VERTICAL DISTRIBUTION OF EGGS AND LARVAE OF THE BOLLWORM WITHIN THE COTTON PLANT[1]

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ABSTRACT - The cotton cultivar 'Tamcot CAMD-E', *Gossypium hirsutum* L., was planted in three different planting dates. Five wood-framed screen cages were used to cover 30 cotton plants during match-head squares and blooming phase for each planting date. Five female and five male bollworm moths, *Heliothis zea*, were released in each cage. The majority of eggs were laid on the upper part of the plant. The greatest proportions of eggs were observed during the second infestation period, which coincided with the blooming phase. Leaves were the most common place for egg deposition. Terminal alone is probably not a good place to scount for larvae. The greatest proportion of larvae were found on the upper part of the plant during the second infestation period, which coincided with a larger canopy and more fruiting structures available. High correlations were obtained among eggs on leaves and total number of eggs on the whole plant. Total larvae on the upper part of the plant yielded higher correlation coefficients than larvae on the terminal. This was true in all infestations and planting dates.

Index terms: *Heliothis zea, Gossypium hirsutum,* artificial infestation, fenology.

DISTRIBUIÇÃO VERTICAL DE OVOS E LARVAS DA LAGARTA-DA-MACÃ DO ALGODOEIRO

RESUMO - A cultivar 'Tamcot CAMD-E', *Gossypium hirsutum* L., foi plantada em três diferentes datas de plantio. Foram usadas cinco gaiolas teladas para cobrir trinta plantas durante o início dos botões florais e floração. Foram liberadas em cada gaiola cinco casais adultos da lagarta-da-maçã, *Heliothis zea*. Grande parte dos ovos foi encontrada no terminal da planta durante a segunda infestação, que coincidiu com a floração. As folhas foram os locais preferidos para oviposição. O terminal da planta não parece ser o local adequado para fazer amostragem de larvas. O maior número de larvas foi encontrado no terço superior da planta durante a segunda infestação, quando as plantas apresentavam maior quantidade de massa verde. Correlações significativas foram obtidas entre o número de ovos nas folhas com o total de ovos na planta. O número total de larvas no terço superior apresentou maior correlação do que simplesmente larvas no terminal. Isto ocorreu durante os três períodos de infestação e datas de plantio.

Termos para indexação: *Heliothis zea, Gossypium hirsutum,* infestação artificial, fenologia.

INTRODUCTION

Many researchers have investigated the behaviors of the bollworm on different hosts. Among these behavior patterns, the vertical distribution of eggs and larvae has been of interest (Quaintance & Brues 1905, Hillhouse & Pitre 1976, Nilakhe & Chalfant 1981, Pencoe & Lynch 1982, Farrar Junior & Bradley Junior 1985 and Terry et al. 1987). The above studies addressed the general description of

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oviposition and larval feeding site preferences during different phenological stages of the hosts. On cotton (*Gossypium hirsutum* L.), Quaintance & Brues (1905), Parson (1940), Beeden (1974), Hillhouse & Pitre (1976), and Farrar Junior & Bradley Junior (1985) showed no consistency in *Heliothis* spp. oviposition preference sites and larval feeding sites.

Hillhouse & Pitre (1976) examined spacial oviposition by *H. zea* and *H. virescens* on soybeans (*Glycine max* (L.)), and cotton. They reported that both species preferred the pubescent lower leaf surface to the upper leaf surface stems or pods of soybeans. Oviposition by both species on soybeans occurred in the upper two-thirds of the plant, whereas on cotton, occurred in the upper one-third of the plant. Wilson et al. (1980) said that 89.6% of the eggs were found on cotton leaves, with 48.2% on mainstem leaves compared with 23.1% on fruit branch leaves, and 18.3% on vegetative branch leaves.

Mistric Junior (1964) and Lincoln et al. (1967) suggested that terminal counts of eggs and larvae of *Heliothis* spp. on cotton were unreliable indices of damage by these insects, and that square damage should be used in determination of the economic threshold infestations. Lincoln et al. (1967) found that high counts of eggs and larvae on the terminal were associated with high square damage percentages. They stressed the necessity of a more intensive study of this subject in different times and locations of the cotton growing area. Quaintance & Bishopp (1905), and Quaintance & Brues (1905) found that the neonate larvae usually do not immediately search for food on the plant, but consume the egg choria. After that, they start looking for other food sources such as any tender leaf or flower.

Reese et al. (1981) found that the patterns of larval distribution varied from one location to another. At each location, more than half of all larvae were found on squares less than 6 mm in diameter. Farrar Junior & Bradley Junior (1985) reported that within plant distribution of *Heliothis* spp., eggs and larvae can also vary from one geographic area to another. They stressed that when egg counts were used in making pest management decisions, they should be supplemented with data on larval populations.

The objective of this study was to determine the vertical distribution of bollworm eggs and larvae within the cotton plant.

MATERIALS AND METHODS

The study of the vertical distribution of bollworm eggs and larvae within the plant was conducted at the Agronomy Research Station near Perkins, Oklahoma. The cotton cultivar "Tamcot CAMD-E" was planted in three areas of approximately 1,833 m^2 each in three different planting dates, May 7, May 15, and June 2.

Five wood-framed screen cages, measuring 1.2 m x 1.7 m at the base, and 1.7 m in height with 1 mm mesh nylon screen were used to cover 30 cotton plants during match-head squares (5 mm of diameter) and blooming phase for each planting date. Each cage was placed over six plants. The plants and cages were sprayed with Malathion (1g AI/liter of water) to control predator and parasites. Twenty-four hours after insecticide treatments, five female and five male bollworm moths were released in each cage. Bollworm eggs, larvae, and adults were obtained from corn fields in Stillwater, Oklahoma, and they were reared in the laboratory and fed on a diet according to Burton (1969, 1970).

The moths were held in oviposition cages in the laboratory until they began to lay eggs and then they were released in field cages between 6 pm and 8 pm. The moths remained in the cages for 36 hours, including two periods of darkness. After this oviposition period, the moths were removed by hand from the cages. Counts for eggs were immediately made on the six plants in each of the five cages. The plants remained covered by cages until they were checked for larvae, which occurred three days after egg counting. The same procedure was used in all three planting dates ant two growing periods of cotton.

Eggs and larvae in each planting date and each growing phase were recorded from the main stem terminals, upper, middle, and lower parts of the cotton plant. Within upper, middle, and lower plant divisions, eggs and larvae were checked on plant parts such as leaves, squares, bolls, and flowers. The

plant part leaf comprised leaves of all sizes; squares comprised flower buds of all sizes; flowers comprised white and red flowers; bolls comprised bolls of all sizes, including those with bloomtags (drying corollas); and terminals comprised the main stem terminal.

The first and second infestations of cages with five pairs of moths on the first planting date were on 07.13.87 and 07.22.87, and sampling for eggs and larvae on (07.15 and 07.17), and (07.24 and 07.27) for first and second infestations, respectively. The second planting dates of the infestations were 08.02 and 08.11, counting for eggs and larvae on 08.04 and 08.07 and 08.13 and 08.16 for the first and second infestations, respectively. For the third planting date, the infestations were done on 08.18 and 08.30, and recording for eggs and larvae on 08.20 and 08.23 and 09.01 and 09.04 for first and second infestations, respectively.

Graphs were prepared to illustrate proportions of eggs/larvae on regions of the plant and on plant parts for each planting date. In addition, a series of stepwise regression procedures was completed to determine the best model to explain variation in each of the dependent variables (egg, larval) on plant divisions and plant parts.

RESULTS AND DISCUSSION

The total numbers of eggs on 60 cotton plants in two infestation periods, in the first planting date, were 1,747. Each plant had an average of 29 eggs. In the first planting date, 21% of the eggs were found on the terminal, 34% on the upper, 30% on the middle, and 15% on the lower of the plant. From a total of 1,343 eggs in the second planting date, 29% were laid on the terminal, 43% on the upper, 21% on the middle, and 7% on the lower of the plant. This planting date had an average of 22.3 eggs per plant. Records of the third planting date showed an average of 18.7 eggs per plant from a total of 1,122 eggs. The proportions of eggs on each plant division were 30% on the terminal, 39% on the upper, 26% on the middle, and 5% on the lower of the plant (Fig. 1 to 3).

The proportions of eggs deposited on leaves were 74, 63, and 73% for the first, second, and third planting dates, respectively. Squares ranked second, with 22, 16 and 17% for the three planting dates. They were followed by bolls and flowers (Fig. 4 to 6). Leaves and squares were the preferred place for neonate larvae during all planting dates. This was followed by flowers and bolls.

A total of 514 larvae were recorded in five cages, during two infestation periods in the

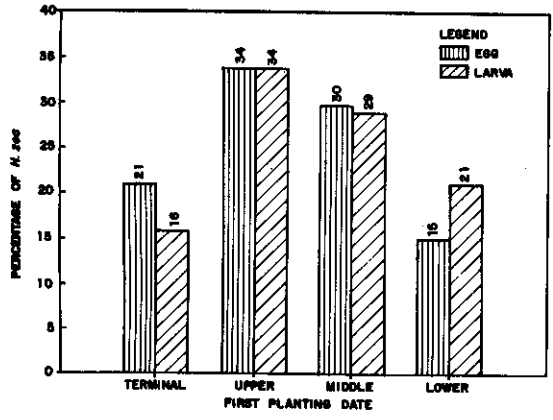

FIG. 1. Percentages of *H. zea* eggs and larvae on main stem terminals, upper, middle, and lower parts of cotton in field cages during first, second, and third planting dates.

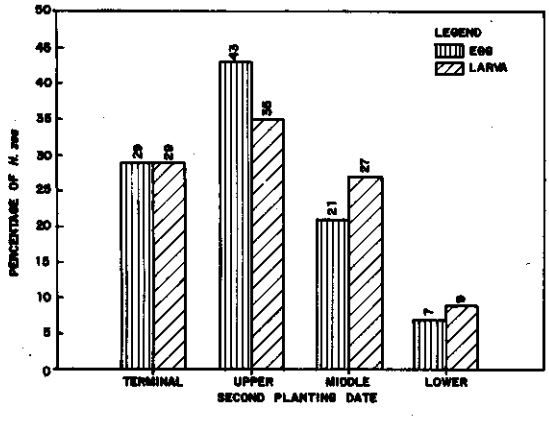

FIG. 2. Percentages of *H. zea* eggs and larvae on main stem terminals, upper, middle, and lower parts of cotton in field cages during first, second, and third planting dates.

first planting date. Of these, 16% were found on the terminal, 34% on the upper, 30% on the middle, and 15% on the lower part of the plant. The second planting date had a total of 299 larvae in all five cages. The proportions of larvae on each plant division were 29% on terminal, 35% on the upper, 27% on the middle, and 9% on the lower of the plant. The proportions for the third planting date were 30, 40, 24, and 6% on terminal, upper, middle, and lower of the plant, respectively. Regressions of total numbers of eggs on the plant and total eggs on the main stem terminal yielded positive and significant relationships (slope > 0; $p < 0.001$) in planting dates 1, 2, and 3.

Higher correlations were obtained among total eggs on leaves with total numbers of eggs on the whole plant in all planting dates. Correlations among total numbers of larvae on the whole plant with larva on terminal were lower than with the total larva on squares. Correlations among total incidence of larvae

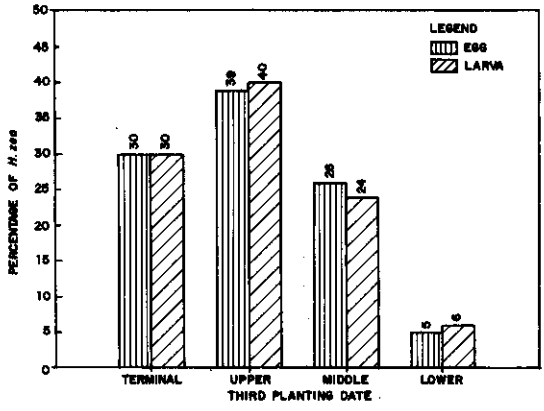

FIG. 3. Percentages of *H. zea* eggs and larvae on main stem terminals, upper, middle, and lower parts of cotton in field cages during first, second, and third planting dates.

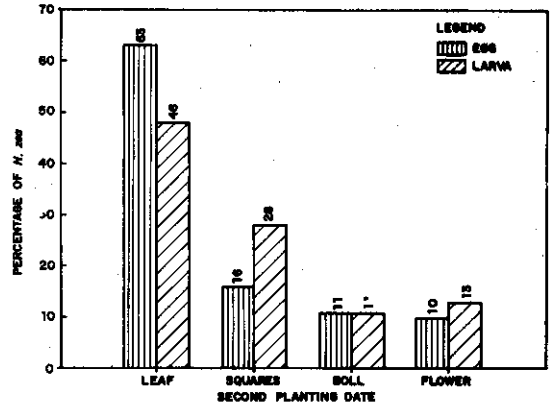

FIG. 5. Percentages of *H. zea* eggs and larvae on leaves, bolls, and flowers of cotton in field cages during first, second, and third planting dates.

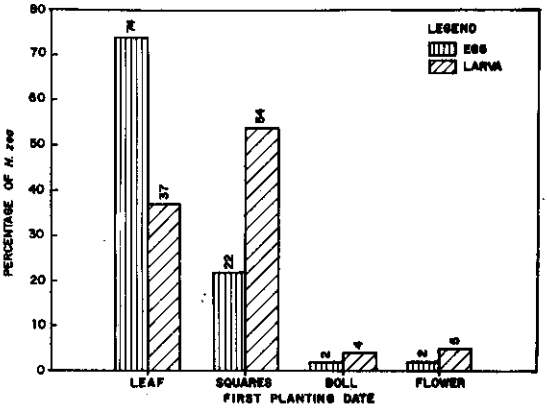

FIG. 4. Percentages of *H. zea* eggs and larvae on leaves, bolls, and flowers of cotton in field cages during first, second, and third planting dates.

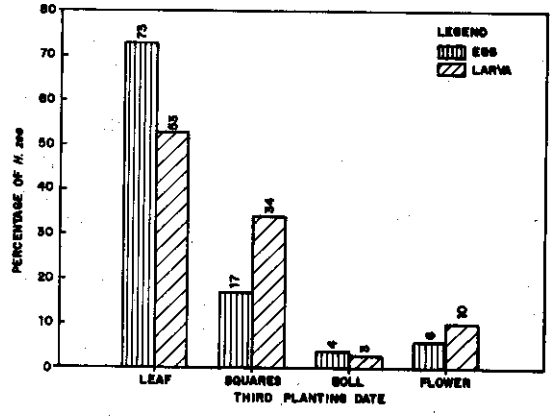

FIG. 6. Percentages of *H. zea* eggs and larvae on leaves, bolls, and flowers of cotton in field cages during first, second, and third planting dates.

on leaves with total larvae on the whole plant were positive and significant ($r > 0.70$; $p < 0.001$). Since larval conts were made in the morning, three days after egg deposition, most of the neonate larvae had not moved yet to suitable sites. These results agree with previous studies which reported that newly hatched larvae did not immediatly move from leaves to another place searching for food, but they stayed there for one or two days, rasping the epidermis of the leaf. When the larval population for each planting date was examined over all cages, correlations of total eggs and total larvae within the whole plant, plant divisions, and plant parts were low ($0.01 < r < 0.70$), which may result from the low percentages of fertile eggs. This fact was observed in laboratory experiments when the same kind of moths was used. General trends of the total eggs and larvae on the plant in each planting date is show in Fig. 7. In all planting dates, more eggs were laid during the second infestation (peak of blooming) than during the first infestation. These results agree with previous investigations which reported that larger canopy and blooming period were highly attractive to oviposition by bollworm moths.

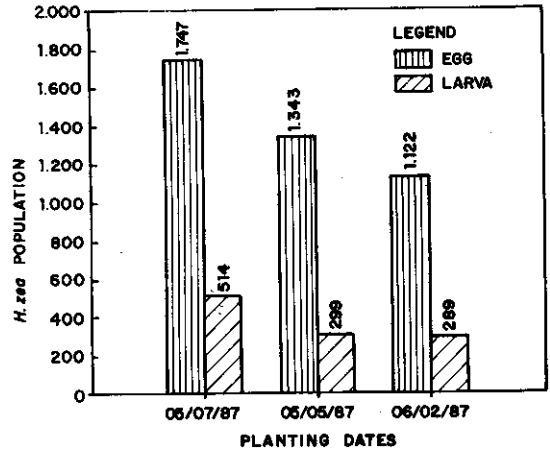

FIG. 7. Total bollworm eggs and larvae on cotton during three planting dates.

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