Overwintering Boll Weevil Populations in Southwestern Arizona Cultivated Cotton

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Summary

Concern regarding the increasing pest status of the boll weevil, Anthonomus grandis Boheman, in southwestern Arizona cotton, Gossypium spp., growing areas prompted studies during 1981 and 1982 to examine boll weevil seasonal infestations in planted cotton, occurrence and development in late-season bolls, emergence in the winter and early-spring from dry bolls, diapuse and initiation of spring infestations.

Peak boll weevil square infestations (22%) occurred in the planted cotton fields near infested stub cotton fields during early July, 1981. High numbers of boll weevils were found in late season bolls throughout the planted cotton fields from late October through December, 1981. At least two generations of boll weevils developed in the late season bolls and approximately 90% of the insects matured to adults by February 1, 1982.

Boll weevil adults emerged from dry bolls elevated 15 cm above the soil and placed on the soil surface until May 23, 1982. No boll weevils emerged from bolls buried in the soil 15 cm deep.

Reproductive boll weevil adults were found from October, 1981 to April, 1982. Approximately 56% of the female and 37% of the male boll weevil adults examined in late February exhibited at least intermediate diapause.

Boll weevil infestations were found in the initial squares of both an abandoned, regrowing cotton field on May 10 and a planted cotton field on June 2, 1982.

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Introduction

Boll weevil, Anthonomus grandis Boheman, infestations were widespread in southwestern Arizona cultivated cotton, Gossypium spp., during 1965 and were greater in stub cotton (Fye 1968). Stub cotton is a cotton culture in which a crop is produced from the previous season's overwintered root systems (Beatty 1977). Cotton stalks with insect damaged and immature bolls remain in the fields through the winter. The stalks are chopped (stubbed) ca. 15 cm above the ground during February.

Fye et al. (1970) reported boll weevils successfully overwintering in dry bolls to emerge by mid April. Moisture was found to enhance the emergence of boll weevils from dry bolls and to increase the survival of freed adults overwintering in plant debris (Leggett and Fye, 1969). These authors and Bottger et al. (1964) and Fye and Parencia (1972) concluded that the early destruction of cotton stalks and subsequent burial of all plant debris was essential to control boll weevils in Arizona.

Boll weevil infestations were not commonly found from 1966 to 1977 in southwestern Arizona when stub cotton was prohibited by state regulation. Stub cotton was again permitted beginning in 1978 and boll weevils, identified as the Mexican form, were found only in stub cotton from 1978 to 1980 (Gillespie et al. 1979 and Bergman et al. 1981). Widespread infestations occurred in 1981 in both stub and planted cotton fields and only nine of 23 infested planted cotton fields reported were near stub cotton (Bergman et al. 1982).

Concern regarding the increasing pest status of the boll weevil in southwestern cotton growing areas prompted studies during 1981 and 1982 to examine boll weevil seasonal infestations in planted cotton, occurrence and development in late season bolls, emergence in the winter and early spring from dry bolls, diapause and initiation of spring infestations. The present paper is a report of these studies.

Methods and Materials

Boll weevil infestations in planted cotton fields near Aztec (Yuma County, Arizona) were studied by sampline at six sites. Three sampling sites were less than 0.4 km and three were 0.4-0.8 km from adjacent boll weevil infested stub cotton fields which were plowed down in early August, 1981. Fifty half grown squares and 50 green bolls, ca. 14-21 days old, were collected at each site at 4-14 day intervals from July 1, 1981 to October 5, 1981. From October 15, 1981 to December 23, 1981, 100 late season green bolls were collected at each site at 6-13 day intervals. Squares were examined for boll and developing larvae, other forms and empty (exited) developmental cells. Insecticides were applied to the fields by the grower as recommended by his pest control advisor.

The development of immature boll weevils to adults in late season bolls was studied by collecting 200-1004 infested bolls per sample at 4-7 day intervals during January, 1982 from stalks remaining in planted cotton fields near Cotton Center (Maricopa County, Arizona). The bolls were examined for live and dead larvae, pupae and adults as well as empty (exited) developmental cells. The percent of the boll weevils that had developed to adults was determined by dividing the number of adults, both live and dead, and empty (exited) developmental cells by the total boll weevil forms and empty (exited) developmental cells less the number of dead larvae and paupae.

The emergence of adult boll weevils from dry bolls was studied by collecting 3200 opened or partially opened dry bolls remaining on stalks in planted cotton fields near Cotton Center on January 20, 1982. The collected bolls were divided into 16 samples of 200 bolls each. Five samples each were either elevated on wire screen 15 cm above the soil (simulating dry bolls remaining on stalks), placed on the soil surface (simulating dry bolls in ground trash) or buried 15 cm deep in loose, sandy soil. Each sample was covered by a screen pyramid emergence cage (1 meter^2, Shiller 1946). The remaining sample of 200 bolls was examined for all boll weevil forms and empty (exited) developmental cells. The cages were checked for emerged adults at 3-4 day intervals through June 27, 1982 and the data was combined into weekly emergence periods. On June 28, 1982, the dry bolls from under the emergence cages were reclaimed (buried bolls were sifted from the soil) and examined for dead boll weevil forms. Daily maximum temperatures and precipitation for Buckeye (Maricopa County, Arizona) and Gila Bend (Maricopa County, Arizona) from National Oceanic and Atmospheric Administration Climatological Date (Volume 86) were averaged to obtain daily temperatures and precipitation representative of the study area.

Adult boll weevils were collected in grandlure baited traps (Leggett and Cross 1971) operated near Cotton Center from October, 1981 to April, 1982. Specimens were separated by age with old boll weevil adults having completely hardened cuticles. The old adults were examined and classified as either reproductive (males with medium to large testes and seminal vesicles distended with sperm, females with at least immature eggs in the ovaries) or nonreproductive (males with small testes and no distension of the seminal vesicles with sperm, females with no eggs in the ovaries) and fat (yellow adipose tissue at least partially obscuring internal organs) or lean (internal organs clearly visible). Adults which were nonreproductive and fat were classified as in at least intermediate diapause (Brazzel and Newsom 1959). Some boll weevil adults were also examined which had been collected from squares and terminals in cotton regrowth on stalks during January and February, 1982.

Initiation of boll weevil infestations in the first squares of the 1982 growing season was studied in an abandoned, regrowing cotton field near Cotton Center, in which the stalks had been shredded, from May 10, 1982 to June 7, 1982 and in a planted cotton field near Gila Bend from June 2-16, 1982. Boll weevil infestations had occurred in both fields during the 1981 season. The number of half grown squares were counted per 4 m of row and 25 were randomly collected in each of the four corners of each field and examined for boll weevil eggs and larvae.

Results

Peak boll weevil square infestations occurred in the planted cotton sampling sites near the infested stub cotton fields from July 1-25, 1981 (Table 1). Thereafter, two or less boll weevils per 50 bolls per sampling date were found in the planted cotton near the infested stub cotton fields and none were detected in the planted cotton distant from the infested stub cotton fields until mid October, 1981, when the last insecticides were applied and the cotton was defoliated. High numbers of boll weevils were found in the late season green bolls throughout the planted cotton fields from late October, 1981 through December, 1981 and at least two generations developed in these bolls (Figure 1).

The percentage of boll weevils which had developed to adults in the late season bolls examined on January 8, 12, 19, 26 and 29 during 1982 was 37%, 58%, 67%, 79%, and 91%, respectively.

When the dry bolls were placed under the emergence cages on January 20, 1982, ca. 22% of the boll weevil developmental cells in the dry bolls were already empty (exited). Thereafter, boll weevil adults emerged from the dry bolls elevated 15 cm above the soil and placed on the soil surface until May 23, 1982 (Table 2). No boll weevils were caught in the emergence cages over the bolls which had been buried 15 cm deep in the soil. There was no significant difference (P=.05) between the number of boll weevils emerging per cage in treatments simluating dry bolls remaining on stalks or in treatments simulating dry bolls in ground debris. The highest number of boll weevils emerging per week occurred from February 16-22, 1982 during a period following fainfall and with increased average daily maximum temperatures. Similar conditions produced increased emergence from March 22-28, 1982 and April 26-May 2, 1982.

Significantly (P=.05) higher percentages of dead boll weevil larvae and pupae were found in the developmental cells in whole bolls retrieved on June 28, 1983 from the emergence cages where the bolls were elevated above the soil (ca. 20%) or placed on the soil surface (ca. 12%) than from emergence cages where the bolls were buried (ca. 4%). Inversely, significantly (P=.05) higher percentages of dead adults were found in the developmental cells of the bolls which were buried (ca. 46%) than were elevated above the soil (ca. 27%) or placed on the soil surface (ca. 17%).

Linear regressions of the cumulative percent development of immature boll weevils to adults in late season bolls from January 8-29, 1982 and the cumulative percent emergence of adults from dry bolls in cages from January 20-May 2, 1982 are compared in Figure 2. Approximately 90% of the boll weevils in the bolls had matured to adults and 30% had emerged from the bolls by February 1, 1982. Thereafter, ca. 60% of the boll weevils emerged by March 1, 1982 and ca. 90% emerged by mid-April, 1982 from the dry bolls.

Reproductive boll weevil adults were found in the grandlure baited trap collections and in the field collections examined from October, 1981 to April, 1982 (Table 3). More than 85% of the males and 70% of the females examined during October, 1981 through December, 1981 were reproductive. The percentages of reproductive adults decreased thereafter in the grandlure baited trap collections although more reproductive adults were found in the field collections than in the grandlure baited trap collections examined during February, 1982.

Some boll weevil adults exhibiting at least intermediate diapause were found in the late October, 1981 and early November, 1981 collections but percentages declined in late November, 1981 (Figure 3). Percentages of adult boll weevils exhibiting at least intermediate diapause increased beginning in early December, 1981 until ca. 56% of the female and 37% of the male boll weevil adults exhibited at least intermediate diapause in late February, 1982. The increase in the incidence of diapause occurred after the percentages of young adults in the collections increased.

Boll weevil infestations were found in the first squares in both the abandoned, regrowing cotton field and in the planted cotton field (Table 4). Peak infestations on May 24, 1982 in the regrowing field that produced the earlier squares were ca. 9x greater than peak infestations on June 7, 1982 in the planted cotton field.

Discussion

Boll weevil adults in Arizona cultivated cotton remain reproductive through December and at least two generations of boll weevils and high infestations occur in the late season bolls not only in areas where high seasonal infestations are found but also in areas distant to high seasonal infestations.

Boll weevils in the late season bolls mature to adults by late January but may not emerge from the bolls until May. It is apparent that more boll weevil adults emerge from dry bolls when enough moisture is present to soften carpel walls and temperature permits adult activity as previously reported by Fye et al. (1970) and Leggett and Fye (1969). Higher mortality of immature boll weevils occurs in exposed bolls during the winter and spring but fewer adults are able to exit the developmental cells in dry bolls buried in dry, sandy soil.

Some boll weevil adults emerging from bolls beginning in December exhibit at least intermediate diapause. However, many boll weevil adults in Arizona remain physiologically and reproductively active throughout the winter similar to those reported by Guerra et al. (1982) in subtropical areas of the Rio Grande Valley in Texas. The higher percentages of reproductive boll weevil adults found in the regrowing cotton during February suggest that specimens caught in grandlure baited traps during the spring may not represent the reproductive status of the total population. Further, the incidence of diapause in overwintering Arizona boll weevils increased dramatically in February following the emergence of adults from dry bolls. Therefore, boll weevil adults successfully overwintering are those produced in the late season bolls which emerge after December.

The results of these studies also show that boll weevils overwintering in Arizona can survive at least until early June to reproduce in squares. If high numbers of boll weevils are produced in Late season bolls and these bolls remain unburied through the winter and early spring, more adults will be present to initiate infestations in spring planted cotton. Therefore, as previously discussed, the early destruction of cotton stalks and the subsequent burial of all debris at the end of the season is essential to control boll weevils in Arizona.

TABLE 1. Average percentages of boll weevil infested squares and the number of boll weevils per 50 bolls in planted cotton at three sites near and three sites distant to infested stub cotton at Aztec, Arizona in 1981.

Sampling Date		Near Stub[1/] % Infested Squares	Near Stub[1/] #/50 Bolls	Distant to Stub[2/] % Infested Squares	Distant to Stub[2/] #/50 Bolls
July	1	22	-[3/]	3	-
	6	21	-	5	-
	13	1	1	0	0
	21	11	2	1	0
	25	11	-	0	-
	29	9	1	0	0
Aug.	4	1	0	0	0
	10	0	-	0	-
	14	0	-	0	-
	20	4	0	-	-
	27	0	0	0	0
Sept.	3	1	<1	0	0
	17	6	2	0	0
Oct.	5	2	1	-	-
	15	-	2	-	0
	28	-	6	-	0
Nov.	5	-	12	-	1
	12	-	13	-	1
	18	-	6	-	2
	24	-	10	-	3
Dec.	2	-	10	-	7
	9	-	11	-	4
	16	-	13	-	7
	23	-	13	-	2

1/ Sampling sites were less than 0.4 km from boll weevil infested stub cotton fields.

2/ Sampling sites were 0.4-0.8 km from boll weevil infested stub cotton fields.

3/ No samples were collected.

TABLE 2. Number of adult boll weevils emerging from five emergence cages with 200 dry bolls each either elevated 15 cm above the soil, placed on the soil surface or buried 15 cm deep in the soil near Cotton Center, Arizona and average daily maximum temperature and total precipitation[1/] for weekly periods during 1982.

Dates	Number of Adults Emerging From Dry Bolls: 15 cm Above Soil	On Soil	15 cm Below Soil	Total	Avg. Daily Max. °C	Total Prec. (cm)
1/20-1/25	3	3	0	6	15	.56
1/26-2/1	6	2	0	8	21	-[2/]
2/2 -2/7	2	0	0	2	19	-
2/8 -2/15	4	7	0	11	22	.69
2/k5-2/22	15	12	-	27	28	-
2/23-3/1	8	9	0	17	26	1.52
3/2 -3/8	11	5	0	16	25	.08
3/9 -3/15	2	2	0	4	25	3.91
3/16-3/21	1	1	0	2	21	.41
3/22-3/28	2	12	0	14	26	.38
3/29-4/4	4	4	0	8	26	-
4/5-4/11	6	7	0	13	29	-
4/12-4/18	1	4	0	5	32	-
4/19-4/24	3	0	0	3	32	-
4/26-5/2	5	1	0	6	36	.03
5/3 -5/9	0	0	0	0	34	1.09
5/10-5/16	0	1	0	1	32	.10
5/17-5/23	1	0	0	1	38	-
Average per cage[3/]	15a	14a	0b			

TABLE 2 (cont'd)

1/ Temperatures and precipitation reported for Gila Bend and Buckeye, Arizona in National Oceanic and Atmospheric Administration Climatological Data (Volume 86) were averaged.

2/ No precipitation was recorded during the period.

3/ Different letters imply significant difference (P=.05).

TABLE 3. Number of old[1/] adult boll weevils examined from grandlure baited trap and field[2/] collections and the percent of males and females which were reproductive[3/], Cotton Center, Arizona, 1981-1982.

Month	Source	Number Examined	% Reproductive	
			Males	Females
October, 1981	Trap	124	88	88
November, 1981	Trap	81	86	78
December, 1981	Trap	227	96	71
January, 1982	Trap	221	91	50
	Field	51	73	50
February, 1982	Trap	250	54	20
	Field	116	75	32
March, 1983	Trap	373	25	20
April, 1982	Trap	187	16	7

1/ Adults with complete hardened cuticles.

2/ Adults collected from cotton squares and terminals.

3/ Adult males with seminal vesicles distended with sperm and females with eggs in the ovaries.

TABLE 4. Percentages of boll weevil infested squares and the number per hectare (ha) in an abandoned, regrowing cotton field near Cotton Center, Arizona and in a planted cotton field near Gila Bend, Arizona in 1982.

Sampling Date		Infested Squares			
		Regrowth		Planted	
		%	#/ha	%	#/ha
May	10	3	446	no squares	
	17	3	1630	no squares	
	24	5	6710	no squares	
June	2	3	5290	2	80
	7	0	-	2	740
	16			0	-

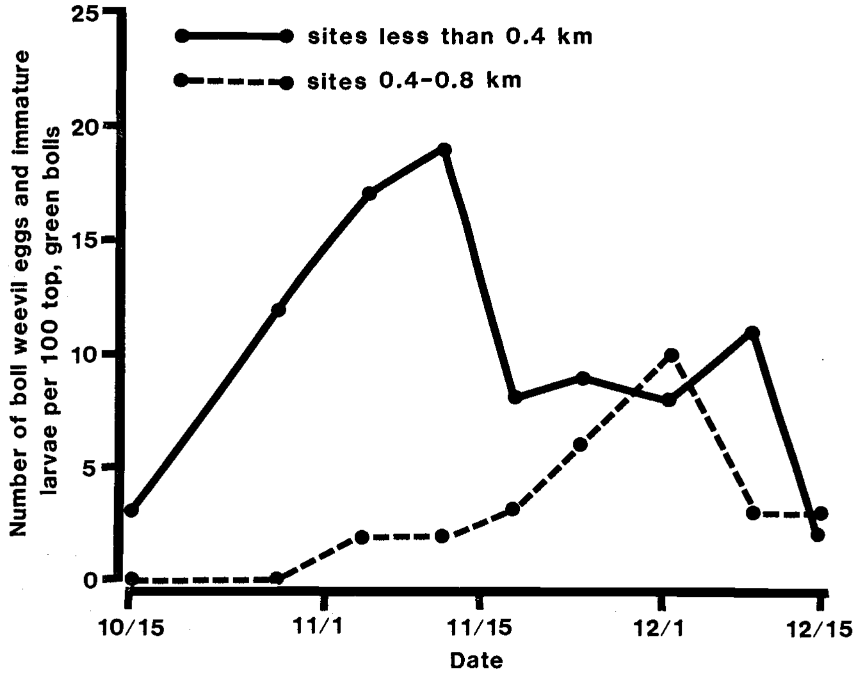

Figure 1. Average number of boll weevil eggs and immature larvae per 100 late-season bolls in planted cotton at 3 sites less than 0.4 km and 3 sites 0.4-0.8 km from earlier infested stub cotton fields at Aztec, AZ during 1981.

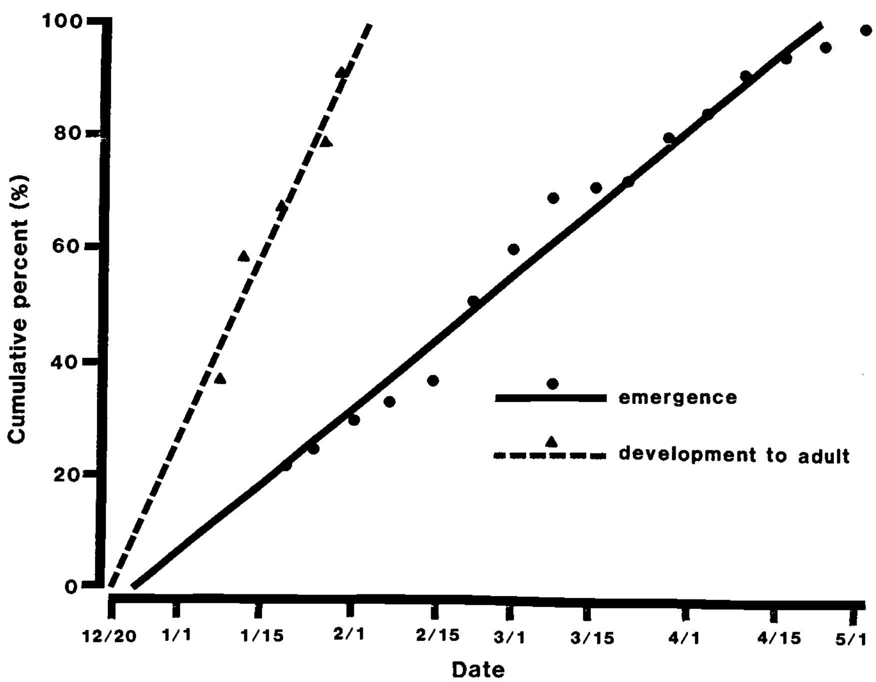

Figure 2. Cummulative percent developement of immature boll weevils to adults in late-season bolls and the cumulative percent emergence of adults from dry bolls from January-April, 1982 near Cotton Center, AZ.

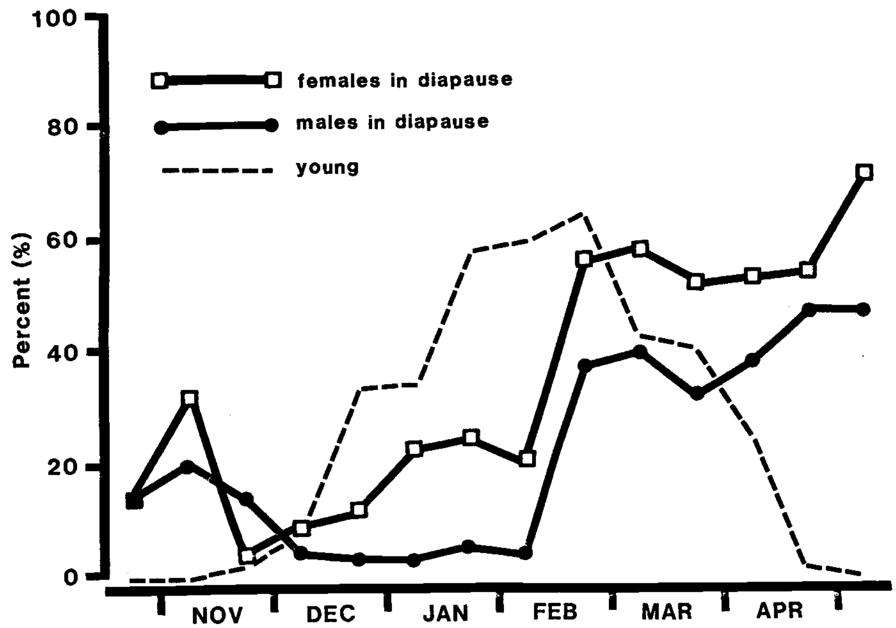

Figure 3. Percentages of male and female boll weevil adults in at least intermediate diapause and young adults in bi-monthly grandlure-baited trap collections from late-October, 1981 to late-April, 1982 near Cotton Center, AZ.

Toxicity of several insecticides to the boll weevil in Arizona

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Summary

Adult boll weevils, Anthonomus grandis grandis Boheman, emerging from bolls collected near Eloy, AZ were treated topically with 13 insecticides and relative susceptibilities were compared. The toxicity of the organophosphate insecticides in descending order of toxicity were: methyl parathion, azinphosmethyl, profenophos, EPN, methidathion, and phosmet. The synthetic pyrethroids exhibited similar toxicity to the boll weevil, making field application for control of this insect questionable, based upon their higher cost factor. Sulprofos, malathion, and acephate were also tested, but concentrations comparable to the other phosphates failed to yield sufficient mortality for which LD_{50}'s could be calculated.

Introduction

The boll weevil has now become established in Arizona; it has recently been reported in California. Screening of available and future insecticides against the boll weevil is necessary to identify effective materials for chemical suppression. The first step is laboratory screening to determine materials that have potential for field testing.

Methods and Materials

Infested cotton bolls were collected near Eloy, Arizona during early December, 1982. They were returned to the Department of Entomology Cotton Insects Laboratory, Tucson, and placed in cages. Emerged adults (unsexed) weighing an average of 18.3 mg. were topically treated on the dorsal surface with technical grade insecticides dissolved in acetone. Insecticides used were acephate, azinphosmethyl, BAY FCR 1272, cypermethrin, EPN, flucythrinate, fluvalinate, malathion, methidathion, methyl parathion, permethrin, phosmet, profenofos, and sulprofos. Likewise, adults collected from grandlure-baited pheromone traps in Avra Valley, Arizona, during this same period of time were treated with azinophosmethyl, EPN, and methyl parathion. Controls were treated with acetone. Treated insects were placed in petri dishes, 15 per dish; this equalled one replicate. At least 4 replicates at each of 4-6