2010-SEASON UPDATE ON MONITORING OF RESISTANCE TO BT COTTONIN KEY LEPIDOPTERAN PESTS IN THE USA

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Abstract

Producers sprayed more Bollgard II to control target lepidopteran pests in 2010 than in previous years, and therefore concerns have been expressed that the susceptibility of the target lepidopteran pests to the Bt Cry1Ac and Cry2Ab proteins in Bollgard II has significantly decreased. However, resistance monitoring of tobacco budworm, *Heliothis virescens*, and bollworm, *Helicoverpa zea,* for the 2010 cotton field season found no evidence of any change in susceptibility to either Cry1Ac or Cry2Ab in either of these target pests. As has been noted for bollworm in past monitoring results, there was continued evidence of high variation in susceptibility to both proteins, but no evidence that the level of variation has increased.

Introduction

Transgenic cotton varieties containing *Bacillus thuringiensis* (Bt) insecticidal Cry proteins have been adopted worldwide and generally provide excellent crop protection against targeted pests including pink bollworm, *Pectinophora gossypiella*, tobacco budworm, *Heliothis virescens*, and cotton bollworm, *Helicoverpa zea.* However, cotton bollworm is typically more difficult to control with Bt cotton than the other target lepidopteran pests, and therefore Bt cotton is often sprayed with insecticides as a supplemental control measure. Insect resistance to the Cry proteins expressed in Bt cotton is a major concern for researchers and regulatory agencies worldwide and therefore the US EPA has required monitoring of Bt susceptibility in targeted cotton pests since 1996. Although monitoring has historically consisted primarily of conducting insect bioassays, PCR-based molecular monitoring replaced insect bioassays for pink bollworm. This article presents the latest monitoring results from the Cotton Belt for tobacco budworm and bollworm against Cry1Ac and Cry2Ab found in Bollgard II.

Materials and Materials

In 2010, insects were collected from Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina and Texas, and shipped to a rearing and bioassay facility for testing. Cry1Ac bioassays were conducted using MVPII powder, whereas Cry2Ab bioassays were conducted using lyophilized corn leaf powder containing Cry2Ab protein. Bioassays were conducted on neonates using one or two discriminating concentrations either as diet incorporation (10 µg/ml for Cry1Ac and Cry2Ab) against tobacco budworm or diet overlays (30µg/cm^2 or 10µg/cm^2 and 30µg/cm^2 for Cry1Ac and Cry2Ab, respectively) against bollworm. The percentage of larvae developing to 3rd instar after seven days was recorded.

Results and Discussion

Tobacco budworm

There were no surviving third instar tobacco budworms on 10 µg/ml Cry1Ac at any location in 2010. This result is similar to 2009, and compares positively to 2008 when almost 1% of the tested larvae survived to 3rd instar at one location. There also were no surviving third instar tobacco budworms on 10 µg/ml Cry2Ab at any location, which compares positively to both 2008 and 2009 when some larvae survived to 3rd instar at a small number of locations (1 and 4, respectively).

Bollworm

There were no surviving third instar bollworm on 10 and 30 µg/cm^2 Cry1Ac at any location in 2010 which compares positively to both 2008 and 2009 when some larvae survived to 3rd instar on 10 µg/cm^2 at a small number of locations (3 and 1, respectively). There were some 3rd instar bollworm surviving on 10 µg/cm^2 Cry2Ab at 4 locations in 2010, but this still compares positively to 2008 when surviving 3rd instars were found on 10 µg/cm^2 and 50 µg/cm^2 Cry2Ab at 22 and 7 locations, respectively.

Conclusions

Industry-wide monitoring for tobacco budworm and bollworm in 2010 did not detect any decrease in susceptibility to Cry1Ac or Cry2Ab at any location throughout the cotton belt. However, as has been observed in previous years, there is high variation in susceptibility to Cry1Ac and Cry2Ab in bollworm depending on the location. Furthermore, surviving bollworm larvae collected from Bollgard II did not display evidence of resistance alleles. The offspring of a field population collected in 2010 in Mississippi from Bollgard II was bioassayed at 30 µg/ml Cry1Ac trypsin-activated toxin resulting in only a few emerging adults and 318 eggs total. When the F_2 population was tested on 100 µg/ml Cry1Ac trypsin-activated toxin, only one larva survived to 3rd instar after 14 days.

Based on observations by many throughout the cotton belt in 2010, there is concern that bollworm might have developed resistance to Cry1Ac. However, our 2010 monitoring results do not support this conclusion.