DEFINING THE TOXICITY OF NOVEL INSECTICIDES AGAINST FALL ARMYWORM

Jarrod T. Hardke
Joshua H. Temple
LSU AgCenter
Baton Rouge, LA
B. Rogers Leonard
LSU AgCenter
Winnsboro, LA

Abstract

Susceptibility of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), larvae to selected insecticides was determined using diet-incorporated assays in Louisiana during 2008-2009. All tests were performed on larvae (L3 stage, 30-45 mg) of a laboratory colony originating from collections in cotton and corn. The colony was validated as the corn strain of fall armyworm using mitochondrial markers. Nine insecticides were evaluated against this colony including four novel insecticides (chlorantraniliprole, cyantraniliprole, flubendiamide, and spinetoram) and five common commercial standards (novaluron, methoxyfenozide, spinosad, indoxacarb, and lambda-cyhalothrin). The LC_{50}'s ranged from 0.066 µg/ml (spinetoram) to 5.27 µg/ml (lambda-cyhalothrin). Lower LC_{50} values (0.066 µg/ml to 0.93µg/ml) generally were observed among the novel insecticides when compared to that for the traditional products (0.166 µg/ml to 5.27 µg/ml). All compounds were significantly more toxic than lambda-cyhalothrin to fall armyworm using this protocol.

Introduction

The fall armyworm, *Spodoptera frugiperda* (J. E. Smith), is a migratory pest of cotton across the Mid-South and Southeastern cotton-producing regions. Annual fall armyworm infestations in field crops have been extremely sporadic because they do not overwinter in cotton-growing areas. Fall armyworm migrates each year into cotton producing areas from warmer climates in South Florida, South Texas, Mexico, the Caribbean islands, and Central America (Sparks 1979, Knipling 1980, Adamczyk et al. 1997).

Many of the insecticides effective in controlling heliothines such as bollworm, *Helicoverpa zea* (Boddie), and tobacco budworm, *Heliothis virescens* (F.), perform inconsistently against fall armyworm. In contrast to heliothines, fall armyworm control with insecticides typically requires maximum rates of these insecticides (Adamczyk and Sumerford 2000). Several factors may be responsible for difficulty in controlling this pest, including the dispersal of fall armyworm low in the plant canopy and inadequate insecticide deposition in this plant region. Resistance to pyrethroids, organophosphates, and carbamates (Wood et al. 1981, Yu 1992, Adamczyk et al. 1999, Al-Sarar et al. 2006, Whalon et al. 2008) has been reported in fall armyworm populations across the U.S., further limiting the number of insecticides effective against fall armyworm.

The widespread use of transgenic *Bacillus thuringiensis* var. *kurstaki* Berliner (Bt) cotton varieties on 70% of U.S. cotton acreage (Williams 2009) has resulted in a further reduction of insecticides used for all caterpillar pests. In addition to a decrease in the overall number of insecticide applications, the common products used as oversprays on transgenic cottons are predominately target-specific and usually do not provide fall armyworm control. Therefore, the objective of this study was to evaluate the toxicity of several novel insecticides against fall armyworm. Many of these products are likely to be registered for use in cotton IPM.

Materials and Methods

Diet-incorporated bioassays were conducted at the LSU Department of Entomology in Baton Rouge, LA during 2008-2009. Nine insecticides including chlorantraniliprole, cyantraniliprole, flubendiamide, spinetoram, novaluron, methoxyfenozide, spinosad, indoxacarb, and lambda-cyhalothrin were evaluated against an established laboratory colony of fall armyworm. The colony utilized in these studies originated from a collection in cotton during 2005, and was supplemented with collections from field corn in 2006 and 2008.

The insecticide: diet bioassay used a meridic semi-solid diet that was prepared following the manufacturer's suggested protocol. Formulated insecticides were dissolved in distilled water to create a stock solution of 100 µg/ml. Serial dilutions were used to develop the desired concentrations of insecticide, but were standardized to a total insecticide/water volume of 40 ml. The selected concentrations of insecticides were combined with the meridic diet to yield 200 ml of a diet/insecticide mixture. The mixtures then were agitated for ≈30 s in a 2 liter bowl using a hand-held electric mixer. Insecticide-treated diet was then placed in 30 ml plastic cups with ≈7 ml of diet per cup. All insecticide-treated diet was used in bioassays within 7 d of preparation. Three to four replicates (20-50 larvae per dose) were used for each insecticide. Third instars of fall armyworm (30-45 mg) were removed from the colony and placed on insecticide-treated and non-treated (control) diet. Insects were evaluated at 96 HAT for mortality. A larva was considered dead if it could not right itself after being placed on its dorsal surface. Data were corrected for control mortality and analyzed with probit analysis using Polo-Plus (LeOra Software 2006) to obtain LC_{50} values.

Results and Discussion

The LC_{50}'s of all insecticides ranged from 0.066 µg/ml for spinetoram to 5.27 µg/ml for lambda-cyhalothrin (Fig. 1). The novel insecticides (chlorantraniliprole, cyantraniliprole, flubendiamide, and spinetoram) had LC_{50}'s ranging from 0.066 µg/ml to 0.93 µg/ml and were generally lower compared to that for traditional insecticides (novaluron, methoxyfenozide, spinosad, indoxacarb, and lambda-cyhalothrin) with LC_{50}'s ranging from 0.166 µg/ml to 5.27 µg/ml. Fall armyworm larvae were significantly less susceptible to lambda-cyhalothrin than all other insecticides.

The results of the present study should be considered preliminary and no definitive conclusions are proposed by the authors. In addition, further study is needed to determine how these results relate to fall armyworm susceptibility in field trials. The final results should better characterize fall armyworm susceptibility to novel and standard insecticides and support cotton IPM recommendations.

Acknowledgements

We would like to thank the student workers at the LSU Dept. of Entomology for their help in maintaining the colony and assisting in field trials. This project was partially funded by the LSU Agricultural Center, Louisiana's Cotton Producers, and Cotton Incorporated.

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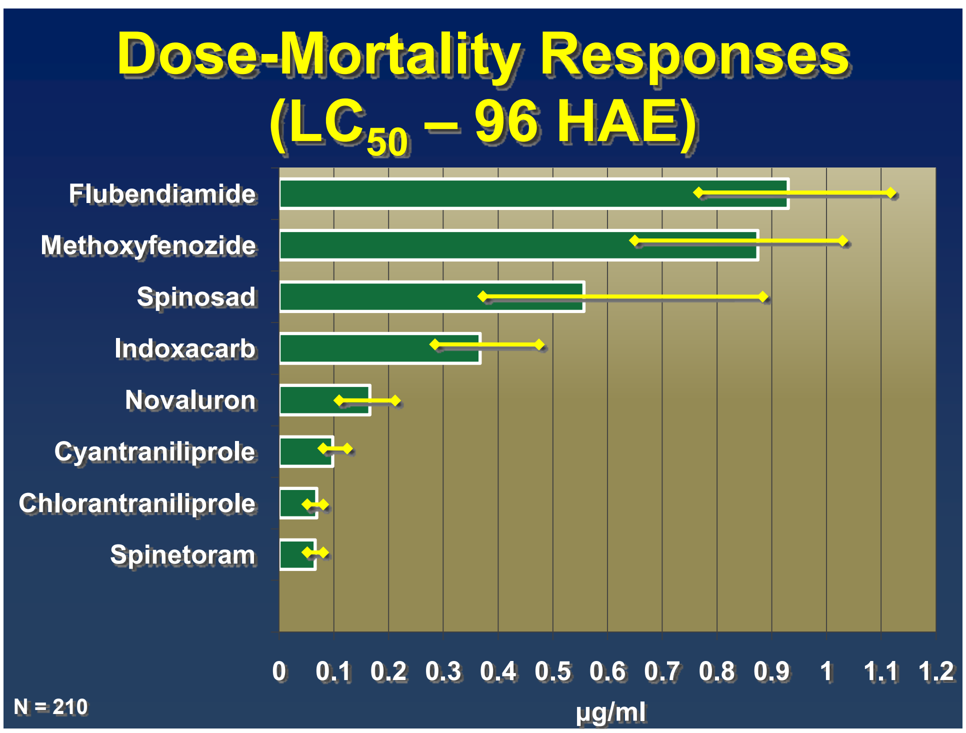

Figure 1. Responses of fall armyworm (corn strain) to selected insecticides in an insecticide and meridic diet bioassay