ENTO-PU-150
March 2019

Bt COTTON

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What is Bt Cotton?

Bt cotton is genetically altered by the insertion of genes from a common soil bacterium, *Bacillus thuringiensis*, to produce certain proteins that are toxic to specific insects. Currently available Bt cotton varieties produce either or both crystal (Cry) and vegetative insecticidal proteins (Vip) that target specific caterpillar pests such as beet armyworm (Fig. 1), cotton bollworm (Fig. 2), and tobacco budworm.

Figure 1. Beet armyworm.

Figure 2. Cotton bollworm.

How does Bt cotton help manage pests?

Initially, Bt cotton provided a means to effectively manage pests, such as tobacco budworm and pink bollworm, that were difficult to control or had developed resistance to commonly used insecticides. Since then, Bt cotton has been instrumental in providing control of other pests, including beet armyworm, bollworm, fall armyworm, and loopers. The use of Bt cotton has reduced the need for foliar insecticides targeting these pests and has also reduced outbreaks of secondary pests.

What Bt traits are available?

Since its introduction in 1996 into U.S agriculture, Bt technology has developed from a single-gene trait to multi-gene trait packages. The first-generation Bt cotton (Bollgard) had a single Bt gene that expressed (produced) Cry1Ac. The second-generation Bt technologies, such as Bollgard 2, TwinLink, and WideStrike, produce two Bt toxins, and the most recent third-generation Bt technologies (WideStrike 3, Bollgard 3, and TwinLink Plus) are three-gene trait products.

Bt technologies	Proteins expressed
Second generation	
Bollgard 2	Cry1Ac + Cry2Ab
WideStrike	Cry1Ac + Cry1F
TwinLink	Cry1Ab + Cry2Ae
Third generation	
WideStrike 3	Cry1F + Cry1Ac + Vip3A
Bollgard 3	Cry1Ac + Cry2Ab + Vip3A
TwinLink Plus	Cry1Ab + Cry2Ae + Vip3Aa19

Which Bt traits are the most effective and what factors affect the efficacy of these traits?

Currently, the third-generation Bt technologies with three genes are expected to be most effective for controlling worms. Biotic (living organisms) and abiotic (physical factors such as prolonged cool and wet soil, soil salinity, extreme drought) stress negatively affect plant growth and, subsequently, protein expression in Bt crops.

Can insect populations develop resistance to Bt?

Yes. Research shows the reduced efficacy of some of the Bt traits against cotton bollworms at many locations across the Southern United States. Newer technologies with two or more relatively dissimilar toxins should slow down the rate of resistance development as it is less likely that any one insect will be simultaneously resistant to more than one or two toxins.

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Does a Bt cotton field need to be scouted for caterpillar pests?

Yes. None of the current technologies provide 100 percent insect control. Cotton varieties with third-generation Bt have excellent activity against tobacco budworm and bollworm. However, under heavy infestation pressure, supplemental insecticide treatment for bollworms may be necessary. Also, field monitoring is essential because bollworm or fall armyworm populations may develop, particularly on blooms, and also appear late in the season on stressed cotton where the Bt toxin production may be compromised.

When is the best time to begin insecticide treatment?

In areas where injury to Bt cotton is common, the recommendation for two-gene cotton is an egg-based threshold of 20 percent egg lay (20 percent of plants with at least 1 egg) (Fig 3). Do not use the egg threshold in areas where injury to Bt cotton is uncommon. In such areas, treat the cotton based on 6 percent damaged squares or bolls with larvae present. The recommendation for three-gene cotton (contains Vip3A) is a larval or damaged reproductive structure-based threshold of 6 percent dam- aged squares or bolls (Fig. 4) with larvae present. Insecticide choice and timing is essential for these thresholds to be efficient. Timing insecticide application toward small larvae is most effective. Once the larvae reach the second instar, they move deeper into the plant canopy and burrow into fruiting structures, significantly limiting insecticide exposure. In much of Texas, pyrethroids perform poorly against bollworms and should be used cautiously. They may also flare aphids or spider mites. Diamides (Prevathon 14–20 ounces, Besiege 7.2–10 ounces) are the products of choice for bollworm control in cotton. Besiege is a mix of the diamide and a pyrethroid, so flaring secondary pests may occur. Other insecticides sometimes used for managing bollworms in cotton include spinosad, indoxacarb, and methomyl, but these insecticides tend to be either less effective or exhibit shorter residual activity.

Figure 3. Bollworm egg.

Figure 4. Bollworm damage.

Relative Efficacy of Bt Traits against Caterpillar Pests

Pest	Bollgard (Cry1Ac)	Bollgard II (Cry1Ac + Cry2Ab)	Widestrike (Cry1Ac + Cry1F)	TwinLink (Cry1Ab + Cry2Ae)	Widestrike 3 (Cry1Ac + Cry1F + Vip3A)	Bollgard 3 (Cry1Ac + Cry2Ab + Vip3A)	TwinLink Plus (Cry1Ab + Cry2Ae + Vip3Aa19)
	1996	2003	2005	2013	2014	2017	2017
Bollworm	4	2.5	4	2.75	2.5	2*	2*
Tobacco budworm	1	1	1	1	1	1	1
Pink bollworm	1	1	1	1	1	1	1
Beet armyworm	2	2	2	2	1-2*	1-2*	1-2*
Fall armyworm	2.5	2	1	2	1	1-2*	1-2*
Soybean looper	1	1	1	1	1	1	1

1 = Complete control 2 = Rarely requires oversprays 3 = Sometimes requires oversprays 4 = Frequently requires oversprays *Incomplete data