PERFORMANCE OF TRANSGENIC COTTON CULTIVARS (*Bt*) IN RELATION TO THE OCCURRENCE OF PESTS IN BRAZIL

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Abstract

This study verifies comparatively the occurrence of lepidopteran pests and non-target pests of the *Bt* technology in three *Bt* cultivars currently planted in Brazil: Bolgard II (Cry1Ac + Cry2Ab2), Widestrike (Cry1Ac + Cry1F) and Twinlink (Cry1Ab + Cry2Ae) and non-*Bt* cultivar FMT701. Therefore two experiments were conducted, in a field condition (Experiment I) and greenhouse condition (Experiment II). The results were submitted to analysis of variance by the F test and the Tukey Test (5%) compared the averages. Bollgard II, Widestrike and Twinlink cotton cultivars were efficient in protecting plants against the attack of *Alabama argillacea*, *Chrysodeixis includens*, *Spodoptera eridania* and *Pectinophora gossypiella* and negatively affected the population of *Spodoptera frugiperda* and *Helicoverpa armigera*, but the Widestrike cultivar is not of high performance in the protection of plants against the attack of these species. Cotton Bt cultivars Bollgard II, Widestrike and Twinlink provided higher productivity than the non-Bt cultivar FMT701, especially the Widestrike cultivar, which achieved the highest productivity. Cotton cultivars Bt Bollgard II, Widestrike and Twinlink were efficient in protecting the plants against *H. armigera* attack under greenhouse conditions.

Introduction

Currently, the area planted with cotton in Brazil occupies approximately 1.4 million hectares (3.5 million acres). The Central-Western region of Brazil accounts for 64% of the country's cotton production, followed by the Southeastern region at 30%, and the Southern region at 15%. Due to the great number of pests that attack cotton, producers must adopt measures for a rational insect control management.

Helicoverpa armigera (Hubner*)* presents a wide geographical distribution and it is registered in several countries. In March 2013 was officially reported in Brazil (Cezepak et al., 2013), where it was considered a quarantine pest. *H.armigera* has a high destructive potential and has brought concerns to Brazilian farmers because of the difficulty of its control and the lack of information about its management in Brazil. *Helicoverpa armigera* (Hübner) is recorded in several countries (Guo, 1997); but until March 2013 had not been officially registered in Brazil. *H. armigera* is a highly polyphagous species with high mobility and high survivability even in adverse conditions and can complete several generations per year (Fitt, 1989). These biological characteristics give the pest high damage production capacity and bring concern to Brazilian cotton farmers, due to the difficulty of its control and the lack of information regarding this pest in Brazil The cotton bollworm feed of leaves and stems, however, It is have preference for squares and boll and cause damages in the phase vegetative and reproductive. The characteristics of that pest demonstrate its destructive potential that caused world losses of about 5 billion dollars/year (Lammers; Macleod, 2007). In Brazil the losses reached about one billion dollars already in the first harvest after the detection (ABRAPA, 2012) and caused losses above 80% in the production of the cotton in the west of Bahia (EMBRAPA, 2013).

The most used method for the control of lepidopteran pests in the cotton crop are the transgenic varieties containing *Bt* technology. The adoption of *Bt* cotton cultivars increased in the last harvest in Brazil, due to the increased availability of cultivars with new protein combinations and the occurrence of lepidopteran pests such as *Helicoverpa armigera*. In high infestations of some field pests such as *Helicoverpa armigera* and *Spodoptera frugiperda*, effective control failure of many Bt varieties in Brazil has been observed. This control experiment may be related to several factors such as the absence of refuge, the lower natural susceptibility of the target insects in plants and the lower expression of the Bt toxin throughout the development cycle of the plant in vegetative and reproductive structures (SANTANA, 2016; ARMSTRONG et al., 2011; SIVASUPRAMANIAN et al., 2008).

The objective of this study was verifies comparatively the occurrence of lepidopteran pests and non-target pests of the *Bt* technology in three *Bt* cultivars currently planted in Brazil: Bolgard II (Cry1Ac + Cry2Ab2), Widestrike (Cry1Ac + Cry1F) and Twinlink (Cry1Ab + Cry2Ae) and non-*Bt* cultivar FMT701.

Materials and Methods

Experiment I (field conditions): The experiment was conducted on Experimental Farm of Unesp (São Paulo State University), located in Selvíria/MS/Brazil. The design was randomized blocks with four treatments and six replicates. Each plot consisted of 12 rows with spacing of 0.9 m, 30 m of length and density of 10 plants/m. The evaluations were carried out weekly, registering the occurrence of pests, damage to reproductive structures and defoliation.

Experiment II (greenhouse conditions): The experiment was conducted on Paulista State University/UNESP, in Ilha Solteira/SP/Brazil. It was used the same cultivars of Experiment I. In each treatment were made artificial infestations with *Helicoverpa armigera* caterpillars obtained from the creation in Laboratory. Artificial infestation was carried out in the proportion of two caterpillars per plant deposited on the pointer when the plants were in the phenological stage B5. After the infestations, the plants were inspected to verify the adaptation and establishment of the caterpillars. The design was completely randomized, with 4 treatments and 10 replications, for each species of caterpillars. Each plot consisted of a cotton plant grown in a ten-liter pot. Daily evaluations were carried out, registering the number of floral buds damaged by caterpillars and the number of alive caterpillars, until five days after infestation.

Variance analysis: The results were submitted to analysis of variance (ANOVA) through the F test, comparing the averages by the Tukey test to 5% of probability, using Software Assistat (SILVA; AZEVEDO, 2016).

Table 1 - Description of treatments, commercial name and proteins expressed in cultivars. Selvíria, MS, 2015.

Tratamentos	Cultivares	Proteína
1	FMT 701	Non Bt
2	Bollgard II®	Cry1Ac + Cry1F
3	Widestrike®	Cry1Ac + Cry2Ab2
4	Twinlink®	Cry1Ab + Cry2Ae

Results

Bollgard II (Cry1Ac + Cry2Ab2), Widestrike (Cry1Ac + Cry1F) and Twinlink (Cry1Ab + Cry2Ae) Bt cotton cultivars were efficient in protecting plants against the attack of *Alabama argillacea*, *Chrysodeixis includes* and *Spodoptera eridania* and negatively affected the population of *Spodoptera frugiperda* and *Helicoverpa armigera*, but the Widestrike cultivar is not of high performance on the protection of plants against the attack of these species.

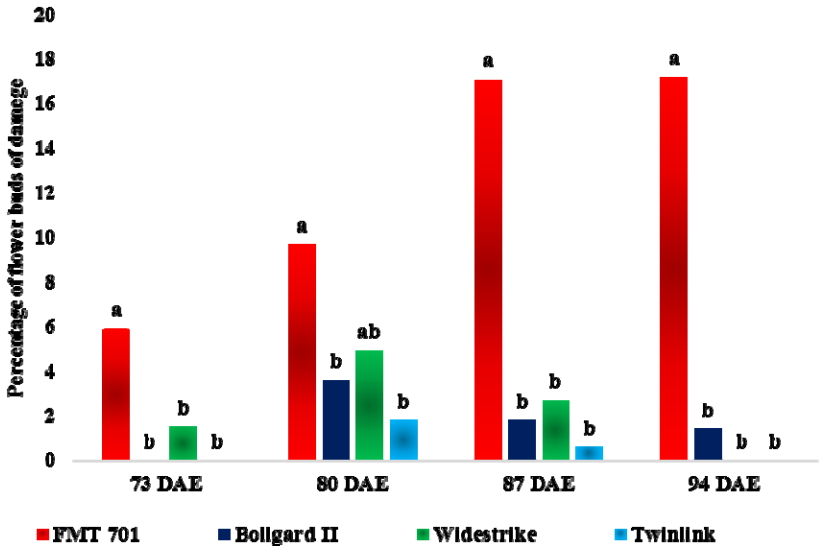

Figure 1 - Percentage of flower buds with damage caused by *Spodoptera frugiperda* and *Helicoverpa armigera*. Selvíria/MS/Brazil. 2016.

The *Bt* Cotton cultivars Bollgard II (Cry1Ac + Cry1F), Widestrike (Cry1Ac + Cry2Ab2) and Twinlink (Cry1Ab + Cry2Ae) provided higher productivity than the non-Bt cultivar FMT701, especially the Widestrike cultivar, which achieved the highest productivity.

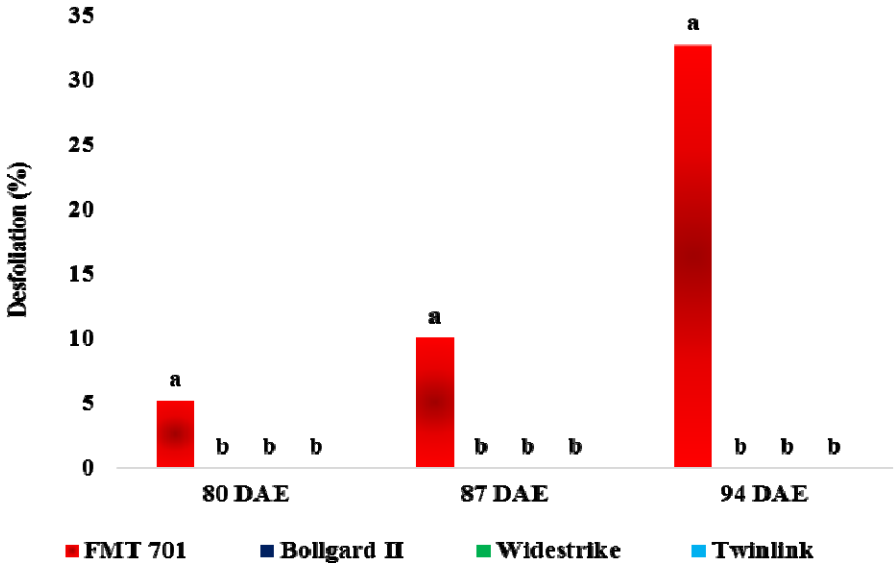

Figure 2 - Average percentage of defoliation in cotton attacked by *Alabama argillacea*, *Chrysodeixis includens* and *Spodoptera eridania* in field. Selvíria/MS/Brazil. 2016.

Table 2 - Number of live caterpillars *H. armigera* and mean number of flower buds attacked five days after infestation. Ilha Solteira, SP. 2016

Treatments	Five days after infestation		Cotton productivity kg/ha
	Flower buds attacked /plant	Number of live caterpillars	
FMT 701	3,2 a*	12a	1495 c
Bollgard II	0,94b	2b	1985 b
Widestrike	1,12b	0b	2550 a
Twinlink	0,88b	0b	1990 b

Conclusions

- Bt cotton Bollgard II, Widestrike and Twinlink were efficient in protecting cotton against the attack of *Alabama argillacea*, *Chrysodeixis includes* and *Spodoptera eridania*

- Bollgard II, Widestrike and Twinlink negatively affected the population of *Spodoptera frugiperda* and *Helicoverpa armigera*.

- The Widestrike cultivar was not of high performance in the protection of cotton against the attack of *Spodoptera frugiperda* and *Helicoverpa armigera*.

- Bt Cotton cultivars Bollgard II, Widestrike and Twinlink provided higher productivity than the non-Bt cultivar FMT701, especially the Widestrike cultivar, which achieved the highest productivity.

Disclaimer

Mention of a trade name or specific equipment does not constitute a guarantee or warranty by the USDA or Brazilian government and not imply its approval to the exclusion of other products that may suitable.

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