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SISTER-LINE COMPARISONS OF BOLLGARD II® VERSUS BOLLGARD® AND NON-BT COTTONS - 2004

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Abstract

Bollgard II® cotton technology offers increased bollworm control and an expanded spectrum (armyworms and loopers) relative to the older Bollgard® single gene technology. Bollgard II® cotton, which contains two B.t. genes, Cry1Ac and Cry2Ab, has been evaluated in small, regulated trials for several years across the Cotton Belt. Federal registration of Bollgard II in December of 2002 allowed for commercial launch with cotton growers in 2003. This report summarizes the results of large-scale field trials in TX, LA, MS, AR, TN, MO, AL, GA, FL, SC, NC and VA in 2004. Our objectives were fourfold: (1) to determine differences in insecticide spray numbers and costs among the technologies (Bollgard II, Bollgard and non-B.t.) under grower conditions (2) to determine the impact of technologies on yield (3) to compare the overall economics of current Bollgard II varieties with "sister-line" Bollgard and non-B.t. varieties under grower conditions and 4) to determine end-of-season level of boll damage due to Lepidopterous pests for each technology type.

Materials and Methods

All comparisons were made under large plot or field-sized grower conditions in TX, LA, MS, AR, TN, MO, AL, FL, GA, SC, NC and VA. Most locations in TX, AL, FL,GA, SC, NC & VA included comparisons of a Bollgard II, Bollgard and non-B.t. variety. In the mid-South (MS, LA, AR, TN & MO) and a few other locations, Bollgard II was compared to a Bollgard variety only. Bollgard adoption in the mid-South is generally 85% or higher and almost all of the growers in this area are using one of the 5% refuge options. Consequently, it is difficult to find growers who are willing to grow a non-B.t. variety and manage it with conventional insecticide applications.

Only sister-line comparisons (for example, ST4646 BII/R was compared to ST4892 B/R and ST4793 R) were made to minimize the impact of varietal differences on yield. Each variety/technology was managed independently for insect control needs. Each variety was scouted and treated for Lepidopterous pests based on local thresholds. Treatment widths varied, but in most cases corresponded to the cooperator's equipment for a sprayer width strip to allow each treatment to be sprayed independently of the adjacent variety. All plots were managed uniformly across treatments for agronomic practices such as irrigation, fertility, weed control, etc. All cost inputs (including insecticide costs and tech fees) were recorded. Lint yields were determined. Gross income was determined based on lint value of $0.60 per pound, except in TX where the actual loan value was determined from lint samples collected from each test plot.

The end-of-season boll damage surveys were taken by inspecting 100 consecutive bolls in three different spots in each plot or field. The number of bolls damaged by Lepidopterous pests was recorded for each technology/field. The boll damage surveys were conducted on most of the economic comparison fields, but additional data was generated by Drs. Angus Catchot (MS State) and Scott Stewart (U. of TN) in their respective states on actual grower fields with each technology type managed independently for Lepidopterous pest control.

Results and Discussion

The economic advantage (or disadvantage) of a Bollgard II variety compared to other technologies will depend on a number of factors, including insect pressure as only one of them. Sister-line comparisons (lines derived from the same parental background) were used in this study to minimize the agronomic differences that are inherent variety to variety. Insect pressure in 2004 was generally moderate to heavy in TX and throughout the Southeastern US, with bollworms, tobacco budworms and fall armyworms being present in many areas. Lepidotperous pest pressure in the Delta states (mid-South) was generally very low, historically low in many of these areas. Particularly in areas where pressure was moderate to high, Bollgard II reduced the number of total Lepidopterous pest insecticide (plus application) costs and significantly increased yields and economic returns compared to Bollgard and non-B.t. varieties (Table 2). However, due to heavy "bug" pressure (primarily plant bugs and stink bugs) in almost all areas,

there was only a small difference in the number of total insecticide sprays between Bollgard and Bollgard II (Tables 1- 2).

End-of-season boll damage surveys continue to demonstrate the added advantage of Bollgard II over Bollgard systems for managing to the lowest levels of Lepidopterous pest damage possible, even when pest pressure is relatively low. Results demonstrate that the amount of worm damage remaining in the field at or near "cutout" is approximately 10-fold less in Bollgard II managed fields relative to adjacent or nearby non-B.t. fields managed with insecticides (Table 3). The significant improvement in the level of end-of-season boll damage over Bollgard is the result of Bollgard II's better bollworm and fall armyworm activity.

Since true isolines of varieties with and without transgenic traits do not exist, comparisons such as the ones in this study represent not only technology (insect control) comparisons, but also varietal (agronomic quality/fit) comparisons. Understanding the true economic value of an insect control trait, beyond its insecticide cost replacement value, will require tests involving multiple years and conditions, with the trait in multiple elite varietal backgrounds. 2004 was the second year that grower managed economic comparisons have been conducted for Bollgard II, and the existing Bollgard II lines are derived from older germplasm. Further testing with the Bollgard II trait in more elite varietal backgrounds will be necessary to understand Bollgard II's full value relative to the newer, more elite Bollgard varieties that are currently available.

Conclusions

- Beltwide - Bollgard II averaged 0.33 fewer Lepidopterous insecticide sprays than Bollgard (Table 1)
- Beltwide - Bollgard II averaged 20 pounds more lint yield per acre than Bollgard (Table 1)
- Beltwide - Bollgard II averaged $10.76 more economic return per acre than Bollgard (Table 1)
- In areas where Lepidopterous pressure was moderate to high and non-B.t. fields were included in the comparison - Bollgard II averaged approximately two fewer Lepidopterous pest sprays and $70.52 more economic return per acre than non-B.t., and a $29.65 economic return advantage over Bollgard (Table 2)

Table 1. All Orthogonal Comparisons of Bollgard vs Bollgard II (Beltwide - 107 Comparisons)

	Bollgard	**Bollgard II**
Total No. Insecticide Sprays	3.34	3.21
Total No. Worm Sprays	0.34	0.01
Total Insecticide Costs/Acre (Sprays + Applications Costs)	$28.10	$26.63
Lint Yield/Acre	1089	1109
Net Dollar Return/Acre	$565.99	$576.75

Bollgard II Economic Advantage over Bollgard = $10.76/Acre

Table 2. All Orthogonal Comparisons of non-Bt vs Bollgard vs Bollgard II (Includes TX and SE States - 59 Comparisons)

	Non-Bt	**Bollgard**	**Bollgard II**
Total No. Insecticide Sprays	2.81	1.88	1.69
Total No. Worm Sprays	1.93	0.42	0.00
Total Insecticide Costs/Acre (Sprays + Applications Costs)	$31.59	$16.83	$14.71
Lint Yield/Acre	883	964	1011
Net Dollar Return/Acre	$461.18	$502.05	$531.70

Bollgard II Economic Advantage over Bollgard = $29.65/Acre
Bollgard II Economic Advantage over Non-Bt = $70.52/Acre
Bollgard Economic Advantage over Non-Bt = $40.87/Acre

Table 3. End-of-season boll damage results (% worm damaged bolls)

	Non-Bt	**Bollgard**	**Bollgard II**
Texas	5.47	1.17	0.31
Mid-South	2.29	1.22	0.41
AL, GA, FL	4.33	3.57	0.05
SC, NC, VA	3.90	2.62	0.33
Overall Beltwide Average	**3.53**	**1.30**	**0.39**