Timing of Glyphosate Application for Weed Control in Glyphosate-tolerant Lettuce: 2nd Year Study

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Abstract

A field study was conducted in Yuma, Arizona during the late fall 2001 growing season to determine the optimum postemergence (POST) timing of glyphosate application on glyphosate- tolerant Lactuca sativa (head lettuce) for weed control. Head lettuce cv. Raider demonstrated excellent tolerance and no injury was observed on the crop after any glyphosate application at the 2, 4, 6, or 8 leaf stage of growth. A single application of glyphosate at 1.0 lb AI/A at the 4 or 6 leaf stage of lettuce growth was optimal for providing near complete control of Portulaca oleracea (common purslane), Chenopodium album (common lambsquarters), C. murale (nettleleaf goosefoot), Physalis wrightii (Wright's groundcherry), volunteer cantaloupe (Cucumis melo), and Echinochloa colonum (junglerice). An early application at the 2 leaf stage resulted in few new weeds emerging after the application. A later application at the 8 leaf stage resulted in reduced yields of lettuce fresh weight due to weed competition. POST applications of glyphosate on lettuce offered superior weed control compared to soil-applied preemergence (PREE) herbicide treatments.

Introduction

In 2000, field studies were initiated in Arizona and California to evaluate the crop safety and weed control efficacy of glyphosate applied postemergence (POST) on glyphosate-tolerant lettuce. The lettuce exhibited excellent tolerance and yields exceeded conventionally grown lettuce that had typical soil-applied herbicides. Weed control was nearly complete and optimal with glyphosate applied when the lettuce was at the 2 to 4 leaf stages of growth. The development of broad spectrum POST weed control as an option for the future of weed control in lettuce or other vegetable crops would have the potential of significantly reducing the need for hand-hoeing and mechanical cultivation. A vegetable crop could possibly be grown as a "no till" crop during the entire growing season when fertilizers could be applied through irrigation water. This field experiment was conducted to confirm the previous evaluations that determined the efficacy and crop safety of glyphosate when applied as a single application on various growth stages of genetically modified head lettuce.

Materials and Methods

A small plot field experiment was conducted at the University of Arizona Yuma Valley Agricultural Center, Yuma County, AZ under simulated commercial growing conditions on a clayey soil. Glyphosate-tolerant head lettuce cv. Raider seed was planted with a four-row belt planter on conventional 40-in raised beds in two seedlines per bed on 8 October 2001. The treatment plots consisted of two beds measuring 25-ft long and each treatment was replicated four

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times in a randomized complete block design. The crop was furrow irrigated for the entire growing season with the first water date on 9 September to germinate and emerge the crop. A second irrigation was applied after the second POST application on 29 October. A typical commercial application of an insecticide was applied for insect pest control. Immediately after planting, the commercial standard herbicide treatments, bensulide and pronamide, were applied PREE on the soil surface. All herbicide treatments were applied using a backpack CO_2 sprayer equipped with a hand-held boom consisting of four flat fan 8002 nozzle tips spaced 20-in apart. All treatments were applied in 25 gpa water pressurized to 30 psi. At the time of PREE herbicide applications, soil was dry. The first POST (POE-1) application of glyphosate was on lettuce having 2 leaves fully developed on 22 October. The weather was clear and 75EF with only a very slight breeze of less than 5 mph. The weeds present were common purslane, common lambsquarters and nettleleaf goosefoot, groundcherry, *Polygonum aviculare* (knotweed), and volunteer cantaloupe at the cotyledon stage and junglerice was at the 2-leaf stage of growth. The second POST (POE-2) application was made on 29 October when the lettuce was fully developed at the 4 leaf stage of growth. The lettuce stand was thinned by hand to one plant spaced 8 to 10-in apart in each of the two seedlines on each bed prior to spraying. The handweeded check plots were also hand-hoed for the first time and then weeds were removed regularly until hand-hoeing was done for the entire experimental area. The air temperature was 88EF, clear, and virtually no winds. The purslane was at the 4 to 6 leaf stage, goosefoot and lambsquarters were at the 2 leaf stage, junglerice was at the 4 leaf stage, groundcherry was at the 2 leaf stage, knotweed was at the 2 leaf stage, and volunteer cantaloupe was at the 1 to 2 leaf stage. The third POST (POE-3) application was made on 05 November when the lettuce was at the very early 6 leaf stage. The weather was almost clear with few clouds, with air temperature at 78EF, and with a breeze at 5 to 10 mph. The purslane had stems measuring 2 to 5-in long, goosefoot and lambsquarters were at the 6 to 8 leaf stage and 1 to 2-in height, junglerice was at the 4 to 6 leaf to tillering stage and 3-in height, groundcherry was at the 6 leaf stage, knotweed was at the 8 leaf stage, and volunteer cantaloupe was at the 3 leaf stage. Few *Amaranthus* sp. (pigweeds) and *Malva parviflora* (cheeseweed) were observed. The fourth POST (POE-4) application was made on 9 November when the lettuce was at the early 8 leaf stage of growth. The air temperature was 76EF, skies almost clear with few high clouds, and winds with gusts up to 12 mph. The purslane was beginning to flower and stems measured 8-in long, goosefoot was at the 8 leaf stage and 3-in high, lambsquarters were also at the 3-in height, junglerice was 3 to 7-in height with 3 tillers, groundcherry was at the 8 leaf stage, knotweed had 8 leaves, and volunteer cantaloupe was at th 6 leaf stage. Visual observations for weed control and weed stand counts were conducted at several intervals before and after herbicide applications. The weed stand counts were collected from a randomly selected 3 ft by 20-in section of the tops of both raised beds within each treatment replicate. On or about 17 November, all weeds in all plots were inadvertently removed by hand-hoeing. The mature lettuce was harvested on 28 January 2002 from a randomly selected area within each plot that measured 5-ft of one seedline on each bed.

Results and Discussion

Glyphosate treatments applied over-the-top of lettuce at all timings provided very good control of all broadleaved and grass weeds when rated at 39 days after planting (DAP). Plots with lettuce treated at POE-2 or POE-3 showed no weeds present when weed counts were collected (Table 1). Near complete control (>99%) of purslane, lambsquarters, goosefoot, groundcherry, junglerice, and volunteer cantaloupe was observed for the two timings of glyphosate applications at 1.0 lb AI/A (Table 2). Weeds that appeared in some plots in too few numbers to evaluate were pigweeds, knotweed, and cheeseweed. Plots treated at the POE-1 exhibited regrowth of few small weeds compared to the handweeded check and glyphosate treatments at the POE-2 or POE-3. Weed control was still very good and observed to be better than 90%. Glyphosate applied at POE-4 gave good control but some weeds were observed in the plots. Large purslane were not completely controlled yet at 89% and the number of plants was similar to the untreated check. Glyphosate generally required more than 7 days after treatment (DAT) to give complete control of weeds. The rating date at 39 DAP was 18 and 11 DAT, respectively, for POE-2 and POE-3.

At 39 DAP, the soil applied herbicides, pronamide and bensulide and the very early POST application of glyphosate at POE-1 exhibited weed infestations of most weeds including purslane, lambsquarters, goosefoot, groundcherry, junglerice, and volunteer cantaloupe. Pronamide treated plots had the most weeds present and most weeds were controlled less than 80%. Bensulide offered better than 90% control of most weeds except for groundcherry and volunteer cantaloupe that were controlled 79% and 20%, respectively. A single POST application of glyphosate at POE-1 offered better control of weeds at 39 DAP compared to the soil applied herbicides.

Shortly after the evaluations at 39 DAP, the test site was cleared of all weeds and the lettuce crop was allowed to grow and mature per typical commercial practices with cultivation, fertilization, and irrigation. At 118 DAP, the lettuce was harvested and the highest yields were achieved in the plots treated with glyphosate at POE-1, POE-2, or POE-3 (Table 3). There were no significant differences in yields among most treatments including the untreated or handweeded checks. The lettuce treated at POE-4 gave the lowest yield that was the only significantly different treatment from the treatment applied at POE-2.

The optimum timing of glyphosate application after the 2 leaf stage and before the 8 leaf stage of lettuce growth coincides with the timing of the typical practice of thinning the lettuce stand. A single POST application appears to be satisfactory to provide season-long weed control when supplemented with one hand-hoeing operation. The window of opportunity to apply glyphosate to treat weeds POST occurs before competition with weeds would begin to suppress lettuce growth and yields. Emergence of new weeds after an early POST application may require subsequent POST applications or mechanical hand-hoeing operations. The application of glyphosate gave exceptional weed control when the lettuce was at the 4 leaf stage of growth. Future research remains to evaluate the integration of PREE herbicide use with POST applications of glyphosate as a sequential combination herbicide treatment.

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References

Umeda, K and T.V. Hicks. 2001. Timing of Glyphosate Application for Weed Control in Glyphosate-tolerant Lettuce. D.N. Byrne and P. Baciewicz, eds. 2001 Vegetable Report, University of Arizona, College of Agriculture and Life Sciences, AZ 1252, August 2001.

Table 1. Weed density in glyphosate-tolerant lettuce with POST applications of glyphosate

Treatment	Rate (lb AI/A)	Timing	Average Weed Density at 39 Days After Planting					
			POROL	CHEAL	CHEMU	PHYWR	ECHCO	CUMMC
			no. plants/5 sq ft					
Untreated check			6.5	0.3	2.0	2.8	4.3	2.3
Handweeded check			0.0	0.0	0.0	0.0	0.0	0.0
Pronamide	1.0	PREE	3.5	0.5	1.5	3.5	3.5	0.8
Bensulide	6.0	PREE	1.3	0.3	1.0	3.0	0.0	2.0
Glyphosate	1.0	POE-1	0.3	0.0	0.3	1.8	0.8	0.8
Glyphosate	1.0	POE-2	0.0	0.0	0.0	0.0	0.0	0.0
Glyphosate	1.0	POE-3	0.0	0.0	0.0	0.0	0.0	0.0
Glyphosate	1.0	POE-4	7.5	0.3	0.0	0.0	2.0	0.0
LSD (p=0.05)			2.69	0.52	1.33	2.5	3.14	0.78

POROL = *Portulaca oleracea* (common purslane), CHEAL = *Chenopodium album* (common lambsquarters), CHEMU = *C. murale* (nettleleaf goosefoot), PHYWR = *Physalis wrightii* (Wright's groundcherry), ECHCO = *Echinochloa colonum* (junglerice), CUMMC = *Cucumis melo* (volunteer cantaloupe)

Table 2. Average weed control in glyphosate-tolerant lettuce with POST applications of glyphosate

Treatment	Rate (lb AI/A)	Timing	Average Weed Control at 39 Days After Planting					
			POROL	CHEAL	CHEMU	PHYWR	ECHCO	CUMMC
			%					
Untreated check			0	0	0	0	0	0
Handweeded check			100	100	100	100	100	100
Pronamide	1.0	PREE	89	78	78	78	70	0
Bensulide	6.0	PREE	91	94	91	79	96	20
Glyphosate	1.0	POE-1	99	99	99	90	97	93
Glyphosate	1.0	POE-2	99	100	100	99	99	99
Glyphosate	1.0	POE-3	99	100	100	100	100	100
Glyphosate	1.0	POE-4	89	98	99	99	97	99
LSD (p=0.05)			4.7	3.4	3.9	5.2	7.8	21

POROL = *Portulaca oleracea* (common purslane), CHEAL = *Chenopodium album* (common lambsquarters), CHEMU = *C. murale* (nettleleaf goosefoot), PHYWR = *Physalis wrightii* (Wright's groundcherry), ECHCO = *Echinochloa colonum* (junglerice), CUMMC = *Cucumis melo* (volunteer cantaloupe)

Table 3. Lettuce yields following glyphosate applications

Treatment	Rate (lb AI/A)	Timing	Yield lb/A
Untreated check			33906
Handweeded check			32313
Pronamide	1.0	PREE	31750
Bensulide	6.0	PREE	34344
Glyphosate	1.0	POE-1	34719
Glyphosate	1.0	POE-2	35344
Glyphosate	1.0	POE-3	34438
Glyphosate	1.0	POE-4	30875
LSD (p=0.05)			3606