HELIOTHINE CONTROL IN *Bt* AND NON-*Bt* COTTON WITH THE ADVENT OF BOLL WEEVIL ERADICATION

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RESEARCH PROBLEM

A successful boll weevil eradication program in Arkansas will not only eliminate the boll weevil as a threat to cotton producers but will also influence the control strategies of other traditional pests. Several new insecticides and a pyrethroid standard were evaluated for heliothine performance in transgenic *Bt* and conventional cotton during the late stages of boll weevil eradication.

BACKGROUND INFORMATION

Cotton bollworm (*Heliocoverpa zea*) and tobacco budworm (*Heliothis virescens*) pest management represents a significant but necessary investment for Arkansas cotton growers. These pests reduced Arkansas cotton yields approximately 3.3%, with more than 60,000 bales lost (Williams, 2001). Many studies have confirmed the positive yield benefit from effective insect pest management. The boll weevil eradication program allows producers to take full advantage of the beneficial insect population in management of cotton pests. Innovation in cost reduction coupled with improved conservation of beneficial insects is needed to help lower cotton production costs for the Arkansas cotton producer. This study will identify improved and more economical means for management of bollworm and tobacco budworm populations and identify improved management strategies, which allow conservation of beneficial insects. Identification and use of improved bollworm and tobacco budworm management practices will in turn improve the competitive position of the Arkansas cotton producer in the world cotton market.

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Arkansas has traditionally adhered to using environmentally sound IPM practices in the management of cotton. The cotton industry is currently on the brink of a new wave of innovation that will utilize several classes of new crop-protection chemicals and revolutionary new approaches in biotechnology. Considering the past performance of the boll weevil eradication program, approximately 5 million acres of cotton in 10 states are weevil-free (El-Lissy and Grefenstette, 2001). The amount of pesticide applied in these areas has been reduced significantly. Yields have also increased due to greater lint production in the upper portion of plants, areas vulnerable to late-season boll weevil infestation (Cunningham and Grefenstette, 1998). Transgenic *Bt* varieties planted in boll weevil-free areas have created low insecticide-use environments compared to historical standards. This shift in insecticide-use patterns has caused significant changes in the cotton pest spectrum (Smith, 1998). Studies in the southeastern U.S. have shown a significant shift in the pest complex associated with cotton production. Early season disruption of beneficial insects using older, broad-spectrum insecticides can lead to increased populations of aphids, cotton bollworm, and fall armyworm in *Bt* cotton. Previous research has indicated early to mid-season applications of broad-spectrum insecticides can compromise the effectiveness of *Bt* cotton by disrupting populations of beneficial insects in the absence of the boll weevil (Turnipseed and Sullivan, 1997). The development of effective bollworm and budworm management strategies is necessary to maximize the benefits from boll weevil eradication and best utilize beneficial insects to help control the pests of *Bt* and conventional cotton.

RESEARCH DESCRIPTION

This trial was conducted on the Gary Burton Farm in Lafayette County, Arkansas, in 2001. The treatments observed in the experiment are listed in Table 1. Stoneville varieties ST 4793 R and ST 4892 BR were planted on 4 May in plots containing 24 38-inch rows 80 ft. in length. The experimental design was a split-plot arranged in a randomized complete block design with four replications. Insecticide treatments were initiated based on state recommendations of one Heliothine-damaged square per row foot with eggs and small larvae present. Applications were made with a John Deere 6000 hi-cycle sprayer equipped with a compressed air delivery system. The boom was equipped with conejet TXVS 6 nozzles on 19-inch spacings. Operating pressure was 45 psi with a final spray volume of 8.6 GPA. Treatments were applied as foliar sprays on 11 July, 19 July, and 6 August. The ST 4892 BR variety was not treated on 19 July due to insect pressure below the recommended treatment threshold. Insect counts and damage ratings were made on 17 July (6DAT#1), 24 July (5DAT#2), and 10 August (4DAT#3). Beneficial insect populations were sampled from each plot using a gas-powered blower equipped with a mechanism for trapping insects in a cloth bag. The beneficial insect samples were transferred to plastic bags, stored in a cool environment, and transported to the lab for identification. Heliothine data were collected by randomly examining 50 squares and 50 terminals from the center of each plot for the presence of live larvae and damage. Seasonal averages of percentage square damage and total number of live larvae were calculated from the rating dates. The center two rows of each plot were machine harvested with a commercial cotton harvester on 30 October (179DAP) 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 conducted and Duncan's New Multiple Range Test (P=0.05) was used to separate means only when AOV Treatment P(F) was significant at the 5% level.

RESULTS AND DISCUSSION

In 2001, Heliothine pressure was predominately from cotton bollworm in Lafayette County. Other areas of Arkansas reported similar population trends.

Average beneficial insect populations for selected species are displayed in Table 1. Lady beetle adults were the predominant species throughout the study, and varietal differences in population are evident. Surprisingly, the Bollgard variety had greater numbers overall when compared to conventional cotton. The Karate treatment resulted in fewer beneficial insects in the conventional variety; however, the lady beetle population in the Bollgard variety was comparable to the other insecticide treatments. Of all the non-pyrethroid compounds, Intrepid had the least effect on populations of big-eyed bugs and parasitic wasps in the Bollgard variety. Applications of malathion were made by the Boll Weevil Eradication Program during the growing season and this likely caused the low beneficial populations observed at the rating dates.

For the conventional variety, all insecticides significantly reduced square damage below the untreated check with the exception of Intrepid (0.25 lb ai/acre; Table 2). As expected, the untreated check had the greatest presence of live larvae throughout the season. Tracer (0.067 lb ai/acre) and Karate had live larvae levels significantly lower than Intrepid (0.25 lb ai/acre). The performance of Karate in the conventional variety reflects back on the species composition throughout the 2001 growing season, with cotton bollworm remaining dominant. Insecticide treatment had no effect on Heliothine control for the Bollgard variety, with no significant differences among treatments with respect to square damage and live larvae. The mean values in Table 2 display the reduced square damage obtained with Bollgard. Only Tracer (0.067) and Steward (0.065) achieved significantly equal levels of suppression regardless of variety. No differences in live larvae were observed between treatments of the Bollgard variety. In this study, Bollgard was successful in suppressing the Heliothine complex without the need for any insecticide applications. Overall, lint yield was very low, and no significant yield differences were observed in this study even between the untreated treatments for both varieties. The level of Heliothine control observed more than likely would have been reflected in the yield. This lack of difference suggests an additional environmental factor was responsible for these results.

PRACTICAL APPLICATION

The results from this study indicate Bollgard to be an effective method of controlling the Heliothine complex without any insecticide applications. All insecticides used in this study successfully controlled insect pressure in conventional cotton. Low populations of tobacco budworm resulted in acceptable performance of Karate in controlling cotton bollworm. Although beneficial populations were affected by malathion, more lady beetles were present in the Bollgard rather than conventional cotton. Further investigation is necessary to determine economical Heliothine management options in boll weevil eradication areas.

LITERATURE CITED

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Table 1. Effect of variety and chemical treatment on seasonal average Heliothine control in cotton.

Variety	Treatment	Damaged squares[z]	Total live larvae[z]	Lint yield
	(lb ai/acre)	(%)		(lb/acre)
ST 4793 R	Untreated	4.16 a[y]	2.75 a	666 a
	Tracer 4SC (0.045)	2.91 bc	0.92 bc	715 a
	Tracer 4SC (0.067)	1.42 def	0.17 c	682 a
	Steward 1.25SC (0.065)	1.25 d-g	1.00 bc	720 a
	Steward 1.25SC (0.09)	2.08 cd	0.92 bc	773 a
	Intrepid 2F (0.125) + Latron CS-7 (0.125%)	2.33 cd	0.75 bc	735 a
	Intrepid 2F (0.25) + Latron CS-7 (0.125%)	3.75 ab	1.58 b	654 a
	Karate Z 2.08CS (0.033)	1.59 de	0.50 c	717 a
ST 4892 BR	Untreated	0.33 efg	0.00 c	778 a
	Tracer 4SC (0.045)	0.34 efg	0.25 c	747 a
	Tracer 4SC (0.067)	0.58 efg	0.08 c	762 a
	Steward 1.25SC (0.065)	0.33 efg	0.17 c	736 a
	Steward 1.25SC (0.09)	0.42 efg	0.00 c	695 a
	Intrepid 2F (0.125) + Latron CS-7 (0.125%)	0.25 efg	0.25 c	644 a
	Intrepid 2F (0.25) + Latron CS-7 (0.125%)	0.00 g	0.08 c	594 a
	Karate Z 2.08CS (0.033)	0.17 fg	0.25 c	765 a

[z] Damage based upon samples of 50 squares and 50 terminals per plot at each rating date.
[y] Means followed by same letter do not significantly differ (P=0.05, Duncan's New MRT).

Table 2. Beneficial insect population response to reduced cost-management strategies for control of the Heliothine complex in cotton.

Variety	Treatment	Lady beetle adults	Minute pirate bugs	Big-eyed bug adults	Parasitic wasps
	(lb/acre)	---------------------- (#/80-row ft)[z]			-----------------
ST 4793 R	Untreated	1.50 e[y]	0.00 b	0.30 b	0.30 bc
	Tracer 4SC (0.045)	4.00 b-e	0.30 b	0.00 b	0.30 bc
	Tracer 4SC (0.067)	4.30 b-e	0.00 b	0.30 b	0.30 bc
	Steward 1.25SC (0.065)	1.80 de	0.00 b	0.30 b	0.00 c
	Steward 1.25SC (0.09)	2.50 cde	0.00 b	0.00 b	0.00 c
	Intrepid 2F (0.125) + Latron CS-7 (0.125%)	1.30 e	0.80 ab	0.00 b	0.00 c
	Intrepid 2F (0.25) + Latron CS-7 (0.125%)	2.30 cde	0.30 b	0.50 b	0.00 c
	Karate Z 2.08CS (0.033)	1.00 e	0.00 b	0.00 b	0.00 c
ST 4892 BR	Untreated	7.50 a-d	1.30 a	0.80 ab	0.80 abc
	Tracer 4SC (0.045)	7.50 a-d	0.30 b	0.80 ab	0.50 bc
	Tracer 4SC (0.067)	4.80 b-e	0.50 ab	0.00 b	1.00 ab
	Steward 1.25SC (0.065)	7.30 a-d	0.50 ab	0.00 b	0.00 c
	Steward 1.25SC (0.09)	10.50 a	0.00 b	0.30 b	0.00 c
	Intrepid 2F (0.125) + Latron CS-7 (0.125%)	8.00 abc	0.00 b	1.50 a	1.30 a
	Intrepid 2F (0.25) + Latron CS-7 (0.125%)	8.50 ab	0.00 b	0.50 b	0.30 bc
	Karate Z 2.08CS (0.033)	7.30 a-d	0.30 b	0.00 b	0.00 c

[z] All insects obtained from an 80-row ft. sample following the final insecticide application in August.

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