Weed Technology. 2001. Volume 15:497–504

Broadleaf Weed Control in Ultra Narrow Row Bromoxynil-Resistant Cotton (*Gossypium hirsutum*)[1]

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Abstract: A field experiment was conducted over 2 yr to study efficacy of bromoxynil mixtures with pyrithiobac or MSMA applied postemergence (POST) with and without fluometuron or fluometuron plus pendimethalin preemergence (PRE) for control of broadleaf weeds in ultra narrow row bromoxynil-resistant cotton in the Mississippi Delta. Bromoxynil applied POST (single or sequential) provided variable control of common purslane (< 9%), sicklepod (< 35%), Palmer amaranth (< 46%), prickly sida (> 75%), hyssop spurge (> 79%), hemp sesbania (> 96%), and pitted morningglory (100%) at 4 wk after early POST (WAT). Broadleaf weed control increased when PRE herbicides were followed by bromoxynil or bromoxynil plus pyrithiobac or MSMA POST. Weed control generally decreased at harvest compared to 4 WAT, and the decrease was greater in bromoxynil POST-only programs compared to bromoxynil POST following PRE programs. Seed cotton yield with bromoxynil POST-only programs was lower (400 to 2,810 kg/ha) compared to bromoxynil POST programs following PRE herbicides (2,150 to 3,720 kg/ha). Early-season weed interference and variable control of weeds in bromoxynil POST-only programs resulted in greater cotton stand reduction and lower open bolls per plant compared to bromoxynil POST programs following PRE herbicides.

Nomenclature: Bromoxynil; fluometuron; MSMA; pendimethalin; pyrithiobac; common purslane, *Portulaca oleracea* L. #[3] POROL; cotton, *Gossypium hirsutum* L. 'BXN 47'; hemp sesbania, *Sesbania exaltata* (Raf.) Rydb. *ex* A. W. Hill # SEBEX; hyssop spurge, *Euphorbia hyssopifolia* L. # EPHHS; Palmer amaranth, *Amaranthus palmeri* S. Wats. # AMAPA; pitted morningglory, *Ipomoea lacunosa* L. # IPOLA; prickly sida, *Sida spinosa* L. # SIDSP; sicklepod, *Senna obtusifolia* (L.) Irwin & Barneby # CASOB.

Additional index word: Transgenic cotton.

Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; POST, postemergence; PRE, preemergence; UNR, ultra narrow row; WAT, weeks after EPOST application.

INTRODUCTION

Cotton is traditionally grown in rows spaced 76 to 102 cm apart (Culpepper and York 2000; Heitholt et al. 1992; Kerby 1998; Robinson 1993). In the United States, ultra narrow row (UNR) cotton production has received considerable attention in recent years. UNR cotton is grown in rows 19 to 25 cm apart. Planting, weed management, cotton management, and harvesting practices are substantially different in UNR cotton production from those used in conventional cotton production systems. Unlike wide row cotton, banded application of PRE herbicides, interrow cultivation, POST-directed herbicide sprays, and hooded sprayer applications are not possible in UNR cotton (Hayes and Gwathmey 1999). Weed control in UNR cotton is dependent on broadcast application of PRE and POST herbicides. High plant populations in UNR cotton promote early canopy closure, which can suppress weed germination and improve crop competitiveness. The weed species encountered in UNR and wide row cotton are similar; however, there are fewer late-season options to control weeds that escape early-season control. UNR cotton is usually maintained less than 81 cm tall to promote early maturity and improve stripper harvesting efficiency (Atwell 1996). Tall-growing weeds such as hemp sesbania, sicklepod, and *Amaranthus* spp. can emerge through the canopy late in the season. Weeds such as prickly sida and hyssop spurge can reduce the harvesting efficiency of a finger stripper (K. N. Reddy, personal observation). Effective manage-

[1] Received for publication November 20, 2000, and in revised form April 25, 2001.

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[3] Letters following this symbol are a WSSA-approved computer code from *Composite List of Weeds*, Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

ment of weeds is essential in UNR cotton production systems to minimize yield loss and grade reduction.

Currently, fluometuron, pyrithiobac, and MSMA are the only herbicides available for POST control of certain broadleaf weeds in nontransgenic cotton. In transgenic cotton resistant to glyphosate and bromoxynil, these herbicides can be used for POST weed control. However, both herbicides lack residual activity. Glyphosate controls most annual broadleaf and grass weeds (Askew and Wilcut 1999; Culpepper and York 1999, 2000; Franz et al. 1997; Reddy and Whiting 2000). Bromoxynil controls several broadleaf weeds, but it lacks activity on grasses and sedges. Tank mixtures and sequential herbicide programs are often required with bromoxynil to improve the broadleaf weed control spectrum (Askew et al. 1999; Paulsgrove and Wilcut 1999; Wilcut et al. 1999).

Information on effectiveness of bromoxynil-based weed management programs in a UNR cotton production system is not widely reported. The objectives of this research were to study the efficacy of bromoxynil-based POST programs with and without PRE herbicides on control of common purslane, hemp sesbania, hyssop spurge, Palmer amaranth, pitted morningglory, prickly sida, and sicklepod in UNR cotton resistant to bromoxynil and to assess yield response of bromoxynil-resistant UNR cotton to various herbicide programs.

MATERIALS AND METHODS

Studies were conducted in 1999 and 2000 at the USDA Southern Weed Science Research Farm, Stoneville, MS (33°N latitude). The soil was a Dundee silt loam (fine-silty, mixed, thermic Aeric Ochraqualf) with pH 7.0, 1.1% organic matter, a cation exchange capacity of 15 cmol/kg, and soil textural fractions of 26% sand, 55% silt, and 19% clay. The experimental area was naturally infested with common purslane (8 plants/m^2), hemp sesbania (1 plant/m^2), hyssop spurge (11 plants/m^2), Palmer amaranth (4 plants/m^2), pitted morningglory (1 plant/m^2), prickly sida (9 plants/m^2), and sicklepod (2 plants/m^2). Weed densities were determined from two 0.84-m^2 areas in nontreated control plots at 2 wk after late postemergence (LPOST) application in both years. Weed densities represent means of both years.

Field preparation consisted of fall subsoiling, disking, and bedding. In the spring, beds were conditioned nearly flat to enable flood irrigation and cotton planting in 25-cm-wide rows. Prior to cotton planting, the experimental area was treated with glyphosate at 1.1 kg ai/ha or paraquat at 1.1 kg ai/ha to kill existing vegetation. BXN 47 bromoxynil-resistant cotton was planted on May 3, 1999, and April 21, 2000, at 312,000 seeds/ha using a Monosem NG Plus precision planter.[4] Each experimental plot consisted of 16 rows spaced 25 cm apart and 13.7 m long. The experiment was a randomized complete block design with four replications. Rainfall during the growing season (May to August) was 24.8 and 34.8 cm in 1999 and 2000, respectively. The 30-yr average rainfall for the corresponding period is 37.1 cm. Because of hot and dry weather, cotton was irrigated on July 19 and August 3 in 1999 and July 17 and August 8 in 2000.

Fertilizer application and insect control programs were standard for cotton production. Disulfoton {*O,O*-diethyl *S*-[2-(ethylthio)ethyl] phosphorodithioate} at 1.12 kg/ha was placed in seed furrows at planting. Acephate (*O,S*-dimethyl acetylphosphoramidothioate), dicrotophos (dimethyl phosphate of 3-hydroxy *N,N*-dimethyl-*cis*-crotonamide), profenofos [*O*-(4-bromo-2-chlorophenyl) *O*-ethyl *S*-propyl phosphorothioate], and malathion (*O,O*-dimethyl phosphorodithioate of diethyl mercaptosuccinate) were applied POST during the growing season as needed to control insects. Cotton plant height was kept short by applying mepiquat chloride (*N,N*-dimethylpiperidinium chloride) POST at first matchhead square stage followed by (fb) a second application 2 wk later. Harvest preparation consisted of defoliation by tribufos (*S,S,S*-tributyl phosphorotrithioate) and boll opening by ethephan [(2-chloroethyl) phosphonic acid] fb desiccation with paraquat.

PRE herbicides were applied broadcast immediately after planting. Early POST (EPOST) and LPOST treatments were applied 3 and 5 wk after planting, respectively, in 1999 and 4 and 6 wk after planting, respectively, in 2000. Sethoxydim at 0.31 kg ai/ha was applied over the entire experimental area 9 d after EPOST in both years to control grass weeds. A nonionic surfactant[5] was added to pyrithiobac, and MSMA at 0.25% v/v or a paraffinic petroleum oil[6] was added to sethoxydim at 1.25% v/v as suggested by the manufacturer. Herbicide treatments were applied with a tractor-mounted sprayer with TeeJet 8004 standard flat spray tips delivering 187 L/ha water at 179 kPa.

Herbicide programs consisted of bromoxynil EPOST

[4] Monosem NG Plus ultra narrow row precision planter, Monosem ATI, Inc., 17135 West 116th Street, Lenexa, KS 66219.

[5] Induce® nonionic low foam wetter/spreader adjuvant contains 90% nonionic surfactant (alkylaryl and alcohol ethoxylate surfactants) and fatty acids and 10% water, Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38119.

[6] Agri-Dex is a proprietary blend of heavy-range, paraffin-based petroleum oil, polyol fatty acid esters, and polyethoxylated derivative nonionic adjuvant (99% active ingredient), Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38119.

Table 1. Hyssop spurge control in bromoxynil-resistant cotton with bromoxynil-based herbicide programs in 1999 and 2000.[a]

Herbicide	Rate	Application timing	Control 4 WAT 1999	Control 4 WAT 2000	Control At harvest 1999	Control At harvest 2000
	kg/ha		%			
Bromoxynil	0.56	EPOST	79	90	54	40
Bromoxynil fb	0.56	EPOST	83	95	63	75
bromoxynil	0.56	LPOST				
Pyrithiobac	0.11	EPOST	93	100	68	80
Bromoxynil +	0.56	EPOST	99	88	86	78
pyrithiobac	0.11					
MSMA	1.12	EPOST	93	100	73	50
Bromoxynil +	0.56	EPOST	99	98	73	63
MSMA	1.12					
Fluometuron fb	1.12	PRE	95	85	78	80
bromoxynil	0.56	EPOST				
Fluometuron fb	1.12	PRE	93	95	89	87
bromoxynil fb	0.56	EPOST				
bromoxynil	0.56	LPOST				
Fluometuron fb	1.12	PRE	98	100	91	95
pyrithiobac	0.11	EPOST				
Fluometuron fb	1.12	PRE	100	98	96	88
bromoxynil +	0.56	EPOST				
pyrithiobac	0.11					
Fluometuron fb	1.12	PRE	91	90	83	75
MSMA	1.12	EPOST				
Fluometuron fb	1.12	PRE	100	100	88	93
bromoxynil +	0.56	EPOST				
MSMA	1.12					
Pendimethalin fb	1.12	PRE	85	85	55	93
bromoxynil	0.56	EPOST				
Fluometuron +	1.12	PRE	95	98	88	93
pendimethalin fb	1.12					
bromoxynil	0.56	EPOST				
Fluometuron +	1.12	PRE	99	100	89	100
pendimethalin fb	1.12					
pyrithiobac	0.11	EPOST				
Fluometuron +	1.12	PRE	100	100	95	98
pendimethalin fb	1.12					
bromoxynil +	0.56	EPOST				
pyrithiobac	0.11					
LSD (0.05)			8		19	

[a] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; PRE, preemergence; WAT, weeks after early postemergence.

at 0.56 kg ai/ha, bromoxynil EPOST at 0.56 kg ai/ha fb LPOST at 0.56 kg ai/ha, pyrithiobac EPOST at 0.11 kg ai/ha, MSMA EPOST at 1.12 kg ai/ha, bromoxynil at 0.56 kg ai/ha plus pyrithiobac at 0.11 kg ai/ha EPOST, and bromoxynil at 0.56 kg ai/ha plus MSMA at 1.12 kg ai/ha EPOST with no soil-applied herbicide or following fluometuron at 1.12 kg ai/ha PRE; pendimethalin at 1.12 kg ai/ha PRE fb bromoxynil at 0.56 kg ai/ha EPOST; fluometuron at 1.12 kg ai/ha plus pendimethalin at 1.12 kg ai/ha PRE fb bromoxynil at 0.56 kg ai/ha EPOST or bromoxynil at 0.56 kg ai/ha plus pyrithiobac at 0.11 kg ai/ha EPOST; fluometuron at 1.12 kg ai/ha plus pendimethalin at 1.12 kg ai/ha PRE fb pyrithiobac at 0.11 kg ai/ha EPOST; and a nontreated control (Table 1). Fluometuron plus pendimethalin PRE fb pyrithiobac EPOST was included as a conventional standard herbicide program to make comparison of bromoxynil-based programs.

Control of individual weed species was visually estimated based on reduction in weed population and plant vigor on a scale of 0 (no control) to 100% (complete control) at 4 WAT and at harvest. At harvest, weed control estimates were based on weeds visible at or above the cotton canopy. Dry weight of broadleaf weeds was recorded from one 0.84-m^2 area within each plot at 5 WAT applications. For lack of a small-plot cotton stripper harvester, cotton was manually harvested from the center four rows of 1-m length. Cotton plants and open bolls were counted from the four rows of 1-m row length at harvest. Weed control data were subjected to arcsine square root transformations. However, interpretations were not different from nontransformed data; therefore, nontransformed data are presented. Data from the no-herbicide treatment were deleted prior to statistical analysis to stabilize variance. Due to heavy weed pressure, there was no yield from nontreated control plots. Data were subjected to analysis of variance using Proc Mixed, and the least squares means were calculated (SAS 1998). Treatment means were separated at the 5% level of significance using Fisher's Protected LSD test. Data were averaged across years where appropriate and are presented for each year when interactions occurred.

RESULTS AND DISCUSSION

Weed Control. Bromoxynil EPOST or EPOST and LPOST with no PRE herbicides controlled hyssop spurge at least 79 and 90% in 1999 and 2000, respectively, 4 WAT (Table 1). Hyssop spurge control with bromoxynil EPOST with and without fluometuron or pendimethalin PRE was similar in both years, with the exception of improved control with fluometuron PRE fb bromoxynil EPOST in 1999. Pyrithiobac or MSMA EPOST alone or mixed with bromoxynil controlled hyssop spurge at least 90% in both years regardless of PRE herbicides. Bromoxynil plus pyrithiobac EPOST in 2000, fluometuron PRE fb bromoxynil EPOST in 2000, and pendimethalin PRE fb bromoxynil EPOST in both years controlled < 90% hyssop spurge. At harvest, hyssop spurge control with single or sequential applications of bromoxynil with no PRE herbicides was similar in 1999, but control was greater with a sequential bromoxynil application than a single application in 2000. Overall, hyssop spurge control decreased at harvest compared to 4 WAT, and the decrease was greater in bromoxynil,

Table 2. Prickly sida and sicklepod control in bromoxynil-resistant cotton with bromoxynil-based herbicide programs in 1999 and 2000.[a,b]

			Control					
			Prickly sida			Sicklepod		
			4 WAT			4 WAT		
Herbicide	Rate	Application timing	1999	2000	At harvest	1999	2000	At harvest
	kg/ha		%					
Bromoxynil	0.56	EPOST	78	75	37	16	33	6
Bromoxynil fb	0.56	EPOST	98	85	81	28	35	11
bromoxynil	0.56	LPOST						
Pyrithiobac	0.11	EPOST	75	85	33	28	70	25
Bromoxynil +	0.56	EPOST	96	83	71	43	79	24
pyrithiobac	0.11							
MSMA	1.12	EPOST	25	53	0	58	50	30
Bromoxynil +	0.56	EPOST	88	60	33	63	58	34
MSMA	1.12							
Fluometuron fb	1.12	PRE	100	98	96	99	95	79
bromoxynil	0.56	EPOST						
Fluometuron fb	1.12	PRE	100	100	96	98	98	80
bromoxynil fb	0.56	EPOST						
bromoxynil	0.56	LPOST						
Fluometuron fb	1.12	PRE	98	100	92	94	100	84
pyrithiobac	0.11	EPOST						
Fluometuron fb	1.12	PRE	100	100	96	98	98	84
bromoxynil +	0.56	EPOST						
pyrithiobac	0.11							
Fluometuron fb	1.12	PRE	94	98	69	93	100	85
MSMA	1.12	EPOST						
Fluometuron fb	1.12	PRE	100	100	96	100	100	85
bromoxynil +	0.56	EPOST						
MSMA	1.12							
Pendimethalin fb	1.12	PRE	95	100	81	11	53	0
bromoxynil	0.56	EPOST						
Fluometuron +	1.12	PRE	100	100	94	98	100	70
pendimethalin fb	1.12							
bromoxynil	0.56	EPOST						
Fluometuron +	1.12	PRE	100	100	97	98	100	76
pendimethalin fb	1.12							
pyrithiobac	0.11	EPOST						
Fluometuron +	1.12	PRE	100	100	100	100	98	89
pendimethalin fb	1.12							
bromoxynil +	0.56	EPOST						
pyrithiobac	0.11							
LSD (0.05)			16		16	22		14

[a] At harvest, data represent an average of 1999 and 2000.

[b] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; PRE, preemergence; WAT, weeks after early postemergence.

pyrithiobac, and MSMA POST-only programs compared to the respective programs following PRE herbicides.

At 4 WAT, bromoxynil applied once or twice controlled at least 75% prickly sida in both years (Table 2). Control of prickly sida with bromoxynil EPOST was similar to that with pyrithiobac EPOST but greater than control by MSMA EPOST in both years. Prickly sida control with sequential bromoxynil applications was comparable to bromoxynil plus pyrithiobac. All other herbicide programs except bromoxynil plus MSMA applied EPOST provided at least 94% control of prickly sida in both years. Control of prickly sida improved when bromoxynil EPOST followed PRE herbicides compared to bromoxynil EPOST. Others have reported similar levels of prickly sida control with bromoxynil EPOST following PRE herbicides (Culpepper and York 1997, 2000; Paulsgrove and Wilcut 1999). At harvest, control of prickly sida was ≤ 37% with bromoxynil, pyrithiobac, or MSMA alone. The decrease in control was generally greater in POST-only programs compared to PRE fb POST programs.

Bromoxynil applied alone or sequentially controlled sicklepod ≤ 35% in both years (Table 2). Sicklepod control with bromoxynil EPOST was similar to pyrithiobac EPOST in 1999. Bromoxynil has limited or no activity on sicklepod, and pyrithiobac provides partial suppression of sicklepod (Anonymous 2000; Monks et al. 1999; Paulsgrove et al. 1998). In the absence of PRE herbicides, MSMA or pyrithiobac mixed with bromoxynil increased sicklepod control over bromoxynil alone. However, sicklepod control was < 63% for the combinations, except in 2000, when bromoxynil plus pyrithiobac controlled 79% sicklepod. The combination of bromoxynil and MSMA has increased sicklepod control compared to bromoxynil alone in other research (Culpepper and York 2000; Paulsgrove and Wilcut 1999). Overall, control of sicklepod was at least 93% at 4 WAT when POST herbicides followed PRE herbicides compared to POST herbicides alone, with the exception of pendimethalin PRE fb bromoxynil EPOST. Sicklepod control was less at harvest than at 4 WAT. The decrease in sicklepod control was greater with bromoxynil, pyrithiobac, or MSMA POST-only programs compared to these POST herbicides following PRE herbicides. This may be due to regrowth of weeds that were partially controlled by POST-only programs or germination of additional seed.

Bromoxynil alone did not control common purslane (Table 3). Pyrithiobac or MSMA EPOST controlled at least 64% common purslane. MSMA or pyrithiobac in combination with bromoxynil greatly increased common purslane control compared to bromoxynil alone. Overall, control of common purslane greatly improved (> 94%) when POST herbicides followed PRE herbicides compared to POST herbicides alone. PRE herbicide programs with bromoxynil, pyrithiobac, or bromoxynil plus pyrithiobac POST controlled common purslane 88 to 95% in other research (Blackley et al. 1999).

Hemp sesbania control 4 WAT was at least 95% regardless of herbicide programs, excluding MSMA EPOST (Table 3). At least 90% control of hemp sesbania with bromoxynil alone or in combination with pyrithiobac following PRE herbicides in bromoxynil-resistant cotton has been reported (Miller et al. 1998; Peters et al. 1998). MSMA alone did not provide season-long hemp sesbania control. Overall, hemp sesbania control at harvest with bromoxynil applied once or pyrithiobac was greatly reduced compared to these POST programs following PRE herbicides.

Palmer amaranth control 4 WAT was less than 46% with single or sequential applications of bromoxynil or pyrithiobac EPOST (Table 3). Overall, PRE herbicides fb EPOST applications of bromoxynil, pyrithiobac, or MSMA improved control of Palmer amaranth over POST herbicides alone. Palmer amaranth control was at least 95%, with the exception of pendimethalin PRE fb bromoxynil EPOST. Similar improvement in Palmer amaranth control with bromoxynil or pyrithiobac POST following pendimethalin and pendimethalin plus fluometuron has been reported (Culpepper and York 1997). Bromoxynil alone or in combination with pyrithiobac or MSMA EPOST following PRE herbicides provided season-long Palmer amaranth control compared to POST herbicides alone.

Season-long control of pitted morningglory was at least 97% with all herbicide programs, except MSMA EPOST (Table 3). Pitted morningglory control was similar in all bromoxynil POST programs with and without fluometuron or fluometuron plus pendimethalin PRE. Other researchers have reported 70 to 96% control of pitted morningglory with bromoxynil, pyrithiobac, or bromoxynil plus pyrithiobac or MSMA POST programs following PRE herbicides (Blackley et al. 1999; Culpepper and York 2000).

Weed dry biomass of predominant broadleaf weeds was highest in no-herbicide plots (Table 3). Bromoxynil EPOST decreased weed dry biomass similar to pyrithiobac or MSMA EPOST. Weed dry biomass decreased 45% with fluometuron PRE fb bromoxynil EPOST and 72% with fluometuron plus pendimethalin PRE fb bromoxynil EPOST compared to the bromoxynil EPOST-only program. Similarly, sequential application of bromoxynil following fluometuron PRE decreased weed dry biomass 46% compared to the bromoxynil POST-only (sequential) program. Bromoxynil EPOST and pyrithiobac EPOST either alone or in combination following fluometuron plus pendimethalin PRE had lowest weed dry biomass. Overall, weed dry biomass in all herbicide programs was 32 to 86% less than with the no-herbicide check. Weed dry biomass reflects the degree of weed control among herbicide programs (K. N. Reddy, personal observation).

Seed Cotton Yield. Nontreated check plots were not harvested due to severe weed infestations in both years and were excluded from statistical analysis. Stand reduction with several herbicide programs at harvest was primarily due to interference from the weeds (Table 4). In 1999, seed cotton yield was highest with fluometuron plus pendimethalin PRE fb bromoxynil plus pyrithiobac EPOST and lowest with MSMA EPOST (Table 4). The low yield with MSMA EPOST was primarily due to severe cotton stand reduction and lowest open bolls. In 1999, among POST-only programs, seed cotton yield was greater with bromoxynil applied alone or in combination with pyrithiobac or MSMA compared to MSMA alone. Seed cotton yield was generally higher with bromoxynil, pyrithiobac, or MSMA applied EPOST following fluometuron PRE or fluometuron plus pendimethalin PRE compared to the EPOST-only programs. A similar trend was observed for the number of open bolls produced per plant. There were no differences in

Table 3. Common purslane, hemp sesbania, Palmer amaranth, and pitted morningglory control and weed dry biomass in bromoxynil-resistant cotton with bromoxynil-based herbicide programs.[a,b]

			Control							
			Common purslane	Hemp sesbania		Palmer amaranth		Pitted morningglory		
Herbicide	Rate	Application timing	4 WAT	4 WAT	At harvest	4 WAT	At harvest	4 WAT	At harvest	Weed dry biomass[c]
	kg/ha		%							kg/ha
Bromoxynil	0.56	EPOST	4	96	69	29	13	100	100	1,580
Bromoxynil fb	0.56	EPOST	9	99	85	46	29	100	99	1,250
bromoxynil	0.56	LPOST								
Pyrithiobac	0.11	EPOST	75	98	64	40	31	100	100	2,120
Bromoxynil +	0.56	EPOST	95	100	94	49	39	100	100	1,310
pyrithiobac	0.11									
MSMA	1.12	EPOST	64	48	3	61	17	78	71	1,760
Bromoxynil +	0.56	EPOST	71	99	74	56	25	100	100	1,970
MSMA	1.12									
Fluometuron fb	1.12	PRE	100	99	99	95	71	100	100	870
bromoxynil	0.56	EPOST								
Fluometuron fb	1.12	PRE	100	100	100	100	91	100	100	670
bromoxynil fb	0.56	EPOST								
bromoxynil	0.56	LPOST								
Fluometuron fb	1.12	PRE	100	100	99	99	94	100	100	910
pyrithiobac	0.11	EPOST								
Fluometuron fb	1.12	PRE	100	100	98	99	88	100	100	980
bromoxynil +	0.56	EPOST								
pyrithiobac	0.11									
Fluometuron fb	1.12	PRE	100	95	51	99	88	97	99	1,130
MSMA	1.12	EPOST								
Fluometuron fb	1.12	PRE	100	100	94	99	91	100	100	870
bromoxynil +	0.56	EPOST								
MSMA	1.12									
Pendimethalin fb	1.12	PRE	94	99	83	71	44	100	100	1,330
bromoxynil	0.56	EPOST								
Fluometuron +	1.12	PRE	100	100	98	99	93	100	100	440
pendimethalin fb	1.12									
bromoxynil	0.56	EPOST								
Fluometuron +	1.12	PRE	100	100	94	100	90	100	99	530
pendimethalin fb	1.12									
pyrithiobac	0.11	EPOST								
Fluometuron +	1.12	PRE	100	100	99	100	96	100	99	510
pendimethalin fb	1.12									
bromoxynil +	0.56	EPOST								
pyrithiobac	0.11									
LSD (0.05)			15	10	17	23	23	2	7	790

[a] Data represent an average of 1999 and 2000.

[b] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; PRE, preemergence; WAT, weeks after early postemergence.

[c] Weed dry biomass in no-herbicide plot was 3,100 kg/ha. Predominant weeds were common purslane, hemp sesbania, hyssop spurge, Palmer amaranth, pitted morningglory, prickly sida, and sicklepod. Weed dry weight was recorded 5 wk after EPOST.

seed cotton yield among bromoxynil, pyrithiobac, or MSMA EPOST programs following fluometuron PRE or fluometuron plus pendimethalin PRE.

In 2000, low seed cotton yields were obtained with POST-only programs. Cotton stand reduction was greater in POST-only programs compared to POST programs following PRE herbicides. Cotton growth and development were slow in April due to cooler than normal daily average temperatures (16.7 C) and higher than normal monthly rainfall (28.2 cm). Lack of canopy closure and reduced competitiveness allowed establishment of weeds following less effective herbicide programs. Overall, seed cotton yields were greater in 1999 compared to 2000, partly due to extreme weather conditions and poor control of certain weed species in 2000.

Results of this study suggest that broadleaf weed management using bromoxynil POST-only programs in UNR cotton production involves risk, since bromoxynil provides poor control of certain broadleaf weed species and lacks residual activity. Partially controlled and late-emerging weeds following POST applications can cause severe reduction in UNR cotton yield. Tall-growing weeds, such as hemp sesbania, sicklepod, and Palmer amaranth, can emerge through the cotton canopy late in the season. However, control of these weeds by POST-directed herbicide applications, hooded sprayer herbicide

Table 4. Cotton stand reduction, open bolls, and seed cotton yield as affected by various bromoxynil-based weed control programs in 1999 and 2000.[a]

Herbicide	Rate	Application timing[b]	Stand reduction[c] 1999	Stand reduction[c] 2000	Open bolls[d]	Seed cotton 1999	Seed cotton 2000
	kg/ha		%		No./plant	kg/ha	
Bromoxynil	0.56	EPOST	13	34	1.9	2,250	400
Bromoxynil fb	0.56	EPOST	10	25	2.6	2,810	670
bromoxynil	0.56	LPOST					
Pyrithiobac	0.11	EPOST	20	54	2.6	2,130	860
Bromoxynil +	0.56	EPOST	13	40	3.1	2,690	1,250
pyrithiobac	0.11						
MSMA	1.12	EPOST	41	49	1.6	1,320	210
Bromoxynil +	0.56	EPOST	20	29	2.5	2,340	600
MSMA	1.12						
Fluometuron fb	1.12	PRE	3	2	3.8	3,720	2,150
bromoxynil	0.56	EPOST					
Fluometuron fb	1.12	PRE	10	2	4.2	3,710	2,650
bromoxynil fb	0.56	EPOST					
bromoxynil	0.56	LPOST					
Fluometuron fb	1.12	PRE	15	4	4.2	2,920	3,180
pyrithiobac	0.11	EPOST					
Fluometuron fb	1.12	PRE	7	0	3.7	3,190	2,600
bromoxynil +	0.56	EPOST					
pyrithiobac	0.11						
Fluometuron fb	1.12	PRE	14	0	3.7	2,970	2,400
MSMA	1.12	EPOST					
Fluometuron fb	1.12	PRE	16	3	4.3	3,520	2,770
bromoxynil +	0.56	EPOST					
MSMA	1.12						
Pendimethalin fb	1.12	PRE	19	24	2.6	2,310	880
bromoxynil	0.56	EPOST					
Fluometuron +	1.12	PRE	25	0	4.2	3,140	2,470
pendimethalin fb	1.12						
bromoxynil	0.56	EPOST					
Fluometuron +	1.12	PRE	5	13	4.5	3,430	3,040
pendimethalin fb	1.12						
pyrithiobac	0.11	EPOST					
Fluometuron +	1.12	PRE	0	0	4.1	3,730	2,930
pendimethalin fb	1.12						
bromoxynil +	0.56	EPOST					
pyrithiobac	0.11						
LSD (0.05)			22		0.8	820	

[a] Nontreated check plots were not harvested due to heavy weed pressure.

[b] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; PRE, preemergence.

[c] Cotton plant population at harvest is expressed as percentage stand reduction compared to fluometuron plus pendimethalin PRE followed by bromoxynil plus pyrithiobac POST.

[d] Data represent an average of 1999 and 2000.

applications, and interrow cultivation is not possible in UNR cotton. Late-emerging weeds can decrease harvesting efficiency of a stripper harvester and increase foreign matter in the cotton. Applying bromoxynil mixtures with other POST herbicides may improve weed control compared to bromoxynil alone. To ensure adequate season-long control of weeds in bromoxynil-resistant cotton, use of residual soil-applied herbicides is critical. In cotton, PRE herbicides reduce detrimental early-season weed interference and improve flexibility of POST herbicide applications, as has occurred with glyphosate programs in UNR glyphosate-resistant cotton (Culpepper and York 2000; Fowler et al. 1999). In this study, weed control was consistently better and seed cotton yield was higher with bromoxynil POST programs following soil-applied herbicides compared to bromoxynil POST-only programs.

ACKNOWLEDGMENTS

I thank Albert Tidwell and Terry Newton for technical assistance in field work and Debbie Boykin for assistance in statistical analysis.

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