

SPATIAL OCCURRENCE OF THE BOLLWORM EGGS, LARVAE AND PREDATORS IN COTTON¹

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ABSTRACT - Intraplant distribution of eggs, larvae and predators of the bollworm (*Heliothis zea* (Boddie)) on cotton (*Gossypium hirsutum* L.) was studied in field trials during 1986 and 1987 in Oklahoma. The largest proportions of eggs were found on the main stem terminals and upper parts of the plant. The total bollworm eggs on terminal and total eggs on the whole plant showed significant relationships, which suggests that the main stem terminal can be used as sampling site for bollworm eggs. Larvae were more commonly found on squares, bolls and flowers. Although large proportions of eggs were laid on the main stem terminals and on leaves, very small proportions of larvae were found on these parts. Chi-square tests between total numbers of eggs, total numbers of larvae on the upper of the plant and total numbers of predators on the whole plant showed no dependence in all planting dates.

Index terms: *Heliothis zea*, *Gossypium hirsutum*, planting date, plant part, sampling.

OCORRÊNCIA TEMPORAL DE OVOS, LARVAS E PREDADORES DA LAGARTA-DA-MAÇÃ-DO-ALGODOEIRO

RESUMO - Distribuição espacial de ovos, larvas e predadores da lagarta-da-maçã do algodoeiro, *Heliothis zea* (Boddie) foi estudada em condições de campo em Oklahoma nos anos de 1986 e 1987. As maiores quantidades de ovos foram encontradas no terminal e na parte superior da planta. O número total de ovos no terminal apresentou uma correlação significativa com o total de ovos na planta. Isto sugere que o terminal da planta pode ser usado como ponto amostral. As larvas foram mais comumente encontradas em botões florais, maçãs e flores. Embora grande quantidade de ovos tenha sido encontrada no terminal e nas folhas, poucas larvas foram encontradas nestas partes. Testes de qui-quadrado entre o número total de ovos e larvas na parte superior da planta e número total de predadores na planta toda mostraram que há independência entre eles em todas as épocas de plantio.

Termos para indexação: *Heliothis zea*, *Gossypium hirsutum*, data de plantio, partes da planta, amostragem.

INTRODUCTION

The bollworm *Heliothis zea* (Boddie) is a pest widely distributed throughout the world.

It has been recorded as a cotton (*Gossypium* spp.) pest in the United States since 1820 (Parencia Junior 1978). According to Robinson et al. (1972) and Young & Price (1975) the bollworm and tobacco budworm (*Heliothis virescens* F.) are serious pests of cotton in Oklahoma. While they are frequently found together, the bollworm is the more common species, especially in the early season. In southwestern Oklahoma, Young & Price (1975) showed that the bollworm is found mainly on cotton (*Gossypium hirsutum* L.), sorghum (*Sorghum bicolor* (L.) Moench) and on alfafa (*Medicago sativa* L.)

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Studies on the behavioral pattern of the bollworm larvae on cotton have been reported by several authors. Quaintance & Brues (1905) reported that usually the neonate bollworm larva does not search for food immediately after egg hatching. It first consumes the egg-chorion. The same behavior was reported by Reed (1965) with *Heliothis armigera* Hubner. Wilson et al. (1980) showed that the first and second instars prefer flowers. Farrar Junior & Bradley Junior (1985a) found that small larvae were most commonly found on squares and terminals during a three-year study, but in another year they were more commonly found on bolls.

Young & Willson (1984) found high correlation ($r^2 = 0.99$) between percent of occupancy of two predators, convergent lady beetle (*Hippodamia convergens* Guerin-Meneville), and soft flower beetles (*Collops* spp.), and their damage reduction from these two cotton pests. They stated that these two predators are distributed independently of the *Heliothis* spp. infestations. The objective of this research was to study the intraplant distribution of bollworm eggs and larvae as well as that of seven predators species on cotton.

MATERIALS AND METHODS

This research was conducted at the Agronomy Research Station near Perkins, Oklahoma, during 1986 and 1987. In 1986, the commercial cotton cultivar Stoneville 112 was planted in a plot of approximately 5,500 m² on May 23. In 1987, the plot was divided in three small areas with about 1,853 m² each. Each plot was planted with the commercial cultivar Tamcot CAMD-E' on three different dates, May 7, May 15 and June 2. During the 2-year period the study area was not sprayed with insecticides. It was not necessary to make any supplementary irrigation during the 2-year study. In 1986, sampling began on July 7 when the plants had matched-head squares (approximately 0.5 cm in diameter). The area was sampled every other day. Each sample consisted of 10 consecutive plants counted in a row. Each day, 10 1-m rows were randomly selected in the plot for sampling. Since each day 10-m rows were sampled, 100 plants were sampled on each date. Each plant was checked for

bollworm eggs and larvae and seven predators (lady beetles larvae and adults; *Hippodamia* spp., insidious flower bugs; *Orius insidiosus* (Say), soft-winged flower beetles; *Collops* spp., lacewing larvae; *Crysopea* spp., big-eyed bugs; *Zelus* spp., and various species of spiders). Bollworm eggs and larvae and predators were recorded on four plant parts: leaves, squares, bolls and terminals. The plant part leaf comprised leaves of all sizes: squares comprised flower buds and open flowers; bolls comprised bolls of all sizes, including those with bloomtags; terminals comprised the main stem terminal.

In 1987 studies, cotton from the three different planting dates were checked for bollworm eggs and larvae and predators. The cotton plant was divided into four sections: terminal, upper, middle and lower parts. In the last three plant divisions, bollworm eggs and larvae and predators were counted on the plant parts: leaves, squares, and flowers. In 1987, the main stem terminal was considered as a plant division, not a plant part as in 1986. In 1987 studies, flowers were included as a plant part which was comprised of white flowers and red flowers, while squares comprised only flower-buds of all sizes. Sampling began for planting date I on July 12 when the plants had matched-head squares. Sampling on planting dates II and III were started on July 22 and July 28, respectively. Each sample was one plant randomly selected from each planting date plot. Every day, 20 plants were randomly checked from each of the three planting date areas.

Chi-square tests were performed to determine if there was any statistically significant relationship among numbers of eggs, larvae, and predators on different cotton plant parts. The chi-square values were calculated according to SAS Institute (1985). Significant values of chi-square tests will suggest rejection of the null hypothesis of independent occurrence of two parameters study. Graphs and tables were constructed to show the distribution and frequencies of observed and expected values of bollworm eggs, larvae, and predators on cotton throughout the season.

RESULTS AND DISCUSSION

The number of bollworm eggs, bollworm larvae and predators found within cotton plant of 'Stoneville 112' in 1986 is shown in (Table 1). The population of bollworm eggs and larvae was low and variable during the season of 1986. The predator population was not

TABLE 1. Numbers of bollworm eggs, larvae, and predators on stoneville 112 cotton in 1986.

Sampling date	Nº eggs	Nº Larvae	Nº Predator
07.07	6	0	21
07.09	2	1	22
07.11	1	5	22
07.14	2	1	27
07.16	0	0	19
07.18	3	1	29
07.21	1	2	28
07.23	2	1	35
07.25	6	0	20
07.29	1	1	29
08.06	1	1	28
08.13	1	1	47
08.18	0	0	24

TABLE 2. Distribution of predators on stoneville 112 cotton during 1986.

Sampling Date	Leaf	Squares	Boll	Terminal
07.07	1	10	-	10
07.09	5	3	-	14
07.11	5	9	-	8
07.14	10	6	-	11
07.16	4	7	-	8
07.18	3	20	-	6
07.21	3	19	-	6
07.23	4	16	6	9
07.25	5	7	3	5
07.29	4	13	6	6
08.26	5	10	7	6
08.13	9	12	23	3
08.18	4	2	18	0

high, but remained almost constant throughout the season, except for two peaks (35,47) on July 23 and August 13, respectively.

All samples resulted in 26 eggs, 14 larvae, and 351 predators. The proportions of predators found in 1986 in different plant parts, compared to the total number on the whole plant, were 15% on leaves, 18% on bolls, 26% on terminals, and 40% on squares, white flowers and red flowers. Predators on bolls were recorded when there were bolls available, i.e., beginning on July 23 (Table 2). This high percent of predators on terminals agreed with the findings of Farrar Junior & Bradley Junior (1985b). Lady beetle larvae and adults, various species of spiders, *Collops* spp., and minute pirate bugs were the most abundant predators throughout the 1986 season.

In 1987, bollworm eggs, bollworm larvae, and predators were recorded within 'Tarcot CAMD-E' planted on three different dates. These are shown in (Fig. 1, 2 and 3). Leaves were the most preferred place for egg deposition in all three planting dates. This was followed by main stem terminal and

squares. Larvae were more commonly found on squares, 34%, 45%, and 64% in the three periods. Larvae on bolls ranked second, followed by flowers and the main stem terminal. Leaves and squares presented the highest numbers of predators. These data show that even though the largest proportions of eggs were laid on terminals and leaves, only small percentages of small larvae stayed on these parts. Intraplant movement probably accounted for the small number of larvae found on places such as leaves and terminals which are not favorable feeding places for long periods.

The data presented here showed high proportions of eggs on the terminal which were comparable to the proportions found on the upper part of the plant. Chi-square tests showed significant relationships between eggs on the terminal with eggs on the rest of the plant (Table 3). This suggests that terminals can be used when a plant is sampled for eggs. Larval distribution on different plant division showed that the percentages of larvae on terminal were 20, 13, and 32 in the first, second, and third planting dates, respectively.

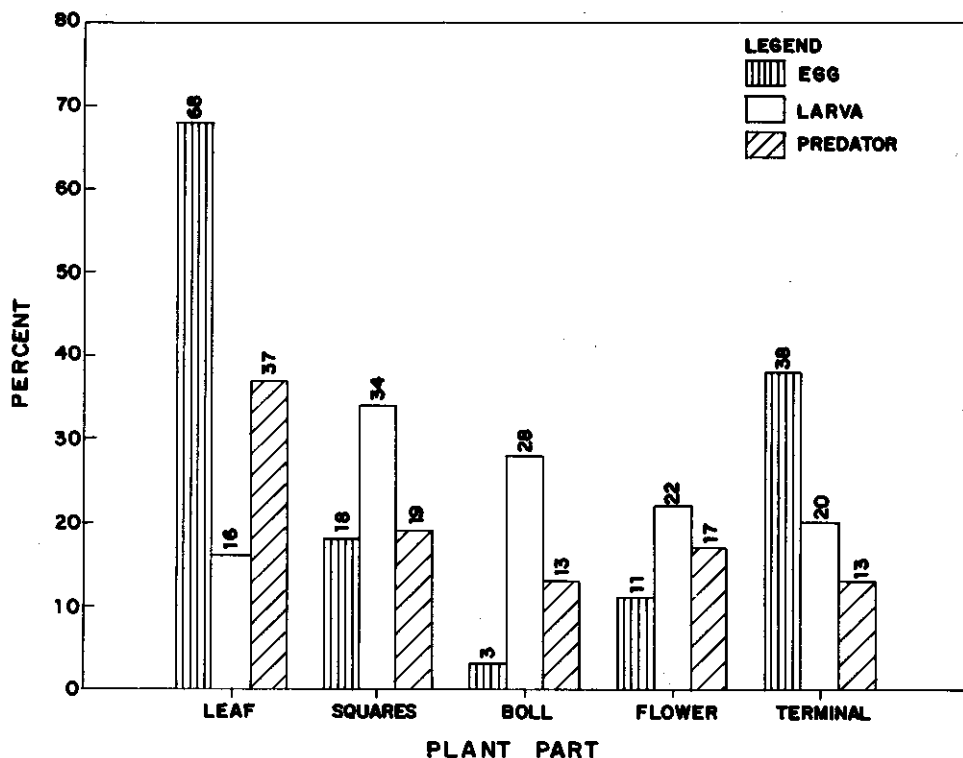


FIG. 1. Percentages of eggs, larvae and predators on cotton plant parts in planting date I, Oklahoma, 1987.

TABLE 3. Chi-square tests of the total bollworm eggs on the main stem terminal and total number of eggs on the whole plant.

Pair Comparison*		Percent of plant		
		Planting date		
		05.07.87	05.15.87	06.02.87
(00)	Obs.	66.4	81.5	66.8
	Exp.	64.9	80.6	68.7
(01)	Obs.	9.6	5.6	15.8
	Exp.	11.1	6.6	13.9
(10)	Obs.	15.5	8.9	13.0
	Exp.	13.2	9.8	11.5
(11)	Obs.	3.5	1.7	0.8
	Exp.	2.7	0.8	2.3
(20)	Obs.	3.6	2.1	3.4
	Exp.	4.4	2.0	3.0
(21)	Obs.	1.4	0.2	0.2
	Exp.	0.7	0.2	0.6
Chi-square		6.763	6.577	9.206
P 0.05		0.034	0.037	0.010

* First number stands for total number of eggs on the plant. Second number stands for total number of eggs on terminal.

On the upper part, 36%, 33%, and 22% for the three planting dates. On the middle 31%, 37%, and 35%. If terminal and upper were considered as a whole plant division, the proportions of larvae would be 67%, 70%, and 56% for the first, second, and third planting dates, respectively. These data support the results found with *Heliothis* spp. by Mistic Junior (1964), Braga Sobrinho (1988) and Farrar Junior & Bradley Junior (1985a, 1985b). The results presented here strongly suggest that sampling for bollworm larvae should be made using the terminal and the upper of the plant together as a sampling site.

The highest number of predators in 1986, and in all planting dates in 1987, did not correspond to the highest numbers of bollworm eggs and larvae. These results suggest a degree of independence between the prey and predator complexes as found by Young &

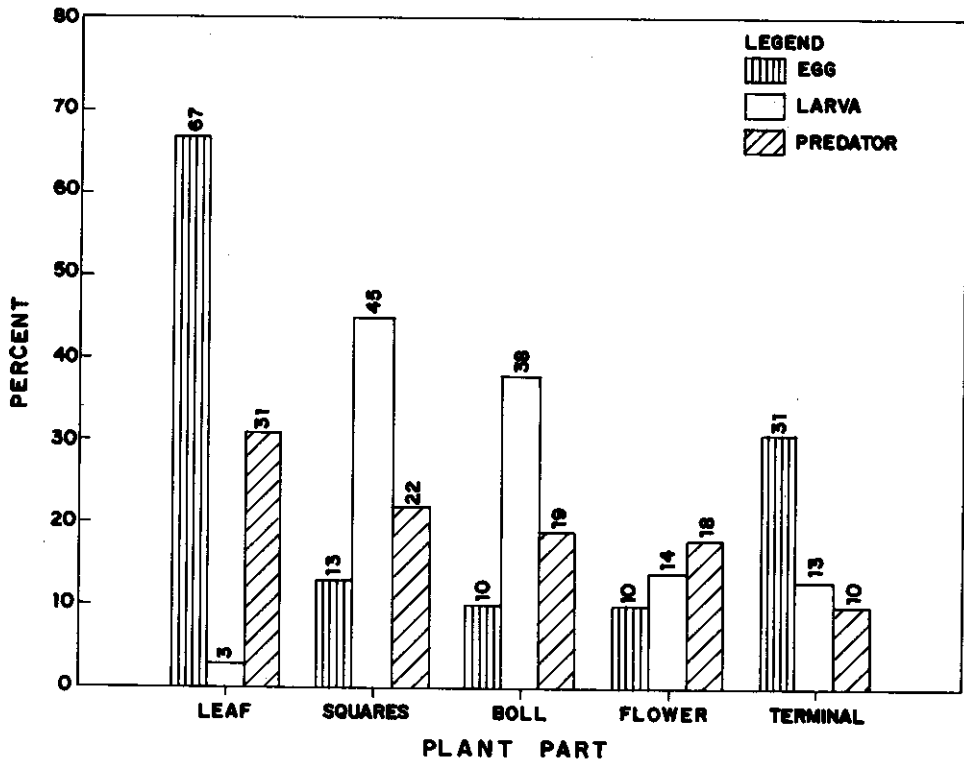


FIG. 2. Percentages of eggs, larvae and predators on cotton plant parts in planting date II, Oklahoma, 1987.

Willson (1984). The occurrence of predators on all planting dates throughout the season showed that lady beetles and spiders were the most numerous predators throughout the season in all three planting dates. Minute pirate bugs and *Collops* spp. occupied the third and fourth places. The numbers of lady beetles of three planting dates were 76, 77 and 86. Spiders ranked second with 85, 78, and 73. Minute pirate bugs in the first planting date, and *Collops* in second and third planting date were 46, 50 and 45, respectively.

Tests of independence between total number of eggs on the upper of the cotton plant and the total number of predators on the whole plant showed no dependence in all planting dates (Table 4.) The total number of larvae within the upper of the plant and the total number of predators within the whole plant

TABLE 4. Chi-square tests of the total bollworm eggs on the upper part of the plant and total numbers of predators on the whole plant.

Pair Comparison*		Percent of plant		
		Planting date		
		05.07.87	05.15.87	06.02.87
(0 0)	Obs.	34.5	36.4	35.2
	Exp.	34.4	37.4	35.6
(0 1)	Obs.	48.4	53.6	50.0
	Exp.	48.5	52.6	49.6
(1 0)	Obs.	6.0	4.0	6.2
	Exp.	6.0	3.5	5.3
(1 1)	Obs.	8.3	4.5	6.4
	Exp.	8.4	5.0	7.3
(2 0)	Obs.	1.0	1.1	0.4
	Exp.	1.1	0.6	0.9
(2 1)	Obs.	1.8	0.4	1.8
	Exp.	1.6	0.9	1.3
Chi-square		0.419	4.405	3.984
P 0.05		0.811	0.111	0.136

* First number stands for total number of eggs. Second number stands for total number of predators.

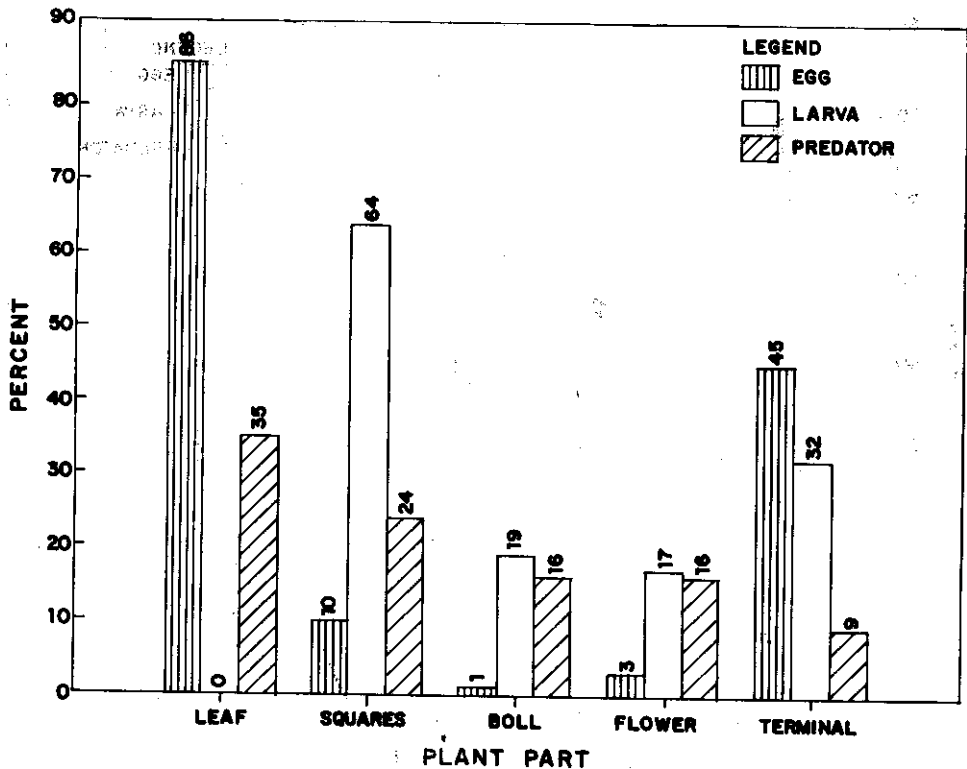


FIG. 3. Percentages of eggs, larvae and predators on cotton plant parts in planting date II, Oklahoma, 1987.

showed no relation in all planting dates (Table 5.) This research supports the findings of

TABLE 5. Chi-square tests for the total bollworm larvae on the upper part of the plant and total numbers of predators on the whole plant.

Pair Comparison*		Percent of plant		
		Planting date		
		05.07.87	05.15.87	06.02.87
(00)	Obs.	36.7	38.5	39.6
	Exp.	37.3	38.8	40.2
(01)	Obs.	53.3	55.1	56.6
	Exp.	52.7	54.7	56.0
(10)	Obs.	4.7	3.0	2.2
	Exp.	4.2	2.7	1.6
(11)	Obs.	5.3	3.4	1.6
	Exp.	5.8	3.8	2.2
Chi-square		0.852	0.461	2.103
P 0.05		0.356	0.497	0.147

* First number stands for total number of larvae. Second number stands for total number of predators.

Young & Willson (1984) who found the independence of relationships between prey and predator complexes.

CONCLUSIONS

1. The largest proportions of eggs were found on the main stem terminals and upper parts of the plant.

2. The total bollworm eggs on the terminal and total on the rest of the plant showed significant relationships, which suggests that a plant terminal can be used as a sampling site for bollworm eggs. This does not discard the idea of using two plant divisions, terminal and upper parts of the plant, as sampling site for eggs.

3. In contrast, the proportions of larvae found on the terminal were very low in comparison to the proportions found on the upper and

middle parts of the plant. This suggests a dynamic dependence of small larvae for suitable feeding sites like squares.

4. Leaves were the most preferred place for egg deposition, followed by square, flowers, and bolls. Larvae were more commonly found on squares, bolls, and flowers. Although large proportions of eggs were laid on terminals and leaves, very small proportions of larvae were found on these parts. This fact might explain the high mobility of larvae within the plant in searching for suitable feeding sites which were usually squares, bolls, or flowers. These results support the assumption of independent relationships of *H. zea* eggs, larvae and their predators found by Young & Wilson (1984).

5. The data showed no relation between total numbers of eggs, larvae, and their predators.

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