Original Article

EFFECT OF COTTON LEAFWORM INFESTATION ON REPRODUCTIVE STRUCTURES OF COTTON PLANTS

EFEITO DA INFESTAÇÕES DO CURUQUERÊ-DO-ALGODOEIRO NAS ESTRUTURAS REPRODUTIVAS DE PLANTAS DE ALGODÃO

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ABSTRACT: The cotton leafworm, *Alabama argillacea* (Hübner, 1818) (Lepidoptera: Noctuidae) is a major defoliating pest that reduces yield and quality of the crop. The purpose of this study was to evaluate the effect of different levels of defoliation caused by different larval densities of *A. argillacea* on four cotton cultivars in three different plant ages. The experiment was conducted at an experimental station of the Agência Paulista de Tecnologia dos Agronegócios (APTA), Polo Centro Norte, in Pindorama, SP, Brazil. The experiment was arranged in a factorial randomized block design with 4 replicates: four cultivars (DeltaOPAL, IAC-25, Fibermax 996 and Fibermax 993) x four larval densities (0, 2, 4, and 6 larvae per plant) x three infestation times (30, 60 and 90 days after plant emergence). Fortnightly evaluations carried out based on the production of squares, flowers, fruits and bolls per plant. It was found that the higher infestation level of *A. argillacea*, the lower was the production of buds per plant and consequently the production of fruits and bolls of the four varieties. Early infestation (30 and 60 DAE) reduced the production of reproductive structures per plant in cultivars more than late infestation (90 DAE).

KEYWORDS: *Alabama agillacea*. *Gossypium hirsutum*. Biotic stress.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.), originally a tropical plant, is a high valuated agricultural commodity for more than 8,000 years, and has long been recognized as a vital component of the global economy (ARPAT et al., 2004). It is also cultivated economically in subtropical regions and is used for fiber production in over 100 countries (HEDGE et al., 2011).

The production and yield of cotton are directly related to the efficiency of pest and disease control. The investments earmarked for pest and disease control can reach 30% of the total production cost of cotton (Agrianual 2004). Consequently, it is important to know the productivity of cultivars when exposed to stressful effects caused by pests, mainly of defoliating species such as the cotton leafworm, *Alabama argillacea* (HÜBNER, 1818) (Lepidoptera: Noctuidae), which has recently infested the crop in early stages.

The cotton leafworm is the main defoliating pest of cotton and the second most damaging pest of the crop in Brazil, after the boll weevil (PEREIRA et al., 2006, SILVA et al., 2011). The larvae feed on leaves and, depending on the development stage and population density, as well as on the time of occurrence, can defoliate the cotton plants completely, significantly reducing the yield (GRAVENA; CUNHA., 1991, JÁCOME et al., 2001, QUIRINO; SOARES ,2001).

In Brazil, chemical control of the cotton leafworm is very intensive, causing different side effects, such as pest resistance (MARTINELLI; OMOTO., 2006). However, since 2005, a transgenic *Bt* cotton cultivar, expressing the Cry1Ac insecticidal δ-endotoxin of *Bacillus thuringiensis* Berliner, has been commercialized in Brazil demonstrating remarkable control of some lepidopteran pests (ALMEIDA et al., 2008).

In view of the scarce information on the impact of the cotton leafworm on the crop yield in the early stage of plant development, the aim of this study was to evaluate the effect of different larval densities of *A. argillacea* in three different plant ages of four conventional (non-*Bt*) cotton cultivars.

MATERIAL AND METHODS

The experiment was carried out on an experimental field and in the Entomology laboratory of the Polo Regional do Centro Norte, of the Agência Paulista de Tecnologia dos Agronegócios

Received: 30/04/14
Accepted: 20/01/15

(APTA), in Pindorama, SP, Brazil (21 º 11' 9" s and 48 º 54' 25" w). The experiment was arranged in a factorial randomized block design with 48 treatments (4 cultivars x 4 larval densities/plant x 3 times), with four replications.

Crop treatments

The soil was tilled and limed as recommended for the crop. The cotton cultivars DeltaOPAL, IAC-25, Fibermax 966 and Fibermax 993 were sown mechanically, for a final germination of 12 plants per meter. Each plot consisted of three 4-m long rows spaced 0.8 m apart.

Larvae of *A. argillacea* were raised according to the method proposed by Santos & Boiça Júnior (2001). The plants were infested with 0, 2, 4 and 6 larvae (length 15 mm, mass 60 ± 10 mg) 30, 60 and 90 days after emergence (DAE), in five plants per replication per cultivar. After infestation, the plants were protected by rectangular cages consisting of metal frames (0.8 x 1.2 x 1.0 m) (Width x Length x Height). In this way, no insecticide was needed to control pests, not even to the boll weevil, which directly attacks squares and bolls.

To prevent excessive growth of cotton plants and facilitate cultivation practices, a plant growth regulator (mepiquat chloride) was sprayed twice (50 and 70 DAE, respectively, at 200 ml of a.i. ha^{-1}) to obtain a final plant height of 1.20 to 1.30 m, as currently suggested for mechanical harvesting (BUSOLI et al., 2012).

Data analysis

After flowering, the number of flower buds, number of flowers, number of fruits, and number of bolls per plant were assessed every two weeks. The data were subjected to analysis of variance (ANOVA) and the treatment means compared by the Tukey test at 5% probability.

RESULTS AND DISCUSSION

Among the tested cultivars, IAC-25 showed highest number of flower buds per plant 45, 60, and 70 DAE, while Fibermax 993 registered the highest value 92 DAE (Table 1). On the other hand, DeltaOPAL presented the lowest number of flower buds per plant in the same period (Table 1).

With regard to the effect of larval infestation on the number of flower buds, it was found that 45, 60 and 70 DAE, the number of buds was inversely proportional to the number of larvae per plant; the non-infested plants had six flower buds per plant, while plants infested with six *A. argillacea* larvae had up to three buds per plant (Table 1).

The results related to the infestation time of *A. argillacea* indicate that the critical infestation period begin 80 DAE. Infestation until 70 DAE did not influence the number of flower buds, and was therefore not detrimental to the development of cotton plants (Table 1). Plants grown in warm climate, as in the tropics, produce more leaves than necessary (BEEVERS; COOPER, 1965). This could indicate that early infestation with *A. argillacea* may be less harmful to plant growth. The same performance was observed by Ezedinma (1973) in cowpea, where limited defoliation of 33 and 50% in the pre-flowering stage did not significantly reduce the cowpea grain yield. However, the results obtained indicate that severe defoliation (4 and 6 larvae per plant) may significantly reduce the production of flower buds and consequently the cotton yield. Moreover, cotton plants produce more reproductive structures than they are able to sustain (EHLIG; LEMERT, 1973, MCMICHEL et al., 1973, SMITH; FALCON, 1973, GUINN 1974, SANTOS et al., 1980, SANTOS, 1987).

The numbers of flowers per plant were similar among cultivars from 45 to 80 142 DAE (Table 2). Significant differences were observed among cultivars for the same 143 parameter 92 DAE and 105 DAE.

In the analysis of the effect of the infestation level (number of larvae) on flower production per plant, no significant differences were found across infestation dates except for 60 and 105 DAE (Table 2).

The time of infestation influenced the number of flowers (Table 2). Larval infestation 90 DAE induced no effect in treatments since the time of defoliation was not long enough to affect the flower development (Table 2). This observation can be taken into account 105 DAE, where plants infested 90 DAE had the same number of flowers as those infested 60 DAE reinforcing the harmful effect of late infestation with cotton leafworm for plants (Table 2). This shows that infestation with *A. argillacea* 60 DAE or later was more harmful to plants for reducing the number of flowers per plant (Table 2). Although plants grown in warmer regions produce more leaves (BEEVERS; COOPER, 1965), the results indicated that after 60 DAE, the attack of *A. argillacea* becomes detrimental to flower production.

Table 1. Mean (±SE) number of buds per plant in cotton cultivars infested with different densities of *Alabama argillacea* larvae at different times after plant emergence.

Cultivars (C)	Days after emergence (DAE)					
	45	60	70	80	92	105
IAC-25	1.9 ±0.29 a	5.4 ±0.58 a	3.0 ±0.69 a	1.7 ±0.02 a	0.3 ±0.10 b	0.2 ±0.05 b
DeltaOPAL	0.9 ±0.33 b	3.1 ±0.63 b	2.1 ±0.24 b	1.1 ±0.22 a	0.6 ±0.32 ab	0.2 ±0.12 ab
Fibermax 966	1.6 ±0.28 ab	5.1 ±0.52 a	2.3 ±0.68 ab	1.5 ±0.08 a	0.5 ±0.27 b	0.2 ±0.08 b
Fibermax 993	1.2 ±0.30 ab	3.6 ±0.54 ab	2.7 ±0.96 ab	1.8 ±0.41 a	0.9 ±0.31 a	0.4 ±0.09 a
F-test	4.61**	4.68**	4.09**	2.21^{ns}	4.29*	3.99**
Larvae (L)						
0	2.0 ±0.34 a	6.0 ±0.31 a	3.1 ±2.27 a	1.8 ±1.22 a	0.5 ±0.78 a	0.3 ±0.64 a
2	1.6 ±0.22 ab	4.9 ±0.37 ab	2.7 ±1.97 ab	1.6 ±1.33 a	0.4 ±0.84 a	0.2 ±0,32 a
4	1.0 ±0.28 b	3.3 ±0.66 bc	2.2 ±1.68 b	1.4 ±0.92 a	0.7 ±1.12 a	0.3 ±0.49 a
6	1.0 ±0.31 b	3.0 ±0.66 c	2.2 ±1.61 b	1.5 ±1.32 a	0.7 ±1.24 a	0.2 ±0.57 a
F-test	6.37**	9.04**	3.47*	0.59^{ns}	1.10^{ns}	0.88^{ns}
Plant age (A)						
30 DAE	1.4 ±0.43	4.3 ±0.19	3.8 ±0.81 a	1.6 ±0.52 a	1.3 ±0.45 a	0.5 ±0.09 a
60 DAE	-[1]	-	1.3 ±0.36 b	1.5 ±0.33 a	0.4 ±0.19 b	0.1 ±0.12 b
90 DAE	-	-	-	-	0.0 ± 0.00 c	0.1 ±0.13 b
F-test	-	-	127.11**	0.63^{ns}	54.60**	28.16**
C x L	0.25^{ns}	1.06^{ns}	0.36^{ns}	0.42^{ns}	0.79^{ns}	0.89^{ns}
C x A	-	-	0.19^{ns}	1.33^{ns}	1.84^{ns}	1.36^{ns}
L x A	-	-	1.31^{ns}	0.29^{ns}	1.57^{ns}	1.41^{ns}
CV (%)	21.77	23.35	21.96	30.66	30.94	22.03

Means followed by the same letter in the column do not differ significantly by the Tukey's test at 5% probability; * Significant at 5% probability; ** Significant at 1% probability; ^{ns} non significant; [1]Not analyzed due to absence of defoliation on the assessment date.

Table 2. Mean (±SE) number of flowers per plant in cotton cultivars infested with different densities of *Alabama argillacea* larvae at different times after plant emergence.

Cultivars (C)	DAE					
	45	60	70	80	92	105
IAC-25	0.3 ±0.20 a	0.6 ±0.20 a	0.4 ±0.30 a	0.5 ±0.29 a	0.10 ±0.39 b	0.03 ±0.02 b
DeltaOPAL	0.4 ±0.12 a	0.5 ±0.23 a	0.3 ±0.40 a	0.3 ±0.34 a	0.20 ±0.21 ab	0.16 ±0.04 a
Fibermax 966	0.4 ±0.15 a	0.6 ±0.27 a	0.4 ±0.29 a	0.4 ±0.46 a	0.13 ±0.44 ab	0.05 ±0.06 b
Fibermax 993	0.3 ±0.14 a	0.6 ±0.19 a	0.4 ±0.27 a	0.6 ±0.42 a	0.28 ±0.21 a	0.11 ±0.01 ab
F-test	1.03^{ns}	0.29^{ns}	1.04^{ns}	2.14^{ns}	3.63*	4.68**
Larvae (L)						
0	0.4 ±0.14 a	0.8 ±0.11 a	0.4 ±0.30 a	0.5 ±0.27 a	0.14 ±0.24 a	0.04 ±0.01 b
2	0.4 ±0.15 a	0.6 ±0.12 ab	0.3 ±0.26 a	0.4 ±0.33 a	0.11 ±0.20 a	0.08 ±0.04 ab
4	0.4 ±0.20 a	0.6 ±0.12 ab	0.4 ±0.34 a	0.5 ±0.42 a	0.25 ±0.46 a	0.15 ±0.03 a
6	0.3 ±0.13 a	0.3 ±0.14 b	0.4 ±0.38 a	0.4 ±0.49 a	0.20 ±0.37 a	0.08 ±0.05 ab
F-test	0.87^{ns}	3.73*	0.30^{ns}	1.09^{ns}	1.75^{ns}	2.86*
Plant Age (A)						
30 DAE	0.4 ±0.15	0.6 ±0.17	0.3 ±0.36 a	0.4 ±0.32 a	0.35 ±0.43 a	0.18 ±0.06 a
60 DAE	-[1]	-	0.4 ±0.28 a	0.4 ±0.45 a	0.18 ±0.31 b	0.05 ±0.04 b
90 DAE	-	-	-	-	0.02 ±0.29 c	0.03 ±0.05 b
F-test			0.71^{ns}	3.17^{ns}	27.93**	13.27**
C x L	0.81^{ns}	0.77^{ns}	0.98^{ns}	0.66^{ns}	1.33^{ns}	2.15^{ns}
C x A	-	-	1.60^{ns}	0.51^{ns}	2.05^{ns}	1.80^{ns}
L x A	-	-	2.19^{ns}	1.00^{ns}	0.93^{ns}	0.90^{ns}
CV (%)	17.44	17.09	16.98	20.08	17.80	13.33

Means followed by the same letter in the column do not differ significantly by the Tukey's test at 5% probability; * Significant at 5% probability; ** Significant at 1% probability; ^{ns} non significant; [1]Not analyzed due to absence of defoliation on the assessment date.

The number of fruits per plant increased until 105 DAE (Table 3). There was no significant difference among cultivars, 45 and 60 DAE. From 70 to 105 DAE, the cultivars with the highest number of fruits per plant were Fibermax 993 and IAC 25 and the one with the lowest number was DeltaOPAL (Table 3).

Plant infested with larvae of cotton leaf worm shower a significant reduction in the number of fruits compared with control plants, only between 70 and 80 DAE (Table 3). No significant differences between infested and control plants were observed since 92 DAE. No significant differences were also found among the studied densities of larvae per plant.

For the interactions of the number of fruits, significant differences between the number of larval density and time of infestation were observed 92 and 105 DAE (Table 3). In the evaluation 92 DAE, for plants infested 30 DAE, it was observed that the greater the number of larvae infested per plant, the lower the number of fruits produced, whereas plants infested 60 and 90 DAE did not differ significantly (Table 4). The same result was observed in the evaluation 105 DAE.

Table 3. Mean (±SE) number of fruits per plant in cotton cultivars infested with different densities of *Alabama argillacea* larvae at different times after plant emergence.

Cultivars (C)	DAE					
	45	60	70	80	92	105
IAC-25	0.4 ±0.12 a	1.6 ±0.28 a	4.5 ±1.71 a	6.7 ±1.37 a	7.7 ±1.94 ab	8.2 ±2.06 ab
DeltaOPAL	0.3 ±0.13 a	1.0 ±0.35 a	2.4 ±2.62 b	4.8 ±1.36 b	5.8 ±1.28 c	6.8 ±2.39 c
Fibermax 966	0.3 ±0.28 a	1.1 ±0.28 a	3.3 ±2.18 ab	5.6 ±1.57 ab	6.5 ±1.47 bc	6.9 ±2.24 bc
Fibermax 993	0.4 ±0.15 a	1.4 ±0.39 a	4.1 ±2.06 a	7.2 ±1.05 a	8.1 ±2.03 a	8.4 ±2.67 a
F-test	1.79^{ns}	1.31^{ns}	6.43**	5.17**	7.83**	6.14**
Larvae (L)						
0	0.4 ±0.11 a	1.4 ±0.25 a	4.8 ±2.54 a	7.7 ±1.99 a	7.8 ±3.17 a	8.1 ±2.49 a
2	0.5 ±0.23 a	1.4 ±0.27 a	3.4 ±1.73 b	6.1 ±1.73 ab	6.8 ±2.90 a	7.3 ±2.89 a
4	0.3 ±0.13 a	1.1 ±0.39 a	2.7 ±1.61 b	5.1 ±1.55 b	6.8 ±3.16 a	7.5 ±2.54 a
6	0.3 ±0.12 a	1.1 ±0.37 a	3.3 ±1.65 b	5.4 ±1.05 b	6.8 ±2.95 a	7.3 ±2.83 a
F-test	1.82^{ns}	0.84^{ns}	5.74**	6.10**	1.62^{ns}	1.23^{ns}
Plant Age (A)						
30 DAE	0.4 ±0.17	1.3 ±0.34	3.6 ±2.04 a	6.0 ±2.26 a	7.7 ±3.61 a	7.7 ±3.11 a
60 DAE	-[1]	-	3.6 ±2.57 a	6.2 ±1.74 a	7.6 ±2.68 a	7.2 ±2.72 a
90 DAE	-	-	-	-	5.8 ±2.43 b	7.8 ±2.20 a
F-test			0.00^{ns}	1.04^{ns}	9.79**	1.06^{ns}
C x L	0.49^{ns}	0.66^{ns}	0.39^{ns}	0.49^{ns}	1.14^{ns}	0.91^{ns}
C x A	-	-	1.72^{ns}	0.33^{ns}	0.67^{ns}	0.47^{ns}
L x A	-	-	0.88^{ns}	2.32^{ns}	2.22*	2.29*
CV (%)	15.84	27.45	27.63	22.49	19.42	16.82

Means followed by the same letter in the column do not differ significantly by the Tukey's test at 5% probability; * Significant at 5% probability; ** Significant at 1% probability; ^{ns} non significant; [1]Not analyzed due to absence of defoliation on the assessment date.

The evaluation 92 DAE showed that plants infested 30 and 60 DAE with 0 and 2 larvae/plant produced a greater number of fruits (Table 4). It was observed that 105 DAE, there was a greater number of fruits produced by cultivars infested with 6 larvae/plant 90 DAE. This can be explained by the shorter exposure period of plants to larvae.

Another aspect to be taken into account is the fact that 30 DAE the plants were less developed, indicating a lower compensation capacity of defoliation than plants 60 and 90 DAE. Additionally, initial infestation with *A. argillacea* can affect the cotton development because the leaves of the main stem are destroyed, which are the first developed by plants and account for over 80% of the cotton yield (SOARES et al., 1999).

In the evaluation of the number of bolls 105 DAE, there was no significant difference between the separately evaluated cultivars (Table 5). The same was observed for the number of larvae infested per plant. However, for the time of infestations, the highest number of bolls was observed for the infestation 90 DAE and the lowest for the infestation 30 DAE (Table 5).

Table 4. Mean (±SE) values of the unfolding analysis of the significant interactions for the average number of fruits per plant in cotton cultivars infested with different densities of *Alabama argillacea* larvae at different times after plant emergence.

Larvae (L)	Mean number of fruits per plant at 92 Days after emergence (DAE)			*F-Test*
	30 DAE	60 DAE	90 DAE	
0	9.6 ±3.56 A a	8.4 ±2.52 A a	6.4 ±1.30 A b	9.49**
2	8.1 ±3.25 AB a	6.8 ±2.36 A ab	5.4 ±1.63 A b	3.79*
4	7.1 ±3.01 AB a	7.3 ±1.99 A a	5.9 ±1.44 A a	1.13^{ns}
6	6.1 ±2.40 B a	7.8 ±1.89 A a	6.4 ±1.50 A a	2.04^{ns}
F-test	4.73**	0.89^{ns}	0.43^{ns}	
	Mean number of fruits per plant at 105 Days after emergence (DAE)			
	30 DAE	60 DAE	90 DAE	
0	9.2 ±0.25 A a	7.9 ±0.31 Aa	7.4 ±0.16 Aa	1.58^{ns}
2	8.2 ±0.16 AB a	6.5 ±0.47 Aa	7.4 ±0.24 Aa	1.82^{ns}
4	7.1 ±0.11 AB a	7.2 ±0.25 Aa	8.1 ±0.25 Aa	0.80^{ns}
6	6.2 ±0.25 B b	7.4 ±0.46 Aab	8.5 ±0.36 Aa	3.74*
F-test	4.25*	1.00^{ns}	0.57^{ns}	

Means followed by the same lowercase letter in the row and capital letter in the column do not differ significantly by the Tukey's test at 5% probability; * Significant at 5% probability; ** Significant at 1% probability; ^{ns} non significant.

Table 5. Mean (±SE) number of bolls per plant in cotton cultivars infested with different densities of *Alabama argillacea* larvae at different times after plant emergence.

Cultivars (C)	Days after emergence (DAE)	
	105	150
IAC-25	0.2 ±0.27 a	8.3 ±1.21 a
DeltaOPAL	0.2 ±0.29 a	6.8 ±0.57 b
Fibermax 966	0.2 ±0.26 a	6.9 ±1.28 b
Fibermax 993	0.2 ±0.35 a	8.2 ±1.97 a
F-Test	0.90^{ns}	14.12**
Larvae (L)		
0	0.2 ±0.24 a	8.3 ±1.74 a
2	0.2 ±0.32 a	6.9 ±1.21 b
4	0.2 ±0.23 a	7.5 ±1.63 ab
6	0.3 ±0.37 a	7.6 ±1.83 ab
F-Test	1.07^{ns}	6.14**
Plant Age (A)		
30 DAE	0.1 ±0.20 b	7.8 ±2.28 a
60 DAE	0.2 ±0.37 ab	7.2 ±2.91 a
90 DAE	0.3 ±0.27 a	7.7 ±2.33 a
F-Test	3.82*	2.23^{ns}
C x L	0.58^{ns}	1.80^{ns}
C x A	1.92^{ns}	1.82^{ns}
L x A	1.51^{ns}	7.99**
CV (%)	18.07	20.37

Means followed by the same letter in the column do not differ significantly by the Tukey's test at 5% probability; * Significant at 5% probability; ** Significant at 1% probability; ^{ns} non significant; ¹Not analyzed due to absence of defoliation on the assessment date.

Although many studies have documented an increase in cotton yield after every real (or simulated) damage caused by insects, relatively few studies have investigated the mechanisms of plant compensation for each injury (MARTENS; TRUMBLE, 1987). The later defoliation probably accelerated plant maturation and thus anticipated fruit opening.

The evaluation 150 DAE, when all bolls had opened, showed that the cultivars Fibermax 993 and IAC 25 produced the highest number of bolls (8.23 and 8.34, respectively) (Table 5). With regard to the

isolated effect of the number of larvae per plant, the number of bolls of the infested plants was lower, independent of the infestation density. The time of infestation did not significantly influence the final boll yield per plant (Table 5).

In the evaluation 150 DAE, a significant interaction was observed between larval density and infestation time. The results of partitioning the interaction of these two factors indicated that higher larval densities 30 DAE reduced the number of bolls per plant considerably (Table 6). Infested plants had produced fewer bolls 60 DAE. The number of bolls was greater on plants with higher larval densities (4 and 6 per plant) 90 DAE (Table 6).

Table 6. Mean (±SE) values of the unfolding analysis of the significant interactions for the average number of bolls per plant in cotton cultivars infested with different densities of *Alabama argillacea* larvae at different times after plant emergence.

Larvae (L)	Mean number of bolls per plant at 150 Days after emergence (DAE)			*F-Test*
	30 DAE	60 DAE	90 DAE	
0	9.6 ±3.05 A a	8.1 ±2.57 A b	7.1 ±1.86 B b	10.60**
2	7.7 ±3.53 B a	6.3 ±3.21 B b	6.8 ±2.41 B ab	3.49*
4	7.6 ±2.53 B ab	6.8 ±2.98 AB b	8.2 ±2.30 AB a	3.33*
6	6.4 ±3.16 B b	6.8 ±2.56 AB b	8.6 ±2.51 A a	8.78**
F-Test	11.93**	5.20**	4.98**	

Means followed by the same lowercase letter in the row and capital letter in the column do not differ significantly by the Tukey's test at 5% probability; * Significant at 5% probability; ** Significant at 1% probability; ^{ns} non significant.

The results of the measured parameters confirmed Quirino e Soares (2001), who had reported a more severe *A. argillacea* attack after flowering. However, the parameters were not negatively affected when the pest attack occurred at the end of the plant development cycle.

Studies by Brook et al (1992) mentioned the occurrence of three or four previously described physiological mechanisms of the plant to compensate for the insect damage: compensation of loss caused by the physiological abscission of the structure; weight increase of the structure; increase in the flowering rate and increased number of bolls. Thus the results suggest that infestation in the final stage of the crop cycle can accelerate the development and/or maturation of fruiting, increasing the number of bolls per plant.

The results on this paper shows that the higher the larval densities of *A. argillacea,* the lower the bud production per plant. The presence of *A. argillacea* larvae reduced the fruit production of the tested cultivars. Late *A. argillacea* infestations did not influence the number of flowers, fruits and bolls, whereas high initial infestations reduced the production of these reproductive organs in the tested cultivars.

ACKNOWLEDGMENTS

We thank the Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP), for financial support (proc. 2006/05725-0).

RESUMO: O curuquerê do algodoeiro, *Alabama argillacea* (Hübner, 1818) (Lepidoptera: Noctuidae) é uma importante praga desfolhadora da cultura, reduzindo a produtividade e a qualidade. O objetivo deste trabalho foi avaliar o efeito de diferentes intensidades de ataque causado por diferentes densidades de lagartas de *A. argillacea* em três idades de plantas de quatro cultivares. O experimento foi realizado na estação experimental da APTA Pindorama, SP, Brasil. O delineamento experimental adotado foi em blocos casualizados, em esquema fatorial com quatro cultivares (DeltaOPAL, IAC-25, Fibermax 996 e Fibermax 993) x quatro densidades populacionais de lagartas (0, 2, 4, e 6 lagartas por planta) x três épocas de infestação (30, 60 e 90 dias após a emergência das plantas), com 4 repetições. As avaliações foram realizadas quinzenalmente, baseando-se na produção de botões florais, flores, maçãs e capulhos por planta. Pelos resultados obtidos verificou-se que a medida que aumenta à infestação de *A. argillacea,* menor é a produção de botões por planta; e consequentemente a produção de maçãs e capulhos nas quatro cultivares avaliadas. Infestações iniciais aos 30 e 60 DAE reduziram mais a produção/planta dos órgãos reprodutivos nas cultivares, do que infestações tardias aos 90 DAE.

PALAVRAS-CHAVE: *Alabama agillacea*. *Gossypium hirsutum.* Estresse biótico.

REFERENCES

AGRIANUAL. *Anuário estatístico da agricultura brasileira.* São Paulo, FNP, p.139-145, 2004.

ALMEIDA, R. P.; SILVA, C.; RAMALHO, F. S. Manejo integrado de pragas do algodoeiro no Brasil. In: BELTRÃO, N. E. M.; AZEVEDO, D. M. P. (Eds). **O agronegócio do algodão no Brasil.** Brasília: Embrapa, 1035-1098, 2008.

ARPAT, A. B.; WAUGH, M.; SULLIVAN, J. P.; GONZALES, M.; FRISCH, D.; MAIN, D. O.; WOOD, T.; LESLIE, A.;WING, R. A.; WILKINS, T. A. Functional genomics of cell elongation in developing cotton fibers. **Plant Mol. Biol.,** Dordrecht, v. 54, n. 6, p. 911-929. 2004.

BEEVERS, L.; COOPER, J. P. Influence of temperature on growth and metabolism of ryegrass. I – Seedling growth and yield components. **Crop Prot.,** Guildford, v. 4, n. 2, p. 39-43, 1965.

BROOK, K. D.; HEARN, A. B.; KELLY, C. F. Response of cotton, *Gossypium hirsutum* L., to damage by insect pests in Australia: Manual simulation of damage. **J. Econ. Entomol.,** Lanham, v. 85, n. 4, p. 1368-1377, 1992.

BUSOLI, A. C.; CROSARIOL NETO, J.; LOPES, D. O. P.; SILVA, E. A.; PESSOA, R.; SOUZA, L. A. D. E.; GRIGOLLI, J. F. J. Atualidades em Manejo Integrado de Pragas. In: BUSOLI, A. C., GRIGOLLI, J. F. J., SOUZA, L. A.; KUBOTA, M. M.; COSTA, E. N.; SANTOS, L. A. O.; CROSARIOL NETO, J.; VIANA, M. A. (Eds) **Tópicos em Entomologia Agrícola** - *V*. Jaboticabal: Gráfica e Editora Multipress, p. 173-192, 2012.

EHLIG, C. F.; LEMERT, R. D. Effects of fruit load, temperature, and relative humidity on boll retention of cotton. **Crop Sci.,** Madison, v. 13, p. 168-17, 1973.

EZEDINMA, F. O. C. Effects of defoliation and topping on semi-upright cowpea *Vigna unguiculata* (L.) walp in a humid tropical environment. *Exp. Agric.*, Cambridge, v. 9, n. 3, p. 203-207, 1973.

GRAVENA, S.; CUNHA, H. F. **Artrópodos predadores na cultura algodoeira: atividade sobre *Alabama argillacea (Hueb*.) com breves referências a *Heliothis sp. (Lepidoptera: Noctuidae)***. Jaboticabal, Boletim Técnico. Funep, 1991. 41p.

GUIN, G. Abscission of cotton floral bud and bolls as influenced by factors affecting photosynthesis and Respiration. **Crop Prot.,** Guildford, v. 14, n. 2, p. 291-293, 1974.

HEDGE, M.; OLIVEIRA, J. N.; COSTA, J. G.; BLEICHER, E.; SANTANA, A. E. G.; BRUCE, T. J. A.; CAULFIELD, J.; DEWHIRST, S. Y.; WOODCOCK, C. M.; PICKETT, J. A.; BIRKETT, M. A. Identification of semiochemicals released by cotton, *Gossypium hirsutum*, upon infestation by the cotton aphid, *Aphis gossypii*. **J. Chem. Ecol.,** New York, v. 37, p. 741-750, 2011.

JÁCOME, A. G.; SOARES, J. J.; OLIVEIRA, R. H.; CORDÃO SOBRINHO, F. P. Efeito da remoção de folhas no desenvolvimento vegetativo e na produção do algodoeiro. **Pesq. Agropec. Bras.,** Brasília, v. 36, n. 5, p. 751-755, 2001.

MARTENS, B.; TRUMBLE, J. T. Structural and photosynthetic compensation for leafminer (Diptera: Agromyzidae) injury in lima beans. **Environ. Entomol.,** College Park, v. 16, n. 2, p. 374-378, 1987.

MARTINELLI, S.; OMOTO, C. Resistência de lepidópteros-praga a inseticidas na cultura do algodão no Brasil. **Rev. Ol. Fibros.,** Campina Grande, v. 10, n. 3, p. 1167-1182, 2006.

PEREIRA, M. J. B.; ALBUQUERQUE, F. A.; BASTOS, C. S. Pragas do algodoeiro: identificação, biologia e sintomas de ataque. **Rev. Ol. Fibros.,** Campina Grande, v. 10, n. 3, p. 1073-1117, 2006.

QUIRINO, E. S.; SOARES, J. J. Efeito do ataque de *Alabama argillacea* no crescimento vegetativo e sua relação com a fenologia do algodoeiro. **Pesq. Agropec. Bras**., Brasília, v. 36, n. 8, p. 1005-1010, 2001.

SANTOS, J. H. R. Biologia dos algodoeiros anuais 'BR 1' e 'ALLEN 333-67'. **Rev. Cienc. Agron.,** Fortaleza, v. 18, n. 1, p.19-28, 1987.

SANTOS, J. H. R.; FAUSTINO, J. D. C.; MENDES, A. J. P.; COELHO, A. C. H.; ALMEIDA NETO, J. Á. Biologia do algodoeiro anual com caracterização de fases críticas ao ataque de pragas, no ciclo da cultura. **Rev. Cienc. Agron.,** Fortaleza, v. 11, n. 2, p. 39-58, 1980.

SANTOS, T. M.; BOIÇA JÚNIOR, A. L. Resistência de genótipos de algodoeiro (*Gossypium hirsutum* L.) e *Alabama argillacea* (Hüebner) (Lepidoptera: Noctuidae). **Neotrop. Entomol**., Londrina, v. 30, n. 2, p. 297-303, 2001.

SILVA, T. B. M.; SIQUEIRA, H. A. A.; OLIVEIRA, A. C.; TORRES, J. B.; OLIVEIRA, J. V.; MONTARROYOS, P. A. V.; FARIAS, M. J. D. C. Insecticide resistance in Brazilian populations of the cotton leafworm, *Alabama argillacea*. **Crop Prot.,** Guildford, v. 30, n. 9, p. 1156-1161, 2011.

SMITH, R. F.; FALCON, L. A. Insect control for cotton in California. **Cotton Grow. Rev**., London, v. 50, p. 15-27, 1973.

SOARES, J. J.; LARA, F. M.; SILVA, C. A. D.; ALMEIDA, R. P.; WANDERLEY, D. S. Influência da posição do fruto na planta sobre a produção do algodoeiro. **Pesq. Agropec. Bras.,** Brasília, v. 34, n. 5, p. 755-759, 1999.