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IN-SEASON MONITORING OF RESISTANCE AND SPECIES COMPOSITION TO AID IN MANAGEMENT OF HELIOTHINES IN VIRGINIA COTTON

D. Ames Herbert, Jr. and Sean Malone
Tidewater Agricultural Research and Extension Center
Virginia Tech
Suffolk, VA

Abstract

A total of 7,200 ears of corn were sampled in mid to late July 2002 from 146 corn fields in 29 counties in Virginia to determine *Helicoverpa zea* larval population levels – and to make predictions regarding sequential infestation levels in cotton, soybean and peanut. An average of 45 to 75% of the ears sampled were infested with larvae or showed signs of damage, depending on region, which was up considerably from 2001 levels. Predictions were that growers could expect moderate to high infestation levels. Potential for insecticide resistance was evaluated using vials pretreated with either cypermethrin at 5 or 10-µg rates, spinosad at a 15-µg rate, or untreated (control). A total of 1,147 moths were captured live in mesh pheromone traps from June 25 through September 5 from two locations and placed into pretreated vials. An average of 5.0, 1.7, and 5.5% survived the 5 and 10-µg cypermethrin and 15-µg spinosad rates, respectively, which was similar to results from 2001, but lower compared with results from 2000. Heliothine eggs were collected from commercial cotton fields on 20 different dates from July 24 to August 30 and subjected to the Agdia Hel-ID egg testing procedure to determine the species. *Heliothis virescens* comprised about 29 to 80% of the total tested in July, dropped to about 5% in mid August, and increased to about 14% towards the end of August. A total of 618 Heliothine larvae were collected from peanut, soybean and cotton fields from August 9 to September 13 and identified to species in the laboratory. Over all sample dates, only 5.0 and 4.0% collected from peanut and soybean, respectively, were *H. virescens*, with the remainder being *H. zea*. However, the proportion of *H. virescens* varied from 0 to 11%. These data and the insights they provided were extended to growers and used to improve in-season worm management practices.

Introduction

Each year, growers in Virginia are faced with making decisions regarding management and control of Heliothine pests in cotton. Lint losses that result from poor or inadequate control have ranged from 60 to 326 lb per acre in the period from 1994 to 2001. Most growers gain adequate to excellent control in conventional cotton using a series of two pyrethroid insecticide sprays, the first at egg threshold (10 eggs/100 terminals, or 2 eggs/10 fruiting forms) and the second in 5 to 7 days; or in bollgard cotton, using a single application 5 to 7 days after egg threshold. Both the timing of spray applications and good efficacy of products are critical to the continued success of these worm control systems. The work presented here details the in-season processes and information developed which are important for maintaining the most efficient cotton insect pest management programs including in-season monitoring of population levels, evaluating the degree of insecticide resistance to pyrethroid insecticides, and monitoring the proportions of the two species, *H. zea* and *H. virescens*, in the Heliothine complex.

Materials and Methods

Mid Season Field Corn Survey

Each year, field corn is surveyed in mid to late July for presence of *H. zea*. Five corn fields are randomly selected in the major soybean, peanut and cotton growing counties (ca. 30 counties). Efforts are made to avoid fields planted to Bt corn varieties. Fifty ears are sampled from each field, 10 in each of five areas of the field. Ears are shucked *in situ* and numbers with either *H. zea* larvae (recorded as small = 1st or 2nd instar, medium = 3rd and 4th instar, or large = 5th or 6th instar) or with evidence of worm damage (recorded as 'exited larva') are recorded. The survey is coordinated among several cooperators so that all data are gathered within 7 to 10 days. Data are summarized and used to make predictions of the infestation intensity of sequential generations that will migrate into soybean, cotton or peanut fields. Pest advisories are developed and provided using several media including email, websites and newsletters.

Insecticide Resistance Monitoring

This is the third year that Virginia has cooperated with Greg Payne, State Univ. of West Georgia, in the vial-testing program for evaluating levels of resistance of *H. zea* adults to cypermethrin and spinosad. In 2002, moths were captured live from June 25 through September 5 using a series of mesh pheromone traps placed adjacent to crop fields (cotton, corn) in two locations (Suffolk or Southampton Counties). Moths were removed from traps and placed into 1-quart paper cartons containing cotton balls moistened with a 3% (g/ml) sucrose/water solution. After 24 hours, active moths were placed individually into pretreated 20-ml glass scintillation vials. Vials had been pretreated with either cypermethrin at 5 or 10-µg rates, spinosad at a 15-µg rate, or were untreated (control). Caps were tightened, and then loosened ¼ turn. Vials were placed into trays

tilted at a near 45º angle and kept at 70º F. After 24 hours, moths were released and categorized as dead, down (active but compromised and unable to fly 3 m), or alive (able to fly ≥ 3 m).

Egg Testing to Differentiate Heliothine Species

Eggs of Heliothines were collected from commercial cotton fields in Suffolk, Isle of Wight and Southampton Counties on 20 different dates from July 24 to August 30. Eggs were collected by surveying fields and picking the plant parts (leaves, terminals, squares, etc.) that they were attached to. Samples were returned to the laboratory where eggs were removed from the plant parts and subjected to the Agdia Hel-ID egg testing procedure to determine the species. This procedure is well described on the Agdia website (www.agdia.com).

Laboratory Identification of Heliothine Larvae

Heliothine larvae were collected from randomly selected peanut, soybean and cotton fields from August 9 to September 13. Larvae were returned to the laboratory and identified to species by inspecting their mouthparts (mandibles) and arrangement of cuticular spines under magnification. The following sources were used to guide identifications:

http://gaipm.org/cotton/larvaid.html
http://creatures.ifas.ufl.edu/veg/corn_earworm.htm#ref http://creatures.ifas.ufl.edu/field/tobacco_budworm.htm

Results

Mid Season Field Corn Survey

A total of 7,200 ears of corn were sampled in mid to late July from 144 corn fields in 29 counties. Number of counties, fields and ears sampled by region were: Eastern Shore – 2 Cos., 10 fields, 500 ears; Mid-East including Middle Peninsula – 11 Cos., 55 fields, 2,750 ears; Southeast – 10 Cos., 50 fields, 2,500 ears; Northern Neck – 4 Cos., 19 fields, 950 ears; Northeast – 2 Cos., 10 fields, 500 ears. By region, corn survey results were as follows: Eastern Shore had 48% infested ears (compared with 8.2% in 2001); Mid-East including Middle Peninsula had 50.6% (compared with 15.3% in 2001); Southeast had 75.1% (compared with 26.4% in 2001); Northern Neck had 45.0% (compared with 4.5% in 2001); Northeast had 55.4% (compared with 0.2% in 2001). Because of the high percentages of infested ears, predictions of moderate to high level infestations by sequential generations were issued to agents, growers, and other clientele via emails, websites and newsletters.

Insecticide Resistance Monitoring

A total of 1,147 moths were tested during the 2002 sampling season. 579 moths were exposed to cypermethrin, 200 to spinosad and 368 to untreated (control) vials (Table 1-A). Of that total, 796 had been captured from the Suffolk site and 311 from the Southampton County site. An average of 5.0, 1.7, and 5.5% survived the 5 and 10-µg cypermethrin and 15-µg spinosad rates, respectively (Table 1-B). These values are similar to results from moths tested in 2001, but lower compared with results from 2000.

Egg Testing to Differentiate Heliothine Species

Of the eggs tested, *Heliothis virescens* comprised 80% on the first sample date (July 24) then dropped to 29% by the end of July (Table 2). The percentage continued to drop to an average of about 5% during mid August, but increased to an average of about 14% through the end of August when sampling was discontinued.

Laboratory Identification of Heliothine Larvae

A total of 618 Heliothine larvae were collected and identified from peanut (243), soybean (364), and cotton (11) fields (Table 3). Percentage of *H. virescens* collected from peanut, soybean and cotton fields was 5.0, 4.0, and 45.4%, respectively. (Note: the sample from cotton was not sufficiently large to be meaningful).

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Table 1-A. Adult vial testing to monitor bollworm resistance to cypermethrin and spinosad. Total number of moths tested in 2000, 2001, and 2002.

Year	Location	Cypermethrin	Spinosad	Untreated	Total
2000	TAREC[a]	208	--	105	313
	Southampton	352	--	178	530
	Total	560	--	283	843
2001	TAREC	298	163	168	629
	Southampton	130	81	88	299
	Total	428	244	256	928
2002	TAREC	407	152	237	796
	Southampton	152	48	111	311
	Total	579	200	368	1147

[a] Virginia Tech Tidewater Agricultural Research and Extension Center.

Table 1-B. Adult vial testing to monitor bollworm resistance to cypermethrin and spinosad. Mean cumulative survival in 2000, 2001, and 2002.

	Cypermethrin				Spinosad	
	5 µg		10 µg		15 µg	
Year	Cumulative Survival (%)	Range (%)	Cumulative Survival (%)	Range(%)	Cumulative Survival (%)	Range(%)
2000	12.0	0-25	6.0	0-25	--	--
2001	3.3	0-33	0.0	0	2.2	0-17
2002	5.0	0-33	1.7	0-14	5.5	0-33

Table 2. Percentage of corn earworm (cotton bollworm) and tobacco budworm eggs based on the Agdia Hel-ID testing system, 2002.

Date	% Tobacco Budworm	% Corn Earworm
24 Jul	80	20
26 Jul	67	33
30 Jul	22	78
31 Jul	29	71
2 Aug	19	81
5 Aug	23	77
7 Aug	14	86
9 Aug	0	100
11 Aug	6	94
14 Aug	5	95
16 Aug	5	95
19 Aug	15	85
21 Aug	14	86
23 Aug	7	93
26 Aug	11	89
26 Aug	14	86
28 Aug	18	82
28 Aug	15	85
30 Aug	19	81
30 Aug	15	85

Table 3. Identification of Heliothine larvae collected from peanut, soybean, and cotton fields in Virginia, 2002.

Crop	Date	Location (County)	No. of Larvae	% Corn Earworm	% Tobacco Budworm
Peanut	9 Aug	Sussex	131	98	2
	12 Aug	Southampton	39	92	8
	13 Aug	Suffolk	46	90	10
	27 Aug	Suffolk	27	100	0
Soybean	12 Aug	Isle of Wight	9	89	11
	13 Aug	Suffolk	81	95	5
	14 Aug	Suffolk	73	96	4
	14 Aug	Suffolk	12	100	0
	16 Aug	Suffolk	78	100	0
	20 Aug	Dinwiddie	16	100	0
	6 Sep	Surry	48	90	10
	13 Sep	Sussex	47	98	2
Cotton	13 Aug	Isle of Wight	11	55	45