PERFORMANCE OF BT COTTON IN MISSISSIPPI, 1997.

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Abstract

Approximately 45% of Mississippi's 960,000 acres of cotton were planted to Bt-transgenic varieties in 1997. A field survey was conducted during late season to compare performance of Bt and non-Bt varieties. Bt-cotton fields sustained significantly less caterpillar induced boll damage than non-Bt fields, 1.86% vs 2.73%, and received fewer treatments targeting bollworms and tobacco budworms, 0.86 vs 3.14 foliar sprays per acre. However, Bt fields required more treatments for control of tarnished plant bugs and boll weevils. Other, less common pests that were observed more frequently in Bt-cotton included stink bugs and fall armyworms. Forty one percent of the Bt-cotton fields in the survey received at least one foliar treatment for control of bollworms. Supplemental foliar treatment of Bt-cotton fields for control of bollworms was more common in the Delta region of the state than in the Hills.

Introduction

The 1997 season represented the second season of commercial availability of transgenic Bt-cotton varieties. Approximately 45% of Mississippi's 960,000 acres of cotton was planted to transgenic Bt varieties in 1997, a portion that was similar to the approximately 42% of total acreage planted to Bt-cotton varieties in 1996.

Experiences in 1996 verified expectations that Bt-cotton should provide excellent control of tobacco budworm, *Heliothis virescens*, but may require supplemental foliar treatment if high populations of bollworms, *Helicoverpa zea*, occurred (Layton, 1996; Mahaffey, et. al., 1995). Bollworm populations were unusually high in 1996, and many producers and consultants expressed concern over the potential for bollworm to damage Bt-cotton. No Bt-cotton fields were treated for tobacco budworm in 1996, but results of a limited statewide survey (Layton et. al., 1997) showed that approximately 28% of the Bt-cotton fields in the state received at least one treatment for control of bollworms, while approximately 89% of the non-Bt fields required treatment for bollworm or tobacco budworm. The average number of bollworm/tobacco budworm treatments applied per field was 0.33 for Bt fields and 3.05 for non-Bt. Despite this lower number of foliar treatments, Bt fields experienced only 2.7% damaged bolls compared to 4.9% boll damage in non-Bt fields.

Determining when bollworm infestations are heavy enough to require supplemental treatment of Bt-cotton and defining criteria for making this decision are some of the key questions regarding use of this new insect management tool. Failure to treat when necessary will allow excessive yield loss, whereas excessive/unnecessary treatment reduces the management benefits and economic advantages associated with use of Bt-cotton. Current guidelines for managing Bt-cotton in Mississippi 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 during the period from first bloom to "cutout" (Layton, 1997). However there is a need to continue to evaluate such guidelines. Late season boll damage surveys are one method of gaining insight into the effectiveness of current recommendations for scouting procedures and treatment thresholds in Bt-cotton. Detection of excessive caterpillar induced boll damage in Bt-cotton would suggest that either scouting procedures and/or thresholds require modification or that current guidelines are not being effectively implemented.

Methods

During the later portion of the 1997 growing season a statewide survey was conducted. The key objectives of the survey were: 1) to compare percent of bolls damaged by caterpillar pests, boll weevils, and "bugs" (tarnished plant bugs + stink bugs) in Bt and non-Bt cotton fields; 2) to compare the number of foliar insecticide treatments applied for control of these three groups of pests, and 3) to compare percent insect damaged bolls and foliar insecticide treatment history of Deltapine Bt varieties to Paymaster Bt varieties.

Farms and fields included in the survey were chosen with the assistance of the County Agents and/or local crop consultants. In most cases, a pair of fields, one Bt field and one non-Bt field, was sampled for each farm visited. In some cases an additional Bt field was sampled to allow comparison of DPL Bt varieties to Paymaster Bt varieties.

The survey was conducted during late August and early September and only included fields that had entered "cutout" but had less that 10% open bolls. For the purposes of this survey cutout was defined as the point when terminal growth had declined to less than "node above white bloom = 5 (Bourland, et. al., 1992). Because bolls that are approximately seven or more days of age often remain on the plant if damaged by insects, sampling fields at this stage provided a partial view of cumulative boll damage. However, it must be noted that the numbers reported for percent damaged bolls still represent an incomplete estimate of total insect damage, because many damaged fruit,

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especially those damaged as squares and small bolls, are shed from the plant.

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 + stink bugs). No attempt was made to differentiate between damage caused by bollworm/tobacco budworm and other caterpillar pests, such as fall armyworm.

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 (e.g. a treatment targeted primarily against fall armyworms was not recorded as a bollworm/budworm treatment even though the insecticide used may also have activity against these pests). Also, applications of ULV malathion that were applied as part of a boll weevil eradication program were not included in the survey.

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

Results & Discussion

A total of 106 fields, from 25 different counties representing all areas of the state, were included in the survey. Fifty six of these fields were planted to Bt-cotton varieties. DPL NuCotn 33B was the most common Bt variety planted, but a total of eight additional Bt-cotton varieties were included in the survey. The non-Bt fields were divided among a total of 13 different varieties with Stoneville 474 being the most common. Fifty five of the survey fields were located in the Delta region of the state, and 51 fields were located in the Hill region.

As in 1996, tobacco budworm populations were unusually low in 1997 and there were no reports of Bt-cotton requiring treatment to control tobacco budworm. Because Bt-cotton is highly effective against tobacco budworm, it is likely that the statewide planting of large acreages to Bt varieties is at least partially responsible for the lower numbers of tobacco budworms experienced during the past two years. This factor must be kept in mind when interpreting results of studies that attempt to compare yields and production costs between Bt and non-Bt cotton. If planting a large portion of acreage to Bt varieties does have an area wide effect on tobacco budworm populations, then adjacent acreages of non-Bt cotton are likely to benefit, both in yield and in reduced insect control costs. Because quantifying such peripheral benefits is difficult or impossible, there is a potential to under estimate any economic benefits that may result from utilization of Bt-cotton.

Bollworm populations were considerably lower than in 1996, but this species was still more common than tobacco budworm in 1997. Overall insect damage was relatively low with the percent caterpillar damaged bolls ranging from 0 to 11% in Bt-cotton fields and 0 to 10.3% in non-Bt fields. However, high populations of bollworms still exhibited a capacity to cause excessive damage to Bt-cotton under some situations. Prior to the initiation of this survey, an average of 26% boll damage was observed in one field of Delta Pine NuCotn 33B Bt-cotton. Although some fall armyworms were present in this field, the majority of the damage was attributed to bollworms.

Approximately 41% of the Bt-cotton fields in the state received at least one treatment specifically for control of bollworms (Table 1). However, the frequency of treatment of Bt-cotton for bollworms was much higher in the Delta region, where 59% of the Bt-fields received at least one supplemental treatment to control bollworm, than in the Hill region of the state, where only 15% of the Bt-fields received a bollworm treatment.

Table 2 presents the results for the comparison of boll damage and treatment history in Bt-cotton and non-Bt cotton for the state as a whole. Bt fields sustained significantly less boll damage from caterpillar pests, 1.86%, than non-Bt fields, 2.73%, but there was no significant difference in the amount of damage caused by boll weevils or "bugs". As expected, the non-Bt cotton required significantly more treatments for control of bollworm and tobacco budworm than the Bt-cotton. However the reduction in foliar sprays targeting bollworm and tobacco budworm in the Bt-cotton resulted in less coincidental control of boll weevils and "bugs". Consequently, Bt-cotton required more treatments specifically for control of these pests.

Data for individual regions of the state, Hills and Delta, are presented in Table 3 and Table 4. Bt cotton sustained less caterpillar induced boll damage in both regions, but the difference was significant only in the Hills. Both regions required significantly more foliar insecticide treatments for control of bollworm and tobacco budworm in non-Bt cotton, but Bt-cotton grown in the Delta required significantly more treatments targeting "bugs", specifically tarnished plant bugs. Bt-cotton required fewer total insecticide treatments in both regions.

In considering the lack of significant differences in number of boll weevil treatments between Bt and non-Bt cotton, it must be noted that the Hill region of the state initiated a boll weevil eradication program during the first week of August. An average of approximately 10.5 treatments of ULV malathion were applied per acre during the remainder of the season. It is likely that the difference in number of boll weevil treatments required on Bt and non-Bt cotton would have been much greater in the Hill region in the absence of this boll weevil eradication program. Bt-cotton definitely presents greater opportunities for boll weevil to increase in pest status, and many Mississippi producers feel that they can not realize the maximum benefit of utilizing transgenic Bt-cotton without eradicating the boll weevil.

Although no attempt was made to distinguish boll damage inflicted by bollworm and tobacco budworm from that caused by armyworms, fall armyworms were present in many of the survey fields and were observed to be a common cause of "caterpillar induced boll damage" in some fields. Fall armyworm infestations were noted to be more common in the southern portion of the state and were also observed to be more common in fields of Bt-cotton than in non-Bt fields. This higher incidence of fall armyworms in Bt-cotton is attributed to less coincidental suppression of small fall armyworm larvae as a result of the reduced number of foliar treatments targeting other caterpillar pests. These observations support the recommendation that scouting for fall armyworms will be relatively more important in Bt-cotton than in non-Bt (Layton, 1997).

Stink bugs were another group of pests that were observed to be more common in fields of Bt-cotton, especially in the more southern portion of the state. Again, this is attributed to less coincidental control as a result of the reduction in foliar treatments for other pests. The extreme Southeastern portion of Mississippi has been involved in boll weevil eradication for several years and weevil populations, and number of insecticide treatments applied to control boll weevils, are extremely low in this area. This is also the area of the state where stink bug problems were observed to be greatest, with some fields requiring two to three treatments specifically to control stink bugs. One survey field from this area sustained 8% “bug” induced boll damage. It is likely that stink bugs will continue to become more important as pests of Mississippi cotton, especially Bt-cotton, as boll weevil eradication progresses through other areas of the state.

During the 1996 season and again in 1997 several pest management professionals noted that some varieties of Bt-cotton appeared to be more susceptible to bollworm/budworm damage than others. Of the Bt fields surveyed in 1997, 37 were planted to transgenic Bt varieties marketed by Deltapine and 18 were planted to Paymaster Bt varieties. This provided an opportunity to compare boll damage and treatment parameters for the two variety sources. Results (Table 5) indicate that the Paymaster Bt varieties sustained significantly more caterpillar induced boll damage, but did not require additional insecticide treatments. However, this relatively small difference in boll damage should not be overemphasized when choosing Bt-cotton varieties. To some degree, yield results of public variety trials already account for differential susceptibility to insect damage, and other factors such as maturity class and disease susceptibility must also be considered when choosing a Bt-cotton variety.

Summary

In summary, the overall performance of Bt-cotton during it's second year of commercial use in Mississippi was positive. Bt-cotton continued to provide excellent control of tobacco budworms and good control of low to moderate populations of bollworms. The relatively low level of caterpillar induced boll damage encountered in Bt-cotton fields indicates that current scouting guidelines and thresholds are adequate for preventing excessive yield loss from bollworms. However, with the reduction in foliar treatments for control of bollworm and tobacco budworm, growers experienced an increased need to treat specifically for control of boll weevils, tarnished plant bugs, and stink bugs. Bt-cotton fields must also be monitored more closely for fall armyworm infestations.

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Table 1. Percent of Bt-cotton fields receiving supplemental foliar treatments for control of bollworms, 1997.

# bollworm Sprays	Delta	Hills	MS combined
0	41	85	59
1 or more	59	15	41
1	28	4	18
2	16	4	11
3 or more	16	8	12

Table 2. Comparison of percent boll damage and number of insecticide treatments, Bt-cotton vs non-Bt cotton, Mississippi, 1997.

	% damaged bolls				
	caterpillars	boll weevil	"bugs"[1]		n
Bt	1.86 *	0.48	0.38		56
non-Bt	2.73 *	0.25	0.31		50
	avg. no. foliar treatments [2]				
	bollworm & tobacco budworm	**boll weevil**	**"bugs"**	**total**	**n**
Bt	0.86 *	2.63	1.16 *	5.11 *	56
non-Bt	3.14 *	2.12	0.76 *	6.34 *	50

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

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

[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 Hill Region, 1997.

	% damaged bolls				
	caterpillars	boll weevil	"bugs"[1]		n
Bt	2.01 *	0.78	0.55		26
non-Bt	3.21 *	0.37	0.44		25
	avg. no. foliar treatments [2]				
	bollworms & tobacco budworms	**boll weevil**	**"bugs"**	**total**	**n**
Bt	0.38 *	2.65	0.19	3.50 *	26
non-Bt	1.88 *	2.32	0.36	4.84 *	25

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

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

[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 Delta Region, 1997.

	% damaged bolls				
	caterpillars	boll weevil	"bugs"[1]		n
Bt	1.73	0.22	0.23		30
non-Bt	2.24	0.12	0.17		25
	avg. no. foliar treatments [2]				
	bollworms & tobacco budworms	**boll weevil**	**"bugs"**	**total**	**n**
Bt	1.27 *	2.60	2.00 *	6.50 *	30
non-Bt	4.40 *	1.92	1.16 *	7.84 *	25

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

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

[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, DPL Bt-cotton varieties vs Paymaster Bt-cotton varieties, Mississippi, 1997.

	% damaged bolls				
	caterpillar s	boll weevil	"bugs"[1]		n
DPL Bts	1.42 *	0.50	0.40		37
Paymaster Bts	2.57 *	0.46	0.37		18
	avg. no. foliar treatments [2]				
	bollworms & tobacco budworms	**boll weevil**	**"bugs"**	**total**	**n**
DPL Bts	0.92	2.38	1.14	4.86	37
Paymaster Bts	0.78	2.89	1.22	5.44	18

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

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

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