

COMPARISON OF TRANSGENIC *Bt* TECHNOLOGIES IN ARKANSAS COTTON SYSTEMS FOR CONTROL OF COTTON BOLLWORM, *HELICOVERPA ZEA*

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Abstract

One of the widely used methods of controlling cotton bollworm (*Helicoverpa zea*) in cotton is the use of transgenic *Bt* technologies. Resistance has recently been documented in cotton bollworm to dual gene *Bt* technologies and results indicate that dual gene cultivars may require supplemental foliar applications to manage high populations of bollworm. There is some evidence that, while more efficacious against bollworm, three gene cotton cultivars yield less than two gene cultivars. Despite this yield gap, growers could have greater profits using three gene cultivars due to lower input and production cost. Research was conducted in 2021 in Drew County, Arkansas to evaluate the efficacy of several *Bt* technologies and the economic value of Bollgard II and Bollgard III technologies. Results suggest sprayed two gene cultivars had similar levels of damage to unsprayed three gene cultivars.

Introduction

Among row crops planted in Arkansas, cotton ranks fourth in terms of area planted, with a total of 525,000 acres in 2021. Cotton bollworm (*Helicoverpa zea*) is one of the most important yield limiting pests in cotton production. Injury caused by the corn earworm ranges from destruction of the host crop to cosmetic damage. These injuries can result in an unusable product for both the fresh and processing market causing the crop to be unmarketable. Feeding typically takes place on the reproductive structures of cultivated and wild host plants. In 2020, 68,000 bales of cotton were lost due to bollworm damage in Arkansas, even though 99% of the cotton acres were planted in *Bt* cotton, with 71% being two gene cotton and 28% being three gene cotton. The objective of this study was to determine if two or three gene cotton would be more cost effective for growers to plant, with the understanding that the two gene cotton may need supplemental foliar applications to control bollworm.

Materials and Methods

Small Plot Efficacy Trials

A study was conducted in Tillar, AR in 2021. Plots were planted on 16 May, a non-*Bt* (DP 1822 XF), a two gene (ST 1518 B2XF), and multiple three gene cultivars (DP 1845 B3XF), (PHY 400 W3FE), (ST 5471 GLTP). Plot sizes were 12.5 ft (4 rows) by 40 ft. Each cultivar had a plot that either remained unsprayed or was sprayed with 20 oz/a Prevathon. Prevathon applications were made on 22 July due to egg lay threshold being met. Data collection occurred at 4, 7, 12, 15 and 19 days after application (DAA). In each plot 25 squares, 25 blooms, and 25 bolls were sampled, and the number damaged for each was recorded. The two center rows of each plot were harvested on Nov 1. The data was analyzed by ARM with an $\pm = 0.05$.

Results

At 4 DAA, the unsprayed non-*Bt* plots had the greatest amount of damaged fruit at 23 percent (Figure 1). Both the sprayed Bollgard II and Bollgard III plots had similar amounts of damage and had less damage than unsprayed non-*Bt* and Bollgard 2. At 7 DAA, the percent damaged fruit was greatest in unsprayed non-*Bt* and Bollgard 2 (Figure 2). Sprayed and unsprayed three gene cultivars and the sprayed Bollgard II had lesser amounts of damage than all other plots. At 19 DAA, only the non-*Bt* and Bollgard II plots benefited from the Prevathon application. Three gene cultivars and sprayed Bollgard II plots contained the least amount of damage (Figure 3).

Yield Data

Plots were harvested and weighed on a seed per acre basis. Sprayed non-*Bt* and Bollgard II had similar yield levels to all three gene cultivars sprayed or unsprayed (Figure 4). Dual gene cotton may not provide the protection needed and additional foliar applications may be required. Growers planting dual gene cultivars should budget at least one application of a diamide to prevent yield loss. Based on information collected from the Arkansas Field Crops Enterprise Budget, Bollgard III provides reduced input and production cost. Three gene cotton reduces insecticide use, lessens the amount of diesel used, and condenses time spent in the field (Table 1). Yields were compared between the two and three gene cultivars from data generated by the On-Farm Variety Trials (OVT) conducted in Arkansas. A two gene cultivar yielded the highest, followed closely behind by three gene cultivars. However, three gene cultivars provided a \$115 per acre advantage compared to two gene cotton. Depending on yield, the reduction in operating expenses and higher average income could provide the grower with a greater profit margin when planting a three gene cultivar. Growers should consider yield potential first and technology second.

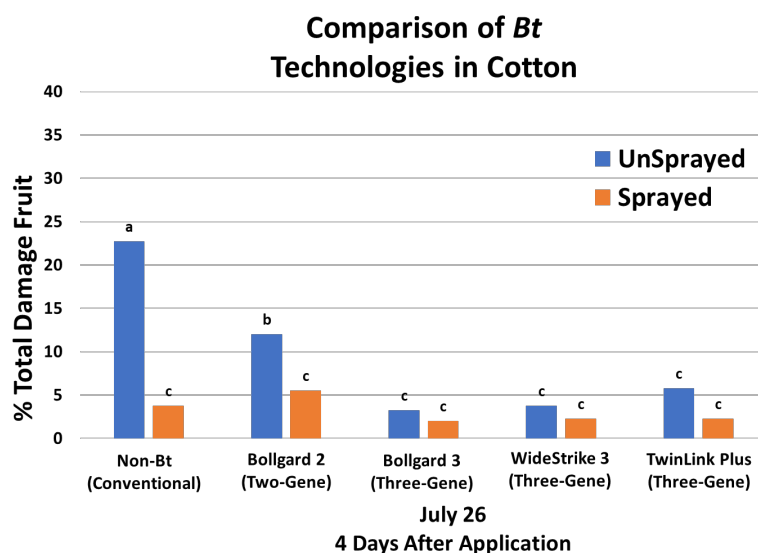


Figure 1. *Bt* Technology Sprayed vs. Unsprayed results from Tillar, AR. Cotton technologies were sprayed on the 22 July. 4DAA on 26 July, each plot was analyzed for fruiting structure damage.

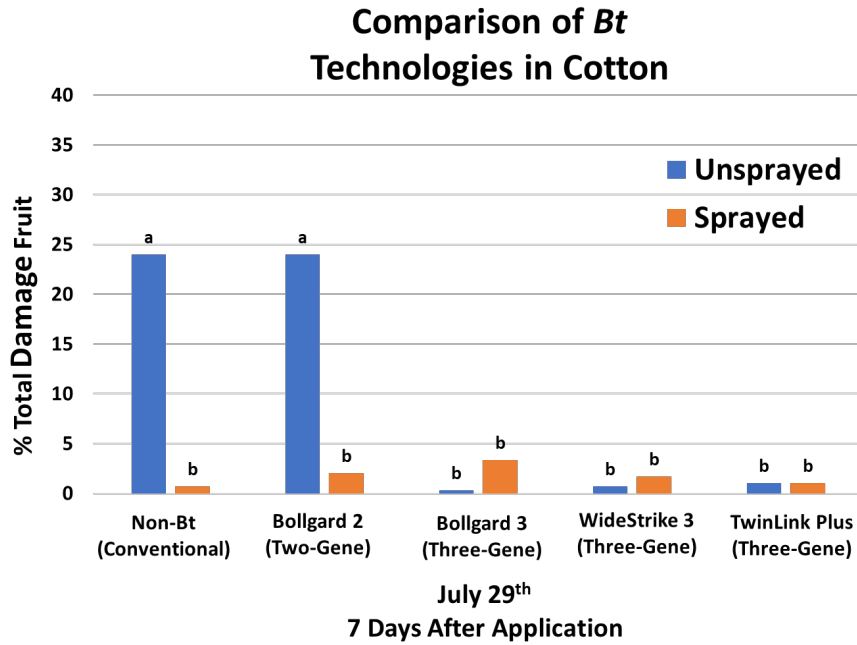


Figure 2. *Bt* Technology Sprayed vs. Unsprayed results from Tillar, AR. Cotton technologies were sprayed on the 22 of July. 7 DAA on 29 July, each plot was analyzed for fruiting structure damage.

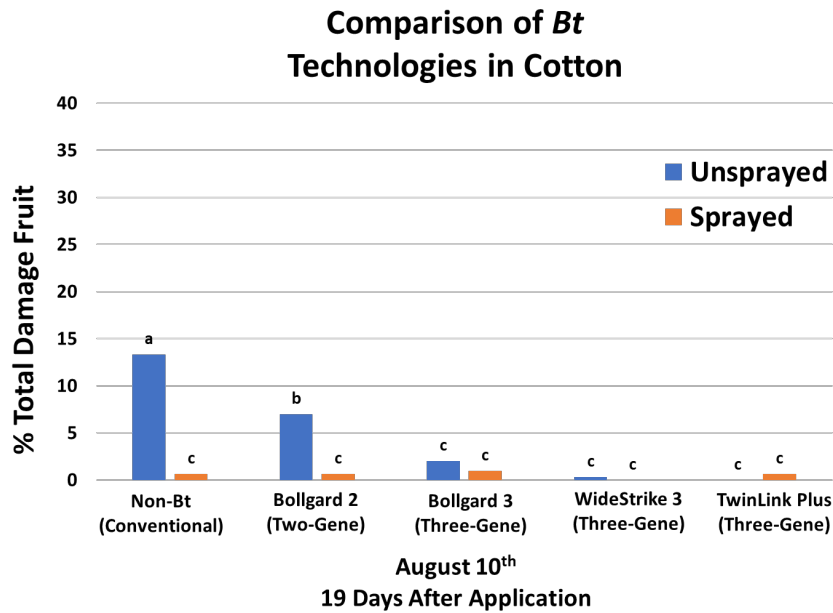


Figure 3. *Bt* Technology Sprayed vs. Unsprayed results from Tillar, AR. Cotton technologies were sprayed on 22 July. 19 DAA on 10 of Aug, each plot was analyzed for fruiting structure damage.

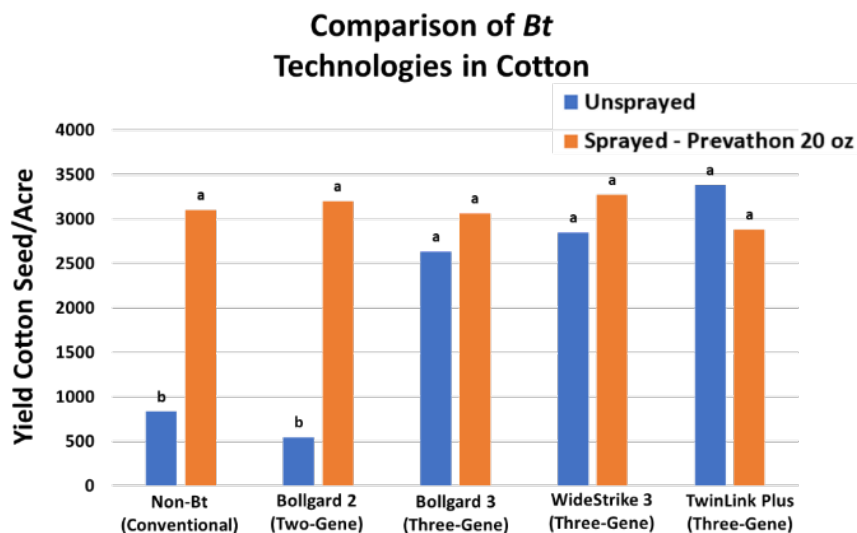


Figure 4. Cotton cultivar net return based upon Desha County, AR location. Evaluation of net return per acre for each cotton cultivar in 2020.

Table 1. Three main operating expenses for growers taken from the Arkansas Field Crops Enterprise Budget 2020.

Bollgard 2 Budget				
Operating expenses	Unit	Quantity	Price/unit	Cost
Insecticide	Acre	1	\$92.76	\$92.76
Diesel(Pre/Post Harvest)	Gallon	5,423	\$1.60	\$8.68
Labor, Field Activities	Hrs	0.929	\$11.33	\$10.53

Bollgard 3 Budget				
Operating expenses	Unit	Quantity	Price/unit	Cost
Insecticide	Acre	1	\$70.36	\$70.36
Diesel(Pre/Post Harvest)	Gallon	5,294	\$1.60	\$8.47
Labor, Field Activities	Hrs	0.915	\$11.33	\$10.36

Table 2. Average income compared between the two and three gene cultivars from data generated by the On-Farm Variety Trials (OVT) conducted in Arkansas in 2020.

Bt Technology	Average Income
Bollgard 2	\$600 ac
Bollgard 3	\$715 ac

Summary

Bollgard II when sprayed with Prevathon at 20 oz/a has similar damage as unsprayed Bollgard III. Bollgard III did not require a supplemental insecticide application to control bollworm. The increased yield coupled with reduced insecticide applications may result in a greater profit margin for Bollgard III cultivars over Bollgard II. Depending on yield, the reduction in operating expenses and higher average income could provide the grower with a greater profit margin when planting a three gene cultivar. Growers should consider yield potential first and technology second.

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References

Arkansas Cotton Variety Test 2019 - University of Arkansas.

https://agcomm.uark.edu/agnews/publications/674_Arkansas_Cotton_Variety_Test_2020.pdf.

2020 Cotton Insect Losses Estimates - Biochemistry.msstate.edu.

<https://www.biochemistry.msstate.edu/resources/pdf/2020/table6.pdf>.

Manuscript in preparation. Crop Enterprise Budget | Arkansas crop budget resources. (2020). Retrieved 14 January 2020, from <https://www.uaex.edu/farm-ranch/economics-marketing/farm-planning/budgets/crop-budgets.aspx>

Stuebaker, G., Bateman, N., Davis, J., Hopkins, J., Thrash, B., & Lee, J. et al. (2019). 2019 insecticide recommendations for Arkansas. [Little Rock, Ark.]: Cooperative Extension Service, University of Arkansas, Division of Agriculture.

USDA - National Agricultural Statistics Service - Arkansas. (2020). Retrieved 14 January 2020, from

https://www.nass.usda.gov/Statistics_by_State/Arkansas/index.php