EFFICACY OF HELIOTHINE CONTROL MATERIALS IN B.t. AND NON-B.t. COTTON

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Abstract

In 2001, supplemental insecticide treatments to Deltapine 451BR (B.t. cotton variety-2 applications) and Deltapine 425R (closely related non-B.t. cotton variety-3 applications) were evaluated to determine if improved Heliothine control could be demonstrated. Insecticides evaluated on both Deltapine 451BR and Deltapine 425R were Steward 1.25SC, Tracer 4SC, Karate Z 2.08CS, and Fury 1.5EC. Vydate C-LV 3.77SL was evaluated only on Deltapine 451BR and Denim 0.16EC was evaluated only on Deltapine 425R. Low or reduced rates were used on Deltapine 451BR and standard rates were used on Deltapine 425R. The test was conducted under predominantly bollworm pressure. With the exception of Vydate C-LV 3.77SL (0.25 lb. (AI)/A), all supplemental insecticide treatments on both varieties significantly reduced Heliothine square damage. Differences in square counts for live Heliothine larvae were not observed among treatments at any time for the B.t. cotton and larval numbers were very low. In the non-B.t. cotton, all chemical treatments significantly reduced the live Heliothine larvae count in squares compared to the untreated non-B.t cotton. There was a numerical trend for reduced Heliothine terminal damage with all chemical treatments in the B.t. cotton; however, virtually no live Heliothine larvae were observed in the terminals of the B.t. cotton. All chemical treatments significantly reduced Heliothine terminal damage and counts of live Heliothine larvae in terminals in the non-B.t. cotton. On a numerical basis, Vydate C-LV 3.77SL (0.25 lb. (AI)/A), Karate Z 2.08CS (0.015 lb. (AI)/A), and Tracer 4SC (0.067 lb. (AI)/A) out yielded the untreated B.t. cotton (1232 lbs. lint/A) by 211, 106, and 100 lbs., respectively. All chemical treatments significantly out yielded the untreated non-B.t cotton (827 lbs. lint/A) and the yield increases ranged from 93 to 235 lbs. lint/A. This study suggests that increased yields can be obtained when appropriate supplemental insecticides, targeted at pests not adequately controlled by the CryIA(c) toxin, are utilized in B.t. 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-B.t. cotton.

Introduction

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-B.t. cotton varieties. The commercialization of transgenic cotton cultivars containing the insecticidal endotoxin of *Bacillus thurengiensis* introduced a new approach in managing the Heliothine complex in cotton (Deaton 1995). This new management tactic for Heliothine control, the utilization of transgenic *B.t.* cotton varieties, is widely used in Arkansas with approximately 8% of the 1.08M cotton acres in 2001 being planted to transgenic B.t. varieties and 51% of the acreage being planted to stacked gene (B.t. plus Round-up 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 *B.t.* cotton alone to provide control has been less than satisfactory. Improved Heliothine control in *B.t.* 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 also a concern when deciding how best to employ B.t. 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 B.t. cotton can help reduce the potential for loss of B.t. efficacy through resistance. The objective of this study was to document, under Arkansas conditions, the benefits of using B.t. cotton along with low or reduced rates of supplemental insecticide for enhanced Heliothine control.

Methods

This trial was conducted on the Chuck Hooker Farm in Jefferson Co., AR, in 2001. This farm was 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 (8-38” rows x 50 ft) arranged in a randomized complete block design with 4 replications. The cotton varieties used were Deltapine 451BR and Deltapine 425R, planted on 30 April 2001. The crop was furrow-irrigated on an as needed basis. During the conduct of this trial, the cotton bollworm made up the majority of the Heliothine population (range 73-100%) based on field collections and pheromone trap catches. 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” spacing. Operating pressure was 45 psi with a final spray volume of 8.6 gpa. Treatments were applied as foliar sprays on 11 July (non B.t. only), 18 July, and 3 August. Insect counts and damage ratings were made in the B.t. cotton on 16 July (Pretreatment), 23 July (5DAT#1), and 7 August (4DAT#2) and in the non-B.t. 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 + >1/4") 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 the 10% level.

Results and Discussion

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

Summary

This study was conducted to evaluate potential benefits from low or reduced rates of supplemental insecticides applied to control the Heliothine complex in B.t. cotton and to evaluate control strategies in B.t. and non-B.t cotton. In B.t. cotton, while not statistically significant, the yield results obtained suggest that the appropriate use of selected supplemental insecticides, targeted at pests not adequately controlled by single gene B.t. cotton alone, can be beneficial. The benefits derived from this improved Heliothine control and increased yield can result in an economic benefit to the producer. In addition, when evaluating Heliothine control in non-B.t cotton, treatment with pyrethroids resulted in lower yield increases compared to those obtained with newer chemistry like Denim, Tracer, and Steward. The results obtained suggest that the potential for higher yields are greater with the tested B.t. cotton variety than with the tested non-B.t. cotton variety and that conventional pyrethroid insecticides may offer increased benefit with respect to Heliothine control in B.t. cotton than in non-B.t cotton. Also, the newer chemistry exhibited by Denim, Tracer, and Steward may offer greater benefit with respect to Heliothine control in non-B.t. cotton than traditional pyrethroid insecticides.

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Acknowledgments

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Fury is a registered trademarks of FMC Corporation.
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Table 1. Seasonal average % Heliothine damaged squares & live larval count: Efficacy of Heliothine Control Materials in B.t. and Non-B.t. Cotton. Jefferson Co., AR. 2001.

	Deltapine 451BR (B.t.)		**Deltapine 425R (non-B.t.)**	
Treatment (lbai/A)	**Heliothine Dam. Sq. / 50 Sq. Seasonal AVG**	**Total Live Heliothine Larvae /50 Sq. Seasonal AVG**	**Heliothine Dam. Sq./ 50 Sq. Seasonal AVG**	**Total Live Heliothine Larvae/50 Sq. Seasonal AVG**
UTC	2.3 a	0.1 a	12.7 a	3.8 a
Fury 1.5EC (0.024)	0.4 b	0 a	5.5 b	1.3 b
Steward 1.25SC (0.078) + Dyne-Amic (0.38%v/v)	0.8 b	0 a	2.8 b	0.8 b
Tracer 4SC (0.067)	0.3 b	0 a	5.2 b	1.1 b
Karate Z 2.08CS (0.015)	0.3 b	0 a	3 b	0.9 b
Vydate C-LV 3.77SL (0.25)	2 a	0.5 a		
Denim 0.16EC (0.015)			4.4 b	0.5 b

Deltapine 451BR (B.t.) received 2 treatment applic. and Deltapine 425R (non-B.t.) received 3 applic.
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 & live larval count: Efficacy of Heliothine Control Materials in B.t. and Non-B.t. Cotton. Jefferson Co., AR. 2001.

	DP 451BR (B.t.)		**DP 425R (non-B.t.)**	
Treatment (lbai/A)	**Heliothine Dam. Term./50 Term. Seasonal AVG**	**Total Live Heliothine Larvae/50 Term. Seasonal AVG**	**Heliothine Dam. Term./50 Term. Seasonal AVG**	**Total Live Heliothine Larvae/50 Term. Seasonal AVG**
UTC	2.5 a	0.1 A	8.4 a	1.3 a
Fury 1.5EC (0.024)	0.9 a	0 a	5.3 b	1 ab
Steward 1.25SC (0.078) + Dyne-Amic (0.38%v/v)	1.3 a	0 a	3.6 b	0.3 bc
Tracer 4SC (0.067)	1 a	0 a	3.3 b	0.2 c
Karate Z 2.08CS (0.015)	0.4 a	0 a	3.8 b	0.4 bc
Vydate C-LV 3.77SL (0.25)	1.9 a	0 a		
Denim 0.16EC (0.015)			2.5 b	0 c

Deltapine 451BR (B.t.) received 2 treatment applic. and Deltapine 425R (non-B.t.) received 3 applic.
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.

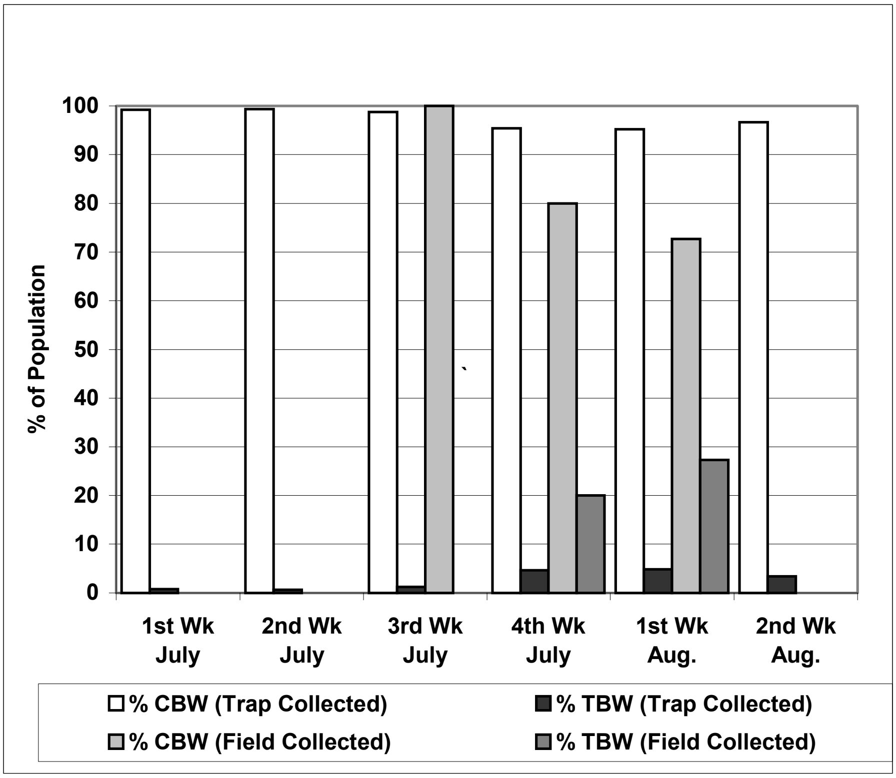

Figure 1. Heliothine Population Distribution Based on Field & Phermone Trap Collections: Jefferson Co., AR. 2001.

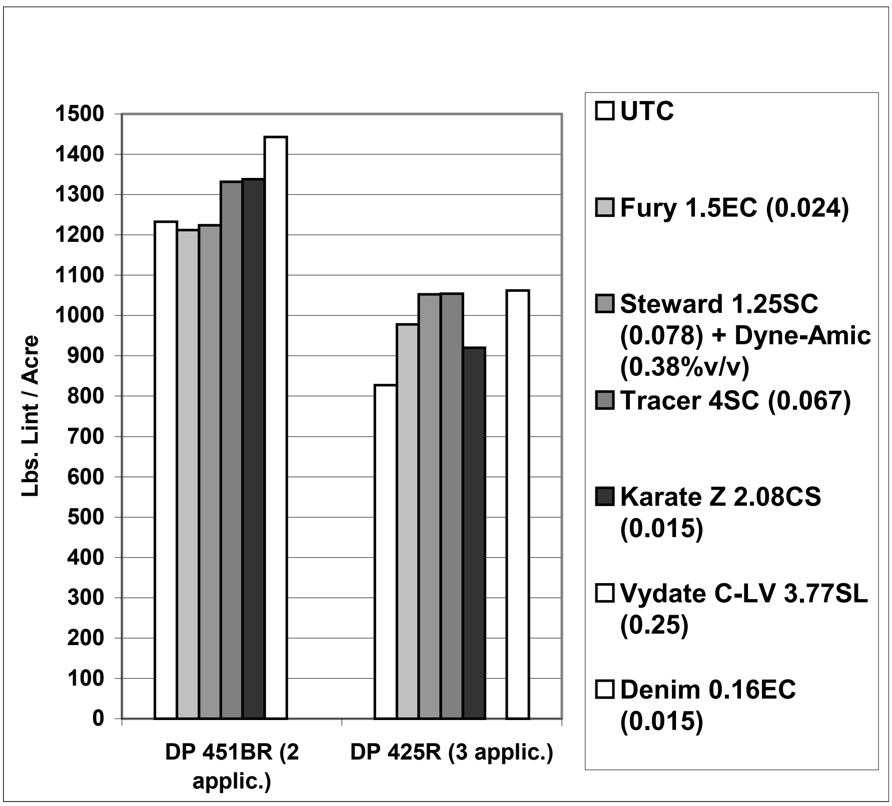

Figure 2. Lint Yield (35% turnout): Efficacy of Heliothine Control Materials in B.t. and Non-B.t. Cotton. Jefferson Co., AR. 2001.