Comparison of Weed Control Systems for Roundup Ready™ Cotton

R. M. Hayes*, G. N. Rhodes, Jr., T. C. Mueller, P. P. Shelby, C. O. Gwathmey, and J. F. Bradley
Tennessee Agricultural Experiment Station **and** Agricultural Extension Service
University of Tennessee

Abstract: Control of weeds in no-tillage cotton after the crop emerges is needed, While graminicides are available to control grasses, antagonism often occurs with tank mixtures of other herbicides. DSMA (disodium methanearsonate) controls some species, but weed resistance and cotton injury limit its effectiveness. Buctril (bromoxynil) herbicide applied to bromoxynil resistant (BXN) cotton can be used to control pitted morningglory *(Ipomoea lacunosa)* but Palmer amaranth *(Amaranthus palmeri)* is not adequately controlled. Staple (pyrithiobac) controls most pitted morningglory and Palmer amaranth but some escapes may reduce yield and quality. Roundup Ready™ cotton allows the use of postemergence Roundup (glyphosate) but a single overtop application is inadequate to control these species for a full-season. However, a postemergence application followed by a post-directed treatment controls both pitted morningglory and Palmer amaranth through harvest without adversely affecting quality.

Introduction

Weed control in no-tillage cotton ranks with stand establishment in relative importance. The lack of availability and cost of herbicides to control weeds that escape preemergence herbicides slows the adoption of no-tillage cotton. Until 1995, overtop herbicides were limited to the graminicides [Poast (sethoxydim), Fusilade (fluazifop), etc.], the arsenicals [DSMA, MSMA (monosodium methanearsonate)] and Cotoran (fluometuron). Control of dicot weeds from these herbicides was erratic and seldom complete. Furthermore, crop injury, delayed maturity, and reduced yield have been associated with both the arsenicals and Cotoran (Shankle, 1996, Guthrie, 1986).

Calgene-Stoneville Pedigreed Seeds, Inc. developed bromoxynil resistant (BXN) cotton that became commercially available for the first time in 1995. This genetically engineered variety permits overtop treatment with Buctril (bromoxynil) herbicide. Buctril quickly kills common cocklebur *(Xanthium strumarium)* and mominglories *(Ipomoea* spp.) but is inconsistent on pigweed *(Amaranthus* spp.) and sicklepod *(Senna obtusifolia).*

Staple is active on many dicot weeds but is incompatible in mixtures with most graminicides. Staple is an inhibitor of acetolactate synthase, an enzyme in the biosynthesis of the amino acids valine, leucine, and isoleucine. Control of weeds is slow and regrowth may occur after a period of inhibited growth. Staple received full registration from the EPA in September 1995.

Roundup Ready cotton has been under development for several years and was first made available to university researchers in 1995. Roundup controls most troublesome grasses and dicot weeds in cotton. We conducted this experiment to evaluate how the Roundup Ready weed control system compares with currently available systems in no tillage cotton.

Materials and Methods

A field experiment was conducted at the West Tennessee Experiment Station (Lexington silt loam) near Jackson, TN. Cotton was planted 10 May 1995 without tillage in previous cotton stubble. Winter weeds were killed with Roundup (glyphosate) at 0.75 lb ai/acre. Plots consisted of four rows spaced 40" apart and 30' in length. Each treatment was replicated three times in an fractional factorial design. Roundup Ready cotton was planted in all treatments except those with Buctril, where BXN (bromoxynil resistant) cotton was planted. Annual weeds that emerged after the Roundup application were killed with Gramoxone Extra (paraquat) after planting on 10 May.

Other than weed control, University of Tennessee recommendations for production of no-tillage cotton were followed (Shelby, 1995). Postemergence herbicides were applied 6 June 1995 to 5"-tall cotton with five leaves. Palmer amaranth *(Amaranthus palmeri)* was 2" tall with six leaves and pitted morningglory was 3" tall with six leaves. A second application of Roundup or Caparol (prometryn) plus MSMA was post-directed on 16 June when cotton was 10" tall and had 12 leaves. Palmer amaranth was 4" tall with eight leaves and pitted morningglory was 6" tall with 10 leaves.

R. M. Hayes. Professor, Plant and Soil Science, West Tenn. Exp. Sta., 605 Airways Blvd., Jackson TN 38301. Phone: 901-424-1643. Fax: 901-425-4750. G. N. Rhodes, Jr. and T. C. Mueller. Professor and Asst. Professor, UT Agric. Ext. Serv. and Tenn. Agric. Exp. Sta.. respectively. P. O. Box 1071, Knoxvile. TN: P. P. Shelby and C. O. Gwathmey. Assoc. Prof. and Asst. Prof., UT Agric. Ext. Serv. and Tenn. Agric. Exp. Sta.. respectively. Jackson. TN: and J. F. Bradley. superintendent. Milan Exp. Sta.. Milan. TN.

Postemergence broadcast herbicides were applied in 10 gallons per acre (gpa) of water carrier. Post-directed applications were made in 15 gpa. Induce (alkylaryloxyethylene, free fatty acids, isopropanpol, and propylene glycol) surfactant was included as indicated in Table 1.

Cotton injury and weed control were recorded on 16 June (10 days after treatment) and on 30 August (10 weeks after the post-directed applications). Prep (ethephon) at 1.3 pt/acre, Folex (tribufos) at 1 pt/acre and Dropp (thidiazuron) at 0.1 lb/acre were applied as a harvest aid on 11 September. Plots were harvested with a John Deere 9930 spindle picker on 29 September and again on 11 October. Seedcotton from each plot was weighed, a subsample of seedcotton was collected, weighed and air dried. Subsamples were bulked across replications. Gin turnout was determined using a 20-saw gin equipped with two lint cleaners. Lint yield (Ib/acre) of each plot was calculated using seedcotton weight, gin turnout, and harvested area. Fiber properties of lint samples were determined by HVI at the USDA-AMS Cotton Classing Office in Memphis, TN. Weed control and lint yield data were subjected to ANOVA and means were separated using Fisher's protected LSD at P<0.05.

Results and Discussion

Cotton Growth and Injury

Stand and early season vigor of Roundup Ready and BXN cotton varieties were comparable to that of ' Deltapine 50' planted in the border surrounding the test. Weed control differed initially among the levels of preemergence herbicides (data not shown). Postemergence herbicides were applied under near optimum environmental conditions for herbicide activity (84°F, 70% RH, moist soil and 2% cloud cover). Staple injured Roundup Ready cotton 30% at 4 DAT. By 10 DAT injury declined to 20% and was not apparent at later evaluations. No other herbicide injury to cotton was observed.

Weed Control

The predominant weeds were pitted morningglory and Palmer amaranth. Pitted morningglory was controlled better when Cotoran was included as a preemergence herbicide (Table 2 and 4). Prowl did not control pitted morningglory (37%) at 4 weeks aftertreatment. Roundup alone controlled pitted morningglory 80% at 10 DAT, and control did not differ with or without preemergence herbicides. Similar results were obtained with Staple postemergence. Buctril controlled pitted morningglory >86% at 10 DAT. Pitted morningglory was not controlled with DSMA following Prowl (62%) or Cotoran (76%), but reached 98% control following Prowl plus Cotoran. There was a significant (P<0.0001) interaction between preemergence and postemergence herbicides at the early evaluation because control with Roundup and Staple was not influenced by the preemergence herbicides while control with DSMA varied depending on the preemergence herbicide (Table 2). No interaction occurred at the later rating because the preemergence herbicides had lost their effectiveness (Table 4).

Neither Prowl nor Cotoran alone controlled Palmer amaranth (<43%), but when combined control nearly doubled to 77% (Table 3). However, without subsequent control, yield loss was as much as 50% (Table 6). Roundup controlled Palmer amaranth 96% at 10 DAT with or without preemergence herbicides (Table 5). Similar control was achieved with Staple. Both Buctril and DSMA improved Palmer amaranth control over Prowl or Cotoran alone, but only DSMA improved control over the combination of Prowl plus Cotoran.

At 10 weeks after the last treatment (WALT), pitted morningglory was controlled >96% with Roundup applied postemergence followed by either Roundup post-directed or Caparol plus MSMA post-directed (Table 4). Pitted morningglory was controlled <90% with Staple treatments and <68% with Buctril or DSMA regardless of preemergence herbicide. No preemergence herbicide controlled Palmer amaranth >33% at 10 WALT (Table 5). Buctril did not control Palmer amaranth following any preemergence herbicide. DSMA, while better than Buctril, never controlled Palmer amaranth more than 73% at 10 WALT. Staple controlled Palmer amaranth best (83%) following Prowl plus Cotoran. Roundup early postemergence followed by Roundup post-directed controlled pitted morningglory >96 and palmer amaranth >92% alone or following any preemergence herbicide. Caparol plus MSMA post- directed was as effective as Roundup post-directed (Table 4 and 5).

Cotton Lint Yield

Roundup Ready cotton produced over 1100 lb lint/acre (Table 6). BXN 57 yield was only 775 Ib/acre, largely due to lack of weed control. Lint yield of Roundup Ready cotton esd lower where Staple was applied. The lower yield was likely due to a combination of early injury from Staple, slower removal of weed competition and reduced weed control. It is very possible that the yield with Staple, Buctril and DSMA could have been improved with a post-directed herbicide. Lint yield with DSMA lagged behind that of Staple due to the failure to control morningglory and Palmer amaranth. DSMA has also been implicated in subtle adverse effects on fruiting (Shankle, 1996) which may have contributed to the lower yields.

Percent First Harvest, Gin Turnout and Lint Quality

Percent first harvest averaged –75% and did not differ among treatments on Roundup Ready or BXN 57 cotton. Gin turnout averaged –34% with Roundup Ready cotton and –36% with BXN 57 cotton. Micronaire ranged from 3.8 to 4.3, length from 1.10 to 1.16 inches, strength form 29.3 to 32.8 g/tex, length uniformity of 82 +/- 1%, color Rd of 73 and +b of 8.4, and HVI color grade of 41-1 to 41-4; all of which compare favorably with the average values from the nearby variety trial (Gwathmey, 1996). However, trash content ranged from 1.4 to 2.5% with Roundup Ready and 1.4 to 1.6% with BXN 57, more than double the average in the nearby variety trial. While weed control may have contrib-

Table 1. Herbicides, rates, methods and date of application.

Herbicide	Rate	Method	Date	Surfactant (Induce)
	lb ai/acre			%
Roundup	0.75	Early Preplant	17 Mar	0.5
Gramoxone Extra	0.31	Preemergence	10 May	0.5
Prowl	1.0	Preemergence	10 May	0.5
Cotoran	1.5	Preemergence	10 May	0
Roundup	0.5	Postemergence	6 June	0.5
Roundup	1.0	Post-directed	16 June	0.5
Staple	0.06	Postemergence	6 June	0.25
Buctril	0.38	Postemergence	6 June	0
DSMA	1.8	Postemergence	6 June	0
Caparol t MSMA	0.5 + 2.0	Post-directed	16 June	0

Table 2. Pitted morningglory control in cottton 10 days after postemergence treatment following selected preemergence herbicides.'

	Preemeraence				
Postemergence	None	Prowl	Cotoran	Prowl+Cotoran	Avg.
			%		
Roundup	80	80	93	76	83
Roundup		88	81	83	84
Staple		87	99	89	92
Buctril		96	96	86	93
DSMA		62	76	98	79
None		37	96	83	72
AVG.		67	90	86	
		$LSD_{0.05}$	PRE = 12	POST = 15	PRE X POST = P=0.0001

"Herbicide rates are in Table 1.

Table 3. Palmer Amaranth control in cotton 10 days after last poetemergence treatment following selected preemergence herbicides.*

	Preemeraence				
Postemergence	None	Prowl	Cotoran	Prowl + Cotoran	Avg.
			%		
Roundup	99	99	99	99	99
Roundup		99	98	99	99
Staple		94	92	98	95
Buctril		70	65	82	72
DSM		81	85	94	87
None		35	43	77	52
AVG.		81	79	91	
		$LSD_{0.05}$	PRE = NS	POST = 20	PRE X POST = NS

'Herbicide rates are in Table 1.

Table 4. Pitted morningglory control in cotton 10 weeks after last treatment following selected preemergence herbicides:

POST TRT.	Preemergence None	Prowl	Cotoran	Prowl+Cotoran	Avg.
			%		
Roundup fb[b] Roundup	96	99	99	99	99
Roundup fb[b] Caparol + MSW		96	98	99	98
Staple		38	90	76	68
Buctril		10	55	58	41
DSW		17	31	68	40
None		0	53	40	31
AVG.		43	*12*	73	
		$LSD_{0.05}$	PRE = 19	POST = *21*	PRE X POST = NS

"Herbicide rates are in Table 1.

[b]fb = followed by.

Table 5. Palmer Amaranth control in cotton 10 weeks after last postemergence treatment following selected preemergence herbicides.

Postemergence	Preemergence				
	None	Prowl	Cotoran	Prowl+Cotoran	Avg.
			%		
Roundup fb[b] Roundup	92	99	93	99	97
Roundup fb[b] Caparol + MSMA		99	99	99	99
Staple		53	65	83	61
Buctril		20	23	52	32
DSMA		70	55	73	66
None		33	10	20	21
AVG.		62	58	71	
		$LSD_{0.05}$	PRE = NS	POST = 20	PRE X POST = NS

[a]Herbicide rates are in Table 1.
[b]fb = followed by.

Table 6. Lint yield of Roundup Ready cotton and selected postemergence treatments compared with BXN cotton treated with Buctril following selected preemergence herbicide treatments.[a]

Postemergence	Lint Yield Preemeruence None	Prowl	Cotoran	Prowl+Cotoran	Avg.
			lb/acre		
Roundup fb[b] Roundup	970	1175	992	1111	1093
Roundup fb[b] Caparol + MSMA		1156	1146	1181	1161
Staple		867	973	948	930
Buctril - BXN 57		776	750	775	767
DSMA		505	739	890	711
None 373		579	558	513	
AVG.		807	863	916	
		$LSD_{0.05}$	PRE = 86	POST = 122	PRE x POST = NS

[a]Herbicide rates are in Table 1.

[b]fb = followed by.

uted, the hirsute characteristic of these lines may contribute to these higher than expected values.

Summary

Roundup herbicide applied postemergence to Roundup Ready cotton offers a promising alternative for weed control, especially for Palmer amaranth. A single application under near optimum conditions was inadequate to control weeds throughout the season, but when followed by a post-directed spray nearly complete control was obtained. Staple, like Roundup, is inadequate to control Palmer amaranth full-season without a supplemental post-directed treatment. Buctril, while effective on pitted morningglory, failed to control Palmer amaranth. DSMA, while failing to completely control weeds, was partially effective following Prowl plus Cotoran.

Based on this limited testing, Roundup Ready cotton offers some exciting opportunities for control of these two important weeds. Further refinement of rates and timing on these and other weeds plus agronomically adapted varieties are needed before commercialization.

References Cited

Gwathmey, C. O., C. L. Brown, C. E. Michaud, and M. Smith. 1996. Tennessee Cotton Variety Test Results in 1995. Univ. Tenn. Agric. Exp. Sta. Res. Rep. 96-05. 37 pp.

Guthrie, D. S. 1986. Fruiting profile of cotton following over-top application of fluometuron and MSMA. Proc. Beltwide Cotton Prod. Res. Conf. 252 pp.

Shelby, P. P. 1995. Cotton Production in Tennessee. Univ. Tenn. Agric. Ext. Serv. Pub. PB 15 14.43 pp.

Shankle, M. W., R. M. Hayes, V. H. Reich, and T. C. Mueller. 1996. MSMA and pyrithiobac effects on cotton development, yield and quality. Weed Sci. 44:137-142.