EFFICACY OF DUAL GENE BT COTTON FOR CONTROL OF BOLLWORM, *HELICOVERPA ZEA* (BODDIE)

Luis Orellana,
Gus Lorenz,
Nichole M. Taillon,
Andrew Plummer,
Michael Chaney,
Benjamin C. Thrash,
Derek L. Clarkson,
Mallory Everett,
University of Arkansas, Division of Agriculture, Cooperative Extension Service
Lonoke, AR

Abstract

Trials conducted at Hooker Farms in Jefferson County, AR, to evaluate conventional varieties treated with insecticides and to compare them with current Bt technologies. Also, to evaluate the impact of insecticide applications for bollworm/budworm control on WideStrike and Bollgard II. In 2011, five insecticide treatments were foliarly applied to a conventional and compared to the unsprayed conventional, a Bollgard II, and a WideStrike variety. In 2012, three insecticide treatments were applied each variety: conventional, Bollgard II, and WideStrike. In 2013, three insecticides treatments were applied to a Bollgard II and a WideStrike variety.

Studies suggest that a conventional variety sprayed with an insecticide can yield similarly to current Bt varieties. It also suggest that Bt cotton varieties can benefit from an insecticide application in years when cotton fields are under high bollworm pressure.

Introduction

Cotton bollworm (CBW) is one of the most damaging pests for cotton (*Gossypium hirsutum* L.) in Arkansas. During the past 10 years CBW has caused an average loss of 24,000 bales per year, ranging from 3,400 to 38,000 bales lost per year. CBW is the predominant species that, along with tobacco budworm (TBW), form a pest complex. In Arkansas CBW/TBW has been reported to be found in a ratio of CBW to TBW of 22:3 (Siebert et al. 2008).

Bollgard II cotton is one of the in-plant insect protection technologies currently available. Bollgard II has been commercially available since 2003. It was released to the market because of the need of tolerant cotton varieties to high pressures of bollworms, as they are tolerant to the Cry1Ac endotoxins (Luttrell et al. 1999). Additionally, there were other lepidopteran pests commonly encountered in cotton fields not controlled by Cry1Ac endotoxin (i.e. fall armyworm, beet armyworm, and soybean looper) that are susceptible to Cry2Ab2 endotoxin expressed in Bollgard II (Stewart et al. 2001). Endotoxins expressed in Bollgard II (i.e. Cry1Ac and Cry2Ab2) are derived from *Bacillus thuringiensis* Berliner subsp. k*urstaki (2002)*.

WideStrike cotton is an alternative technology that also expresses two stacked Bt endotoxins. This technology has been commercialized since 2005. As in the case of Bollgard II, it also expresses Cry1Ac endotoxin, but it differs in that it expresses Cry1F endotoxin derived from *B. t. aizawaii (2005)*. WideStrike cotton targets heliothines, worms, armyworms, and loopers.

For 2011, the objective was to evaluate the performance of insecticide applications for bollworm/budworm on conventional cotton vs non-sprayed Bt cotton. For both 2012 and 2013, the objective was to evaluate the impact of foliar applications for bollworm/budworm on WideStrike and Bollgard II.

Materials and Methods

The trials were conducted at Hooker Farms in Jefferson County, AR, between the crop seasons of 2011-2013. Plots consisted of eight rows that had 38 in row spacing and 40 ft in length. Insecticide applications were made with a Mud Master equipped with hollow cone Tee-Jet TXVS 8 nozzles operated at a pressure of 40 psi, and driven at a speed of 4.1 mph. It delivered 10 gpa. Damage assessment was based on counts made on 25 plants per plot. Plant structures assessed were: terminals, squares, blooms, and bolls. When encountered, larvae were counted. A cotton mechanized plot picker was used to harvest and measure yield. All experiments were statistically analyzed through the methods one-way anova and Duncan's New Multiple Range Test (α=0.10), using Agriculture Research Manager Version 8 or Version 9 (Gylling Data Management, Inc., Brookings, SD).

In 2011, experimental plots were planted on May 15th. There were five treatments that consisted of an insecticide applied to the conventional variety. The insecticides used were: Prevathon at 20 oz/a, Prevathon at 27 oz/a, Belt at 2 oz/a, Belt 3 oz/a, and a tank-mix of Tracer 2 oz/a and Bifenthrin 5.12 oz/a. There were three unsprayed treatments: a conventional variety (DP174), a Bollgard II variety (DP0912), and a WideStrike variety (PHY 375). Because of the high bollworm pressure, insecticide treatments were foliarly applied twice on July 5 and July 23. Observations were conducted on July 8, July 13, July 21, July 26, July 29, and August 3.

The 2012 plots were planted on May 9th, and insecticides were applied on July 10th. The varieties planted were a conventional (DP174), a Bollgard II (ST5288), and a WideStrike (PHY375). There were four treatments assigned to each variety. First, each variety had a treatment where no insecticide was applied. Then, each variety had three treatments where one of the following insecticides was applied: Prevathon 14 oz/a, Prevathon 20 oz/a and Belt 3 oz/a. Observations were conducted on July 17, July 24, July 31, and August 7.

In 2013, plots were planted on May 29th, and the varieties planted were a WideStrike (PHY375) and a Bollgard II (DP0912). No conventional variety was used in that year. Like the previous year, each variety had assigned four treatments. Two treatments consisted of each variety without any foliarly sprayed insecticide. Then, each variety had three treatments where one insecticide was applied: prevathon 20 oz/a, Belt 3 oz/a, or Tracer 3.5 oz/a. Observations were conducted on August 6, August 14, and August 20th.

Results and Discussion

During the 2011 crop season (Table 1), high bollworm density treatments with an insecticide had to be re-applied 18 days after the first application. When the conventional variety was treated with Prevathon 20 oz/a, Prevathon 27 oz/a, Belt 2 oz/a, or Belt 3 oz/a, there were no statistical differences on total bollworm larval counts compared to the Bollgard II and WideStrike treatments. There were no statistical differences in season total damage when treatments where the conventional variety was treated with Prevathon 20 oz/a and Prevathon 27 oz/a was compared to Bollgard II and WideStrike treatments. Yield of conventional cotton treated with Prevathon 20 oz/a, Belt 2 oz/a or Belt 3 oz/a, was not statistically different than Bollgard II and WideStrike cotton. When Prevathon 27 oz/a was applied to the conventional variety, yield was significantly greater than the WideStrike variety.

Table 1. 2011 treatment means for season total larvae, season total damage and seed cotton yield.

Treatment	Season Total Larvae	Total Season Damage	Yield
UTC	39.3 a*	228.9 a	431.5 d
Prevathon SC 20 oz/a	3.8 c	44.3 c	1965.9 ab
Prevathon SC 27 oz/a	3.0 c	41.3 c	2112.3 a
Belt 2 oz/a	6.8 bc	75.5 b	1551.8 c
Belt 3 oz/a	7.3 bc	68.8 b	1998.9 ab
Tracer 2 oz/a + Bifenthrin 5.12 oz/a	11.0 b	80.3 b	1489.7 c
BGII DP0912	2.8 c	25.0 c	1796.2 abc
WS PHY375	7.0 bc	39.5 c	1598.4 bc

*Means followed by same letter do not significantly differ (α=0.10)

During the 2012 crop season (Table 2), treatment where the conventional variety was applied with an insecticide had statistically lower total season larval counts compared to the unsprayed treatment. There were no significant differences on larval counts between sprayed and unsprayed Bollgard II or sprayed and unsprayed WideStrike. Both rates of Prevathon applied to the conventional and WideStrike cotton had significantly lower damage than the unsprayed of each category. When Prevathon 20 oz/a and Belt 3 oz/a were applied to Bollgard II, yield was significantly higher than unsprayed Bollgard II. Both rates of Prevathon applied to WideStrike cotton resulted in significantly higher yield than unsprayed WideStrike.

Table 2. 2012 treatment means of season total larvae, season total damage and seed cotton yield.

Treatment		Season Total Larvae	Total Season Damage	Seed Cotton Yield (lb/a)
Variety	Insecticide Rate			
Conventional DP174	UTC	34 a	146 a	1662.0 e
Conventional DP174	Prevathon 14 oz/a	24.7 b	64.8 c	2025.2 d
Conventional DP174	Prevathon 20 oz/a	21.3 b	55.3 c	2237.1 c
Conventional DP174	Belt 3 oz/a	21 b	85.8 b	1604.5 e
Bollgard II DP9012	UTC	5.3 cd	20 ef	2361.5 bc
Bollgard II DP9012	Prevathon 14 oz/a	1.3 d	8 f	2560.3 ab
Bollgard II DP9012	Prevathon 20 oz/a	0.5 d	10.8 ef	2679.6. a
Bollgard II DP9012	Belt 3 oz/a	3.5 cd	12 ef	2744.6 a
WideStrike PHY 375	UTC	9.3 c	35.8 d	2162.3 cd
WideStrike PHY 375	Prevathon 14 oz/a	3 cd	17.5 ef	2697.8 a
WideStrike PHY 375	Prevathon 20 oz/a	3 cd	17.3 ef	2725.2 a
WideStrike PHY 375	Belt 3 oz/a	4 cd	24.5 de	2380.3 bc

*Means followed by same letter do not significantly differ (α=0.10)

During the 2013 crop season (Table 3), bollworm pressure was not as high as in the previous two years. Insecticide applications on Bt cotton did not reduce cotton bollworm damage or bollworm larval counts. The only significant difference in yield was between Belt 3 oz/a applied to WideStrike and the unsprayed WideStrike treatment.

Table 3. 2013 treatments means of season total larvae, season total damage and seed cotton yield.

Treatments		Season Total Larvae	Season Total Damage	Seed Cotton Yield (lb/a)
Variety	Insecticide Rate			
Bollgard II DP0912	UTC	14.0 abc	20.3 a	3024.4 ab
Bollgard II DP0912	Prevathon 20 oz/a	8.5 c	6.9 a	2941.9 ab
Bollgard II DP0912	Belt 3 oz/a	10.8 bc	4.3 a	2892.6 ab
Bollgard II DP0912	Tracer 3.5 oz/a	10.5 bc	11.9 a	3146.1 a.
WideStrike PHY499	UTC	17.8 ab	15.8 a	2383.6 c
WideStrike PHY499	Prevathon 20 oz/a	19.8 a	14.9 a	2617.9 bc
WideStrikePHY499	Belt 3 oz/a	19.0 a	18.4 a	2865.5 ab
WideStrike PHY499	Tracer 3.5 oz/a	17.5 ab	12.2 a	2761.7 abc

*Means followed by same letter do not significantly differ (α=0.10)

Summary

In 2011 crop season, three insecticide treatments applied on the conventional variety had a yield similar to the two Bt technologies tested, and when the higher rate of Prevathon was applied to the conventional, yield was comparable to Bollgard II, and excided yield of WideStrike. During the 2012 crop season, only Prevathon 20 oz/a applied to the conventional variety had similar yield to the Bt technologies. However, when Prevathon and Belt were applied on Bollgard II, a Prevathon was applied on WideStrike yield was higher than unsprayed Bollgard II and WideStrike, respectively. During 2013 low bollworm pressure prevented the observation of much effect from supplementing Bollgard II and WideStrike with insecticides. These studies suggest that first, that when a conventional variety is sprayed with insecticides it can yield similarly to current Bt varieties. Secondly, Bt cotton can benefit from an insecticide application in years when cotton fields are under high bollworm pressure

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