EVALUATION OF THE AREA-WIDE BUDWORM/BOLLWORM MANAGEMENT PROGRAM WITH VIRUS IN THE MISSISSIPPI DELTA

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Abstract

Results were reported from the 1997 area-wide management program with baculovirus in the Mississippi Delta. A circular study area encompassing approximately 40,500 ha was treated in early May with virus to coincide with the larval emergence of bollworms and tobacco budworms. Adult emergence, moth numbers, and virus persistence were monitored to assess the impact of the virus. Adult emergence was reduced significantly (82.7%) in naturally-infested enclosure cages treated with the virus. Pheromone trap data suggested that total moth emergence was reduced 47% when compared with moth emergence in untreated areas. Wild geranium treated with the virus retained >50% of the original activity 3 days after virus application. A projected cost analysis for a large area-wide program using a lower virus application rate in the Mississippi Delta is also addressed.

Introduction

The cotton bollworm, *Helicoverpa zea* (Boddie), and the tobacco budworm, *Heliothis virescens* (F.) are multivoltine pest species on cotton and other cultivated crops. In the Mississippi Delta these pests are active prior to the availability of host crops and the first larval generation of these species develops on wild host plants (Stadelbacher 1981). The principal wild host plant is a wild geranium, *Geranium dissectum* L (Stadelbacher 1979) with *H. zea* larvae usually found one week earlier than *H. virescens* larvae among wild host plants in the Delta of Mississippi (Stadelbacher 1981).

Knipling and Stadelbacher (1983) proposed an area-wide approach to *Heliothis* management that would implement preventative suppression tactics to manage tobacco budworm and bollworm populations during the first generation as opposed to managing the pests during later generations with chemical insecticides. Several potential control tactics were discussed, including application of the baculovirus, *Helicoverpa zea* nuclear polyhedrovirus(HzSNPV).

Since 1990, an area-wide management program with HzSNPV has been conducted in the Delta to control the first generation of bollworm and tobacco budworm (Hardee and Bell 1996) in geranium before movement to cotton can occur in the later generations. A 90% suppression of reproduction during the first generation of *H. zea* and *H. virescens* was considered necessary to ensure adequate protection of the crop during the entire growing season (Knipling and Stadelbacher 1983). However, the 90% level of suppression was proposed to control the 2nd, 3rd, and 4th generation of moths during the growing season. Shorter season varieties are now utilized for most cotton production in the MidSouth area (Luttrell 1994). This would significantly reduce the importance of suppressing the 4th generation moth populations and consequently lower the level of suppression necessary for controlling the 2nd and 3rd generation of moths. If a lower level of suppression during the first generation of moths will provide adequate protection of the crop, then a lower virus application rate may be acceptable. The following study reports the results from the 1997 area-wide management program with HzSNPV at a lower virus application rate .

Materials and Methods

Treatment Site and Virus Application

A circular treatment area was established near Bourbon, MS (N33^0 19.386' W90^0 47.908') with an 8-km radius that encompassed approximately 40,500 ha. Plots of *G. dissectum* were selected at two locations in the treatment area. The HzSNPV formulation used in this study consisted of Gemstar™ LC (Thermo Trilogy, Inc.) diluted in water with an equal volume of cotton seed oil (PBSY) with an emulsifier (Quality Unlimited Products). The HzSNPV formulation was applied aerially at an application volume of 2.33 liters per ha. Aerial application of the virus was applied from May 4 to May 6 at a rate of 2.47 X 10^{11} occlusion bodies (OB=s) per ha.

Laboratory bioassays were conducted to verify virus activity as described by Bell and Romine (1986) with the following modifications. Six concentrations of virus were incorporated into the diet by dispersing each pathogen concentration in 30 ml of distilled water and blending with 270 ml of diet. Colony-reared *H. virescens* were used in all the assays conducted at 30^0 C.

Enclosure Cage Sampling

Sixteen plots with *G. dissectum* were selected at two locations in the treatment area. Plot edges were mowed and the plots were randomized in a complete block design with four replicates of four treatments. Treatments within each replicate consisted of an untreated naturally-infested control, a naturally-infested virus treatment, an artificially-infested control, and an artificially-infested virus treatment. The plots selected for artificial infestation were treated on April 23 with methyl-parathion (0.25 lb ai/acre) to reduce parasites and predators. Neonate *H. zea* and *H. virescens* were released daily (100/ species) into the artificially infested plots during the four days preceding aerial

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application. Control plots were covered with plastic during the aerial application. Enclosure cages (26.8 m^2 x 1.8 m high) were set up one hour after application on each treatment. Each treatment cage was monitored daily for adult emergence from May 30 until July 3. Earlier studies have shown that each enclosure cage isolated a representative sample of tobacco budworm and bollworm larvae. The number and species of moths emerging in each cage were recorded for data analysis.

Viral Persistence Sampling

Eight plots of *G. dissectum* were selected at two locations in the treatment area, and the plot edges were mowed to assist in identifying plot boundaries. Untreated control plots were covered with plastic during the virus application. The control plots were entered first on a sampling date to reduce contamination. Plant terminals of *G. dissectum* were removed randomly from both the control and virus treated plots at 0,1,3 5, and 7 days post-application. Thirty-two *H. virescens* larvae (6 day old) were individually fed a single plant terminal for 48 hrs from each plot on a given sampling date. Those that failed to consume the entire plant terminal were excluded from the assay. The remaining larvae were placed on clean artificial diet and reared for 14 days at 30^0 C. Virus inactivation was measured by recording viral mortality at 7, 10, and 14 days after the initial feeding period. Original activity remaining (OAR) was calculated by dividing percent mortality of sample at a given time period by the percent mortality at 0 h and multiplying by 100.

Pheromone Trap Sampling

Pheromone trap counts were used to evaluate the number of adult tobacco budworms and bollworms in the treated area compared to the untreated surrounding area during the period of time moths were emerging from early season hosts. A sampling transect ran east to west through the study site center and extended 4.8 km beyond the study site boundaries. Sampling sites were located every 1.6 km along the transect with two (one each for bollworm and tobacco budworm) standard cone traps (Hartstack et al. 1979) established at each site. Trap contents were sorted for identification and counted three times each week over the 12 wk period following virus application.

Results and Discussion

In an earlier enclosure cage study by Bell (1990) a lower application rate of virus was found to sufficiently reduce adult moth emergence. Enclosure cages in the study had been artificially infested with larvae and treated with either 0, 50 or 100 larval equivalents (LE) of virus per ha. The 50 and 100 LE/ha treatments produced similar results with adult moth emergence reduced 95% when compared to the 0 LE/ha rate. Bell (1990) suggested the effectiveness of the 50 LE/ha rate may have been due to the artificially high larval numbers actually promoting the spread of the virus. Early instar mortality due to virus can serve as inoculum for healthy larvae. Nevertheless, while density-dependent horizontal transmission may explain the effectiveness of the 50 LE/ha rate in treated plots, other explanations may also account for the effectiveness of the 50 LE/ha rate.

Our studies in 1997 with a dose 2.47 X 10^{11} occlusion bodies (OB=s) per ha. (approx. 50 LE/ha) appeared to be effective at reducing *H. zea* and *H. virescens* adult emergence. Overall *H. zea* adult emergence among all of the treatments in the study area was low, so these data were combined with the *H. virescens* adult emergence data for analysis. Adult emergence within the enclosure cages began on June 9 and ended 25 June. In the naturally-infested cages a significant reduction (P = 0.05) in adult emergence (82.7%) was observed for the virus treatments compared with the control (Table 1). A significant reduction of 77% in adult emergence was also detected for the artificially-infested cages treated with virus compared to the control (Table 1). Mean total trap captures per week for the two sampling sites along the transect near the center of the virus treatment area (treated) and at the two sampling sites along the transect that were furthest from the center of the treatment area (control) are presented in Figure 1. *H. zea* was the predominant species with 71 % present in the control and treated area. Tobacco budworm moth captures in the center of the virus treatment area averaged 21 moths/trap/week versus 49 moths/trap/week in the untreated area during peak trap capture. This represented a 57% reduction in tobacco budworm moth captures. Trap counts for bollworms in the center of the virus treatment area averaged 62 moths/trap/week, whereas moth captures in the surrounding untreated area averaged 108 moths/trap/week for a 43% reduction in trap captures.

Results from the pheromone trap capture data suggests that the virus application was less effective at reducing bollworm moth emergence than tobacco budworm moth emergence. These results were consistent with earlier pheromone trap capture results in the area-wide program (Hardee and Bell 1996). Timing of application or movement into the treatment area were considered to be the primary factors responsible for the observed lack of reduction in bollworm moth emergence in the treatment area. The pheromone trap sites reported for the treatment area were only 3.2 km from the border of the treatment area. Movement of 8 km and upwards to 19 km has been reported for *H. virescens* and *H. zea* depending upon environmental conditions (Hayes 1991). This degree of movement could have a significant impact on any attempt to evaluate the success of the 1997 area-wide program using pheromone trap capture data.

Virus inactivation on geranium did not occur rapidly. Most of the viral activity was lost between day 3 and 5 post-application. Viral mortality among larvae fed geranium terminals 5 days after application had decreased to 11% of the original virus activity (Fig. 2). This was substantially lower than the 75% virus mortality reported at 6 days post-

application for tobacco budworms at the higher HzSNPV application rate(Bell and Hardee 1994). The lower virus activity on geranium terminals observed 5 days after application in this study can be explained by the lower virus application rate.

Projected Cost Analysis

A grower-funded program for managing *Heliothis/Helicocoverpa* has been proposed for the Mississippi Delta that would encompass approximately 324,000 ha. A conservative estimate on the amount of cotton planted in this area would be approximately 91,000 to 101,000 ha of cotton although this amount may vary by 20% for a given year. The total grower contribution per cotton acre can be calculated by determining the total cost of the program and dividing by the total acreage of cotton planted in the treated area.

The estimated cost for aerial application of the virus would range from $1.24 to $1.73 per ha and the cost for the oil adjuvant would be approximately $1.06 per ha. Thus, the estimated total cost for the aerial application and oil adjuvant would not exceed $2.79 per ha. Virus costs would be $3.09 per ha at the lower application rate. The estimated total cost for the program in the proposed area would be $5.88 per ha or $1,905,120. The area-wide virus program at the current virus application rate has an estimated cost of $28.70 per hectare of cotton ($11.61 per cotton acre). The lower virus application rate apparently provided adequate suppression of the pest population. Therefore, it may be possible to reduce grower costs to approximately $19.00 per ha of cotton ($7.69 per cotton acre) for a 34% reduction in total cost for future area-wide management programs.

Future Research Plans

It is our intention to continue evaluating the impact of a lower virus application rate during the 1998 field season. These studies will include evaluating the use of a virus enhancing agent, such as an optical brightener in conjunction with a lower virus application rate. It may be possible to reduce grower costs still further in future area-wide management programs.

Conclusion

The *Helicoverpa zea* nuclear polyhedrovirus has been used in the Delta since 1990 as a preventative suppression tactic to manage tobacco budworm and bollworm populations during the first generation. Application of HzSNPV at the lower application rate has thus far resulted in a substantial prevalence of infection among larvae and a substantial reduction in adult emergence during the second generation. We believe that an area-wide management program with HzSNPV can be a cost-effective preventative suppression tactic to manage tobacco budworm and bollworm populations in the Delta.

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Disclaimer

Mention of a proprietary product does not constitute an endorsement by the USDA.

References

Bell, M. R. 1990. Aerial application of a nuclear polyhedrosis virus for reducing the emergence of *Heliothis* from early-season hosts. Proceedings Beltwide Cotton Prod. Conf., pp. 273-275.

Bell, M. R. and D, D. Hardee. 1994. Early season application of a baculovirus for area-wide management of Heliothis/Helicoverpa (Lepidoptera: Noctuidae): 1992 Field trial. J. Entomol. Sci. 29: 192-200.

Bell, M. R., and C. L. Romine. 1986. *Heliothis virescens* and *H. zea* (Lepidoptera: Noctuidae): Dosage effects of feeding mixtures of *Bacillus thuringiensis* and a nuclear polyhedrosis virus on mortality and growth. Environ. Entomol. 15: 1161-1165.

Hardee, D.D., and M. R. Bell. 1996. Six years of area-wide management of bollworm/budworm with pathogens--what does it mean and where do we go from here. Proceedings Beltwide Cotton Prod. Conf., pp. 897-902.

Hartstack, A. W. , J. A. Witz, and D. P. Buck. 1979. Moth traps for the tobacco budworm. J. Econ. Entomol., 72: 519-522.

Hayes, J. L. 1991. Elemental marking of arthropod pests in agricultural systems: Single and multigenerational marking. Southwestern Entomol. 14: 37-47.

Knipling, E. F., and E. A. Stadelbacher. 1983. The rationale for areawide management of *Heliothis* (Lepidoptera: Noctuidae) populations. Bull. Entomol. Soc. Am. 29: 29-37.

Luttrell, R. G. 1994. Cotton Pest Management: Part 2. US Perspective. Annu. Rev. Entomol., 39:527-542.

Stadelbacher, E. A. 1979. *Geranium dissectum*: an unreported host of the tobacco budworm and its role in their seasonal and long term population dynamics in the delta of Mississippi. Environ. Entomol. 8: 1153-1156.

Stadelbacher, E. A. 1981. Role of early-season wild and naturalized host plants in the buildup of the F_1 generation of

Heliothis zea and *H. virescens* in the Delta of Mississippi. Environ. Entomol., 10: 766-770.

Table 1. Bollworm and Budworm Emergence from Geranium in Area-Wide Virus Program in 1997

Infestation	Treatment	Total (Mean No./Cage)
Natural	Control	33.5
Natural	Virus	5.8
Artificial	Control	88.5
Artificial	Virus	20.3

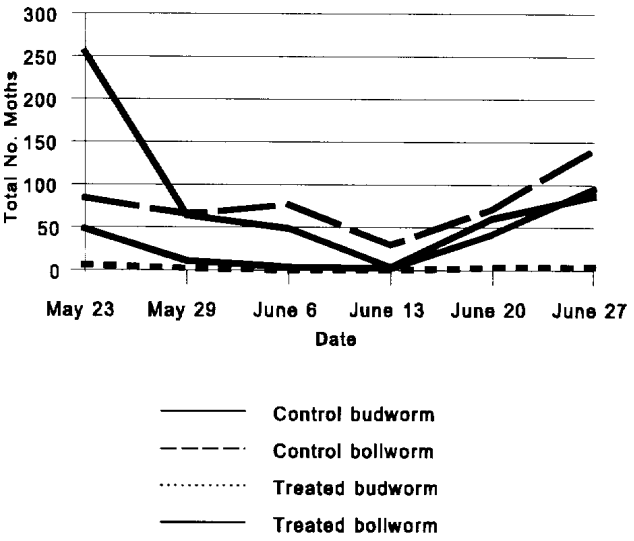

Figure 1. Moth Pheromone Trap Captures in 1997.

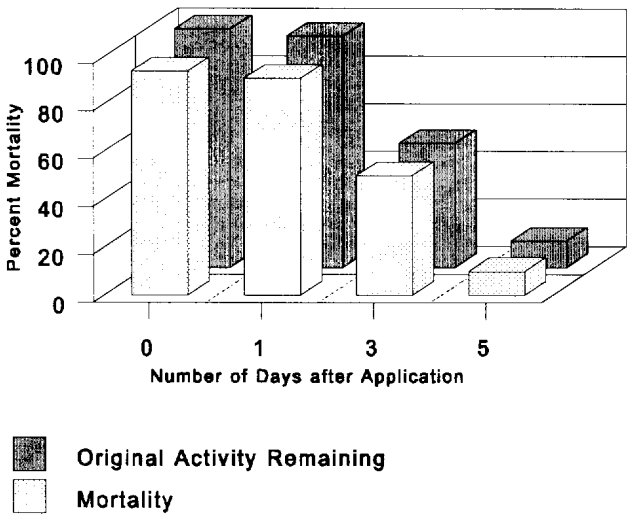

Figure 2. Viral Persistence in Geranium (1997 Field Test)