Woollyleaf Bursage *(Ambrosia grayi)* Management in Transgenic Cotton on the Texas Southern High Plains

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ABSTRACT

Field studies were established in 1998 and repeated in 1999 to evaluate woollyleaf bursage management in glyphosate- and bromoxynil-tolerant cotton. Glyphosate and bromoxynil, applied three times during the growing season, were evaluated with and without in-season cultivation. Glyphosate alone and in combination with cultivation and bromoxynil with cultivation controlled woollyleaf bursage greater than 70% after one season and greater than 90% after two seasons. Glyphosate treatments reduced woollyleaf bursage density >88% after two years. Weed control systems in both glyphosate- and bromoxynil-tolerant cotton increased yields and net returns over weed control costs compared to cultivation alone for both years of this study.

KEYWORDS: Bromoxynil, Glyphosate, Woollyleaf bursage, *Ambrosia grayi* (A.Nels) AMBGR, Cotton, *Gossypium hirsutum* L., Paymaster HS 200, Paymaster 2200RR, and Stoneville BXN 16

Abbreviations: DAT-1, days after first treatment; DAT-2, days after second treatment; DAT-3, days after third treatment; fb, followed by; PDIR, postemergence-directed; POST, postemergence; PPI, preplant incorporated; PRE, preemergence

Cotton producers have traditionally used preplant incorporated (PPI) and preemergence (PRE) herbicides, spot spraying, cultivation and/or hand-hoeing to control annual and perennial weeds (Newsom and Shaw 1996, Snipes and Mueller 1992). Transgenic glyphosate- and bromoxynil-tolerant cotton provide producers new options to control many annual and perennial weeds. However, most research to date has focused on annual weed control and little information exists on control of most perennial weeds. Effective Palmer amaranth (*Amaranthus palmeri* S. Wats.), ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.] and Russian thistle (*Salsola iberica* Sennen and Pau) control has been reported using soil-applied herbicides followed by (fb) glyphosate in-season (Keeton and Murdock 1997, Keeling and Dotray 1997; Keeling et al. 1996). Combinations of trifluralin fb glyphosate, prometryn fb glyphosate, or trifluralin fb prometryn fb glyphosate provided ≥85% control of Palmer amaranth season-long (Asher et al. 1998). Bromoxynil controlled devil's-claw (*Proboscidea louisianica* (Mill.) Thellung), lanceleaf sage (*Salvia reflexa* Hornem.), and red morningglory (*Ipomoea coccinea* L.) ≥95%, but did not control Palmer amaranth (Jones et al. 1994).

Perennial weed species, including woollyleaf bursage [*Ambrosia grayi* (A.Nels.) Shinners], are common on the Texas Southern High Plains. Woollyleaf bursage is an aggressive creeping perennial, common in low-lying areas, in and around playa lakes, and in wet areas throughout the central and southern Great Plains region (Whitson et al. 1996). This weed has become an increasing problem to cotton producers in recent years, with heavily infested areas producing little or no yield. Non-selective herbicides, such as picloram, control woollyleaf bursage in non-cropped areas (Smith et al. 1972). Currie and Thompson (2000) also reported effective control with picloram, but only limited control with glyphosate or 2,4-D. Fall applications of dicamba controlled woollyleaf bursage early-season, but little long-term control was achieved (Chykaliuk et al. 1980, Keeling and Abernathy 1988). Field studies indicated that *Pseudomonas syringae* pv. *tagetis* did infect woollyleaf bursage, but activity was slow and erratic (Sheikh et al. 2001).

Traditional management of woollyleaf bursage, which includes fall applications of dicamba, preplant applications of MSMA, and in-season glyphosate spot spraying, does not provide consistent control, therefore the use of glyphosate and bromoxynil in transgenic cotton provides new opportunities to control this weed. The objectives of this research were: to evaluate woollyleaf bursage control using glyphosate and bromoxynil applied alone or in combination with cultivation; evaluate changes in woollyleaf bursage populations after each season of treatment; and determine effects of woollyleaf bursage control on cotton lint yield and net economic returns with the glyphosate and bromoxynil systems.

MATERIALS AND METHODS

A field experiment was conducted in 1998 and repeated in 1999 at the Texas Agricultural Experiment Station near Halfway, TX at a site containing a dense homogeneous population of woollyleaf bursage. The soil was an Olton clay loam (Fine, mixed, thermic Aridic Paleustolls) with less than 1.0% organic matter and pH 7.4. Trifluralin at 0.8 lb ai/ac PPI and prometryn at 1.2 lb ai/ac PRE were applied over the entire test area to control Palmer amaranth and annual grasses. Paymaster 2200RR (glyphosate-tolerant) was planted in plots receiving glyphosate treatments, BXN 16 (bromoxynil-tolerant) was planted in plots receiving bromoxynil treatments, and Paymaster HS 200 (non-transgenic) was planted in the untreated plots. These varieties were planted on 40 inch rows at the rate of 15 lb/ac. Plots four rows wide by 100 ft in length were arranged in a randomized block design replicated four times. Herbicides were applied with either a tractor-mounted compressed air or CO_2 backpack sprayer calibrated to deliver 10 gpa at 28 psi. Postemergence (POST) bromoxynil applications were made to cotton at the 1-to 2-leaf, 4-leaf, at the mid-bloom stages of growth. Glyphosate postemergence-directed (PDIR) applications were made at the mid-bloom stages of cotton growth. All glyphosate treatments were applied at 0.75 lb ae/ac and included ammonium sulfate at 0.17 lb/gal and all bromoxynil treatments were applied at 0.5 lb ai/ac. Cultivation was performed between the first and second POST applications and between the second and third POST/PDIR applications. Weed species were 1 to 3 inches in height at the time of the initial treatment. Plots received 9 inches of supplemental irrigation in 1998 and 6 inch in 1999 due to differences in rainfall (Table 1). Treatment timing and application dates are summarized in Table 2.

Table 1. Rainfall distribution at Halfway for 1998, 1999, and the 30 year average.

Month	Year		
	1998	1999	30 year Avg.
January	0	1.4	0.5
February	2	3.6	0.6
March	1.5	1	0.8
April	0.3	2.1	1.2
May	0	4.3	2.6
June	1.5	4	2.5
July	0	1	2.2
August	3.6	0.6	2
September	0	3.3	2.5
October	2.4	0.8	2
November	0.8	0	0.6
December	0.6	0	0.6
Total	15.4	22.1	18.1

Table 2. Treatment timing and application dates for 1998 and 1999.

Treatment	Date	
	1998	1999
Postemergence-topical (POST)	May 29	June 7
Postemergence-topical (POST)	June 9	June 28
Postmeregence-topical (POST)	July 7	August 6
Postemergence-directed (PDIR)	July 7	August 6
Cultivations	June17/July 27	July 6/August 27

Percent weed control was estimated visually on a 0 to 100 scale (0 = no control and 100 = complete control) throughout each year. Lint was collected at harvest using a sample area of 44 ft^2. Harvested samples were ginned and fiber quality was evaluated to determine loan price for an economic comparison between systems. Cotton loan price, lint yield, cultivation, herbicide and application costs, as well as seed technology fees associated with herbicide-tolerant varieties, were used to determine net returns over weed control costs. Weed density was recorded on May 5, 1998 (prior to any treatments being applied), on May 19, 1999 (after 1998 treatments and prior to any 1999 treatments), and on April 26, 2000 (after 1998 and 1999 treatments). Weed densities per plot were determined by counts/3 ft^2.

Data were subjected to analysis of variance and means were separated using Fisher's Protected LSD at 0.05 level of significance. Percentage data were arcsine transformed before analysis to stabilize variances and non-transformed data are presented.

RESULTS AND DISCUSSION

Weed Control. In 1998, the first POST herbicide application was applied in late May. At 14 days after first treatment (DAT-1), glyphosate treatments controlled woollyleaf bursage 65 to 72% and was similar to the control achieved with bromoxynil (63%) (Table 3).

Table 3. Effects of POST herbicides on woollyleaf bursage control in cotton, 1998 and 1999[a].

Treatment	Rate	Application timing	1998				1999			
			14DAT-1	14DAT-2	14DAT-3	30DAT-3	14DAT-1	14DAT-2	14DAT-3	30DAT-3
	lb ai or ae/ac									
Untreated	-	-	0	0	0	0	0	0	0	0
Cultivation[b]	-	MID fb LATE	0	38	43	38	0	57	28	38
Glyphosate fb glyphosate fb glyphosate	0.75 fb 0.75 fb 0.75	POST fb POST fb PDIR	65	68	82	72	85	74	92	93
Glyphosate fb glyphosate fb glyphosate fb cultivation[b]	0.75 fb 0.75 fb 0.75	POST fb POST fb PDIR fb MID fb LATE	72	85	91	88	92	89	96	99
Bromoxynil fb bromoxynil fb bromoxynil	0.5 fb 0.5 fb 0.5	POST fb POST fb POST	63	68	66	45	23	55	68	47
Bromoxynil fb bromoxynil fb bromoxynil fb cultivation[b]	0.5 fb 0.5 fb 0.5	POST fb POST fb POST fb MID fb LATE	63	84	87	79	40	84	85	88
LSD(0.05)			8	8	9	13	23	18	13	10

[a] Abbreviation: DAT-1, days after first treatment; DAT-2, days after second treatment; DAT-3, days after third treatment; fb, followed by; Late, late season; MID, mid-season; PDIR, postemergence directed; POST, postemergence.

[b] Two in-season cultivations were made in each year.

At 14 days after second treatment (DAT-2), glyphosate fb cultivation and bromoxynil fb cultivation improved woollyleaf bursage control to 85 and 84%, respectively (Table 3). Glyphosate and bromoxynil without cultivation were less effective at controlling woollyleaf bursage (68%). Cultivation alone provided only 38% control of woollyleaf bursage.

Unlike the findings of Currie and Thompson (2000) who reported limited control of woollyleaf bursage from glyphosate and 2,4-D treatments, glyphosate and glyphosate fb cultivation controlled woollyleaf bursage 82 and 91%, respectively at 14 days after third treatment (DAT-3). Bromoxynil fb cultivation provided similar control (87%). However, bromoxynil without cultivation was less effective at controlling woollyleaf bursage (66%). Cultivation alone controlled woollyleaf bursage only 43%.

At 30 DAT-3, after all herbicide and cultivation treatments were performed, glyphosate fb cultivation controlled woollyleaf bursage 88% (Table 3). Bromoxynil fb cultivation provided similar control (79%), and glyphosate without cultivation controlled woollyleaf bursage 72%. Bromoxynil alone and cultivation alone were less effective (45 and 38%, respectively).

In 1999, glyphosate treatments controlled woollyleaf bursage 85 to 92% at 14 DAT-1 (Table 3). Woollyleaf bursage was not effectively controlled by the bromoxynil treatments (23 to 40%).

At 14 DAT-2, glyphosate fb cultivation controlled woollyleaf bursage 89%, which was similar to control achieved by bromoxynil fb cultivation and glyphosate alone (84 and 74%, respectively) (Table 3). Similar to bromoxynil alone (55%), cultivation controlled woollyleaf bursage 57%.

In early August (14 DAT-3), effective woollyleaf bursage control (85 to 96%) was achieved with glyphosate, glyphosate fb cultivation, and bromoxynil fb cultivation (Table 3). Bromoxynil without cultivation provided less effective woollyleaf bursage control (68%). Cultivation alone provided the least effective control (28%).

In September (30 DAT-3), excellent woollyleaf bursage control (88 to 99%) was achieved with glyphosate, glyphosate fb cultivation, and bromoxynil fb cultivation. Similar to earlier ratings, control was less effective with bromoxynil without cultivation and cultivation alone.

In the spring of 1998, woollyleaf bursage initial density was 80 plants per 3 ft^2. After the treatments in 1998, glyphosate and glyphosate fb cultivation reduced the woollyleaf bursage population 52 and 64% (38 and 29 plants per 3 ft^2), respectively (Table 4). Similarly, bromoxynil fb cultivation reduced the woollyleaf bursage population 41%. Bromoxynil alone had little effect on the population of woollyleaf bursage, only reducing the population density by 17% (66 plants per 3 ft^2). Cultivation alone had no effect on the woollyleaf bursage population.

At the beginning of the 2000 crop season, glyphosate alone and glyphosate fb cultivation were the most effective treatments and reduced woollyleaf bursage population to 18 plants per 3 ft^2 (Table 4). Bromoxynil treatments had less impact on the woollyleaf bursage population, only reducing density 27% and 33% (58 and 53 plants per 3 ft^2, respectively). Two seasons of cultivation had no effect on woollyleaf bursage populations.

Table 4. Effects of herbicides on woollyleaf bursage densities, 1998, 1999, and 2000[a,b].

			Woollyleaf bursage Density	
Treatment	Rate	Application	1998	1999
	lb ai or ae/ac		----------#/3 ft^2----------	
Untreated	-	-	80	70
Cultivation[c]	-	MID fb LATE	80	67
Glyphosate fb glyphosate fb glyphosate	0.75 fb 0.75 fb 0.75	POST fb POST fbPDIR	38	18
Glyphosate fb glyphosate fb glyphosate fb cultivation[c]	0.75 fb 0.75 fb 0.75	POST fb POST FbPDIR fb MID fb LATE	29	18
Bromoxynil fb bromoxynil fb bromoxynil	0.5 fb 0.5 fb 0.5	POST fb POST fb POST	66	58
Bromoxynil fb bromoxynil fb bromoxynil fb cultivation[c]	0.5 fb 0.5 fb 0.5	POST fb POST fbPDIR fb MID fb LATE	47	53
LSD (0.05)			16	14

[a]Abbreviation: DAT-1, days after first treatment; DAT-2, days after second treatment; DAT-3, days after third treatment; fb, followed by;LATE, late season; MID, mid-season; PDIR, postemergence directed; POST, postemergence.

[b]Initial populations in May 1998 average 80 weeds per 3 ft^2.

[c]Two in-season cultivations were made in each year.

Cotton Lint Yields and Net Returns. In 1998, cotton lint yield ranged from 100 lb/ac (untreated) to 850 lb/ac (Table 5). No difference in yield was observed between glyphosate fb cultivation, bromoxynil, or bromoxynil fb cultivation. These treatments produced greater yields (730 to 850 lb/ac) than glyphosate alone and cultivation alone. In 1999, yields ranged from 0 lb/ac (untreated) to 1020 lb/ac. The greatest yields were produced with glyphosate and glyphosate fb cultivation. Less yield was produced with the bromoxynil alone treatments, although the addition of cultivation improved yields over bromoxynil treated plots. All other treatments produced greater yields than plots treated with the cultivation alone. In official variety trials conducted at the Texas Agricultural Experiment Station at Halfway in 1998 and 1999, Paymaster 2200RR produced 14% greater lint yields than BXN 16 (Gannaway et al. 1998 and 1999)

Net returns over weed control costs in 1998 ranged from 0 to 330 $/ac (Table 5). Glyphosate and bromoxynil treatments, either alone or in combination with cultivation, produced similar net returns over weed control costs, which were greater than cultivation alone. In 1999, net returns over weed control costs ranged from 0 to 360 $/ac. The greatest net returns were achieved with the glyphosate and glyphosate fb cultivation. Net returns from bromoxynil treatments were greater than with the cultivation alone.

These studies indicate that woollyleaf bursage can be controlled and population densities reduced with the use of glyphosate in-season. Bromoxynil alone was not effective at reducing woollyleaf bursage populations; however, these treatments did reduce weed growth and allowed the cotton to better compete. Glyphosate applied in glyphosate-tolerant cotton provided the most consistent woollyleaf bursage control and greatest overall reduction in population density.

Table 5. Cotton lint yields and net economic returns as a result of woollyleaf bursage, 1998 and 1999[a]

			Lint Yields		Net Returns[b]	
Treatment	Rate	Application Timing	1998	1999	1998	1999
	kg ai or ae/ha		-----lb/ac-----		-----$/ac-----	
Untreated	NA	NA	100	0	0	0
Cultivation fb cultivation	NA	MID fb LATE	260	45	90	4
Glyphosate fb glyphosate fb glyphosate	0.84 fb 0.84 fb 0.84	POST fb POST fbPDIR	620	920	240	320
Glyphosate fb glyphosate fb glyphosate fb cultivation(2)[c]	0.84 fb 0.84 fb 0.84	POST fb POST fbPDIR fb MID fb LATE	730	1020	270	360
Bromoxynil fb bromoxynil fb bromoxynil	0.56 fb 0.56 fb 0.56	POST fb POST fb POST	730	490	290	140
Bromoxynil fb bromoxynil fb bromoxynil fb cultivation(2)	0.5 fb 0.5 fb 0.5	POST fb POST fbPOST fb MID fb LATE	850	690	330	220
LSD (0.05)			180	160	100	130

[a]Abbreviation: DAT-1, days after first treatment; DAT-2, days after second treatment; DAT-3, days after third treatment; fb, followed by;LATE, late season; MID, mid-season; PDIR, postemergence directed; POST, postemergence.

[b]Net returns over weed control cost. Based on gross revenue minus seed, herbicide and application and cultivation costs.

[c]Two in-season cultivations were made in each year.

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