MOVEMENT OF BOLL WEEVILS RELATIVE TO COTTON PLANT PHENOLOGY

J. R. Coppedge, G. D. Jones, and T. M. O'Neil
USDA-ARS
College Station, TX
J. R. Raulston and D. W. Spurgeon
USDA-ARS
Weslaco, TX
E. Salgado
INIFAP
Tampico, MX

Abstract

Boll weevil movement, measured by pheromone-baited traps, was investi-gated relative to the development of cotton in selected (core) cotton fields. In general, more boll weevils were captured at sites away from than near cotton fields. High numbers of boll weevils were captured up to five miles from cotton. Boll weevil trap captures declined at all sites as the growing season progressed; however, the decline was much more rapid near cotton. Boll weevils were captured at all locations during the entire cropping season indicating that overwintered boll weevils may enter cotton over the entire cropping season or that there is a continuous movement of boll weevils between cropped and uncropped areas. The percentage of total number of boll weevils captured before first one-third grown square ranged from 95 percent at Munday, Texas, to 50 percent in Tampico, Mexico. Evidence is presented which suggests that a portion of the F_1 boll weevil population leaves cotton and moves to remote areas although cotton is near the peak fruiting period.

Introduction

Boll weevil movement, as measured by grandlure baited traps, is generally characterized by peaks of activity in the spring and late summer and little or no activity during mid-season. The reasons for decreased response of boll weevils to pheromone traps during mid-season is not fully understood. This decline has been attributed to competition from pheromone-producing male boll weevils in fruiting cotton or sometimes to a depletion of the overwintered boll weevil population as the season progresses (Hardee et al. 1970, Boyd et al. 1973a, 1973b). Rummel and Bottrell (1976) reported that the most consistent feature of the decline in boll weevil response to pheromone during the spring was the time it occurred and not the location of the pheromone source in respect to cotton.

Most boll weevil management programs, as well as ongoing boll weevil eradication programs, are predicated on the belief that a high percentage of overwintered boll weevils have either entered cotton or have starved by the time cotton starts to square. In most areas where the boll weevil is a recurring pest, one to three insecticide applications are made prior to the first one-third grown square to kill the overwintered weevils and reduce the size of subsequent generations during that cropping season. For the most part overwintered boll weevil treatments are prophylactic and their impact on subsequent generations of boll weevils in the treated fields is not carefully monitored. The value of these treatments for population management likely varies depending on planting date of cotton, weather, location, etc.

The research reported herein had several objectives. First, we wanted to compare boll weevil trap captures near cotton fields to trap captures in remote areas up to five miles from cotton, and boll weevil response to pheromone-baited traps prior to and after the first one-third grown square. Also, we wanted to research the factors responsible for the lack of boll weevil response to pheromone-baited traps at the time cotton is rapidly fruiting.

Materials and Methods

Initially, the following six sites were selected for these studies: Raymondville (Rio Grande Valley), Uvalde, Crockett, and Munday, Texas; Stoneville, Mississippi, and Tampico, Mexico. At each location we selected a core area of one or more cotton fields and placed traps in turn rows or fence lines next to the fields. The number of traps deployed per core area varied according to the size of the core area; i.e., at Uvalde, Texas and Munday, Texas, the core area was 30-40 acres and we deployed three traps while at Crockett, Texas the core area was 760 acres and we deployed seven traps. Next, pheromone-baited traps were deployed along directional lines at one mile intervals from the core area up to five miles from the core area. Trapping was initiated 3-4 weeks before squaring of cotton in the core acre.

The traps were installed on slotted 3/4" PVC pipe at a height of 36-42" above the ground. Hercon Boll Weevil Scout® traps baited with Hercon Luretape Grandlure-10 were used in these studies. Traps were inspected twice weekly (generally 3-4 day intervals) and the lures were replaced every two weeks. Boll weevil trap captures were recorded at each inspection and captured weevils were frozen for later examination in the laboratory. At weekly intervals, 50-100 cotton plants were selected at random and examined in the core field(s). Plant examinations were made from first square to crop termination, and the numbers and size of fruit were recorded.

Results and Discussion

The results presented in the report are mainly from the Uvalde, Crockett and Munday, Texas locations. The results from Raymondville are not included because the test area,

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:972-976 (1996)
National Cotton Council, Memphis TN

including the traps five miles from the core area, were essentially within a 25,000 acre block of cotton. Additionally, about the time traps were deployed for these tests at Raymondville, survey traps for the boll weevil eradication program were also deployed in the same area at the rate of one trap per 10 acres of cotton. Finally, the cotton in the core area near Raymondville suffered from drought and severe beet armyworm infestations, and consequently fruiting patterns were not typical. The Stoneville location lacked the manpower to make the plant counts; consequently, it is difficult to compare this data to the three Texas sites. At the time this report is being written, the Tampico, Mexico trial is still in progress.

At the Uvalde, Texas location (Table 1), we captured more boll weevils in remote sites than near cotton both before and after the first one-third grown square. The number of boll weevils captured in all traps declined from test initiation to first bloom but declined more rapidly near cotton than at the remote sites. As will be discussed later, the slight increase in trap captures from first bloom to mature bolls (hard - not open) compared with first one-third grown square to first bloom may have resulted from the captures of F_1 weevils near cotton and at the remote sites.

At Crockett, Texas (Table 2), the boll weevil trap capture at the core area was the highest from test initiation (9.0 boll weevils per trap) to the first one-third grown square and declined rapidly to the first mature boll (1.2 weevils/trap). However, boll weevil trap captures in the remote areas were the lowest from test initiation to first one-third grown square (5.8 to 23.2 adults/trap); trap captures peaked during the period from first one-third grown square to first bloom (15.7 to 30.5 weevils/trap) and then dropped off during the period of first bloom to first mature boll (10.9 to 17.8 boll weevils/trap).

The results from Munday, Texas (Table 3) were somewhat similar to those obtained from the Uvalde location. The highest trap captures of boll weevils in the core area (13.1 adults/trap) and the remote areas (29.3 to 59.1 adults/trap) were from test initiation to first one-third and then dropped rapidly to the first mature boll. Boll weevil trap captures from test initiation to first bloom dropped much more rapidly at the core area (94 percent) than in the remote areas (70-80 percent).

When the results from the Uvalde, Crockett, and Munday, Texas locations are combined and normalized according to cotton plant phenology (Tables 4 and 5), we find that traps near cotton did not capture as many boll weevils as traps in remote locations (average of 7.6 adults per trap at core field and 15.0 to 23.9 adults per trap in remote locations during the first observation period). Trap captures declined from first one-third grown square to first mature bolls at all trapping sites but usually declined much more rapidly near cotton. These data indicate (Table 5) more boll weevils were captured at trapping sites north of cotton than at trapping sites in other directional lines.

The effectiveness of traps deployed north of cotton may be explained by the prevailing southeast winds in some locations; however, this is not the case at all locations. The definite tendency for boll weevils to move northward to overwintering areas deserves further investigation.

Table 6 estimates what the potential effectiveness of overwintered weevil treatments would be for that given year. The results from Munday, Texas indicate that 94.7 percent of the boll weevils captured around the cotton field were captured before the first one-third grown square and 83.1 percent of the weevils captured in the remote areas were captured before the first one-third grown square in the core area. In the other locations from 50 to 72.6 percent of the boll weevils were captured before the presence of the first one-third square. In these areas only 26.9 to 64.9 percent of the total number of captured boll weevils in the remote areas were captured prior to first one-third grown square.

During the field tests at Uvalde, Crockett and Munday, Texas, we observed a substantial increase in boll weevil trap captures both at the core field and in the remote areas at approximately 35-40 days after the first one-third grown square (Table 7). The number of boll weevils captured per trap peaks at two weeks before squaring (4.0 adults per trap near core fields and 7.4 to 33.7 adults per trap in remote areas). The number captured dropped to the lowest point at four weeks after first one-third grown (0.4 in core field and 0.9 to 3.3 adults in remote area). At five weeks after first one-third grown square trap captures increased (1.2 adults per trap in the core area and 8.8 to 10.8 adults per trap in the remote area). After this period, trap captures began to decline again. Initially, this was thought to be normal variation in boll weevil response to pheromone traps. However, after carefully reviewing the data in relation to cotton plant phenology, we now believe that this increased response indicates movement and response to pheromone-baited traps of a segment of newly emerged F_1 weevils from cotton.

The available data do not provide insight into the percentage of F_1 popu-lations that leave the cotton; however, based on captures after cotton terminates, the percentage leaving cotton would appear to be small. This apparent movement occurs even though there is abundant cotton fruiting forms for feeding and oviposition.

The results of these studies have several implications. When pheromone-baited traps are used for survey or research purposes, they are almost always placed around cotton fields. Our data indicate that this placement probably gives a biased estimate of actual boll weevil numbers. Only at one location (D. D. Hardee, unpublished data), Stoneville, Mississippi, did trap captures at the core area equal or exceed the trap captures in the remote areas.

In the current boll weevil eradication program, survey traps are placed around fields planted or to be planted in cotton. The servicing of these traps, especially during inclement weather, can be time consuming and costly. The data reported herein suggest that for survey purposes the traps could be deployed for ease of service, i.e., along paved or all-weather roads, without a loss of efficacy. Strategic trap placement could reduce the need for laborers and reduce program cost.

These data strongly suggest that overwintered boll weevils survive for long periods and probably move into cotton throughout the production season. In the past it has been a general belief that boll weevils that cannot locate cotton for a food source within a few weeks after emergence from overwintering probably die from starvation (suicidal emergence). These data and the data to be presented in another paper at this meeting by Dr. G. D. Jones, strongly indicate that boll weevils can survive for long periods of time in the absence of cotton if there are other acceptable sources of pollen for foraging. Cate and Skinner (1978), Jones et al. (1993) and Benedict et al. (1991) have provided evidence that the boll weevil feeds on pollen other than cotton pollen and this pollen feeding may be linked to extended survival in the absence of cotton. We now feel the boll weevil is a general pollen feeder and clearly non-cotton pollen feeding is a survival mechanism that is well developed in this pest. The availability of pollen as a foraging resource may play a significant role in the ability of this pest to locate and colonize cotton. If pollen sources are abundant, boll weevil movement may be restricted and the possibility of contacting cotton is low. As the season progresses and pollen sources become scarce, the boll weevil is probably forced to search more widely and thus its chances of locating cotton becomes greater. Consequently, not only does weather, planting date, and location impact the percentage of the boll weevil population that enters cotton by the first one-third grown square, but availability of acceptable pollen resources probably is an important consideration.

During these studies we noted that boll weevil response to pheromone-baited traps is usually the poorest at or near cotton and the response to these traps decreases more rapidly at first one-third grown square. These data seem to suggest that pheromone by in-field boll weevils does compete with pheromone-baited traps near the field. Also, there is a natural decline in the numbers of overwintered boll weevils available for capture as the growing season progress. Although there is little doubt that the number of overwintered boll weevil decreases as the season progresses, the question of competition from in-field pheromone-producing weevils is less clear. The traps at or near cotton routinely, as previously mentioned, captured fewer boll weevils than remote traps. Why? Is the cotton plant itself competing with the pheromone-baited traps? Does the lack of pollen sources around a seedling cotton field affect the number of weevils congregated in the area? In each of the areas where we have worked, the cotton has been treated with one to three insecticide applications for overwintered boll weevils. Do these treatments impact trap catches near cotton? These are some of the questions we will try to answer in future research.

Acknowledgments

The authors would like to thank Karen Gray, Clint Tracey, Josh Blair, Russell Baker, Randy Walker, and Jason Lytle for their technical assistance.

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Table 1. Boll Weevil Trap Captures and Cotton Plant Phenology - Uvalde, Texas 1995.

Stage of Plant Growth in Core Field	Average Number of Boll Weevils Captured/Trap/Inspection					
	At Core Field	at Different Distances from Core Field (miles)				
		1	2	3	4	5
Four leaf to 1/3 grown square (19 days)	2.8	2.9	6.5	6.5	6.7	6.7
1/3 grown square to first bloom (23 days)	0.5	1.2	2.8	5.1	5.2	4.0
First bloom to mature boll (41 days)	0.7	1.5	3.9	3.5	3.7	4.0

Table 2. Boll Weevil Trap Captures and Cotton Plant Phenology - Crockett, Texas 1995.

Stage of Plant Growth in Core Field	Average Number of Boll Weevils Captured/Trap/Inspection					
	At Core Field	at Different Distances from Core Field (miles)				
		1	2	3	4	5
Four leaf to 1/3 grown square (30 days)	9.0	12.5	12.0	23.2	12.0	5.8
1/3 grown square to first bloom (21 days)	2.2	15.7	30.5	23.8	23.0	17.5
First bloom to mature boll (42 days)	1.2	10.9	17.8	13.4	13.6	12.2

Table 3. Boll Weevil Trap Captures and Cotton Plant Phenology - Munday, Texas 1995.

Stage of Plant Growth in Core Field	Average Number of Boll Weevils Captured/Trap/Inspection					
	At Core Field	at Different Distances from Core Field (miles)				
		1	2	3	4	5
Four leaf to 1/3 grown square (27 days)	13.1	53.9	59.1	29.3	44.1	35.9
1/3 grown square to first bloom (22 days)	0.4	8.5	13.6	5.4	7.9	7.2
First bloom to mature boll (44 days)	0.3	0.3	0.8	0.2	0.8	0.7

Table 4. Boll Weevil Trap Captures and Cotton Plant Phenology - Combined Results from Uvalde, Crockett, and Munday, Texas 1995.

Stage of Plant Growth in Core Field	Average Number of Boll Weevils Captured/Trap/Inspection					
	At Core Field	at Different Distances from Core Field (miles)				
		1	2	3	4	5
Four leaf to 1/3 grown square (avg. 25 days)	7.6	21.1	23.9	18.4	19.4	15.0
1/3 grown square to first bloom (avg. 22 days)	1.1	7.7	15.3	10.8	11.1	8.8
First bloom to mature boll (avg. 42 days)	0.7	4.9	7.0	5.7	6.7	5.4

Table 5. Boll Weevil Trap Captures and Cotton Plant Phenology - Combined Results from Uvalde, Crockett, and Munday, Texas 1995.

Stage of Plant Growth in Core Field	Average Number of Boll Weevils Captured/Trap/Inspection				
	At Core Field	at Different Directions from Core Field			
		North	East	South	West
Four leaf to 1/3 grown square (avg. 25 days)	7.6	31.6	15.9	9.4	21.4
1/3 grown square to first bloom (avg. 22 days)	1.1	18.2	12.6	4.1	8.0
First bloom to mature boll (avg. 42 days)	0.7	10.6	7.3	3.2	2.6

Table 6. Capture of Boll Weevils Relative to Cotton Plant Phenology in Core Field.

		% of Total Capture of Boll Weevils During Indicated Period of Plant Development in Core Field		
Location	Trap Location	to 1/3 square	1/3 grown square to bloom	bloom to mature bolls
Munday	Core field	94.7	2.9	2.3
	Remote	83.1	15.9	1.0
Crockett	Core field	72.6	17.7	9.7
	Remote	26.9	45.3	27.8
Uvalde	Core field	69.1	13.4	17.4
	Remote	45.7	28.4	25.9
Tampico Mexico	Core field	50.0	50.0	0.0
	Remote	64.9	27.4	7.7

Table 7. Boll Weevil Trap Captures Relative to the Presence of the First One-Third Grown Square - Combined Results from Munday, Crockett, and Uvalde, Texas 1995.

Weeks from first 1/3 grown square	Average Number of Boll Weevils Captured/Trap/Inspection					
	At Core Field	at Different Distances from Core Field (miles)				
		1	2	3	4	5
-4	1.8	4.1	8.3	3.4	10.6	8.2
-2	4.0	7.4	33.7	16.6	26.3	14.1
0	1.6	13.3	16.8	13.5	13.3	10.9
+2	0.5	7.8	11.3	7.1	8.3	6.2
+4	0.4	3.3	0.9	1.6	2.2	2.8
+5	1.2	8.8	16.3	10.8	9.8	11.5
+9	0.7	2.2	3.3	2.8	5.7	2.3