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EVALUATION OF TREATMENT THRESHOLDS FOR BOLLGARD II COTTON

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Abstract

Secondary pests have become a problem in B.t. cotton because of decreased insecticide applications that were previously needed to target the tobacco budworm (*Heliothis virescens*) and the bollworm (*Helicoverpa zea*). Monsanto has developed Bollgard II cotton, which further reduces and may eliminate the need for bollworm treatment. Secondary pests such as stink bugs and plant bugs now pose a serious threat. Two field locations were planted with Bollgard II cotton, and 10 treatment thresholds were examined, including thresholds for both bollworm and piercing/sucking pests. Bollworm thresholds were not reached. With the plant bug/stink bug complex, a significant correlation was made between plant bug numbers and boll damage at one location (P=0.0376), but not at the second location. There were no significant correlations between stink bugs and boll damage at either location. No differences in yield were shown at either location.

Introduction

In the past, cotton boll damage and yield loss has been attributed to two major lepidopterous pests, bollworm (*Helicoverpa zea*) and tobacco budworm (*Heliothis virescens*). Introduction of transgenic, *Bacillus thuringiensis* (Bt) cotton has decreased losses from these pests and reduced the need for early season insecticide applications (Turnipseed et al. 1995). Secondary pests, once controlled by these lepidopterous insecticide applications, have become major pests. These include the southern green stink bug, *Nezara viridula* (L.), the green stink bug, *Acrosternum hilare* (Say), the brown stink bug, *Euschistus servus* (Say), and the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois).

The original Bt cotton, which contains one gene (Cry 1Ac), is very effective controlling damage from tobacco budworm but less effective against bollworm. Treatment thresholds were established for bollworm, particularly in the southeast, to avoid yield loss (Sullivan et al. 1998). Monsanto Corporation has now developed Bollgard II, which contains two genes (Cry 1Ac, Cry 1Ab) from the Bt bacterium. Bollgard II cotton has shown excellent control of bollworm (Ridge et al. 2001), but has no activity against the piercing/sucking bug complex.

Currently, the SC threshold for stink bugs is 1 bug per 6 ft of row. The plant bug threshold is 1 bug per foot of row (Clemson Extension 1999). These pests are not evenly distributed within fields and sampling these flighty and sporadic insects is difficult. Feeding by these piercing/ sucking bugs causes damage on the inside of the boll wall. Damage ranges from a simple puncture wound to a more obvious “wart.” Recently, a boll damage threshold was established to initiate treatment. The current SC threshold is 20% boll damage on quarter-sized bolls. The objectives of this study were to assess the need for threshold development for bollworms in Bollgard II cotton, refine established boll damage thresholds concerning stink bugs and plant bugs, and distinguish which of these piercing/sucking insects are most responsible for the boll damage.

Materials and Methods

Experimental fields were located at the Edisto Research and Education Center in Blackville, SC (Station Field) and at the Bamberg farm in Denmark, SC (Bamberg Field); both locations were irrigated. Test plots were arranged in a randomized complete block design with four replications per treatment. Plots at the Station field were 12 rows wide and 50 ft in length and at the Bamberg field, 16 rows wide and 50 ft long. Treatments were applied using a CO_2 backpack sprayer at 55 psi with four 3x nozzles that covered 2 rows. The total volume applied was 10.5 gallons/acre. Four rows of cotton from each were picked with a two row cotton picker.

In 2001, the following ten treatment thresholds were evaluated for Bollgard II cotton at the Bamberg field.

Threshold	Treatment/Rate (lbs. ai/ac)
1. 75 eggs per 100 plants	Karate .033
2. 4 worms per 100 plants	Karate .033
3. 4 worms per 100 bloom tags	Karate .033
4. untreated check	
5. Insurance spray (weekly 6×)	Karate .033 and Tracer .067
6. 20% bug damage to 100 bolls	Karate .033
7. Automatic: 10d* after init. Bw** flight	Karate .033
8. Automatic: 10d, 20d after init. Bw** flight	Karate .033
9. Automatic: 10d, 20d after init. Bw** flight	Bidrin .5
10. Automatic: 20d after init. Bw** flight	Karate .033

* day.
**initial bollworm flight.

With plots located at the station field, it became obvious that bollworm thresholds would not be met. Changes were then made to incorporate other possible thresholds with piercing/sucking insects. The following were the revised treatment thresholds used at the Station field.

Threshold	Treatment/Rate (lbs. ai/acre)
1. 75 eggs per 100 plants	Karate .033
2. Late season 20%	Karate .033
3. 4 worms / 100 bloom tags	Karate .033
4. untreated check	
5. Insurance spray (weekly 6×)	Karate .033 and Tracer .067
6. Early season 20%	
7. Automatic: 10d* after init. Bw** flight	Karate .033
8. Automatic: 10d, 20d after init. Bw** flight	Karate .033
9. Automatic: 10d, 20d after init. Bw** flight	Bidrin .5
10. Bug damage to bolls at 40%	Karate .033

* day.
**initial bollworm flight.

Sampling of insects was done using a 1m × 1m drop cloth, placed between rows. Insects counted were the bollworm, *Helicoverpa zea* , the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), the southern green stink bug, *Nezara viridula* (L.), the green stink bug, *Acrosternum hilare* (Say), and the brown stink bug, *Euschistus servus* (Say). All three species of stink bugs were later combined into one category because of low numbers.

Boll damage from plant bugs and stink bugs was evaluated by examination of the internal wall of the boll. A boll with either a puncture wound or a wart was recorded as a damaged boll. Twenty-five bolls were pulled randomly from each replication of a treatment and examined for internal symptoms. Quarter-sized bolls were determined to give the best representative sample of damage.

Treatment 1 was examined by scouting the top 1/3 of 100 plants for eggs. In treatment 2, whole plant scouting was used to search for four large worms. This involved the examination of terminals, leaves, stems, squares, white and pink blooms, bracts, and bolls. At the Station Field, when it became apparent that this threshold would not be reached (14 August), it was changed and treated for a late season 20% boll damage threshold. This was done to show the difference in treating at 20% on 14 August or treating at 20% on June 27 (treatment 6). In treatment 3, 100 bloom tags were examined for presence of bollworms. Bloomtags were categorized as those blooms that were dry and no longer purple.

The insurance treatment (treatment 5) was sprayed 7 times on a weekly basis. The first application was on 7/3 and the last on 8/14. For treatments 7, 8, 9, and 10, the “initial bollworm flight” was determined to be the day that scouting numbers reached 15 eggs per 100 plants (July 16). Ten days after this initial flight, insecticide was applied. Three to five days after every insecticide application, plots were sampled with a drop cloth and compared to an untreated check (treatment 4). Treatment 10 at the Station Field was treated for 40% boll damage on August 3.

Results

Station Field

Treatment thresholds were never reached in either location for cotton bollworm. Only one large worm was found in Bollgard II plots throughout the entire season in untreated plots. These data are consistent with those found in other experiments conducted in 2000 and 2001 (Ridge, personal communication). Bollworms have not been a problem in Bollgard II cotton.

There was no significant relationship between stink bug numbers and boll damage (P= 0.1136). However, when looking at plant bug numbers and boll damage, there is a significant correlation (P=.0376, Fig. 1). Observations during sampling indicate that plant bugs were usually common and well dispersed, whereas stink bugs were found in low numbers and concentrated locations (Table 3). Yield data (Table 1) indicate that any stink bug/plant bug damage incurred during the summer at any of the thresholds did not effect lint yields. The untreated plot yield (treatment 4) differed very little from that treated weekly (treatment 5). Even treatment 10, which was sprayed at 40% boll damage, showed no significant loss in yield compared to other treatments.

Bamberg Field

There was no significant correlation between stink bugs and boll damage (P= 0.1094) or plant bugs and boll damage (P=0.2064). Table 5 indicates that plant bugs were more common throughout the season, though both stink bug and plant bug numbers were generally low. Treatment 2 and treatment 3 were never initiated during the season. Neither of these treatments, nor the untreated check, showed less yield than others that were treated (Table 2). Treatment 5, which was treated weekly, was no different from the untreated plots.

Discussion

Data collected from these two studies indicate the cotton bollworm is not a problem in Bollgard II cotton. Small numbers of piercing/sucking bugs were found throughout the season; established thresholds of 1 stink bug per 6 ft. row or 1 plant bug per 1 ft row were never reached. However, boll damage thresholds were reached despite low bug numbers, even the late season 40% damage threshold at the Station field. It is important to note that every internal symptom, warts and punctures, was counted as boll damage. It is not likely that all of these symptoms lead to yield loss. Bug damage to bolls was low throughout the season (about 10%) at Bamberg field due to lack of insect pressure. This is shown by no difference in lint yields and the insignificant correlation between stink bugs and boll damage and plant bugs and boll damage.

Data at the Station Field indicate that plant bugs were responsible for the majority of the damage seen to bolls at this location in 2001 (P=.0376), with stink bugs contributing a lesser amount (Fig 4, Table 3).

These results do not mean that bug damage should go unnoticed throughout the season in Bollgard II cotton. These insects can and will cause damage to both conventional and Bollgard cotton (Wene and Sheets 1964, Toscano and Stern 1976, Roach 1988, Barbour et al. 1990, Turnipseed et al. 1995, Turnipseed and Greene 1996). Our results indicate that current thresholds regarding boll damage by the piercing/sucking bug complex may be too low and current damage assessment levels may need to be revised. In other words, should a boll with a single puncture wound and no evident lint damage be counted the same as a boll with multiple warts and obvious lint damage? Current boll damage recommendations do not account for different levels or degrees of damage. Further studies are needed to discriminate between various levels of damage.

Works Cited

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Table 1. Application rates, dates, and lint yields at Station Field in 2001.

Treatment	Rate (lbs ai/acre)	# appli.(dates)	Mean Yield (lbs/acre)
1. Karate	0.033	1(7/23)	1246.a
2. Karate	0.033	1(8/15)	1464.a
3. Karate	0.033		1336a
4. untreated			1300a
5. Karate and Tracer	.033 and .067	7(7/3---8/14)	1314a
6. Karate	0.033	1(7/27)	1384a
7. Karate	0.033	1(7/27)	1404a
8. Karate	0.033	2(7/27, 8/6)	1330a
9. Bidrin	0.5	2(7/27, 8/6)	1336a
10. Karate	0.033	1(8/2)	1443a

Mean in each column followed by same letter are not significantly different (alpha = .05).

Table 2. Application rates, dates, and lint yields at Bamberg Field in 2001.

Treatment	Rate (lbs ai/acre)	# appli.(dates)	Mean Yield (lbs/acre)
1. Karate	0.033	1(7/26)	1709a
2. Karate	0.033		1573a
3. Karate	0.033		1670a
4. untreated	untreated		1664a
5. Karate and Tracer	.033 and .067	7(7/2-8/13)	1641a
6. Karate	0.033	1(7/26)	1563a
7. Karate	0.033	1(7/26)	1695a
8. Karate	0.033	2(7/26, 8/7)	1684a
9. Bidrin	0.5	2(7/26, 8/7)	1707a
10. Karate	0.033	1(8/7)	1668a

Mean in each column followed by same letter are not significantly different (alpha = .05).

Table 3. Mean numbers of stink bugs and plant bugs in 3 beats/plot in untreated check. Station Field.

	21-Jul	27-Jul	2-Aug	8-Aug	16-Aug	28-Aug
stink bugs	0.5a	0.75a	1.25a	0.5a	0.75a	1.75a
plant bugs	5a	7.25b	7.75a	6.75b	1.5a	0.5a

Means in column followed by same letter are not significantly different (alpha = .05).

Table 4. Mean stink bugs and plant bugs in insurance treatment 5. Station Field.

	21-Jul	27-Jul	2-Aug	8-Aug	16-Aug	28-Aug
stink bugs	0a	0.25a	0.5a	0.5a	0.25a	4.5a
plant bugs	1.5a	0a	0.5a	0a	0a	0.25a

Means in each column followed by same letter are not significantly different (alpha = .05).

Table 5. Mean numbers of stink bugs and plant bugs in 3 beats/plot in untreated check. Bamberg Field.

	21-Jul	1-Aug	16-Aug
stink bugs	0a	1.5a	2.25a
plant bugs	6.5b	5b	5.5a

Means in column followed by same letter are not significantly different (alpha = .05).

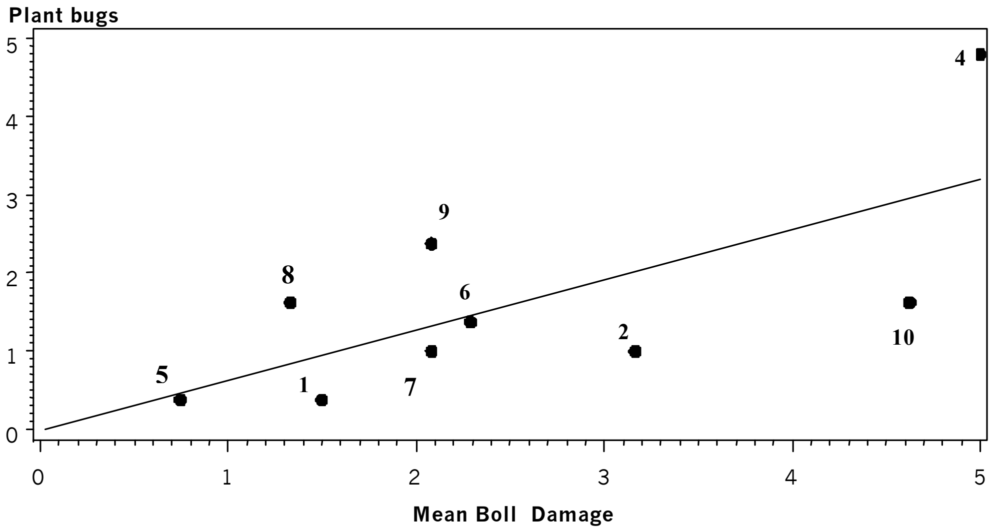

Figure 1. Correlation of Mean Plant Bugs (3 bts/plot) and Boll Damage at Station Field (P=0.0376).