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Ivyleaf Morningglory Control with Roundup in Roundup Ready Cotton

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INTRODUCTION

Morningglory plants compete with cotton for light, water, and nutrients, and they greatly interfere with harvest operations when left partially or totally uncontrolled. Cotton farmers in Mississippi consider morningglory to be one of the most troublesome weeds to control. Morningglory is considered to be more difficult to control with Roundup® than many other weeds. The objective of this study was to compare ivyleaf morningglory control and cotton response from over-the-top and postemergence directed applications of Roundup.

MATERIALS AND METHODS

An experiment on the control of ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.] with Roundup® in Roundup Ready® cotton was conducted with limited tillage (Table 1) during 2000-2002 at the Delta Research and Extension Center at Stoneville, Mississippi. Treatments are listed in Table 2 and were arranged in a randomized complete block design with four replications. Individual plots were four 40-foot rows, spaced 40 inches apart. Treatments were applied to the same area each year. The soil type was silt loam (34% sand, 50% silt, 16% clay) with a pH of 6.2 and 0.97 percent organic matter. No supplemental irrigation was used. All treatments received the same soil fertility as well as disease and insect control practices. Deltapine DP 451 B/R was the variety used with planting dates of May 9, 2000; April 30, 2001; and April 24, 2002.

Roundup, Touchdown®, Fusilade DX®, and Select® were applied in a broadcast volume of 10 gallons per acre. Fusilade DX (2000) and Select (2002) were used to control late-season annual grass weeds, primarily browntop millet [*Brachiaria ramose* (L.) Stapf]. Other herbicides were applied in 20 gallons total volume per acre. Preemergence (PRE) and over-the-top (OT) herbicide applications were

Table 1. "Burn-down" herbicide and tillage used for an experiment for ivyleaf morningglory control with Roundup in Roundup Ready cotton, 2000-2002.

	2000	2001	2002
"Burn-down" Herbicides			
Roundup 1.0 lb ai/A	5/8	–	2/28
Touchdown 1.0 lb ai/A	–	4/6	4/30
Tillage Practice			
Subsoil	10/29/99	10/11/00	10/30/01
Hip	3/3	2/6	2/18 (Trt. 1), 3/6
Bed Conditioner	3/7	2/6	2/18 (Trt. 1), 3/8
Cultivate (12-inch undisturbed band on row)	5/16, 5/29 (Trt. 1)	5/30 (Trt. 1)	–

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made with a four-row, tractor-mounted boom sprayer. Postemergence directed (PODIR) and lay-by herbicides were applied with an "S and N" sprayer. This device directs the spray to the lower portion of the cotton plants under fenders positioned on each side of the row. A nozzle is located between rows which can be turned on to complete broadcast coverage.

Ivyleaf morningglory control was monitored on several dates during the season by counting the number of plants from a previously marked area. In 2000, plants were identified either as newly emerged or "old" prior to July 6. After July 6, 2000, and on all count dates in 2001 and 2002, plants were separated into three categories: (1) plants newly emerged, (2) injured plants without regrowth, and (3) noninjured/injured plants with regrowth. A visual ivyleaf morningglory control estimate of 0 = no control and 100 = complete control was made in late July each year.

The number of cotton plants from one harvest row was determined each year. The two center rows of each plot were harvested with a two-row mechanical plot picker for seed cotton yield.

All data were subjected to an analysis of variance. Means were separated using Duncan's Multiple Range Test and a significance level of 0.05.

Table 2. Treatments for an experiment for ivyleaf morningglory control with Roundup in Roundup Ready cotton, 2000-2002.

Treatment	Rate (lb ai/A)	Method	Application date[1] 2000	2001	2002
1	Treflan 4E 0.75	PPI	–	–	3/5
	Cotoran 4L 1.25 + Cy-Pro 4L 0.5	PRE[2]	5/9	–	4/24
	Cotoran 4L 1.25 + Dual 8E 1.0 + Gramoxone Extra 2.5E 0.65	PRE[2]	–	5/1	–
	Meturon 4L 1.0 + MSMA 6 1.5	PODIR	5/29[2]	5/30[2]	5/30
	Cy-Pro 4L 0.8 + MSMA 6 1.5	PODIR	–	–	6/12
	Fusilade DX 2E 0.19 + Agri-Dex 1% v/v	OT	7/7	–	–
	Select 2E 0.25 + Agri-Dex 1% v/v	OT	–	–	7/22
	Roundup Ultra 0.75 + Harvade 5F 0.38	Lay-by	–	6/20	–
	Direx 1.0 + surfactant 0.5% v/v	Lay-by	–	–	6/24
2	Roundup Ultra 0.5	OT	6/9, 6/23, 7/7	5/21, 6/5, 6/20	5/23, 6/6, 6/20
3	Roundup Ultra 1.0	OT	6/23	6/5	6/6
4	Roundup Ultra 0.5	OT	6/1, 6/16, 6/30	5/14, 5/29, 6/12	5/15, 5/30, 6/13
5	Roundup Ultra 1.0	OT	6/16	5/29	5/30
6	Roundup Ultra 0.5	PODIR	6/12, 6/23, 7/7	5/21, 6/5, 6/20	5/23, 6/6, 6/20
7	Roundup Ultra 1.0	PODIR	6/23	6/5	6/6
8	Roundup Ultra 0.5	PODIR	6/1, 6/16, 6/30	5/14, 5/29, 6/12	5/15, 5/30, 6/13
9	Roundup Ultra 1.0	PODIR	6/16	5/29	5/30
10	Roundup Ultra 0.25	OT	6/1, 6/9, 6/16, 6/23, 6/30, 7/7	5/14, 5/21, 5/29, 6/5, 6/12, 6/20	5/15, 5/23, 5/30 6/6, 6/13, 6/20

[1]Applied Roundup Ultra broadcast at 0.5 lb ai/A to Treatments 2-10 on 3-leaf cotton 5/29/00 and on 1-leaf cotton 5/10/01, 5/8/02.
[2]Applied to 20-inch band on row, all other applications applied broadcast.

Results and Discussion

Morningglory

Newly emerged morningglory plants – On June 8, 2000, plant counts ranged from 7.5 to 59.5 plants per 67-square-foot area (Table 3). The average reduction in morningglory plants from each previous count date was 66% for June 23, 69% for July 6, and 58% for July 21. The only treatment that had soil residual activity with the herbicides applied was Treatment 1 (Cotoran® + Cy-Pro® PRE on May 9 followed with Meturon® + MSMA6 Plus® PODIR on May 29). The respective reductions for Treatment 1 were 79, 100% on June 23, July 6, and an increase on July 21. It does not appear that any treatment affected the emergence of morningglory plants in 2000. In 2001, the June 5 count ranged from 1.0 to 8.3 morningglory plants per 67-square-foot area (Table 3). By June 19, the average count was reduced 32%. On July 3, morningglory emergence increased with greater numbers than were recorded on June 5. Average numbers were reduced 91% with the count on July 25, ranging from 0 to 1.3 plants per 67-square-foot area. The initial count in 2002 on May 29 resulted in very low newly emerged morningglory plants ranging from 0 (for most treatments) to 1.5 plants per 67-square-foot area. Subsequent counts on June 12 and 26 resulted in higher counts for most treatments followed by no plants identified as being newly emerged on July 3, 12, 18, and 29 (data not shown). The late-season low emergence of ivyleaf morningglory in this study was probably influenced by environmental conditions (rainfall, temperature) rather than by any of the treatments employed.

Ivyleaf morningglory plants without regrowth – Plants in this category were stunted, 2-3 inches in height, with no visible new growth at the plant terminal. The count on June 8, 2000, resulted in no differences between treatments (Table 4). Counts on June 23 resulted in higher numbers with Treatments 3 and 7. These treatments had only the early three-leaf cotton application of Roundup (May 29) made prior to this date. Treatments 8 and 9 were intermediate in count numbers, both having subsequent PODIR Roundup applications [Treatment 8 – 0.5 lb ai/A on June 1 and 16 and Treatment 9 – 1.0 lb ai/A on June 16 (Table 2)]. All other treatments had the lowest count numbers, all different from treatments discussed above. The July 6 count

Table 3. Ivyleaf morningglory plant counts from sequentially applied Roundup OT vs. PODIR, 2000-2002.

Treatment	Newly emerged ivyleaf morningglory plants (plants per 67 square feet)[1,2]												
	6/8/00	6/5/01	5/29/02	6/23/00	6/19/01	6/12/02	7/6/00	7/3/01	6/26/02	7/21/00	7/25/01	8/9/00	8/20/01
1	26.3 bc	3.5 ab	0.0 b	5.5 ab	9.0 a	8.5 b	0.0 a	8.5 b	1.5 b	1.3 a	1.3 a	1.0 a	0.0 a
2	26.0 bc	2.5 b	0.0 b	5.8 ab	1.0 b	0.5 b	4.8 a	6.5 b	4.0 b	0.5 a	1.0 a	0.5 a	0.0 a
3	59.5 a	3.3 ab	0.0 b	7.0 ab	2.3 b	18.0 b	0.3 a	14.8 ab	7.5 b	0.3 a	0.3 a	0.0 a	0.0 a
4	11.3 c	3.8 ab	0.0 b	7.0 ab	0.3 b	2.0 b	1.3 a	6.3 b	2.0 b	0.3 a	0.8 a	0.5 a	0.3 a
5	16.3 c	1.0 b	0.0 b	10.8 ab	1.5 b	2.5 b	0.8 a	5.3 b	0.5 b	1.0 a	0.8 a	0.0 a	0.0 a
6	11.3 c	1.8 b	0.0 b	3.5 b	0.0 b	2.0 b	1.8 a	3.0 b	0.0 b	0.5 a	0.0 a	0.5 a	0.0 a
7	51.5 ab	2.5 b	1.5 a	5.0 ab	2.5 b	67.5 a	2.0 a	11.0 ab	24.0 a	0.0 a	0.0 a	0.0 a	0.0 a
8	35.5 abc	8.3 a	0.5 b	9.3 ab	0.5 b	3.5 b	0.0 a	22.3 a	3.0 b	0.0 a	0.8 a	2.0 a	0.0 a
9	51.8 ab	4.3 ab	0.0 b	15.0 a	2.0 b	21.5 b	2.8 a	10.5 ab	6.5 b	0.0 a	1.0 a	2.3 a	0.0 a
10	7.5 c	4.8 ab	0.0 b	4.3 ab	0.0 b	2.0 b	3.8 a	10.3 ab	2.5 b	0.5 a	1.3 a	0.3 a	0.3 a

[1]Numbers within a column with the same letter are not different using a significance level of .05 according to Duncan's Multiple Range Test.
[2]None on 7/3, 7/12, 7/18, 7/29/02.

resulted in the highest morningglory number with Treatment 9, a PODIR application of Roundup at 1.0 lb ai/A made on June 16. This treatment was different from all other treatments except Treatment 8, a PODIR application of Roundup at 0.5 lb ai/A made three times on June 1, 16, and 30. The lowest count numbers were obtained with Treatments 2 and 10, both OT treatments. The morningglory count numbers on July 21 were low and not different between treatments. The July 28 count numbers were also low and inconsistent between treatments.

In 2001, morningglory plants without regrowth on June 5 (Table 4) were low with Treatments 3 and 7, both without subsequent Roundup applied after the early 0.5 lb ai/A application to one-leaf cotton on May 10. This is probably the result that plants in these treatments grew out of the initial injury and were recorded as plants with regrowth (Table 5). Count numbers with the no-Roundup and other Roundup treatments were not different on June 5. Count numbers on June 19 were not different between treatments but were generally similar or higher than on June 5. On July 3, count numbers with treatments 5, 7, and 9 were less than with Treatments 1 and 2. Plants from Treatments 7 and 9 with regrowth (Table 5) on July 3 were higher, which accounted for the lower count numbers without regrowth. Morningglory count numbers without regrowth on July 25 were low and were not different between treatments.

In 2002, morningglory plant count numbers without regrowth were not different between treatments on May 29 and June 12 (Table 4). Also, plant counts on June 19 and 26 and July 3 and 12 did not result in any plants being identified without regrowth (data not shown). With the exception of Treatments 3 and 7, count numbers of plants with regrowth (Table 5) were also low on these dates indicating excellent morningglory control. July 18 and 29 counts for morningglory numbers without regrowth were not different between treatments except Treatment 7 was higher than other treatments (Table 4).

Ivyleaf morningglory plants with regrowth – In 2000, morningglory plants with regrowth on July 14 were higher with Treatment 9 (Table 5). This treatment had Roundup at 1.0 lb ai/A applied PODIR on June 16. A large number of plants without regrowth were recorded with this treatment on July 6 (Table 4), so with no Roundup applied after June 16 many of these plants produced regrowth by July 14. Morningglory count numbers with regrowth on July 14 for other treatments were not different. The no-Roundup control (Treatment 1) was highest for the plant count with regrowth on July 28 and was higher than all other treat-

Table 4. Ivyleaf morningglory plant counts from sequentially applied Roundup OT vs. PODIR, 2000-2002.

Treatment	Ivyleaf morningglory plants without regrowth (plants per 67 square feet)[1,2]												
	6/8/00	6/5/01	5/29/02	6/23/00	6/19/01	6/12/02	7/6/00	7/3/01	7/21/00	7/25/01	7/18/02	7/28/00	7/29/02
1	9.3 a	4.5 abc	1.0 a	27.0 c	4.8 a	0.0 a	22.0 cd	5.5 a	1.0 a	0.0 a	0.0 b	0.0 b	0.0 b
2	9.8 a	3.5 abc	0.0 a	8.0 c	6.0 a	0.0 a	7.0 d	5.5 a	0.5 a	2.0 a	4.5 b	0.3 ab	2.5 b
3	17.5 a	1.3 bc	0.5 a	86.5 a	6.5 a	0.5a	34.3 bc	1.8 ab	1.5 a	0.5 a	6.5 b	1.5 ab	2.5 b
4	15.0 a	3.8 abc	0.0 a	30.3 c	2.3 a	0.0 a	25.8 cd	2.5 ab	1.8 a	1.3 a	5.5 b	1.3 ab	1.0 b
5	13.0 a	5.0 abc	2.5 a	16.5 c	3.8 a	0.0 a	28.0 cd	1.0 b	2.8 a	0.0 a	4.0 b	1.3 ab	2.5 b
6	12.8 a	2.0 abc	0.5 a	13.0 c	4.3 a	0.0 a	13.3 cd	1.8 ab	0.5 a	0.5 a	0.0 b	0.0 b	0.0 b
7	21.8 a	0.3 c	1.5 a	86.0 a	5.8 a	0.5 a	33.3 bc	1.0 b	3.0 a	0.0 a	35.0 a	1.0 ab	8.0 a
8	27.5 a	6.8 ab	0.0 a	54.3 b	7.3 a	0.0 a	51.5 ab	4.8 ab	2.8 a	0.0 a	9.0 b	2.3 ab	3.0 b
9	22.0 a	7.8 a	0.0 a	56.5 b	7.0 a	0.0 a	55.5 a	1.0 b	5.3 a	0.0 a	6.0 b	3.0 a	2.5 b
10	15.0 a	3.5 abc	0.0 a	14.0 c	2.8 a	0.0 a	8.5 d	2.5 ab	0.0 a	1.8 a	5.0 b	0.0 b	1.0 b

[1]Numbers within a column with the same letter are not different using a significance level of .05 according to Duncan's Multiple Range Test.
[2]None on 6/19, 6/26, 7/3, 7/12/02.

Table 5. Ivyleaf morningglory plant counts from sequentially applied Roundup OT vs. PODIR, 2000-2002.

Treatment	Ivyleaf morningglory plants with regrowth (plants per 67 square feet)[1]										
	6/5/01	5/29/02	6/19/01	6/12/02	7/14/00	7/3/01	6/26/02	7/28/00	7/25/01	7/12/02	8/20/01
1	23.8 ab	3.0 b	42.0 a	0.0 b	13.0 b	7.0 bc	0.0 c	29.3 a	55.0 ab	0.0 e	30.3 bc
2	14.3 bc	0.0 b	9.0 b	0.5 b	0.8 b	1.8 d	1.0 c	0.0 c	8.3 d	7.5 b-e	2.0 c
3	29.0 a	4.0 b	10.5 b	3.5 a	9.5 b	10.3 ab	15.0 b	10.0 bc	37.8 bc	19.0 b	70.0 bc
4	1.5 d	0.0 b	1.5 b	0.0 b	2.0 b	1.3 d	0.0 c	3.8 bc	10.0 b	3.0 de	0.8 c
5	3.3 cd	0.5 b	4.3 b	0.5 b	11.3 b	3.3 cd	3.0 c	9.0 bc	24.0 cd	2.0 de	33.5 bc
6	10.8 cd	0.0 b	7.8 b	0.0 b	0.3 b	2.8 d	1.0 c	0.8 c	9.3 d	2.0 de	2.0 c
7	27.0 a	8.5 a	17.3 b	4.5 a	4.0 b	13.5 a	30.5 a	8.3 bc	71.8 a	33.5 a	199.8 a
8	4.3 cd	0.0 b	2.0 b	0.0 b	1.8 b	0.3 d	2.5 c	6.0 bc	9.0 d	14.5 bcd	4.0 c
9	5.5 cd	3.0 b	9.3 b	1.5 b	34.8 a	8.8 b	3.5 c	17.0 b	43.5 bc	17.0 bc	102.5 b
10	5.0 cd	0.0 b	2.8 b	0.0 b	0.0 b	1.0 d	0.5 c	2.8 c	5.5 d	5.5 cde	1.5 c

[1]Numbers within a column with the same letter are not different using a significance level of .05 according to Duncan's Multiple Range Test.

ments. Treatments 2, 6, and 10 were lowest in plant count numbers. They were not different from other treatments except Treatments 1 and 9.

In 2001, Treatments 3 and 7 were highest for morningglory plants with regrowth on June 5 (Table 5). They were higher than other treatments except the no-Roundup control. On June 19, the no-Roundup control was higher for morningglory plants with regrowth than all other treatments. Treatments 2-10 were not different. The July 3 count numbers were lowest with Treatments 2, 4, 6, 8, and 10 but were not different from Treatment 5. Though overall count numbers were higher, these same treatments were lowest on July 25 and on August 20. All these treatments were treated multiple times either OT or PODIR with Roundup.

In 2002, morningglory plants with regrowth were highest with Treatment 7 on May 29 and with Treatments 3 and 7 on June 12 (Table 5). Other treatments were not different. On June 26, Treatment 7 was highest for morningglory plants with regrowth and was different from Treatment 3, which was different from the other treatments. On July 12, Treatment 7 morningglory plants with regrowth remained the highest and was different from other treatments.

Visual estimate of morningglory control – Treatments 2, 3, 4, 6, 8, and 10 provided excellent morningglory control on July 28, 2000 (Table 6). When compared with the no-Roundup control treatment, all other treatments provided better morningglory control. Morningglory control on July 18, 2001, was excellent (95% or greater) with Treatments 2, 4, and 10 and good (80–85%) with Treatments 5, 6, and 8. Treatments 3 (64%), 7 (28%), and 9 (41%) provided poor control. This reflects the higher number of morningglory plants that had regrowth (Table 5). In 2002, the no-Roundup control provided excellent control of morningglory on July 26. This resulted from the added herbicides in 2002. These were Treflan® PPI, the second PODIR application with Cy-Pro + MSMA on June 12, and lay-by with Direx® on June 24, which was activated with 1.69 inches of rainfall June 28. Less than adequate control was obtained with Treatments 3, 7, and 9.

Table 6. Estimated late-season ivyleaf morningglory control from sequentially applied Roundup OT vs. PODIR, 2000-2002.

Treatment	Ivyleaf morningglory control (%)[1,2]		
	7/28/00	7/18/01	7/26/02
1	54 d	56 bc	95 a
2	100 a	96 a	97 a
3	96 a	64 bc	75 b
4	100 a	96 a	97 a
5	84 b	80 ab	96 a
6	100 a	85 ab	97 a
7	79 bc	28 d	59 c
8	98 a	85 ab	81 b
9	71 c	41 cd	78 b
10	100 a	95 a	97 a

[1]Numbers within a column with the same letter are not different using a significance level of .05 according to Duncan's Multiple Range Test.
[2]Based on 0 = no control, 100 = complete control.

Table 7. Cotton response to treatments for ivyleaf morningglory control with sequentially applied Roundup OT vs. PODIR, 2000-2002.[1]

Treatment	Cotton plants per acre (thousands)			Seed cotton yield (lb/A)		
	2000	2001	2002	2000	2001	2002
1	24.7 abc	37.8 ab	38.1 a	1390 d	2139 de	4044 ab
2	24.8 abc	37.5 b	37.6 a	1809 c	3054 ab	3659 bc
3	26.8 ab	39.8 ab	39.2 a	2041 abc	2556 bcd	3877 abc
4	28.1 ab	42.1 ab	34.8 a	2260 ab	2806 abc	4090 ab
5	29.6 a	42.3 ab	35.9 a	2231 ab	2481 cd	3639 bc
6	30.2 a	43.5 a	34.3 a	2191 abc	2932 abc	4278 a
7	26.0 abc	39.3 ab	35.6 a	2212 abc	1686 ef	3764 abc
8	23.0 bc	37.5 b	35.8 a	2452 a	2962 abc	4025 ab
9	20.6 c	37.2 b	37.4 a	1899 bc	1473 f	3317 c
10	27.6 ab	42.3 ab	37.4 a	2138 abc	3198 a	4260 a

[1]Numbers within a column with the same letter are not different using a significance level of .05 according to Duncan's Multiple Range Test.

Cotton

Cotton stand – In 2000, less than optimum cotton stands were obtained with all treatments (Table 7). In 2001 and 2002, stands were adequate for optimum yield with no difference between treatments in 2002.

Cotton yield – In 2000, the greatest yield was obtained with Treatment 8 (Table 7). Treatment 8 was not different in yield from other treatments except Treatments 1, 2, and 9. The low yield for Treatment 9 was probably the result of the very low stand and less than adequate morningglory control (Table 6). Lowest yield was obtained with the no-Roundup control (Treatment 1). Morningglory control with this treatment was poor. The low yield with Treatment 2 cannot be explained.

Lowest yield in 2001 (Table 7) resulted from poor morningglory control with Treatment 9. This was not different from Treatment 7. Both treatments had one PODIR Roundup application at 1.0 lb ai/A on May 29 or June 5 (Table 2). The number of ivyleaf morningglory plants with regrowth was high with these treatments on July 25 and August 20, indicating poor control. Higher yields were obtained in 2001 from treatments with multiple OT or PODIR applications of Roundup. The no-Roundup control (Treatment 1) yield was lower than the multiple Roundup application treatments.

In 2002, all treatments provided high yields, due to excellent environmental conditions during the growing season and timely harvest before the onset of late-season rainfall. In 2002, highest yields were obtained with treatments providing good morningglory control. The highest yields occurred with multiple-application Roundup treatments and the no-Roundup control. The high yield with the no-Roundup treatment resulted from the morningglory control with the added PODIR and lay-by applications made in 2002.

CONCLUSIONS

- Multiple low-rate Roundup applications were equal to or more effective for ivyleaf morningglory control than single applications of the higher rate of Roundup.
- The number of newly emerged ivyleaf morningglory plants was considerably lower after July 6, 2000, and July 3, 2002, but did not drop until the July 25 date in 2001.
- Seed cotton yield was higher with multiple OT or PODIR Roundup treatments at 0.25 or 0.5 lb ai/A than single treatments at 1.0 lb ai/A.

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