# Glyphosate Impact On Irrigated and Dryland Roundup Ready™ Cotton

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## ABSTRACT

**Over the past few years, the capability to apply glyphosate over-the-top of cotton for controlling weeds has been realized on a commercial level with Monsanto's development of Roundup Ready™ technology. Since perhaps 90% of the cotton acreage in Alabama is planted to this system, it was our goal to understand the effects that glyphosate might have when applied according to the manufacturer's label directions. This study was conducted in 1999 and 2000 at the Tennessee Valley Research and Extension Center in north central Alabama on a Decatur silt loam. A stacked gene cotton variety (DPL 458) was planted in late April each year using conventional procedures. Main plots were sprinkler irrigated individually for maximum yield or were left as dryland. Glyphosate subplots included four treatments: 1.) untreated, 2.) 1.0 quart acre$^{-1}$ formulated material applied postemergence over-the-top at the 4-leaf stage (POST), 3.) 1.0 quart acre$^{-1}$ post-directed to pre-bloom cotton (DIR), and 4.) 1.0 quart acre$^{-1}$ applied POST and DIR. Data collection included cotton yield, plant mapping, and fiber quality from first and second position bolls from 30 plants in each plot. Glyphosate applications had no effect on earliness, overall yield, growth and reproductive parameters, number of reproductive nodes, or fiber quality (except for micronaire on node 14 in 2000). Irrigation increased yield and number of reproductive nodes/plant. Irrigation also had a positive effect on plant growth and fiber quality compared to cotton produced under dryland conditions.**

## KEYWORDS

Roundup Ready cotton, weed control, herbicide tolerant, cotton physiology, drought stress

## INTRODUCTION

Cotton weed control has changed over the past five to seven years with the introduction of glyphosate tolerant, Roundup Ready™ cotton varieties (McClelland *et al*., 1996). The Roundup Ready technology has provided producers with an effective, inexpensive weed control system for managing grass and broadleaf weeds (Faircloth *et al*., 2001). Acceptance of this system has resulted in the replacement of most older, conventional herbicide based operations. With conservation tillage increasing in cotton production in Alabama, the Roundup Ready technology has enabled producers to control weeds without the expenses associated with cultivation and generally without visible crop injury (Dugger and Richter, 2000). This technology also allows cotton to germinate and become established in an herbicide-free soil environment that often causes some level of seedling damage.

The objectives of this study were: 1) to evaluate the overall effect of glyphosate applications on cotton yield and development and 2) to evaluate the effect of glyphosate applications when applied under adequate moisture and drought situations.

## MATERIALS AND METHODS

Field experiments were conducted in 1999 and 2000 at the Tennessee Valley Research and Extension Center in north central Alabama. The soil at this location is a Decatur silt loam with 1.0 % organic matter and pH 6.1. Experimental areas were maintained according to Alabama Cooperative Extension System recommendations. The test was maintained weed-free for the duration of the study using labeled rates of trifluralin (preplant incorporated), fluometuron plus pyrithiobac applied preemergence, or cultivation. 'Deltapine 458' stacked gene cotton was planted in mid-April both years.

Plot size was eight, 38-inch rows by 50 ft long. Treat-

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**Table 1.** Monthly irrigation and rainfall from emergence in late April through to late bloom in mid-August for 2000 and 2001.

| | 2000 | | 2001 | |
|---|---|---|---|---|
| Month | Irrigation | Rainfall | Irrigation | Rainfall |
| | ------------------- mm ---------------------- | | | |
| April | 0 | 40 | 0 | 13 |
| May | 0 | 119 | 24 | 19 |
| June | 0 | 166 | 96 | 80 |
| July | 76 | 93 | 255 | 45 |
| August | 70 | 0 | 29 | 34 |

ments were in a factorial arrangement in a completely randomized experimental design with four replications. There were four glyphosate treatments: 1.) untreated, 2.) 1.0 lbs a.i. acre$^{-1}$ applied postemergence at the 4-leaf cotton stage, 3.) 1.0 lbs acre$^{-1}$ post-directed at the pre-bloom cotton stage, and 4.) 1.0 lbs acre$^{-1}$ applied at the 4-leaf and pre-bloom cotton stages. Irrigation treatments were established by irrigating for maximum yield or by maintaining cotton under dryland conditions. Irrigation scheduling was based on the evapo-transpiration rate as determined by an on-site weather station (Table 1).

Data collection included earliness (open and closed boll counts per 16 row feet), lint yield and quality by node and treatment, and growth and reproductive parameters using traditional plant mapping procedures. Cotton was machine-harvested in early October or mid-September in 1999 and 2000, respectively. Data were subjected to ANOVA and means separated using Fisher's protected LSD test at the 5% level. Data were averaged across years, irrigation, or glyphosate treatment where appropriate except where interactions occurred.

## RESULTS AND DISCUSSION

### Effects on Cotton Growth and Reproductive Development

Internode length, plant height, number of reproductive nodes/plant, boll retention on the first fruiting position, or boll retention on the second fruiting position data were pooled due to absence of year interactions or glyphosate effects. Irrigation had a positive affect on all measured parameters of plant growth (Table 2). Internode length and plant heights were increased in irrigated compared to dryland plots. An increase in yield potential for irrigated cotton was reflected by an increase of 3 reproductive nodes/plant. Irrigation also increased boll retention at the first and second fruiting position.

**Table 3.** Effect of irrigation on boll opening and seed cotton yield. Data were pooled over years and glyphosate treatment due to absence of interactions and glyphosate main effect. Open bolls were counted when most mature treatment reached 65% open.

| Moisture | Open bolls | Yield |
|---|---|---|
| | -- % -- | --lbs acre$^{-1}$ -- |
| Dryland | 65 | 1655 |
| Irrigated | 17 | 3464 |
| LSD $_{0.05}$ | 5 | 107 |

**Table 2.** Effect of irrigation on plant height, internode length, reproductive nodes, and boll retention at the first and second fruiting positions. Data were pooled over years and glyphosate treatments due to absence of interactions and glyphosate main effect.

| Measurement | Dryland | Irrigated | LSD $_{0.05}$ |
|---|---|---|---|
| Internode length, cm | 3.9 | 4.8 | 0.6 |
| Plant height, cm | 71 | 109 | 10 |
| Reproductive nodes, no. plant$^{-1}$ | 16 | 19 | 1 |
| Retention on first position, % | 47 | 55 | 3 |
| Retention on second position, % | 14 | 28 | 4 |

### Effects on Earliness and Cotton Yield

Open and closed boll counts and seed cotton yield data were pooled over years and glyphosate treatments due to an absence of interaction and effect. Irrigation had the greatest effect on boll maturity (percent open) when compared to the dryland plots (Table 3). Dryland plots were 65% open compared to 17% for irrigated cotton. Moisture

**Table 4.** Effect of irrigation on cotton fiber quality. Data were pooled over years and glyphosate treatments due to absence of interactions and glyphosate main effect.

| Node no. | Micronaire | Dryland | Irrigated | $LSD_{0.05}$ | Dryland | Irrigated | $LSD_{0.05}$ |
|---|---|---|---|---|---|---|---|
| | | ------------- cm | ------------- | | ------------ g $tex^{-1}$ | ----------- | |
| 7 | 3.9 | 2.74 | 2.84 | 0.06 | 29.5 | 30.1 | NS |
| 8 | 4.0 | 2.69 | 2.92 | 0.06 | 28.4 | 30.9 | 1.1 |
| 9 | 4.2 | 2.67 | 2.87 | 0.05 | 27.5 | 29.5 | 1.6 |
| 10 | 4.2 | 2.67 | 2.87 | 0.04 | 27.2 | 29.6 | 1.6 |
| 11 | 4.2 | 2.67 | 2.84 | 0.05 | 27.2 | 29.9 | 1.6 |
| 12 | 4.2 | 2.82 | 2.84 | NS | 27.6 | 30.1 | 1.7 |
| 13 | 4.1 | 2.62 | 2.84 | 0.05 | 27.5 | 30.8 | 1.7 |
| 14 | GLY† | 2.82 | 2.84 | NS | 27.3 | 30.5 | 1.7 |
| Whole plant | 4.1 | 2.67 | 2.84 | 0.03 | 27.8 | 30.2 | 1.2 |

† GLY, the main effect for glyphosate was significant at $P = 0.05$.

**Table 5**. Effect of glyphosate treatment on micronaire at node 14.

| Rate | Stage | Method | Micronaire |
|---|---|---|---|
| Untreated control | | | 4.3 |
| 1 lbs $acre^{-1}$ | 4-leaf | POST† | 3.9 |
| 1 lbs $acre^{-1}$ | Pre-bloom | DIR‡ | 4.0 |
| 1 lbs $acre^{-1}$ | 4-leaf & pre-bloom | POST, DIR | 3.8 |
| $LSD_{0.05}$ | | | 0.3 |

† POST, postemergence over-the-top of 4-leaf cotton.
‡ DIR, postemergence directed

stress can cause cotton to cutout and open earlier than cotton that does not experience the same stresses. As in our study, irrigation in north Alabama has been shown to dramatically increase seed cotton yield (Huber *et al*., 1999).

### Effects on cotton fiber quality by node

Micronaire was not affected by any treatment in any year except at node 14, where a glyphosate main effect was recorded (Tables 4 and 5). Micronaire was highest in the untreated cotton compared to cotton treated with glyphosate (Table 5). However, the differences were not in the range of discounts according to industry standards. Since fiber length and strength were not affected over years or by glyphosate treatment, these data were pooled (Table 4). Irrigation resulted in longer fiber measurements recorded on all nodes except 12 and 14, where no differences were recorded. The overall average for length was also higher in irrigated cotton. Strength was higher (above node 7) when irrigated cotton was compared to dryland cotton.

## CONCLUSIONS

Since over 90% of the cotton acreage in Alabama utilizes the Roundup Ready technology, it was important to determine if cotton is affected by glyphosate applied according to the manufacturer's label and if stress influences those effects. Our results indicate that glyphosate, when applied according to label directions, had no effect on overall yield, growth, reproductive structure, or fiber quality. Irrigation increased yield, total number of reproductive nodes on each plant, and boll retention. Overall, irrigation had a positive effect on plant growth and fiber quality.

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