

ENHANCED ROUNDUP READY TOLERANCE AND AGRONOMIC TRIALS – MARICOPA, ARIZONA

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Abstract

The trial was planted on 4 May 2001 in Maricopa, AZ. Total area was 2.7 acres. The design was a split plot with 4 replications. The main plot treatments were unsprayed, 1.5 lb ae/A and 2.25 lb ae/A Roundup applications. The sub plot treatments were 10 different transformation events. Plots were sprayed on the 3, 6, 10 and 14 node stages. The number of dead cotton plants counted 10 days after first Roundup application showed that there were significant differences between transformation events. It may be that the genotypes had different levels of contaminated seed or the trait that makes them susceptible. Plant height was found to be significantly different with the 1445 plots at 170 cms being tall and the eRR-3 and eRR-9 plots at 140 cms being short. Aborted bolls resulted in carbohydrates being redirected to plant growth making 1445 tall. There may be genotype differences too. Rates of Roundup had no significant effect on events.

Plants were rated for sterility when most of them were at first bloom (42 days after last Roundup application). Ten white flowers at first position were rated. Rating was done at about weekly intervals. The first 3 ratings done at 8, 15 and 25th day after the last Roundup application showed 1445 sprayed with Roundup to be significantly different from the other events. Unsprayed 1445 plants were fertile. Fourth rating done on the 29th day after the last roundup application showed no significant differences between events tested. The glyphosate might have been metabolized or degraded to low levels between 25th and 29th day after Roundup application.

Plot yield from the tolerance trial showed no significant differences. The 1445 plots might have been able to recover and produce bolls comparable to other events tested. Yields were low and this may be because of climate in Maricopa during July, August. Maximum temperature is about 115 F and nighttime temperature around 85 coupled with low heat tolerance of Coker lines.

The agronomic trial had a randomized block design with 10 events. Five had the glyphosate resistance gene and 5 without. DP 565 was a substitute, yielded the most. ERR-9 negative yielded the least and the differences were significant. ERR-6 was the only line that had reduced agronomic performance that resulted from the inserted gene sequence. There were no significant differences between the other eRR events tested.

Introduction

The adoption of transgenic glyphosate tolerant cotton varieties is increasing. Introduced in 1997 glyphosate tolerant cotton varieties were grown in less than 3 percent of cultivated cotton. In 2000 more than 5 million acres or 40 percent of cotton was glyphosate tolerant (James 2001). Glyphosate-tolerant cotton offers growers the potential to use a post-emergence only herbicide program. The herbicide application can be more flexible and can control a broader spectrum of weeds and reduced tillage (Jones and Snipes, 1999). With conventional Roundup Ready cultivars glyphosate must be applied prior to the 5th leaf stage of cotton, whereas, enhanced Roundup Ready genotypes we tested were tolerant to higher doses of glyphosate applied at later stage.

Materials and Methods

The trial was planted 4 May, 2001 in Maricopa, Arizona. The ten different genotypes were eRR-1, eRR-2, eRR-3, eRR-4, eRR-5, eRR-6, eRR-7, eRR-8, eRR-9 and 1445. All the entries except 1445 had an enhanced Roundup resistance gene. Genotype 1445 had current commercial Roundup resistance gene in a Coker 312 background. The design was a split plot with the treatments as whole plots and genotypes as subplots. The three treatments were unsprayed, 1.5 lb ae/A Roundup and 2.25 lb ae/A Roundup applications. Plots were 30' long with 2 rows for the tolerance trial and 4 rows for the agronomic trial.

Plots were sprayed at 3, 6, 10 and 14 node stages. The field was treated with Prowl[®] 2 pints/A before planting. Plots were side-dressed with ammonium sulfate at 270 lb/A during the growing season.

Emergence stand counts were recorded 7 and 14 days after planting. Cotyledons that completely cleared the soil were considered emerged. Final stands were approximately 3 plants per row foot.

All 4 Roundup applications were made from tractor mounted sprayer. Four rows were sprayed at a time using 8 nozzles spaced 20" apart. Sprayer had 3 tanks so both Roundup rates were sprayed in same pass. Independent spray systems used a 4-roller pump and have independent booms. Plants were rated for injury (chlorosis or necrosis) 7 days after each Roundup application. Plots were rated on a scale from 0 to 100 percent with 0 being no chlorosis or necrosis.

The first pollen sterility rating was done when most of the plants were at first bloom (1st fruiting branch, 1st position). Successive ratings were done at about weekly intervals. Unsprayed control was rated as '5' on a 1 to 5 scale with 5 shedding normal amounts of pollen. Two enhanced Roundup Ready genotypes eRR-2 and eRR-7 were deleted from the trial after first sterility rating.

Plant height were measured from 10 plants from each plot. The 2 rows from each plot were harvested using a 2-row picker fitted with a load cell connected to a Weightronix[®] display.

Agronomic trial was also planted 4 May 2001. There were 10 genotypes, 5 with the inserted gene sequence (positive) and 5 without the gene sequence (negative). The genotypes were eRR-5, eRR-6, eRR-7, eRR-8 and eRR-9. After the trial was planted genotype eRR-7 was deleted from the trial. There were no Roundup applications. The genotypes were not rated for sterility.

Results and Discussion

Tolerance Trial

Segregation Counts. There was significant differences on the number of dead plants after the first Roundup application. Dead plants lacked glyphosate resistance gene. Genotypes had varying amounts of contamination or the trait that makes them susceptible. Rate and Entry x Rate interaction was significantly different.

Plant Height. There were significant differences between events. The 1445 plots at 170 cm was the tallest and the eRR-3 and eRR-9 plots were the shortest at 140 cm. It has been reported that carbohydrates produced by the plants are redirected towards crop growth as a result of aborted bolls. The differences may be in the genotypes too. Roundup rates had no significant effect on plant height. There were no significant interaction with entries.

Pollen Sterility Rating. First sterility rating recorded 8 days after the last Roundup application showed significant differences between 1445 and other enhanced Roundup Ready genotypes at both 1.5 lb ae/A and 2.25 lb ae/A (Chart 1). Unsprayed 1445 plots shed normal amounts of pollen. Second and third sterility rating performed 15 and 25 days after last Roundup application also showed 1445 to be significantly different from the other events tested (Chart 2, 3). The fourth and last sterility rating 29 days after Roundup application showed no significant differences between any of the transformation events tested (Chart 4). We think that between 25 and 29 days the concentration of glyphosate in the plant system were either degraded or metabolized to levels that would have not affected pollen production.

Seed Cotton Yield. The yields from plots were generally low and ranged from about 6 lb/plot to 10 lb/plot. Reason for such low yields might be the planting date. The trial was planted at the beginning of May. In Arizona monsoon season begins in the second week of July. The following 30 to 45 days have high daytime temperatures (110 – 115 F) and nighttime temperatures ranges between 85 - 90 F. We have seen heat induced sterility in normal lines and Coker may not be an exception. Genotype 1445 which displayed severe reduction in pollen production recovered and yielded as much as or better than the others tested, though yield differences were not significant. There were no significant differences between unsprayed and sprayed plots at both rates. Events x Roundup interaction was not significant.

Agronomic Trial. Analysis of yield data showed that DP565 (a fill-in for dropped out entry) was the best yielder and eRR-9 (negative) yielded the least. There were significant differences from the insertion of gene sequence in eRR-6. New gene sequence reduced agronomic performance in eRR-6 (negative). Insertion of gene sequence into eRR-5, eRR-7 and eRR-8 did not show significant difference in yield.

Conclusion

Nine genotypes in Coker background showed normal pollen production when they were sprayed with Roundup. Genotype 1445 was significantly different from the rest. Both 1.5 lb ae/A and 2.25 lb ae/A reduced pollen number markedly up to the

25th day after Roundup application. The 7 enhanced Roundup Ready events that will be studied in future showed no significant differences in yield between sprayed and unsprayed plots. Roundup sprayed at 1.5 lb ae/A and 2.25 lb ae/A did not have any significant effect on plant height or yield on new Roundup Ready events. In the agronomic trial DP 565 yielded most and eRR-9 (negative) yielded the least.

Acknowledgment

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References

James, C. 2001. Global review of commercialized transgenic crop 2000. p 1-12.
 Jones, M.A. and C.E. Snipes. 1999. Tolerance of transgenic cotton to topical applications of glyphosate. J. Cotton Sci. 3:19-26.

First pollen sterility ratings in eRR Tolerance trial, Maricopa AZ (7/6/01)

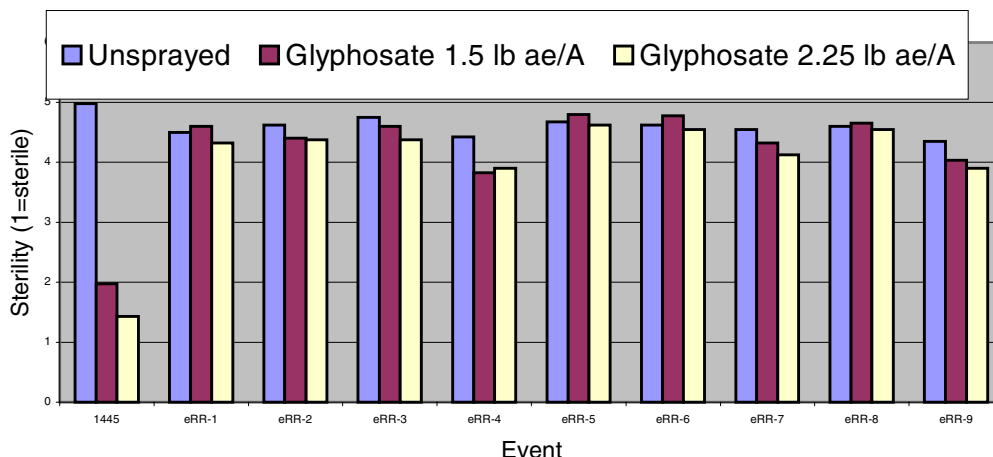


Figure 1. First pollen sterility rating.

Second pollen sterility ratings in eRR Tolerance trial, Maricopa AZ (7/13/01)

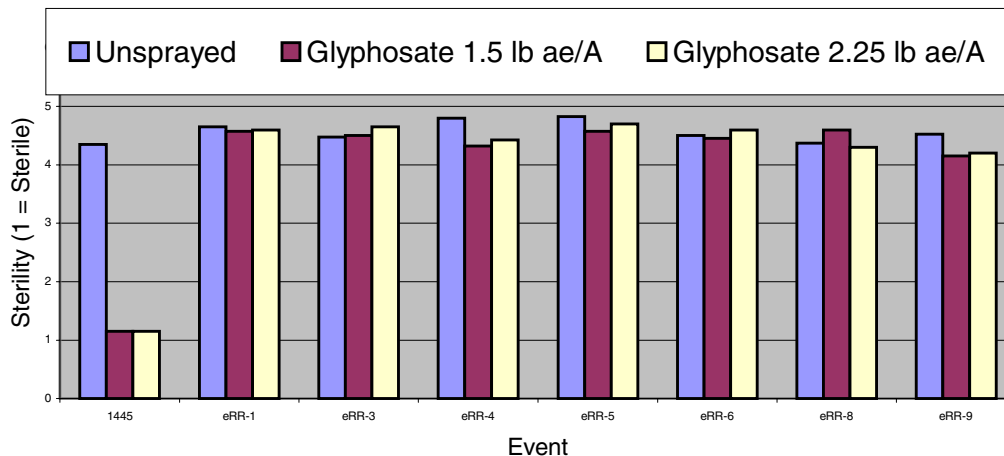


Figure 2. Second pollen sterility rating.

Third pollen sterility ratings in eRR Tolerance trial, Maricopa AZ (7/23/01)

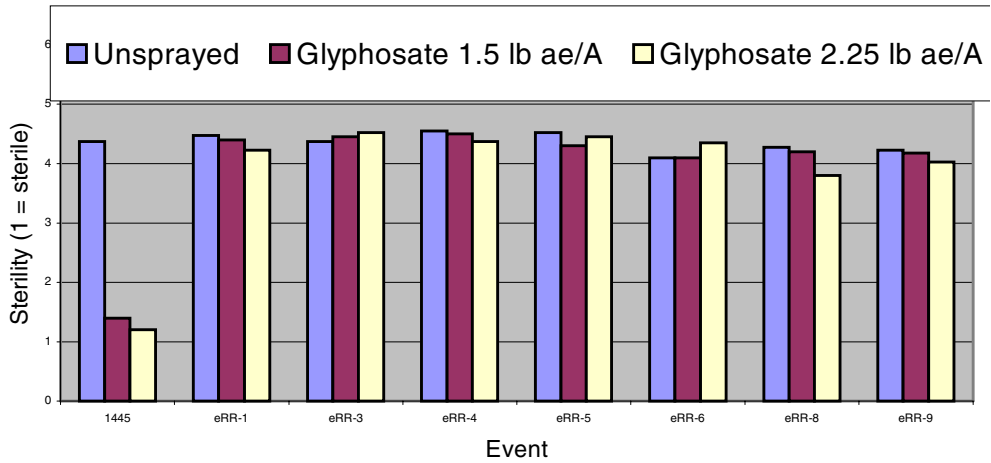


Figure 3. Third pollen sterility rating.

Fourth pollen sterility ratings in eRR Tolerance trial, Maricopa AZ (7/27/01)

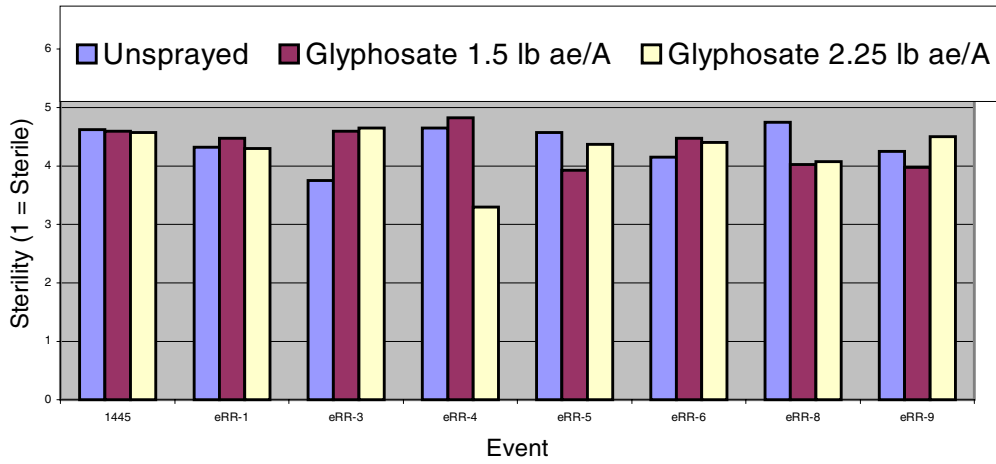


Figure 4. Fourth pollen sterility rating.