III. Sulfonylurea Herbicides for Postemergence Control of Virginia Buttonweed (*Diodia virginiana*)

Abstract: A common experiment was conducted at the Auburn University Turfgrass Research Unit to evaluate sulfonylurea herbicides for control of Virginia buttonweed and turfgrass tolerance. Variables for the first experiment included full rates and full rates followed by half rates of chlorsulfuron, metsulfuron, rimsulfuron, and trifloxysulfuron. The full rates of these herbicides applied alone provided equivalent Virginia buttonweed control to full rates followed by the half rates. Only treatments that contained chlorsulfuron provided acceptable Virginia buttonweed control 1 month after treatment (MAT). The sequential application significantly reduced regrowth in all treatments 1 month after plant removal. Turfgrass tolerance varied across species evaluated. A single full rate of trifloxysulfuron applied to common centipedegrass and 'Palmetto' St. Augustinegrass resulted in 54 and 58% injury, respectively 1 MAT. Other treatments provided (<30%) injury to these two turfgrasses. 'Meyer' zoysiagrass and 'Tifway' bermudagrass were injured < 5% with a single full rate application of any treatments. The full rate followed by the half rate of chlorsulfuron and trifloxysulfuron injured centipedegrass and 'Palmetto' St. Augustinegrass 35, 86 and 51, 80%, respectively 1 MAT. Injury to 'Meyer' zoysiagrass and 'Tifway' bermudagrass from these two

treatments did not exceed 14 and 6%, respectively. The remaining sequential treatments did not injure centipedegrass, 'Palmetto' St. Augustinegrass, 'Meyer' zoysiagrass, and 'Tifway' bermudagrass > 23, 24, 5, and 3% respectively. A second experiment was conducted at McCall's Sod Farm with the objective of evaluating adjuvants effects on chlorsulfuron, metsulfuron, and rimsulfuron. Normal use rates of these herbicides were reduced by half for testing surfactant effects. At these lowered rates, < 60% control was observed with all treatments.

Nomenclature: chlorsulfuron, metsulfuron, rimsulfuron, trifloxysulfuron; common centipede *Eremochloa ophiuroides* (Munro) Hack #[1]ERLOP; hybrid bermudagrass *Cynodon dactylon X C. transvaalensis* Burtt-Davey 'Tifway'; St. Augustinegrass *Stenotaphrum secundatum* Walt. Kuntze 'Raleigh' #STPSE; Virginia buttonweed *Diodia virginia* L. # DIQVI; zoysiagrass *Zoysia japonica* Steud 'Meyer' #ZOYMA

Additional index words: CYNDA, ERLOP, STPSE, DIQVI, ZOYMA, herbicide application, herbicide rate, adjuvants, Virginia buttonweed regrowth.

Abbreviations: MAT, month after treatment; WAT, weeks after treatment.

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[1] Letters following this symbol are a WSSA approved computer code from *Composite List of Weeds*, Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

INTRODUCTION

Virginia Buttonweed (*Diodia virginiana* L.) is a problematic weed in warm-season turfgrasses throughout the Southeast and is considered the most troublesome turf weed in Alabama, Georgia, Louisiana, Mississippi, and Tennessee (Dickens and Turner 1985a; Dickens and Turner 1985b; Dowler 2000). It is difficult to control due to variable fecundity and adaptability (Baird et al. 1992; Dute et al. 1988). Present recommendations for postemergence control include multiple applications of two- and three-way mixes of auxin-type herbicides including the phenoxy carboxylic acids and dicamba. However, regrowth from vegetative structures of treated plants is common as soon as 3 weeks after treatment (WAT) and the rates required to achieve adequate control are frequently injurious to warm-season turf (Coats 1986; Duble et al. 1986; Jordan 1980; Jordan and Coats 1980; Scott and Coats 1998).

Some sulfonylurea herbicides including metsulfuron have efficacy on Virginia buttonweed. Of the herbicides that Dickens et al. (1991) evaluated, metsulfuron at 0.067 kg ai/ha and 2,4-DP at 2.24 kg ai/ha provided the best control of Virginia buttonweed. The combination of these two products did not increase control over either applied alone. Metsulfuron applied at 0.042 kg ai/ha is a recommended treatment for Virginia buttonweed control in Texas (Duble 1999). Kelly and Coats (2000) showed metsulfuron produced 65% control 1 month after treatment (MAT) and 56% control 2 MAT. They concluded, as did Dickens et al. (1991), that control was not increased with the addition of 2,4-DP. Both studies showed a decrease in control over time and it was not clear if reduction was due to regrowth of treated plants and/or re-infestation from seed.

Weed control with sulfonylurea herbicides can be improved by including certain adjuvants. Green and Green (1993) reported that a nonionic surfactant with the appropriate structure and in a specific concentration increased rimsulfuron activity 10 fold. Adjuvants increased rimsulfuron activity with increased concentration up to 0.1% (v/v). They evaluated the chemical, physical, and surface properties of 14 adjuvants on giant foxtail (*Setaria faberi* L.), velvetleaf (*Abutilon theophrasti* L.), and corn (*Zea maize* L.). The most active surfactants had a hydro-lipophilic balance between 12 and 17 and formed a moist gel spray droplet on the leaf of all three species.

The first objective (Study 1) was to evaluate four sulfonylurea herbicides i.e. chlorsulfuron, metsulfuron, rimsulfuron, and trifloxysulfuron applied in a single full rate and a single full rate followed by a sequential half rate. Treatments were applied to Virginia buttonweed infested turf that contained the four major warm-season species and to Virginia buttonweed plants maintained in a monoculture. The second objective (Study 2) was to evaluate four adjuvants with chlorsulfuron, metsulfuron, and rimsulfuron applied at reduced rates in St. Augustinegrass (*Stenotaphrum secundatum* Walt. Kuntze) infested with Virginia buttonweed.

MATERIAL AND METHODS

Study 1. During the fall of 2000, two locations at Auburn were designated for the evaluation of Virginia buttonweed response to certain sulfonylurea herbicides with varying numbers of applications. Virginia buttonweed seed was collected from the Auburn Turfgrass Research Unit in the fall of 2000 and stored in a controlled environment (7 C and 56% relative humidity) for 3 months. Seeds were sown March 2001 into a 90:10 v/v sand:peat growth media mixture where they were subjected to wetting and drying cycles for 5 days to stimulate germination in a greenhouse environment. Without subjecting seed to this previously described process, consistent germination was difficult to obtain. This wetting and drying procedure allowed for the propagation of plants that very were very similar in size and age. Individual seedlings were transplanted into 1-L styrofoam cups containing the aforementioned growth media. Seedlings were grown for 55 days in a greenhouse environment (21-32 C) and watered four times per day. Biweekly, each cup received 50 ml of a soluble fertilizer solution containing 4 ml of 20-10-20/L. Previous observations of growth of Virginia buttonweed seedlings in the above greenhouse environment showed equal root and shoot development at 6 weeks after emergence.

Location 1 contained a Marvin sandy loam soil (fine-loamy, kaolinitic, thermic Typic Kanhapludults) with 1.2% organic matter, and a pH of 6.0. The site was fumigated with metam-sodium (Vapam®[2]) at 123 L of product per hectare and tarped the previous fall and seeded to perennial ryegrass (*Lolium perenne* L.) for soil stability. Individual 1.2- by 6-m plots spaced on 1.2-m centers were treated with glufosinate at 0.84 kg ai/ha to provide a plant-free environment for transplanting and establishment of the greenhouse-grown Virginia buttonweed plants.

Three holes with an in-row spacing of 1.5 m were created with a putting green cup cutter in individual plots that contained the desiccated perennial ryegrass. Virginia buttonweed plants were removed from the styrofoam cups and the entire contents of one cup placed into a hole. These plants were then fertilized with 100 ml of the solution previously described. Supplemental irrigation was applied in the absence of rain to obtain 6.4-mm/week and plants were allowed to grow for 40 days prior to herbicide treatment. Treatments were arranged in a four herbicide by two applications factorial and placed in a randomized complete block design with four replications. Appropriate non-treated controls were also included in each block.

All full rate herbicide treatments were applied 9 July, 2001 with a CO_2 backpack sprayer attached to a push boom containing four 6502 flat fan nozzles on 25-cm spacing calibrated to deliver 280 L/ha at 213 Kpa. Cohort DC®[3] adjuvant was used at a rate of

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[2] Vapam is a registered trademark of AMVAC Chemical Corporation, 4100 E. Washington Blvd., Los Angeles, CA 90023.

[3] Cohort DC is a proprietary blend of polyethoxylated hydroxyl alkyl surfactants, encapsulated in organic nitrogen. Helena Chemical Company 225, Schilling Blvd. Collierville, TN 38017.

1.5 g/L of spray solution (Table III. 1). Percent control of Virginia buttonweed was evaluated 1 MAT. After the initial evaluation, the above-ground portions of Virginia buttonweed plants within treatments receiving a full single rate with no sequential application were removed. The area around individual plants was vacuumed to remove seeds in order to evaluate regrowth of each treated plant. Plants within treatments receiving a sequential application were left undisturbed. The sequential application was applied 9 August, 2001 as described above. Virginia buttonweed control was again evaluated 1 MAT. All above-ground plant portions and seeds were removed 6 weeks after the sequential treatment as previously described.

Virginia buttonweed regrowth was evaluated using a scale of 1-5, where 5 = plant size equal to the non-treated. Regrowth for plants that received the single application was evaluated 1 month after plant removal (8 weeks after herbicide application). Regrowth for plants that received the sequential half rate application were evaluated 1 month after plant removal (11 weeks after sequential treatment).

Location 2 also contained a Marvin sandy loam soil with 1% organic matter, and pH 6.0. Test area was fumigated spring 2000 with methyl bromide (448 kg/ha of product). Individual 1.2- by 6-m plots received a 41- by 61-cm piece of centipedegrass [*Eremochloa ophiuroides* (Munro) Hack], 'Palmetto' St. Augustinegrass, 'Meyer' zoysiagrass (*Zoysia japonica* Steud), and 'Tifway' bermudagrass (*C. dactylon X Cynodon transvaalensis* Burtt-Davey) sod on 10 June, 2000. Placement of sod was random within each of the four replications. Virginia buttonweed seed were sown between the middle two pieces of sod in each replication. The sod and Virginia buttonweed were allowed to grow for the reminder of 2000.

The area described above was used to evaluate the same herbicides and applications as described for location 1 Table III. 3. This trial was designed as a randomized complete block design with a split plot restriction on randomization. Herbicide treatments were assigned to whole plots and turfgrass species to subplots. Virginia buttonweed control and turfgrass response to herbicide applications were evaluated 1 month after each respective application. Turfgrass injury was evaluated on a scale from 0 to 100 where 0 = no injury and 100 = death. Within this scale, 0-30% = slight, 31-60 = moderate, and 61-100 = severe injury. Values > 30% were considered an unacceptable level of injury.

Study 2. This test was conducted at McCall's Sod Farm (McCall's) on a Leon sand (Sandy, siliceous, thermic Aeric Alaquods) soil with 1.3% organic matter and 5.8 pH to evaluate Virginia buttonweed control and St. Augustinegrass tolerance to chlorsulfuron, metsulfuron, and rimsulfuron as influenced by four selected adjuvants. To make the adjuvant effects more apparent, the herbicides were reduced to half of their normal use rate. Herbicides were applied alone and with each of the four adjuvants. In addition, all adjuvants were applied without herbicide.

Treatments were applied to Virginia buttonweed infested St. Augustinegrass sod. The entire test area was mowed just prior to treatment application and thereafter on a weekly schedule. Center-pivot irrigation was available, but not needed during the testing period due to excessive rainfall (>410 mm during July). Virginia buttonweed control and St. Augustinegrass injury were evaluated 1 MAT.

Data analysis. Data were analyzed using mixed models analysis of variance techniques as implemented in the SAS® procedure mixed (Littell et al. 1996). Mixed models analysis has many advantages over the traditional generalized linear models (GLM) technique. The mixed procedure uses an iterative restricted maximum likelihood approach to estimate model solutions. It is superior because it offers a way to handle violations of implicit assumptions. One assumption that is commonly violated in herbicide trials is that all treatments have homogeneous variances. This is clearly not the case because of the negative association between efficacy and error. In this study, within treatment variances differed by as much as 460 times. Mixed models procedures are able to handle these situations because treatments can be grouped based on common error variances. Our approach was to first analyze a given dataset under the assumption of equal variances for all treatments and recording the magnitude of the model fit statistics. We then grouped treatments based on the size of the within treatment variance and repeated the analysis with these groupings using the 'REPEATED / GROUP=VARGRP' statement within SAS® PROC MIXED, where VARGRP represents a number from 1 to the total number of treatments. If the second analysis resulted in better-fit statistics, this model was then chosen for the final analysis. The result of this type of refined analysis is that (a) only probability values are printed without either Type I or Type III sums of squares, and (b) least squares treatment means are reported with different standard errors.

Linear contrasts were used to determine the significance of differences among treatments of interest.

RESULTS AND DISCUSSION

Study 1. At the first location within the Auburn University Turfgrass Research Unit, chlorsulfuron was the only treatment that provided acceptable control of Virginia buttonweed with a single (78%) or sequential application (87%) 1 MAT, Table III. 2. A single application of the remaining treatments provided 11 to 50% control and with a sequential application control was 14 to 41% 1 month after respective treatments were applied. A sequential application of half rates did not enhanced initial control of Virginia buttonweed over a single application. The sequential application of metsulfuron and trifloxysulfuron actually provided less control 1 MAT than a single application. Though a sequential application of all treatments did not enhance initial control, it did significantly reduce regrowth of Virginia buttonweed to ≤ 1.2 compared to the non-treated that received the maximum rating of 5, Table III. 1. These compounds did not perform well here, but had performed well in other studies and thus the reason they were selected. The studies in which these herbicides were successful consisted of smaller plants, the presence of turfgrass competition, and frequent mowing. The non-treated Virginia buttonweed plants in this study had grown to over 1 m^2 in size by the end of the growing season. The absence of competition from turfgrass coupled with the plants not being mowed for 1 MAT may have contributed to these results.

At the second Auburn location, chlorsulfuron was again the only treatment that provided acceptable control ($\geq$ 70%) of Virginia buttonweed with a single or sequential application resulting in 70 and 81% control 1 MAT, respectively, Table III. 3. In general, levels of control were higher at this location especially following the sequential application. The sequential applications enhanced Virginia buttonweed control from 6 to 25%. This increased level of control may be attributed to added stress on the treated plants by competition from the turfgrasses. Though these plants were not as large as the ones grown in monoculture, they were larger, healthier, more robust and not mowed as frequently as the plants that were controlled with chlorsulfuron, metsulfuron, and trifloxysulfuron in preliminary studies.

A single application of trifloxysulfuron applied to common centipedegrass and 'Palmetto' St. Augustinegrass resulted in unacceptable injury of 54 and 58%, respectively, 1 MAT, Table III. 4. 'Palmetto' St. Augustinegrass injury was 27% from a single full rate application of chlorsulfuron. Other single application treatments injured the four turfgrass species evaluated at < 10%. Though a sequential herbicide application increased Virginia buttonweed control, it also significantly increased injury to the turf species evaluated. Sequential treatments of trifloxysulfuron were detrimental to common centipedegrass and 'Palmetto' St. Augustinegrass resulting in 86 and 80% injury, respectively. This data is similar to the findings of Brecke and Unruh (2000). They reported unacceptable injury to St. Augustinegrass and no injury to zoysiagrass and bermudagrass with all rates of trifloxysulfuron evaluated (0.024 to 0.10 kg ai/ha). Teuton et al. (2001) further strengthened Brecke and Unruh's earlier report when they concluded that the tolerance of 'TifEagle' bermudagrass to multiple applications of trifloxysulfuron was excellent, but St. Augustinegrass injury was variable and cultivar dependent. Chlorsulfuron applied sequentially also injured centipedegrass and 'Palmetto' St. Augustinegrass at 35 and 51%, respectively. Sequential applications of metsulfuron to common centipedegrass and 'Palmetto' St. Augustinegrass resulted in 23 and 24% injury, respectively. Gannon and Yelverton (2001) also observed common centipedegrass injury when using metsulfuron at 0.021 and 0.042 kg ai/ha. Rimsulfuron was the least injurious treatment on common centipedegrass and 'Palmetto' St. Augustinegrass. 'Meyer' zoysiagrass was injured $\leq$ 14% and 'Tifway' bermudagrass $\leq$ 6 with sequential applications.

Across both locations, chlorsulfuron was the only sulfonylurea herbicide to provide acceptable control of Virginia buttonweed. Rimsulfuron consistently provided the lowest control and trifloxysulfuron was most injurious to the turfgrasses.

Study 2. Interpretation of the data collected at McCall's revealed that no treatment provided acceptable control. Treatments containing chlorsulfuron provided the greatest control of Virginia buttonweed (56 to 58%), followed by metsulfuron (20 to 41%), and then by rimsulfuron (1 to 8%) 1 MAT, Table III. 5. Though the levels of control were not acceptable, they were similar to the findings of Anderson and Coats (1985). They reported no significant control of Virginia buttonweed with chlorsulfuron or metsulfuron when applied at 0.014 kg ai/ha. Brooks and Bauman (1995) reported only marginal control of Virginia buttonweed following an application of metsulfuron.

Control with metsulfuron and chlorsulfuron was independent of adjuvant. However, within the metsulfuron treatments, Cohort DC and Genapol 26-L-80 were the best adjuvants with both providing 41% control. All rimsulfuron treatments were ineffective and adjuvant effects could not be determined. Injury to St. Augustinegrass followed the same trend as the control of Virginia buttonweed. Injury was greatest in treatments containing chlorsulfuron (27 to 36%), followed by metsulfuron (15 to 23%); and then by rimsulfuron (8 to 11%). The metsulfuron injury observed in this study is not what Brooks and Bauman reported in 1995. They found that metsulfuron did not provide any significant injury to St. Augustinegrass. The St. Augustinegrass cultivar was not reported and other reports have suggested that injury from other sulfonylurea herbicides may be cultivar dependent (Brecke and Unruh 2000 and Teuton et al. 2001).

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Table III. 1. Description and source of adjuvants.

Adjuvant	Description	Source
Cohort DC®	Proprietary blend of polyethoxylated hydroxyl alkyl surfactants, encapsulated in organic nitrogen.	Helena Chemical Company 225 Schilling Blvd Collierville, TN 38017
Induce®	Proprietary blend of alkyl aryl polyalkane ether free fatty acids.	Helena Chemical Company 225 Schilling Blvd Collierville, TN 38017
Genepol 26-1-80®	Primary linear alcohol ethoxylates.	Clariant Corp. 4000 Monroe Rd Charlotte, NC 28205
Renex-30®	Primary linear alcohol ethoxylates.	Uniquema 3411 Silverside Rd Wilmington, DE 19803

Table III. 2. Virginia buttonweed control and regrowth evaluation 1 month after respective sulfonylurea herbicide treatments applied as a single full rate (kg ai/ha) or the full rate followed 1 month later by a sequential half rate at the first location within the Auburn Research Unit; 2001.

		Single application			Sequential application			Contrast[a]
Treatment	Rate	% Control	SE	$P > 0$	% Control	SE	$P > 0$	$P > 0$
Metsulfuron	0.05	43	5.7	*	19	3.9	*	*
Trifloxysulfuron	0.05	50	5.7	*	41	3.7	*	*
Rimsulfuron	0.05	11	3.2	*	14	2.6	*	NS
Chlorsulfuron	0.36	78	3.9	*	87	1.8	*	*
		Regrowth[b]		*	Regrowth		*	
Metsulfuron	0.05	4.6[c]	0.3	*	1.0	0.3	*	*
Trifloxysulfuron	0.05	4.4	0.3	*	1.2	0.3	*	*
Rimsulfuron	0.05	4.6	0.3	*	0.9	0.3	*	*
Chlorsulfuron	0.36	2.8	0.3	*	0.6	0.3	*	*

[a]Contrast of 1 application vs sequential application.

[b]Regrowth evaluated 1 month after plant removal.

[c]Regrowth scale 0-5. 0 = no regrowth; 5 = regrowth equivilent to non-treated.

Table III. 3. Virginia buttonweed control 1 month after respective sulfonylurea herbicide treatments applied as a single full rate (kg ai/ha) or the full rate followed by 1 month later by a sequential half rate at the second location within the Auburn Research Unit; 2001.

		Single application			Sequential application			Contrast[a]
Treatment	Rate	% Control	SE	$P > 0$	% Control	SE	$P > 0$	$P > 0$
Metsulfuron	0.05	43	4.8	*	68	1.2	*	*
Trifloxysulfuron	0.05	48	2.4	*	54	2.3	*	*
Rimsulfuron	0.05	4	2.4	NS	23	1.2	*	*
Chlorsulfuron	0.36	70	4.1	*	81	0.5	*	*

[a]Contrast of 1 application vs sequential application.

Table III. 4. Turfgrass injury 1month after treatment at the second location within the Auburn University Turfgrass Research Unit following sulfonylurea herbicides treatments applied either at a single full rate (kg ai/ha) or the full rate followed 1 month later by a half rate.

		Single application			Sequential application			Contrast[a]
Turfgrass/ Herbicide	Rate	Injur	SE	$P > 0$	% Injur	SE	$P > 0$	$P > 0$
Centipedegrass								
Metsulfuron	0.05	3[b]	2.4	NS	23	7.4	*	*
Trifloxysulfuron	0.05	54	2.4	*	86	1.3	*	*
Rimsulfuron	0.05	0	1.0	NS	1	1.3	NS	NS
Chlorsulfuron	0.36	0	1.0	NS	35	2.2	*	*
'Palmetto' St. Augustinegrass								
Metsulfuron	0.05	0	1.5	NS	24	7.1	*	*
Trifloxysulfuron	0.05	58	8.2	*	80	2.5	*	*
Rimsulfuron	0.05	9	4.4	NS	21	6.0	*	NS
Chlorsulfuron	0.36	27	6.4	*	51	8.5	*	*
'Meyer' Zoysiagrass								
Metsulfuron	0.05	0	1.5	NS	5	4.6	NS	NS
Trifloxysulfuron	0.05	0	1.5	NS	14	5.6	NS	*
Rimsulfuron	0.05	0	1.5	NS	0	2.3	NS	NS
Chlorsulfuron	0.36	0	1.5	NS	13	5.8	NS	*
'Tifway' Bermudagrass								
Metsulfuron	0.05	4	3.8	NS	3	2.0	NS	NS
Trifloxysulfuron	0.05	0	0.9	NS	1	1.3	NS	NS
Rimsulfuron	0.05	0	0.9	NS	0	2.0	NS	NS
Chlorsulfuron	0.36	0	0.9	1.000	6	2.0	*	*

*P = 0.05.

[a]Contrast of 1 application vs sequential application.

[b]Injury rating scale 0-100; where > 30% was considered unacceptable.

Table III. 5. Adjuvant effect on Virginia buttonweed control and St. Augustinegrass tolerance 1 month after treatment; McCall's 2001.

				Virginia buttonweed			St. Augustinegrass 'Raleigh'		
Herbicide	Rate[a]	Adjuvant	Rate[b]	%Control	SE	$P > 0$	% Injury	SE	$P > 0$
Metsulfuron	0.03			28	4.8	0.011	15	3.1	0.003
Metsulfuron	0.03	CoHort[c]	1.50	41	3.1	<.0001	23	2.3	<.0001
Metsulfuron	0.03	Genapol 26-L-80	0.25	41	2.5	<.0001	17	2.7	<.0001
Metsulfuron	0.03	Renex 30	0.25	20	1.7	<.0001	16	3.8	0.023
Metsulfuron	0.03	Induce	0.25	38	1.2	<.0001	23	1.5	<.0001
Rimsulfuron	0.03			1	1.2	0.329	11	2.3	0.000
Rimsulfuron	0.03	CoHort	1.50	5	1.7	0.009	11	2.7	0.002
Rimsulfuron	0.03	Genapol 26-L-80	0.25	8	1.2	<.0001	11	1.3	0.000
Rimsulfuron	0.03	Renex 30	0.25	4	1.2	0.009	10	2.3	0.001
Rimsulfuron	0.03	Induce	0.25	5	2.5	0.090	8	1.5	<.0001
Chlorsulfuron	0.14			56	3.1	<.0001	36	3.1	<.0001
Chlorsulfuron	0.14	CoHort	1.50	56	1.7	<.0001	27	2.3	<.0001
Chlorsulfuron	0.14	Genapol 26-L-80	0.25	58	1.2	<.0001	34	1.5	<.0001
Chlorsulfuron	0.14	Renex 30	0.25	57	3.1	<.0001	35	2.3	<.0001
Chlorsulfuron	0.14	Induce	0.25	56	2.5	<.0001	34	2.7	<.0001
None		CoHort	1.50	0	1.7	1.000	1	1.5	0.416
None		Genapol 26-L-80	0.25	3	2.5	0.330	9	2.7	0.008
None		Renex 30	0.25	3	2.5	0.330	1	1.3	0.356
None		Induce	0.25	10	1.7	<.0001	10	1.5	<.0001
Non-treated				0	1.7	1.000	1	1.5	0.416
Contrast				Est.	SE	P > 0	Est.	SE	P > 0
Herbide vs. none				473	27.1	<.0001	292	24.4	<.0001
Rimsulfuron vs. others				-407	11.3	<.0001	-157	12.5	<.0001
Chlorsulfuron vs. metsulfuron				116	8.6	<.0001	71	8.3	<.0001
Surfactant on rimusulfuron				16	6.1	0.014	-5	10.0	0.624
Surfactant on chlorsulfuron				2	13.4	0.870	-14	13.1	0.326
Surfactant on metsulfuron				30	19.7	0.216	19	13.4	0.193
Cohort vs. others within metsulfuron				25	10.0	0.029	11	8.4	0.205
Induce vs. Renex and Genapol within metsulfuron				14	3.9	0.001	13	5.5	0.033
Genapol vs. Renex within metsulfuron				21	3.0	<.0001	1	4.6	0.876

[a] Rate reported in kg ai/ha.

[b] Rate of surfactant reported as % v/v.

[c] CoHort rate = 1.5 g/L of spray solution.