BEET ARMYWORMS (LEPIDOPTERA: NOCTUIDAE) IN NORTHEAST LOUISIANA: OBSERVATIONS ON AN UNCOMMON INSECT PEST

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ABSTRACT

Outbreaks of beet armyworm, *Spodoptera exigua* (Hubner), in cotton in Louisiana occurred in 1983, 1988, 1992 and 1993. The outbreaks generally followed historic patterns observed in other locations, i.e., (l) local endemic populations developed rapidly for one or two generations when climatic conditions were favorable and (2) biological control organisms were suppressed by pesticides. Outbreaks of beet armyworm in Louisiana usually are less severe than in other southeastern states, because populations are usually lower and they occur in the latter part of the growing season. In 1993, beet armyworms infested more ha and caused higher levels of economic damage in Louisiana than in prior years. Insecticide screening tests conducted in 1993 indicated that Pirate (AC 303630) was more efficacious compared to all other insecticides. Beet armyworm larvae (2nd-3rd instar) were confined to Monsanto transgenic *Bacillus thuringiensis* (Bt) cotton (line 1076) and untreated Coker 312 in the laboratory. No significant ($P \leq 0.05$) differences in leaf area consumed, mortality or pupal weights were detected.

Key Words: Beet armyworm, *Spodoptera exigua*, cotton, insecticides

RESUMEN

Brotes del gusano trozador de la remolacha, *Spodoptera exigua* (Hubner), ocurrieron en el algodón de Louisiana en 1983, 1988, 1992 y 1993. Los brotes generalmente siguieron los patrones históricos observados en otras localidades, o sea, que (1) las poblaciones locales endémicas se desarrollaron rápidamente en una o dos generaciones cuando las condiciones climáticas fueron favorables y (2) los enemigos naturales fueron eliminados por los pesticidas. Los brotes del gusano trozador de la remolacha en Louisiana usualmente son menos severos que en otros estados del sureste, porque sus poblaciones son menores y aparecen al final de la estación. En 1993, los gusasnos trozadores de la remolacha infestaron más hectáreas y causaron más dano económico en Louisiana que en los anos anteriores. Las pruebas de tamizaje de insecticidas llevadas a cabo en 1993 indicaron que Pirate (AC 303630) fue más eficaz en comparación con otros insecticidas. En el laboratorio fueron confinadas larvas del gusano trozador de la remolacha (2° y 3er instar) con algodón Monsanto transgénico de *Bacillus thuringiensis* (Bt) (línea 1076) y Cocker 312 sin tratar. No fueron detectadas diferencias significativas ($P \leq 0.05$) en el area de hojas consumida, mortalidad o peso pupal.

Beet armyworms, Spodoptera exigua (Hubner), were introduced into the western U.S. in the late 19th century (Chittenden 1902). They dispersed rapidly across the U.S. and, by the late 1920's, they were recognized as a sporadic pest of cotton in the Southeastern U.S. (Wilson 1932).

The earliest preserved beet armyworm specimens from Louisiana in the LSU Department of Entomology museum were collected in Baton Rouge. One specimen was collected from broadbean on 6 January 1932 and another from turnip on 29 September 1937 (Joan B. Chapin, Dept. of Entomology, LSU Agricultural Center, Baton Rouge, personal communication). Light trap collections of noctuids in Baton Rouge

from the years 1957 through 1960 revealed that beet armyworm moths were captured from 27 March through 6 December (Chapin & Callahan 1967). Beet armyworm larvae were collected from cole crops (Brassicae) in mid-December (date unknown) in Baton Rouge (Oliver & Chapin 1981).

Outbreaks of beet armyworm are reported to be sporadic, occurring roughly every 2-5 years (Rabb & Kennedy 1979). These outbreaks typically occur one or two generations after favorable climatic conditions are accompanied by suppression of biological control agents by pesticides used for control of other pests.

In Florida, no evidence of hibernation has been observed, and all stages of the insect are found throughout the year (Smith 1993). The ability of beet armyworms to overwinter is limited by frost kills of host plants and by temperatures below 10°C (Butler et al. 1976). Whether or not the beet armyworm hibernates and/or overwinters in Louisiana is unknown. Average daily minimum temperatures (1931-1980) for the Northeast Research Station at St. Joseph for January, February, March, are respectively 3.0, 4.2 and 7.8°C (Thompson et al. 1983). Therefore, during most years, cold temperatures in Northeastern Louisiana may cause high mortality of beet armyworms.

Other deterrents to population growth of beet armyworms in Louisiana may exist. For example, they are polyphagous feeders that damage vegetable crops, ornamentals and field crops, and commercial production of ornamentals and vegetable crops within the major cotton production regions in Louisiana is limited.

Several private agricultural consultants have annually reported problems with beet armyworms in isolated fields in Northeast Louisiana. This suggests a need for studies of migration and/or overwintering biology of beet armyworm in this area. Their scouting records show armyworm egg masses (fall armyworm, *Spodoptera frugiperda* (J.E. Smith) or beet armyworm) were found in August of 1980, 1983 and 1985, and in July of 1988 and 1990. The 1988 beet armyworm outbreaks in Louisiana occurred within two days of severe outbreaks in Alabama (Ed Jones Consulting Service, Rayville Louisiana, personal communication). In 1993, the first beet armyworm egg masses were observed in June (Ray Young, Young Consulting Service, Wisner, Louisiana, personal communication).

Beet armyworm outbreaks in Louisiana have generally followed the patterns observed in other major cotton producing states in the Southeastern U.S [Alabama (Smith 1985, 1989a, 1989b, 1993, 1994), Georgia and Mississippi], except that the percent of the total cotton ha infested is usually lower (Head 1989-1992). An exception occurred in 1993 in Louisiana, when 242,820 of the 354,113 ha harvested (69%) were infested and economic injury occurred on about 80,940 ha (23% of harvested ha, Williams, 1994). Reports from Alabama indicated 73% of the ha planted to cotton were infested with beet armyworm in 1993 with 26% of harvested ha suffering economic damage (Williams 1994). Williams (1994) also reported that 82% of the cotton (546,345 ha) in Mississippi was infested with beet armyworms in 1993 and 69% received one or more insecticide applications for beet armyworm control.

The outbreaks of beet armyworm in 1983 and 1992 in Louisiana provided an opportunity to evaluate the efficacy of several insecticides. In 1983, the pyrethroids cypermethrin (0.0670.112 kg AI/ha), flucythrinate (0.09 kg AI/ha) and tralomethrin (0.021 kg AI/ha) failed to provide satisfactory control of the pest. However, maximum labeled rates of sulprofos (1.68 kg AI/ha) and profenofos (1.12 kg AI/ha) as well as methomyl (0.5 kg AI/ha) and thiodicarb (0.67 kg AI/ha) provided satisfactory control (Burris 1983). In 1992, sulprofos (1.68 kg AI/ha), methomyl (0.51 kg AI/ha), thiodicarb (1.0 kg AI/ha) and Pirate (AC 303630) (0.23-0.39 kg AI/ha) were the only insecticides that significantly reduced numbers of beet armyworm larvae (Graves 1993a, 1993b, 1993c). However, Pirate was the only insecticide that provided >90% control. Mix-

tures of fenvalerate (0.17 kg AI/ha) + profenofos (0.56 kg AI/ha) and fenvalerate (0.17 kg AI/ha) + amitraz (0.28 kg AI/ha) also significantly reduced beet armyworm larval densities, but control by these treatments was only about 70%.

The widespread beet armyworm infestations and numerous field control failures that occurred in 1993 in Louisiana prompted research to re-evaluate the efficacy of selected insecticides and to determine the effectiveness of transgenic cotton containing the Bt toxin on development of this pest.

MATERIALS AND METHODS

Insecticide Screening Tests.

Northeast Research Station. Cotton (DPL 51) was planted on 8 May with plots consisting of four 19.8m rows with 102 cm centers. Treatments (see Table 1) were arranged in a randomized complete block design and replicated four times. Applications were made with a high clearance sprayer calibrated to deliver 93.5 liters total spray per ha through Teejet X-12 hollow cone nozzles (two per row) at 3.9 kg/cm^2. For Test 1, insecticide treatments were applied 29 July and 2 and 16 August. On 14 August, visual ratings were used to estimate the level of foliage feeding by the beet armyworm.

TABLE 1. EVALUATION OF SELECTED INSECTICIDES AGAINST BEET ARMYWORM ON THE NORTHEAST RESEARCH STATION—1993.

Treatment	Rate/ha (kg AI)	Visual[1] Ratings	Percent[2] Control
	Test 1		
UTC	--	3.0a	0
AC 303630	0.17	0.5c	83
AC 303630	0.22	0.0d	100
AC 303630	0.28	0.5c	83
l-cyhalothrin	0.045	3.0a	0
Thiodicarb	0.31	1.0b	67
Thiodicarb	1.01	0.5c	83
AC 303630 + *l*-cyhalothrin	0.28 + 0.031	0.5c	83
AC 303630 + amitraz	0.28 + 0.28	0.5c	83
	Test 2		
UTC	--	3.0a	0
l-cyhalothrin	0.03	2.4ab	20
Profenofos	1.12	1.9ab	37
Profenofos + thiodicarb	0.75 + 0.30	1.3ab	57
Profenofos + *l*-cyhalothrin	0.45 + 0.028	2.5a	17
Profenofos + Bt (Design 100 WP)	0.45 + 0.83[3]	2.4ab	20
Profenofos + methomyl	0.56 + 0.17	0.6b	80

[1]Means followed by same letter do not significantly differ (P≤0.05; Duncans MRT). For visual ratings: 0 (no feeding damage), 1 (feeding damage within the lower 1/3 of the plant), 2 (feeding damage in the lower 1/3 and middle 1/3 of the plant) or 3 (feeding damage throughout the plant).

[2]Compared to UTC.

[3]Formulated product.

For Test 2, treatments were applied on 19, 23, 27 July and 2, 6 and 17 August. Visual ratings of beet armyworm damage to foliage were made on 19 August. A visual defoliation rating for each plot was scored as follows: 0 (no feeding damage), 1 (feeding damage within the lower 1/3 of the plant), 2 (feeding damage in the lower 1/3 and middle 1/3 of the plant), or 3 (feeding damage throughout the plant).

Macon Ridge Branch. Cotton (Stoneville 887) was planted on 2 June with plots consisting of four 15.2m rows with 102 cm centers. Treatments (see Table 2) were arranged in a randomized complete block design and replicated four times. Applications were made with a high clearance sprayer through Teejet X-8 hollow cone nozzles (2 per row) at 3.2 kg/cm^2.

For Test 1, insecticide treatments were made on 4, 9, 20 and 31 August with 56.1 liters total spray per ha. Visual ratings of beet armyworm damage to all plots were made on 8 September using the rating system previously described. For Test 2, insecticide treatments were made on 30 August with 93.5 liters total spray per ha. The plots were sampled 7 days after treatment using a shake cloth. Two samples were taken between the two center rows in each plot (total of 1.8 meters per plot). Plants were vigorously shaken on both rows to dislodge all larvae, which were then counted.

Effects of Transgenic Bt Cotton on Beet Armyworm.

A randomized block experimental design with four replications was used to compare the development of beet armyworms on cotton plants expressing the *Bacillus thuringiensis* (Bt) toxin (Monsanto line 1076) or the nontransgenic parent (Coker

TABLE 2. EVALUATION OF SELECTED INSECTICIDES AGAINST BEET ARMYWORM ON THE MACON RIDGE BRANCH OF THE NORTHEAST RESEARCH STATION—1993.

Treatment	Rate/ha (kg AI)	Efficiency Rating	Percent[2] Control
	Test 1	Visual Rating[1]	
UTC	--	3.0a	0
AC 303630	0.22	0.1c	97
AC 303630	0.34	0.3c	90
AC 303630	0.45	0.0c	100
AC 303630 + methomyl	0.22 + 0.14	0.0c	100
l-cyhalothrin	0.03	2.3b	23
Profenofos	1.12	2.6ab	13
	Test 2	Larvae/1.8m	
UTC	--	9.5a	0
AC 303630	0.28	1.2b	87
Bt (Javelin 100WG)	1.68[3]	5.0ab	47
Thiodicarb	0.45	7.6a	20
Thiodicarb	0.90	5.6ab	18
Methomyl	0.67	7.8a	18
Chlorpyrifos	1.12	5.9ab	38

[1]Means followed by same letter do not significantly differ (P≤0.05; Duncans MRT). For visual ratings: 0 (no feeding damage), 1 (feeding damage within the lower 1/3 of the plant), 2 (feeding damage in the lower 1/3 and middle 1/3 of the plant) or 3 (feeding damage throughout the plant).
[2]Compared to UTC.
[3]Formulated product.

312). Seed for both genotypes was supplied by Monsanto Company (Agricultural Products, 800 North Lindbergh Boulevard, St. Louis, MO 63167) and planted 17 May in plots four 9.2m rows with 102 cm centers. All plots received an in-furrow treatment of PCNB plus etridiazole (1.40 kg AI/ha) plus acephate (0.84 kg AI/ha) at planting. Visual rating of defoliation were made on 2 August using the system previously described.

A laboratory experiment was conducted to further examine the effects of transgenic Bt cotton on beet armyworm. Newly hatched aggregates of beet armyworm larvae were collected from several fields at the Northeast Research Station on 13 August and transported to the laboratory. Ten leaves per plot were randomly collected from the second and third position below the terminal from transgenic Bt cotton and Coker 312 cotton plants. Each leaf was placed in a petri dish and five beet armyworm larvae (50 per plot) were placed in each dish. The petri dishes were covered and larvae were allowed to feed for 72 h. Leaf area was determined for each leaf at the beginning and end of the experiment using a LiCor®, (Li-3100) Area Meter (Lincoln, Nebraska). Surviving larvae were transferred to a petri dish containing fresh leaves collected from the same plots as previously described. The experiment was terminated when larvae pupated. Percent pupation and pupal weights were determined.

Results and Discussion

Insecticide Screening Tests.

Pirate (AC303630) was the only insecticide among those evaluated that consistently provided satisfactory control of beet armyworm larvae. Applications of Pirate at rates of 0.17-0.45 kg AI/ha resulted in 83-100% control (Tables 1 and 2) at both locations of the Northeast Research Station. Similar control was observed at the same application rate (0.28 kg AI/ha) using two different efficacy ratings (83% control using visual ratings, Test 1, Table 1 versus 87% control using shake cloth, Test 2, Table 2). In all tests and at every rate tested Pirate, either alone or in combination with other insecticides, significantly ($P \leq 0.05$) decreased defoliation. Also, significantly ($P \leq 0.05$) fewer live larvae were observed than in the untreated plots or the plots treated with l-cyhalothrin, profenofos, methomyl or thiodicarb at low rates (0.31 and 0.45 kg AI/ha). Thiodicarb at high rates (0.9 and 1.01 kg AI/ha) resulted in 41 and 83% control, respectively (Tables 1 and 2). Chlorpyrifos at 1.12 kg AI/ha only provided 38% control (Table 2).

Transgenic Cotton Evaluations.

Natural infestations of beet armyworm were present in all field plots. The visual observations of damaged leaves on 2 August indicated no significant ($P \leq 0.05$) differ-

Table 3. Evaluation of transgenic Bt cotton for beet armyworm control on the Northeast Research Station—1993.

Treatment	Percent Pupating	Pupal Weight (g)	Leaf area (% Consumed)	Visual Ratings[1]
Bt Line 1076	18a	0.05718a	49.35a	2.2a
Coker 312	31a	0.05458a	49.35a	2.4a

[1]Means followed by same letter do not significantly differ ($P \leq 05$; Duncan's MRT). For visual ratings: 0 (no feeding damage), 1 (feeding damage within the lower 1/3 of the plant), 2 (feeding damage in the lower 1/3 and middle 1/3 of the plant) or 3 (feeding damage throughout the plant).

ences for beet armyworm damage between nontransgenic cotton and transgenic cotton plants (Table 3). However, leaf area measurements were significantly ($P \leq 0.05$) higher for Bt line 1076 than for Coker 312 parent line on 16 August (data not presented). When beet armyworm larvae were confined to Bt line 1076 and Coker 312 parent line leaves in the laboratory, there was no significant ($P \leq 0.05$) difference in leaf consumption, mortality (% pupating) and pupal weights (Table 3). The Bt endotoxin present in line 1076 appeared to have little or no effect on beet armyworm development.

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