Timing of Herbicide Application Affects Weed Control©[1]

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This study evaluated three herbicides BroadStar (150 lb/acre), Rout (100 lb/acre), and Snapshot (200 lb/acre) applied at 0, 3, 7, and 10 days after seeding (DAS) trade gallon containers with *Eclipta prostrate* (syn. *E. alba*) (eclipta) or *Chamaesyce maculata* (syn. *Euphorbia maculata*) (spotted spurge) at 25 seeds per container. Results indicated BroadStar™ herbicide (flumioxazin), Rout™ herbicide (oxyfluorfen + oryzalin), and Snapshot™ herbicide (trifluralin + isoxaben) applied at either 0 or 3 DAS had similar eclipta or spotted spurge control. BroadStar, Rout, and Snapshot applied at 7 or 10 DAS to containers overseeded with eclipta had 86%, 72%, and 48% reduction in weed number from 7 to 28 DAS. With spotted spurge control, weed number was reduced by 95%, 70%, and 52% at 28 DAS when BroadStar, Rout, and Snapshot were used. Data reported showed BroadStar had the greatest post-emergence control followed by Rout then Snapshot.

INTRODUCTION

Traditionally weed control during nursery production has been primarily managed through hand weeding and/or herbicides. However, increased labor cost has made hand-weeding cost prohibitive as a sole weed-control practice (Gilliam et al., 1990; Judge et al., 2004). Standard practice for nursery growers is to apply herbicides soon after potting according to herbicide label and other research (Case et al., 2005). Several options that have been suggested for an effective weed control program include: proper selection of herbicide, use of an effective rate, proper timing, uniform application, weed scouting, sanitation, proper sprayer calibration, and herbicidal knowledge (Case et al., 2005; Neal and Derr, 2005).

Generally, pre-emergent herbicides are the most common chemical control in container nurseries (Gilliam et al., 1992) due to the limited registration of post-emergent herbicides and increasing labor costs (Monsanto, 2005; Everest et al., 1998). Pre-emergence applied herbicides work by preventing enzyme activity, which is needed for germination (Ashton and Crafts, 1973). For effective weed control the herbicide has to be applied within a certain time frame or the proper application stage (Harker et al., 2000). For instance, if herbicides are applied too late, the enzyme has already reacted and germination has been initiated. This leaves only a small window open for effective herbicide application.

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Recent research has evaluated post-emergence weed control in container-grown nursery crops. Altland et al. (2000) showed that Gallery provided excellent post-emergence bittercress (*Cardamine hirsuta*) control when applied to small nonflowering bittercress, and had no signs of injury to 10.2-cm (4-inch) pots of crapemyrtles. Simpson et al. (2004) reported Diuron had excellent post-emergent control of oxalis when applied. Another recent study suggested Diuron rate and volume influenced post-emergent control of *Marchantia polymorpha* (liverwort) and provides excellent long-term control (Newby et al., 2005). Newby et al. (2005) reported control of liverwort with Ronstar. Liverwort was once a problem only in the northeast and northwest part of the United States, but now has become a problem across most of the United States. Judge and Neal (2004) reported control of hairy bittercress > 96% when BroadStar, OH2, and Snapshot TG were applied at the cotyledon to one-leaf growth stage. Furthermore, BroadStar provided > 80% control of hairy bittercress when applied at the two- to four-leaf growth stage. Additionally, applying BroadStar and OH2 to common groundsel at the cotyledon to one-leaf stage provided greater than 90% (BroadStar) and less than 80% (OH2) control. BroadStar, OH2, and Snapshot TG controlled spotted spurge less than 99% at the cotyledon to one-leaf growth stage and only BroadStar had greater than 90% control when applied at the two- to four-leaf stage.

With increasing issues with labor shortages, many growers are finding it difficult to make application of pre-emergence herbicides in a timely manner. Growers are often asking "how soon do I need to apply pre-emergent herbicides after potting or, if in the production cycle, after hand weeding." Most recommendations indicate that pre-emergent-applied herbicides should be applied with 2–3 days of potting or within 2–3 days of hand weeding. Similarly, weather events may preclude application in a timely manner and growers' question what might be the best approach if application has been delayed several days due to weather. The objective of this study was to compare three commonly used herbicides: BroadStar, Rout, and Snapshot and determine how long after potting they could be applied and still obtain effective weed control.

MATERIALS AND METHODS

On 17 Aug. 2006 trade-gallon containers were filled with pine bark and sand medium (6 : 1, v/v) amended with Polyon 17–6–12 at 9 lbs/yd^3 (6.35 kg of 17–6–12) (17N–2.6P–10K) control-release fertilizer, dolomitic lime at 5.0 lbs/yd^3 (2.27 kg) and Micromax at 1.5 lbs/yd^3 (0.89 kg). The following day [temperature 82 °F with 55% relative humidity (RH)] we overseeded two separate sets of containers with either *Eclipta prostrate* (syn. *E. alba*) (eclipta) or *Chamaesyce maculata* (syn. *Euphorbia maculata*) (spotted spurge) (25 seed per container) and watered in ($^1/_4$ inch). After irrigation the first application of herbicides were applied, then irrigated $^1/_2$ inch. Three herbicides; BroadStar™ herbicide (flumioxazin) (150 lb/acre), Rout™ herbicide (oxyfluorfen + oryzalin) (100 lb/acre), and Snapshot™ herbicide (trifluralin + isoxaben) (200 lbs/acre) were applied using a hand-held shaker, either on the day of seeding (0 days after seeding) (DAS), or 3, 7, and 10 DAS. The second application (3 DAS) was applied 21 Aug. 2006 (84 °F, 67% RH), followed by the third (25 Aug., 75 °F, 90% RH), and final treatment (28 Aug., 88 °F, 59% RH). Containers were overhead irrigated twice daily for an average of 0.5 inch per day (12.7 mm). Data collected; weed number 7, 14, 21, 28, 35, 42, 49, and 60 DAS and fresh weight

60 DAS. Experiment was a completely randomized design, 3 × 4 factorial, with 6 single-pot replications. Data were analyzed using generalized linear model with least significant difference means separation alpha set at 0.05.

RESULTS

Eclipta. BroadStar applied at 0 and 3 DAS had 100% eclipta control at all collection dates (Table 1). Prior to application of BroadStar at 7 and 10 DAS, eclipta had already germinated. Between 7 and 14 DAS eclipta number was reduced from 6.5 to 0.8 (89%) when BroadStar was applied 7 DAS. BroadStar applied 10 DAS reduced eclipta number from 10.5 (7 DAS) to 6.8 (14 DAS). From 7 to 28 DAS there was an 85% reduction (10.5–1.3) in eclipta number when BroadStar was applied to eclipta seedlings 10 DAS. Our data was comparable to that of Judge and Neal (10) who had post-emergent control of bittercress with BroadStar, applied at the cotyledon to one-leaf growth stage. By the end of the study (60 DAS) BroadStar applied at 7 and 10 DAS had mean fresh weights of 35.9 and 29.0 resulting in 56% and 65% eclipta control (fresh weight) compared to the nontreated.

Rout applied at 0 and 3 DAS had 74% and 98% control compared to non-treated control fresh weights. Data for 0 DAS was impacted by one or two large eclipta. Rout applied 7 DAS resulted in a reduction in eclipta number from 7.7 to 2.3 (70%) from 7 to 28 DAS. When Rout was applied 10 DAS, eclipta (8.3) were present and at 38 DAS were reduced by 72% (2.3). At the end of the study Rout applied 7 DAS had an average fresh weight of 2.4 vs. 82.2 in the nontreated control, 97% eclipta control. Rout applied 10 DAS had an average fresh weight of 3.3 vs. 82.2 in the nontreated control resulting in 96% eclipta control.

Snapshot applied at 0 and 3 DAS had minimal weed germination throughout the study with 99% and 94% control of eclipta compared to the nontreated (fresh weights), 60 DAS (Table 1). Similar to that of BroadStar and Rout, Snapshot applied at 7 DAS had a reduction in eclipta number from 7.3 to 3.8 and from 8.2 to 4.3 at 28 DAS with the 10 DAS application of Snapshot. Although Snapshot showed some post-emergent activity, eclipta control 60 DAS was less than optimal with fresh weights of 47.6 and 51.2 compared to the nontreated 82.2 fresh weights.

Spurge. BroadStar applied at 0 and 3 DAS had minimal spotted spurge germination with 1.6 (0 DAS) and 0.4 (3 DAS) mean average fresh weights 60 DAS compared to the nontreated containers (Table 1). Spotted spurge (3.5 per container) were present prior to application of BroadStar at 7 (3.5) and 10 DAS (5.5). From 7 to 28 DAS there was a 94% (7 DAS application) and 96% (10 DAS application) reduction in spotted spurge number when BroadStar was applied to spotted spurge seedlings. Sixty DAS BroadStar reduced spurge number by 94% (7 DAS application) and 85% (10 DAS application) compared to the nontreated containers.

Similar to BroadStar, Rout applied at 0 and 3 DAS had 97% and 99% control respectively of spotted spurge (60 DAS) compared to the nontreated containers (fresh weight). Prior to the 7 DAS application, spotted spurge (3.3 per container) were present and by 28 DAS were reduced by 85% (0.5 per container). With 10 DAS application, spotted spurge number were reduced (8.5 to 3.7) by 56% (7 to 28 DAS) when Rout was applied to spotted spurge seedlings compared to the nontreated control. At 60 DAS spotted spurge fresh weights were less than 0.1 g per container in both the 7 and 10 DAS application of Rout compared to non-treated having 50.5 g (fresh weights).

Table 1. Eclipta and spurge establishment when herbicides are applied at or soon after seed inoculation.

		Eclipta							Spurge						
	Herbicide timing	Weed number/pot[z]						FW (g)[y]	Weed number/pot						FW (g)
Herbicide	(DAS)[x]	7 DAS[w]	14 DAS	28 DAS	38 DAS	45 DAS	60 DAS	60 DAS	7 DAS	14 DAS	28 DAS	38 DAS	45 DAS	60 DAS	60 DAS
BroadStar	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.3	1.6
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.4
	7	6.5	0.7	0.8	0.8	1.3	1.5	35.9	3.5	0.7	0.2	0.3	0.3	0.8	3.0
	10	10.5	6.8	1.3	1.2	1.2	1.5	29.0	5.5	2.5	0.2	0.2	0.3	0.3	7.3
Rout	0	0.0	0.3	0.7	0.8	0.7	1.7	21.7	0.0	0.0	0.8	0.0	1.7	4.8	1.0
	3	0.0	0.0	0.5	0.3	0.5	0.7	1.6	0.0	0.0	0.0	0.8	2.0	5.2	0.8
	7	7.7	4.7	2.3	2.7	2.8	2.2	2.4	3.3	2.2	0.5	0.0	0.2	4.0	0.1
	10	8.3	8.0	0.0	2.3	2.3	2.2	3.3	8.5	8.5	3.7	0.0	0.3	1.8	0.1
Snapshot	0	0.0	0.3	0.0	0.3	0.5	1.5	1.0	0.0	0.0	0.5	1.5	2.2	3.7	8.8
	3	0.0	0.2	0.2	1.2	1.2	2.3	4.8	0.0	0.0	0.7	0.5	2.5	10.2	2.5
	7	7.3	7.2	3.8	3.5	3.0	3.3	47.6	4.5	4.5	2.2	1.5	4.0	3.8	9.4
	10	8.2	10.2	4.3	3.7	3.3	3.0	51.2	4.3	6.8	2.5	0.7	1.8	6.3	7.0
Non-treated		9.0	11.8	6.3	5.5	5.8	3.3	82.2	5.5	9.7	9.2	6.3	4.8	5.8	50.5
LSD (0.05)		0.5	0.6	0.5	0.5	0.5	0.5	27	0.4	0.4	0.6	0.5	0.7	0.8	12
Anova main effects		probability													
Herbicide		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Timing		0.0001	0.0001	0.0001	0.0001	0.0001	0.0009	0.0011	0.0001	0.0001	0.0054	0.8091	0.5514	0.1921	0.7832
Interaction		0.8675	0.0126	0.0001	0.5313	0.8435	0.5874	0.0067	0.0163	0.0001	0.1504	0.3824	0.2587	0.3688	0.9355

[z] Weed number - number of eclipta per container.

[y] FW - fresh weight.

[x] Herbicide timing (DAS) - application of herbicide 0, 3, 7, and 10 days after seeding.

[w] DAS - days after seeding, when data was collected.

[v] Data were analyzed using generalized linear model with least significant difference means separation α = 0.05.

Snapshot applied at 0 and 3 DAS had 83% and 95% control respectively compared to the non-treated containers, 60 DAS (fresh weights). Prior to the 7 and 10 DAS application of Snapshot spotted spurge were present. Both applications (7 and 10 DAS) reduced spotted spurge number by 4.5 to 2.2 (51%) and 4.3 to 2.5 (53%) compared to the nontreated containers from 7 to 28 DAS. At the end of the study Snapshot applied 7 and 10 DAS had fair control (81% and 86%) compared to the nontreated control (fresh weight).

DISCUSSION

Our results showed some post-emergent control in all three herbicides evaluated. All treatments, regardless of time of application, were significantly different compared to the nontreated control with the exception of Snapshot applied at 7 or 10 DAS (60 DAS). Pre-emergent weed control was best achieved when herbicides were applied within 3 days after potting. However, our study shows these three herbicides have limited post-emergence activity on weed seedlings. With eclipta control at 7 and 10 DAS, BroadStar provided an average of 82% post-emergence control (60 DAS), while Rout and Snapshot provided 73 and 59% post-emergence control, respectively. When averaged across 7 and 10 DAS, BroadStar provided about 95% post-emergence control (60 DAS) of spotted spurge numbers while Rout and Snapshot provided 70% and 52% post-emergence control, respectively. These data confirm current recommendations concerning pre-emergent herbicide application. Some post-emergent control can be achieved and the level of post-emergent control obtained, depends on the herbicide applied.

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