EFFECTS OF GLYPHOSATE ON YIELD AND EARLINESS OF ROUNDUP READY™ COTTON

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Abstract

This study was designed to determine the effects of glyphosate (MON 14420) on earliness and lint yield of Roundup Ready™ and conventional cotton varieties. The varietal evaluation was carried out in 1997 at "La Laguna" Experiment Station at Matamoros, Coahuila, Mexico. The experimental design was a split-plot with eight cotton varieties as the main plots and two herbicide treatments as the sub-plots. Glyphosate was topically applied in a 0.40-m band, when cotton plants were at four-leaf stage. Earliness was measured based on the date of first flower, date of first open boll and percentage of crop harvested at the first picking. Lint yield was also estimated. The date of first flower and the date of first open boll of transgenic varieties were not affected by the application of the herbicide glyphosate. The transgenic varieties PM 1244 RR and PM 1220 RR had the highest values of percentage of crop harvested. The varieties DP 5690 RR, PM 1244 and DP 5415 RR had the highest yields. Finally, The Roundup Ready gene gives to the transgenic varieties tolerance to glyphosate.

Introduction

Glyphosate is a broad-spectrum, non selective, post emergence herbicide used for the control of many annual and perennial broad leaf and grass species (Baird *et al*., 1971). It has minimum impact on the environment, no soil residual, no bio-accumulation, and minimum leaching (Reuppel *et al*., 1977). Although, cotton is moderately tolerant to glyphosate, it cannot be safely sprayed on top of the crop. The herbicide is registered for use on weeds before the crop is planted, or applied with ropewick or roller applicators for weeds that extend above the crop (Keeley *et al*., 1984a; Keeley *et al*., 1984b). Severe stunting may result if the herbicide contacts cotton plants. Most serious injury will occur when glyphosate is sprayed over-the-top of cotton at 1.5 to 3 pounds per acre. These rates delay maturity and decrease boll size enough to reduce yield (Banks and Santelmann, 1977). In another study, glyphosate sprayed over-the-top cotton reduced blooming, fruit set and yield (Frans *et al*., 1982).

With the introduction of Roundup Ready cotton in 1997, Roundup can be used as an early-season, over-the-top herbicide to control annual and perennial weeds up through the 4-leaf stage of cotton. However, employment of glyphosate on these varieties will require of research to know the effects on yield and earliness of tolerant varieties.

This study was designed to determine the effects of glyphosate application on earliness and lint yield of Roundup Ready cotton varieties.

Materials and Methods

The varietal evaluation was carried out in 1997 at "La Laguna" Experiment Station at Matamoros, Coahuila, Mexico. The experimental design was a split plot with four replications, were varieties and herbicide rates were main and sub-plots, respectively. Plots were six rows wide and 10 m long. Cotton varieties were planted on 0.76 m rows. Cotton was planted on April 9.

The varieties evaluated were:

A). Paymaster 1244 (PM 1244)
B). Paymaster 1244 RR (PM 1244 RR)
C). Paymaster 1220 (PM1220)
D). Paymaster 1220 RR (PM 1220 RR)
E). Deltapine 5690 (DP 5690)
F). Deltapine 5690 RR (DP 5690 RR)
G). Deltapine 5415 (DP 5415)
H). Deltapine 5415 RR (DP 5415 RR)

The two herbicide rates which were randomized within each main plot were as follow:

1). 0 (control)
2). 0.960 kg of a.e./ha of glyphosate (MON 14420).

MON 14420 was applied (May 13) post emergence in a 0.40 band over-the-top at 4-leaf stage of cotton.

Local recommendations for cotton management, including fertilization, water requirements and insect-pest control were applied in this experiment.

Earliness was measured as the date of first flower (DFF), date of first open boll (DFOB) and percentage of crop harvested at the first picking (PCH-1). The center two rows of each plot were handed picked and weighed to estimate lint cotton. Lint yield, DFF, DFOB and PCH-1 data were analyzed using analysis of variance. The means were compared using Least Significant Difference test at the 5% level of probability.

Results and Discussion

Date of First Flower

The values of DFF of transgenic and conventional varieties sprayed with the herbicide MON 14420 are presented in Table 1. There were statistically significant differences among varieties, herbicide rates and for the interaction

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varieties x herbicide rates. The transgenic varieties with and without herbicide began to produce flowers at the same time than conventional varieties without herbicide. However, the susceptible varieties with herbicide had a significant delay of 23 to 29 days to start the flowering period compared with the resistant varieties sprayed with herbicide.

Date of First Open Boll

The effects of rates of MON 14420 on DFOB of Roundup Ready and conventional cotton varieties are presented in Table 2. The analysis of variance detected significant differences among varieties, herbicide rates and for the interaction varieties x herbicide rates. The values of DFOB of Roundup Ready varieties sprayed with the herbicide MON 14420 was statistically the same as DFOB of conventional varieties without herbicide treatment. Roundup Ready varieties PM 1244 RR, DP 5690 RR and DP 5415 RR without herbicide treatment had a delay in the DFOB of 3, 3 and 4 days, respectively compared with their recurrent parent without herbicide treatment. The variety PM 1220 RR was the first that began to produce flowers independently of the herbicide treatment.

Percentage of Crop Harvested at the First Picking

The first picking of seed cotton was at 133 days after planting. The amount of seed cotton harvested at the first picking referred to the total seed cotton produced is presented as percentage of cotton harvested at the first picking in Table 3.

The statistical analysis showed significant differences among varieties, herbicide treatment and for the interaction varieties x herbicide rates. The values of PCH-1 of Roundup Ready varieties, PM 1220 RR and PM 1244 RR over the herbicide treatments was higher than the values of the other varieties. The transgenic varieties PM 1244 RR and DP 5415 RR treated with the herbicide MON 14420 did not showed significant differences in the values of PCH-1 compared with the conventional varieties PM 1244 and DP 5415.

Lint Yield

The analysis of variance detected significant differences among varieties, herbicide treatments and for the interaction varieties x herbicide treatments, Table 4.

The highest lint cotton yields independently of the herbicide treatment were obtained for Roundup Ready varieties DP 5690 RR, DP 5415 RR and PM 1244 RR. The transgenic varieties PM 1244 RR and DP 5690 RR sprayed with MON 14420 had a 15 and 16 percent respectively more lint than their conventional varieties PM 1244 and DP 5690 without herbicide. All conventional varieties were severely damaged by the herbicide. Their lint yields were reduced in 51, 34, 34 and 23 percent, respectively compared with the transgenic varieties treated with herbicide MON 14420.

Conclusions

The date of first flower and the date of first open boll of conventional cotton varieties were significantly delayed by the application of the herbicide MON 14420. The transgenic varieties PM 1244 RR and PM 1220 RR had the highest values of PCH-1. The transgenic varieties DP 5690 RR, PM 1244 RR and DP 5415 had the highest lint yield. The Roundup Ready gene gives to the varieties PM 1220 RR, PM 1244 RR, DP 5690 RR and DP 5415 RR tolerance to the herbicide MON 14420.

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Table 1. Date of first flower (DFF) of transgenic and conventional cotton varieties.

Variety	Rate of MON 14420		Average
	0	0.960 kg a. e./ha	
PM 1244	63	91	77
PM 1244 RR	62	62	62
PM 1220	63	90	77
PM 1220 RR	61	64	63
DP 5690	61	87	74
DP 5690 RR	63	65	64
DP 5415	64	83	74
DP 5415 RR	64	64	64
Average	63	76	

LSD 0.05: Means of varieties, 4.06; Means of herbicide treatments, 1.87; Among herbicide treatments on the same variety, 5.28; among herbicide treatments on different variety, 1.59.

Table 2. Date of first open boll (DFOB) of transgenic and conventional cotton varieties.

Variety	Rate of MON 14420		Average
	0	0.960 kg a. e./ha	
PM 1244	109	115	112
PM 1244 RR	112	110	111
PM 1220	108	123	116
PM 1220 RR	107	108	108
DP 5690	111	119	115
DP 5690 RR	114	111	113
DP 5415	110	113	111
DP 5415 RR	114	111	113
Average	111	114	

LSD 0.05: Means of varieties, 3.36; Means of herbicide treatments, 1.74; Among herbicide treatments on the same variety, 4.93; among herbicide treatments on different variety, 0.96.

Table 3. Percentage of crop harvested at the first picking (PCH-1) of transgenic and conventional cotton varieties.

Variety	Rate of MON 14420		Average
	0	0.960 kg a. e./ha	
PM 1244	52	8	30
PM 1244 RR	40	48	44
PM 1220	48	9	28
PM 1220 RR	50	39	45
DP 5690	40	5	23
DP 5690 RR	22	23	22
DP 5415	22	5	14
DP 5415 RR	22	24	23
Average	37	20	

LSD 0.05: Means of varieties, 9.57; Means of herbicide treatments, 4.21; Among herbicide treatments on the same variety, 11.92; among herbicide treatments on different variety, 3.21.

Table 4. Lint yield (kg/ha) of transgenic and conventional cotton varieties.

Variety	Rate of MON 14420		Average
	0	0.960 kg a. e./ha	
PM 1244	1913	986	1449
PM 1244 RR	2424	2260	2342
PM 1220	1839	1212	1526
PM 1220 RR	1837	1843	1840
DP 5690	2061	1876	1969
DP 5690 RR	2554	2453	2503
DP 5415	2504	1829	2166
DP 5415 RR	2271	2359	2315
Average	2175	1852	

LSD 0.05: Means of varieties, 451; Means of herbicide treatments, 151; Among herbicide treatments on the same variety, 428; among herbicide treatments on different variety.