GLYTOL COTTON - NEW HERBICIDE TOLERANT COTTON FROM BAYER CROPSCIENCE

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Abstract

Bayer CropScience has developed in-house glyphosate tolerant, Glytol® cotton (event GHB614), expressing the 2*mepsps* gene. Contingent upon regulatory approval, Glytol® cotton is planned for commercial release in 2009 and will provide US cotton growers with new cotton varieties with robust, season-long tolerance to a number of commercial formulations of glyphosate herbicide. Agronomic performance field trials have been conducted with Glytol® cotton across the US cotton belt since 2001. Extensive field testing of Glytol® cotton was conducted in 2004 and 2005 to support submissions to US regulatory agencies and collaborative trials with University Weed Scientists were conducted across the US cotton belt in 2006 and 2007. These trials have recorded no adverse effects on Glytol® cotton plant establishment, plant height, maturity, vigour, yield or quality following multiple applications at full rates of a number of commercial formulations of glyphosate. Results of replicated field trials conducted with Glytol® cotton throughout the U. S. cotton belt in 2006 and 2007 are presented here.

Introduction

Bayer CropScience has developed in-house glyphosate tolerant cotton, Glytol® (event GHB614) expressing the 2*mepsps* gene. Contingent upon regulatory approval, Glytol® cotton is planned for commercial release in 2009 and will provide US cotton growers with new cotton varieties with robust, season-long tolerance to a number of commercial formulations of glyphosate herbicide.

Glytol® cotton, (event GHB614) was created by transforming Coker 312 plant material using a disarmed *Argobacterium tumefaciens* vector and a novel 2*mepsps* gene construct. The 2*mepsps* protein is expressed in both vegetative as well as reproductive tissues and provides robust tolerance to a range of commercially available formulations of glyphosate. This allows for a more flexile window of over-the-top applications of glyphosate, extending the window for control of economically damaging weeds. There are several advantages to GlyTol® cotton herbicide system such as robust crop tolerance, to a range of glyphosate formulations, wide application window, increased production proficiency, and less dependence on selective spray equipment (McLawhorn 2005, Kelly *et al.* 2005, Culpepper and York 2005).

EPSPS is a key enzyme in the shikimate pathway. In conventional wild type plants EPSPS is selectively inhibited by glyphosate, leading to the death of the plant by shutting off synthesis of aromatic amino acid and metabolites (Steinrucken and Amrhein, 1980). The wild type EPSPS gene has been isolated from the maize genome. The EPSPS coding region was mutated using site directed mutagenesis. There are two point mutations which give rise to the double mutant 2*mepsps* gene (Lebrun *et al.* 1997). The double mutant 2*mepsps* protein is insensitive to glyphosate inhibition, but has retained its function in the shikimate pathway. Expression of the 2*mepsps* gene is driven by the H4 Histone promoter from *Arabodopsis thaliana* (Chaboute *et al.* 1982) and is constitutively expressed in both vegetative as well as reproductive tissues and provides robust tolerance to a range of commercially available formulations of glyphosate.

Agronomic performance field trials have been conducted with Glytol® cotton across the US cotton belt since 2001. Extensive field testing of Glytol® cotton was conducted in 2004 and 2005 to support submissions to US

regulatory agencies and collaborative trials with University Weed Scientists were conducted across the US cotton belt in 2006 and 2007. Once approved and available in elite germplasm, Glytol® cotton will provide US cotton growers with the flexibility of over the top applications of a number of different formulations of glyphosate (Huff *et al.* 2006). Results of replicated field trials conducted with this technology throughout the U. S. cotton belt in 2006 and 2007 are presented here.

Materials and Methods

Replicated field trials were conducted with David Moore (Tifton Co., GA), Charlie Guy (Drew Co., AR), Tom Blythe (Tate Co., MS), Don Harlan (Crittendon Co., TX), Kevin Bell (Hockley Co., TX), Wendy Shoffner (Jackson Co., AR), Chuck Doty (Fresno Co., CA), David Wilde (Wharton Co., TX), Scott Baker (Lubbock Co., TX), and David Hughes (Washington Co., MS), Bill McCloskey (Pinal Co., AZ), Todd Baughman (Hardemann Co., TX), Paul Baumann (Williamson Co., TX), Robert Lemon (Brazos Co., TX), Peter Dotray (Lubbock Co., TX), Mike Jones (Darlington Co., SC), Randy Boman, Dan Fromme (Caldwell Co., TX), Ken Smith (Deshay Co., AR), Trey Koger, Dan Reynolds (Noxubee Co., MS), Chris Main (Madison Co., TN), Mike Patterson (Macon Co, AL), Gary Cloud (Brooks Co., GA), Joel Faircloth (Sulfolk City, VA), Gary Heniger, Jeff Ellis, Sam Garris (Yazoo Co., MS), Jon Peirson (Escambia Co., FL), Dave Doran (Washington Co., MS), Macon LaFoe (Shelby Co., TN), and Mark Rinehardt (Halifax Co., NC) under USDA permits # 06-054-02n, 06-054-03n and 07-065-110n. Trial work was conducted using a randomized complete block design in all studies with four replications per treatment. Plots were 4 rows by 40 feet in length. Treatments were applied using either a CO_2 backpack sprayer or tractor mounted sprayer, calibrated to deliver an application volume of 15 gallons of water per acre.

Herbicide tolerance studies were initiated to evaluate various glyphosate formulations applied to GlyTol® cotton. Glyphosate formulations tested in 2006 included: Glyfos X-tra®, Touchdown Hi Tech® + NIS, Credit Extra®, Roundup Weathermax®, and Roundup Original Max® (Table 1). Glyphosate formulations tested in 2007 included: Glyfos X-tra®, Touchdown Total®, Credit Extra®, Roundup Weathermax®, Roundup Original Max®, Makaze®, and Honcho Plus® (Table 2).

Table 1. Glyphosate formulations, rates, and application timings for 2006 trials.

Treatments	Application timing and Rate (g ai/ha)					
	2 true leaf	6-8 true leaf	Lay-by	10 d prior to 60% open boll	60% open boll	7 d prior to harvest
UTC						
Credit Extra	1,121	1,681	1,681	561	2,242	2,242
Glyfos X-tra	1,121	1,681	1,681	561	2,242	2,242
Roundup Original Max	1,121	1,681	1,681	561	2,242	2,242
Roundup Weathermax	1,121	1,681	1,681	561	2,242	2,242
Touchdown Hi Tech + NIS[1]	1,121	1,681	1,681	561	2,242	2,242

[1]NIS = nonionic surfactant applied at 0.5% v/v

Table 2: Glyphosate formulations, rates, and application timings for 2007 trials.

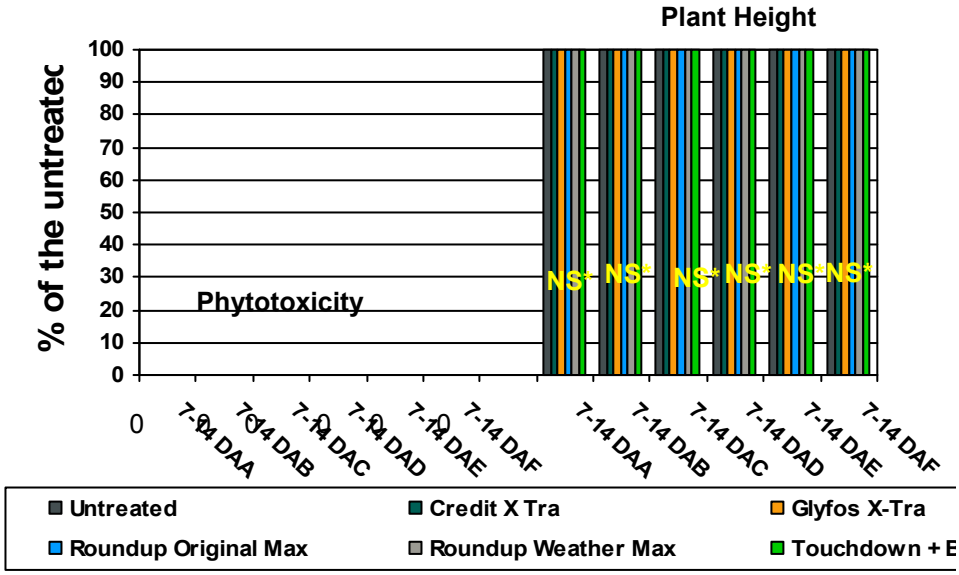
Treatments	Application timings and Rates (g ai/ha)			
	2 true leaf	6-8 leaf	Lay-by	60% open boll
UTC				
Credit Extra	1,121	1,121	1,121	1,121
Glyfos X-tra	1,121	1,121	1,121	1,121
Roundup Original Max	1,121	1,121	1,121	1,121
Roundup Weathermax	1,121	1,121	1,121	1,121
Touchdown Total	1,121	1,121	1,121	1,121

Assessments

Glytol® cotton plots were rated for plant stand at 14 days after planting (DAP), for plant height at 60 DAP and for phyto-toxicity using a 1-5 scale 14 days after each herbicide application. Plots were individually harvested and ginned to estimate seed cotton and lint yields. Fiber samples from each plot were analyzed by HVI for quality parameters by Louisiana State University fiber lab. Data were analyzed using SCOUT, the Bayer CropScience version of ARM software (Gylling data management, SD).

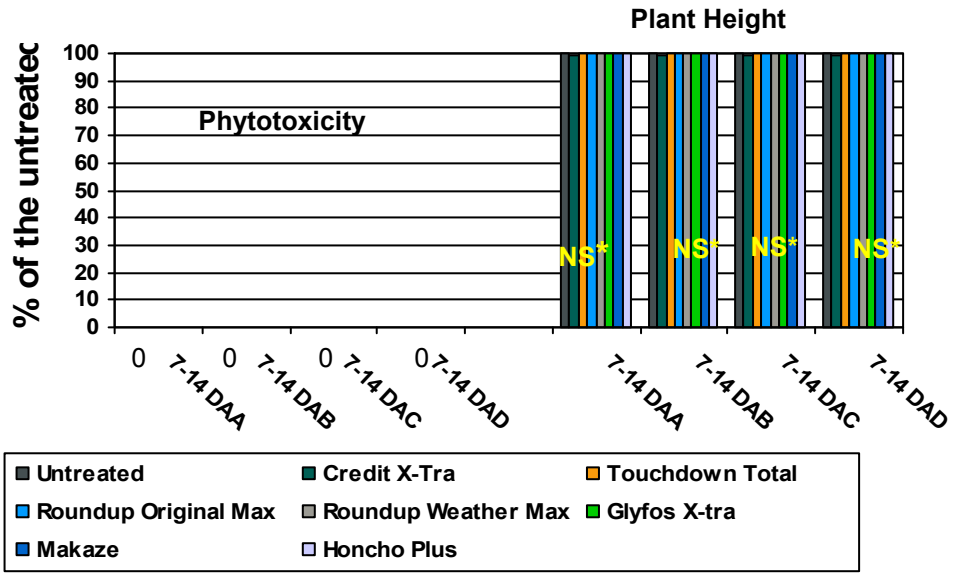
Results

No adverse effects on plant establishment, plant height, maturity, vigour, yield or quality were recorded following multiple applications of several formulations of glyphosate in trials in 2006 and 2007 (Figures 1 and 2).



***NS = Not significant using Duncan's New Multiple Range Test**

Figure 1. 2006 Glytol® cotton crop injury and plant height results.



***NS = Not significant using Duncan's New Multiple Range Test**

Figure 2. 2007 Glytol® cotton crop injury and plant height results.

No adverse effects on yield or fiber quality parameters were recorded following multiple applications of several formulations of glyphosate in 2006 (Table 3). Yield and fiber quality data has not been analysed for 2007.

Table 3. 2006 Glytol® cotton yield and and fiber quality

Treatment	Yield and Quality					
	Yield %check	Mic %	Length in	Uniformity %	Strength g/ex	Staple Quality
UTC	100	4.6	1.2	84.1	31.4	39.3
Credit Extra	104	4.6	1.2	84.2	30.8	38.8
Glyfos X-tra	103	4.6	1.2	83.9	30.9	38.8
Roundup Original Max	116	4.6	1.2	84.1	31.4	39.5
Roundup Weathermax	108	4.6	1.2	84.3	30.9	39.5
Touchdown + NIS	109	4.6	1.2	84.2	31.1	39.3
	NS*	**NS***	**NS***	**NS***	**NS***	**NS***

*NS = Not significant using Duncan's New Multiple Range Test

Discussions

In replicated Glytol® cotton trials conducted across the US cotton belt in 2006 and 2007, robust crop tolerance was observed following multiple applications of a number of commercial glyphosate formulations. Across all trials and cotton growing regions, no injury or crop height reductions to Glytol® cotton were reported following multiple applications of glyphosate herbicide. For those trials that were harvested, no reduction in cotton yield or quality parameters were recorded for treated Glytol® cotton plots versus the untreated checks.

Based on our research, GlyTol® cotton is a very good option for cotton growers throughout the U. S. cotton belt. Glytol® cotton has demonstrated a wide window of robust tolerance to several different formulations of glyphosate. Contingent upon regulatory approval, Glytol® cotton is planned for commercial release in 2009 and will provide US cotton growers with new cotton varieties with robust, season-long tolerance to glyphosate herbicide.

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