COMPARISON OF *BT* TECHNOLOGIES, WITH AND WITHOUT DIAMIDE APPLICATIONS, FOR CONTROL OF *HELICOVERPA ZEA* IN ARKANSAS COTTON

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Abstract

The cotton bollworm (*Helicoverpa zea,* Boddie) is a major pest of cotton in Arkansas and can cause significant yield losses if not controlled. An increasing amount of fruit damage has been observed in dual gene cotton cultivars in the last several years. A study was conducted in Drew County, Arkansas to evaluate the efficacy of dual gene and triple gene *Bt* cotton cultivars in sprayed and unsprayed conditions. Results indicated that dual gene cultivars may require supplemental foliar applications for control of high populations of bollworms while triple gene cultivars did not benefit from supplemental foliar applications.

Introduction

The cotton bollworm (BW) (*Helicoverpa zea,* Boddie) is a major pest of post-bloom cotton in the Midsouth. In 2017, 100% of Arkansas cotton acres were infested by the BW. Of those acres, 98% were planted in *Bt* cotton cultivars (Cook, et. al., 2017). A meta-analysis of cotton data in the Midsouth suggests that Bollgard 2 and WideStrike efficacy have declined in recent years due to resistance of cotton bollworm to several *Bt (Bacillus thuringiensis)* toxins (Fleming, et. al., 2018). With the high technology fees associated with these traits and the growing concern of *Bt* resistance, it is important to monitor the efficacy of different traits for control of caterpillar pests.

Recent studies have indicated that dual gene *Bt* cultivars such as WideStrike, TwinLink, and Bollgard 2 may not provide the protection needed to prevent fruit damage from cotton bollworms and can benefit from supplemental foliar applications in years when bollworm populations are high (Taillon, et. al., 2015; 2016; 2017). In 2013, the average cost of insect control related technology fees in transgenic cotton in Arkansas was $29.48 per acre, but has since decreased to $9.32 in 2017. Within the same period, supplemental foliar insecticide application costs increased from $2.95 to $15.00 per acre (Williams, et. al., 2013; Cook, et. al., 2017). In 2017 around 75% of cotton acres in Arkansas received a supplemental foliar application for control of the cotton bollworm. (Cook, et. al., 2017). Currently, Arkansas' cotton bollworm threshold for dual transgenic cotton cultivars is 6% damaged fruit (squares + bolls) with worms present or eggs present on 25% of plants (Studebaker et. al., 2018). In 2017, triple gene varieties such as WideStrike 3, TwinLink Plus, and Bollgard 3 provided a superior level of control without requiring a supplemental foliar application (Taillon, et. al., 2017). The objective of this study was to evaluate dual and triple gene *Bt* cotton cultivars for cotton bollworm injury and to determine the impact of a supplemental foliar insecticide application in the *Bt* cotton cultivars.

Materials and Methods

A trial was conducted on a grower field in Drew County, Arkansas in 2018. Plot size was 12.5 ft. (4rows) by 40 ft., in a randomized complete split block design with 4 replications. Cultivars included: Non-*Bt* (DP1822XF); WideStrike (PHY333WRF); WideStrike 3 (PHY330W3FE); TwinLink (ST5122GLT); TwinLink Plus (ST5471GLTP); Bollgard 2 (DP1518B2XF); Bollgard 3 (DP1835B3XF) (Table 1). Each of the tested cultivars contained a sprayed and unsprayed plot. Sprayed plots were treated with a single foliar application of Prevathon (chlorantraniliprole) at 20 oz/acre on July 24. Insecticide application was made using a Mudmaster high clearance sprayer fitted with TXVS-6 nozzles at 19.5 inch spacing with a spray volume of 10 gal/acre at 40 psi. Damage was rated by sampling 25 squares, 25 blooms, and 25 bolls per plot. Ratings were taken 6, 13, and 21 days after application (DAA). The data was

processed using Agriculture Research Manager 2018 (Gylling Data Management, Inc., Brookings, S.D.) with Duncan's New Multiple Range Test (P=0.10) to separate means. Means followed by same letter do not significantly differ (P=.10, DNMRT). Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

Table 1. A list of cotton varieties used during cotton bollworm efficacy studies in 2018.

Cotton Cultivars by Transgenic Trait Package		
Conventional	**Dual Gene**	**Triple Gene**
Non-*Bt* (DP1822XF)	WideStrike (PHY333WRF)	WideStrike 3 (PHY330W3FE)
	TwinLink (ST5122GLT)	TwinLink Plus (ST5471GLTP)
	Bollgard 2 (DP1518B2XF)	Bollgard 3 (DP1835B3XF)

Results and Discussion

All plots had less damage than the untreated non-*Bt* control for each sampling date except for WideStrike unsprayed 21 days after application (DAA), (Figures 1-4).

At 6 DAA, all Bt cultivars, sprayed and unsprayed, as well as the non Bt sprayed had less damage than the unsprayed WideStrike (Figure 1). When sprayed, the WideStrike was no different than the non-Bt sprayed. All other Bt Cultivars, sprayed and unsprayed were at or below threshold.

At 13 DAA, similar results were observed; however, damage in TwinLink and Bollgard II were no different than the non Bt sprayed and WideStrike sprayed and were above threshold (Fig. 2).

At 21 DAA, WideStrike unsprayed was no different than the non-Bt unsprayed (Figure 3). Bollgard II unsprayed and WideStrike sprayed had more damage than the TwinLink sprayed, BollGard II sprayed, and the triple gene cultivars - sprayed and unsprayed.

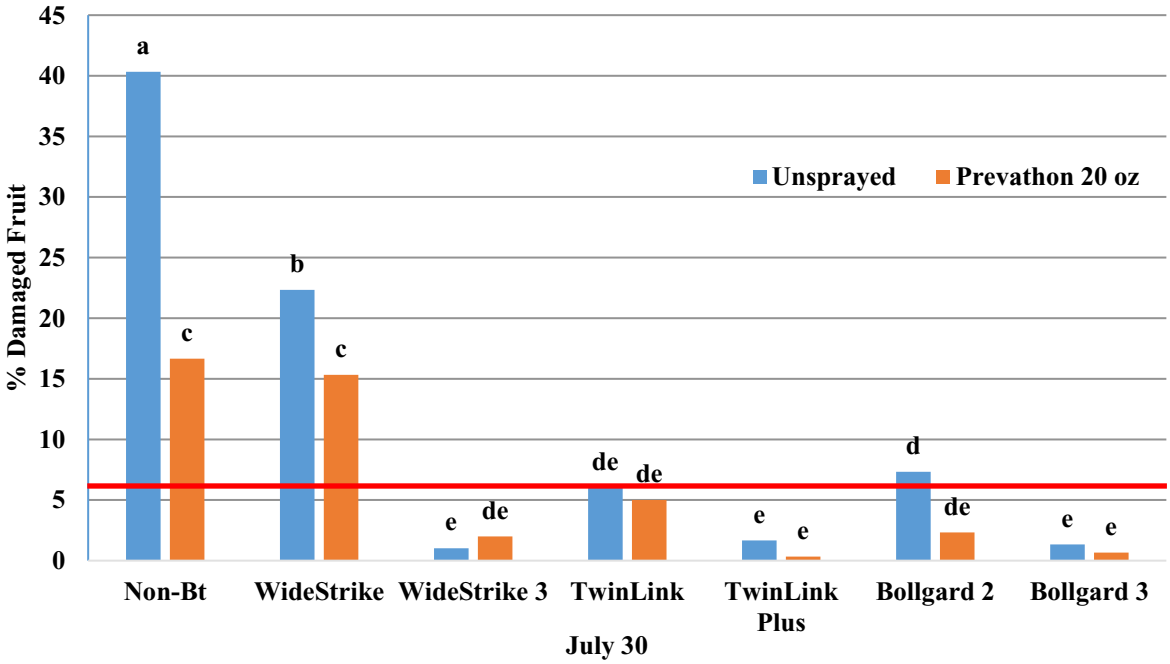

Figure 1. Percent damaged fruit 6 days after application of Prevathon at 20 oz/acre (red line denotes 6% threshold).

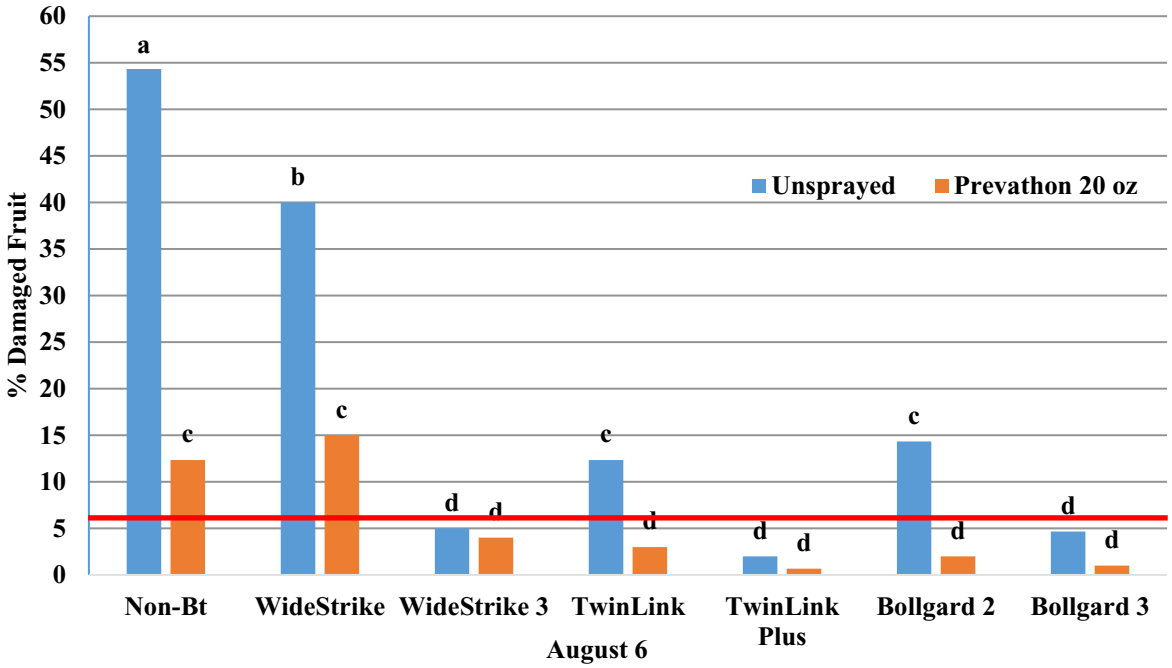

Figure 2. Percent damaged fruit 13 days after application of Prevathon at 20 oz/acre (red line denotes 6% threshold).

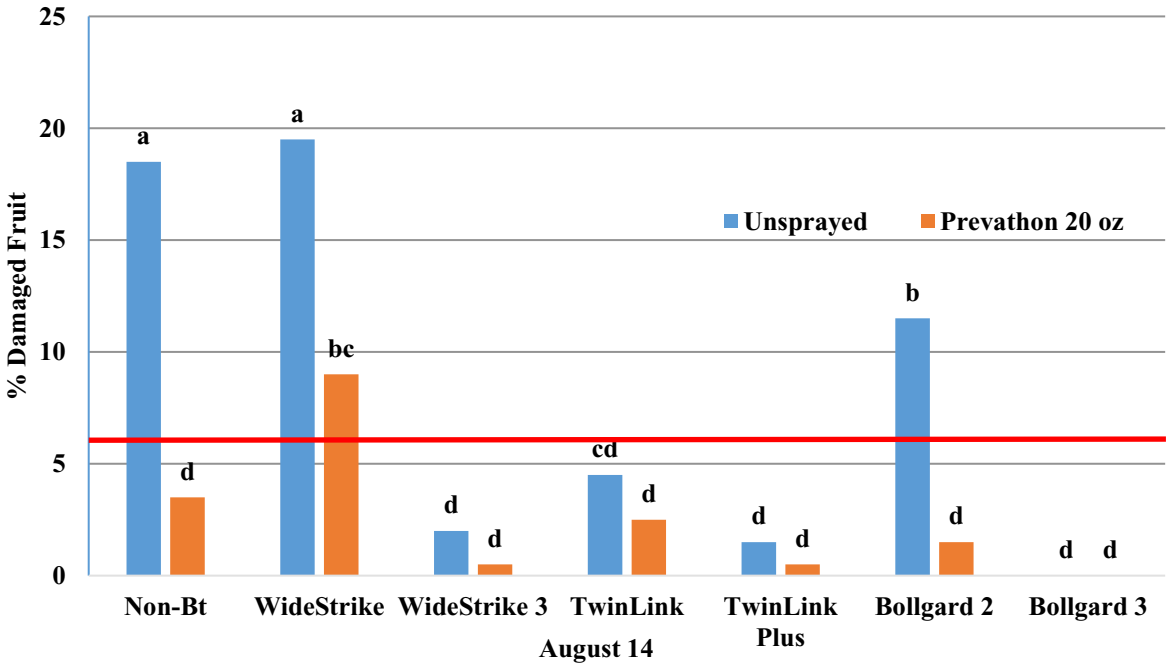

Figure 3. Percent damaged fruit 21 days after application of Prevathon at 20 oz/acre (red line denotes 6% threshold).

There was high BW pressure in this trial as indicated by the level of damage in the non-*Bt* cultivar. In the first two sample dates, the unsprayed non-*Bt* cultivar had about 47% fruit damage in a two week period. As a result, there was not enough fruit left on the last sample date to accurately sample damaged fruit in the non-Bt unsprayed plots. This caused the data to appear as if the non-*Bt* had less damage than was actually present. At all three sample dates, the WideStrike cultivar, sprayed and unsprayed, exceeded the 6% threshold averaging 27% fruit damage in the unsprayed

plots and 13% in sprayed plots. In unsprayed WideStrike 3, the damage level never reached the 6% damage threshold and provided much greater control than both sprayed and unsprayed WideStrike plots. Unsprayed Bollgard II averaged 11% damaged fruit across all three sampling dates indicating the need for a supplemental foliar application for bollworm control.

Conclusion

Cotton bollworms are developing resistance to the dual gene *Bt* toxins. A foliar insecticide application reduced damage in all dual gene cultivars in this trial. However, the triple gene cultivars did not benefit from a foliar insecticide application for control of cotton bollworm, even under the intense cotton bollworm pressure experienced in this study. Based on these results, growers planting dual gene cultivars should budget at least one application of a diamide to prevent yield loss. However, triple gene cultivars appear to provide adequate control but should still be monitored to ensure adequate control. When selecting cultivars, growers should consider yield potential first and then technology, but be aware that dual gene varieties could need a supplemental foliar application for worm control.

Acknowledgments

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