DETERMINING THE RELATIONSHIP OF VIAL BIOASSAYS TO FIELD EFFICACY FOR THE CONTRTOL OF BOLLWORMS *HELICOVERPA ZEA* (BODDIE) WITH CYPERMETHRIN

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Abstract

Infestations of bollworms, *Helicoverpa zea*, commonly result in yield loss in cotton. Where economically damaging infestations occur, insecticides are commonly employed to prevent yield loss. Among the insecticides used, pyrethroids are the popular choice for managing bollworms due to their low cost relative to newer alternatives. However, bollworm resistance to pyrethroids is common in much of the southern U.S. Bollworm pyrethroid resistance monitoring relies on adult vial bioassays using the insecticide cypermethrin. However, there is no data available that demonstrates a relationship between adult vial tests and field performance. Therefore, during the 2016 growing season, studies were conducted at the Macon Ridge Research Station in Winnsboro, Louisiana to determine the relationship of vial bioassays and field efficacy with cypermethrin (Up-Cyde 2.5EC). Applications of Up-Cyde at 0.025, 0.05, 0.075, 0.10 (1X high rate) and 0.20 lbs-ai/ac (2X rate) were used to determine field efficacy. At 3 days following application surviving bollworm larvae were collected in each plot and reared to adults for adult vial bioassays. Additionally, Hartstack pheromone traps were placed along the field edges to collect male bollworms for comparative purposes. Our data suggests that cypermethrin offered very little bollworm control, even at a 2X rate. Adult moth vial assays verified that the bollworms were highly resistant to cypermethrin. Preliminary results suggest that where adult moth bioassays indicate a high level of resistance, pyrethroids should not be relied upon for field control.

Introduction

In Northeast Louisiana cotton, *Gossypium hirsutum* (L), is one of the major agronomic crops grown with 255,000 acres in 2010 (NASS 2016). By 2015, cotton acres in Louisiana had greatly declined to approximately 115,000 acres, driven primarily by low cotton prices and higher prices on alternative commodities (NASS 2016). Another major reason for this decline is the cost associated with arthropod pest management in Northeast Louisiana cotton. One of the major pests growers are faced with is the bollworm. Bollworms can cause severe injury to cotton by feeding on bolls, flowers, squares and terminals.

In Northeast Louisiana, issues with unexpected injury to Bt cotton have resulted in a greater reliance on insecticides to prevent yield loss. In this region growers rely heavily on lepidopteran specific insecticides such as Prevathon and Besiege for control, but these insecticides can be costly. Pyrethroids have been traditionally utilized due to this class of chemistry's relatively low cost and high efficacy against many pests including bollworms. Yet, overuse and reliance on this class of chemistry has caused resistance issues in much of the cotton producing regions of the Mid-south. Resistance monitoring in Louisiana has been conducted since 1988, using the adult vial assays, and has shown a steady increase in survivorship over time. Although resistance has been documented, no data exists to show a correlation between vial assays and field control failures. The objective of this research was to determine the relationship of vial assays to field performance.

Materials and Methods

Research was conducted at the Macon Ridge Research Station in Winnsboro, LA during the 2016 growing season. Non-Bt cotton was planted on 21 April. The test was initiated once *H. zea* were present in the field and moth traps had a sufficient number of moths to conduct a full range of adult vial bioassays. Treatments were arranged in a randomized complete block design, replicated 4 times. Each plot was 4 rows wide (40 inch rows) X 50 ft in length. Native *H. zea* populations were utilized for the experiment. Prior to treatments populations were estimated inside each plot by counting the number of larva per 10 whole plants. Larvae were categorized as small < 0.25 inch in length, medium > 0.25 but < 0.5 inch in length and large > 0.5 inch in length. For each test cypermethrin (Up-Cyde

2.5EC) was evaluated at rates of 0.00, 0.025, 0.050, 0.075, 0.10, and 0.20 lbs-ai/ac. Plots were treated using a 4 row, John Deere 6000 high clearance sprayer, equipped with Teejet TX-6 hollow cone nozzles (two/row), calibrated to 10 gallons of finished spray per acre. *H. zea* was estimated by counting total number of larva in 20 whole plants, for each plot 3 days after treatment. Percent control for field efficacy data was calculated using Henderson-Tiltons. Data were analyzed using ANOVA and means separated using an F protected Tukey's HSD (P=0.05).

Vials were prepared by coating 20 ml liquid scintillation vials with technical-grade cypermethrin as described by Plapp et al. (1987). Larvae were collected 3 days after application from each treated plot. Once collected, they were reared to adults on diet and individually placed in vials treated with 10 µg of cypermethrin per vial. Vials treated with acetone were used as controls. Vials containing moths were placed on their side at room temperature. Mortality was determined 24 h after exposure. Adults unable to fly more than a short distance (<3 m) were considered dead.

Hartstack pheromone traps were used to monitor and collect adult male *H. zea* (Hartstack et al. 1979). Pheromones were placed at 2 locations on the Macon Ridge Station. Each trap was baited with *H. zea* sex pheromone (Luretape with Zealure, Hercon Environmental) and changed every two weeks. Traps were monitored weekly from May to September.

Results and Discussion

Since the beginning of pyrethroid resistance monitoring in 1988, the level of resistance has grown from roughly 5% to just over 40% in 2015 (Figure 1). In 2007 a 10µg dose was added to the assay and survivorship has remained constant at around 20%, while spiking to over 50% in 2013 (Figure 2). The studies conducted in 2016 showed similar results. Adult moth bioassays using moths collected from Hartstack traps exhibited 71% survivorship for 5µg dose and 75% survivorship for the 10µg dose (Table 1). Larvae collected from field treated plots were determined to be highly resistant and showed no differences in susceptibility between larvae collected from non-treated plots and those collected from treated plots (Figure 3). Field efficacy stayed consistent with previous data. No statistical differences were found across all treatments from the lowest dose (0.025 lbs-ai/ac) and 2x rate (0.20 lbs-ai/ac) (Table 2). With this high level of resistance to cypermethrin, using this chemistry can cause field control failures. Although it is the cheapest option, the level of control is not satisfactory. Thresholds have become much greater in importance when deciding the timing of the application and the insecticide to be applied. While Bt cotton has a higher threshold than non-Bt, this doesn't mean they are immune to unacceptable injury.

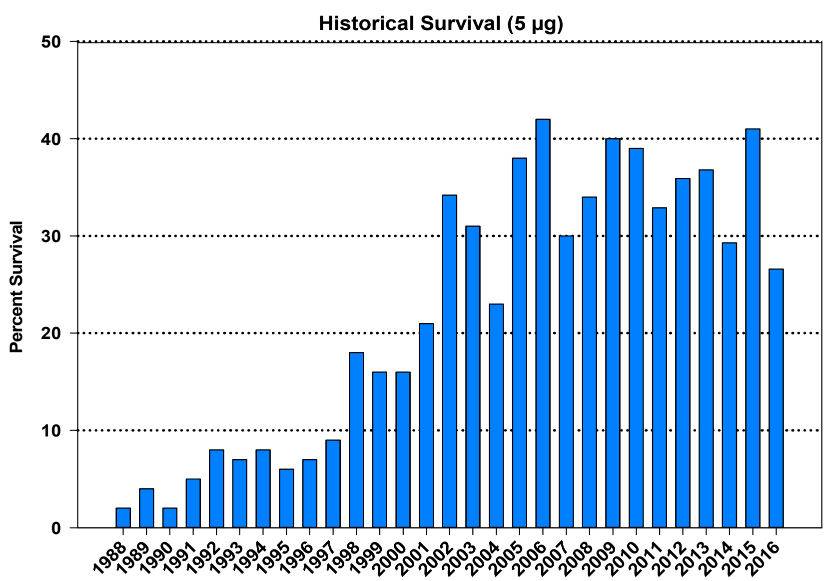

Figure 1. Historical survivorship 5µg adult vial bioassays

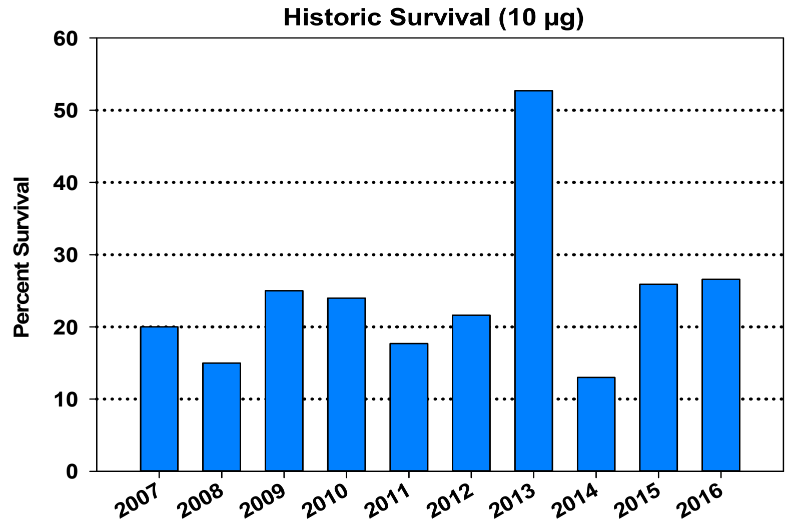

Figure 2. Historical survivorship 10µg adult vial bioassays.

Table 1. Hartstack Trap Collections

Rate	Number Collected	Alive	Dead	Percent Survival	Corrected*
0 µg	207	163	30	78.7	-
5 µg	209	47	147	22.5	71.41
10 µg	209	40	159	19.1	75.73

*Corrected for mortality (Abbott 1925)

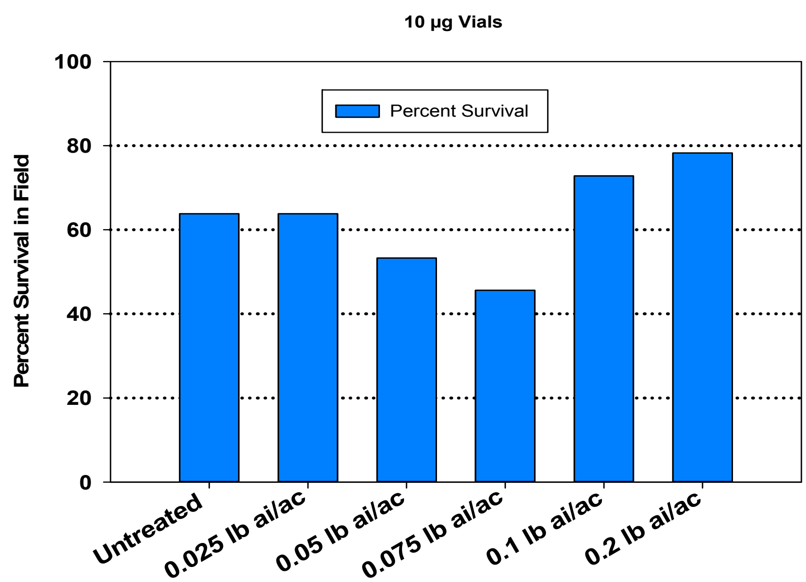

Figure 3. Survivorship of adult moths reared from field collected larvae, using 10µg adult vial bioassays.
Table 2. Percent Control

Treatment	Large Larva	Small Larva	Medium Larva
0.025 lb-ai/ac	-25.0a	33.3a	66.67a
0.05 lb-ai/ac	12.5a	-100.0a	-6.25a
0.075 lb-ai/ac	21.8a	8.3a	12.5a
0.10 lb-ai/ac	25.0a	25.0a	-37.5a
0.20 lb-ai/ac	0.0a	41.67a	-56.25a

Summary

Field efficacy trials demonstrated poor control of the cotton bollworm with cypermethrin at a 2X application rate. Total percent control in the field showed a negative control across all applications. Moths reared from larvae collected from treated plots, survived a 10µg dose of cypermethrin. No difference was shown in moth assay survival between larvae collected in the non-treated plots and those collected from treated plots. This may suggest that the majority of the larvae infesting the field were resistant to cypermethrin and not selected by the spray applications. Moths collected from nearby Hartstack traps likewise exhibited resistance to cypermethrin with 66 and 73% of moths surviving the 5 and 10µg dosages respectively. This is suggesting that most of the moths assayed were highly resistant to cypermethrin. These data lend credibility to the detection of pyrethroid resistance, in field settings, using adult moth vial assays. However, to further verify the relationship, the study should be repeated in an area where pyrethroid resistance is not consistently an issue.

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