EFFICACY OF HELIOTHINE CONTROL MATERIALS IN *Bt* AND NON-*Bt* COTTON

John D. Hopkins, Donald R. Johnson, Gus M. Lorenz, III, and Jack D. Reaper, III[1]

RESEARCH PROBLEM

This study was conducted to evaluate potential benefits from low or reduced rates of supplemental insecticides applied to control the Heliothine complex in *Bt* cotton and to evaluate control strategies in *Bt* and non-*Bt* cotton.

BACKGROUND INFORMATION

The bollworm, *Helicoverpa zea* (Boddie), and the tobacco budworm, *Heliothis virescens* (Fab.), are perennial pests of cotton in Arkansas and growers utilize control measures to prevent economic damage each year in non-*Bt* cotton varieties. The commercialization of transgenic cotton cultivars containing the insecticidal endotoxin of *Bacillus thurengiensis* (*Bt*) introduced a new approach in managing the Heliothine complex in cotton (Deaton, 1995). This new management tactic for Heliothine control, the utilization of transgenic *Bt* cotton varieties, is widely used in Arkansas with approximately 8% of the 1.08 million cotton acres in 2001 being planted to transgenic *Bt* varieties and 51% of the acreage being planted to stacked gene (*Bt* plus Roundup Ready) varieties. Continued research is needed to help understand how best to maximize the benefits of this new tactic for Heliothine control in cotton. Cotton containing a single gene for the production of CryIA(c) toxin has been shown to provide excellent mortality of the tobacco budworm but is less efficacious 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 Heliothine control in *Bt* cotton has been documented through the use of supplemental insecticide applications (Burd et al., 1999; Johnson et al., 2000; Hopkins et al., 2001). Resistance management is

[1] Entomology associate specialist, Cooperative Extension Service, Lonoke; extension entomologist-pest management section leader and extension entomologist-IPM coordinator, Cooperative Extension Service, Little Rock; and entomology extension specialist, Cooperative Extension Service, Lonoke.

also a concern when deciding how best to employ *Bt* cotton. A selected colony of the bollworm exhibited 50-fold resistance to the CryIA(c) toxin after 6 generations of selection and nearly 100-fold resistance after 10 generations of selection (Burd et al., 2000). The use of supplemental insecticides when needed in *Bt* cotton can help reduce the potential for loss of *Bt* efficacy through resistance. The objective of this study was to document, under Arkansas conditions, the benefits of using *Bt* cotton along with low or reduced rates of supplemental insecticide for enhanced Heliothine control.

RESEARCH DESCRIPTION

This trial was conducted on the Chuck Hooker Farm in Jefferson County, Arkansas, in 2001. This farm is located within the boll weevil eradication zone and received programmed sprays of ULV malathion that virtually eliminated boll weevil pressure and reduced plant bug pressure. Treatments were evaluated in small plots (eight 38-inch rows x 50 ft) arranged in a randomized complete block design with four replications. The cotton varieties used were Deltapine 451BR and Deltapine 425R, planted on 30 April. The treatments tested with *Bt* cotton were: untreated control, Fury 1.5 EC (0.024 lb ai/acre); Steward 1.25 SC (0.078 lb ia/acre) + Dyne-Amic (0.38% v/v); Tracer 4 SC (0.067 lb ai/acre); Karate Z 2.08 CS (0.015 lb ai/acre); and Vydate C-LV 3.77 SL (0.25 lb ai/acre). The treatments test with non-*Bt* cotton were: untreated control, Fury 1.5 EC (0.0375 lb ai/acre); Steward 1.25 SC (0.104 lb ai/acre) + Dyne-Amic (0.38% v/v); Tracer 4 SC (0.067 lb ai/acre); Karate Z 2.08 CS (0.028 lb ai/acre); and Denim 0.16 EC (0.015 lb ai/acre).

The crop was furrow-irrigated on an as-needed basis. Treatments were initiated based on estimated peak Heliothine egg lay. Applications were made with a John Deere 6000 hi-cycle equipped with a compressed air delivery system. The boom was equipped with conejet TXVS 6 nozzles on a 19-inch spacing. Operating pressure was 45 psi with a final spray volume of 8.6 gallons per acre. Treatments were applied as foliar sprays on 11 July (non *Bt* only), 18 July, and 3 August. Insect counts and damage ratings were made in the *Bt* cotton on 16 July (Pretreatment), 23 July ((t days after treatment; 5DAT#1), and 7 August (4DAT#2); and in the non-*Bt* cotton on 16 July (5DAT#1), 23 July (5DAT#2), 7 August (4DAT#3). Data were collected by examining 50 squares and 50 terminals at random from the center of each plot for the presence of live larvae (<1/4 inch + >1/4 inch) and square damage. The center two rows of each plot were machine harvested with a commercial two-row John Deere cotton picker on 23 October (176DAP) and lint yields were determined based on a 35% gin turnout. Data were processed using Agriculture Research Manager Ver. 6.0.1. Analysis of variance was run and Duncan's New Multiple Range Test (P=0.10) was used to separate means only when AOV Treatment P(F) was significant at P=0.05.

RESULTS AND DISCUSSION

This trial was conducted under predominantly cotton bollworm pressure. Based on pheromone trap catches, the percentage of the Heliothine population made up of bollworms ranged from 95 to 99% and 73 to 100%, respectively, during the conduct of the trial (Fig. 1). With the exception of Vydate C-LV 3.77SL (0.25 lb ai/acre), all supplemental insecticide treatments on both *Bt* and non-*Bt* varieties significantly (P=0.05) reduced Heliothine square damage. In the *Bt* cotton, no differences were observed among treatments with respect the seasonal average live Heliothine larvae count in squares. In the non-*Bt* cotton, all insecticide treatments significantly lowered (P=0.05) the live Heliothine larvae count in squares compared to the untreated control when looking at the seasonal average (Table 1). On a numerical basis, all chemical treatments in the *Bt* cotton resulted in less Heliothine damaged terminals than found in the untreated *Bt* cotton alone; however, no treatment differed significantly from the untreated *Bt* cotton with respect to the live Heliothine larvae count in terminals. In the non-*Bt* cotton, all chemical treatments resulted in significantly less (P=0.05) Heliothine damaged terminals and lower live-Heliothine larvae counts in terminals compared to the untreated non-*Bt* cotton control (Table 2). In the *Bt* cotton, no chemical treatment significantly out-yielded the untreated *Bt* cotton control. On a numerical basis only, Vydate C-LV 3.77SL (0.25 lb ai/acre), Karate Z 2.08CS (0.015 lb ai/acre), and Tracer 4SC (0.067 lb ai/acre) did out-yield the untreated *Bt* cotton control (1232 lb lint/acre) by 211, 106, and 100 lb lint/acre, respectively. In the non-B.t cotton, all chemical treatments significantly (P=0.05) out-yielded the untreated non-*Bt* control but did not differ among themselves. Numerically, the highest yielding treatments in the non-*Bt* cotton plots were Denim 0.16EC (0.015 lb ai/acre), Tracer 4SC (0.067 lb ai/acre), and Steward 1.25SC (0.104 lb ai/acre) + Dyne-Amic (0.38% v/v), which each out-yielded the untreated non-*Bt* control by 235, 227, and 226 lb lint/acre, respectively (Fig. 2).

PRACTICAL APPLICATION

The results obtained suggest that the potential for higher yields is greater with the tested *Bt* cotton variety than with the tested non-*Bt* cotton variety. Also, trends in the data suggest that increased yields may be obtained when appropriate supplemental insecticides, targeted at pests not adequately controlled by the CryIA(c) toxin, are utilized in *Bt* cotton. In addition, the results of this study show that increased yields can be obtained when appropriate supplemental insecticides are utilized to control the Heliothine complex in non-*Bt* cotton.

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Table 1. Seasonal average percent Heliothine-damaged squares and live larval count: Efficacy of Heliothine control materials in *Bt* and non-*Bt* Cotton. Jefferson County, AR. 2001.

	Deltapine 451BR (*Bt*)[z]		Deltapine 425R (non-*Bt*)	
Treatment	Heliothine-damaged sq./50 sq. seasonal avg.	Total live Heliothine larvae/ 50 sq. seasonal avg.	Heliothine-damaged sq./50 sq. seasonal avg.	Total live Heliothine larvae/ 50 sq. seasonal avg.
(lb ai/acre)				
Untreated control	2.3 a[y]	0.1 a	12.7 a	3.8 a
Fury 1.5EC (0.024)	0.4 b	0.0 a	5.5 b	1.3 b
Steward 1.25SC (0.078) + Dyne-Amic (0.38%v/v)	0.8 b	0.0 a	2.8 b	0.8 b
Tracer 4SC (0.067)	0.3 b	0.0 a	5.2 b	1.1 b
Karate Z 2.08CS (0.015)	0.3 b	0.0 a	3.0 b	0.9 b
Vydate C-LV 3.77SL (0.25)	2.0 a	0.5 a		
Denim 0.16EC (0.015)			4.4 b	0.5 b

[z] Deltapine 451BR (*Bt*) received 2 treatment applications and Deltapine 425R (non-*Bt*) received 3 applications.

[y] Means in same column followed by same letter do not significantly differ (P=.05, Duncan's New MRT). Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 2. Seasonal average Heliothine-damaged terminals and live larval count: Efficacy of Heliothine control materials in *Bt* and Non-*Bt* Cotton. Jefferson Co., AR. 2001.

	Deltapine 451BR (*Bt*)[z]		Deltapine 425R (non-*Bt*)	
Treatment	Heliothine-damaged sq./50 sq. seasonal avg.	Total live Heliothine larvae/ 50 sq. seasonal avg.	Heliothine-damaged sq./50 sq. seasonal avg.	Total live Heliothine larvae/ 50 sq. seasonal avg.
(lb ai/acre)				
Untreated control	2.5 a[y]	0.1 a	8.4 a	1.3 a
Fury 1.5EC (0.024)	0.9 a	0.0 a	5.3 b	1.0 ab
Steward 1.25SC (0.078) + Dyne-Amic (0.38%v/v)	1.3 a	0.0 a	3.6 b	0.3 bc
Tracer 4SC (0.067)	1.0 a	0.0 a	3.3 b	0.2 c
Karate Z 2.08CS (0.015)	0.4 a	0.0 a	3.8 b	0.4 bc
Vydate C-LV 3.77SL (0.25)	1.9 a	0.0 a		
Denim 0.16EC (0.015)			2.5 b	0.0 c

[z] Deltapine 451BR (*Bt*) received 2 treatment applications and Deltapine 425R (non-*Bt*) received 3 applications.

[y] Means in same column followed by same letter do not significantly differ (P=0.05, Duncan's New MRT). Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

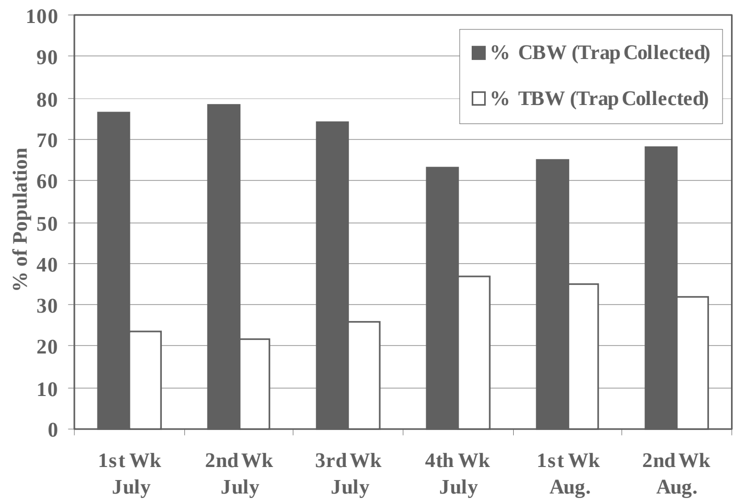

Fig. 1. Heliothine population distribution based on pheromone trap collections. Jefferson County, AR, 2001.

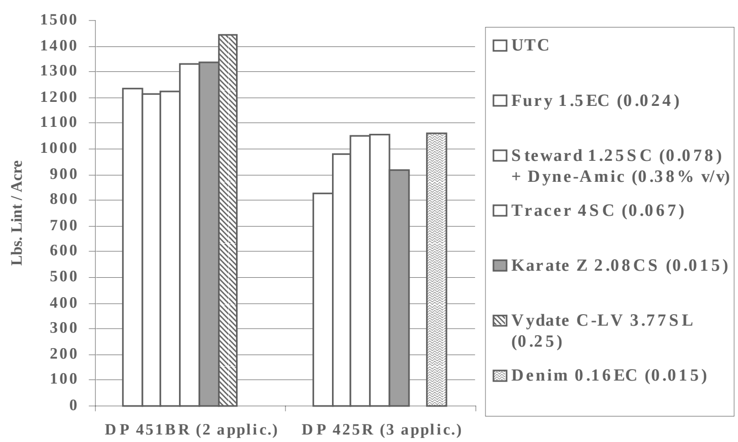

Fig. 2. Lint yield (35% turnout): Efficacy of Heliothine control materials in *Bt* and non-*Bt* cotton. Jefferson County, AR, 2001.