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EIGHT YEARS OF ECONOMIC COMPARISONS OF BOLLGARD® COTTON

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Abstract

The economics of Bollgard cotton on a field scale have been examined by a number of investigators, including Monsanto and independent scientists since 1995, one year before Bollgard's commercial release. Many of these comparisons have been reported in the *Proceedings of the Beltwide Cotton Conference*. The results demonstrate that growers, on average, realize a significant Bollgard economic advantage, when using Bollgard cotton. These economic advantages are due to a combination of increased yields and decreased insect control costs. The economic advantage of Bollgard over conventional cotton production over the five-year test period (1995-1999) in the independent trials was $49.80. This is consistent with the average advantage ($40.18) calculated for Bollgard from 549 economic comparisons sponsored by Monsanto over the period of 1995 to 2001. Data from Monsanto's 2002 field economic comparison trials (107 sites) gave an average Bollgard advantage of approximately $33.72 per acre. The 2002 Bollgard end-of-season boll damage survey conducted on growers' fields across the cotton belt showed that Bollgard varieties exhibited an average of 1.76% worm damaged bolls compared to 4.60 % for non-Bollgard varieties managed with conventional insecticides.

Introduction

Economic comparisons of Bollgard cotton compared to conventional cotton and conventional insect control programs have been conducted in many areas of the US cotton belt since Bollgard was introduced (ReJesus et. al., 1997; Stark, 1997; Weir et. al., 1998; Mullins and Mills, 1999; Bryant et. al., 1999; Seward et. al., 2000; Reed et. al., 2000; Karner et. al., 2000; Cooke et.al., 2000; Oppenhuizen et. al., 2001; Mullins et. al., 2002). These comparisons show that on average, growers benefit from Bollgard cotton due to increased yield, decreased insect control costs, or both. Monsanto has conducted economic comparisons since 1995 on 654 large plot or field situations resulting in a database covering a variety of growing and insect pressure conditions. Most of the studies show that even in years of light worm pressure where spray thresholds may not be reached, Bollgard provides higher yields than the non-Bollgard cotton, presumably because it is protecting bolls from damage even under light pressure.

Materials and Methods

For the Monsanto field trials, grower fields were required to be in close proximity to one another, planted on or near the same date, and managed the same agronomically. All costs, particularly insect control costs, were recorded in the comparison of Bollgard to non-Bollgard varieties. Varieties from the same maturity grouping were used in all individual comparisons. Lint yields were recorded and yield value was calculated using $0.50 per lb. as the value of the lint in 2002. The Bollgard Tech Fee was based on the actual cost per acre when actual seed drop rates were below the 'standard' seed drop rates used to calculate the per bag Tech Fee.

For the Bollgard end-of-season boll damage survey, state cotton entomologists (AL-Barry Freeman and Ron Smith; GA-Phillip Roberts; LA-Ralph Bagwell; MS- Blake Layton; NC- Jack Bacheler; TN-Scott Stewart; OK-Miles Karner, TX-Doug Jost(Monsanto); AR-Dr. Jeremy Greene, Mr. George Hackman (Monsanto); SC-Mitchell Roof; VA-Ames Herbert) surveyed fields in their state for end-of-season boll damage due to worms (bollworms, budworms, armyworms) and "bugs" (stink bugs and plant bugs). Bollgard varieties were compared to non-Bollgard varieties managed conventionally with insecticides. Non-Bollgard cotton used as an unsprayed or embedded refuge was not surveyed for the purpose of this study. Fields were chosen with the assistance of county agents and/or consultants in each area. Surveys were conducted from late August into September, generally after "cutout". One hundred to 300 bolls from each field were sampled. Samples were taken as consecutive boll samples with two to three replicate areas per field. Each boll was rated as: worm damaged, bug damaged or undamaged. Where applicable, treatment histories were collected from the grower to determine the number of "worm" treatments applied to each field.

Results

The Monsanto field comparisons are presented regionally in Tables 1-4 with an overall summary presented in Table 5. The data show that for all regions tested, the average Bollgard trial needed fewer total insect applications and had higher yields. When averaged across all regions, the Boll Damage Survey results showed Bollgard fields required 0.74 sprays for Tobacco Budworm or Cotton Bollworm, 1.65 sprays less than non-Bollgard fields. Applications for budworm and bollworm to Bollgard fields can generally be made at lower rates or with less expensive insecticides to obtain control. Total insecticide sprays

in Bollgard fields averaged 3.1, while total insecticide sprays in non-Bollgard fields averaged 4.6. Lint yield increases with Bollgard cotton averaged from 28 lbs. to 106 lbs. across the five regions, with an overall average of 72 lbs. more lint across all sites tested. Combining the total insect control costs with the yield advantage resulted in an average Bollgard advantage of approximately $35.14 per acre overall.

Tables 6-12 were developed from Bollgard economic comparisons to conventional varieties conducted by university scientists and reported in the *Proceedings of the Beltwide Cotton Conference*, 1997-2000. The 'Gross Dollar Return' was calculated based on the lint yield difference between Bollgard and non-Bollgard cotton and does not include any of the savings benefit from reduced insect control costs. The 'Net Dollar Return' is the sum of the total insect control costs and gross dollar return. This review includes only those studies that were conducted on large plots or farmer field situations where the Bollgard variety(s) was managed independently in terms of insect control from the non-Bollgard variety. In some of the studies below other differential costs were considered, e.g., growth regulators, harvest costs, etc., where the Bollgard variety differed from the non-Bollgard variety. In the great majority of these cases the Bollgard advantage was calculated by comparing yields and the differential insect control costs (includes Bollgard Tech fee), with all other input costs being the same between the Bollgard variety(s) and the non-Bollgard conventional variety(s). Numbers in parenthesis indicate the economic advantage to the non-Bollgard variety. Table 13 contains an overall summary of the five years of third party comparisons, showing the Bollgard advantage for each year across all locations. For comparison, the Monsanto sponsored Bollgard economic comparison eight year summary is included in Table 14.

Tables 15-18 were developed from the Bollgard end-of-season-boll damage survey. Data are presented on the percent worm damage, number of worm sprays and the percent bug damage for ten states.

Discussion

The results from the 2002 Monsanto sponsored trials and previous economic comparisons demonstrate that Bollgard provides value under a variety of growing and insect pressure conditions. As would be expected, individual comparisons vary in the economic advantage/disadvantage of Bollgard varieties over non-Bollgard varieties. However, on average, Bollgard provides significant yield improvement and protects more bolls than conventional insecticide on non-Bollgard cotton from insect damage even under conditions of light worm pressure where spray thresholds have not been reached. Coupled with the savings in insect control costs that are seen in the majority of comparisons, Bollgard growers have a significant advantage over growers of non-Bollgard cotton.

The economic advantage of Bollgard over non-Bollgard cotton production over the five-year test period in the independent trials was $49.80 with an average yield increase of 10% over the non-Bollgard comparisons. This is consistent with the average advantage ($40.18 and 6% increase) calculated for Bollgard from Monsanto sponsored trials. Clearly, the Bollgard advantage is related to insect pressure in a given season. However, it is apparent that even in very light insect years, such as 1996, 1997, 1999 and 2001, when insect control costs were higher in Bollgard cotton in some areas, there was an overall economic advantage due to higher yields in the Bollgard cotton. This consistent yield advantage, even in the light insect years, may be explained either by agronomic advantages of the Bollgard varieties and/or better insect control (including 24 hours a day, seven days a week control) with the Bollgard varieties.

It should also be noted that, even though in some years/locations the total insect control costs were greater in the Bollgard cotton than in the non-Bollgard cotton, there were consistently fewer dollars spent on foliar insecticides, with fewer applications made on Bollgard. None of these studies accounts for any Bollgard value based on labor savings (with the exception of application costs) or environmental benefits. Additionally, there has been no assigned value to the risk management benefit or "peace of mind" factor associated with Bollgard cotton.

These averages do not mean that *any* Bollgard variety will provide economic benefits over *any* non-Bollgard variety, since yield is such an important factor in the total calculation of economic benefit. However, these studies do indicate that well adapted Bollgard or Bollgard/Roundup Ready varieties for a particular area will provide the producer with the best chance for the highest economic returns, regardless of the level of insect pest pressure.

The Bollgard end-of-season boll damage survey showed that Bollgard varieties on average exhibited over 2.5 times less worm damaged bolls compared to non-Bollgard varieties. The boll damage survey assessed bolls that remained on the plant and did not quantify bolls and squares that may have been damaged and aborted from the plant prior to harvest. Bollgard varieties had slightly more "bug" damage (1.16%) which was attributed to fewer worm sprays with "bug" activity. Bollgard varieties needed 1.46 less worm sprays.

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Table 1. Summary of 2002 Economic Comparisons Conducted in Georgia, Florida and Alabama (19 Comparisons).

Category (Average)	Non-Bollgard Variety	Bollgard Variety
No. BW/TBW Sprays*	2.70	0.7
Cost for Single BW/TBW Spray	$7.40	$4.75
Total No. of All Insecticide Application	3.6	2.2
Total Insect Control Costs**	$50.04	$53.89
Yield (Lb. Lint)	902	930
Dollar Return	$400.96	$411.11
Bollgard Advantage		$10.15

*BW/TBW = Cotton Bollworm / Tobacco Budworm

**Includes Insecticide Costs, Application Costs & Tech Fee for Bollgard

Table 2. Summary of 2002 Economic Comparisons Conducted in North Carolina, South Carolina and Virginia (16 Comparisons).

Category (Average)	Non-Bollgard Variety	Bollgard Variety
No. BW/TBW Sprays*	2.9	1.4
Cost for Single BW/TBW Spray	$5.38	$4.87
Total No. of All Insecticide Application	2.9	1.4
Total Insect Control Costs**	$35.26	$41.92
Yield (Lb. Lint)	590	626
Dollar Return	$259.74	$271.08
Bollgard Advantage		$11.34

*BW/TBW = Cotton Bollworm / Tobacco Budworm
**Includes Insecticide Costs, Application Costs & Tech Fee for Bollgard

Table 3. Summary of 2002 Economic Comparisons Conducted in Louisiana and Mississippi (17 Comparisons).

Category (Average)	Non-Bollgard Variety	Bollgard Variety
No. BW/TBW Sprays*	4.1	1.8
Cost for Single BW/TBW Spray	$10.42	$5.90
Total No. of All Insecticide Application	6.2	4.8
Total Insect Control Costs**	$84.50	$78.53
Yield (Lb. Lint)	869	936
Dollar Return	$350.00	$389.47
Bollgard Advantage		$39.47

*BW/TBW = Cotton Bollworm / Tobacco Budworm
**Includes Insecticide Costs, Application Costs & Tech Fee for Bollgard

Table 4. Summary of 2002 Economic Comparisons Conducted in North Delta (Arkansas, Southeast Missouri and Tennessee) (18 Comparisons).

Category (Average)	Non-Bollgard Variety	Bollgard Variety
No. BW/TBW Sprays*	2.9	0.6
Cost for Single BW/TBW Spray	$10.85	$7.54
Total No. of All Insecticide Application	5.7	3.9
Total Insect Control Costs**	$69.04	$61.53
Yield (Lb. Lint)	827	905
Dollar Return	$344.46	$390.97
Bollgard Advantage		$46.51

*BW/TBW = Cotton Bollworm / Tobacco Budworm
**Includes Insecticide Costs, Application Costs & Tech Fee for Bollgard

Table 5. Summary of All 2002 Mid-South, Southeastern and East Texas Economic Comparisons (Areas Combined - 107 Comparisons).

Category (Average)	Non-Bollgard Variety	Bollgard Variety
Total Insect Control Costs**	$55.16	$56.63
Yield (Lb. Lint)	794	864
Dollar Return	$341.84	$375.37
Bollgard Advantage		$33.53

**Includes Insecticide Costs, Application Costs & Tech Fee for Bollgard

Table 6. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in Georgia.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1996	14	27.50	11	72.80	100.30

Stark, 1997

Table 7. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in South Carolina.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1996	2	42.78	NR	NR	11.62

ReJesus et. al., 1997
NR = Not Reported

Table 8. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in Mississippi – Hills and Delta.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1995	5	25.45	12	66.35	91.80
1996	5	(15.34)	7	40.50	25.16
1997	5	(4.34)	8	45.50	41.16
1998	5	4.00	18	79.30	83.30
1999	5	(14.66)	12	39.52	24.86
Average		(0.98)	11.4	54.23	53.26

Reed et. al., 2000

Table 9. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in the Mississippi Delta.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1997	14	(5.93)	(2)	(13.44)	(14.61)
1998	15	29.13	0	(2.59)	34.54
1999	13	(11.93)	2	18.67	1.23
Average		4.00	0	0.88	7.05

Cooke et. al., 2000

Table 10. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in Tennessee.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1998	9	(3.00)	12	55.25	52.25
1999	8	(19.00)	3	10.20	(9.00)
Average		(11.00)	8	32.73	21.63

Seward et. al., 2000

Table 11. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in Arkansas.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1996	6	(4.38)	NR	91.12	86.74
1997	7	(11.39)	NR	(15.56)	(26.95)
1998	7	10.22	NR	54.30	64.52
Average		(1.85)		43.29	41.44

Bryant et. al., 1999
NR = Not Reported

Table 12. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted in Oklahoma.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1996	5	(13.25)	35	121.80	83.53
1997	16	(32.00)	9	73.80	46.45
1998	12	(26.34)	22	114.60	64.12
1999	14	(16.47)	19	77.50	40.06
Average		(22.02)	21	96.93	58.54

Karner et. al., 2000

Table 13. Bollgard Advantage/(Disadvantage) of Third Party Economic Comparisons Conducted Over Five years in the Mid-South and Southeast.

Year	Number of Tests	Number of Locations	% Lint Increase	Bollgard Advantage Net Dollar Return ($)
1995	1	5	12	91.80
1996	5	32	15	75.45
1997	4	42	4	12.72
1998	5	48	11	55.12
1999	4	40	9	13.90
Average			10	49.80

Table 14. Bollgard Advantage/(Disadvantage) from Monsanto Sponsored Trials in the Mid-South and Southeast.

Year	Number of Comparisons	Total Insect Control Cost ($)	% Lint Increase	Gross Dollar Return ($)	Net Dollar Return ($)
1995	23	22.70	10	59.80	82.50
1996	203	(5.19)	5	29.90	24.71
1997	94	(1.87)	9	54.60	53.73
1998	109	15.43	4	24.43	39.86
1999	29	(6.46)	7	37.20	31.12
2000	27	10.12	5	26.14	36.26
2001	64	(4.87)	4	17.60	13.05
2002	107	(1.47)	9	35.00	33.53
Average		3.55	6	35.58	39.35

Wier et. al., 1998; Mullins and Mills, 1999; Oppenhuizen et. al, 2001; Mullins et.al. 2002
*In 1995-2000 yield value was calculated using $0.65 per lb.; 2001 yield value was calculated using $0.55 per lb.; 2002 yield value was calculated using $0.50 per lb.

Table 15. 2002 Bollgard End-of-Season Boll Damage Survey- Percent Worm Damaged Bolls.

State	Bollgard	Non-Bollgard
Alabama	1.66	5.22
Arkansas	1.75	3.17
Georgia	1.27	2.73
Louisiana	0.98	1.22
Mississippi	2.56	4.32
North Carolina	1.20	4.13
South Carolina	0.33	0.75
Tennessee	2.41	9.39
East Texas	2.35	8.65
West Texas	4.16	10.25
Virginia	0.66	0.85
Average	1.76	4.60

Table 16. 2002 Bollgard End-of-Season Boll Damage Survey- Number of Worm Sprays.

State	Bollgard	Non-Bollgard
Alabama	0.32	1.24
Arkansas	1.74	4.94
Georgia	0.85	3.85
Louisiana	NR	NR
Mississippi	1.17	3.35
North Carolina	NR	NR
South Carolina	0.65	0.75
Tennessee	0.55	2.55
East Texas	0.14	1.55
West Texas	0.25	1.25
Virginia	1.00	2.00
Average	0.74	2.39

Table 17. Bollgard End-of-Season Boll Damage Survey- Percent Bug Damage.

State	Bollgard	Non-Bollgard
Alabama	9.39	5.60
Arkansas	3.86	3.73
Georgia	5.04	4.00
Louisiana	NR	NR
Mississippi	1.55	0.87
North Carolina	2.03	0.81
South Carolina	0.63	0.66
Tennessee	4.21	2.67
East Texas	1.87	1.00
West Texas	NR	NR
Virginia	NR	NR
Average	3.57	2.42

Table 18. 2002 Bollgard End-of-Season Boll Damage Survey- Total Sprays.

State	Bollgard	Non-Bollgard
Alabama	1.16	1.76
Arkansas	6.06	9.45
Georgia	1.30	4.10
Louisiana	NR	NR
Mississippi	4.29	5.72
North Carolina	0.88	2.66
South Carolina	1.75	1.80
Tennessee	3.20	4.91
East Texas	2.95	4.64
West Texas	4.25	4.75
Virginia	2.00	3.00
Average	2.78	4.28