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WEED SCIENCE

Glyphosate-Resistant Cotton Interference in Glyphosate-Resistant Soybean

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ABSTRACT

A negative aspect of glyphosate-based management systems is the potential for volunteer glyphosate-resistant (GR) crop plants to impact subsequent crops. Two independent studies were conducted to determine the effect of differing density (full-season competition) and differing duration of interference (constant density) of GR cotton (*Gossypium hirsutum* L.) on GR soybean (*Glycine max* (L.) Merr.) growth and yield. Cotton density and duration of interference effects were not observed on soybean height at harvest. Season-long competition with a cotton density of 1 plant per row m would be expected to reduce soybean yield 6%. A cotton density of 5.25 plants per row m would have to interfere with soybean for at least 6 wk following emergence before a yield reduction would be expected. Even then, yield reduction would be significantly lower than 1%. The cotton densities and duration of interference periods evaluated did have a significant impact on soybean yield. However, impact does not appear to be as significant as other common problematic grass or broadleaf weeds.

INTRODUCTION

The commercialization of glyphosate-resistant (GR) technology in soybean provided producers a highly efficacious and cost effective weed management option. Acceptable weed control and yield with consistent net income have been realized with a total post-emergence (POST) GR soybean glyphosate program when compared with conventional weed control programs (Payne and Oliver, 2000; Reddy and Whiting, 2000; Shaw et al., 2001). A net return of \$407/ha^{-1} was observed with a sequential glyphosate program in GR soybean compared to \$271/ha^{-1} in conventional soybean with a standard pre-emergence (PRE) followed by a POST herbicide program (Reddy and Whiting, 2000). In addition, GR cropping systems in soybean can allow producers to integrate weed, insect, and crop management strategies through chemical co-application of glyphosate with insecticides and micronutrient solutions (Scroggs et al., 2005).

Reported success of the GR soybean technology in research has also been observed in producer production systems, thereby reducing reliance on long-established non-glyphosate herbicides. In Louisiana in 2006, glyphosate was the herbicide with the greatest in-crop usage in soybean at 1.5 million kg compared with less than 560 kg for the leading non-glyphosate herbicide used in crop (USDA-NASS, 2007).

One negative aspect of the continued use of GR cropping systems is the potential for volunteer GR crop plants in subsequent crops, thereby requiring additional herbicide inputs (York et al., 2004, 2005). Surviving GR volunteers can directly interfere with crop growth and yield and potentially physically interfere with harvest. In the Great Plains, volunteer GR wheat (*Triticum aestivum* L.) was reported as becoming more common and gaining greater profile as a weed (Harker et al., 2005). Thomas et al. (2007) indicated GR corn (*Zea mays* L.) density of 5.25 plants per m GR cotton row reduced late season cotton height 24 to 49%. One corn plant per m of crop row decreased lint yield 5 to 8%. In a 1-year study, Tingle and Beach (2003) reported GR cotton at a density of 1 plant per row m reduced GR soybean yield 6%.

Depressed commodity prices and higher production costs have resulted in decreased cotton acreage in Louisiana, with many of those acres now planted to GR soybean (Anonymous, 2007). Limited research has been conducted on the impact of interference of GR cotton in GR soybean. Therefore, two independent studies were conducted to determine the effect of differing density (full-season competition) and differing duration of interference (constant density) with GR cotton as a weed in GR soybean.

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MATERIALS AND METHODS

Field experiments were conducted at the Northeast Research Station near St. Joseph, LA in 2004 and repeated in 2005. Experimental design in each study was a randomized complete block with 4 replications. Plots consisted of two rows 12.2 m long and spaced 101.6 cm apart. Soybean (26 seed m^{-1} row) and cotton were planted on 26 May 2004, and 18 May 2005. Soil type was a Mhoon silt loam (fine-silty, mixed nonacid, thermic Typic Fluvaquent). To ensure weed-free conditions throughout the season, glyphosate (Roundup Weathermax, Monsanto, St. Louis, MO.) at 916 g a.e. ha^{-1} was applied using a hooded sprayer in row middles and post directed nozzles angled toward the crop row at approximately 2, 4, and 6 wk after planting. Conventional soil tillage practices including disking and row formation in spring were utilized.

Density Study. In the density study, 'PM 1218RR' cotton (commercial seed) was mechanically planted approximately 5.08 cm beside 'DP 5644RR' soybean and thinned after emergence to densities of 0, 0.16, 0.33, 0.66, 1.3, 2.6, or 5.25 plants per m of row and allowed to compete season-long.

Duration of Interference Study. In the duration of interference study, varieties were the same as used in the density study. Cotton was mechanically planted approximately 5.08 cm beside the soybean and thinned after emergence to a density of 5.25 plants per m row. Cotton was allowed to compete with the soybean crop for durations of 0, 1, 2, 3, 4, 5, 6, 7, or 8 wk and season-long. The cotton plants were removed by hand at each interference interval by cutting at the soil line.

Data Collection and Statistical Analysis. In both studies, soybean height was determined prior to harvest by measuring 10 randomly selected plants from the ground to the plant terminal. Soybean was mechanically harvested, and yield was adjusted to 13% moisture. The MIXED procedure analysis with year designated as a random variable was performed on soybean height and yield data using SAS (2003). If significant effects for density or duration of interference were found, then post-ANOVA polynomial response effects were explored. Expected percentage reductions alluded to in subsequent discussion were calculated using the polynomial regression factors associated with the particular variable of interest (intercept value – calculated expected value/ intercept value * 100).

RESULTS AND DISCUSSION

Density study. A significant cotton density effect was not observed with respect to soybean height as height at harvest ranged from 72 to 78 cm (Table 1). There was, however, a significant cotton density effect on soybean yield. Based on polynomial regression factors, a soybean yield reduction of approximately 19% can be expected with a cotton density of 3 plants per row m (Table 1). In previous research, similar densities of Palmer amaranth (*Amaranthus palmeri* S. Wats) reduced soybean yield 64% (Klingaman and Oliver, 1994). Common cocklebur (*Xanthium strumarium* L.) and entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula*) at a density of 3.3 plants per row m reduced soybean yield 60 and 12%, respectively, under non-irrigated

Table 1. Observed values and corresponding regression equation describing relationship between season-long glyphosate-resistant cotton interference at varying densities and mature soybean height and yield.[y]

Density	Soybean height[z]	Soybean yield
Plants per row m	cm	kg/ha
0	76	3143
0.16	72	3062
0.33	78	3166
0.66	78	3076
1.3	75	3249
2.6	75	2675
5.25	72	2250
Regression equation:	NS	Y = 3224.24-181.76 (D)

[y] Experiment conducted in 2004 and 2005 at St. Joseph, La. Year considered a random effect in PROC MIXED data analysis.

[z] Significant density effect not observed on soybean height at maturity.

conditions (Mosier and Oliver, 1995). In the current research, a cotton density of 1 plant per row m would be expected to reduce soybean yield 6%. Similarly, Tingle and Beach (2003) reported a 6% GR soybean yield reduction with GR cotton interference at this same density. Rushing and Oliver (1998) reported that a common cocklebur density of 1 plant per 0.9 m of soybean row reduced yield 33%. Johnsongrass (*Sorghum halepense* (L.) Pers.), hemp sesbania (*Sesbania exaltata* (Raf.) Rydb. Ex. A.W. Hill), and common cocklebur at densities of 2.5, 0.5, and 2 plants per m row reduced soybean yield 14 to 30% in previous research (Grymes et al., 1999).

Duration of interference study. A significant cotton duration of interference effect was not observed with respect to soybean height as height ranged from 72 to 78 cm (Table 2). There was, however, a significant cotton duration of interference effect on soybean yield. Based on polynomial regression factors, cotton at a density of 5.25 plants per row m would have to interfere with soybean for at least 6 wk beginning at emergence before a yield reduction would be expected (Table 2). Even then, yield reduction would be significantly lower than 1%. Tingle and Beach (2003) reported that a GR cotton density of 1 plant per row m had to compete season-long with GR soybean to reduce yield, and reductions at that point were minimal. In previous research, giant ragweed (*Ambrosia trifida* L.) interference with soybean for a period of 6 and 8 wk resulted in yield reduction of 10 to 63 and 49 to 74%, respectively (Baysinger and Sims, 1991).

These findings indicate that GR cotton seed surviving winter and germinating as volunteers in a subsequent GR soybean crop do not appear to be as competitive as other common weeds previously studied. It should be noted that other critical factors, including impacts on harvest efficiency and insect/disease host potential and impact on insect eradication efforts were not taken into account with the current research and should be considered when implementing control strategies. In this research, cotton emerged simultaneously with soybean and negative effects on growth and yield may be more pronounced if cotton becomes well established prior to soybean emergence. Tingle and Beach (2003) reported that GR cotton at a density of 1 plant per row m reduced soybean yield 6% when emerging simultaneously. When GR cotton was introduced 2 wk prior to soybean planting, however, yield was reduced 16% (Tingle and Beach, 2003). Therefore, producers are cautioned that volunteer cotton plants should be removed prior to soybean planting if at all possible.

Table 2. Observed values and corresponding regression equation describing relationship between glyphosate-resistant cotton interference at varying duration intervals and mature soybean height and yield.[y]

Interference interval	Soybean height[z]	Soybean yield
weeks	cm	kg/ha
0	76	3360
1	78	3346
2	73	3359
3	76	3354
4	77	3315
5	75	3453
6	76	3307
7	76	3295
8	78	3308
20	77	2588
Regression equation:	NS	$Y = 3344.42+14.842\ (wk) - 2.6309\ (wk)^2$

[y] Experiment conducted in 2004 and 2005 at St. Joseph, La. Year considered a random effect in PROC mixed data analysis.

[z] Significant duration of interference effect not observed on soybean height at maturity.

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