AGRONOMIC AND ECONOMIC EVALUATION OF BOLLGARD COTTONS ON THE SOUTHERN HIGH PLAINS OF TEXAS

Jeff Miller, Tom Speed and Dave Albers
Delta and Pine Land Company
Lubbock, TX
Dan R. Krieg
Texas Tech University
Lubbock, TX

Abstract

On farm split field comparisons were conducted during the 1999 and 2000 growing season to compare the agronomics and economics of Bollgard/Roundup Ready cotton to Roundup Ready cotton on the Southern High Plains of Texas. These trials were located from Lamesa to Hereford. PM 2200RR was compared to PM 2280 BGRR and PM 2326 RR was compared to PM 2326 BGRR on approximately 13 split field comparisons each year. These comparisons were conducted each year with the BGRR variety planted on one side of the field and the RR planted on the adjacent side. Each variety/technology was managed independent of the adjacent variety/technology regarding insecticide use for bollworm control. Bollgard varieties tended to be slightly shorter plants and earlier maturing. BGRR cotton demonstrated a yield increase of approximately66 lbs/acre across all varieties over both years. Total fruit retention and bolls/plant were significantly increased as a result of bollgard. Preliminary cost analysis indicates an average savings of $28.66 per acre across both varieties and two years data.

Introduction

The Bollworm, considered a secondary pest, has long attracted attention. The larval stage is the most economically destructive by causing damage from terminal feeding on the plant through square and boll feeding. I the United States the bollworm, *Helicoverpa zea* (Boddie), and the tobacco budworm, *Heliothis virescens* (Fabricus) comprise a worm complex that causes the most economic damage of any single insect pest according to Metcalf (1994). Until 1996 bollworms were controlled solely by insecticides and more specific, pyrethroids. In 1996 Delta and Pine Land Company in cooperation with Monsanto released Bollgard™ cotton for commercial plantings across the cotton belt. Bollgard was first released only in Picker type cottons until 1999 when Bollgard was released commercially in Stripper type cottons. The first two stripper varieties that Bt was introduced into were PM 2280 BGRR and PM 2326 BGRR. These two varieties were selected from lines of PM 2200 RR and PM 2326 RR. These new varieties are expected to outyield their parent lines as well as possess greater fruit retention, fiber qualities, and be earlier maturing. In 1996 Paymaster Cottonseed tested 14 new picker varieties, along with 5 associated recurrent parents. The varieties all received identical management inputs. The transgenic varieties had similar growth, fruiting, and yield characteristics after plant maps, yield, and fiber data were collected. The Bollgard varieties tended to be slightly shorter than their parent varieties. Bollgard, Roundup Ready, and Stacked varieties tended to exhibit slightly earlier maturity, while they began fruiting at the same node as the parent variety. The transgenic varieties yielded equal to or greater than the parent did (Albers 1997). This yield advantage should be noticed in the stripper varieties. Fiber quality will be positively affected as well due to less boll damage from bollworms. Bt fields in Mississippi sustained significantly less caterpillar induce boll damage, 2.55% vs. 4.81% in non-Bt fields (Layton 1999). The southern High Plains of Texas usually possesses a light-medium bollworm infestation during the growing season. Producers on the Southern High Plains normally initiate bollworm control 1-2 times per season. The Bollweevil Eradication Program was implemented in 1999 for the Southern and Western Counties and passed for initiation in the fall of 2001 for the rest of the southern high plains. This program utilizes area wide applications of malathion, which will reduce bollworm predator insects. Without predators bollworm populations will increase causing conventional control methods to increase as well. Bollgard cotton will help to keep conventional control methods for the bollworm to remain at a minimum as well as achieving greater yields, fruit retention, and fiber quality. Higher net returns will be achieved by the producer due to higher yields, quality, and an earlier maturing cotton. In Mississippi Bt cotton outyielded non-Bt cotton by 92, 46, and 84lbs of lint per acre on average in 1995, 1996, and 1997. After yield values and net returns were evaluated, Bollgard demonstrated a cost advantage of $82.50, $24.71, and $53.73 greater than in the non-Bt cotton in 1995, 1996, and 1997. Other regions of the cotton belt experienced $11-$54 Bt advantage above technology fee (Wier 1998). The technology fee is assessed by Monsanto on all transgenic products to ensure that revenue is gained to fund further research. This fee is generally included as an insecticide cost because the fee could be substituted for an insecticide application in non-Bt cotton. It has been reported that in regions of moderate-heavy bollworm pressure or if the region possesses a lengthy bollworm egglay then Bt varieties will pay for themselves. In regions of lower bollworm populations the benefits of Bollgard varieties are greater fruit retention, higher quality, and subthreshold protection.

Materials and Methods

This experiment was conducted at 12 different locations across the Southern High Plains of Texas. The Southern High Plains of Texas was split into three separate zones. Zone 1 covered Dawson, Gaines, Lynn, and Terry Counties, which are all in Bollweevil eradication. Zone Two counties include Crosby, Hockley, and Lubbock Counties, which are not in Bollweevil eradication. Zone Three counties include Castro, Hale, Floyd, Lamb, and Swisher Counties. Castro and Lamb counties were the only counties out of Zone Three to participate in Bollweevil eradication during the 2000 growing season. Four varieties of cotton were utilized to determine whether Bollgard varieties have superior Fruit Retention, Maturity, Yield and Economic Benefits. The tests were set up on 120 acre center pivot irrigation systems in all three zones mentioned above. One-half of the cotton acreage under the pivot was planted to a Roundup Ready variety and the other half was planted to a Bollgard/Roundup Ready variety. Planting rate, row spacing, irrigation frequency, and tillage system were determined by the cooperator. The Roundup side and the Bollgard/Roundup Ready side were setup to be treated the same regarding tillage, herbicide, and insecticide treatments excluding Bollworm/Budworm control. Bollworm control was administered to the Bollgard/Roundup Ready side only if economic threshold was exceeded. This control is based on larvae counts instead of egg counts. During the growing season, 20 plants from each side of the pivot were mapped to monitor plant growth and fruit retention. At harvest 20 more plants were mapped to determine the plant's final growth development and boll distribution. This plant mapping data was entered into the Delta and Pine Land Company's mapping database to analyze this data. The field was then mechanically harvested and ginned according to the cooperators normal practices. Gin Recap sheets were collected from the respective gins after they were classed by the local USDA classing office. Economic evaluations were made by obtaining insecticide inputs that were applied to each variety and then compared to the average loan price received at the gin for net profits per variety. Microsoft Excel, D&PL mapping database and the SAS system were used to evaluate final data.

Results

PM 2280 BGRR was found to be slightly shorter and earlier maturing than PM 2200 RR (table 1). Fruit retention on PM 2280 BGRR was about 5% higher than PM 2200 RR. Bolls per plant was significantly higher on the

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:408-410 (2001)
National Cotton Council, Memphis TN

PM 2280 BGRR than on PM 2200 RR (table 3). PM 2280 BGRR had a significant gain in staple length and strength and a slight decrease in micronaire. The micronaire difference would only be significant if the comparison variety was less than 3.5. PM 2280 BGRR had an 82 lb/acre yield increase over PM 2200 RR. Gross returns per acre were $43.88 more than the PM 2200 RR.

PM 2326 BGRR and PM 2326 RR had similar maturity and fruiting nodes. The stacked variety was slightly shorter in stature. Fruit retention was approximately 11% higher on PM 2326 BGRR (table 2). PM 2326 BGRR had a significant increase in number of first position bolls as well as bolls per plant. PM 2326 BGRR experienced a significant decrease in staple length, but micronaire and strength remained equal to PM 2326 RR (table 4). PM 2326 BGRR outyielded PM 2326 RR by over 38 lbs/acre with gross returns per acre approaching $4.00 per acre on PM 2326 BGRR.

Stacked varieties overall were found to be slightly shorter with fewer fruiting nodes (i.e. earlier maturing). Bollgard fruit retention averaged approximately 8% better than Roundup Ready varieties. Bolls per plant averaged 1.5 times better than RR varieties. Overall stacked varieties experienced a slight increase in staple length and strength, with a slight decrease in micronaire. Bollgard varieties had a 65.6 lb./acre increase in yield over their roundup ready counterparts (table 5). BGRR varieties gross returns per acre average $28.66 over RR varieties at 21 locations.

Acknowledgment

I would like to give special thanks to Kathy Vaughn for helping collect data for this study. I appreciate the help of Dan Krieg, Dave Albers, Tom Speed, Eric Best, Marcus Sullivan, James Culp, and Keith Waters for their help in locating cooperators and analyzing data; Richard Adams, Chris Bednarz, Glen Bednarz, Earl Bowman, Kent Birkenfield, Tommy Cleavenger, Wayne Crotwell, Ricky Cude, Dahlen Hancock, Eddie Foster, Bobby McNabb, Steve Olsen, Greg Sides, Burkie Slaughter, Tullie Struve, Dale Swinburn, Dan Taylor, Brad Vaughn , and Steve Verett for allowing me to sample their cotton fields and for providing pesticide records, yield, and fiber information.

References

Albers, D.W., C. Williams, and J. Mitchell. 1997. Fruiting Patterns, Maturity, and Yield of Bollgard and Roundup Ready Cotton Varieties. p. 411. *In* Proc. Beltwide Cotton Conferences. New Orleans. LA. 6-10 Jan. 1999. National Cotton Council, Memphis, TN.

Layton, M.B., S.D. Stewart, M.R. Williams and J. L. Long. 1999. Performance of Selected Bt Cotton in Mississippi, 1998. p. 942-944. *In* Proc. Beltwide Cotton Conferences. Orlando, FL. 3-7 Jan. 1999. National Cotton Council, Memphis, TN.

Metcalf, R.L. (ed.) and W.H. Luckman. 1994. Introduction to Pest Management. 3rd ed. John Wiley and Sons, New York.

Wier, A.T., J.W. Mullins, and J.M. Mills. 1998. Bollgard Cotton and Economic Comparisons including New Varieties. p. 1039-1040. *In* Proc. Beltwide Cotton Conferences. San Diego, CA. 5-9 Jan. National Cotton Council, Memphis, TN.

Table 1. Plant Mapping Comparison between RR and BGRR varieties.

Variety	n	height	tnodes	nwcb	HNR
PM 2200 RR Average	17	24.32	17.5	11.9	1.40
PM 2280 BGRR Average	17	23.86	17.6	12.5	1.28
Difference		-0.46	0.1	0.6	-0.12
PM 2326 RR Average	9	24.39	15.7	10.3	1.53
PM 2326 BGRR Average	9	23.37	16.3	10.4	1.43
Difference		-1.02	0.6	0.1	-0.10
RR Average	26	24.35	16.8	11.4	1.44
BGRR Average	26	23.69	17.1	11.8	1.33
Difference		-0.66	0.3	0.5	-0.11

* Data collected from 20 plants mapped/treatment

Table 2. Main Stem Node Region Percent Retention Comparison.

Variety	n	%R (MN6-10)	%R (MN11-15)	%R (MN16-20)
PM 2200 RR Average	17	61.18	40.89	3.04
PM 2280 BGRR Average	17	62.18	44.64	3.73
BG Advantage		1.00	3.74	0.69
PM 2326 RR Average	9	60.04	22.78	0.67
PM 2326 BGRR Average	9	68.07	26.48	0.83
BG Advantage		8.04	3.70	0.15
RR Average	26	60.78	34.62	2.22
BGRR Average	26	64.22	38.35	2.72
BG Advantage		3.44	3.73	0.50

* Data from 20 plants mapped/treatment

Table 3. Number of Bolls by position (First, Second, and Third).

Variety	n	fp1	fp2	fp>2	total	bolls/plant
PM 2200 RR Average	17	105.2	35.2	5.6	152.2	7.9
PM 2280 BGRR Average	17	110.2	39.1	7.8	164.5	8.4
BG Advantage		5.0	3.9	2.2	12.3	0.6
PM 2326 RR Average	9	89.9	32.1	5.1	131.0	6.7
PM 2326 BGRR Average	9	99.9	30.2	5.3	139.1	7.2
BG Advantage		10.0	-1.9	0.2	8.1	0.4
RR Average	26	99.9	34.2	5.4	144.9	7.5
BGRR Average	26	106.6	36.1	6.9	155.7	8.0
BG Advantage		6.7	1.9	1.5	10.8	0.5

Table 4. Staple, Micronaire, and Strength Comparison for BGRR Varieties.

Variety	Staple	Mic	Strength
PM 2200 RR Average	33.71	3.89	27.87
PM 2280 BGRR Average	34.34	3.67	28.49
BG advantage	0.62	-0.22	0.62
PM 2326 RR Average	32.83	4.38	28.81
PM 2326 BGRR Average	32.23	4.30	28.47
BG advantage	-0.60	-0.09	-0.34
Overall RR Average	33.38	4.08	28.23
Overall BG Average	33.53	3.91	28.48
BG advantage	0.16	-0.17	0.26

Table 5. Yield Comparison between RR and BGRR varieties.

		Yield (lbs/acre)				
Variety	**n**	**1999**	**2000**	**Avg**	**Range**	**% Wins**
PM 2200 RR	13	988.9	845.8	933.9	460-1533	15
PM 2280 BGRR	13	1102.3	878.6	1016.2	477-1606	85
BG Advantage		113.4	32.8	82.3		
PM 2326 RR	8	855.5	1010	870.9	346-1386	50
PM 2326 BGRR	8	875.8	917	909.3	317-1518	50
BG Advantage		20.22	-93	38.4		
Overall RR	21	931.8	866.3	909.9		
Overall BGRR	21	1005.2	916.1	975.5		
BG Advantage		73.4	49.8	65.6		

Table 6. Gross Return Comparison for RR and BGRR varieties.

Variety	**n**	**1999**	**2000**	**Avg**
PM 2200 RR	13	$ 513.75	$ 415.80	$ 476.07
PM 2280 BGRR	13	$ 591.06	$ 406.17	$ 519.95
BG Advantage		$ 77.31	$ (9.63)	$ 43.88
PM 2326 RR	8	$ 439.36	$ 452.99	$ 442.77
PM 2326 BGRR	8	$ 439.36	$ 484.94	$ 446.71
BG Advantage		$ (5.4)	$ 31.95	$ 3.94
Overall RR	21	$ 481.87	$ 426.42	$ 463.39
Overall BGRR	21	$ 523.74	$ 428.68	$ 492.05
BG Advantage		$ 42.10	$ 2.26	$ 28.66

* Gross Return figured by multiplying average yield by average loan rate.