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Vertical distribution, population density, and natural egg parasitism of cotton leafworm on cotton under IPM

Distribución vertical, densidad poblacional y parasitismo natural de los huevos del curuquere del algodón bajo MIP

Distribuição vertical, densidade populacional e parasitismo natural de ovos de curuquerê-do-algodoeiro sob condições de MIP

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Abstract. *Alabama argillacea* is one of the most important pests of cotton crops in Brazil, and therefore it is necessary to research its behavior and natural biological control in areas under IPM conditions to improve the management of its population. In the pursuit of this objective, experiments were carried out on cotton crops in Dourados, Mato Grosso do Sul, in the 1997-1998 growing season. With the object of determining the population density and vertical distribution of eggs, larvae, and pupae, the total number of eggs, small, medium and large sized larvae and pupae found on the upper, middle, and lower sections of the plants were weekly recorded. This was conducted in an area where pest management was done according to IPM techniques and tactics. In the same area, eggs of this species were also gathered to determine the proportion of parasitism. The pest lays the majority of eggs on the upper part of the plants where the majority of mid- and large-sized larvae were also found. Small larvae were generally found on both middle and lower parts of the plants. A growing percentage of parasitism by *Trichogramma pretiosum* was found from the beginning through the end of the crop season, reaching almost 100% parasitized eggs by the end of plant development. The average number of eggs found per plant was high during almost the whole crop cycle, reaching about 30 eggs per plant by the end of the cycle. The total number of small caterpillars was high and constant during the whole evaluation period, while medium and large ones were more abundant in the final phase of the crop cycle. The total caterpillar population reached peaks of around four caterpillars per plant.

Key words. *Gossypium hirsutum*. *Alabama argillacea*. Behavior. Oviposition. *Trichogramma* spp.

Resumen. *Alabama argillacea* es uno de los parásitos más importantes en el cultivo del algodón en el Brasil, y por tanto, es necesario investigar su comportamiento y control biológico natural en áreas bajo condiciones de MIP para mejorar el manejo de sus poblaciones. En la búsqueda de este objetivo, se realizaron experimentos en cultivos del algodón en Dourados, Mato Grosso do Sul, en la época de la cosecha 1997-1998. Con el objeto de determinar la densidad poblacional y la distribución vertical de huevos, las larvas y las crisálidas de esta especie, se contaron semanalmente el número total de huevos, larvas pequeñas, medias y grandes y crisálidas encontradas en las secciones superiores, medias y más bajas de las plantas; esto se realizó en un área en donde el manejo de la plaga se hace según técnicas y tácticas del MIP. En la misma área, los huevos de esta especie también fueron recolectados para determinar la proporción de parasitismo. La plaga pone la mayoría de huevos en la parte superior de las plantas, en donde también se encontraron la mayoría de larvas medias y de gran tamaño. Las larvas pequeñas fueron encontradas generalmente en las partes medias e inferiores de las plantas. Se encontró un porcentaje creciente de parasitismo por *Trichogramma pretiosum* durante toda la estación de la cosecha, alcanzando casi 100% de huevos parasitados al final del desarrollo de las plantas. El número medio de los huevos encontrados por planta fue muy alto durante casi todo el ciclo de la cosecha, alcanzando cerca de 30 huevos por planta en el extremo final del ciclo. El número total de orugas pequeñas fue alto y constante durante toda la evaluación, mientras que las de tamaño medio y grande eran más abundantes en la fase final del ciclo de la cosecha. La población total de la oruga alcanzó picos de alrededor cuatro orugas por la planta.

Palabras clave. *Gossypium hirsutum*. *Alabama argillacea*. Comportamiento. Oviposición. *Trichogramma* spp.

Resumo. *Alabama argillacea* é importante praga do algodoeiro no Brasil, o que torna necessário pesquisar detalhes de seu comportamento e controle biológico natural em áreas conduzidas sob condições do Manejo Integrado de Pragas (MIP), visando tornar mais eficiente o manejo de sua população. Para tanto, foram conduzidos experimentos durante a safra 1997-1998, em algodoeiro na região de Dourados, Mato Grosso do Sul, buscando determinar a distribuição vertical e a densidade populacional das formas imaturas dessa espécie através de amostragens semanais em área onde o manejo das pragas foi efetuado de acordo com as técnicas e táticas preconizadas pelo MIP. Nessa área amostral foi realizada a contagem de ovos, lagartas pequenas, médias e grandes e pupas presentes nos terços superior, médio e inferior das plantas. Também foram coletados ovos dessa espécie para determinar o índice de parasitismo por parasitóides. A maior parte dos ovos foi encontrada no terço superior das plantas, assim como de lagartas médias e grandes, enquanto que as lagartas pequenas foram encontradas, principalmente, entre os terços médio e inferior das plantas. Ocorreu aumento constante do índice de parasitismo dos ovos por *Trichogramma pretiosum* ao longo do desenvolvimento das plantas, atingindo valores próximos de 100% dos ovos coletados. O número médio de ovos encontrado por planta foi alto durante, praticamente, todo o ciclo da cultura, atingindo quase 30 ovos por planta próximo do final do ciclo. O número de lagartas pequenas encontradas foi alto e constante durante todo o período de avaliação, enquanto que lagartas médias e grandes foram mais abundantes no final do ciclo da cultura. A população total de lagartas alcançou picos próximos de quatro lagartas por planta.

Palavras-chave. *Gossypium hirsutum*. *Alabama argillacea*. Comportamento. Oviposição. *Trichogramma* spp.

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Introduction

The state of Mato Grosso do Sul consolidated, in a few years, as one of the great Brazil's cotton producers, reaching 44,675 ha in the 2002/2003 crop season, with average productivity of 3,449 kg/ha (IBGE 2003). A quick expansion of the planted area in the last decade has been verified for the country (Freire *et al.* 1999). Optimum productivity averages and fiber quality are achieved at each year in the whole Midwest Brazilian Region that, nowadays, is responsible for more than 70% of the national cotton production.

In Brazil, mainly in the state of Mato Grosso do Sul, the cultivation of cotton plays important social and economical role in the rural areas, being practiced by small, medium, and large producers (Ferraz and Lamas 1996). The large scale applications of chemical products in agroecosystems, aggravated the previously existing problems in the productive process, such as pests resistance to several pesticides, outbreaks of pests considered secondary before, the return of pests, and the toxic effects of chemical products harmful to man. All these factors concurred to the appearance of the Integrated Pest Management (IPM), on the contrary to the way in which the pests control was previously conducted.

The cotton agroecosystem includes a wide diversity of arthropods that can vary from a few hundred to more than a thousand species (Hearn and Fitt 1992), being the majority of these predators and phytophagous species (Luttrell *et al*. 1994). It is estimated that the number of cotton pest species would be between 20 and 60, but significant harms in the cotton crop are caused by five to 10 key-pests in the majority of the production systems (Hearn and Fitt 1992).

Alabama argillacea (Hübner, 1818) (Lepidoptera, Noctuidae) occurs in practically all the country's cotton producing regions. Ramalho (1994) estimated that this pest can reduce up to 67% the crop yield. According to the same author, the critical period for the occurrence of this species is from 0 to 20 days after the seedlings emergence, and the control level must be of 53% of plants with an infested leaf by larvae. The control techniques of this pest must be part of a large IPM program, aiming at the production costs reduction and avoiding the negative impact of pesticides to the environment.

To implant an appropriate management of the cotton leaf worm it is necessary to build a sampling plan that allows to estimate, in a fast and accurate way, the population density of this pest in the crop (Fernandes *et al*. 2003). The knowledge of the *A. argillacea* foraging and oviposition behaviors is needed in order to develop an adequate sampling and control plan for this pest. The national scientific literature related to this subject is still reduced and refers to few cultivars. The study of the vertical distribution of eggs and worms of this species, aiming at the determination of its location in the plant, is crucial to minimize the time consumed during the sampling process and augment the reliability of the IPM. In this sense, Fye (1972), Bleicher *et al*. (1983) and Farrar and Bradley (1985) admit that the knowledge of the eggs and caterpillar distribution in the parts of the plant is of utmost importance to monitor the pest in the crop. For this reason, it is necessary to consider Degrande's (1998) affirmation that the whole cotton-IPM program must be based on reliable samplings, which imposes the need of periodic monitoring and the development of technology able to speed this process.

A reduced number of works that deal with the vertical distribution of caterpillars of *A. argillacea* can be found in the Brazilian scientific literature, and the few existent, generally, do not classify the larvae by size. As an example, Marchini (1976) and Mariconi (1976) indicated that the caterpillars attack the uppermost third of the plant, mainly the new leaves. In an experiment conducted in Pernambuco with the 'Reba B-50' cultivar, Bleicher *et al*. (1983) also described that caterpillars of this Noctuidae prefer the superior part of the plant, although they did not classify the larvae by size or instar.

In this way, the present research had as objective to evaluate the vertical distribution, also called intraplant distribution, as well as the population density of eggs, caterpillars, and pupae of *A. argillacea* in cotton crop where the pests control was conducted according to the techniques and tactics of IPM. It was also searched the determination of the *A. argillacea*'s eggs parasitism by *Trichogramma* spp., due to the great importance of this biological control agent on the population density of this pest in this region; looking forward, in this way, to furnish basic information for the posterior development of fast and efficient sampling plans of this Noctuidae in large cotton growth areas in Brazil.

Materials and Methods

The study was conducted during the crop season 1997-1998 in the county of Dourados, Mato Grosso do Sul, in an area cultivated with cotton *Gossypium hirsutum* L., CNPA-ITA-90 cultivar, managed under cotton-IPM conditions (Degrande 1998), and routinely practiced by this region growers. To determine the vertical distribution of eggs, larvae, and pupae of *A. argillacea*, weekly evaluations were made from the seedlings emergency until 129 days after plant emergency (DAE). The evaluations consisted of counting eggs, caterpillars, and pupae found in the superior, medium, and inferior thirds of 50 plants taken at random throughout the sampling area. The caterpillars were classified into small (up to 15 mm), medium (between 15 and 25 mm), and large (above 25 mm) length sizes.

To determinate percentage of egg parasitism, 50 eggs were collected throughout the sampling area and weekly evaluated. The leaves containing eggs were sent to laboratory, conditioned in glass tube sealed with PVC film (Rolopac), and maintained in room conditions. With a stereo-microscope (40X) the eggs were observed, being recorded the number of hatched caterpillars and emerged parasitoids. The adults of *Trichogramma* spp., the only parasitoids obtained, were placed in glass tubes containing alcohol 70%. Male parasitoids were mounted in microscope slides and sent to Dr. R. A. Zucchi (ESALQ/USP), who identified these as *Trichogramma pretiosum* Riley, 1879.

The control actions were made whenever moth population reached two caterpillars per plant; since it was of interest to know the vertical distribution of this species in the area. Six insecticide applications during the crop cycle were necessary to control this pest. The first application occurred at 44 DAE with endosulfan (2.0 L p.c. /ha), and the others at 56 DAE with endosulfan (2.0 L p.c. /ha) + diflubenzuron (60 g. p.c. /ha), 79 DAE with deltamethrin (0.25 L p.c. /ha) + triazophos (0.5 L p.c. /ha), and at 86, 96, and 109 DAE with deltamethrin (0.45 L p.c. /ha). The data were analyzed with descriptive statistic.

Results and Discussion

The largest number of eggs was found in the superior third of the plants, followed by the medium and inferior thirds, this trend was observed during the whole crop cycle (Fig. 1). The

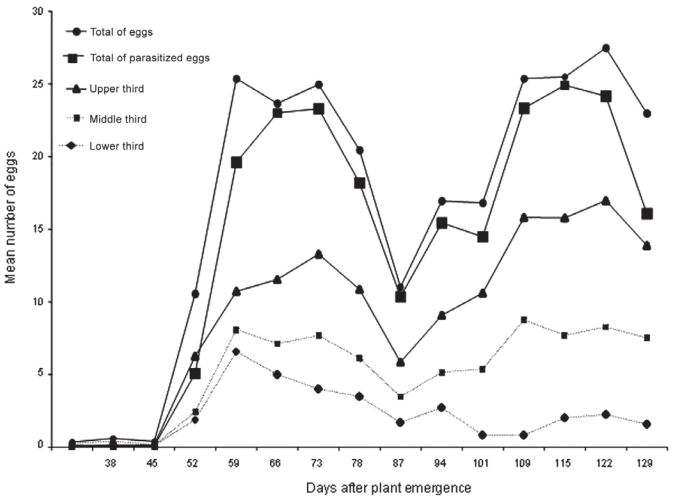

Figure 1. Mean number of *A. argillacea* eggs and parasitized eggs in different parts of cotton plant, cv. CNPA-ITA-90.

number of eggs in the superior third presented around 40% of the total found in the plant during all the infestation period, reaching values higher than 65% of the total in some of the samplings. The variation of the egg number between the thirds of the plants was similar throughout the crop cycle. The egg percentage found in the lower third was between 5 and 30%. The oviposition behavior in the superior third of the plant, possibly occur because the presence of new leaves which favors the young larvae. Due to that behavior, Bleicher *et al*. (1983) affirmed that the highest leaf of the cotton plant can be used as a sampling unit for *A. argillacea* eggs.

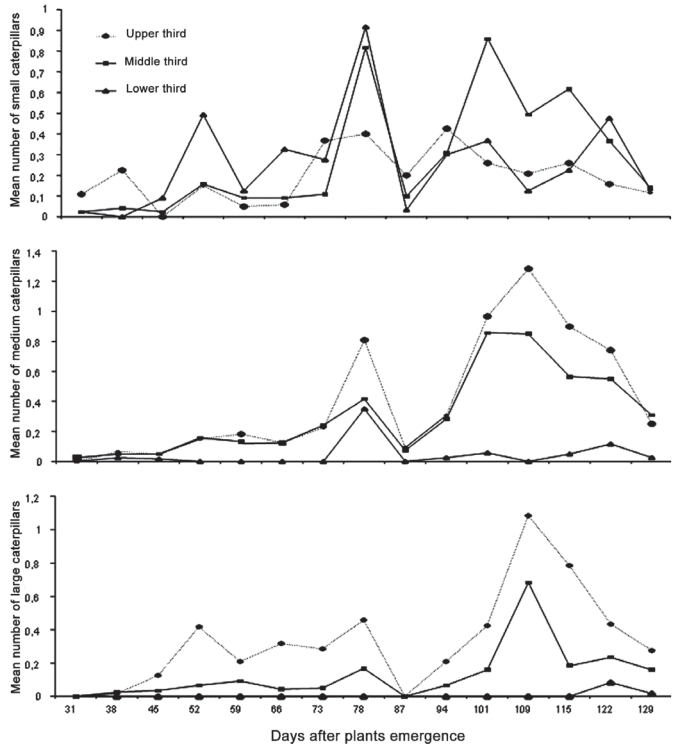

Figure 2. Mean number of large, medium, and small *A. argillacea* caterpillars in different parts of cotton plants.

In spite of the great number of eggs found, the majority of them were parasitized by *T. pretiosum* during most of the occurrence of the Noctuidae. During the beginning of the pest oviposition period, there were no parasitism records and then this number increased gradually with the increase of the population and oviposition of *A. argillacea*; two weeks after the initiation of oviposition the parasitism reached 100% (Fig. 1). This population behavior supports the suggestion of Parra *et al*. (1992), that the utilization of these parasitoids in applied biological control programs should be done via mass releases in the beginning of the pest appearance.

The *A. argillacea* egg numbers, with parasitoids and without parasitoids, have shown that the parasitoid population grows quickly. A similar result was found by Hohmann and Santos (1989), which verified high *A. argillacea* eggs parasitism levels (up to 99%) by *T. pretiosum* in cotton areas in the state of Paraná during the 1986-1987 crop season. These data point out the great potential of *T. pretiosum* as a natural biological agent of this pest.

The small sized caterpillars were located mostly in medium and inferior thirds (Fig. 2). The average number of small larvae by plant section varied from 0.45/plant (superior third), to 0.86/plant (medium third) and to 0.92/plant (inferior third). These results differ with those of the eggs distribution. The medium sized caterpillars found in the upper part of the plants varied from 0 to 13/plant during the study, while in the medium part it varied from 0 to 0.85, and in the lower part never surpassed 0.4/plant, which represents 24% of the total of medium caterpillars present per plant (Fig. 2). The preference of the *A. argillacea* large sized caterpillar for the upper part of the cotton plant was more obvious than that of the medium sized ones. Practically no caterpillars were found in the inferior third of the plant, (Fig. 2). In the superior third of the plant the greatest pupae number was found (Fig. 3).

Since the larger number of eggs was deposited in the uppermost part of the plant, the presence of the greatest portion of small larvae in the medium and inferior thirds suggest that, after hatching, the caterpillars migrate to the lower parts of the plant, where they find better quality food, besides greater protection against climate adversities and natural enemies. As

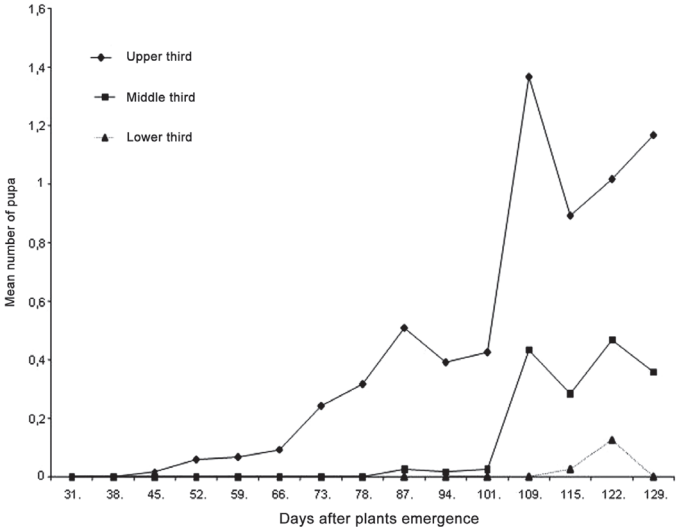

Figure 3. Mean number of *A. argillacea* pupae in different parts of cotton plants.

they develop, the caterpillars return to the superior parts of the plant, where they pupate. It is possible though, that greater predation, egg parasitism, and pesticide exposition occurs in the superior region of the plant; thus, greater egg and caterpillar survival may occur in the lowest part of the plants due to the difficult insecticide translocation. This phenomena can be more evident with a higher plant density (90,000 to 110,000 plants per ha), in relation to the traditional cultivars (i. e.: IAC-22 which does not surpasses 70,000 plants per ha), because the large number of plants per area offers more difficulties to apply pesticides since these can not reach the lower part of the plants, specially in areas whose plants do not present growth conditioned by the application of chemical growth regulator products.

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