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Rate Response of Halosulfuron, Trifloxysulfuron, and Thifensulfuron-methyl on Three Common Weed Species of Field Grown Caladiums [*Caladium bicolor* (Aiton) Vent.]

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Broadleaf weeds are a persistent problem in field grown Caladium production due in part to the lack of registered post-emergence herbicides. Previous research found that many caladium varieties tolerate post emergence sprays of halosulfuron, trifloxysulfuron, and thifensulfuron-methyl. Research was conducted at the Gulf Coast Research and Education Center (GCREC) in 2014 to determine the minimum rate needed to achieve adequate control of common purslane (*Portulaca oleracea*), spotted spurge (*Euphorbia maculata*), and morning glory (*Ipomoea cordatotriloba*). Experiments were set up as randomized complete-block designs with four blocks. Spotted spurge and common purslane were grown in pots in a greenhouse whereas the morning glory trial was set up in the field at the GCREC. Halosulfuron was applied at 0, 13.12, 26.25, 52.5, 105, and 210 $g\cdot ha^{-1}$ (ai), trifloxysulfuron was applied at 0, 5.25, 10.5, 21, 42, and 84 $g\cdot ha^{-1}$ (ai), and thifensulfuron-methyl was applied at 0, 1.75, 3.5, 7, 14, and 28 $g\cdot ha^{-1}$ (ai). Thifensulfuron-methyl achieved the greatest common purslane control with 82% control at 7 $g\cdot ha^{-1}$ (ai). Trifloxysulfuron achieved 100% spotted spurge control at 21 $g\cdot ha^{-1}$ (ai). Thifensulfuron-methyl and trifloxysulfuron achieved 91% and 87% control with 28 and 42 $g\cdot ha^{-1}$ (ai), respectively. Our results indicate that adequate control of common problematic weeds in field grown caladiums can be achieved with the herbicides evaluated.

In 2003, approximately 95% of the world supply of caladium (*Caladium bicolor* (Aiton) Vent.) tubers were produced on 1,330 acres in Highlands County, Florida (Deng et al., 2011). These tubers are sold to every state in the continental United States and more than 40 countries worldwide. For many years methyl bromide was the primary pest management tool for most caladium growers. Though caladium farms are currently exempt from the phase-out of methyl bromide use, many growers have opted not to use this fumigant due in part to rising costs. This has likely played a role in the rapid increase in weed density and diversity seen throughout the production region. For example, growers reported that doveweed has not historically been a significant issue in caladium production, but in 2014, Nathan Boyd observed densities in some fields high enough to significantly reduce yields, tuber size, and in some cases inhibit harvest operations. Growers need weed management options and there are currently no registered herbicides for this crop.

A variety of preemergence herbicides have been evaluated for use in caladiums. Gilreath et al. (1985), evaluated 12 preemergence herbicides in field grown caladiums and found that oryzalin consistently provided acceptable weed control with little to no caladium injury. Gilreath et al. (1994) found that metolachlor, flumetralin, oryzalin, and a tankmix of isoxaben+oryzalin were all possible weed management options in caladiums though none of the herbicide treatments influenced tuber yield. Metolachlor provides adequate early season weed control whereas oryzalin applied in conjunction with fumigation can provide satisfactory weed control into mid-fall (Gilreath et al. 1999). Post-emergence herbicides are needed to control weeds that emerge following preemergence herbicide applications. Research conducted at the Gulf Coast Research and Education Center found that halosulfuron, thifensulfuron-methyl, and trifloxysulfuron are safe on caladiums but further research is needed to identify the application rate required to control problematic weed species.

The objective of this research was to determine the halosulfuron, thifensulfuron-methyl, and trifloxysulfuron rate needed to adequately control three problematic weeds in commercial caladium fields.

Materials and Methods

Three experiments were conducted in 2014 at the Gulf Coast Research and Education Center (GCREC) in Balm, FL, to evaluate the impact of six rates of halosulfuron, thifensulfuron-methyl, and trifloxysulfuron on common purslane (*Portulaca oleracea* L.), spotted spurge (*Euphorbia maculate* L.), and morning glory (*Ipomoea cordatotriloba* Dennst.). Each weed species was run as a separate experiment. All experiments were set up as a factorial experiment with herbicide as one factor and herbicide rate as the second factor. Herbicide rates used in the experiment were 0, 0.25x, 0.5x, 1x, 2x, and 4x, where the 1x rate for each herbicide was based on the rate registered for use in vegetable crops in Florida (Table 1). Experiments were set up as a randomized complete block with four blocks. All herbicides were applied using a handheld CO_2 pressurized sprayer at 240 KPa equipped with a single nozzle boom with a Teejet 8002VS nozzle. The

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Table 1. Herbicide rates used in three dose-response studies conducted during 2014 at the Gulf Coast Research and Education Center in Balm, FL.

	g ha-1 (ai)		
Rate	Halosulfuron	Thifensulfuron-methyl	Trifloxysulfuron
0	0	0	0
0.25x	13.1	1.75	5.2
0.5x	26.3	3.5	10.5
1x	52.5	7	21
2x	105	14	42
4x	210	28	84

application volume was 187 L·ha-1 and a nonionic surfactant was added at 0.2% of the application volume.

Spotted spurge seedlings were collected from a commercial caladium field and transplanted on July 8, 2014 in 15 cm x 10 cm pots filled with Fafard 3B potting soil (Sungro Horticulture, Agawam, MA). Common purslane was grown from seed collected at GCREC and stored at room temperature until August 2014 when it was planted in the same size pots and potting soil as spotted spurge. Herbicides were sprayed on the spurge and purslane on 29 July 2014 and 13 Sept. 2014, respectively. Pots were kept in a greenhouse for the duration of the experiment and drip-irrigated daily. The morning glory experiment occurred in a field where tomatoes had been grown the preceding season and substantial numbers of morning glory seedlings emerged in the planting holes. Each plot was 7.6 m of a single 0.8-m wide bed. Herbicides were sprayed on 5 Aug. 2014, using the same spray equipment as previously noted.

The percentage of damage was estimated on a 0–100 scale where 0 is no damage and 100 is complete shoot death. Damage ratings were taken 2, 4, and 8 weeks after treatment (WAT). Above ground shoot biomass was collected 8 WAT and dried in an oven for 6 days at 40 °C.

Data was analyzed in SAS using Proc Mixed with block as the random factor. Data were analyzed using the repeated statement in SAS with means compared using the PROC LSMEANS statement. Data were transformed as necessary to meet model assumptions but back-transformed means are presented.

Results and Discussion

Common purslane. Averaged across 2, 4, and 8 WAT, there was a significant herbicide by rate interaction ($P < 0.0001$). Eighty-two percent control was achieved at 7 g·ha-1 (ai) of thifensulfuron-methyl (Table 2). Equivalent rates of control were achieved with 42 g·ha-1 (ai) of trifloxysulfuron. Halosulfuron was less effective with only 42% control at 210 g·ha-1 (ai). At the highest rate, halosulfuron reduced purslane biomass by 36% whereas thifensulfuron-methyl and trifloxysulfuron reduced biomass by 53% at 7 and 42 g·ha-1 (ai), respectively (Table 3). Our results indicate the thifensulfuron-methyl is the most effective herbicide for common purslane control.

Spotted spurge. Averaged across 2, 4, and 8 WAT, there was a significant herbicide by rate interaction ($P < 0.0001$). Thifensulfuron-methyl did not adequately control spotted spurge with only 30% control achieved at the highest applied rate (Table 2). Eighty-two percent control was achieved with 210 g·ha-1 (ai) of

Table 2. Effect of herbicide and herbicide rate on percentage of damage of common purslane, morning glory, and spotted spurge.

Rate	Halosulfuron	Thifensulfuron	Trifloxysulfuron
Common purslane			
0x	0 f[z]	0 f	0 f
0.25x	8 ef	18 def	12 def
0.5x	28 cd	50 b	42 bc
1x	20 de	82 a	58 b
2x	30 cd	85 a	82 a
4x	42 bc	85 a	80 a
Morning glory			
0x	0 f	0 f	0 f
0.25x	0 f	22 e	22 e
0.5x	0 f	44 d	58 cd
1x	1 f	48 cd	66 bc
2x	5 ef	58 cd	87 ab
4x	3 ef	91 a	89 a
Spotted spurge			
0x	0 i	2 i	2 i
0.25x	2 i	2 i	2 i
0.5x	48 e	5 i	85 bcd
1x	40 ef	10 hi	100 a
2x	75 d	22 gh	95 abc
4x	82 cd	30 fg	98 ab

[z]Means within species followed by the same letter are not significantly different at $P < 0.05$.

Table 3. Effect of herbicide and herbicide rate on dry biomass 8 weeks after treatment of common purslane and spotted spurge.

	g/plant		
Rate	Halosulfuron	Thifensulfuron	Trifloxysulfuron
Common purslane			
0x	3.6 ab[z]	3.6 a	3.6 ab
0.25x	3.2 a–d	3.6 ab	3.5 ab
0.5x	3.3 abc	2.7 cde	2.9 b–e
1x	3.6 ab	1.7 gh	2.1 fg
2x	2.5 def	1.6 h	1.7 gh
4x	2.3 ef	1.5 h	1.7 gh
Spotted spurge			
0x	4.9 a	3.8 ab	3.0 bcd
0.25x	4.0 ab	3.7 b	4.0 ab
0.5x	2.3 cde	3.0 bcd	0.8 fgh
1x	2.0 de	3.4 bc	0.3 gh
2x	1.7 ef	1.4 efg	0.2 gh
4x	1.6 ef	1.7 ef	0.1 h

[z]Means within species followed by the same letter are not significantly different at $P < 0.05$.

halosulfuron whereas 100% control was achieved with trifloxysulfuron at 21 g·ha-1 (ai). A 90% reduction in biomass was observed with trifloxysulfuron at 21 g·ha-1 (ai) (Table 3). The maximum suppression achieved with both other products was 65%. Our results indicate that trifloxysulfuron is the most effective herbicide for spotted spurge control.

Morning glory. Averaged across 2, 4, and 8 WAT, there was a significant herbicide by rate interaction ($P < 0.0003$). Halosulfuron did not adequately control morning glory (Table 2). Thifensulfuron-methyl and trifloxysulfuron provided 91 and 87%

control at 28 and 42 g·ha^{-1} (ai), respectively. Both product may adequately control morning glory.

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