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Technical Bulletin



Roundup Ready® Flex Cotton

Since Roundup Ready® cotton was introduced in 1997, it has redefined weed management in cotton production. Now, research and development has set the stage for a new weed management standard—the Roundup Ready® Flex cotton system. Tested across the U.S. Cotton Belt since 2001, Roundup Ready Flex cotton offers an increased margin of crop safety due to its increased tolerance to glyphosate during cotton fruiting. This allows for a more flexible window of over-the-top applications of Roundup® agricultural herbicides, extending from cotton emergence through layby, the key timing for the control of economically damaging weeds.

Benefits of Roundup Ready Flex Cotton

Roundup Ready cotton has been rapidly adopted by U.S. cotton growers due to the superior weed control and proven agronomic, economic and environmental benefits that growers have enjoyed in the Roundup Ready System:

- A broad-spectrum weed control system
- Increased crop rotational options
- Increased grower profitability
- Reduced labor costs
- Broad compatibility with reduced tillage and Integrated Pest Management (IPM) practices



Research shows that the Roundup Ready Flex cotton system would be expected to provide additional grower benefits and efficiencies gains including:

- Enhanced flexibility and convenience due to season-long application options
- Increased production efficiency as Roundup agricultural herbicide applications are combined with other crop chemical products
- Less dependence upon selective spray equipment
- Potential for greater weed control efficacy (due to current label restrictions and weather/equipment limitations)
- Enhanced crop safety during sensitive cotton reproductive stages
- Ability to tailor herbicide applications to weed height/ stage instead of to the cotton stage of development

◀ Improved tolerance of Roundup Ready Flex cotton (right) compared to Roundup Ready cotton (left)*.

*Sequential over-the-top season long applications of Roundup WeatherMAX®.

Roundup Ready Cotton and Roundup Ready Flex Cotton Comparison

The protein produced in Roundup Ready Flex cotton is the same protein used in current Roundup Ready cotton, which has an extensive history of safe use.

| | Roundup Ready Cotton | Roundup Ready Flex Cotton |
|------------------------------------|--|---------------------------------------|
| Event | Line 1445 | MON 88913 |
| Glyphosate tolerance | | |
| Vegetative | Yes | Yes |
| Reproductive | Limited | Yes |
| Over-the-top application window** | Through 4th leaf (node) | Through layby and beyond |
| Post-directed applications** | Precision post directed 5th leaf (node) through layby | As needed to achieve weed coverage |
| Preharvest application available** | Yes | Yes |

**Anticipated product label.

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Varieties

Monsanto will continue to broadly license its traits, including Roundup Ready Flex cotton through seed company licensees. It is expected that seed companies will incorporate Roundup Ready Flex technology alone and in combination with other technologies such as Bollgard II® into their leading cotton varieties. As the length of the growing season and environmental conditions vary across the Cotton Belt, variety performance may also vary. Monsanto strongly encourages the grower to utilize seed company and local university resources in making variety decisions specific to your farm.



Roundup Ready Flex Cotton Testing

The Roundup Ready Flex cotton trait will be incorporated into seed company varieties using conventional methods of cotton breeding. Ahead of this step, extensive laboratory, greenhouse and field trials were conducted to evaluate the agronomic characteristics and composition of cotton containing the Roundup Ready Flex trait. In all, 458 comparisons of over 50 agronomic characteristics were made including seed germination and emergence, plant growth and development, and harvest quality as shown at right. Further, an additional 69 different compositional components of the cottonseed were evaluated.

Agronomic Characteristics and Compositional Factors Evaluated for Roundup Ready Flex Cotton

Early Season

| | |
|----------------------------|---|
| Seed germination/emergence | ✓ |
| Plant vigor | ✓ |

In Season/Harvest

| | |
|--|---|
| Plant vigor | ✓ |
| Plant height | ✓ |
| Number of nodes | ✓ |
| Plant height per node | ✓ |
| Days to 50% flowering | ✓ |
| Total number of bolls | ✓ |
| Number/quality of 1st & 2nd position bolls | ✓ |
| Number of vegetative bolls | ✓ |
| Percent abnormal bolls | ✓ |

Post Harvest

| | |
|-------------------------|---|
| Boll size | ✓ |
| Seed Index (g/100 seed) | ✓ |
| Total seed per boll | ✓ |
| Mature seed per boll | ✓ |
| Immature seed per boll | ✓ |
| Yield | ✓ |

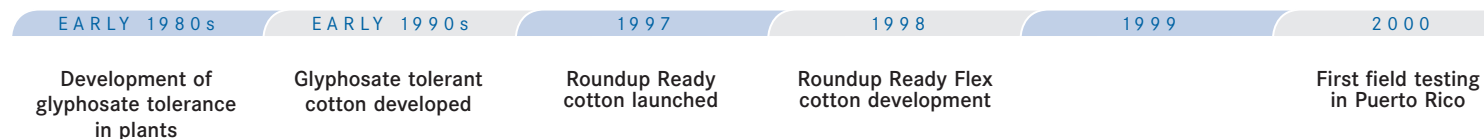
Fiber Quality

| | |
|-----------------|---|
| Staple length | ✓ |
| Staple strength | ✓ |
| Micronaire | ✓ |

Cotton Seed Analysis

| | |
|--|---|
| Proximates (protein, total fat, ash, moisture) | ✓ |
| Acid detergent fiber (ADF) | ✓ |
| Neutral detergent fiber (NDF) | ✓ |
| Crude fiber | ✓ |
| Total dietary fiber (TDF) | ✓ |
| Amino acids | ✓ |
| Fatty acids | ✓ |
| Cyclopropanoid fatty acids | ✓ |
| Vitamin E | ✓ |
| Minerals (Ca, Cu, Fe, Mg, Mn, P, K, Na, Zn) | ✓ |
| Gossypol | ✓ |
| Aflatoxins | ✓ |
| Carbohydrates/calories (by calculation) | ✓ |

Roundup Ready Flex Cotton Research and Development



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General Weed Control Recommendations for Cotton

Weed control in cotton is essential to maximize both fiber yield and quality. Cotton is very sensitive to early season weed competition when growing conditions are less than ideal. Where dense stands of annual grass and broadleaf weeds are expected (e.g. pigweed, panicum and others), the following agronomic practices are suggested:

- Start clean with tillage or burndown in no-till and reduced-till systems
- Consider using a soil residual herbicide
- Use the right rate of Roundup agricultural herbicides at the right time (proper weed size). Reducing Roundup agricultural herbicide rates when tank mixing with a residual, or use of premixes utilizing a reduced rate of glyphosate, is not recommended.

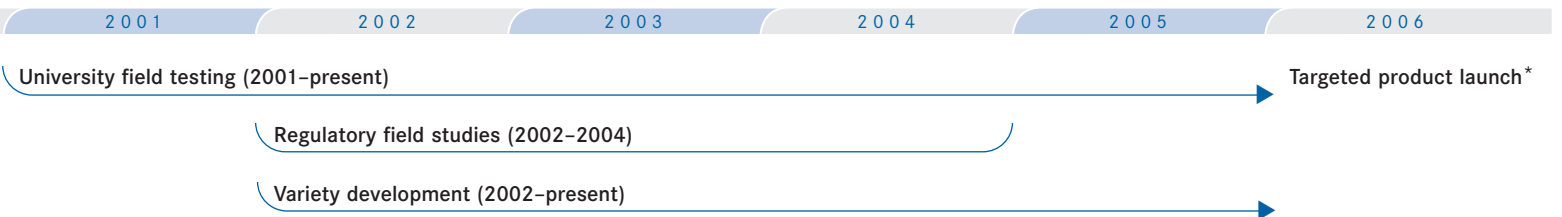


Weed/cotton competition effects from delayed Roundup WeatherMAX applications.



Timely application of Roundup WeatherMAX to Roundup Ready Flex cotton.

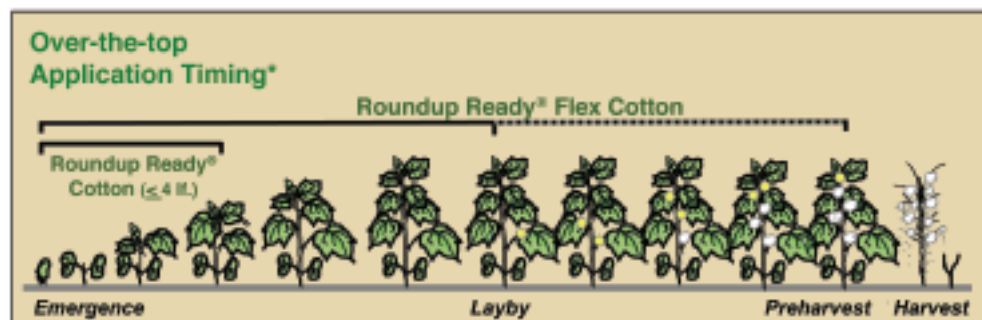
Trial photos from the University of Tennessee, Dr. Robert Hayes, 2003.



*Product launch depends on a variety of factors, including successful completion of the regulatory process.

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Proposed Roundup Agricultural Herbicide(s) New Use Label



Roundup Ready Flex cotton is not approved for sale or distribution in the United States. Roundup agricultural herbicides are not yet registered for use on this technology. It is a violation of federal law to promote any unregistered herbicide use.

* Pending approval of new use label for Roundup agricultural herbicide(s).

Roundup Ready Flex Cotton Field Testing 2001 to Present**

Roundup Ready Flex cotton has been tested at field locations across the Cotton Belt. This field work includes agronomic and tolerance testing, regulatory studies and development of weed management recommendations by local University scientists. University and third party testing to date has accounted for three of every four Cotton Belt research locations.

University Testing

| | | |
|---------------------------------|---------------------------------|-------------------------|
| Auburn University | Texas A&M University | University of Georgia |
| Clemson University | Texas Agric. Experiment Station | University of Missouri |
| Louisiana State University | University of Arizona | University of Tennessee |
| Mississippi State University | University of Arkansas | USDA ARS |
| North Carolina State University | University of California | Virginia Tech |
| Oklahoma State University | University of Florida | |

** Does not include additional seed company licensee field trial and seed production locations.

