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Note

Response of Squash and Cucumber Cultivars to Halosulfuron[1]

THEODORE M. WEBSTER, A. STANLEY CULPEPPER, and W. CARROLL JOHNSON, III[2]

Abstract: Greenhouse studies were conducted to evaluate halosulfuron tolerance of several squash and cucumber cultivars commonly grown in Georgia. There was an inverse linear relationship between squash plant biomass and rate of halosulfuron (r^2 = 0.70 to 0.92). With the exception of 'Supersett', the slopes from regression of all squash cultivars were equivalent. The estimated amount of halosulfuron required to reduce growth by 20%, based on regression, ranged from 8.2 to 45 g ai/ha (for Supersett and 'Dixie', respectively). Squash plant height was also reduced by halosulfuron, though plants began to recover from the injury by the end of the study. There was no effect of halosulfuron rate on cucumber plant biomass or height. Cucumber cultivars appeared to be more tolerant to halosulfuron than did squash cultivars.

Nomenclature: Halosulfuron; cucumber, *Cucumis sativus* L.; squash, *Cucurbita pepo* L.

Additional index words: *Cyperus esculentus*, *Cyperus rotundus*, methyl bromide alternatives, MON 12037, purple nutsedge, vegetable weed management, yellow nutsedge.

Abbreviations: DAP, days after planting; GR_{20}, herbicide rate required to reduce crop growth 20%; POST, postemergence; PRE, preemergence; PRE–POST, half rate PRE followed by half rate POST.

INTRODUCTION

With the mandated elimination of methyl bromide use in the United States in 2005, vegetable growers will soon lose a valuable tool for managing multiple pests including weeds. There is a concern that nutsedges will become unmanageable in vegetable crops after the elimination of methyl bromide use (Harrison and Fery 1998). Nutsedges are the most troublesome weeds in many vegetable production areas (Webster 2002). Weediness of these species is related to their vigorous early-season growth due to large energy supplies in their tubers, rapid spread through rhizomes, and tolerance to many herbicides.

Halosulfuron is currently being evaluated as a potential methyl bromide replacement for nutsedge control in several vegetable crops. Halosulfuron reduced purple and yellow nutsedge (*Cyperus rotundus* L. and *C. esculentus* L.) shoot regrowth greater than 95% and reduced tuber dry weight at least 78% 60 d after treatment (Vencill et al. 1995). The objective of this study was to evaluate the effect of halosulfuron rate and application method on the early-season growth of several cucumber and squash cultivars commonly grown in Georgia.

MATERIALS AND METHODS

A greenhouse trial was conducted in 1999 and 2000 in Tifton, GA. The study was a randomized complete block design with six replications and was repeated over time. Treatments were arranged as a factorial that included levels of planting method (direct seeded or transplanted), application method (preemergence [PRE], postemergence [POST], and half rate PRE followed by half rate POST [PRE–POST]), and halosulfuron rate (18, 35, 53 g ai/ha). Cultivars included the pickling cucumbers 'Calypso' and 'Sumter'; slicing cucumbers 'Dasher II', 'Marketmore', 'Speedway', and 'Thunder'; yellow crookneck squash 'Dixie' and 'Supersett'; yellow straightneck squash 'Lemondrop'; and zucchini 'Senator', 'Spineless Beauty', and 'Tigress'. These represent approximately 55 and 70% of Georgia squash and cucumber hectarage, respectively.[3] Each cultivar also had a nontreated control for both planting methods. Direct-

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[2] Research Agronomist, Crop Protection and Management Research Unit, United States Department of Agriculture, Agricultural Research Service, Coastal Plain Experiment Station, Tifton, GA 31794; Assistant Professor, Crop and Soil Sciences, University of Georgia, Tifton 31794; Research Agronomist, Crop Protection and Management Research Unit, United States Department of Agriculture, Agricultural Research Service, Coastal Plain Experiment Station, Tifton, GA 31794. Corresponding author's E-mail: twebster@tifton.usda.gov.

[3] Kelley, W. T. 2002. Personal communication. Extension Vegetable Horticulturalist, University of Georgia, Rural Development Center, P.O. Box 1209, Tifton, GA 31793.

Table 1. Parameters of linear regression of squash plant biomass and plant height regressed on rate of halosulfuron (equation: y = a + bx). There were no differences in y-intercepts among the squash cultivars. Regression slopes among cultivars with similar letters were not different from one another based on a *t*-test.

Cultivar	Shoot biomass				Plant height			
	a	b	r^2	GR_{20}[a]	a	b	r^2	GR_{20}
				g/ha				g/ha
Dixie	98.0	− 0.40 b	0.92	45.0	97.5	− 0.35	0.78	50.0
Lemondrop	98.1	− 0.71 b	0.85	25.6	98.8	− 0.48	0.88	39.2
Senator	98.6	− 0.45 b	0.82	41.3	99.8	− 0.28	0.85	> 53.0
Spineless Beauty	94.8	− 0.50 b	0.82	39.6	100.0	− 0.25	0.79	> 53.0
Supersett	88.7	− 1.06 a	0.71	8.2	98.4	− 0.32	0.80	> 53.0
Tigress	94.2	− 0.48 b	0.70	29.5	96.5	− 0.35	0.73	47.1

[a] GR_{20} is the estimated amount of halosulfuron (g/ha) required to reduce squash shoot biomass by 20%.

seeded and transplanted treatments were planted the same day. Direct-seeded treatments were planted into 13- by 13-cm pots that were 12 cm tall and filled with nonsterilized field soil, Dothan loamy sand (fine-loamy, siliceous thermic Plinthic Paleudult: 93% sand, 4% silt, 3% clay). Seedlings for transplanted treatments were grown using previously described methods (Webster et al. 2001).

PRE applications were made the same day after the planting of direct-seeded treatments and to bare soil in pots for the transplant treatments. Cucurbits were transplanted from trays to pots 11 to 13 d after planting (DAP). Under the near-ideal growing conditions in the greenhouse, transplant shock was minimal. The POST treatments were applied to both direct-seeded and transplanted treatments 14 to 18 DAP (3 to 5 d after transplanting). Herbicides were applied in a spray volume of 187 L/ha at 234 kPa with flat-fan nozzle tips using a spray chamber with a compressed-air propellant. All POST applications included 0.25% (v/v) nonionic surfactant.[4]

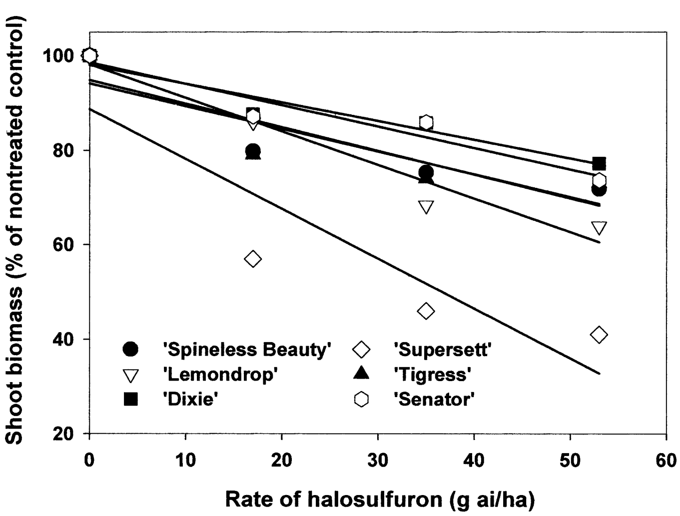

Figure 1. Regression illustrates the inverse linear relationship between squash shoot biomass and rate of halosulfuron among squash cultivars. Details of the regression equations can be found in Table 1.

Plant height at the base of the tallest leaf and shoot dry weight were measured 39 to 40 DAP. All data were subjected to analysis of variance and regression analysis where appropriate. Before analysis of variance, shoot biomass for each species was converted to percentage of the nontreated control to facilitate comparison of cultivars. The lack of a significant treatment by trial (repetition of the study over time) interaction indicated that data could be combined over trials. Application method treatment means were separated using Fisher's Protected LSD at an alpha level of 0.05. Differences among regression slopes were evaluated using a *t* test. Although many studies have often used the 50, 90, or 99% levels of growth reduction for pests (Seefeldt et al. 1995), the purpose of this study was to evaluate crop safety. The amount of halosulfuron necessary to reduce crop growth by 20% (GR_{20}) was estimated using regression because this growth reduction represents an acceptable level of crop injury (Table 1).

RESULTS AND DISCUSSION

There was an inverse linear relationship between the rate of halosulfuron and shoot biomass for each of the squash cultivars (r^2 = 0.70 to 0.92) (Figure 1). The slopes of the regression and the y-intercepts were equivalent among cultivars, with the exception of the slope of Supersett (Table 1). In terms of shoot biomass, Supersett had the most negative slope (−1.06) and a GR_{20} of 8.2 g/ha of halosulfuron. This rate of halosulfuron would likely be too low for acceptable control of nutsedge species.

The GR_{20} values for Lemondrop, Tigress, and Spine-

[4] Chem Nut 80-20 Surfactant, 80% alkyl and alkylaryl polyoxyethylene glycol and 20% coupling agents. Chem Nut, Inc., 1918 Ledo Road, Albany, GA 31707.

Table 2. The effect of halosulfuron application method on cucurbit shoot biomass compared with the nontreated control. Treatment means separated using Fisher's Protected $LSD_{0.05}$ = 20.2.[a]

Cultivar	PRE	POST	PRE–POST	Nontreated control
	Plant biomass (% of nontreated control)			
Supersett	44*	51*	50*	100
Tigress	74*	83	70*	100
Spineless Beauty	78*	80	68*	100
Senator	81	81	84	100
Lemondrop	74*	77*	66*	100
Dixie	96	77*	75*	100
Thunder	111	99	96	100
Calypso	98	106	102	100
Dasher II	81	97	91	100
Marketmore	88	93	99	100
Speedway	90	95	101	100
Sumter	103	105	112	100

[a] Abbreviations: PRE, preemergence; POST, postemergence; PRE–POST, half rate PRE followed by half rate POST.

* Indicates that treatment is different from the nontreated control using Fisher's Protected $LSD_{0.05}$.

less Beauty shoot biomass ranged from 25.6 to 29.6 g/ha (Table 1). Halosulfuron applied at these rates POST controlled yellow nutsedge 64 to 98% in field studies (Culpepper and Batts 2001; Stall and Majek 1995). The squash cultivars most tolerant to halosulfuron were Senator and Dixie, with GR_{20} values for shoot biomass 41.3 and 45.0 g/ha of halosulfuron, respectively (Table 1). These GR_{20} values exceed the maximum registered rate (39 g/ha) of halosulfuron for use in other cucurbits, muskmelon (*Cucumis melo* L.), and cucumber for the 2002 growing season.[5] Also, although these rates reduced early-season squash shoot biomass, it is uncertain how marketable yields would be affected. Previous studies demonstrated that squash plants were capable of recovering from early-season injury (up to 38% injury) to produce crop yields equivalent to the weed-free control (Garvey et al. 1997).

One means of potentially minimizing cucurbit injury from halosulfuron is to use a PRE–POST application (Mitchem and Monks 1997; Starke et al. 1998). However, this strategy did not eliminate plant growth suppression due to halosulfuron with five of the six squash cultivars tested (Table 2). With the exception of Senator, the PRE–POST halosulfuron treatments reduced squash shoot biomass relative to the nontreated controls. Shoot biomass of Supersett was reduced by all application methods at least 49%, relative to the nontreated control. In contrast, no treatment reduced the shoot biomass of Senator in comparison with the nontreated control. When halosulfuron was applied PRE to Dixie, shoot biomass was similar to that of nontreated control but greater than when applied PRE–POST.

For the cucumber cultivars, regression of shoot biomass on halosulfuron rate was not significant. Shoot biomass was reduced less than 10% for each cucumber cultivar at the highest tested rate of halosulfuron. Also, no treatment reduced cucumber shoot biomass relative to the nontreated control for any of the cultivars tested (Table 2). This supports the previous work in which Calypso cucumber was tolerant to 71 g/ha of halosulfuron when applied PRE or PRE–POST (Mitchem and Monks 1997).

The primary form of crop injury to squash plants from halosulfuron was stunting and yellowing of the plant. Regression of plant height on halosulfuron rate (r^2 = 0.73 to 0.88) indicated that plant height was reduced with increasing rates of halosulfuron (Table 1). The estimated GR_{20} values based on plant height were at least 39 g/ha of halosulfuron for all the cultivars, with three of the cultivars (Supersett, Spineless Beauty, and Senator) having a GR_{20} greater than the maximum tested application rate of halosulfuron. This indicates that squash plants were capable of recovering from initial plant stunting and that plant height may not be the most robust measurement to demonstrate the effect of halosulfuron on squash growth. In addition, height of the tallest cucumber leaf was not affected by rate of halosulfuron.

The cucumber cultivars appeared to be more tolerant to halosulfuron treatments than did the squash cultivars. Further study in the field of the effects of halosulfuron on the cucurbit growth and yield is needed to integrate this into vegetable weed management systems.

[5] Sandea herbicide 24(c) product label for Georgia, 2002, Gowan Company, Yuma, AZ 85366-5569.

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