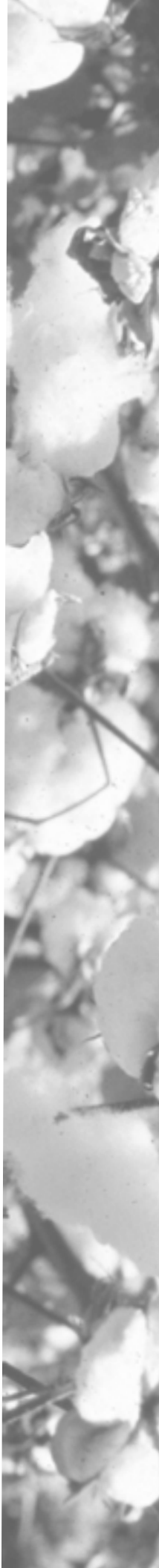


**MANAGING GLYPHOSATE TOLERANT
COTTON**



Managing Glyphosate Tolerant Cotton

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Managing Glyphosate Tolerant Cotton

Introduction

Louisiana producers have, in recent years, benefited greatly from the technology of genetically modified cotton. What began as inserting the Bt (*Bacillus thuringiensis*) gene into cotton to confer resistance against several insect pests has evolved into not only resistance to the herbicide Roundup (glyphosate) but also a combination of the two genes, commonly referred to as “stacked gene” technology.

Although the exact number of acres of Roundup Ready® cotton planted by Louisiana producers in 2000 is not precisely known, estimates by extension personnel range from 65 percent to 70 percent in most areas and may be as high as 85 percent to 90 percent in localized areas. Acreage planted to Roundup Ready® cotton will most likely remain constant in 2001 or possibly increase slightly.

As with most new technology, not everything is known about the Roundup Ready® system, including how it will fit into cotton weed control in Louisiana. This publication provides the most up-to-date information available as well as observations from the 2000 growing season. Because several generic Roundup formulations are on the market, we will refer to the active ingredient in these products (glyphosate) rather than trade names. Also, rates will be expressed as active ingredient per acre (broadcast), because various concentrations of these products are available. Be certain to read and follow the label directions for the specific product you use.

Application Timings

Overtop applications

Roundup Ready® cotton allows two over-the-top applications to cotton from cracking through the four-leaf stage of development (when the fifth leaf is the size of a quarter). Applications must be at least 10 days apart, and cotton should have at least two nodes of incremental growth between applications. Producers are limited to two over-the-top applications. Any application made after the four-leaf stage may result in boll shed, delayed maturity or yield loss. The maximum labeled amount of glyphosate that may be used per application is 1 pound of active ingredient per acre.

Post-directed or hooded sprayer applications

Although Roundup Ready® cotton is tolerant to post-directed applications of glyphosate, be careful to minimize spray contact with the cotton plant. Recent research indicates that glyphosate is more readily absorbed through the cotton stem than the leaves. The amount of spray solution intercepted by the stems is, however, often very low, especially when compared to that intercepted by a leaf.

As with over-the-top timings, no more than two applications may be directed under cotton from fifth leaf stage to layby. Again, a 1 pound per acre limitation per application and 10 days and two nodes of growth between applications are required. Layby rigs, post-direct and hooded sprayers should be set so that the spray solution is contacting the cotton plant at the cotyledonary node (base of stem) while maintaining adequate coverage of weeds. This will minimize the amount of spray solution coming in contact with leaves and stems. Residual herbicides also can be applied in a tank-mix at this time.

Salvage treatment

One quart per acre may be applied overtop to Roundup Ready® cotton after the fourth-leaf stage. This treatment, however, should be used only in situations where competition from weeds will cause a producer to lose the crop. Please note this treatment may result in significant boll loss, delayed maturity or yield loss. Do not apply more than one salvage treatment per season. Glyphosate can reduce yield by affecting pollination. A portion of those flowers developing within days of glyphosate application may become sterile and produce no fruit.

Preharvest applications

Roundup may be applied to cotton for annual and perennial weed control or desiccation before harvest. Apply as a broadcast treatment after 20 percent crack boll and at least seven days before harvest. Do not apply to crops grown for seed. Roundup will not prevent regrowth of Roundup Ready® cotton. Again, those flowers developing after this application may not produce fruit.

Non-labeled overtop applications

Several cases were observed in the 2000 growing season where over-the-top applications were not made within size limitations stated on the label. In many instances, this caused abnormal fruiting. In some cases where good growing conditions existed throughout the season and irrigation was available, cotton did achieve near normal fruiting. The cotton plant does have the capability to overcome early season fruit loss if growing conditions are favorable. If growing conditions were not favorable and irrigation was not available, however, fruit retention was affected. This fruit loss was likely caused by glyphosate interference with pollination, as mentioned. To predict environmental conditions accurately is very difficult. The LSU AgCenter recommends using the cotton plant growth stages listed on the label as guidelines for glyphosate applications and following them strictly.

Weed Control

Although Roundup has been used for several years in Roundup Ready soybeans, its spectrum of weed control and behavior when tank-mixed with cotton herbicides is still being investigated. As a general rule, however, glyphosate is excellent on grasses and a number of broadleaves, but it may be inadequate in controlling weeds such as morningglories, hemp sesbania and prickly sida if applications are not made in a timely manner consistent with the label. Table 1 lists a number of weeds in Louisiana that are controlled by glyphosate. While Roundup Ready® cotton is sufficiently tolerant to glyphosate when applied in accordance to the label, there are limitations to the amount of product that can be applied to the crop as shown in Table 2.

Controlling weeds when they are small is desirable since weed competition is minimized and often less herbicide can be used. Correct identification of weeds is essential. Be certain to consult the product label for size limitations of specific weeds in your field at time of application and glyphosate rate required for control.

Knowing what weeds are present at time of application, as well as historically, is important if an additional herbicide is needed. Also, note what weeds are in your fields after crop harvest so you may plan for them next year. For example, if a corn field has a significant morningglory infestation after harvest, and you plan to rotate to cotton the following year,

planning for that infestation may prevent possible yield losses and reduced harvest efficiency.

The primary question that arises in planning a herbicide program using the Roundup Ready® system is: Do I use a total postemergence (POST) program, or do I include a residual herbicide? The answer is simply another question: Can you make applications in a timely manner? If your farm is equipped to make timely applications to all of your Roundup Ready® cotton, then you may not need a residual herbicide at planting. If your primary weeds are grasses, eliminating the PRE herbicide may be most cost effective since glyphosate is very effective at controlling grasses.

The cornerstone in this system is timely applications to prevent early season weed competition. Early research has shown that, to realize maximum yield potential, cotton needs to be kept free from weed competition for about 10 to 12 weeks from time of emergence. Perennial weeds are becoming more and more problematic as producers shift to reduced tillage systems.

Although we discuss this in detail later in this publication, a couple of points bear mentioning now. Glyphosate generally will not control some of the perennial weeds we are likely to see during the growing season, since the rates for in-crop use are limited. In-crop applications, however, can often help prevent bermudagrass, trumpetcreeper and redvine from spreading, and may be used as an additional tool for managing these particular weeds.

Tank-mixing herbicides with Roundup Ultra

Tank-mixing herbicides is a desirable practice since this normally increases the spectrum of weeds controlled and may eliminate an additional pass through the field. Since glyphosate is a fairly broad spectrum herbicide, tank-mixing is advantageous only in a few instances. One of the more common tank-mixes for early season weed control is with Staple®. This combination is also available as a prepackaged product, Staple Plus®. This treatment can increase control of larger morningglories and hemp sesbania that glyphosate can miss. It also can provide some residual control if rainfall occurs or irrigation is applied, ideally within 12 to 24 hours after application.

Tank-mixing residual herbicides with glyphosate when post-directing appeared to be a popular treatment with producers in 2000, with one of the most popular

combinations being glyphosate + Direx. Some reduced grass control was observed with this tank-mix, however, if 0.5 or 0.75 pound per acre of Roundup Ultra was used, caused by possible antagonism. This can be overcome by using 1 pound per acre of glyphosate in the combination.

Similarly, glyphosate also may be tank-mixed with residual herbicides for controlling emerged weeds present at layby. Like the tank-mix with Direx, antagonism of grass control can result if less than 1 pound per acre of glyphosate is used. Some of these herbicides include Command 3ME, Linex 4L (both Section 24c labels) and Caparol 4L. The spectrum of weeds present should dictate which of these herbicide(s) to use at layby. Table 4 lists the amount of control normally expected of these herbicides.

Addition of surfactants


Under normal circumstances, no additional surfactant should be required with any of the glyphosate formulations labeled on Roundup Ready® Cotton.

Some surfactants can cause injury, so read the label and follow the recommendations for that particular product.

Choosing the right formulation

Numerous generic glyphosate formulations are on the market. Any of these should provide acceptable weed control, but take care to choose only those that are labeled for use on Roundup Ready® cotton. A list of those products is shown in Table 3. This list is current at this time, but new formulations or products may be introduced. Be certain to read and follow label directions of the product(s) you use. Also, be aware if the product requires adding a surfactant.

A new formulation of Touchdown® has recently received registration for use in Roundup Ready® cotton, with the same growth stage restrictions as with other glyphosate formulations. This formulation was evaluated by LSU AgCenter extension



and research personnel in 2000 and provided similar weed control to other glyphosates, with no cotton injury. Be aware that limited quantities of the original Touchdown 5® formulation are still available. Touchdown 5® is extremely injurious to Roundup Ready® cotton. Be extremely careful to use the correct product.

Residual herbicides

The addition of a residual herbicide in your weed control system should be carefully considered. If early postemergence applications of glyphosate can be made in a timely manner (1- to 3-inch weeds), an early residual herbicide at planting may not be needed. With the growing conditions in Louisiana, however, a residual herbicide at layby is recommended. Several choices are available, and some are listed in Table 6, along with expected levels of control of specific weeds. Cyanazine (Bladex or Cy-pro) is listed among those choices, but supplies will be limited in 2001, and it cannot be applied after December 31, 2001. Several alternatives are available at this time. Louisiana recently received section 24c registration for Linex and Command as layby herbicides in cotton. These labels are good for six years and should help to fill the void caused by the loss of cyanazine. Several other materials are listed in this table. Be certain to choose your residual herbicide based on the weeds present or known to be in your particular fields.

Tillage Systems

The Roundup Ready® cotton system can be used in conventional or limited tillage systems, but it is probably better suited for a reduced tillage system in which the ground is not disturbed throughout the growing season.

In conventional tillage systems in which the ground is frequently cultivated, new weed seed are brought into the germination zone with each pass. If no residual herbicide is applied, new flushes of weeds will emerge as soon as germination conditions are favorable. By limiting the amount of tillage, one can potentially reduce flushes of weeds between glyphosate applications.

In no-till or reduced till systems, producers generally begin the season with a burndown program to remove existing vegetation before planting. In many cases, the resulting dead

vegetation acts as a cover on the soil surface, retaining moisture and shading the soil, thus preventing germination of most weed seed. This can provide several weeks of effective weed control in and of itself, but timing is critical in this system. If existing weeds are not removed at least three weeks before cotton emergence, cutworms may move from dying vegetation onto the germinating cotton, reducing stands.

As tillage is reduced, we may see a shift in the weed species present in the fields. We may see more perennial weeds and surface-germinating weeds such as crabgrass. Weeds such as sicklepod require scarification of the seed coat in to germinate, and, by reducing tillage, we can potentially reduce sicklepod populations over time.

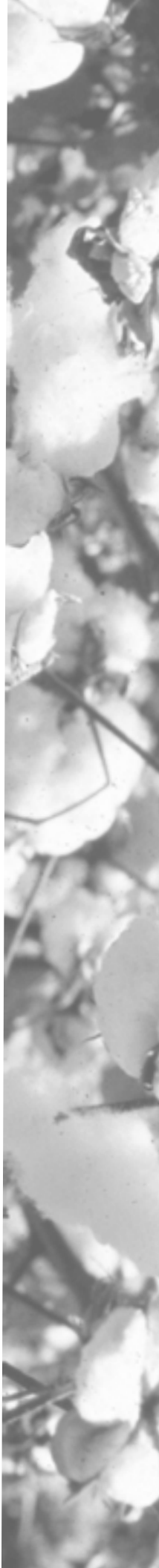
Perennial plants such as redvine, common bermudagrass, trumpet creeper and others may become problematic as tillage is reduced if steps are not taken to keep populations at manageable levels. Postharvest applications of glyphosate can allow us to do this. We do need to keep a few things in mind when developing our postharvest weed control program. Generally, harvest season is one of the drier times of the growing season. During this time, plants are not actively growing, and absorption of herbicides is often poor unless rainfall is sufficient. It is advisable to be certain that weeds are actively growing at

application time. Be certain to take into account if defoliant or desiccant have been used before application. Either can greatly affect the amount of glyphosate absorbed, thus the amount of weed control. Apply at least one week before the first killing frost. Also, since perennial weeds are our targets, herbicide rates need to be adjusted accordingly. Since perennial weeds generally radiate outward from a few plants in the field, complete coverage of the field is generally not necessary. Spot spraying infested portions of the fields is usually the most economical way to deal with perennial weeds.

Selecting Varieties

Several excellent cotton varieties that have been genetically altered to resist Roundup herbicide are available commercially. Some contain a single gene making them resistant to glyphosate. Others contain a combination of the Roundup Ready® gene and a gene conferring resistance to several insect pests. Regardless of the gene technology, producers should not plant 100 percent of their acreage to a single specific

transgenic variety. They should use multiple varieties to spread risk associated with varied growing seasons and environmental conditions. Based on two or three years of testing by the LSU AgCenter research stations, Tables 4 and 5 list the Roundup Ready transgenic varieties recommended for planting in Louisiana in 2001 at the designated locations.





TABLETS

Table 1. List of common annual weeds in Louisiana that are controlled by 1 lb/A glyphosate. Rates may be adjusted accordingly for exact weed size at application. Consult product label.

Common name	Scientific name	Weed size at application (inches)
anoda, spurred	<i>Anoda cristata</i>	3
barnyardgrass	<i>Echinachloa crus-galli</i>	7
broadleaf signalgrass	<i>Brachiaria platyphylla</i>	7
browntop panicum	<i>Panicum fasciculatum</i>	12
Carolina foxtail	<i>Alopecurus carolinianus</i>	20
carpetweed	<i>Mollugo verticillata</i>	12
common ragweed	<i>Ambrosia artemisiifolia</i>	8
copperleaf, hophornbeam	<i>Acalypha ostryifolia</i>	3
crabgrass	<i>Digitaria spp.</i>	18
eclipta	<i>Eclipta prostrata</i>	12
florida pusley	<i>Richardia scabra</i>	12
foxtail	<i>Setaria spp.</i>	20
giant ragweed	<i>Ambrosia trifida</i>	6
goosegrass	<i>Eleusine indica</i>	8
hemp sesbania	<i>Sesbania exaltata</i>	4
horseweed	<i>Conyza canadensis</i>	30
itchgrass	<i>Rottboellia cochinchinensis</i>	18
jimsonweed	<i>Datura stramonium</i>	6
johsongrass	<i>Sorghum halepense</i>	18
junglerice	<i>Echinochloa colona</i>	7
ladysthumb	<i>Polygonum persicaria</i>	8
lambquarters	<i>Chenopodium album</i>	12
morningglories	<i>Ipomoea spp.</i>	4
panicum, fall	<i>Panicum dichotomiflorum</i>	8
pigweed	<i>Amaranthus spp.</i>	24
prickly sida	<i>Sida spinosa</i>	3
purselane	<i>Portulaca oleracea</i>	6
red rice	<i>Oryza sativa</i>	4
sandbur, field	<i>Cenchrus incertus</i>	12
shattercane	<i>Sorghum bicolor</i>	18
shepherd's-purse	<i>Capsella bursa-pastoris</i>	12
sicklepod	<i>Senna obtusifolia</i>	4
smartweed, Pennsylvania	<i>Polygonum pennsylvanicum</i>	8
sprangletop	<i>Leptochloa spp.</i>	20
spurge, prostrate	<i>Euphorbia humistrata</i>	20
spurge, spotted	<i>Euphorbia maculata</i>	20
velvetleaf	<i>Abutilon theophrasti</i>	4
waterhemp	<i>Amaranthus tuberculatus</i>	12

Table 2. Maximum yearly allowable amount of glyphosate.

Application method	Amount allowed/year
1. Combined total per year (all applications)	8 lbs/A
2. Preplant, Preemerge applications	5 lbs/A
3. Total in-crop applications (cracking to layby)	4 lbs/A
4. Preharvest	2 lbs/A

Table 3. Glyphosate formulations labeled for use on Roundup Ready® cotton.

Glyphosate formulation	Manufacturer
Roundup Ultra	Monsanto
Roundup Ultra Max	Monsanto
Roundup Ultra Dry	Monsanto
Glyphosate Original	Griffin
DuPont Glyphosate	DuPont
Touchdown	Syngenta
Glyphos	Cheminova
Glyphomax Plus	DowAgro

Table 4. Recommended Roundup Ready Cotton Varieties for 2001 Early Maturing Group - Variety and Yield (lbs. lint per acre) by location.

Variety	Winnsboro No Irrigation	Winnsboro Irrigated	St. Joseph Sharkey Clay	Bossier City	St. Joseph Commerce Silt Loam
Deltapine 436 RR	458				
Stoneville 4892 BR		1756			1444
SureGrow SG 501 BR			1097	929	

Table 5. Recommended Roundup Ready Cotton Varieties for 2001 Medium Maturing Group - Variety and Yield (lbs. lint per acre) by location.

Variety	Alexandria	Winnsboro No. Irr.	Winnsboro Irrigated	St. Joseph Commerce Silt Loam	St. Joseph Sharkey Clay	Bossier City
Deltapine 5415 RR	1090		1406	1266	982	728
Deltapine 458 BR		391	1399	1272	1038	796

Table 6. Expected levels of weed control with currently available post-direct and layby herbicides.

Herbicide	grasses	nutsedge	teaweed	pigweed	morningglory	cocklebur	coffeebean (sesbania)	spotted spurge	sicklepod
Karmex or Direx + surfactant	6	0	7	8	7	7	6	3	8
Karmex or Direx + DSMA or MSMA + surfactant	9	7	8	9	8	8	6	4	8
Cotoran, Meturon or Fluometuron + surfactant	6	3	6	7	5	6	5	6	-
Cotoran, Meturon or Fluometuron + MSMA or DSMA + surfactant	8	6	7	9	8	8	6	7	8
Caparol or Cotton-Pro + surfactant	7	5	7	8	8	7	6	6	-
Caparol or Cotton-Pro + DSMA or MSMA + Surfactant	8	7	8	9	9	8	7	6	8
Linex + MSMA + surfactant	8	6	8	9	9	8	7	6	8
Bladex + Surfactant	8	5	8	8	8	7	6	6	-
Bladex+MSMA+ surfactant	8	8	8	9	9	8	7	7	
Goal+MSMA+ surfactant	8	7	7	8	9	8	7	8	8
Cobra + MSMA+ COC	7	6	8	9	9	8	8	7	6
Staple	5	5	8	9	8	7	8	1	6
Roundup	9	7	8	9	8	8	8	9	8
Staple + Roundup	9	7	9	9	9	9	9	9	8

*Control rating estimates are for weeds 2" or less in size. Poorer control will be obtained with larger weeds. For perennial weeds, top kill only should be expected.
CONTROL RATING SCALE: 0 to 10 with 0 equal to no control and 10 equal to 100% control.



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Pub. 2838 (2.5M) 2/01

Issued in furtherance of Cooperative Extension work, Acts of Congress of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. The Louisiana Cooperative Extension Service offers equal opportunities in programs and employment.