Effect of Halosulfuron on Rotational Crops

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Abstract

A field test was conducted to evaluate and determine the safety of halosulfuron on typical rotational crops such as lettuce, broccoli, spinach, onion, alfalfa, barley, field corn, and melons after an initial application on cantaloupes. Halosulfuron at 0.05 or 0.1 lb AI/A applied on cantaloupes did not detrimentally affect crop stand establishment, height, or whole plant fresh weights when alfalfa, barley, spinach, lettuce, onion, and broccoli were planted at approximately 4 to 5 MAT. Cantaloupes and field corn planted at 1 YAT were not affected in establishing a stand and in growing during the early season as height or vine lengths were measured. At 15 to 16 MAT, lettuce, onion, and broccoli were not affected in establishing a stand. Watermelon planted at 1 YAT exhibited slight stand reduction and crop injury with halosulfuron applied PREE. Alfalfa planted after PREE applications indicated slightly depressed height and yield compared to POST treatments and the untreated check. Spinach planted where POST applications were made on cantaloupes tended to show a slight reduction in fresh weight at 15 to 16 MAT. Halosulfuron does not appear to be a major deterrent to typical crop rotational schemes in the diverse desert agricultural systems.

Introduction

Halosulfuron is a sulfonylurea herbicide that is being developed for weed control in cucurbit crops. In desert production systems, it has demonstrated exceptional activity on purple nutsedge (*Cyperus rotundus*) when applied postemergence. It appears to control other broadleaved weeds such as pigweeds but does not provide adequate activity on Wright's groundcherry (*Physalis wrightii*). In addition to the foliar activity on nutsedge, it has soil activity that is marginally safe on melon crops. Many of the sulfonylurea herbicides have exceptionally long soil residual activity and are detrimental to many sensitive rotational crops. Halosulfuron has a relatively shorter soil residual that could allow planting back typical desert-grown vegetable crops safely in an intensive rotational system. This field test was conducted to evaluate and determine the safety of halosulfuron on typical rotational crops such as lettuce, broccoli, spinach, onion, alfalfa, barley, field corn, and melons after an initial application on cantaloupes.

Materials and Methods

A small plot field test was conducted at the University of Arizona Maricopa Agricultural Center , Maricopa, AZ during May 1999 to January 2001. The soil in the test area is characterized as a clay loam. The land was leveled and raised 40-inch beds were listed and shaped in a north-south orientation. Cantaloupe cv. Cruiser was planted on 17 May 1999 in a single seedline in the middle of each bed. The raised beds allowed for typical furrow irrigation of the crops. Individual treatment plots consisted of twelve beds measuring 45 ft in length. The test was arranged in a randomized complete block design with four replicates. Halosulfuron was applied at 0.05 and 0.1 lb AI/A preemergence (PREE), postemergence (POST), or sequentially as PREE followed by POST. PREE treatments were applied to the soil after

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planting and prior to furrow irrigation on 18 May when the temperature was 90F and skies were overcast. All herbicide treatments were applied using a tractor-mounted sprayer with a boom having seven 8003 flat fan nozzle tips spaced 20 inches apart. The treatments were applied in 42 gpa water pressurized to 22 psi. POST treatments, alone and sequential, were applied with Latron CS-7 adjuvant added at 0.25% v/v on 07 June. The weather during POST applications was clear and 75F. The cantaloupe was at the 2-leaf stage of growth, with predominant weeds Palmer amaranth (*Amaranthus palmeri*) at the 6 to 8 leaf stage, ivyleaf morningglory (*Ipomoea hederacea*) at the 3 to 4 leaf stage, and sporadic infestations of volunteer cotton, purple nutsedge and Wright's groundcherry. At intervals after the herbicide applications, cantaloupe injury and weed control efficacy were evaluated. During the growing season, the melons were furrow irrigated four times after the first germination water. The cantaloupe was cultivated once and then terminated at approximately 3 months after planting (MAP). To minimize the soil movement and disturbance within and between treatment plots, the "Sundance lister" re-listed the existing beds in September 1999. The beds were re-shaped with a rototiller-bedshaper in the same location and fall/winter crops were planted back in the same cantaloupe beds. A vegetable planter planted 2 seedlines of each crop (Solum barley, alfalfa cv. Mecca, spinach cv. Unipak 144, lettuce cv. Del Oro, onion cv. Desex, and broccoli cv. Liberty) into two beds within each replicate plot on 26 October 1999. This first set of rotational crops was furrow irrigated and grown through March 2000. A total of 13 irrigations was put on the crops at approximately weekly intervals. Crop stand counts and height measurements were collected from 10 ft of row of each bed at intervals during the growing season and then whole plants were harvested for fresh weights. The remaining crops were shredded and then the "Sundance lister" was used three times and the rototiller-bedshaper passed over the same beds to achieve adequate soil consistency to replant the second set of rotational crops. Four beds with a single seedline each of field corn, cantaloupe cv. Torreon, and watermelon cv. Paradise were planted into the field on 09 May 2000 at 1 year after treatment (YAT) by the herbicides. A total of 7 irrigations was put on the crops at approximately weekly intervals through July 2000. Crop stand counts and height or vine length measurements were collected from 10 ft of row of each bed at intervals during the growing season and then whole plant fresh weights of corn were collected. The remaining melons and corn were shredded and the "Sundance lister" was used two times and the rototiller-bedshaper passed over the same beds to achieve adequate soil consistency to replant the third set of rotational crops. Alfalfa, barley, spinach, lettuce, onion, and broccoli were planted on 22 September 2000 at 15 to 16 MAT using a vegetable planter similar to practices in fall 1999. A total of 9 irrigations was put on the crops at approximately weekly intervals until harvest in January 2001. Crop stand counts and height measurements were collected from 10 ft of row of each bed at intervals during the growing season and then whole plant fresh weights were harvested in January 2001.

Results and Discussion

Crop safety and weed control efficacy. Slight injury up to 16% was observed on cantaloupes on 16 June at 29 DAT of the PREE treatments and 9 DAT of the POST treatments (Table 1.) Slightly more unacceptable injury up to 28% was observed for PREE plus POST treatments on cantaloupes. The injury was much less at less than 10% at 8 WAT of the PREE treatments and 5 WAT of the POST treatments applied singly or sequentially. POST weed control of Palmer's amaranth and ivyleaf morningglory was superior to PREE treatments. A single application at 0.1 lb AI/A was similar to sequential applications at the early rating date. At 5 WAT of the POST treatments, two applications of halosulfuron at 0.1 lb AI/A gave better than 93% control of Palmer's amaranth and morningglory. Purple nutsedge population was sparse and inconsistent throughout the plots and halosulfuron gave acceptable control of 85 to 90% at the early rating date and no nutsedge was observed at the later date. Halosulfuron did not adequately control sporadic infestations of Wright's groundcherry.

First rotational crops. Halosulfuron did not affect crop stand establishment when alfalfa, barley, spinach, lettuce, onion, and broccoli were planted on 26 October 1999 at approximately 4 to 5 MAT of the cantaloupes (Table 2). The number of plants of each crop that was counted was similar to the untreated check. Spinach, lettuce, and onion stand counts exhibited more plants than the untreated. Measurement of crop height showed that barley, spinach, lettuce, onion, and broccoli were not affected by halosulfuron treatments (Table 3). Most of the crop heights were similar or exceeded the average plant height of the untreated checks. Alfalfa plant heights were slightly reduced compared to the untreated check except where the highest rate applied POST was less affected than the lower rate without an explanation. Barley, spinach, lettuce, and broccoli whole plants were harvested in March 2000 and no significant differences in average fresh weight were observed compared to the untreated check.

Second rotational crops. Cantaloupes, watermelon, and field corn planted at 1 YAT were not affected in establishing a stand and in growing during the early season as height or vine lengths were measured (Table 5). Watermelon tended to show a slight decrease in stand establishment and vine growth for PREE applied halosulfuron with respect to the untreated check and POST treatments. However, no stand or growth reduction occurred for the sequential PREE plus POST treatments. Corn yields did not show any detrimental effects from halosulfuron treatments.

Third rotational crops. At 15 to 16 MAT, spinach, lettuce, onion, and broccoli were not affected in establishing a stand (Table 6). Alfalfa treated by halosulfuron at 0.1 lb AI/A PREE had fewer plants compared to the untreated check and other PREE, POST, and sequential treatments. At harvest, alfalfa had slightly reduced fresh weight of whole plants where halosulfuron was applied PREE only. Alfalfa planted where sequential PREE plus POST treatments were applied did not exhibit any significant reduction. Spinach planted where POST applications were made on cantaloupes tended to show a slight reduction in fresh weight compared to the untreated check and where PREE treatments were applied. Broccoli and lettuce fresh weights did not exhibit differences between treatments and the untreated check. Barley did not establish an adequate stand to provide reliable data. Onions were not harvested due to immaturity of the stand.

In summary, rotational crops planted successively for three seasons after an initial halosulfuron application were not appreciably injured. Vegetable crops and field crops including lettuce, broccoli, spinach, onion, cantaloupe, corn and barley planted at 4 to 5 MAT, 11 to 12 MAT, and again at 15 to 16 MAT did not exhibit significant crop stand reduction, height reduction, or fresh weight reduction. Watermelon planted at 1 YAT appeared to exhibit slight stand reduction and crop injury with halosulfuron applied PREE. However, a sequential PREE plus POST treatment or POST treatment alone did not cause greater injury even when more halosulfuron was applied. Alfalfa planted after PREE applications indicated slightly depressed height and yield compared to POST treatments and the untreated check.

The intensive irrigation schedule of approximately weekly applications during the repeated cropping seasons and light tillage operations more than likely contributed to the halosulfuron degradation by biological/microbial, chemical, and solar radiation processes. Halosulfuron does not appear to be a major deterrent to typical crop rotational schemes in the diverse desert agricultural systems. Soil textural differences, tillage practices, number of applications and the rates of application may be considerations for further research to determine the absolute safety of halosulfuron in the desert.

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Table 1. Weed control and rotational crop effects with halosulfuron.

Treatment	Rate (lb AI/A)	Timing	Crop Injury		Weed Control (%)			
			16 Jun	12 Jul	AMAPA		IPOHE	
					16 Jun	12 Jul	16 Jun	12 Jul
Untreated Check			0	0	0	0	0	0
Halosulfuron	0.05	PREE	8	0	71	48	64	38
Halosulfuron	0.1	PREE	11	5	80	74	55	64
Halosulfuron	0.05	POST	16	4	91	75	85	78
Halosulfuron	0.1	POST	15	4	93	83	85	81
Halosulfuron + Halosulfuron	0.05 + 0.05	PREE + POST	21	4	93	85	86	85
Halosulfuron + Halosulfuron	0.1 + 0.1	PREE + POST	28	10	93	95	89	93
LSD (p=0.05)			4.4	6.5	8.4	11.9	8.5	20.6

Herbicides applied on 18 May 1999 (PREE) and 07 June 1999 (POST).
AMAPA = *Amaranthus palmeri* (Palmer's amaranth), IPOHE = *Ipomea hederacea* (ivyleaf morningglory)

Table 2. Effect of halosulfuron on first set of rotational crops' stand establishment

Treatment	Rate (lb AI/A)	Timing	Crop Stand					
			Alfalfa	Barley	Spinach	Lettuce	Onion	Broccoli
			No. plant/10 ft row					
Untreated Check			50	65	92	62	35	22
Halosulfuron	0.05	PREE	59	58	100	70	38	22
Halosulfuron	0.1	PREE	62	62	99	65	35	19
Halosulfuron	0.05	POST	58	60	95	73	38	21
Halosulfuron	0.1	POST	61	62	104	72	40	22
Halosulfuron + Halosulfuron	0.05 + 0.05	PREE + POST	57	60	100	66	40	24
Halosulfuron + Halosulfuron	0.1 + 0.1	PREE + POST	45	63	100	68	36	19
LSD (p=0.05)			20.2	6.6	6.5	9.7	6.3	4.0

Herbicides applied on 18 May 1999 (PREE) and 07 June 1999 (POST).
Crops planted on 26 October 1999 at approximately 4 to5 MAT.
Crop stand counts on 16 November 1999 at 3 WAP.

Table 3. Effect of halosulfuron on first set of rotational crops' height

Treatment	Rate (lb AI/A)	Timing	Crop Height					
			Alfalfa	Barley	Spinach	Lettuce	Onion	Broccoli
			Avg. height (inches)/ 10 plants					
Untreated Check			1.6	14.8	2.9	1.4	2.1	3.7
Halosulfuron	0.05	PREE	1.4	15.3	3.1	1.4	2.1	4.4
Halosulfuron	0.1	PREE	1.4	14.9	2.9	1.3	2.4	4.4
Halosulfuron	0.05	POST	1.2	15.1	2.8	1.4	2.1	3.8
Halosulfuron	0.1	POST	1.6	14.8	2.9	1.4	2.0	4.1
Halosulfuron + Halosulfuron	0.05 + 0.05	PREE + POST	1.4	15.8	3.3	1.1	2.3	5.1
Halosulfuron + Halosulfuron	0.1 + 0.1	PREE + POST	1.4	15.4	3.1	1.3	2.4	4.8
LSD (p=0.05)			0.3	1.2	0.4	0.5	0.5	1.6

Plant height measurements on 22 December 1999 at approximately 2 MAP.

Table 4. Effect of halosulfuron on first set of rotational crops' yields

Treatment	Rate (lb AI/A)	Timing	Crop Yield			
			Barley	Spinach	Lettuce	Broccoli
			Fresh weight (lb) / 10 ft row			
Untreated Check			23.0	11.8	38.4	23.6
Halosulfuron	0.05	PREE	23.8	11.2	34.8	27.4
Halosulfuron	0.1	PREE	22.2	10.4	31.0	21.0
Halosulfuron	0.05	POST	22.4	11.2	31.2	24.9
Halosulfuron	0.1	POST	23.0	11.6	37.1	30.6
Halosulfuron + Halosulfuron	0.05 + 0.05	PREE + POST	22.2	11.8	36.3	30.6
Halosulfuron + Halosulfuron	0.1 + 0.1	PREE + POST	23.3	11.5	35.5	24.3
LSD (p=0.05)			2.00	1.73	8.86	7.89

Whole plants cut in March 2000 at 5 MAP.

Table 5. Effect of halosulfuron on second set of rotational crops

Treatment	Rate (lb AI/A)	Timing	Crop Stand			Crop Injury			Crop Yield
			Watermelon	Cantaloupe	Corn	Watermelon	Cantaloupe	Corn	Corn
			No. plant/10 ft row			Avg. plant ht (in)			lb/plot
Untreated Check			8.6	13.9	30.3	15.4	11.7	16.8	12.9
Halosulfuron	0.05	PREE	8.1	13.1	29.8	13.1	11.7	18.5	17.3
Halosulfuron	0.1	PREE	6.9	13.9	29.3	11.3	10.7	17.7	11.7
Halosulfuron	0.05	POST	9.1	13.8	31.3	13.8	11.6	18.0	15.5
Halosulfuron	0.1	POST	9.3	14.8	30.9	12.7	12.9	17.2	15.4
Halosulfuron + Halosulfuron	0.05 + 0.05	PREE + POST	8.5	14.8	30.5	12.1	11.4	17.9	14.9
Halosulfuron + Halosulfuron	0.1 + 0.1	PREE + POST	9.3	13.6	30.3	13.1	12.8	18.0	15.1
LSD (p=0.05)			1.94	6.38	1.77	3.24	3.08	2.48	4.62

Herbicides applied on 18 May 1999 (PREE) and 07 June 1999 (POST). Crops planted 1 YAT.
Crop stand counts on 01 June 2000 at 3 WAP. Crop height measurements on 15 June 2000 at 5 WAP.
Corn harvest at 7 WAP.

Table 6. Effect of halosulfuron on third set of rotational crops and yields

Treatment	Rate (lb AI/A)	Timing	Crop Stand					Crop Yield			
			Alfalfa	Spinach	Lettuce	Onion	Broccoli	Spinach	Broccoli	Lettuce	Alfalfa
			No. plant/10 ft row					Fresh weight (lb) / 10 ft row			
Untreated Check			71	137	46	24	37	6.7	4.3	6.8	1.5
Halosulfuron	0.05	PREE	67	129	47	24	37	5.5	4.3	6.4	1.2
Halosulfuron	0.1	PREE	57	133	44	25	34	7	4.6	6.5	1.2
Halosulfuron	0.05	POST	70	132	46	27	36	5.6	3.9	6.1	1.4
Halosulfuron	0.1	POST	67	138	46	26	38	4.4	4.2	6.9	1.4
Halosulfuron + Halosulfuron	0.05 + 0.05	PREE + POST	66	132	48	24	37	4.6	4	5.9	1.4
Halosulfuron + Halosulfuron	0.1 + 0.1	PREE + POST	67	134	46	28	36	4	4.1	6.7	1.5
LSD (p=0.05)			9.3	11.4	6.6	6.1	5.3	2.58	1.78	2.16	0.53

Herbicides applied on 18 May 1999 (PREE) and 07 June 1999 (POST). Crops planted at approximately 14 to 16 MAT.
Crop stand counts on 27 October 2000 at 4 WAP. Crop harvest on 26 January 2001 at 3 MAP.