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Annual Weed Control with Cultivation and Band-Applied Herbicides in Roundup Ready Cotton

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INTRODUCTION

With conventional tillage, Mississippi cotton producers usually direct herbicides to small weeds on the crop row during the first or second trip with cultivators using spray shields. This leaves an undisturbed band of soil on each side of the crop row. The use of the rolling tine cultivator "dirts" the cotton row, depositing soil along the base of cotton plants and covering small weeds. Postdirected herbicides normally are not used with this operation. The rolling tine cultivator can be adjusted to increase the amount of soil deposited on the row as the crop grows taller. With the use of effective over-the-top herbicides, weeds remaining on the row after cultivation using either of the above procedures allow thorough weed coverage with band spraying. This can result in 50% or greater reduction in herbicide cost and less chemical being applied in the environment.

The objective of this study was to measure the response of annual weeds and Roundup Ready cotton to band-applied herbicide used with two cultivation procedures. Selected no-till treatments were included for comparison.

MATERIALS AND METHODS

Cotton (Deltapine DP 5415RR) was planted on April 27, 1998, May 3, 1999, May 2, 2000, April 29, 2001, and May 7, 2002, on a Bosket (Mollic Hapludalfs) and Beulah (typic Dystrudepts) sandy loam soil with 65% sand, 24% silt, 11% clay, pH 6.7, and 0.85% organic matter. The area was furrow-irrigated four times each in 1998 and 2000, three times each in 2001 and 2002, and five times in 1999 with amounts equivalent to approximately 1.5 to 2 inches of rain water each irrigation. A natural population of annual weeds was identified on the area. Predominate weeds were southern crabgrass [*Digitaria ciliaris* (Retz.) Koel.], red sprangletop [*Leptochloa filiformis* (Lam.) Beauv.], browntop millet [*Brachiaria ramosa* (L.) Stapf], palmer amaranth (*Amaranthus palmeri* S. Wats.), nodding spurge (*Euphorbia nutans* Lag.), and ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.]. Scattered plants of prickly sida (*Sida spinosa* L.), horse purslane (*Trianthema portulacastrum* L.), redvine [*Brunnichia ovata* (Walt.) Shinners], and pitted morningglory (*Ipomoea lacunosa* L.) were present but were not considered to be in numbers large enough to influence cotton yield. Cultivation and herbicide treatments are listed in Table 1. Herbicide application dates are listed in Tables 2-3 and cultivation dates in Table 4.

Treatments were arranged in a randomized complete block design with four replications. Individual plots were four cotton rows 40 inches apart and 60 feet long. All data were taken from the two center rows of each plot. All data were subjected to an analysis of variance. Treatment means were separated using a significance level of 0.05 according to Duncan's Multiple Range Test.

Weed control was visually estimated in early- and late-season each year using a rating scale of 0 = no control to 100 = complete control (Tables 5 and 6). Weeds were also counted in June of 1998, 2000, and 2002 from an area of 12 inches by 20 feet on a preselected row (Table 7). Cotton stand was determined each year by counting cotton plants on one row in each plot and is presented in Table 8 as plants per acre. Cotton yield

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Table 1. Cultivation and herbicides used with an experiment for annual weed control with band-applied herbicides in Roundup Ready® cotton, 1998-2002.

Treatment	Cultivation[1]	Herbicide rate (lb ai/A)[2]		
		Preplant Incorporated	Preemergence	Postemergence[3]
1	None	None	None	Roundup 4E 1.0
2	None	None	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
3	None	None	Cotoran 4L 0.63 + Staple 85SP 0.023	Roundup 4E 1.0
4	Band	Treflan 4E 0.75	Cotoran 4L 1.25 + Staple 85SP 0.045	Cotoran 4L 1.0 + MSMA 6.6L 1.5 Followed by Cy-Pro 4L 0.8 + MSMA 6.6L 1.5 Roundup 4E 1.0
5	Band	Treflan 4E 0.75	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
6	Band	Treflan 4E 0.75	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
7	Band	None	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
8	Band	None	Cotoran 4L 0.63 + Staple 85SP 0.023	Roundup 4E 1.0
9	Band	None	None	Roundup 4E 1.0
10	Dirt	None	Cotoran 4L 1.25 + Staple 85SP 0.045	Cotoran 4L 1.0 + MSMA 6.6L 1.5 Followed by Cy-Pro 4L 0.8 + MSMA 6.6L 1.5 Roundup 4E 1.0
11	Dirt	Treflan 4E 0.75	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
12	Dirt	Treflan 4E 0.75	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
13	Dirt	None	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
14	Dirt	None	Cotoran 4L 0.63 + Staple 85SP 0.023	Roundup 4E 1.0
15	Dirt	None	None	Roundup 4E 1.0
16	Dirt	None	None	Staple 85SP 0.063 + Assure II 0.8E 0.093 – 1998-2000 Roundup 4E 0.25 (2001, 2002)
17	Band	None	Cotoran 4L 1.25 + Staple 85SP 0.045	Roundup 4E 1.0
18	Band	None	None	Roundup 4E 1.0
19	Dirt	None	Cotoran 4L 1.25 + Staple 58SP 0.045	Roundup 4E 1.0
20	Dirt	None	None	Roundup 4E 1.0

[1]See Table 4 for timing.
[2]Roundup was applied on an as needed basis either over-the-top 10 inches above cotton or weed plants or by directed sprays. Staple + Assure were applied over-the-top. Treatments 1-3 were applied broadcast. Others were applied to a 20-inch band centered on the row.
[3]See Tables 2-3 for dates and type of application.

was determined by mechanically harvesting the two center rows of each plot one time each year and converting plot weight to pounds of seed cotton per acre (Table 9).

The preplant-incorporated herbicide was applied broadcast on beds in 20 gallons total volume per acre with tractor-mounted boom sprayer and was soil-incorporated once-over with a bed conditioner. Herbicides were applied broadcast to the no-till treatments. Other treatments had herbicides applied to a 20-inch band centered on the crop row. Preemergence (PRE) and over-the-top (POT) applications were made with a tractor-mounted boom sprayer delivering 20 gallons per acre for PRE and 10 gallons per acre for POT applications. Postemergence-directed (PDR) applications were made in 20 gallons per acre with a four-row cultivator with spray shields, while cultivating for Treatment 4 and with plows removed for Treatment 10. PDR applications of Roundup were made in 10 gallons per acre with an "S and N" applicator. This device directs spray to each side of the cotton row under fenders that minimize cotton foliar contact. Treatment 16 was applied POT with a four-row boom sprayer with one nozzle spraying over each row 10 inches above the tallest plants (cotton or weed). In 1999, all plots were treated lay-by (LBY) on July 10 with Direx 4L plus Cy-Pro 4L plus surfactant at 0.5 + 0.5 lb ai/A + 0.5% v/v using a slide unit spraying broadcast in 20 gallons total volume per acre.

No primary tillage was used with Treatments 1-3. Preplant "burn-down" of weeds on Treatments 1-3 was accomplished by applying Roundup at 1.0 lb ai/A one time each year (twice in 2000) plus Touchdown at 1.0 lb ai/A once each in 2001 and

Table 2. Preplant and preemergence herbicide application dates for an experiment for annual weed control with band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Preplant Incorporated (month/day)					Preemergence (month/day)				
	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	4/27	5/3	5/2	4/20	5/7
3	-	-	-	-	-	4/27	5/3	5/2	4/20	5/7
4	3/23	2/25	3/6	3/19	3/5	4/27	5/3	5/2	4/20	5/7
5	3/23	2/25	3/6	3/19	3/5	4/27	5/3	5/2	4/20	5/7
6	-	2/25	3/6	3/19	3/5	4/27	5/3	5/2	4/20	5/7
7	-	-	-	-	-	4/27	5/3	5/2	4/20	5/7
8	-	-	-	-	-	4/27	5/3	5/2	4/20	5/7
9	-	-	-	-	-	-	-	-	-	-
10	3/23	-	-	-	-	4/27	5/3	5/2	4/20	5/7
11	3/23	2/25	3/6	3/19	3/5	4/27	5/3	5/2	4/20	5/7
12	-	2/25	3/6	3/19	3/5	4/27	5/3	5/2	4/20	5/7
13	-	-	-	-	-	4/27	5/3	5/2	4/20	-
14	-	-	-	-	-	427	5/3	5/2	4/30	5/7
15	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	4/27	5/3	5/2	4/20	5/7
18	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	4/27	5/3	5/2	4/20	5/7
20	-	-	-	-	-	-	-	-	-	-

Table 3. Postemergence herbicide application dates for an experiment for annual weed control with band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Over-the-top (month/day)					Directed (month/day)				
	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
1	5/14	5/26	5/25	5/15, 5/25	5/15, 6/5	6/15	6/21	6/26	6/11	7/8
2	5/14	-	-	5/25	6/5	6/15	6/21	6/12	6/11	7/8
3	5/14	-	5/25	5/25	6/5	6/15	6/8	6/26	6/11	7/8
4	-	-	-	-	7/8	5/28, 6/15	6/9, 6/21	6/26	-	6/5, 6/13
5	6/16	-	6/26	-	6/14, 7/8	-	6/8	-	-	-
6	-	-	-	5/25	-	6/15	6/8	6/26	-	7/8
7	-	-	-	5/25	5/22, 6/5	6/15	6/8	6/26	-	6/14, 7/8
8	-	5/24	5/25	5/25	5/22, 6/5	6/15	6/21	6/26	-	6/14, 7/8
9	5/14	5/24	5/25	4/30, 5/25	5/15	6/15	6/21	6/26	-	6/14, 7/8
10	-	-	-	-	5/22, 7/8	5/28	6/21	6/26	5/18, 5/25	6/5, 6/13
11	-	6/21	-	5/25	6/5, 7/8	-	-	-	-	-
12	-	-	6/26	5/25	6/5	-	6/21	6/26	-	-
13	-	-	-	5/18, 5/25	5/15, 6/5	-	6/8	6/26	-	7/8
14	-	5/24	5/25	5/25	5/22, 6/5	-	-	6/26	-	6/14, 7/8
15	5/14	5/24	5/25	4/30, 5/25	5/15, 6/5	6/15	-	6/12	-	7/8
16	5/14, 6/16	5/24, 6/8, 6/22	5/25, 6/12, 7/6	4/30, 5/7, 5/14, 5/21, 5/29, 6/5, 6/11, 6/18	5/15, 5/22, 5/29, 6/5, 6/12, 6/19, 7/8	-	-	-	-	-
17	5/28	-	-	5/25	5/22	6/15	6/8	6/26	-	7/8
18	5/14	-	5/25	4/30, 5/25	5/15, 6/5	6/15	6/21	6/26	-	-
19	5/28	-	-	5/25	5/22	-	6/21	6/26	-	6/14, 7/8
20	5/14	-	5/25	4/30, 5/25	5/15, 6/5	-	6/21	6/26	-	-

2002. "Burn-down" of weeds on Treatments 4-20 was used one time each in 1998 and 1999 with Gramoxone® at 0.94 lb ai/A + surfactant at 0.5% v/v and in 2002 with Touchdown at 1.0 lb ai/A. Primary tillage was used on Treatments 4-20, which consisted of subsoiling, hipping, and bed conditioning. Subsoiling was between the rows in the fall of 1998-2000 and under the rows in 2001. No subsoiling was performed in the fall of 1997. Rows were formed with a four-row hipper in February of 1998, 1999, 2001, and 2002 and in November 1999. Rows were re-hipped in March 2000-2002 and re-hipped again in 2000. After each hipping operation, a bed conditioner was used to reduce bed height for drainage on Treatments 4-20 or to soil incorporate Treflan® on Treatments 4-6, 11, and 12.

Cultivation was used to control weeds between the rows of Treatments 4-20. This was either with the use of a conventional four-row cultivator with spray shields (Treatments 4-9, 17, 18), leaving an undisturbed 12-inch band centered on the row, or with a four-row rolling tine cultivator that moves soil to the base of cotton plants on the row (Treatments 10-16, 19, 20). When plants are small, the rolling tine unit can easily cover cotton plants with soil if operated at high speeds. As cotton plants gain height, the speed of operation can be increased, thereby allowing more soil for covering small weeds while not covering cotton plants. The first cultivation was made 8-18 days after cotton emerged to a complete stand. Selected treatments had the first cultivation delayed in some years to evaluate the influence of delaying cultivation on weed control, especially with the rolling tine unit. Except with treatments that were selectively delayed, usually three cultivations per year were needed for controlling weeds between the rows. From field observation, the delay with the first cultivation resulted in larger weed plants between rows that caused poor cultivation with both units but was more detrimental to the rolling tine unit. This was more pronounced with the extended delay with Treatments 17 and 19 in 2000 and 2001.

Table 4. Cultivation, timing with an experiment for annual weed control with cultivation and band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	First cultivation[1]					Second cultivation[1]					Third cultivation[1]				
	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	8	8	12	17	18	28	27	21	23	30	38	-	40	41	42
5	8	8	12	17	18	28	27	21	23	30	38	-	40	41	42
6	8	8	12	17	18	28	27	21	23	30	38	-	40	41	42
7	8	16	21	23	18	28	35	40	41	42	38	-	-	-	56
8	8	8	12	17	18	28	27	21	23	30	38	-	40	41	42
9	8	8	12	17	18	28	27	21	23	30	38	-	40	41	42
10	8	8	13	17	18	24	27	21	24	30	38	-	40	41	42
11	8	8	13	17	18	24	27	21	24	30	38	-	40	41	42
12	8	8	13	17	18	24	27	21	24	30	38	-	40	41	42
13	8	16	21	24	18	24	35	40	41	42	38	-	-	-	56
14	8	8	13	17	18	24	27	21	24	30	38	-	40	41	42
15	8	8	13	17	18	24	27	21	24	30	38	-	40	41	42
16	8	8	13	17	18	24	27	21	24	30	38	-	40	41	42
17	8	27	40	41	18	22	42	-	-	42	38	-	-	-	56
18	24	8	12	17	18	38	27	21	23	30	-	-	40	41	42
19	8	27	40	41	18	22	42	-	-	42	38	-	-	-	56
20	24	8	13	17	18	38	27	21	24	30	-	-	40	41	42

[1]Measured in days after cotton emergence. Cotton emerged on 5/7/98, 5/11/99, 5/12/00, 5/1/01, 5/13/02

Table 5. Early-season weed control with an experiment for annual weed control with cultivation and band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Cultivation	Herbicide application[1]				Estimated early-season annual weed control date[2]				
		PPI	PRE	POT	PDR	5/13/98	5/20/99	6/2/00	5/15/01	5/20/02
						%	%	%	%	%
1	None	No	No	RUP	RUP	0 c	0 f	94 cd	0 g	91 a-d
2	None	No	Full Rate	RUP	RUP	91 a	100 a	76 e	98 abc	98 ab
3	None	No	Half Rate	RUP	RUP	63 b	95 abc	98 abc	91 b-e	94 abc
4	Band	Yes	Full Rate	RUP	Conv.	100 a	93 abc	98 abc	99 ab	97 abc
5	Band	Yes	Full Rate	RUP	RUP	100 a	91 abc	98 abc	100 a	99 a
6	Band	Yes	Full Rate	RUP	RUP	100 a	92 abc	100 a	98 ab	99 a
7	Band	No	Full Rate	RUP	RUP	99 a	96 ab	98 abc	94 a-e	88 a-d
8	Band	No	Half Rate	RUP	RUP	98 a	65 bcd	100 a	94 a-e	83 cde
9	Band	No	No	RUP	RUP	24 c	34 de	98 abc	98 abc	61 fg
10	Dirt	No	Full Rate	RUP	Conv.	99 a	98 a	97 a-d	70 f	56 g
11	Dirt	Yes	Full Rate	RUP	No	100 a	87 abc	100 a	99 ab	97 abc
12	Dirt	Yes	Full Rate	RUP	RUP	100 a	93 abc	97 a-d	99 ab	99 a
13	Dirt	No	Full Rate	RUP	RUP	100 a	91 abc	95 bcd	85 e	85 bcd
14	Dirt	No	Half Rate	RUP	RUP	99 a	60 d	99 ab	87 de	60 g
15	Dirt	No	No	RUP	RUP	24 c	50 d	93 d	96 a-d	83 cde
16	Dirt	No	No	Conv. RUP	No	0 c	56 d	41 f	89 cde	63 efg
17	Band	No	Full Rate	RUP	RUP	100 a	94 abc	99 ab	93 a-e	75 d-g
18	Band	No	No	RUP	RUP	0 c	20 ef	97 a-d	96 a-d	86 a-d
19	Dirt	No	Full Rate	RUP	RUP	99 a	96 ab	99 ab	85 e	74 d-g
20	Dirt	No	No	RUP	RUP	0 c	61 cd	95 bcd	96 a-d	85 bcd

[1]Refer to Table 1 for herbicide and rate and Tables 2-3 for date(s) of application. RUP = Roundup UltraMax, Conv. = Cotoran + MSMA followed by Cy-Pro + MSMA.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Results and Discussion

Weed Control

The early-season weed control was the result of PPI and/or PRE herbicide application in 1998, 1999, and 2001. The first postemergence (POT or PDR) application was not made until the day of rating or afterward. Ratings in 2000 and 2002 were made 8 and 5 days after the first POT application, so control may have been increased with Treatments 1, 3, 8, 9, 14-16, 18, and 20 in 2000 and Treatments 1, 9, 13, 15, 16, 18, and 20 in 2002. In 1998, all treatments except those not receiving PPI and/or PRE gave excellent (≥91%) control. The no-till half-rate Cotoran plus Staple PRE treatment (Treatment 3) gave poor control, but control was excellent (≥91%) in other years. In 1999, all treatments receiving PPI and/or PRE resulted in good to excellent control (87-100%), with poor control by the conventional-till half-rate PRE treatments (60% and 65%). In 2000, all treatments except 2 (Cotoran + Staple PRE) and 16 (no PRE) resulted in excellent (≥93%) control. In 2001, early-season control was excellent ((≥91%) with all treatments except 1 (no PRE) and 10 (Cotoran + Staple PRE), which resulted in poor control (0% and 70%), and was good (≥85%) with Treatments 13 (Cotoran + Staple PRE), 14 (Cotoran + Staple half-rate PRE), 16 (Roundup POT 2X), and 19 (no PRE). In 2002, control was excellent (≥91%) with

Table 6. Late-season weed control with an experiment for annual weed control with cultivation and band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Cultivation	Herbicide application[1]				Estimated late-season annual weed control date[2]				
		PPI	PRE	POT	PDR	7/23/98	7/30/99	8/22/00	8/23/01	8/6/02
						%	%	%	%	%
1	None	No	No	RUP	RUP	96 a-e	82 bc	61 ef	79 a-d	93 abc
2	None	No	Full Rate	RUP	RUP	100 a	96 ab	64 e	89 ab	100 a
3	None	No	Half Rate	RUP	RUP	99 ab	85 abc	80 b-e	89 ab	100 a
4	Band	Yes	Full Rate	RUP	Conv.	100 a	91 ab	83 a-d	89 ab	98 ab
5	Band	Yes	Full Rate	RUP	RUP	100 a	99 a	92 ab	90 ab	100 a
6	Band	Yes	Full Rate	RUP	RUP	100 a	98 a	94 a	93 a	91 bcd
7	Band	No	Full Rate	RUP	RUP	100 a	98 a	92 ab	84 abc	74 fgh
8	Band	No	Half Rate	RUP	RUP	93 cde	94 ab	91 ab	92 a	80 d-g
9	Band	No	No	RUP	RUP	94 b-e	98 a	92 ab	71 b-e	71 gh
10	Dirt	No	Full Rate	RUP	Conv.	98 a-d	74 cd	41 f	44 d	70 gh
11	Dirt	Yes	Full Rate	RUP	No	97 a-e	94 ab	94 a	78 a-d	69 gh
12	Dirt	Yes	Full Rate	RUP	RUP	92 def	91 ab	90 ab	88 abc	91 bcd
13	Dirt	No	Full Rate	RUP	RUP	96 a-e	89 ab	61 ef	86 abc	92 bcd
14	Dirt	No	Half Rate	RUP	RUP	85 fg	69 d	80 b-e	79 a-d	90 b-e
15	Dirt	No	No	RUP	RUP	96 a-e	69 d	70 de	55 ef	78 e-h
16	Dirt	No	No	Conv. RUP	No	84 g	58 d	20 g	78 a-d	89 cde
17	Band	No	Full Rate	RUP	RUP	99 ab	96 ab	72 de	79 a-d	86 c-f
18	Band	No	No	RUP	RUP	94 b-e	96 ab	85 abc	79 a-d	60 h
19	Dirt	No	Full Rate	RUP	RUP	99 ab	95 ab	61 ef	61 def	85 c-f
20	Dirt	No	No	RUP	RUP	91 efg	97 ab	77 c-f	66 cde	66 gh

[1]Refer to Table 1 for herbicide and rate and Tables 2-3 for date(s) of application. RUP = Roundup UltraMax, Conv. = Cotoran + MSMA followed by Cy-Pro + MSMA.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Table 7. Annual weed plant count with an experiment for annual weed control with cultivation and band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Cultivation	Herbicide application[1]				Weed plants per 12" x 20' on row[2]		
		PPI	PRE	POT	PDR	6/9/98	6/9/00	6/11/02
1	None	No	No	RUP	RUP	87.0 a	29.3 bcd	5.5 cd
2	None	No	Full Rate	RUP	RUP	2.5 e	56.8 b	0.8 d
3	None	No	Half Rate	RUP	RUP	19.6 de	27.1 cd	1.3 d
4	Band	Yes	Full Rate	RUP	Conv.	12.2 de	11.0 d	7.0 bcd
5	Band	Yes	Full Rate	RUP	RUP	10.1 de	7.7 d	3.8 d
6	Band	Yes	Full Rate	RUP	RUP	10.8 de	7.1 d	0.5 d
7	Band	No	Full Rate	RUP	RUP	8.0 de	12.7 d	6.3 bcd
8	Band	No	Half Rate	RUP	RUP	40.5 bcd	23.9 cd	6.5 bcd
9	Band	No	No	RUP	RUP	58.8 abc	9.2 d	13.3 bc
10	Dirt	No	Full Rate	RUP	Conv.	0.9 e	23.7 cd	25.8 a
11	Dirt	Yes	Full Rate	RUP	No	1.2 e	10.6 d	4.3 d
12	Dirt	Yes	Full Rate	RUP	RUP	1.3 e	8.5 d	2.5 d
13	Dirt	No	Full Rate	RUP	RUP	0.6 e	17.3 cd	2.5 d
14	Dirt	No	Half Rate	RUP	RUP	5.2 e	21.8 cd	14.3 b
15	Dirt	No	No	RUP	RUP	31.7 cde	44.5 bc	4.8 d
16	Dirt	No	No	Conv. RUP	No	6.8 e	104.9 a	1.3 d
17	Band	No	Full Rate	RUP	RUP	28.0 cde	12.4 d	3.8 d
18	Band	No	No	RUP	RUP	66.2 ab	8.3 d	2.3 d
19	Dirt	No	Full Rate	RUP	RUP	1.3 e	17.1 cd	6.8 bcd
20	Dirt	No	No	RUP	RUP	2.9 e	14.8 cd	1.8 d

[1]Refer to Table 1 for herbicide and rate and Tables 2-3 for date(s) of application. RUP = Roundup UltraMax, Conv. = Cotoran + MSMA followed by Cy-Pro + MSMA.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Treatments 1-6, 11, and 12. Treatment 1 had Roundup 1.0 lb ai/A PPF on May 2. Treatments 2 and 3 had Cotoran + Staple PRE and Cotoran + Staple half-rate PRE, and both had Roundup PPF on May 2. Treatments 4, 5, 6, 11, and 12 all had Treflan PPI and Cotoran + Staple PRE.

Late-season control in 1998 was excellent (≥91%) with all treatments except 14 (Cotoran + Staple half-rate PRE) and 16 (Staple 0.063 lb ai/A + Assure 0.093 lb ai/A POT 2X) and was good (≥84%) with these. Control for Treatments 5 and 6 continued at 90% or higher in 1999-2002. Most other treatments were lower in control during one or more years after 1998. Treatment 16 resulted in poor control with multiple over-the-top applications of Assure + Staple in 1999 and 2000. When Roundup was substituted in 2001 and 2002 with seven or eight weekly applications at a very low rate, control improved. Control with PDR Cotoran + MSMA followed by (fb) Cy-Pro + MSMA was higher in all years except 1998 with band cultivation (Treatment 4) than with rolling tine cultivation (Treatment 10). This reduced control was the combined result of no PPI herbicide with Treatment 10 after 1998 and the rolling tine unit moving untreated soil from between rows to the row.

When late-season control was averaged over the 5 years, treatments with band cultivation (Treatments 4-9, 17, 18) resulted in 90% control, while rolling tine treatments (10-15, 19, 20) were 10% less. No-till treatments (1-3) averaged 88% control. Treatment 16 averaged 66% control over 5 years, but for the final 2 years, the average control was 84%. When full-rate PRE treatments (2, 4-7, 10-13, 17, 19) were averaged over 5 years, late-season control was 87%. The half-rate PRE treatments (3, 8, 14) averaged 87%, while treatments including PPI (4-6, 11, 12) averaged 92%.

Table 8. Cotton stand with an experiment for annual weed control with cultivation and band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Cultivation	Herbicide application[1]				Cotton plants per acre (thousands)[2]				
		PPI	PRE	POT	PDR	1998	1999	2000	2001	2002
1	None	No	No	RUP	RUP	27.4 b-e	24.5 fg	29.9 cde	27.0 a	48.7 ab
2	None	No	Full Rate	RUP	RUP	31.2 a	22.5 g	34.7 a-e	27.9 a	54.1 ab
3	None	No	Half Rate	RUP	RUP	29.1 a-d	25.9 c-f	34.6 a-e	28.6 a	51.8 ab
4	Band	Yes	Full Rate	RUP	Conv.	29.7 ab	26.5 b-f	29.8 de	27.3 a	51.8 ab
5	Band	Yes	Full Rate	RUP	RUP	26.1 cde	27.7 b-e	38.8 a-e	28.6 a	54.9 ab
6	Band	Yes	Full Rate	RUP	RUP	26.2 b-e	28.3 abc	41.1 a-d	27.6 a	58.3 a
7	Band	No	Full Rate	RUP	RUP	29.2 abc	28.5 abc	41.5 abc	25.7 a	51.0 ab
8	Band	No	Half Rate	RUP	RUP	26.4 b-e	28.0 a-d	41.9 ab	28.5 a	52.1 ab
9	Band	No	No	RUP	RUP	29.0 a-d	27.2 b-e	41.3 a-d	27.2 a	47.2 ab
10	Dirt	No	Full Rate	RUP	Conv.	27.3 b-e	27.0 b-f	40.1 a-e	27.6 a	44.4 b
11	Dirt	Yes	Full Rate	RUP	No	28.6 a-e	26.4 c-f	45.0 a	28.9 a	56.4 a
12	Dirt	Yes	Full Rate	RUP	RUP	28.0 a-e	28.6 abc	42.6 ab	27.2 a	52.6 ab
13	Dirt	No	Full Rate	RUP	RUP	27.2 b-e	25.2 ef	38.9 a-e	28.5 a	52.9 ab
14	Dirt	No	Half Rate	RUP	RUP	26.8 b-e	28.6 abc	39.6 a-e	27.7 a	49.8 ab
15	Dirt	No	No	RUP	RUP	28.5 a-e	30.6 a	40.4 a-d	25.5 a	54.9 ab
16	Dirt	No	No	Conv. RUP	No	25.6 de	26.0 c-f	28.6 e	27.5 a	48.0 ab
17	Band	No	Full Rate	RUP	RUP	25.3 e	28.1 a-d	33.0 b-e	28.5 a	48.0 ab
18	Band	No	No	RUP	RUP	27.0 b-e	28.1 a-d	35.2 a-e	29.6 a	53.6 ab
19	Dirt	No	Full Rate	RUP	RUP	27.5 b-e	29.2 ab	40.8 a-d	27.6 a	49.8 ab
20	Dirt	No	No	RUP	RUP	27.0 b-e	25.5 def	37.4 a-e	27.8 a	54.6 ab

[1]Refer to Table 1 for herbicide and rate and Tables 2-3 for date(s) of application. RUP = Roundup UltraMax, Conv. = Cotoran + MSMA followed by Cy-Pro + MSMA.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

Weed Counts

Weed numbers on the row in June of 1998, 2000, and 2002 were variable and inconsistent. In 1998, high weed numbers were counted in Treatment 8 (Cotoran + Staple PRE), Treatment 9 (Roundup POT), and Treatment 18 (Roundup POT). In 2000, high numbers were counted with Treatment 16 (Staple + Assure POT), Treatment 2 (Cotoran + Staple PRE), and Treatment 15 (Roundup POT). In 2002, weed numbers were high with Treatment 10 (Cotoran + Staple PRE and Cotoran + MSMA PDR), Treatment 14 (Cotoran + Staple half-rate PRE and Roundup POT 2X), and Treatment 9 (Roundup POT).

Cotton Stand

Cotton stand was low and not considered high enough for optimum yield in 1998, 1999, and 2001 (Table 8). However, high yields were obtained in 1999 (Table 9). There were no consistent differences due to treatment effects on cotton stand over the 5 years of the study.

Cotton Yield

Seed cotton yields are presented in Table 9. Yields were low in 1998 and 2000. In 1998, low yields were harvested from Treatment 5 (Treflan PPI, Cotoran + Staple PRE, Roundup POT) and Treatment 14 (Cotoran + Staple PRE). Treatment 14 had lower late-season control (Table 6), indicating a negative effect on yield. Treatment 5 had excellent late-season weed control, but Roundup applied OT at 1.0 lb ai/A on June 16 is thought to have reduced yield. This was also true with this treatment when Roundup POT was applied June 26, 2000, and June 14 and July 8, 2002. The very low yield with Treatment 16 (Staple + Assure POT 3X) in 2000 was due to poor weed control as were the low yields with Treatment 10 (Cotoran + Staple PRE, Cotoran + MSMA PDR, Cy-Pro + MSMA PDR) and Treatment 11 (Treflan PPI, Cotoran + Staple PRE).

Highest yield in 2001 was 3,103 lb/A with Treatment 2 (Cotoran + Staple PRE, Roundup POT and PDR). In 2002, highest yields were obtained with Treatment 6 (Treflan PPI, Cotoran + Staple PRE, Roundup PDR) (3,343 lb/A), Treatment 9 (Roundup POT and PDR 2X) (3,285 lb/A), and Treatment 2 (Cotoran + Staple PRE, Roundup POT and PDR) (3,289 lb/A).

When averaged over 5 years, seed cotton yields were 2,402 lb/A for treatments using band cultivation (4-9, 17, 18) and 2,325 lb/A for treatments using rolling tine cultivation (10-16, 19, 20). The no-till treatments (1-3) averaged 2,605 lb/A. Treatments with PPI and/or full-rate PRE (2, 4-7, 10-13, 17, 19) averaged 2,445 lb/A, the half-rate PRE treatments (3, 8, 14) averaged 2,545 lb/A, and treatments with POT and/or PDR (1, 9, 15, 18, 20) averaged 2,418 lb/A over 5 years.

Table 9. Cotton yield with an experiment for annual weed control with cultivation and band-applied herbicides in Roundup Ready cotton, 1998-2002.

Treatment	Cultivation	Herbicide application[1]				Seed cotton yield[2]				
		PPI	PRE	POT	PDR	1998	1999	2000	2001	2002
						lb/A	*lb/A*	*lb/A*	*lb/A*	*lb/A*
1	None	No	No	RUP	RUP	1904 abc	3036 ab	1864 a-d	2378 d-g	3110 ab
2	None	No	Full Rate	RUP	RUP	2015 abc	3035 ab	1746 b-e	3103 a	3289 a
3	None	No	Half Rate	RUP	RUP	2138 ab	3019 ab	2278 a	2946 ab	3217 ab
4	Band	Yes	Full Rate	RUP	Conv.	1797 bc	2789 abc	1855 a-e	2239 efg	2192 c
5	Band	Yes	Full Rate	RUP	RUP	1390 d	2929 abc	1405 de	2412 c-g	1596 d
6	Band	Yes	Full Rate	RUP	RUP	1940 abc	2879 abc	2092 ab	2868 a-d	3343 a
7	Band	No	Full Rate	RUP	RUP	1980 abc	3109 a	1889 ab	2572 b-f	2954 ab
8	Band	No	Half Rate	RUP	RUP	2073 abc	2819 abc	2186 ab	2886 abc	2913 ab
9	Band	No	No	RUP	RUP	2033 abc	3013 ab	2210 ab	2165 fg	3285 a
10	Dirt	No	Full Rate	RUP	Conv.	1965 abc	2629 abc	1389 e	2031 g	1788 cd
11	Dirt	Yes	Full Rate	RUP	No	1880 abc	2101 d	1418 cde	2217 fg	2731 b
12	Dirt	Yes	Full Rate	RUP	RUP	2049 abc	2843 abc	1792 b-e	2866 a-d	3169 ab
13	Dirt	No	Full Rate	RUP	RUP	2082 abc	3118 a	1801 a-e	2737 a-e	3284 a
14	Dirt	No	Half Rate	RUP	RUP	1713 c	2515 bcd	1904 ab	2664 a-f	2898 ab
15	Dirt	No	No	RUP	RUP	1847 bc	2627 abc	1798 a-e	2157 fg	2832 ab
16	Dirt	No	No	Conv. RUP	No	2067 abc	2485 cd	849 f	2364 efg	3027 ab
17	Band	No	Full Rate	RUP	RUP	1866 abc	3056 a	1945 ab	2480 b-g	3060 ab
18	Band	No	No	RUP	RUP	1939 abc	2768 abc	1965 ab	2419 c-g	2771 b
19	Dirt	No	Full Rate	RUP	RUP	1960 abc	2863 abc	1797 a-e	2225 fg	2984 ab
20	Dirt	No	No	RUP	RUP	2232 a	2977 abc	1878 abc	2340 efg	2914 ab

[1]Refer to Table 1 for herbicide and rate and Tables 2-3 for date(s) of application. RUP = Roundup UltraMax, Conv. = Cotoran + MSMA followed by Cy-Pro + MSMA.
[2]Means within the same column with the same letter are not different using a significance level of 0.05 according to DMRT.

CONCLUSIONS

Band-applied PPI and/or PRE followed by Roundup POT and PDR in conjunction with either conventional or rolling-tine cultivation was effective for controlling annual weeds and producing high cotton yields. With heavy annual grass pressure, there was a 5% average advantage in late-season control with Treflan PPI over full-rate or half-rate Cotoran + Staple PRE. Delay of the first cultivation event resulted in poor weed control between the rows with both cultivation types but was less effective with the rolling tine unit especially when weeds were large.

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