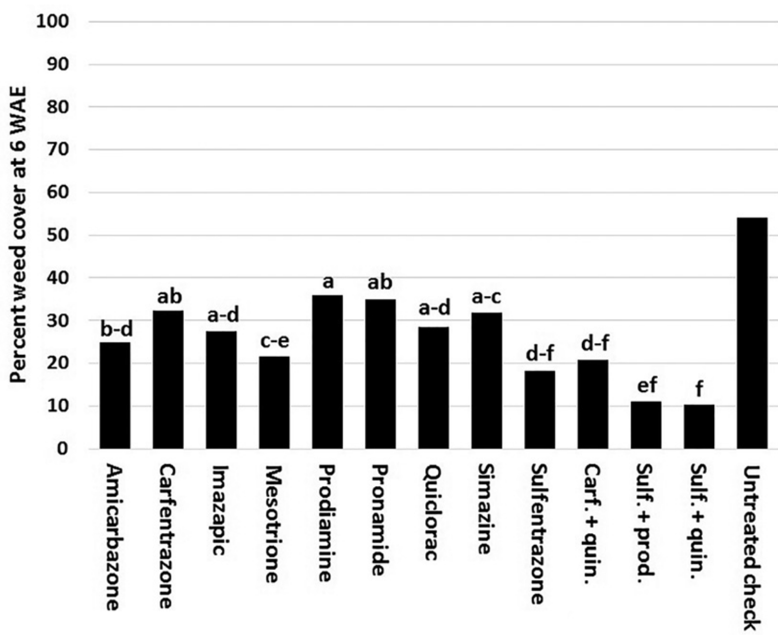

Figure 6. Percent weeds (primarily common purslane, redroot pigweed, and/or yellow foxtail) cover in 'Sundancer' buffalograss rated 6 weeks after emergence (6 WAE). Buffalograss was treated with 12 herbicides applied at or shortly after seeding. Means with a different letter are significantly different at *P* = 0.05. Means are over three application timings with three replications in each of two years. Untreated check means were not included in the factorial analysis and are shown for reference only. Carf. + quin. = carfentrazone + quinclorac; Sulf. + prod. = sulfentrazone + prodiamine; Sulf. + quin. = sulfentrazone + quinclorac.

applied AS resulted in 80 to 95% cover. Sulfentrazone + prodiamine, sulfentrazone + quinclorac, or carfentrazone + quinclorac applied 0 WAE produced >82% cover, and sulfentrazone + prodiamine applied 2 WAE produced 78% cover (Fig. 4). Cover of Sundancer treated with imazapic or prodiamine applied AS remained low at 6 WAE (≤35% cover), but Sundancer treated with prodiamine + sulfentrazone reached 62% cover.

No herbicide × timing interaction was observed in weed cover of Sundancer when rated at 6 WAE. Averaged over herbicide, weed cover was lower when applications were made AS or 0 WAE (Fig. 5). When applied AS, weed cover averaged over all 12 herbicides was 18%. Higher average weed cover was observed when applied 0 WAE (23%) and when applied 2 WAE (34%). Regardless of timing, herbicides always resulted in lower weed cover than the untreated check (Fig. 5). Averaged over application timing, amicarbazone, mesotrione, sulfentrazone, sulfentrazone + quinclorac, sulfentrazone, sulfentrazone + prodiamine, or carfentrazone + quinclorac resulted in the lowest weed cover (<25%) in Sundancer (Fig. 6). Our data agree with Fry et al. (1997) that weed control applied

shortly after seeding of buffalograss is required to reduce weed pressure, thus maximizing establishment of buffalograss (Fry et al., 1997).

Primary weed species in our studies were common purslane, redroot pigweed, and/or yellow foxtail, depending on the year. In addition to safety on buffalograss seedlings, it is likely that efficacy of herbicides on the specific weeds on a site will largely determine buffalograss establishment. Therefore, herbicides with multiple active ingredients and/or with effects on a wide range of weeds may be most effective for buffalograss establishment. We did not evaluate the effect of multiple applications of these herbicides on buffalograss safety or weed control. However, given the margin of safety of single applications of these herbicides on newly seeded buffalograss, and that the labels of many of these herbicides suggest multiple applications for most effective weed control, we speculate that multiple applications would improve weed control without increased risk of reduced buffalograss cover.

Most of the herbicides we evaluated should be applied AS or at emergence to maximize weed control and buffalograss establishment. Though we cannot compare cultivars statistically because they were in adjacent studies, both cultivars responded similarly to individual herbicides and application timings used in this study. Mesotrione, sulfentrazone, quinclorac, carfentrazone, simazine, amicarbazone, sulfentrazone + quinclorac, carfentrazone + quinclorac, or sulfentrazone + prodiamine applied either AS or 0 WAE are safe on Bowie or Sundancer buffalograss, effectively minimize weed pressure, and maximize buffalograss establishment.

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