RESPONSES OF COTTON IN 2000 TO STRESS ASSOCIATED WITH TREATMENT LEVELS OF INSECT CONTROL, IRRIGATION, AND GLYPHOSATE

J. L. Barrentine, N. P. Tugwell, D. M. Danforth, O. C. Sparks and M. R. McClelland
University of Arkansas
Fayetteville, AR
T. G. Teague
Univ. of Ark. Agri. Expt. Sta., Ark. State Univ.
Jonesboro, AR

Abstract

Cotton fruiting patterns were evaluated at Marianna, AR, after treatment with glyphosate applied up to maximum labeled rates and, in a separate study, under different irrigation and insect management regimes with labeled and off-label rates. Boll retention was reduced by glyphosate applied within the label at 1 and 2 lb ai/A at the 3- to 4-leaf cotton stage and by a total of 4 lb/A during the season, but cotton compensated for fruit loss, and yield was not reduced. Glyphosate applied 'off label' (over-the-top at 7- to 8-lf cotton): did not affect pre−flower square shed; increased shed of large bolls (> 9 days old), but not of small bolls (< 9 days old); resulted in delayed crop maturity as measured by higher NAWF (nodes above white flower), especially in plots with no early insect control; and reduced cotton yield, regardless of level of irrigation or insect control. Glyphosate applied early in the season evoked a crop response after first flower that could be detected with in-season monitoring using the COTMAN program.

Introduction

Glyphosate is labeled for over-the-top application to tolerant cotton cultivars through the four-leaf stage and must be applied post-directed after that. Total in-crop applications from cracking to layby should not exceed 4 lb ai/A. Glyphosate can reduce yield or delay maturity of glyphosate-tolerant cotton by affecting early-season fruit retention if applied over-the-top after the four-leaf stage of development (Jones and Snipes 1999; Baughman et al. 1999; Kalaher et al. 1997), although the ability of cotton to compensate for fruiting losses may mask effects of potential yield-reducing stresses (Matthews et al. 1997; Voth et al. 1997; Reynolds et al. 1999). Data on how cotton fruiting is affected by glyphosate throughout the season are needed so a high-yielding crop can be grown without having to rely on late-season compensation to achieve that yield.

Materials and Methods

Two experiments were conducted at Marianna, Arkansas, in 2000. In the glyphosate selectivity experiment, five treatments of glyphosate were applied, all within the label: 1 and 2 lb ai/A at the cotyledon (cot.) to 1-leaf (lf) stage and 3- to 4-lf stage and 1 lb/A at cot. to 1-lf followed by (fb) 3- to 4-lf fb 8-lf fb 13-lf (cot. to 1-lf and 3- to 4-lf treatments were applied over-the-top; 8- and 13-lf treatments were post-directed). An untreated check was included. Cotton (DP 451BR) was planted May 24 in 13- by 24-ft plots (four replications), and glyphosate was applied June 5 (cot. to 1-lf), June 19 (3- to 4-lf), June 28 (8-lf), and July 8 (13-lf) at 15 gal/A carrier volume.

The glyphosate/crop stress experiment was conducted as a split-split plot design with main plots of insect control (full-season and no control before first flower); subplots of irrigation (irrigated full-season and to first flower only); and sub-subplots of five glyphosate treatments (1, 2, and 4 lb ai/A overtop at 3- to 4-lf cotton; 2 lb/A overtop at 7- to 8-lf cotton; and untreated). Cultivar SG 125 BG/RR was planted May 10 in 25- by 40-ft plots (three replications). Insecticides (Leverage, Karate, or Baythroid) were applied June 23 through July 13 on full-season control plots only and July 19 through August 28 (after first flower) on all plots. All plots were irrigated July 8 (before first flower), and plots with full-season irrigation were irrigated July 19 through August 28.

Cotton stands, heights, and yields were recorded for each experiment. Cotton growth and development were monitored using COTMAN (COTton MANagement monitoring system) (Danforth and O'Leary 1998) for in-season nodal development. Cotmap (Bourland and Watson 1990) was used for final plant mapping to evaluate treatment effects on plant structure, fruiting pattern, and fruit retention. Data were analyzed by analysis of variance, and means were separated with LSD at 0.05.

Results

Glyphosate applied within the label in the glyphosate selectivity experiment did not reduce cotton yield, although boll retention at first position sympodia and early boll retention were reduced by 1 and 2 lb/A glyphosate applied at 3- to 4-leaf cotton (Table 1). Slight visual injury (<14%), expressed as "water soak" spots on leaves, was observed from glyphosate applied at 2 lb/A to cot. to 1-leaf cotton.

No immediate visual injury or pre-flower differences from glyphosate were evident in the crop stress experiment; however, differences in boll retention became apparent after first flower. Plants treated with off-label glyphosate (2 lb/A over-the-top at 7- to 8-leaf cotton) shed more large bolls (> 9 days old) than plants treated at the 2- to 3-leaf stage (Figure 1). The relative effect on boll shed of glyphosate rates and application times was more apparent with full-season insect control than with no early insect control (Table 2). The off-label glyphosate treatment was apparent regardless of level of insect control. Where shedding occurred on the first two positions of the lower five sympodia, a higher percentage of bolls was retained on the 3rd and outer positions. Higher levels of square (no early insecticide) plus boll shedding (glyphosate) were associated with later continued terminal growth (higher NAWF) (Figure 2a). Higher boll shedding (insects controlled) was expressed by a still later surge in growth (Figure 2b). Late continued growth was also expressed in a significant maturity delay when glyphosate was applied off-label (data not shown). Only glyphosate applied at the 7- to 8-leaf stage reduced lint yields (421 lb/A vs. 609 to 675 lb/A for other treatments). In summary, glyphosate applied early in the season may evoke a response in the cotton plant much later, and the response can be detected by in-season monitoring using COTMAN. Glyphosate should not be applied over-the-top after the 4-leaf stage to current glyphosate-tolerant cotton cultivars, regardless of irrigation and insect control practices.

Literature Cited

Baughman, T.A., E.P. Webster, J.W. Sij, Jr., and D.G. Bordovsky. 1999. Effect of postemergence topical applications of Roundup on Roundup Ready cotton. Proc. Beltwide Cotton Conf. (v. 1) p. 731.

Bourland, F.M. and C.E. Watson. 1990. COTMAP, a technique for evaluating structure and yield of cotton plants. Crop Sci. 30:224-226.

Danforth, D.M. and P.F. O'Leary (eds). 1998. COTMAN expert system 5.0. University of Arkansas Agric. Exp. Stn., Fayetteville, and Cotton Incorporated, Raleigh, NC.

Jones, M.A. and C.E. Snipes. 1999. Tolerance of transgenic cotton to topical applications of glyphosate. J. Cotton Sci. 3:19-26.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1234-1236 (2001)
National Cotton Council, Memphis TN

Kalaher, C.J., H.D. Coble, and A.C. York. 1997. Morphological effects of Roundup application timings on Roundup Ready cotton. Proc. Beltwide Cotton Conf. (v. 1) p. 780.

Matthews, S.G., P. Brawley, T.C. Mueller, and R.M. Hayes. 1997. What happens when Roundup Ready cotton is sprayed with Roundup after the four-leaf stage? Proc. Beltwide Cotton Conf. (v. 1) p. 779.

Reynolds, D.B., S.L. File, R.E. Blackley, and C.E. Snipes. 1999. The effect of Roundup on Roundup Ready cotton. Proc. Beltwide Cotton Conf. (v. 1) p. 732.

Voth, R.D., J.A. Mills, and P.R. Rahn. 1997. Roundup Ready cotton tolerance to Roundup Ultra (glyphosate) herbicide. Proc. Beltwide Cotton Conf. (v. 1) p. 779.

Table 1. Effect of glyphosate rate and timing on cotton yield and fruiting, Marianna, AR, 2000.[a]

Application stage[b]	Glyph. rate	Seed-cotton yield	BR[c] 1st posit.	EBR[d]	NAWF[e]
	lbai/A	lbA	%	%	days
Cot - 1 lf	1	2954 a	39 a	44 a	74 a
	2	3185 a	37 a	40 ab	75 a
3 - 4 lf	1	2635 a	24 b	29 bc	74 a
	2	2438 a	25 b	27 bc	72 a
Cot - 1lf + 3 - 4 lf + 8 lf + 13 lf	1	2728 a	22 b	24 c	80 a
Untreated		2979 a	38 a	47 a	75 a

[a] Means followed by the same letter do not differ by LSD (0.05).
[b] Cot to 1-lf and 3- to 4-lf applied overtop; 8 and 13 lf post-directed.
[c] Boll retention at first position sympodia.
[d] Early boll retention at first and second position on five lowest fruiting branches.
[e] Projected days to physiological cutout (nodes above white flower = 5).

Table 2. Interaction of glyphosate treatment and insect control on large-boll shed, averaged over irrigation (Aug. 2).

	Large boll shed[b]	
Glyph. OT[a] rate/stage	Full-season insecticide	No insecticide pre-flower
lb ai/A	% [c]	
1, 2-3 lf	23 bc	52 b
2, 2-3 lf	17 c	61 ab
4, 2-3 lf	40 b	59 b
2, 7-8 lf	81 a	80 a
Untreated	18 c	51 b

[a] OT = over-the-top.
[b] Means within each column followed by the same letter do not differ according to LSD (0.05) = 19.5.
[c] Percentages include insect-induced square shed and boll shed associated with glyphosate.

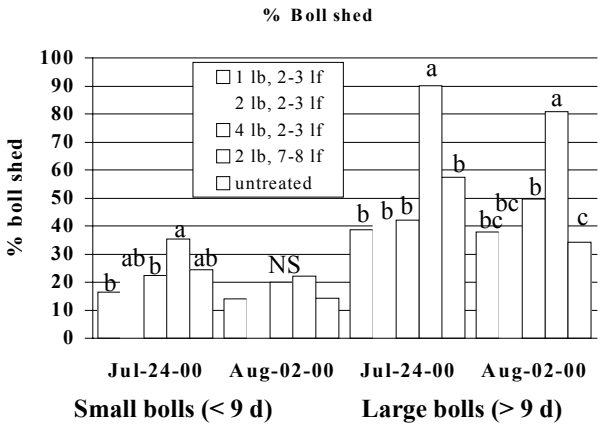

Figure 1. Percent shed of small (<9 days old) and Large (>9 days old) bolls as affected by glyphosate applied over-the-top, averaged over irrigation and insect control. Means in each date and boll size group with the same letter do not differ.

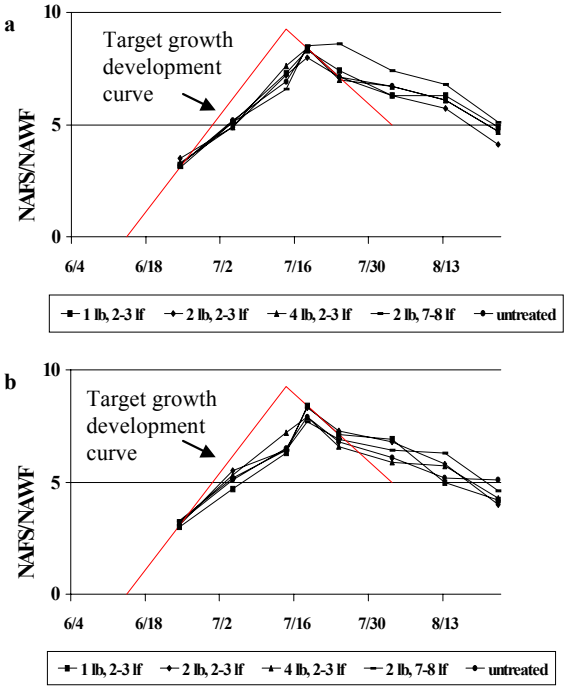

Figure 2. Growth patterns for irrigated cotton treated with glyphosate applied over-the-top. a = no insect control before first flower; b = full-season insect control. NAFS/NAWF = nodes above first square (until after first flower at 7-14), then nodes above white flower.