PERFORMANCE OF BT COTTON IN MISSISSIPPI, 1998

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Abstract

Approximately 55% of Mississippi's 930,000 acres of cotton were planted to Bt-transgenic varieties in 1998. A field survey was conducted during late season to compare performance of Bt and non-Bt varieties. Bt fields sustained significantly less caterpillar induced boll damage, 2.55% vs 4.81%, and received significantly fewer foliar insecticide treatments for control of bollworm and tobacco budworm, 1.22 vs 5.18. However, in the Delta region of the state, Bt fields sustained significantly more boll damage due to tarnished plant bug and received significantly more treatments for control of boll weevils. Although the Bt variety Stoneville 4740 received significantly more foliar sprays to control bollworm, it also sustained significantly more caterpillar induced boll damage than the average for all other Bt varieties.

Introduction

Of the approximately 930,000 acres of cotton grown in Mississippi in 1998, an estimated 55% were planted to Bt-transgenic varieties. As in the previous two years since the introduction of this technology, utilization of Bt-cotton was considerably higher in the Hill region of the state, approximately 85%, than in the Delta where Bt-cotton was planted on approximately 40% of total acreage. The Hill region was involved in the first full season of boll weevil eradication, and most growers planted a high percentage of their acreage to Bt varieties to mitigate against outbreaks of tobacco budworm, *Heliothis virescense*. Also, the Hill region suffered a severe outbreak of tobacco budworms during the 1995 growing season, and growers were well aware of the damage potential of resistant tobacco budworm on non-Bt cotton.

Two years of previous commercial experience demonstrated the high level of tobacco budworm control provided by Bt varieties. However, field experience during 1996 and 1997 also verified reports that Bt-cotton was less effective against bollworm, *Helicoverpa zea*, and may require supplemental foliar treatments when high populations of bollworms occur (Layton, 1996: Mahaffey, et. al., 1995). During the 1996 season, the first year of commercial planting of transgenic Bt-cotton, 28% of the Bt fields included in a statewide survey received at least one foliar treatment to control bollworms (Layton et. al., 1997). In a similar survey conducted in 1997, 41% of all Bt fields received one or more bollworms treatments (Layton, et. al., 1998). This 1997 survey also showed that Bt fields sustained significantly less caterpillar induced boll damage than non-Bt varieties, 1.86% vs 2.73%, and received significantly fewer foliar insecticide treatments for caterpillar pests, 0.86 treatments per field vs 3.14.

Because Bt varieties are highly effective against tobacco budworm but potentially susceptible to damage from high populations of bollworms, special scouting and management guidelines are recommended for Bt-cotton (Layton, 1996). Current guidelines recommend supplemental foliar treatments for bollworm if the number of larvae surviving to 1/4 inch in length or greater exceeds four per 100 plants (Layton, 1998). With the exception of the size criterion, this is the same threshold recommended for non-Bt varieties. Late season boll damage surveys provide a mechanism of evaluating the performance of Bt varieties and of gaining insight into the effectiveness of current recommendations for managing Bt-cotton.

Methods

Beginning in mid August of 1998 a statewide survey was conducted with the primary objectives being to: 1) compare percent of bolls damaged by caterpillar pests, boll weevils, and "bugs" (plant bugs or stink bugs) in Bt and non-Bt cotton fields, 2) compare number of foliar insecticide treatments applied for each of these three groups of pests, and 3) compare percent insect damaged bolls and insecticide treatment history of the Stoneville 4740 Bt variety to other Bt varieties. This third objective was included in response to observations made earlier during the season that the Stoneville 4740 Bt, which was being grown commercially for the first time, appeared to be more susceptible to bollworm infestations than other Bt varieties.

Fields included in the survey were chosen with the assistance of County Agents and/or local crop consultants. In most cases a pair of fields, one Bt and one non-Bt, were sampled from each farm visited. However, on farms where the Stoneville 4740 variety was available, an additional sample was taken. A total of 133 fields were included in the survey, 78 Bt and 55 non-Bt, from 28 counties, providing a representative sample of all cotton growing areas of the state.

The survey was conducted during the later half of August and early September and only included fields that had entered "cutout" as defined by Bourland et. al., 1992 (ie. Terminal growth had declined to the point that there were 5 or fewer nodes above the first position white bloom). Because of the unusually early crop maturity experienced in 1998, many fields had some open bolls on the lower nodes when the survey was conducted. Bolls that are damaged after they have attained approximately 7 days of age often remain on the plant, thus sampling fields at this stage

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provides an effective method of comparing relative levels of cumulative boll damage. It must be emphasized that these percent damaged boll counts do not provide a complete estimate of insect induced yield loss. Many fruit, especially those damaged as squares and small bolls, were shed from the plant before the survey samples were taken.

Percent boll damage was determined by sampling 300 bolls per field, taken as 100 consecutive unopened bolls from each of 3 randomly chosen sites per field, and determining the percent of bolls damaged by caterpillars (bollworms, tobacco budworms, armyworms, etc), boll weevils, or "bugs" (plant bugs or stink bugs). No attempt was made to differentiate between damage caused by bollworm/budworm and other caterpillar pests.

Treatment history was determined by interviewing the producer, referencing field treatment records, and determining the primary target pest of each insecticide application. Only treatments which the grower indicated were targeted primarily against bollworm or tobacco budworm were recorded as bollworm or tobacco budworm treatments. Thus, a treatment targeted primarily against fall armyworms was not recorded as a bollworm treatment, even though the material used may also have activity against bollworms.

Applications of ULV malathion applied as part of a boll weevil eradication program were not included in the survey. This is an important point, because the Hill region of the state, consisting of approximately 365,000 acres, was involved in the first full season of boll weevil eradication, and fields in the Hills received an average of 13.4 applications of ULV malathion. Also a portion of the South Delta, approximately 125,000 acres, initiated an eradication effort in August of 1998, and fields in this area received an average of 8.7 ULV malathion sprays. Because these treatments were applied uniformly to both Bt and non-Bt cotton, they would be expected to have a masking effect on potential differences in boll damage and number of treatments for non-caterpillar pests.

Data were analyzed as a simple t-test with the P level set at 0.1.

Results and Discussion

A total of 133 fields, from 28 different counties representing all areas of the state, were included in the survey. Seventy-eight of these fields were planted to Bt varieties, with DPL NuCotn 33B being the most common Bt variety and a total of 13 different Bt varieties being represented. Of the 55 non-Bt fields, Stoneville 474 was the most common variety, but an additional 15 non-Bt varieties also were represented. Forty-five of the fields sampled were from the Delta region of the state, and 88 fields were from the Hills. The larger number of fields from the Hill region reflects the larger number of cotton growing counties in this region, rather than acreage.

Although tobacco budworm populations were somewhat higher than in the two previous years of use of Bt-cotton, there were no reports of Bt-cotton requiring treatment to control tobacco budworms. Bollworm populations also were higher than they had been in 1997, and 79% of the Bt fields included in this survey received one or more foliar insecticide treatments specifically targeting bollworms (Table 1). This is considerably more than in previous surveys (Layton et. al., 1997; 1998) conducted in 1996 and 1997 when the percent of Bt fields receiving one or more bollworm treatments was 28% and 41%, respectively. It is especially noteworthy that a much larger portion of Bt-cotton in the Hill region was treated for bollworms in 1998 than in 1997, 83% vs 15%. This is likely a result of the reduction in beneficial insect populations due to repeated boll weevil eradication treatments.

Table 2 presents the comparisons of percent boll damage and treatment history in Bt and non-Bt cotton from a statewide perspective. As in previous years, Bt fields sustained significantly less caterpillar induced boll damage, 2.55%, than non-Bt fields, 4.81%, and also received fewer foliar insecticide applications targeted specifically against bollworm/tobacco budworm. There were no significant differences between Bt and non-Bt cotton in number of foliar treatments applied to control boll weevils or plant bugs, but Bt fields did sustain significantly more "bug" induced boll damage. However, it must be emphasized that ULV malathion treatments applied as part of the Boll Weevil Eradication Program in the Hills tended to mask many potential differences due to non-caterpillar pests.

Although there were no significant differences in percent caterpillar damaged bolls in the Delta, non-Bt fields did receive significantly more treatments for budworm/bollworm (Table 3). Note also in Table 3 that Bt fields received significantly more treatments for boll weevils and sustained significantly more "bug" induced boll damage. Essentially all of this "bug" damage can be attributed to tarnished plant bug, which was the primary hemipterous pest present in the Delta. These results, which were collected from areas that were either not involved in Boll Weevil Eradication or did not initiate eradication until late season, agree with previous reports and observations that both boll weevils and tarnished plant bugs are relatively more important in Bt-cotton (Layton, et. al., 1997). This increase in relative importance of boll weevils and plant bugs is a consequence of the reduction in treatments targeting caterpillar pests and the resulting reduction in coincidental control of boll weevils and plant bugs provided by these treatments.

In the Hill region (Table 4) Bt fields sustained significantly less caterpillar induced boll damage than non-Bt fields, 2.58% vs 6.2%, and received significantly fewer treatments

for bollworm/budworm. It is notable that the level of boll damage in non-Bt fields in the Hills is considerably higher than that detected in Delta fields, even though the number of budworm/bollworm treatments was similar. This reflects the higher populations of tobacco budworms experienced in the Hill region in 1998.

Table 5 shows the results for the comparison of the Stoneville 4740 Bt variety to all other Bt varieties. These results verify field observations that this variety is relatively less effective against bollworms than other Bts. Stoneville 4740 sustained significantly more damaged bolls, despite receiving significantly more foliar insecticide treatments specifically targeted against bollworms.

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Table 1. Percent of Bt cotton receiving supplemental foliar treatments for control of bollworms, 1998.

# bollworm sprays	Delta	Hills	MS combined
0	29	17	21
1 or more	71	83	79
1	29	65	54
2	25	13	17
3 or more	17	6	9

Table 2. Comparison of percent boll damage and number of insecticide treatments, Bt-cotton vs non-Bt cotton, Mississippi, 1998.

	% damaged bolls				
	caterpillars	boll weevils	"bugs"[1]		n
Bt	2.55*	0.26	0.76*		78
non-Bt	4.81*	0.24	0.4*		55
	avg. no. foliar treatments[2]				
	bollworm & tobacco budworm	boll weevil	"bugs"	total	n
Bt	1.22*	1.03	0.58	3.62*	78
non-Bt	5.18*	0.73	0.65	6.96*	55

Pairs of means followed by * are significantly different according to t-test (P=0.1)

[1]The category "bugs" includes tarnished plant bug and stinkbugs.

[2]Does not include treatments applied as part of the Boll Weevil Eradication Program.

Table 3. Comparison of percent boll damage and number of insecticide treatments, Bt-cotton vs non-Bt cotton, Mississippi Delta Region, 1998.

	% damaged bolls				
	caterpillars	boll weevils	"bugs"[1]		n
Bt	2.47	0.47	1.49*		24
non-Bt	2.56	0.54	0.57*		21
	avg. no. foliar treatments[2]				
	bollworm & tobacco budworm	boll weevil	"bugs"	total	n
Bt	1.46*	3.25*	1.58	6.79*	24
non-Bt	5.24*	1.9*	1.38	9.0*	21

Pairs of means followed by * are significantly different according to t-test (P=0.1)

[1]The category "bugs" includes tarnished plant bug and stinkbugs.

[2]Does not include treatments applied as part of the Boll Weevil Eradication Program.

Table 4. Comparison of percent boll damage and number of insecticide treatments, Bt cotton vs non-Bt cotton, Mississippi Hill Region, 1998.

	% damaged bolls				
	caterpillars	boll weevils	"bugs"[1]		n
Bt	2.58*	0.17*	0.44		54
non-Bt	6.2*	0.05*	0.29		34
	avg. no. foliar treatments[2]				
	bollworm & tobacco budworm	boll weevil	"bugs"	total	n
Bt	1.11*	0.04	0.13	2.2*	54
non-Bt	5.15*	0	0.21	5.71*	34

Pairs of means followed by * are significantly different according to t-test (P=0.1)

[1]The category "bugs" includes tarnished plant bug and stinkbugs.

[2]Does not include treatments applied as part of the Boll Weevil Eradication Program.

Table 5. Comparison of percent boll damage and number of insecticide treatments, Stoneville 4740 Bt-cotton vs all other varieties.

	% damaged bolls			
	caterpillars	boll weevils	"bugs"[1]	n
STV Bt	3.91*	0.28	0.61	19
other Bt	2.11*	0.26	0.81	59

	avg. no. foliar treatments[2]				
	bollworm & tobacco budworm	boll weevil	"bugs"	total	n
STV Bt	1.63*	0.68	0.74	3.84	19
non - Bt	1.08*	1.14	0.53	3.54	59

Pairs of means followed by * are significantly different according to t-test (P=0.1)

[1]The category "bugs" includes tarnished plant bug and stinkbugs.

[2]Does not include treatments applied as part of the Boll Weevil Eradication Program.