CONTROL OF THE HELIOTHINE COMPLEX IN BOLLGARD COTTON CULTIVARS, 1998-1999

Donald R. Johnson, Gus M. Lorenz, John D. Hopkins, and Larry M. Page[1]

RESEARCH PROBLEM

The bollworm, *Helicoverpa zea* (Boddie), and the tobacco budworm, *Heliothis virescens* (Fab.), are perennial pests of Arkansas cotton that require some level of control each year. A new management tactic, the utilization of transgenic *Bacillus thuringiensis* (Bt) cotton varieties, is now available to growers to help manage the Heliothine complex. Research is needed to help understand how to integrate this new tactic with traditional methods of Heliothine control.

BACKGROUND INFORMATION

The commercialization of transgenic cotton cultivars containing the insecticidal endotoxin of Bt introduced a new approach in managing the Heliothine complex in cotton (Deaton, 1995). Bt cotton alone has been shown to provide excellent mortality of the tobacco budworm but is less effective on the bollworm (Leonard *et al.*, 1997). In instances where bollworm pressure is high, the reliance on Bt cotton alone to provide control has been less than satisfactory. Improved bollworm control in Bt cotton has been documented through the use of supplemental insecticide applications (Burd *et al.*, 1999). The objective of these studies was to document, under Arkansas conditions, improved Heliothine control in Bt cotton through supplemental applications of traditional and new insecticides.

RESEARCH DESCRIPTION

Two field trials were conducted in Jefferson County in 1998 and 1999, to determine the efficacy of Bt cotton, with and without supplemental insecticides, on the Heliothine complex. Treatments were evaluated in small plots arranged in a randomized complete-block design with four replications. The cotton varieties used were DP50B (1998) and DP50 (non-Bt), DP50B, 15813, and 15985 (1999). Insecticide treatments were initiated when Heliothine egg densities were at or approaching recommended treatment levels. Applications were made with a John Deere 6000 hi-cycle at 65 psi / 10 gal/acre (1998) and 45 psi for every 8.56 gal/acre (1999) using Teejet TXVS-6 nozzles on 20-inch centers. In 1998, treatments (lb ai/acre) evaluated were a Bollgard/

---

[1] Pest Management Section Leader and IPM Coordinator, University of Arkansas, Cooperative Extension Service, Little Rock, AR; Insecticide Testing Coordinator and Extension Associate (Pest Management), University of Arkansas Cooperative Extension Service, Lonoke, AR.

untreated control, Tracer 4SC (0.067), Karate 1EC (0.025), Steward 1.25SC (0.09), Decis 1EC (0.025), Asana 0.66EC (0.03), Baythroid 2EC (0.028), and Larvin 3.2SC (0.4). Application dates in 1998 were 10 July, 17 July, and 28 July. Evaluation dates in 1998 were 15 July (5DAT#1), 22 July (5DAT#2), 31 July (3DAT#3), and 23 October (at harvest). In 1999, Treatments (lb ai/acre) evaluated were a DP50/untreated control, DP50/Baythroid 2EC (0.03), DP50B/untreated control, DP50B/Baythroid 2EC (0.03), 15813/untreated control, 15813/Baythroid 2EC (0.03), 15985/untreated control, 15985/ Baythroid 2EC (0.03). Application dates in 1999 were 9 July, 2 August, and 9 August. Evaluation dates in 1999 were 13 July (4DAT#1), 20 July (11DAT#1), 26 July (17DAT#1), 5 August (3DAT#2), 13 August (4DAT#3), 16 August (7DAT#3), and 12 October (at harvest). Data were collected in 1998 by examining 25 squares and 25 flower at random from the center of each plot for the presence of live larvae. In 1999, data were collected by examining 50 terminals and 50 squares at random from the center of each plot for the presence of live larvae and square damage. Yields were determined by harvesting the middle rows of each plot with a commercial two-row John Deere cotton picker. Data were processed using Agriculture Research Manager Ver. 6.0.1. Analysis of variance was run and the least significant difference was used to separate means.

RESULTS AND DISCUSSION

In 1998, terminal egg counts indicated Heliothine pressure at 5DAT#1; however, terminal larvae counts and live worm counts/50 squares and 50 blooms, showed that all treatments were controlling worms, including the Bollgard protected untreated control. Worm counts in 1998 at 5DAT#2 and 3DAT#3 indicated that all insecticide treatments significantly reduced the number of total live larvae found in squares and blooms compared to the Bollgard/untreated control. At 3DAT#3 Larvin 3.2SC at 0.4 lb ai/acre provided significantly less control of Heliothine larvae than all other insecticide treatments except Asana 0.66EC at 0.03 lb ai/acre (Table 1).

In 1998, all treatments numerically out yielded the Bollgard/untreated control with Decis 1EC at 0.025 lb ai/acre being the only insecticide treatment to significantly out yield the Bollgard/untreated control (Table 1). However, Decis failed to significantly out yield the other insecticide treatments. In 1999, all treatments containing the Bollgard gene, Bollgard II gene, or Baythroid had a significantly lower seasonal average for live Heliothine larvae per 50 terminals than the DP50 (non-Bollgard) / no insecticide treatment. There were no significant differences among treatments for the seasonal average of live Heliothine larvae per 50 squares; however, there was a distinct numerical reduction in the seasonal average of live Heliothine larvae per 50 squares in treatments containing the Bollgard or Bollgard II genes. Given the seasonal average for Heliothine square damage, all treatments containing the Bollgard or Bollgard II gene had significantly fewer Heliothine damaged squares than the DP50 (non-Bollgard)/ no insecticide treatment. The DP50 (non-Bollgard) + Baythroid treatment was intermediate in the level of Heliothine square damage and did not differ significantly from any other treatment (Table 2).

When rated 7DAT#3, there were no significant differences among treatments for the numbers of beet armyworms found; however, on a numerical basis, cotton receiving Baythroid treatment or containing the Bollgard II gene did have fewer beet armyworms present. This same relationship was true for beet armyworm damage, with the differences being statistically significant. Also, when rating beet armyworm damage, all treatments receiving Baythroid insecticide had significantly less damage than treatments protected by the Bollgard II gene alone (data not shown). Yield differences among beet armyworm treatments were not significant; however, all treatments that received Baythroid applications or were protected by the Bollgard or Bollgard II genes numerically out-yielded the DP50 / untreated control treatment (data not shown).

PRACTICAL APPLICATION

The commercial Bt variety DP50B containing the Bollgard gene provided an acceptable level of Heliothine protection compared to the variety DP50 without the Bollgard gene. When Bt technology was supplemented with insecticide applications to provide additional control of lepidopterous pests other than the tobacco budworm, additional significant benefits to worm control and yield were achieved. In addition, Bt technology via the Bollgard II gene appears to offer an additional measure of beet armyworm control over the Bollgard gene.

ACKNOWLEDGMENTS

The authors would like to express their appreciation to AgrEvo, Bayer, Dow-Agrosciences, DuPont, Monsanto, Rhone-Poulenc, and Zeneca for their support of this work.

LITERATURE CITED

Burd, T., J.R. Bradley, Jr., and J.W. Van Duyn. 1999. Performance of selected *BT* cotton genotypes against bollworm in North Carolina. Proc. Beltwide Cotton Conf., National Cotton Council, Memphis, TN. pp. 931-934.

Deaton, W.R. 1995. Bollgard™ gene for cotton. Proc. Beltwide Cotton Conf., National Cotton Council, Memphis, TN. p. 37.

Leonard, B.R., H. Fife, K. Torrey, J.B. Graves, and J. Holloway. 1997. *Helicoverpa/ Heliothis* management in Nucotn and conventional cotton cultivars in Louisiana. Proc. Beltwide Cotton Conf., National Cotton Council, Memphis, TN. pp. 863-867.

Table 1. 1998 Evaluation of insecticides for control of Heliothine species in Bollgard cotton.

			Total larvae		Lint
Treatment	Form	Rate	5DAT#2	3DAT#3	yield
		lb ai/acre	----- 25 sq & 25 blm ----		lb/acre
Bollgard/Untreated			2.5 a[z]	3.8 a	781.6 b
Tracer	4 SC	0.067	0.5 b	0.0 c	968.2 ab
Karate	1 EC	0.025	0.3 b	0.0 c	968.2 ab
Steward	1.25 SC	0.09	0.5 b	0.3 c	852.6 ab
Decis	1 EC	0.025	0.0 b	0.3 c	1086.3 a
Asana	0.66 EC	0.03	0.3 b	0.8 bc	856.2 ab
Baythroid	2 EC	0.028	0.3 b	0.0 c	886.3 ab
Larvin	3.2 SC	0.4	0.5 b	1.8 b	881.5 ab

[z] Means followed by same letter do not significantly differ (P=0.05, Duncan's New MRT).

Table 2. 1999 Evaluation of Bollgard technology for control of bollworm and tobacco budworm.

		Heliothine species[z]		Square
Treatment	Rate	Term.	Squares	damage
	lb ai/acre			
DP50 untreated	–	0.9 a[y]	0.7 a	2.2 a
DP50 Baythroid	0.03	0.4 b	0.7 a	1.7 ab
DP50B untreated	–	0.1 b	0.1 a	0.5 b
DP50B Baythroid	0.03	0.0 b	0.0 a	0.1 b
15813 untreated	–	0.1 b	0.1 a	0.5 b
15813 Baythroid	0.03	0.1 b	0.1 a	0.5 b
15985 untreated	–	0.1 b	0.0 a	0.1 b
15985 Baythroid	0.03	0.0 b	0.0 a	0.1 b

[z] Heliothine counts and damage are seasonal means of averages of 50 squares and 50 terminals.

[y] Means followed by same letter do not significantly differ (P=0.05, Student-Newman-Keuls).

Table 3. 1999 Evaluation of Bollgard technology for control of bollworm and tobacco budworm.

		Beet armyworm[z]		Lint
Treatment	Rate	Damage	No./3 sites	yield
	lb ai/acre			lb/acre
DP50 untreated	–	2.0 a[y]	30.0 a	997.1 a
DP50 Baythroid	0.03	0.0 c	0.0 a	1024.2 a
DP50B untreated	–	2.3 a	31.5 a	1060.4 a
DP50B Baythroid	0.03	0.0 c	0.0 a	1071.5 a
15813 untreated	–	1.0 b	1.8 a	1154.9 a
15813 Baythroid	0.03	0.0 c	0.0 a	1087.6 a
15985 untreated	–	1.0 b	0.3 a	1162.9 a
15985 Baythroid	0.03	0.0 c	0.0 a	1090.6 a

[z] BAW counts and damage were rated 7DAT#3.

[y] Means followed by same letter do not significantly differ (P=0.05, Student-Newman-Keuls).