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# Lay-By Herbicides for Weed Control in Roundup Ready Cotton

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## INTRODUCTION

Cotton farmers have used lay-by herbicides for many years. These herbicides are used primarily for residual weed control after cotton plants have grown too large to cultivate without mechanical damage. Contact activity to control existing weeds is also a desirable trait for this type of application. The application is made during or shortly after the last cultivation with conventional tillage or at a similar time with conservation tillage.

With glyphosate-tolerant cotton (Roundup Ready®), it is generally thought that residual lay-by herbicides are more critical as many producers either eliminate or reduce the rates of at-planting preemergence residual herbicides. After a period of years, the non-use or reduced-rate use of residual preemergence herbicides may allow additional mid- to late-season weeds to increase to a level that will interfere with harvest operations provided adequate control is not obtained at lay-by. This would most likely be true with difficult-to-control weeds such as hemp sesbania [*Sesbania exaltata* (Raf.) Rydb. ex. A. W. Hill] or morningglory.

The objective of this study was to compare several herbicides alone and in combination when applied at lay-by for control of a naturally occurring mixed population of ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.], nodding spurge (*Euphorbia nutans* Laq.), and browntop millet [*Brachiaria ramosa* (L.) Stapf]. A few very scattered plants of smooth pigweed (*Amaranthus hybridus* L.), spurred anoda [*Anoda cristada* (L.) Schlecht.], and honeyvine milkweed [*Ampelamus albidus* (Nutt.) Britt.] were also present in the test area but not at a level expected to influence yield.

## MATERIALS AND METHODS

The experiment was conducted from 1998 to 2001 on a silt loam soil (sand 16%, silt 61%, clay 23%, pH 5.8, organic matter 1.1%) without supplemental irrigation. A randomized complete block design with eight replications was used. The entire area was treated preemergence (PRE) with pendimethalin (Prowl®) at the rate of 1 pound of active ingredient per acre (lb ai/A) in combination with fluometuron (Cotoran®) at 1.25 lb ai/A. In addition, the entire area was treated over-the-top (OT) with Roundup Ultra® at 1 lb ai/A to three- to four-leaf cotton each year. The PRE application was broadcast in 1998 and on a 20-inch band centered on the row in 1999-2001. Roundup was applied broadcast in 1998 and 2000 and on a 20-inch band centered on the row in 1999 and 2001. "Burn-down" herbicides before planting and cultivation (two times in 1999 and once in 2001) after planting were used for early-season weed control. Roundup alone and in mixtures were applied in 10 gallons per acre broadcast volume with all applications while other herbicides were applied in 20 gallons per acre total volume. Individual lay-by treatments are listed in Table 2 and were applied to the same area each year. Individual plots were four 40-foot rows spaced 40 inches apart. All

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data were obtained from the two center rows of each plot. All data were submitted to an analysis of variance and treatment means were separated using Duncan's Multiple Range Test at P = .05. Lay-by herbicides were applied broadcast with an "S and N" applicator in a manner to provide maximum weed contact and minimum cotton foliar contact (Figure 1). Estimates of cotton and weed heights at the time of the lay-by herbicide applications were as follows. Cotton was 20-34 inches, very early bloom, in 1998; 17-22 inches in 1999; 6-12 inches, six to eight nodes, in 2000; and 8-15 inches, seven to nine nodes, in 2001. Ivyleaf morningglory plants ranged from 0.5-12 inches in 1998, 0.5-7 inches in 1999, 0.5-6 inches in 2000, and 0.5-9 inches in 2001. There were occasional plants with vines up to 20 inches each year. Nodding spurge plants ranged from 0.25 inch to 5-8 inches tall each year, and browntop millet plants ranged from 0.25 to 4-6 inches tall. An estimate of weed control whereby 0 = no control and 100 = complete control was made on individual weeds. The results for morningglory (2000, 2001) and the average control for morningglory, nodding spurge, and browntop millet (1998-2001) are presented in Table 5. In addition, weed plant counts were made from an area of 40 inches wide by 40 feet long for all weeds in 1998-2000 and for morningglory in 2001 (Table 4).

Cotton (Deltapine brand "DP 436RR," May 7, 1998; and "DP 458B/R," May 4, 1999, May 8, 2000, and April 27, 2001) was planted on a prepared seedbed in 1998 and on reduced tillage seedbeds in 1999-2001.

**Figure 1. S&N spray applicator.**

Cotton stand was determined by counting plants from one preselected row in each plot. An estimate of cotton injury (0 = no injury, 100 = complete kill) was made 5 to 14 days after lay-by application in 1998, 2000, and 2001. No injury occurred in 1999. Cotton canopy closure was estimated in July each year (0 = no closure between plants in adjacent rows, 100 = complete closure by foliage of plants in adjacent rows). This was made to obtain an estimate of any temporary delay in vegetative growth due to treatment. Seed cotton yield was determined each year by mechanical harvest of the two center rows of each plot. Plot yields were converted to pounds per acre and are presented in Table 8.

**Table 1. Tillage and herbicide application for an experiment on lay-by herbicides for weed control in Roundup Ready cotton, general to entire area, 1998-2001.**

| Operation | Date and broadcast rate (lb ai/acre) | | | |
|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 |
| Subsoil | Low-till 10/6/97 | Parabolic 10/9/98 | Parabolic 10/20/99 | Parabolic 10/10/00 |
| Hip | 10/16/97 | 3/1 | 3/3 | 2/6 |
| Bed Conditioner | 10/17/97; 5/4, 5/17 | 3/1 | 3/7 | 2/7 |
| "Burn-Down" | Roundup (glyphosate) 1.0 applied broadcast 4/24 | Roundup 1.0 applied broadcast 3/11<br>Gramoxone (paraquat) 0.94 applied broadcast 4/23<br>Gramoxone 0.625 applied 20-inch band 5/4 | Roundup 1.0 applied broadcast 2/9, 5/8 | Touchdown 5 (glyphosate) 1.0 + Surfactant 0.5% applied broadcast 4/6 |
| Preemergence | Prowl (pendimethelin) 1.0 + Cotoran (fluometuron) 1.25 applied broadcast 5/7 | Prowl 1.0 + Cotoran 1.25 applied 20-inch band 5/4 | Prowl 1.0 + Cotoran 1.25 applied 20-inch band 5/8 | Prowl 1.0 + Cotoran 1.25 applied 20-inch band 4/27 |
| Postemergence OT 3- to 4-lf cotton | Roundup 0.75 applied broadcast 6/2 | Roundup 1.0 applied 20-inch band 5/27 | Roundup 1.0 applied broadcast 5/23 | Roundup 1.0 applied 20-inch band 5/18 |
| Cultivation | None | 5/14, 6/10 | None | 5/11 |

**Table 2. Lay-by herbicide treatments for weed control in Roundup Ready cotton, 1998-2001.**

| Year(s) | Herbicide | Broadcast rate |
|---|---|---|
| | | *lb ai/A* |
| 1998-2001 | 1. None [1] | — |
| 1998-2001 | 2. Roundup Ultra [2] | 1.0 |
| 1998, 1999<br>2000, 2001 | 3. Bladex (cyanazine) 4L + Surfactant<br>Valor (flumioxazin) 50 WDG + Surfactant<br>followed by Select (clethodim) 2E + Agri-Dex OT 6/20/01 | 0.75 + 0.25%<br>0.094 + 0.25%<br>0.094 + 1.0% |
| 1998, 1999<br>2000<br>2001 | 4. Bladex 4L + Herbicide 912 (MSMA)<br>Valor 50 WDG + Harvade (dimethipin) 5F + Surfactant<br>Direx (diuron) 4L + Linex (linuron)4L + Surfactant | 0.75 + 1.0<br>0.031 + 0.235 + 0.25%<br>0.5 + 0.5 + 0.25% |
| 1998-2000<br>2001 | 5. Direx 4L + Surfactant<br>Roundup Ultra Max<br>OT 5/25, 6/4, 6/11, 6/18 | 0.75 + 0.25%<br>0.25 |
| 1998-2000<br>2001 | 6. Direx 4L + Herbicide 912<br>Direx 4L + MSMA 6 Plus (MSMA) | 0.75 + 1.0<br>1.0 + 1.0 |
| 1998, 1999<br>2000, 2001 | 7. Roundup Ultra + Bladex 4L<br>Roundup Ultra Max + Valor 50 DWG | 1.0 + 0.75<br>1.0 + 0.031 |
| 1998-2001 | 8. Roundup Ultra + Direx 4L | 1.0 + 0.75 |

[1]PO-DIR – 5/30/02 Meturon (fluometuron) 4L + MSMA 6 Plus 6E 1.0 + 2.0 lb ai/A (band).
6/12/02 Caparol (prometryn) 4L + MSMA 6 Plus 6# 0.5 + 1.5 lb ai/A (broadcast).
[2]Repeat with 0.75 lb 7/8/99 due to early wash-off with 0.41 inches of rainfall within 2 hours (total 2.15 inches within 68 hours).

**Table 3. Weekly rainfall for 30 days after application with an experiment on lay-by herbicides for weed control in Roundup Ready cotton, 1998-2001.**

| Weeks after treatment | Rainfall following lay-by at five application dates | | | | |
|---|---|---|---|---|---|
| | 6/25/98 | 6/23/99 | 7/8/99 [1] | 6/14/00 | 6/12/01 |
| | *in* | *in* | *in* | *in* | *in* |
| First week | 0.66 | 2.36 | 0.14 | 1.18 | 0.11 |
| Second week | 0.11 | 0.47 | 0.42 | 0.66 | 0.18 |
| Third week | 4.85 | 0.14 | 0.00 | 1.82 | 1.82 |
| Fourth week | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 |

[1]Due to early wash-off with 0.41 inches rainfall within 2 hours after 6/23 application (Roundup treatment 2 only).

# RESULTS AND DISCUSSION

## Weed Response

***Weed counts —*** In 1998, only Direx + Herbicide 912 (Treatment 6) and Roundup + Bladex (Treatment 7) reduced the weed numbers below that of the no lay-by control (Treatment 1). In 1999 and 2000, Roundup (Treatment 2), Roundup + Bladex (Treatment 7) (1999) or Roundup + Valor (Treatment 7) (2000), and Roundup + Direx (Treatment 8) reduced weed numbers below the control. In 2000, Valor + surfactant (Treatment 3) and Valor + Harvade + surfactant (Treatment 4) also reduced the number of weeds below the control. With morningglory in 2001, newly emerged plants (less than 3 inches) were reduced with all treatments except Roundup OT (Treatment 5) when compared with the control. The number of large morningglory plants (more than 3 inches) were reduced below the control count with Roundup + Valor (Treatment 7) and Roundup + Direx (Treatment 8).

***Weed visual control —*** Estimated control of all weeds was good to excellent with Roundup (Treatment 2) and with Roundup in combination with Direx (Treatment 8) (all years) and with Bladex (Treatment 7) (1998, 1999) or Valor (Treatment 7) (2000, 2001). The control with Roundup OT (Treatment 5) in 2001 was excellent also. Estimated control of morningglory in 2000 and 2001 resulted in excellent control with the above treatments after 4 weeks with numerically less control after 7 weeks with Roundup + Valor (Treatment 7) and Roundup + Direx (Treatment 8) in 2001.

**Table 4. Weed counts with an experiment on lay-by herbicides for weed control in Roundup Ready cotton, 1998-2001.[1]**

| Treatment | All weeds | | | | Morningglory (7/12/01) | |
|---|---|---|---|---|---|---|
| | 7/29/98 | 7/21/99 | 6/26/00 | 7/5/00[2] | <3" tall | >3" tall |
| Treatment 1 | 154.1 a | 146.8 ab | 161.4 a | 23.6 ab | 29.5 a | 18.5 a |
| Treatment 2 | 85.3 ab | 15.2 d | 31.9 c | 36.1 a | 9.5 b | 12.5 ab |
| Treatment 3 | 83.3 ab | 68.0 bcd | 36.7 c | 5.1 c | 3.5 b | 17.5 a |
| Treatment 4 | 112.8 ab | 76.8 bcd | 51.9 bc | 14.3 b | 10.3 b | 15.3 a |
| Treatment 5 | 118.5 ab | 173.2 a | 127.2 a | 17.0 b | 40.0 a | 23.5 a |
| Treatment 6 | 49.4 b | 116.2 abc | 99.2 a | 36.3 a | 11.5 b | 17.3 a |
| Treatment 7 | 57.3 b | 50.8 cd | 18.6 d | 19.1 b | 3.0 b | 2.3 b |
| Treatment 8 | 71.1 ab | 37.2 cd | 24.9 cd | 17.6 b | 8.3 b | 2.0 b |

[1]Plants per 133 square feet. Values in the same column with a common letter are not different (P=.05) according to DMRT.
[2]Newly emerged plants less than 3 inches tall.

**Table 5. Estimated weed control with an experiment on lay-by herbicides for weed control in Roundup Ready cotton, 1998-2001.[1]**

| Treatment | All weeds | | | | | Morningglory | | |
|---|---|---|---|---|---|---|---|---|
| | 7/27/98 | 7/21/99 | 7/24/00 | 7/16/01 | 8/1/01 | 7/24/00 | 7/16/01 | 8/6/01 |
| | % | % | % | % | % | % | % | % |
| Treatment 1 | 12 c | 14 d | 42 c | 74 b | 59 b | 16 d | 69 b | 48 b |
| Treatment 2 | 89 a | 100 a | 98 a | 99 a | 98 a | 99 a | 97 a | 95 a |
| Treatment 3 | 51 b | 62 c | 88 a | 75 b | 72 b | 87 bc | 63 b | 61 b |
| Treatment 4 | 72 ab | 64 c | 86 a | 71 b | 65 b | 81 c | 66 b | 58 b |
| Treatment 5 | 61 b | 58 c | 63 b | 99 a | 97 a | 76 c | 98 a | 96 a |
| Treatment 6 | 82 a | 54 c | 78 b | 71 b | 63 b | 77 c | 73 b | 64 b |
| Treatment 7 | 89 a | 89 b | 97 a | 97 a | 96 a | 96 ab | 94 a | 90 a |
| Treatment 8 | 89 a | 88 b | 98 a | 97 a | 95 a | 98 ab | 94 a | 85 a |

[1]Visual control. Values in the same column with a common letter are not different (P=.05) according to DMRT.

## Cotton Response

***Cotton stand*** — There were no treatment differences on the number of cotton plants in any year. Cotton stand ranged from 29,200 to 32,900 plants per acre in 1998; 32,700 to 36,400, 1999; 22,800 to 28,100, 2000; and 47,300 to 53,700, 2001.

***Cotton injury*** — An estimate of foliage injury resulted in insignificant values for the control (Treatment 1) and Roundup (Treatment 2) in all years. No injury was detected from any treatment in 1999. This was due to the large size of the cotton plants when they were treated. Injury was great in 2000 with Valor + surfactant (Treatment 3), Valor + Harvade + surfactant (Treatment 4), and Roundup + Valor (Treatment 7) when these treatments were applied to cotton plants 6 to 12 inches tall. Injury was considerably less in 2001 when the same treatments were applied to 8- to 15-inch-tall cotton plants. Direx + Linex + surfactant (Treatment 4) was the exception in 2001, resulting in 28% injury after 16 days. Stem injury was estimated in 2001 at 5 and 16 days after lay-by application. Injured stems at 16 days were darkened at the point of spray contact. The degree of injury only ranged to 8%, which is not considered to be significant.

***Canopy closure*** — The degree of plant canopy closure was not affected by any treatment in 1998 and 1999 when compared with the control. In 2000 and 2001, treatments that resulted in greatest foliar injury also had lower canopy closure values. However, these treatments were not lower than the control.

***Seed cotton yield*** — All treatments except Roundup (Treatment 2) and Bladex + Herbicide 912 (Treatment 4) had higher seed cotton yield than the control in 1998. Roundup (Treatment 2) was among the highest yielding treatments in 1999-2001. Bladex + surfactant (Treatment 3) and Roundup + Bladex (Treatment 7) in 1999 and Roundup + Valor (Treatment 7) in 2000 and 2001 were among the highest yielding treatments as was Roundup + Direx (Treatment 8) in 2000. Low yields were obtained with Valor + surfactant (Treatment 3) and Valor + Harvade + surfactant (Treatment 4) treatments in 2000. These treatments had high injury values at 5 days after treatment. High injury values were also obtained with Roundup + Valor (Treatment 7) after 5 days, but yields were not reduced. In 2001, Roundup (Treatment 2), Roundup OT (Treatment 5), and Roundup + Valor (Treatment 7) had higher yields than the control. The application of Valor should be made to larger cotton plants to avoid yield reduction.

**Table 6. Estimated cotton injury with an experiment on lay-by herbicides for weed control in Roundup Ready cotton, 1998-2001.[1]**

| Treatment | Foliage | | | | Stem | |
|---|---|---|---|---|---|---|
| | 7/7/98 | 6/19/00 | 6/19/01 | 6/28/01 | 6/19/01 | 6/28/01 |
| | % | % | % | % | % | % |
| Treatment 1 | 0 c | 1 d | 4 de | 3 c | 0 a | 2 c |
| Treatment 2 | 0 c | 2 d | 3 de | 0 d | 0 a | 0 d |
| Treatment 3 | 12 b | 44 a | 16 b | 4 bc | 0 a | 4 b |
| Treatment 4 | 18 a | 44 a | 29 a | 28 a | 1 a | 8 a |
| Treatment 5 | 16 ab | 9 bc | 0 e | 0 d | 0 a | 0 d |
| Treatment 6 | 13 ab | 4 cd | 8 cd | 5 bc | 0 a | 3 bc |
| Treatment 7 | 14 ab | 41 a | 22 ab | 6 b | 0 a | 3 bc |
| Treatment 8 | 19 a | 19 b | 13 bc | 7 b | 0 a | 2 bc |

[1]Values in the same column with a common letter are not different (P=.05) according to DMRT.

**Table 7. Estimated cotton canopy closure with an experiment on lay-by herbicides for weed control in Roundup Ready cotton, 1998-2001.[1]**

| Treatment | 7/29/98 | 7/29/99 | 7/28/00 | 7/3/01 |
|---|---|---|---|---|
| | % | % | % | % |
| Treatment 1 | 78 a | 94 ab | 73 bcd | 68 ab |
| Treatment 2 | 82 a | 93 b | 84 a | 70 ab |
| Treatment 3 | 75 a | 96 a | 64 cd | 67 ab |
| Treatment 4 | 75 a | 95 a | 63 d | 65 b |
| Treatment 5 | 74 a | 97 a | 76 bc | 70 ab |
| Treatment 6 | 78 a | 96 a | 83 ab | 71 a |
| Treatment 7 | 83 a | 95 a | 73 bcd | 69 ab |
| Treatment 8 | 80 a | 96 a | 80 ab | 71 a |

[1]Values in the same column with a common letter are not different (P=.05) according to DMRT.

**Table 8. Seed cotton yield with an experiment on lay-by herbicides for weed control in Roundup Ready cotton, 1998-2001.[1]**

| Treatment | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|
| | lb/A | lb/A | lb/A | lb/A |
| Treatment 1 | 1,807 c | 2,055 c | 835 d | 2,024 b |
| Treatment 2 | 2,250 bc | 2,535 a | 2,221 a | 2,507 a |
| Treatment 3 | 2,553 ab | 2,538 a | 1,619 bc | 1,986 b |
| Treatment 4 | 2,263 abc | 2,407 abc | 1,315 c | 1,952 b |
| Treatment 5 | 2,373 ab | 2,308 abc | 1,837 ab | 2,452 a |
| Treatment 6 | 2,664 ab | 2,129 bc | 1,807 ab | 2,258 ab |
| Treatment 7 | 2,780 a | 2,595 a | 1,940 a | 2,410 a |
| Treatment 8 | 2,546 ab | 2,504 ab | 2,064 a | 2,300 ab |

[1]Values in the same column with a common letter are not different (P=.05) according to DMRT.

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