OCCURRENCE AND CONTROL OF BEET ARMYWORM OUTBREAKS IN THE COTTON BELT

Scott D. Stewart, M. Blake Layton, Jr.
and Michael R. Williams
Department of Entomology and Plant Pathology
Mississippi State University
Mississippi State, MS

Abstract

The occurrence of area-wide outbreaks of beet armyworm, *Spodoptera exigua*, are reported for 1986-1995. We examined these outbreaks to deter-mine whether they corresponded to early-season climatic conditions and insecticide applications, including applications made by boll weevil eradication programs. The data show that early-season sprays for aphids (*Aphis* spp.), plant bugs (*Lygus* spp. and *Pseudatomoscelis seriatus*) and boll weevil (*Anthonomous grandis*) were statistically related with the occurrence of beet armyworm outbreaks. Especially dry years also appear to contribute to beet armyworm outbreaks, and wet weather may alleviate beet armyworm outbreaks caused by early-season insecticide applications.

Introduction

The beet armyworm, *Spodoptera exigua*, has become an increasingly important pest during the last 10 years. In the *Cotton Insect Losses* report published annually in the Proceeding of the Beltwide Cotton Conference, armyworms were grouped with other incidental pests prior to 1986. After 1986, armyworms were included under there own category, reflecting their increasing occurrence. Outbreaks have occurred in Georgia (1988, 1989, 1990), Alabama (1988, 1989, 1990, 1993, 1995), Mississippi (1993) and Texas (1995).

Traditionally, the beet armyworm has been considered an occasional pest associated with hot and dry conditions. However, most of the serious outbreaks during the last 10 years have corresponded to areas actively attempting to eradicate the boll weevil, *Anthonomous grandis*, particularly during years when multiple, in-season insecticide applications of Malathion (ULV) were made. The first season of multiple, in-season applications for weevil eradication occurred in most of Georgia, southeastern Alabama and northern Florida in 1988; in central and west Alabama in 1994; and in north Alabama, central Tennessee, east Mississippi and parts of Texas in 1995.

The secondary pest status of beet armyworm is now well established. Re-search has demonstrated that in-season insecticide applications dramatically reduce natural enemies and can result in beet armyworm outbreaks (Graham et al. 1995, Ruberson 1993). So, efforts to eradicate the boll weevil may cause secondary outbreaks of beet armyworm. However, wide-spread armyworm outbreaks have occurred in areas not actively pursuing weevil eradication (e.g., Mississippi and Alabama in 1993). The purpose of this paper is to document what influence boll weevil eradication efforts and climatic conditions have had on the occurrence of beet armyworm outbreaks during the last 10 years.

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Materials and Methods

Weather Data

Several sources were used for weather data including the Southern Regional Climate Center at Louisiana State University and the Southeastern Agricultural Weather Service Center at Auburn University. Data from weather stations were obtained for several locations in Mississippi, southern and central Alabama, southern Georgia and the lower Rio Grande Valley of Texas for the years 1986-1995 (see Table 1). The weather stations were selected to coincide with areas where severe beet armyworm outbreaks have occurred during the past 10 years. In Mississippi, weather data was sometimes missing at certain locations, and the average data for nearby weather stations were substituted for the missing values. We utilized the data for monthly rainfall and average temperature for June and July, except in Texas, where data was used for April and May. These months were chosen because they generally correspond to cotton that is in pinhead square to mid-bloom development. Most beet armyworm outbreaks occur after mid-bloom, but we assumed that earlier conditions are responsible for later-season outbreaks. Mean temperature and monthly rainfall were averaged across locations for each region (state) being considered.

Beet Armyworm Damage and Insecticide Sprays

The percent yield losses caused by beet armyworm and the number insecticide applications made for plant bugs and aphids were determined from annual surveys that are made in each cotton-producing state. The results of these surveys are summarized in the Proceedings of the Beltwide Cotton Production Research Conferences (*Cotton Insect Losses*, 1987-1995), and one of the authors (MRW) had access to the data for 1995 growing season. Plant bug (*Lygus* spp. and *Pseudatomoscelis seriatus*) and aphid (*Aphis* spp.) applications were of particular interest because they were assumed to occur in early season and could contribute to secondary outbreaks of beet army-worm. Except for areas with active boll weevil eradication, we assumed that weevil sprays occurred either too early (i.e., “pinhead-square applications”) or too late (after mid bloom) to cause severe beet armyworm outbreaks. In some years, summary data were not available for states. For example, Mississippi reported the Delta and Hill regions of the state separately prior to 1989 (with no whole-state summary information).

Also, central and south Alabama were reported individually after 1989. In these cases, the number of insecticide applications and percent yield loss for the entire state (or region) being considered was a mean of the reported values, weighted by the cotton acreage associated with each value.

For areas trying to eradicate the boll weevil, we estimated the number of ULV Malathion sprays made from pinhead square to mid bloom. These estimates were made after discussions with entomologists and eradication program officials from the various states and by examining the available literature (e.g., Haney and Lewis unpublished data). The area for which the *Cotton Insect Losses* estimates are reported do not necessarily correspond to areas with active eradication programs. For example, only the eastern-border counties of Mississippi were within the eradication program during 1995. The *Cotton Insect Losses* report data for the Hills and Delta of Mississippi, and only part of the Hills and none of the Delta were within the eradication program. So when necessary, our estimates of early-season eradication sprays were reduced to reflect the proportion of the acreage (in the region being considered) that was in the program.

Ranking and Correlation

Multiple linear regressions (PROC REG; SAS Institute, Inc. 1985) were done across years for rainfall, temperature, and number of insecticide applications on the percent yield loss caused by beet armyworm in each region where outbreaks have occurred. The parameter estimates and the probability that these estimates are different from zero are reported.

We also ranked early-season temperature (1 = hottest), rainfall (1 = driest) and insecticide applications (1 = most applications) for the last 10 years. A combined 'weather factors' ranking (1-10) was made after summing the individual rankings for temperature and rainfall. A sum ranking was then made for weather factors and insecticide applications in a similar fashion.

Results

The percent yield losses caused by beet armyworms during the last 10 years are shown in Table 1 for each region being considered. The highest losses were in the lower Rio Grande Valley of TX (50% in 1995), Georgia (13.8% in 1988 and 5.2% in 1990), Mississippi (4.4% in 1993) and southern and central Alabama (3.1% in 1995). The southern rolling plains of Texas also had huge yield losses (22.5%) in 1995 but are not included in these analyses. Except for Mississippi, these losses correspond to times when multiple, in-season insecticide applications were being made for boll weevil eradication (Table 5). However, the number of applications for aphids and plant bugs was also very high in Texas for 1995 (Table 5). No part of Mississippi was in an eradication program during 1993, but for the last 10 years, 1993 was the most dry and second hottest year (Tables 3 and 4). So, the combined ranking of these two weather factors was at its lowest in 1993 (Table 6). Beet armyworm outbreaks in Texas (1995), Alabama (1990) and Georgia (1988, 1990) also corresponded to unusually hot and dry years (Table 6).

When data from all four states were included, our regression analysis indicated a relationship between the number of early-season insecticide applications ($t = 4.3$, $P < 0.0001$) and rainfall ($t = 2.5$, $P < 0.02$), but not temperature ($t = 0.3$, $P < 0.78$), to percent yield loss caused by beet armyworm ($F = 7.9$, $P < 0.0004$, $df = 3{,}36$ for entire model). The parameter estimates for insecticide applications (2.8) and rainfall (-1.0) indicate that the more early-season insecticide applications are made, and the drier the weather, the greater the risk of beet armyworm outbreaks. The number of eradication sprays made for boll weevil was a highly significant factor when regressed by itself against yield losses ($F = 8.6$, $P < 0.006$, $df = 1{,}38$). However, sprays made for plant bugs and aphids were related to yield losses nearly as well ($F = 8.0$, $P < 0.008$, $df = 1{,}38$). Parameter estimates and their significance for individual states are shown in Table 7.

Discussion

These data indicate that severe beet armyworm outbreaks occur following early seasons with multiple insecticide applications or when it is unusually dry. The most important factor appears to be insecticide use, especially that by weevil eradication programs. However, a strong correlation also existed between beet armyworm outbreaks and applications for plant bugs and aphids.

In areas with the potential for armyworm outbreaks, they appear likely to occur during the first 2-3 years of in-season insecticide sprays made for boll weevil eradication. This corresponds to times when multiple applications are made during the early season. Wet weather may prevent or alleviate outbreaks of beet armyworm. In the midst of the boll weevil eradication, the beet armyworm outbreak in Georgia during 1989 was less severe than in 1988 or 1990. Interestingly, 1989 was an unusually wet in June and July. Also, the number of insecticide applications in Mississippi and Alabama during 1994 should have predisposed cotton to beet armyworm outbreaks, but this year was also wet in both locations.

The two highest recorded yield losses caused by beet armyworm (Texas in 1995 and Georgia in 1988) not only coincided with the first year of in-season weevil eradication sprays but also with dry conditions. For all locations and years, the lower Rio Grande Valley of Texas was the second driest and had the most insecticide applications during the early production season of 1995. The number of aphid applications was especially high (4.0.). This explains the 50% yield loss caused by beet armyworm.

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Table 1. Locations of weather stations used to determine mean temperature and rainfall in central and southern Alabama, southern Georgia, Mississippi and the lower Rio Grande Valley of Texas.

	Weather Station Locations				
AL	Headland	Geneva	Brewton	Demopolis	Selma
GA	Albany	Valdosta	Tifton	Bainbridge	--------
MS	Cleveland	Oxford	Corinth	Stoneville	MSU
TX	Mcallen	Brownsville	----------	----------	--------

Table 2. Percent yield losses caused by beet armyworm in the entire US cotton belt, central and southern Alabama, Georgia, Mississippi, and the lower Rio Grande Valley of Texas.

	Percent Yield Loss				
Year	All states	AL	GA	MS	TX
1986	0.02	0.02	0.12	0.00	0.00
1987	0.02	0.00	0.00	0.00	0.04
1988	0.67	2.16	13.82	1.30	0.03
1989	0.15	0.46	2.95	0.03	1.74
1990	0.29	0.96	5.25	0.09	0.00
1991	0.02	0.00	0.18	0.04	0.01
1992	0.00	0.08	0.00	0.00	0.02
1993	0.57	1.92	0.07	4.44	0.00
1994	0.05	0.00	0.00	0.31	0.00
1995	1.41	3.10	0.20	0.58	50.00
Mean	0.29	0.87	2.26	0.70	5.18

Table 3. Mean temperature in June and July (April and May in Texas) for central and southern Alabama, southern Georgia, Mississippi, and the lower Rio Grande Valley of Texas.

	Temperature (ºF)			
Year	AL	GA	MS	TX
1986	81.92	82.56	81.42	79.35
1987	79.53	80.61	79.18	75.85
1988	79.24	79.28	79.00	77.37
1989	78.70	80.06	77.55	79.41
1990	79.86	81.05	79.27	79.24
1991	79.55	79.75	79.89	81.09
1992	79.09	79.85	77.70	75.63
1993	80.49	81.38	80.30	76.86
1994	77.96	79.13	78.79	77.88
1995	78.60	80.09	78.48	79.32
Mean	79.49	80.38	79.12	78.20

Table 4. Mean monthly rainfall in June and July (April and May in Texas) for central and southern Alabama, southern Georgia, Mississippi, and the lower Rio Grande Valley of Texas.

	Rainfall (inches)			
Year	AL	GA	MS	TX
1986	3.23	3.94	3.08	5.74
1987	4.58	4.77	3.74	4.01
1988	5.21	4.44	2.75	0.79
1989	9.06	7.69	9.35	3.27
1990	2.76	2.98	2.43	4.66
1991	6.68	7.66	3.19	9.38
1992	5.48	6.22	5.51	11.19
1993	4.34	5.27	2.37	2.56
1994	11.00	8.99	6.66	2.43
1995	3.74	5.87	5.34	0.89
Mean	5.61	5.78	4.44	4.49

Table 5. Number of insecticide applications for plant bugs + aphids and for boll weevil eradication in June and July (April and May in Texas) in central and southern Alabama, Georgia, Mississippi, and the lower Rio Grande Valley of Texas.

	Insecticide Applications Plant bugs + aphids, Weevil eradication			
Year	AL	GA	MS	TX
1986	0.7, 0.0	0.4, 0.0	1.38, 0.0	0.6, 0.0
1987	0.0, 0.0	0.2, 0.0	1.7, 0.0	0.3, 0.0
1988	1.7, 2.0	0.8, 5.0	1.6, 0.0	0.4, 0.0
1989	1.75, 1.0	1.7, 2.5	2.85, 0.0	0.6, 0.0
1990	1.0, 0.5	1.6, 1.0	2.1, 0.0	0.5, 0.0
1991	2.1, 0.25	0.5, 0.0	2.9, 0.0	0.5, 0.0
1992	0.25, 0.25	0.2, 0.0	1.7, 0.0	0.8, 0.0
1993	0.4, 0.25	0.2, 0.0	2.1, 0.0	1.2, 0.0
1994	3.1, 2.5	0.2, 0.0	3.1, 0.0	0.5, 0.0
1995	0.95, 3.0	0.6, 0.0	2.1, 1.25	5.8, 2.0
Mean	2.17 (total)	1.49 (total)	2.28 (total)	1.12 (total)

Table 6. Rankings for the combined weather factors, the number of insecticide applications, and the sum ranking of weather and insecticide factors in central and southern Alabama, southern Georgia, Mississippi, and the lower Rio Grande Valley of Texas.

	Rankings Combined weather factors, Insecticide applications, Sum			
Year	AL	GA	MS	TX
1986	1, 7, 8	1, 6, 7	2, 10, 12	7, 4.5, 11.5
1987	4, 10, 14	4, 8.5, 12.5	6, 7.5, 13.5	9, 10, 19
1988	6, 3, 9	6, 1, 7	5, 9, 14	3, 9, 12
1989	9, 4, 13	8, 2, 10	10, 4, 14	2, 4.5, 6.5
1990	2, 6, 8	2, 3, 5	3, 5.5, 8.5	8, 7, 15
1991	6, 5, 11	9, 5, 14	4, 3, 7	5, 7, 12
1992	8, 9, 17	7, 8.5, 15.5	9, 7.5, 16.5	10, 3, 13
1993	3, 8, 11	3, 8.5, 11.5	1, 5.5, 6.5	5, 2, 7
1994	10, 1, 11	10, 8.5, 18.5	8, 2, 10	5, 7, 12
1995	6, 2, 8	5, 4, 9	7, 1, 8	1, 1, 2

Table 7. Parameter estimates and the probability that these estimates are **not** different from zero; for multiple regressions across years of rainfall, temperature, and number of insecticide applications on percent yield losscaused by beet armyworm in central and southern Alabama, southern Georgia, Mississippi, and the lower Rio Grande Valley of Texas.

	Parameter Estimates (x 10) and their *P* Values (x 100) Temperature, Rainfall, Insecticides			
	AL	GA	MS	TX
Parameter estimates	-3.3, -4.4, 4.3	-16.9, -11.5, 15.2	0.8, -2.4, 2.9	4.3, -1.6, 91.5
P value	42, 2, 10	6, 3, 0	90, 53, 75	45, 58, 0