Postemergence Spurge Control in Container-Grown Liriope©[1]

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Three experiments were conducted to evaluate postemergence applied herbicides for prostrate spurge [*Chamaesyce maculata* (syn. *Euphorbia supina*)] control and tolerance of container-grown liriope (*Liriope muscari*). In experiment 1, Manage at 0.0084, 0.017, or 0.034 kg ai ha^{-1} (0.0075, 0.015, or 0.03 lb ai ac^{-1}); Image at 0.07, 0.14, or 0.28 kg ai ha^{-1} (0.0625, 0.125, or 0.25 lb ai ac^{-1}); Trimec Southern at 0.64, 1.28, or 2.56 kg ai ha^{-1} (0.57, 1.14, or 2.28 lb ai ac^{-1}); and Roundup at 0.11, 0.22, or 0.45 kg ai ha^{-1} (0.1, 0.2, or 0.4 lb ai ac^{-1}) were applied to 10.2-cm (4-inch) liners of 'Big Blue' liriope infested with prostrate spurge. Only Roundup at 0.45 kg ai ha^{-1} (0.4 lb ai ac^{-1}) provided effective postemergence spurge control (96%) and caused no short-term or long-term injury to 'Big Blue'. In Experiment 2, Finale at 0.28, 0.56, or 1.12 kg ai ha^{-1} (0.25, 0.5, or 1.0 lb ai ac^{-1}), and Roundup at 0.45, 0.9, or 1.8 kg ai ha^{-1} (0.4, 0.8, or 1.6 lb ai ac^{-1}) were applied to 'Variegata' liriope infested with mature spurge. Finale at 1.12 kg ai ha^{-1} (1.0 lb ai ac^{-1}) and Roundup at 1.8 kg ai ha^{-1} (1.6 lb ai ac^{-1}) provided effective spurge control (100 and 92.8%, respectively) and caused no short-term injury to 'Variegata'. In Experiment 3, the same rates used in Experiment 2 were applied to either small [2.5 to 10.1 cm (1 to 8 inches)] or large [24.4 to 38.1 cm (10 to 15 inches)] spurge to determine if larger spurge are more difficult to control. Finale at 0.56 and 1.12 kg ai ha^{-1} (0.5 and 1.0 lb ai ac^{-1}) provided excellent control of small nonflowering spurge, but there was a decline in control of large-flowering spurge. Roundup at 0.9 and 1.8 kg ai ha^{-1} (0.8 and 1.6 lb ai ac^{-1}) provided good control of large and small spurge (91% to 100%).

INTRODUCTION

Prostrate spurge [*Chamaesyce maculata* (syn. *Euphorbia supina*)] is a serious weed problem in container nurseries. It is a summer annual that propagates by seed. Spurge seed typically germinate within 5 days (Krueger and Shaner, 1982) and plants grow to maturity in approximately 4 weeks (Gallitano and Skroch, 1993). Effective preemergence herbicides for controlling prostrate spurge include Rout (oxyfluorfen + oxadiazon), a combination of Ronstar (oxadiazon) and Surflan (oryzalin), or a combination of Ronstar and Barricade (prodiamine) (Ruter and Glaze, 1992). However, a survey of container nurseries in Alabama reported prostrate spurge as the weed most often uncontrolled by preemergence herbicides (Gilliam et al., 1990). Liriope (*Liriope muscari* 'Big Blue' and 'Variegata') is a herbaceous perennial in the lily family (*Liliaceae*). Used for groundcover, edging, and massing, it has become popular in urban landscapes and a major crop in nursery production. Nurseries in Alabama have reported difficulty in controlling prostrate spurge in liriope production. Liriope is typically propagated by division, after which many nurserymen are reluctant to apply preemergence herbicides to avoid poten-

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tial root inhibition. Because spurge can germinate within 5 days, failure to apply preemergence herbicides immediately after potting up may result in widespread spurge infestations. This often leads to hand-weeding, which is a costly remedy for weed control. Postemergence weed control alternatives to hand weeding spurge from container-grown liriope would be a useful tool for nurserymen.

Several herbicides have potential for postemergence spurge control in container-grown liriope. Manage (halosulfuron) and Image (imazaquin) are postemergence herbicides labeled for broadleaf weed and nutsedge control in established turfgrass. In other studies, they caused no short-term (30 days) injury or growth reduction to liriope (Hurt and Vencill, 1994; Hurt and Vencill 1994). Trimec Southern (2,4-D + dicamba + mecoprop) also has potential because of its selectivity against broadleaf weeds in grasses and other monocots. Finale (glufosinate) has potential because it is effective on a broad range of weeds as a contact herbicide and is not translocated far beyond sprayed foliage. Other studies have shown that several landscape crops, including liriope, pittosporum, *Ilex cornuta* 'Burfordii', *I. cornuta* 'Rotunda', *I. vomitoria, Buxus sempervirens, Juniperus horizontalis, J. rugida* subsp. *conferta, Ligustrum* sp., *Nandina domestica*, and others have tolerance to Roundup (glyphosate) when used at low rates (Self, 1974; Self and Washington, 1977); however, long-term injury had never been reported on these crops. The following experiments evaluated these postemergence applied herbicides for spurge control and tolerance of container-grown liriope.

MATERIALS AND METHODS

Experiment 1. The first test was conducted in Mobile, Alabama, where container-grown 'Big Blue' liriope were over seeded with spurge seed on 16 Sept. 1997. Containers were treated with the following herbicides on 1 Oct. 1997, when the spurge were 1 to 2 cm (0.4 to 0.8 inch) wide: Manage at 0.0084, 0.017, or 0.034 kg ai ha^{-1} (0.0075, 0.015, or 0.03 lb ai ac^{-1}); Image at 0.07, 0.14, or 0.28 kg ai ha^{-1} (0.0625, 0.125, or 0.25 lb ai ac^{-1}); Trimec Southern at 0.64, 1.28, or 2.56 kg ai ha^{-1} (0.57, 1.14, or 2.28 lb ai ac^{-1}); and Roundup at 0.11, 0.22, or 0.45 kg ai ha^{-1} (0.1, 0.2, or 0.4 lb ai ac^{-1}) (concentrations of 0.125, 0.25, or 0.5 % applied in 187 liter ha^{-1} (20 gal ac^{-1}). Herbicides were applied with a CO_2 sprayer. All treatments consisted of 10 single plant replicates in a randomized complete block design. Data collected included percent spurge control 9 and 20 days after treatment (DAT), spurge shoot fresh weight (SFW) 30 DAT, and a bib count of liriope the following spring (May 1998).

Experiment 2. A second study evaluated Finale and Roundup for postemergence spurge control and injury on 'Variegata' liriope. Single bibs of 'Variegata' in 10-cm (4-inch) pots obtained from a commercial nursery were treated on 28 June 2000 with Finale at 0.28, 0.56, or 1.12 kg ai ha^{-1} (0.25, 0.5, or 1.0 lb ai ac^{-1}), and Roundup at 0.45, 0.9, or 1.8 kg ai ha^{-1} (0.4, 0.8, or 1.6 lb ai ac^{-1}) [(0.25, 0.5, and 1.0% solutions applied in 374 liter ha^{-1} (40 gal ac^{-1})]. At the time of treatment, 'Variegata' were 17.0 to 20.1 cm (6.7 to 7.9 inches) tall (foliage fully extended) and prostrate spurge were 25.4 to 35.1 cm (10 to 13.8 inches) long (branches fully extended). Data collected included percent spurge control 7 and 21 DAT, spurge shoot fresh weight (SFW) and dry weight (SDW) 21 DAT, and an injury rating from 1 to 5 (1 = no injury and 5 = plant death) on 'Variegata' 7, 14, 21, 28, and 50 DAT. Injury data will be collected through spring of 2001 to determine long-term effects of herbicide treatments. All treatments consisted of 8 single plant replicates in a completely randomized design.

Experiment 3. A third experiment was conducted to determine if larger spurge are more difficult to control than smaller spurge with Roundup or Finale. One-gallon containers were filled with a medium consisting of pine bark : sand (7 : 1, v/v) amended per m^3 (yd^3) with 8.9 kg (15 lb) of Osmocote 17N-7P-K12, 3.9 kg (5 lb) of dolomitic limestone, and 0.9 kg (1.5 lb) of Micromax micronutrients. Containers were divided into two groups containing either small or large spurge. Small spurge were characterized as being 2.5 to 10.1 cm (1 to 8 inches) wide without flower or seed structures; large spurge were characterized as being 24.4 to 38.1 cm (10 to 15 inches) wide,flowering, and beginning to set seed. On 20 July 2000 Finale at 0.28, 0.56, or 1.12 kg ai ha^{-1} (0.25, 0.5, or 1.0 lb ai ac^{-1}) and Roundup at 0.45, 0.9, or 1.8 kg ai ha^{-1} (0.4, 0.8, or 1.6 lb ai ac^{-1}) [0.25, 0.5, or 1.0% solutions at 374 liter ha^{-1} (40 gal ac^{-1})] were applied to containers with 1 to 3 spurge plants each. Herbicides were applied with a CO_2 sprayer. Data collected included percent spurge control 7, 14, and 21 DAT, and spurge SFW and SDW 21 DAT. Each treatment contained eight single plant replicates in a completely randomized design.

RESULTS

In the first experiment Manage and Image provided little or no spurge control (Table 1) and were deleted from subsequent experiments. At 9 DAT, the high rate of Trimec Southern appeared to control spurge, however, re-growth of spurge began to occur from injured tissue by 20 DAT. Control from Roundup was initially poor; however, at 20 DAT the 0.45 kg ai ha^{-1} (0.4 lb ai ac^{-1}) rate provided 96% control. At 30 DAT, spurge SFW from middle and high Roundup rates of 0.22 and 0.45 kg ai ha^{-1} (0.2 and 0.4 lb ai ac^{-1}) were 0.0 g compared to 8.6 g (0.3 ounce) for nontreated controls. Only the high rate of Trimec Southern caused injury to 'Big Blue' (data not shown) and was characterized by necrosis of leaf blade tips. We consider fall application of Roundup to liriope to be a severe test of liriope tolerance to Roundup since greater translocation and more effective control occurs in the fall with perennial plants (Whitcomb, 1978). During the next spring following fall herbicide application, liriope had similar bib numbers regardless of treatment, indicating no long-term herbicide effects.

In the second experiment Finale was added based on grower comments that liriope is normally cut back several months prior to marketing to stimulate bib development. Because Finale has little translocation beyond sprayed foliage it has potential in situations where foliage with localized injury will be pruned back in the normal production process. At 7 DAT, middle and high Finale rates of 0.56 and 1.12 kg ai ha^{-1} (0.5 and 1.0 lb ai ac^{-1}) provided excellent postemergence spurge control (94 and 98%, respectively) while poor control occurred with all rates of Roundup (Table 2). By 21 DAT, the higher rates of Finale [1.12 kg ai ha^{-1} (1.0 lb ai ac^{-1})] and Roundup [1.8 kg ai ha^{-1} (1.6 lb ai ac^{-1})] provided 100% and 93% control respectively; however, it appeard that spurge began to recover from low and middle rates of both herbicides. SFW data followed a trend similar to spurge control data at 21 DAT. Unlike the first experiment where Roundup at 0.45 kg ai ha^{-1} (0.4 lb ai ac^{-1}) provided excellent control, the same rate in the second experiment provided poor control. An explanation for this difference may be that spurge in Experiment 2 were larger and physiologically older than those in Experiment 1 at the time of treatment; hence, they were more difficult to control. Other studies have shown that larger weeds are typically more difficult to control than smaller ones (Altland et al., 2000). By 50 DAT,

no injury was observed on 'Variegata' with any herbicide treatment. These data are surprising in that Finale caused no foliar injury. This portion of the study is ongoing to determine if growth suppression occurs from herbicide treatment.

In Experiment 3, which was conducted without any liriope in containers, spurge of different sizes were treated to test the hypothesis that larger spurge are more difficult to control. Finale controlled small spurge better than large spurge, while

Table 1. Effect of herbicides on spurge (*Chamaesyce maculata)* control and *Liriope muscari* 'Big Blue' injury, 1997.

Herbicide[z]	Rate (kg ai ha^{-1})	Spurge control (%) 9 DAT[y]	Spurge control (%) 20 DAT	Spurge fresh wt (g)	'Big Blue' bib number[x]
Manage	0.0084	0	20	6.5	11.4
	0.0170	0	0	6.8	11.0
	0.0340	0	0	9.8	9.7
Significance		NS[w]	NS	NS	NS
Image	0.07	0	10	9.0	11.5
	0.14	0	10	6.1	10.3
	0.28	0	0	6.5	10.6
Significance		NS	NS	NS	NS
Trimec Southern	0.64	0	20	4.5	10.3
	1.28	0	10	3.1	10.6
	2.56	85	63	1.4	7.7
Significance		L***Q***	L***Q*	NS	NS
Roundup	0.11	0	25	3.9	9.3
	0.22	15	83	0.0	11.9
	0.45	45	96	0.0	11.6
Significance		L***	Q***	NS	NS
Control		0.0	0.0	8.6	11.6

[z] Herbicides applied in 187 liter ha^{-1} (20 gal ac^{-1})
[y] Days after treatment.
[x] Data taken the following spring (1998).
[w] NS, L, or Q represent no significant, linear, or quadratic responses within a herbicide.
*, **, and *** represents significance at alpha = 0.05, 0.01, and 0.001.

Roundup provided similar or better control of large spurge compared to small spurge. Finale at 0.56 and 1.12 kg ai ha^{-1} (0.5 and 1.0 lb ai ac^{-1}), provided 98% and 99% control, respectively, among small spurge at 7 DAT with up to 100% control for each rate at 21 DAT (Table 3). However, Finale was not as effective controlling large spurge at rates of 0.56 and 1.12 kg ai ha^{-1} (0.5 and 1.0 lb ai ac^{-1}); the 81% and 93% control, respectively, at 7 DAT decreased to 36% and 83% control, respectively, by 21 DAT. Large spurge treated with these Finale rates appeared to be severely injured or dead at 7 DAT; however, new buds began to emerge from the crown and branch tips by 21 DAT. Spurge control from Roundup was initially poor (10 to 84%), regardless of spurge size. However, by 21 DAT Roundup at 0.9 and 1.8 kg ai ha^{-1} (0.8 and 1.6 lb ai ac^{-1}) had similar control among large spurge (97 to 100%), and 91 and 100% control of small spurge. More notable is that Roundup at 0.45 kg ai ha^{-1} (0.4 lb ai ac^{-1}) provided 59% control among large spurge with only 3% control of small spurge. These data indicate that smaller spurge are more effectively controlled by Finale, however, with Roundup larger spurge are as easy to control as smaller spurge. Our research concurs with others in that spurge treated with Roundup at flowering is more effectively killed than spurge treated prior to flowering (Friesen, 1978; Whitwell et al., 1980).

Table 2. Effect of Finale and Roundup on spurge (*Chamaesyce maculata*) control.

		Spurge control (%)		Spurge
Herbicide[z]	Rate (ai ha^{-1})	7 DAT [y]	21 DAT	fresh weight (g)
Finale	0.28	73	47	2.3
	0.56	94	87	0.3
	1.12	98	100	0.0
		L***Q*[x]	L***Q***	L***Q***
Roundup	0.45	15	11	4.8
	0.90	21	16	3.7
	1.80	56	93	0.1
		L***Q*	L***Q***	L***
Control	2	5	3.6	

[z] Herbicides applied in 374 liter ha^{-1} (40 gal ac^{-1}).
[y] Days after treatment.
[x] L or Q represent linear or quadratic responses within a herbicide.
*, **, and *** represents significance at alpha = 0.05, 0.01, and 0.001.

DISCUSSION

This research shows that Roundup at 0.9 and 1.8 kg ai ha^{-1} (0.8 to 1.6 lb ai ac^{-1}) and Finale 0.56 and 1.12 kg ai ha^{-1} (0.5 to 1.0 lb ai ac^{-1}) provide excellent postemergence spurge control with no injury to liriope. Control from Finale is more effective when spurge are smaller and not flowering. Spurge control from Roundup may be more effective when spurge are large and flowering.

Roundup rates that provide effective spurge control caused no long-term injury to 'Big Blue' and no short-term injury to 'Variegata'. An ongoing test is being conducted to further evaluate long-term effects from these herbicides on 'Variegata'. Though these data are promising, we are conducting similar research regarding liriope tolerance to Roundup and Finale application at different stages of growth and times of year. Nurserymen should use caution in applying Roundup or Finale to nursery crops and should conduct trials prior to treating their entire stock. The results of this research provide nurserymen with another option when they want to delay preemergence herbicide applications until plants are rooted or when labor for hand weeding is unavailable or too costly.

Table 3. Effect of spurge (*Chamaesyce maculata*) size on control from Finale and Roundup.

		Spurge control (%)			
		7 DAT [z]		21 DAT	
Herbicide[y]	Rate (ai ha^{-1})	Small spurge	Large spurge	Small spurge	Large spurge
Finale	0.28	69	19	75	4
	0.56	98	81	100	36
	1.12	99	93	100	83
		L***[x]	L***	L***Q*	L**
Roundup	0.45	10	20	3	59
	0.90	51	55	91	97
	1.80	84	70	100	100
		L***	L***	L***	L***Q**
Control		0	3	0	0

[z] Days after treatment
[y] Herbicides applied at 374 liter ha^{-1} (40 gal ac^{-1}).
[x] L or Q represent linear or quadratic responses within a herbicide.
*, **, and *** represents significance at alpha = 0.05, 0.01, and 0.001

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