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Weed Control and Bermudagrass [*Cynodon dactylon* (L.) Pers.] Response to Nicosulfuron Plus Metsulfuron Combinations

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ABSTRACT

Research was conducted from 2007 to 2010 to evaluate nicosulfuron plus metsulfuron combinations for weed control and crop injury to Tifton 85 and Jiggs bermudagrass. Sequential applications of nicosulfuron plus metsulfuron controlled Carolina horsenettle at least 73% with the exception of nicosulfuron at 32.9 g ai/ha plus metsulfuron at 5.3 g ai/ha sequential applications, which controlled Carolina horsenettle 67%. Single applications of nicosulfuron provided 68% or less control. In one study, field sandbur control was 75 to 81% with single applications of nicosulfuron plus metsulfuron while sequential applications of nicosulfuron plus metsulfuron at the higher rates controlled sandbur at least 90%. In another study, field sandbur control was at least 94% when nicosulfuron plus metsulfuron was applied sequentially at 39.4 g ai/ha plus 10.5 g ai/ha, respectively. Johnsongrass control was 88% with nicosulfuron plus metsulfuron at 59.1 plus 13.2 g ai/ha. Although both Tifton 85 and Jiggs were stunted with nicosulfuron plus metsulfuron, stunting was greater on Jiggs. However, only Tifton 85 yield was reduced with nicosulfuron plus metsulfuron combinations.

KEY WORDS: bermudagrass, nicosulfuron, metsulfuron, weed control

INTRODUCTION

Bermudagrass occurs on approximately 12 million ha used for livestock grazing and hay production in the US (Taliaferro et al. 2004). Although 'Coastal' bermudagrass has been the predominant hybrid bermudagrass in the southern United States for many years, newer hybrids such as 'Tifton 85' have gained popularity in recent years. Tifton 85 and 'Jiggs' hybrid bermudagrasses offer high yield and nutritive value (Grichar et al. 2008; Matocha et al. 2010). Tifton 85 is desired by forage producers due to its large rhizomes and rapidly spreading stolons capable of growing > 7.5 cm d (Grichar et al. 2008; Matocha et al. 2010).

Field sandbur (*Cenchrus spinifex* M.A. Curtis) is an annual or short-lived perennial grassy weed commonly found in pastures throughout Texas (Gould 1975). Field sandbur is found in the southern United States from California to North Carolina and is adapted to dry, sandy soils (Holm et al. 1991). When conditions are dry, field

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sandbur is short-lived and produces few burs, while with adequate soil moisture conditions it may be long-lived, grow much larger and produce numerous burs (Holm et al. 1991). Field sandbur competes with forage grasses causing delays in establishment and reducing yield and quality (Walker et al. 1998).

Nicosulfuron plus metsulfuron (Pastora®, DuPont Crop Protection, Wilmington, DE 19898) has recently been registered for selective postemergence (POST) control of sandbur in bermudagrass pastures (Anonymous 2010b). Matocha et al. (2010) reported that field sandbur control with single or sequential applications of nicosulfuron plus metsulfruon was comparable to that previously reported with imazapic plus 2,4-D (Grichar et al. 2008). Other herbicides such as diuron have shown control of sandbur in pasture but must be applied preemergence (PRE) at establishment (Walker et al. 1998). Previous attempts at POST control of field sandbur have focused on low rates of glyphosate applied soon after forage harvest. Grichar et al. (2000) reported at least 90% control of field sandbur with glyphosate at 0.58 and 1.17 L/ha when applied within 8 d after Coastal bermudagrass harvest. Glyphosate application for sandbur control after forage harvest requires timely application (prior to bermudagrass developing new leaves), otherwise significant crop injury may result. Glyphosate applied 17 d after harvest resulted in 36 to 80% injury to Coastal bermudagrass (Grichar et al. 2000).

Grichar et al. (2008) reported that imazapic plus 2,4-D allowed grass producers to control weeds in bermudagrass pastures. However, under dry conditions where water was a limiting factor, bermudagrass stunting and a reduction in forage production was possible. Furthermore, bermudagrass varieties respond differently to imazapic plus 2,4-D with Tifton 85 being more susceptible to injury from imazapic plus 2,4-D than Coastal bermudagrass. Due to the above issues with imazapic plus 2,4-D, the pasture label was removed and imazapic plus 2,4-D is no longer available for pasture use.

Previous research has shown potential for sandbur control with nicosulfuron plus metsulfuron tank mixes (Matocha et al. 2010). Nicosulfuron is a postemergence sulfonylurea herbicide labeled for use in corn (*Zea mays* L.) and controls many difficult to control grassy weeds and some broadleaf weeds at rates of 17.5 to 70 g ai/ha (Anonymous 2009). A single application of nicosulfuron controlled over 90% of quackgrass [*Elythigia repens* (L.) Gould] five weeks after treatment (WAT) and provided greater than 80% control one year later (Bhowmik et al. 1992). When applied in corn, nicosulfuron controlled giant foxtail (*Setaria faberi* Herrm.) 98 to 100% in two years at two locations (Dobbels and Kapusta 1993). Shattercane (*Sorghum bicolor* (L.) Moench ssp. bicolor) was controlled > 90% when nicosulfuron was applied at 30 g/ha (Rosales-Robles 1993).

Metsulfuron controls several broadleaf weeds in bermudagrass (Anonymous 2010a). Kelly and Coats (2000) reported that metsulfuron alone controlled Virginia buttonweed as effectively as 2,4-D and combining the two herbicides was not advantageous if metsulfuron was applied at 32 g/ha or higher. Bradley et al. (2004) reported that metsulfuron controlled broadleaf plantain (*Plantago major* L.), buckhorn plantain (*Plantago lanceolata* L.), and wild carrot (*Daucus carota* L.) 70 to 90%. When applied alone or in combination with 2,4-D, metsulfuron reduced herbaceous broadleaf plant ground cover at several locations in Texas (Meyer and Bovey 1990). Metsulfuron applied alone is not injurious to bermudagrass (Anonymous 2010a).

Metsulfuron may be used for bahiagrass (*Paspalum* spp.) control in bermudagrass pastures, hay fields, golf courses, and sports fields (Bunnell et al. 2003). The herbicide label states that metsulfuron applied between 10.5 and 31.5 g/ha will

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control bahiagrass in bermudagrass (Anonymous 2010a). The label also states that the higher rate of metsulfuron is needed for control of 'Common', 'Paraguayan', and Argentine bahiagrass (*Paspalum notatum* Fluegge var. *notatum*).

Although the tolerance of hybrid bermudagrass varieties to nicosulfuron plus metsulfuron, as well as field sandbur control has been previously reported (Matocha et al. 2010), additional data using different nicosulfuron plus metsulfuron rates was necessary under the varying conditions found in south Texas. Also, weed efficacy data was needed on weeds commonly found in south Texas pastures including Carolina horsenettle (*Solanum carolinense* L.) and johnsongrass [*Sorghum halepense* (L.) Pers.]. Thus, the objective of this study was to evaluate nicosulfuron plus metsulfuron applied POST at different rates for control of field sandbur, johnsongrass, and Carolina horsenettle and bermudagrass tolerance.

METHODS AND MATERIALS

Pasture weed control studies. Field studies were conducted in 2007, 2009, and 2010 in either Dewitt County near Cuero, TX or in Lavaca County near Shiner, TX in fields with high infestations of field sandbur (10 to 15 plants/m^2), Carolina horsenettle (4 to 6 plants/m^2), or perennial johnsongrass (6 to 8 plants/m^2). The soil at the Dewitt County location was a Crockett fine sandy loam (fine, montmorillonitic, thermic Udertic Paleustalfs) with pH 7.1 and less than 1.0% organic matter, while the soil in Lavaca County was a Victoria sandy clay loam soil (Fine, smectitic, hyperthermic Udic Haplusterts) with pH 7.2 and 1.0% organic matter. Experimental design was a randomized complete block with three replications. Plot size was 2.4 m wide by 9.1 m long.

In the 2007 study near Shiner, in a pasture with a mixed stand of Carolina horsenettle and field sandbur, the herbicides included nicosulfuron at 43.6 g ai/ha plus metsulfuron at 7.0 g ai/ha, nicosulfuron at 54.8 g ai/ha plus metsulfuron at 8.8 g ai/ha, and nicosulfuron at 65.7 g ai/ha plus metsulfuron at 10.5 g ai/ha applied once when Carolina horsenettle was approximately 10 to 15 cm tall while field sandburs were approximately 4 to 6 cm tall. Nicosulfuron at 32.9 g ai/ha plus metsulfuron at 5.3 g ai/ha, nicosulfuron at 43.6 g ai/ha plus metsulfuron at 7.0 g ai/ha, and nicosulfuron at 54.8 g/ha plus metsulfruon at 8.8 g ai/ha were applied two times. Also, nicosulfuron at 43.6 g ai/ha plus metsulfuron at 7.0 g ai/ha, nicosulfuron at 54.8 g ai/ha plus metsulfuron at 8.8 g ai/ha, and nicosulfuron at 65.7 g ai/ha plus metsulfuron at 10.5 g ai/ha were applied at the initial application and followed by nicosulfuron at 32.9 g ai/ha plus metsulfuron at 5.3 g ai/ha at the second application. All herbicide treatments included Induce® [blend of alkylarylpolyoxyalkane ether, free fatty acids, and isopropyl (90%), and water and formulation acids (10%); Helena Chemical Co] at 0.5% v/v. The initial herbicide application (May 22) was made when Carolina horsenettle plants were 10 to 15 cm tall and field sandbur plants were 3 to 6 cm tall with the sequential application (June 12) when Carolina horsenettle was 15 to 18 cm tall. Seasonal rains in 2007 were approximately 51 mm for May and 87 mm for June. An untreated check was included for comparison.

In the field sandbur studies conducted in 2010 in Lavaca and Dewitt Counties, the herbicide treatments included nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha, nicosulfuron at 59.1 g ai/ha plus metsulfuron at 31.2 g ai/ha, nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha plus 32% nitrogen at 75% v/v, and glyphosate at

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840 g/ha applied once while nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha was applied twice. The initial herbicide applications (May 20, Dewitt County; June 6, Lavaca County) were made when field sandburs were approximately 2.5 to 5 cm tall while the sequential applications (June 17, Dewitt County; July 6, Lavaca County) were made approximately three to four weeks later when field sandbur was 5 to 8 cm tall. All nicosulfuron plus metsulfuron combinations include Induce® at 0.25% v/v with the exception of the three-way mixture of nicosulfuron plus metsulfruon plus nitrogen which did not include a surfactant. The 2010 season can be characterized as extremely wet with 118, 95, and 201mm rainfall for May, June, and July, respectively.

In the perennial johnsongrass study conducted in Lavaca County in 2009, the herbicide treatments included nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha, nicosulfuron at 59.1 g ai/ha plus metsulfuron at 13.2 g ai/ha, nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha plus 32% nitrogen at 75% v/v, and glyphosate (Roundup Original Max®, Monsanto Company, St. Louis, MO 63167) at 840 g/ha. Johnsongrass was 15 to 20 cm tall at the time of herbicide application (May 18).

All herbicide treatments, with the exception of the three-way mixture of nicosulfuron plus metsulfuron plus nitrogen and the glyphosate treatment, included Induce® at 0.25% v/v. An untreated check was included for comparison. The growing season in 2009 was characterized as extremely dry with rainfall amounts for May, June, and July of 16, 4, and 5 mm, respectively.

Tolerance Study. A field study was conducted in 2008 in Lavaca County near Yoakum, TX on fully established 'Tifton 85' and 'Jiggs' bermudagrass fields that were weed-free and had no prior herbicide applied during that growing season. The soil in both fields was a Tremona loamy fine sand (thermic Aquic arenic Paleustalfs) with less than 1% organic matter and pH 7.0 to 7.2. The experimental design was a randomized complete block with three replications. Plot size was 2.4 m wide by 9.1 m long. Rainfall for May, June, and July were 1, 65, and 55 mm, respectively. Herbicide treatments included nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha plus Induce at 0.5 % v/v, nicosulfuron at 59.1 g ai/ha plus metsulfuron at 15.7 g ai/ha plus either Induce® at 0.5% v/v, Agridex® (blend of 83% paraffin-based petroleum oil and 17% surfactant; Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38137) at 1.0% v/v. or Phase® (100% blend of methylated esters of fatty acids and organosilicone surfactant fluid; Loveland Industries, Inc., Greeley, CO 80632) at 1.0% v/v, and nicosulfuron at 59.1 g ai/ha plus metsulfuron plus either 2,4-D at 1120 g ai/ha, dicamba at 280 g ai/ha plus 2,4-D at 804 g ai/ha (Weedmaster®, BASF Corp., Research Triangle Park, NC 27709), or pendimethalin (Prowl H_20, BASF Corp.) at 2130 g ai/ha. Application timings were based on bermudagrass height with herbicides applied when bermudagrass was approximately 15 to 20 cm tall. The combinations with 2,4-D, dicamba plus 2,4-D, and pendimethalin were planned since many hay producers use these combinations to improve hay quality (author's personal observations). Sequential nicosulfuron plus metsulfuron were planned but not applied due to extremely dry conditions.

Herbicide application, weed control, bermudagrass injury, and harvest. All herbicide applications were made with a CO_2 backpack sprayer equipped with 11002 DG flat fan nozzles (11002 DG flat fan spray tips, Teejet Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60188) calibrated to deliver 187 L/ha at 200 kPa pressure.

Weed control was estimated visually through the growing season on a scale of 0

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to 100 (0 indicated no control and 100 indicated complete control), relative to the nontreated control. Very little bermudagrass was present in study areas due to heavy weed infestions; therefore, no attempt was made to rate bermudagrass response to herbicides in the weed control studies. Data were subject to ANOVA and means were separated using Duncan's MRT test at P = 0.05.

Tifton 85 and Jiggs phytotoxicity was evaluated visually at 15 and 35 d after herbicide treatment using a scale of 0 to 100 with 0 = no injury to 100 = plant death. A 1.2 m^2 area of each bermudagrass plot was hand harvested when bermudagrass was approximately 45 to 60 cm tall using hand-clippers to a height of approximately 5 cm above soil surface. Both bermudagrass varieities were harvested only once due to severe drought conditions, which developed during the 2008 growing season. After samples from each harvest were air dried, bermudagrass yields on a dry matter basis were determined. Data were subjected to ANOVA and treatment means were separated using Duncan's MRT test at P = 0.05.

RESULTS AND DISCUSSION

Field Sandbur Control. In 2007, when rated 21 days after treatment (DAT), all initial nicosulfuron plus metsulfruon combinations provided at least 80% field sandbur control (Table 1). When rated 42 DAT, all sequential applications of nicosulfuron plus metsulfuron, with the exception of nicosulfuron at 32.9 g/ha plus metsulfuron at 5.3 g ai/ha, provided at least 90% control while single applications of nicosulfuron plus metsulfuron were 75 to 81%.

In 2010, at Location 1, field sandbur control was at least 88% with all herbicide treatments (including glyphosate) when rated 27 DAT (Table 2). When rated 69 DAT, complete field sandbur control was obtained with the sequential treatment of nicosulfuron at 39.4 g ai/ha plus metsulfuron at 10.5 g ai/ha while nonsequential applications of nicosulfuron plus metsulfuron controlled field sandbur no greater than 88% and glyphosate controlled 63%. At Lavaca County, glyphosate at 840 g/ha and nicosulfuron at 59.1 g ai/ha plus metsulfuron at 13.2 g ai/ha provided at least 91% control when rated 29 DAT while at the 106 DAT rating only the sequential treatment of nicosulfuron plus metsulfuron controlled field sandbur at least 90% (Table 2). These results confirm earlier work in which Matocha et al.(2010) reported that sequential applications of nicosulfuron at 54.8 g ai/ha plus metsulfuron at 8.8 g ai/ha provided 85% field sandbur control, whereas all nonsequential treatments provided less than 63% control. Also, field sandbur control with nicosulfuron plus metsulfuron was comparable to that previously reported with imazapic plus 2,4-D (Grichar et al. 2008). Grichar et al. (2008) reported that imazapic plus 2,4-D controlled sandbur 83 to 99% in forage bermudagrass. However, bermudagrass injury from imazapic plus 2,4-D ranged between 28 to 87%. Low rates of glyphosate (280 to 540 g/ha) applied within 8 d of forage harvest has controlled field sandbur (Grichar et al. 2000) and is currently used by some hay products as a means of improving hay quality by reducing field sandbur infestations (author's personal observations).

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Table 1. Field sandbur control with nicosulfuron plus metsulfuron combinations in 2007 near Shiner, TX.[a]

Treatment[b,c]	Rate (g ai/ha)	Field sandbur 21 DAT (%)	Field sandbur 42 DAT (%)
Untreated check	-	0	0
Nicosulfuron + metsulfuron	43.6 + 7.0	83	75
Nicosulfuron + metsulfuron	54.8 + 8.8	85	81
Nicosulfuron + metsulfuron	65.7 + 10.5	87	77
Nicosulfuron + metsulfuron fb nicosulfuron + metsulfuron	32.9 + 5.3 fb 32.9 + 5.3	80	84
Nicosulfuron + metsulfuron fb nicosulfuron + metsulfuron	43.6 + 7.0 fb 43.6 + 7.0	81	90
Nicosulfuron + metsulfuron fb nicosulfuron + metsulfuron	43.6 + 7.0 fb 32.9 + 5.3	80	92
Nicosulfuron + metsulfuron fb nicosulfuron + metsulfuron	54.8 + 8.8 fb 32.9 + 5.3	83	94
Nicosulfuron + metsulfuron fb Nicosulfuron + metsufuron	65.7 + 10.5 fb 32.9 + 5.3	80	95
Nicosulfuron + metsulfuron fb nicosulfuron + metsulfuron	54.8 + 8.8 fb 54.8 + 8.8	81	90
LSD (0.05)		7	5

[a] Abbreviations: DAT, days after initial herbicide treatment; fb, followed by.
[b] Initial herbicide application made when Carolina horsenettle was 10 to 17 cm tall while field sandbur was 3 to 6 cm tall. Sequential applications made when Carolina horsenettle was 10 to 16 cm tall and field sandbur was 6 to 8 cm tall, approximately one week after initial application.
[c] All herbicide treatments included Induce at 0.5% v/v.

Johnsongrass control. When rated 22 DAT, johnsongrass control was greater than 90% with all herbicides including glyphosate; however, when rated 107 DAT, only nicosulfuron at 59.1 g ai/ha plus metsulfuron at 13.2 g ai/ha provided greater than 85% control (Table 3). Lack of rainfall after herbicide application (only 16 mm for May) may have accounted for poor johnsongrass control. The reduced performance of other postemergence herbicides such as fenoxaprop have been reported under conditions of moisture stress (Dortenzio and Norris 1980). Alleviating moisture stress with irrigation within 48 h of herbicide application improved fenoxaprop efficacy in crabgrass (*Digitaria* spp.) (Rossi et al. 1993). Rossi et al. (1993) reported that decreased spray retention and alterations in fenoxaprop metabolism contribute to reduced fenoxaprop activity observed in moisture-stressed smooth crabgrass (*Digitaria ischaemum*).

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Table 2. Field sandbur control with nicosulfuron plus metsulfuron combinations[a,b].

Treatment[c,d]	Rate (g ai/ha)	Location 1		Location 2	
		27 DAT	69 DAT	29 DAT	106 DAT
		(%)			
Untreated check	-	0	0	0	0
Nicosulfuron + metsulfuron	39.4 + 10.5	94	73	87	47
Nicosulfuron + metsulfuron	59.1 + 13.2	97	88	91	83
Nicosulfuron + metsulfuron fb nicosulfuron + metsulfuron	39.4 + 10.5 fb 39.4 + 10.5	88	100	78	94
Nicosulfuron + metsulfuron + 32% nitrogen	39.4 + 10.5 + 75% v/v	92	68	84	53
Glyphosate	840 g	95	63	99	70
LSD (0.05)		10	15	10	38

[a] Location 1, Dewitt County; Location 2, Lavaca County.
[b] Abbreviations: DAT, days after initial herbicide treatment; fb, followed by.
[c] Initial herbicide application made when field sandbur was 2.5 to 5 cm tall. Sequential application made when field sandbur was 5 to 8 cm tall, approximately one month after initial application.
[d] All nicosulfuron + metsulfuron treatments with the exception of the 32% N treatment and glyphosate included Induce at 0.25% v/v.

Table 3. Johnsongrass control with nicosulfuron plus metsulfuron combinations [a b].

Treatment[c]	Rate (g ai/ha)	Lavaca County	
		22 DAT	107 DAT
		(%)	
Untreated check	-	0	0
Nicosulfuron + metsulfuron	39.4 + 10.5	94	73
Nicosulfuron + metsulfuron	59.1 + 13.2	97	88
Nicosulfuron + metsulfuron + 32% nitrogen	39.4 + 10.5 + 75% v/v	92	68
Glyphosate	840	95	63
LSD (0.05)		10	15

[a] Abbreviations: DAT, days after initial herbicide treatment; fb, followed by.
[b] Herbicide application made when johnsongrass was 15 to 20 cm tall.
[d] All nicosulfuron + metsulfuron treatments with the exception of the 32% N treatment included Induce at 0.25% v/v.

Bermudagrass response to nicosulfuron plus metsulfuron combinations. Visual

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injury ratings for Tifton 85 15 DAT with nicosulfuron plus metsulfuron alone ranged from 8 to 15% while the addition of 2,4-D, dicamba plus 2,4-D, and pendimethalin to the nicosulfuron plus metsulfuron combination resulted in no greater than 4% injury (Table 4). By 35 DAT, only the nicosulfuron at 59.1 g ai/ha plus metsulfuron at 15.7 g ai/ha plus Agridex combination injured Tifton 85 10% while all other nicosulfuron plus metsulfuron combinations injured Tifton 85 4% or less. Combinations with 2,4-D, dicamba plus 2,4-D, or pendimethalin did not cause any injury.

Table 4. Bermudagrass injury with nicosulfuron plus metsulfuron combinations[a].

Treatment[b]	Rate (g ai/ha)	Tifton 85		Jiggs	
		15 DAT	35 DAT	15 DAT	35 DAT
		(%)			
Untreated check	----	0	0	0	0
Nicosulfuron + metsulfuron + Induce	39.4 + 10.5 + 0.5 % v/v	13	2	17	2
Nicosulfuron + metsulfuron +Induce	59.1 + 15.7 + 0.5 % v/v	8	4	13	3
Nicosulfuron + metsulfuron +Agridex	59.1 + 15.7 + 1.0 % v/v	15	10	15	7
Nicosulfuron + metsulfuron +Phase	59.1 + 15.7 + 1.0 % v/v	12	0	18	2
Nicosulfuron + metsulfuron + 2,4-D + Induce	59.1 + 15. 7 + 1120 + 0.5 % v/v	1	0	13	0
Nicosulfuron + metsulfuron + dicamba + 2,4-D[c] + Induce	59.1 + 15.7 + 280 + 804 + 5 % v/v	1	0	10	5
Nicosulfuron + metsulfuron + pendimethalin[d] + Induce	59.1 + 15.7 + 2130 + 0.5 % v/v	4	0	10	1
LSD (0.05)		8	6	10	7

[a] Abbreviations: DAT, days after herbicide treatment.
[b] Herbicide application made when bermudagrass was 15 to 20 tall.
[c] Marketed as Weedmaster®.
[d] Marketed as Prowl H_20®.

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Table 5. Bermudagrass dry matter yield with nicosulfuron plus metsulfuron combinations[a].

Treatment[b]	Rate (g ai/ha)	Bermudagrass	
		Tifton 85 (Kg/ha)	Jiggs (Kg/ha)
Untreated check	-	5770	4414
Nicosulfuron + metsulfuron + Induce	39.4 + 10.5 + 0.5 % v/v	3329	3329
Nicosulfuron + metsulfuron +Induce	59.1 + 15.7 + 0.5 % v/v	3206	3995
Nicosulfuron + metsulfuron +Agridex	59.1 + 15.7 + 1.0 % v/v	2663	4883
Nicosulfuron + metsulfuron +Phase	59.1 + 15.7 + 1.0 % v/v	2885	2441
Nicosulfuron + metsulfuron + 2,4-D + Induce	59.1 + 15. 7 + 1120 + 0.5 % v/v	4217	4883
Nicosulfuron + metsulfuron + dicamba + 2,4-D[c] + Induce	59.1 + 15.7 + 280 + 804 + 0.5 % v/v	4880	3551
Nicosulfuron + metsulfuron + pendimethalin[d] + Induce	59.1 + 15.7 + 2130 + 0.5 % v/v	5992	3995
LSD (0.05)		2213	2148

[a] Abbreviations: DAT, days after initial herbicide treatment.
[b] Herbicide application made when bermudagrass was 15 to 20 tall.
[c] Marketed as Weedmaster®.
[d] Marketed as Prowl H_20®.

Results of these studies indicate that nicosulfuron plus metsulfuron combinations are a viable option for field sandbur control and will provide partial control of johnsongrass and Carolina horsenettle which are also commonly found in bermudagrass pastures in Texas. Under low moisture conditions, some stunting and yield reduction is possible with nicosulfuron plus metsulfuron combinations.

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