ASSESSING THE EFFICACY OF SELECTED TRANSGENIC BT COTTON TECHNOLOGIES AGAINST FALL ARMYWORM DURING 2007

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Abstract

Laboratory studies evaluated fall armyworm, *Spodoptera frugiperda* (J.E. Smith), mortality on Bollgard® (Cry1Ac), Bollgard II® (Cry1Ac + Cry2Ab), and WideStrike™ (Cry1Ac + Cry1F) and VipCot™ (Vip3A + Cry1Ab) cotton lines. Larval (L3 stage) from a laboratory colony were offered freshly harvested flower buds (squares). Plant tissue was replaced every two-three days and a record of larval mortality was recorded at the same intervals. Maximum observed mortality of larvae and time (d) required to achieve maximum mortality differed among the Bt cotton lines in these studies.

Introduction

The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is a sporadic to occasional pest of cotton, due to its annual migratory behavior. The lack of a diapausing mechanism forces this insect pest to migrate into the U.S. cotton production regions each year from warmer environments such as South Florida, Caribbean islands, South Texas, Mexico, or Central America (Adamczyk et al. 1997). The majority of the insecticide treatments that are effective against the more common Lepidopteran pests of cotton, such as the bollworm, *Helicoverpa zea* (Boddie), and tobacco budworm, *Heliothis virescens* (F.), provide inconsistent control of fall armyworm (Adamczyk et al. 1997). Fall armyworm larvae usually disperse low in the plant canopy, and poor deposition of insecticides in this plant region further reduces the effectiveness of these products.

The first transgenic *Bacillus thuringiensis* var. *kurstaki* (Berliner) (Bt), cotton cultivars became available in the U.S. during 1996 (Jackson et al. 2005). Monsanto released Bollgard® cotton, which contains an insecticidal crystal (Cry) protein (Leonard et al. 2006). The protein in Bollgard®, Cry1Ac, is highly toxic to specific Lepidopteran pest targets in cotton including tobacco budworm and pink bollworm, *Pectinophora gossypiella* (Saunders) (Jackson et al. 2005). The bollworm and numerous other occasional Lepidopteran pests, are not as susceptible to the Cry1Ac protein as the tobacco budworm (Stewart et al. 2000). Bollgard II® (Cry1Ac + Cry2Ab) was released in 2002, and has provided significantly better control of bollworm, in addition to the tobacco budworm (Adamczyk and Mahaffey 2007). In 2004, Dow AgroSciences commercialized the WideStrike technology in cotton lines that express Cry1Ac and Cry1F proteins (Adamczyk and Mahaffey 2007). WideStrike™ provides control of many of the same target pests as Bollgard II, but the Cry1F protein also improves efficacy against bollworm and other secondary Lepidopteran pests (Tindall et al. 2006).

In addition to the aforementioned Bt traits in transgenic cotton lines, Syngenta Crop Protection is currently developing another unique combination of Bt proteins in plants (Adamczyk and Mahaffey 2007). The VipCot™ technology incorporates an exotoxin (Vip3A) with Cry1Ab. The Vip3A protein is unique in both structure and mode of action compared to the Cry proteins currently utilized in commercial Bt varieties (Leonard et al. 2005).

The efficacies of Bollgard®, Bollgard II®, WideStrike™, and VipCot™ cotton lines have been evaluated in numerous studies against primary cotton pests such as heliothines and pink bollworm (Henneberry et al. 2001, Sims

et al. 2002, Haile et al. 2004) . Only limited information is available on the performance of these Bt technologies against occasional insect pests such as fall armyworm. Therefore, the objective of this report is to summarize the results of preliminary laboratory trials with selected Bt cotton traits and susceptibility of fall armyworm.

Materials and Methods

No-choice laboratory trials were performed at the LSU AgCenter's Macon Ridge Research Station (MRRS) near Winnsboro, LA, during 2007. Cotton lines transformed to express Bt proteins included Bollgard® (Stoneville 5599BG), Bollgard II® (Stoneville 6611B2RF), WideStrike™ (Phytogen 375WRF) and VipCot™ (Coker 312 background – advanced line). Conventional non-Bt parental lines were tested as negative controls to standardize larval survival for cotton genotype background and each specific combination of Bt proteins. Field plots of all cotton lines were planted during June 2006, and managed with agronomic and IPM strategies to optimize plant development and production of fruiting forms. This study used freshly harvested flower buds (squares) as the specific plant tissue to evaluate fall armyworm cumulative mortality.

The fall armyworm colony originated from field collections in cotton (fall, 2005) and field corn (summer, 2006). It has been maintained as a laboratory colony on meridic diet according to previously described methods (Adamczyk et al. 1998). Larvae (one – L3 stage insect/cup) were removed from the laboratory colony and placed in 40 dram specimen cups that contained two-three squares per cup. The cups were sealed with a plastic lid to prevent larval escape and to reduce desiccation of cotton squares. For each date of infestation and subsequent observations, all squares were immediately harvested from field plots, debracted, gently washed and placed into cups. Squares were exchanged at least every third day after infestation or more often when daily examination of the cups indicated the squares were deteriorating or had been fully consumed by the insect. A minimum of two replicates, each with a total of 30 larvae, produced a total sample size of 60 larvae per cotton line. Cumulative larval mortality was recorded daily until 12 d after the initial infestation (DAI).

Results and Discussion

Fall armyworm larvae readily consumed squares in the non-Bt control cotton lines. Complete (100%) mortality was never observed on non-Bt cotton squares at the endpoint (12 DAI) of the experiments. Larval mortality on non-Bt cotton squares ranged from 1.67% at 2 DAI to 41.67% at 12 DAI. On Bollgard® squares, mortality ranged from 0% at 2 DAI to 65% at 12 DAI. As previously observed with the non-Bt control squares, Bollgard® squares did not produce complete mortality at 12 DAI. On Bollgard II® squares, mortality ranged from 1.67% at 2 DAI to 88.34% at 12 DAI. Considerable, (85%) larval mortality was observed at 7 DAI. Complete mortality of fall armyworm on WideStrike™ squares was observed at 7 DAI. VipCot™ squares produced results similar to that for the WideStrike™ technology and complete larval mortality was observed at 12 DAI. Nearly complete, (97.5%) mortality was observed at 7 DAI on WideStrike™ squares.

These results of the present study should be considered preliminary and no definitive conclusions are proposed by the authors. Fall armyworm infestations on cotton leaf tissues, bolls, as well as squares, will be repeated during 2008. In general, the interpretation of these observations are not dissimilar from those presented in other studies evaluating fall armyworm susceptibility to Bollgard® (Akin et al. 2001, Leonard et al. 2006), Bollgard II® (Akin et al. 2001, Coots and Pitts 2003, Leonard et al. 2006), WideStrike™ (Leonard et al. 2005; Willrich et al. 2005, Tindall et al. 2006, Jackson et al. 2007) and VipCot™ (Leonard et al. 2005, Adamczyk and Mahaffey 2007). The final results generated at the conclusion of these experiments should better characterize the activity of selected Bt cotton traits against fall armyworm. Cotton producers will then have additional information to use in the selection of the most appropriate cultivar and Bt trait combination for their individual needs.

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