Annual Weed Control in Roundup Ready Cotton with Conventional and Minimum Tillage Production Systems

Harold R. Hurst and Gordon R. Tupper

INTRODUCTION

Mississippi cotton producers have recently shown an increasing interest in producing crops using less tillage. This has been the result of a severe economic constraint due to very low cotton lint prices. When shallow tillage for weed control is reduced, there is an increased reliance on herbicides to control weeds. With the recent availability of effective herbicides with added application flexibility, perhaps the need to rely on tillage can be reduced. However, studies have shown a definite economic advantage for deep tillage to reduce compaction on silt loam or sandy soil types that usually produce high cotton yields.

This study was conducted over a 3-year period to evaluate the influence of two cotton tillage systems on the control of large infestations of annual weeds and the yield response of Roundup Ready cotton.

MATERIALS AND METHODS

Roundup Ready cotton was planted on silt loam to loam soil (39% sand, 52% silt, 9% clay, 6.3 pH, 0.75% organic matter) without supplemental irrigation during 1996-1998. Table 1 lists the tillage, planting, and weed control practices used and their respective dates. Tables 2 and 3 list the herbicides used and their respective rates and dates of application. The experimental design was a randomized split block with a split plot treatment arrangement and five replications. Main-plot treatments were conventional tillage and minimum tillage consisting of 16 rows, 40 inches wide and 90

Table 1. Tillage and planting practices and dates for annual weed control in Roundup Ready cotton with conventional-till and minimum-till production systems, 1996-1998.

Production	Date of tillage practices					Plant[1]			Plant growth regulator[2]		Harvest
	Year	Subsoil	Hip rows	Bed conditioner	Cultivate[3]	Date	Variety	Seeds	Date	Rate	date
								no/ft		*pt/A*	
Conventional-till	1996	10/13/95, 2/26[4]	3/11, 4/9	5/2	5/21, 6/7	5/2	Coker 312RR	6	6/28 7/17	1.0 0.5	9/30 10/15
Conventional-till	1997	10/25/96, 2/26[4] 3/12	4/1	5/6	5/22, 6/16, 7/7[5]	5/6	PM 1244RR	5	7/10 7/25	1.0 0.5	10/9
Conventional-till	1998	3/13	3/26, 4/8	4/27	5/11, 6/15	4/27	PM 1220 BG/RR	7	7/23 7/29	0.5 0.5	9/18 9/30
Minimum-till	1996	10/13/95	–	5/2	–	5/2	Coker 312RR	6	6/28 7/17	1.0 0.5	9/30 10/15
Minimum-till	1997	3/12	–	5/6	–	5/6	PM 1244RR	5	7/10 7/25	1.0 0.5	10/9
Minimum-till	1998	–	–	4/27	–	4/27	PM 1220BG/RR	7	7/23 7/29	0.5 0.5	9/18 9/30

[1]Applied Temik 15G @ 3.3 lb/A and Terrachlor SuperX 18.8G @ 7 lb/A in-furrow.
[2]Pix or Mepex.
[3]12-inch band on row left undisturbed.
[4]Parabolic at 45E to row, other dates low-till under drill.
[5]Treatment 4 not cultivated due to excess weeds.

Dr. Hurst is a plant physiologist and Dr. Tupper is an agricultural engineer (retired) at the Delta Research and Extension Center in Stoneville, Mississippi. For more information, contact Dr. Hurst by telephone at (662) 686-9311. Research Report 23:7 was published by the Office of Agricultural Communications, a unit of the Division of Agriculture, Forestry, and Veterinary Medicine at Mississippi State University.

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feet long. Subplot treatments were herbicides and/or shallow tillage for weed control consisting of four rows, 40 inches wide and 90 feet long. Treatments were applied to the same areas each year. Immediately before planting in 1996 and 1997, a mixture of annual weed seeds was broadcast over the experimental area. The weed seed mixture was composed of smooth pigweed (*Amaranthus hybridus* L.), browntop millet [*Brachiaria ramosa* (L.) Stapf], goosegrass [*Eleusine indica* (L.) Gaertn.], barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], pitted morningglory (*Ipomoea lacunosa* L.), ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.], prickly sida (*Sida spinosa* L.), broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash], and southern crabgrass [*Digitaria ciliaris* (Retz.) Koel]. The predominate species present in-season in the plot areas from the over-seeding were smooth pigweed, southern crabgrass, goosegrass, and broadleaf signalgrass. Other species were present but were not considered abundant enough to influence treatment results.

Table 2. Herbicides and application dates and rates for preplant and preemergence annual weed control in Roundup Ready cotton with conventional-till and minimum-till production systems, 1996-1998.

Treatment	Year	Preplant[1]			Preemergence[2]	
		Herbicide	Rate	Date	Herbicide	Rate
			lb ai/A			*lb ai/A*
Treatment 1	1996	Roundup Ultra	0.75	3/4	Prowl/Cotoran	1.0+1.25
	1997	Roundup Ultra	1.0	2/13	Prowl/Cotoran/Gramoxone/NIS	1.0+1.0 + 0.5+0.5%
	1998	Roundup Ultra	1.0	2/20	Prowl/Cotoran	1.25+1.25
Treatment 2	1996	Roundup Ultra	0.75	3/4	None	
	1997	Roundup Ultra	1.0	2/13	None	
	1998	Roundup Ultra	1.0	2/20	None	
Treatment 3	1996	Roundup Ultra	0.75	3/4	None	
	1997	Roundup Ultra	1.0	2/13	None	
	1998	Roundup Ultra	1.0	2/20	None	
Treatment 4	1996	Roundup Ultra	0.75	3/4	None	
	1997	Roundup Ultra	1.0	2/13	None	
	1998	Roundup Ultra	1.0	2/20	None	

[1]Applied to minimum-till Treatments 2,3.
[2]Applied to Treatment 1 only; conventional-till 20-inch band on row, minimum-till broadcast. Added Gramoxone 2.5E + NIS 0.063 lb ai/A + 0.5% v/v 4/27/98.

Table 3. Herbicides and application dates and rates for postemergence annual weed control in Roundup Ready cotton with conventional-till and minimum-till production systems, 1996-1998.

Treatment	Year	Over-the-top			Directed			Lay-by		
		Herbicide	Rate	Date	Herbicide	Rate	Date	Herbicide	Rate	Date
			lb ai/A			*lb ai/A*			*lb ai/A*	
Treatment 1	1996	None			Cotoran/MSMA	1+1.5	5/22	Bladex/NIS	1.0+0.5%	6/21
					Cobra/MSMA	0.13+1.5	6/14			
	1997	None			Cotoran/MSMA	1+1.5	6/2	Bladex/NIS	1.0+0.5%	7/15
					Bladex/MSMA	0.6+1.5	6/16			
					Staple/NIS	0.063+0.5%	7/7			
	1998	None			Cotoran/MSMA	1.0+1.5	5/21	Cy-Pro/NIS	1.0+0.5%	6/30
					Bladex/MSMA	0.6+1.5	6/15			
Treatment 2	1996	Roundup Ultra	1.0	5/22	Roundup Ultra	1.0	6/14	None		
	1997	Roundup Ultra	0.75	5/16	Roundup Ultra	1.0	7/7	None		
		Roundup Ultra	0.75	6/2						
	1998	Roundup Ultra	0.75	5/6	Roundup Ultra	1.0	6/15	None		
		Roundup Ultra	1.0	5/21	Roundup Ultra	1.0	7/16			
Treatment 3	1996	Roundup Ultra	1.0	5/22	Roundup Ultra	1.0	6/14	Bladex/NIS	1.0+0-.5%	6/21
	1997	Roundup Ultra	0.75	5/16	Roundup Ultra	1.0	7/7	Bladex/NIS	1.0+0.5%	7/15
		Roundup Ultra	0.75	6/2						
	1998	Roundup Ultra	0.75	5/6	Roundup Ultra	1.0	6/15	Cy-Pro/NIS	1.0+0.5%	6/30
		Roundup Ultra	1.0	5/21	Roundup Ultra	1.0	7/16			
Treatment 4	1996	None			None			None		
	1997	None			None			None		
	1998	None			None			None		

All data were obtained from the two center rows of each subplot. Weeds were counted from an area 40 inches wide by 90 feet long in each subplot and are presented as the total number per square foot (Table 4). A visual estimate of pigweed and annual grass control was made in early- and late-season using a scale of 0 = no control to 100 = complete control. Cotton stand was determined by counting the cotton plants in the two center rows of each subplot and converting to plants per acre. Seed cotton yield was determined by mechanically harvesting the two center rows of each subplot with a spindle picker modified for plot harvesting. One or two harvests were made each year on subplot treatments 1-3. Only a few plants in subplot treatment 4 produced open cotton in 1996, which was picked by hand. No cotton was produced with treatment 4 in 1997 or 1998 due to the intense weed competition.

Table 4. Annual weed populations in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Plants per square foot at three dates		
	6/4/96	5/26/97	5/19/98
Main-Plot Treatment[1]			
Conventional-till	1.14 a	0.80	11.13 a
Minimum-till	1.20 a	–	0.73 b
Subplot Treatment[1]			
Conventional herbicides (PRE, POST)	0.17 c	0.17 c	0.64 b
Roundup only	0.70 bc	0.68 b	1.39 b
Roundup + lay-by	1.36 b	0.53 bc	1.00 b
None	2.45 a	2.05 a	20.82 a

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

RESULTS

Weed Control

There were no main-plot by subplot interactions with weed counts or with estimated control ratings in any year.

Weed counts on June 4, 1996, resulted in subplot differences among chemical treatments with all having fewer plants than the control (Table 4). Main-plot tillage treatments were not different. The subplot conventional herbicide treatment had fewer weeds than the Roundup + lay-by treatment but was not different from the Roundup-only treatment. This was not a treatment response, as the Roundup applied May 22 had not yet killed plants, so many affected plants were counted as survivors. A similar situation occurred in 1997 with weed plants counted in minimum-till subplot treatments (counts were not obtained from conventional-till subplots in 1997). In 1997, the minimum-till, Roundup-only subplot treatment had fewer weeds than the control but had more weeds than the conventional herbicide treatment. The conventional herbicide and Roundup + lay-by subplot treatments were not different. In 1998, the conventional-till main-plot treatment had a very large weed population on May 19. The difference in main-plot treatment counts was due to the very low weed emergence on the minimum-till subplot control treatment due to the very thick weed residue remaining on the soil surface from the previous year. The preplant tillage with the conventional-till subplot control treatment destroyed this residue, which allowed large numbers of weed plants to germinate and emerge. All herbicide subplot treatments had fewer weeds than the control. There were no differences in weed numbers among herbicide subplot treatments in 1998. Early-season pigweed control in June 1996 was excellent with all herbicide subplot treatments (Table 5). Early-season pigweed control on June 13, 1997, was poor — only 75% control was obtained with the best treatment. Even though poor, Roundup treatments were better than the conventional herbicide treatment. Generally, pigweed control with main-plot, conventional-till treatments was greater than with minimum-till treatments, although all treatments in

Table 5. Estimated early-season pigweed control in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Percent weed control at three dates		
	6/4/96	6/13/97	5/28/98
Main-Plot Treatment[1]			
Conventional-till	75 a	65 a	72 a
Minimum-till	75 a	42 b	70 a
Subplot Treatment[1]			
Conventional herbicides (PRE, POST)	100 a	65 b	91 b
Roundup only	99 a	74 a	97 a
Roundup + lay-by	100 a	75 a	97 a
None	0 b	0 c	0 c

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Table 6. Estimated late-season pigweed control in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Percent weed control at three dates		
	7/2/96	8/7/97	7/27/98
Main-Plot Treatment[1]			
Conventional-till	75 a	66 a	60 a
Minimum-till	75 a	59 a	66 a
Subplot Treatment[1]			
Conventional herbicides (PRE, POST)	100 a	72 b	74 b
Roundup only	99 a	88 a	84 ab
Roundup + lay-by	100 a	90 a	94 a
None	0 b	0 c	0 c

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Table 7. Estimated early-season annual grass control in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Percent grass control at three dates		
	6/24/96	6/13/97	5/28/98
Main-Plot Treatment[1]			
Conventional-till	74 a	65 a	72 a
Minimum-till	74 a	42 b	73 a
Subplot Treatment[1]			
Conventional herbicides (PRE, POST)	99 a	65 b	97 a
Roundup only	99 a	74 a	98 a
Roundup + lay-by	100 a	75 a	98 a
None	0 b	0 c	0 b

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Table 8. Estimated late-season annual grass control in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Percent grass control at three dates		
	7/2/96	8/7/97	7/27/98
Main-Plot Treatment[1]			
Conventional-till	75 a	77 a	74 a
Minimum-till	75 a	68 b	72 a
Subplot Treatment[1]			
Conventional herbicides (PRE, POST)	100 a	88 b	89 b
Roundup only	100 a	94 ab	96 a
Roundup + lay-by	100 a	99 a	100 a
None	0 b	0 c	0 c

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

both systems had very poor control in 1997. In 1998, early-season pigweed control was good to excellent (91% to 97%) with all subplot herbicide treatments regardless of tillage system. Late-season pigweed control in 1996 was the same as early-season (Table 6). In 1997, control with Roundup subplot treatments was greater (88% and 90%) than with conventional herbicides (72%). In 1998, a late-July rating for pigweed control was similar to 1997, except that the Roundup + lay-by subplot treatment was numerically greater (10%) than the Roundup-only treatment. The Roundup-only subplot treatment was numerically greater (10%) in pigweed control than the conventional herbicide treatment. There were no main-plot tillage differences in late-season pigweed control in any year.

The early-season annual grass control was very similar to the pigweed control for all years, except in 1998 the conventional herbicide subplot treatment for annual grass control was not different from the Roundup subplot treatments (Table 7). Late-season annual grass control was excellent in 1996 within all herbicide subplot treatments (Table 8). In 1997 and 1998, the Roundup subplot treatments gave excellent annual grass control (94% to 100%). In 1997, control with the Roundup + lay-by subplot treatment was greater than the conventional herbicide treatment. In 1997, the conventional-till main-plot treatment gave 9% greater control than the minimum-till treatment.

Cotton Response

No main-plot by subplot interactions occurred with cotton stand in any year. The conventional-till, main-plot treatment had more cotton plants in 1997 than the minimum-till, main-plot treatment (Table 9). This was the result of weather-related effects on the emergence and early vigor of plants in the minimum-till treatments. Cotton stand with all subplot treatments in 1996 and with subplot herbicide treatments in 1997 and 1998 were not different. The subplot control treatment had fewer cotton plants in 1997 and 1998 primarily because of the soil surface residue from the previous year. Seed cotton yield was not different in 1996 with main-plot tillage or subplot herbicide treatments (Table 10). The large weed infestation only allowed very low seed cotton yield with the control subplot treatments. A main-plot by

Table 9. Cotton stand in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Plants per acre (thousands)		
	1996	1997	1998
Main-Plot Treatment[1]			
Conventional-till	38.4 a	45.2 a	26.6 a
Minimum-till	37.5 a	22.7 b	24.4 a
Subplot Treatment[1]			
Conventional herbicides (PRE, POST)	37.7 a	42.7 a	30.9 a
Roundup only	37.6 a	38.0 a	29.3 a
Roundup + lay-by	38.0 a	36.3 a	28.7 a
None	38.4 a	18.6 b	13.1 b

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Table 10. Seed cotton yield in an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Yield (lb/A)	
	1996	1998
Main-Plot Treatment[1]		
Conventional-till	1,682 a	1,720 a
Minimum-till	1,667 a	1,345 b
Subplot Treatment[1]		
Conventional herbicides (PRE, POST)	2,062 a	2,122 a
Roundup only	2,079 a	1,986 a
Roundup + lay-by	2,030 a	2,021 a
None	526 b	0 b

[1]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

subplot interaction for seed cotton yield occurred in 1997 (Table 11). The Roundup treatments with minimum tillage produced less seed cotton yield than with conventional tillage (1,365 vs. 1,860 and 974 vs. 2,180 pounds per acre for Roundup only and Roundup lay-by, respectively). In 1997 with conventional tillage, there were no seed cotton yield differences among herbicide subplot treatments. In 1997 with minimum tillage, the conventional herbicide treatment seed cotton yield was greater (1,678 pounds per acre) than the Roundup + lay-by (9,74 pounds per acre) but was not different from the Roundup-only subplot yield (1,365 pounds per acre). The subplot control treatment did not produce any open cotton in 1997 and 1998. The seed cotton yield in 1998 (Table 10) was greater (1,720 pounds per acre) with the main-plot, conventional-till treatment than with the minimum-till treatment (1,345 pounds per acre). Among subplot herbicide treatments, there were no seed cotton yield differences in 1998.

Table 11. Main-plot by subplot interaction effect on seed cotton yield with an experiment on weed control with conventional-till and minimum-till Roundup Ready cotton, 1996-1998.

Treatment	Yield (lb/A)		
	1996 [1]	1997 [2]	1998 [1]
Conventional-till			
Conventional herbicides	2,119	2,139 A a	2,288
Roundup only	1,947	1,860 A a	2,198
Roundup + lay-by	2,077	2,180 A a	2,392
None	585	0 A b	0
Minimum-till			
Conventional herbicides	2,005	1,678 A a	1,955
Roundup only	2,212	1,365 B ab	1,774
Roundup + lay-by	1,983	974 B bc	1,650
None	466	0 A c	0

[1]No interaction effect.
[2]Main-plot means with the same upper case letter within the same subplot and the same lowercase letter within the same main-plot are not different using a significance level of 0.05 according to DMRT.

Conclusions

1. Early-season weed control was excellent in 1996 and 1998. Poor control of smooth pigweed and annual grass plants occurred in 1997. This was probably a function of the cool, wet environment.
2. Late-season weed control for pigweed was good to excellent in 1996 and 1998 and was good to excellent for annual grass control with Roundup treatments for all years. Late-season annual grass control with conventional herbicides was poor in 1997 and 1998.
3. Cotton stand was lower with minimum tillage in 1997. The cool, wet conditions resulted in more cotton plants dying in minimum-till plots.
4. Seed cotton yield was lower with minimum-till plots receiving Roundup in 1997 and with all minimum-till plots in 1998.

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