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Biological aspects of *Spodoptera littoralis* reared on cotton varieties

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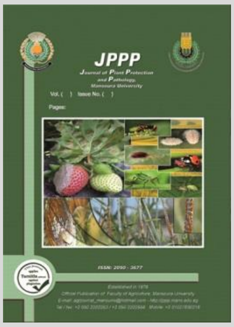

ABSTRACT

Cotton, *Gossypium barbadense* L. is a very important crop in Egypt, and represents a vital source of foreign currency. The present investigation was conducted to determine the effect of three Egyptian cotton varieties; Giza 92, Giza 94 and Giza 96 used for rearing *Spodoptera littoralis* (Bosid.), on certain biological aspects, at Sakha Agricultural Research Station, under laboratory conditions. Results revealed that larvae fed on Giza 92 and Giza 94 leaves had longer larval duration (21.66 and 20.68 days, respectively) than those fed on Giza 96 leaves (18.16 days). Furthermore, the maximum and minimum pupal durations were recorded on Giza 92 and Giza 96 (10.33 and 6.50 days, respectively). The maximum significant female longevity was recorded on Giza 96 (7.00 days). Also, moths emerging from larvae fed on Giza 96 laid the highest number of eggs (503.66 egg/female) while, the lowest number (300 eggs/female) resulted from moths of larvae fed on Giza 92 variety. The highest larval growth index was observed on Giza 96 (5.23%) followed by Giza 94 (4.43%), and Giza 92 (4.07%). According to this study, biological parameters of *S. littoralis* on these varieties indicated greater developmental rates and fecundity on Giza 96 and Giza 94, while poorer on Giza 92 variety. So, these results may be used as potential candidates for developing eco-friendly strategies, to manage this pest, through host plant resistance component.

***Keywords*:** Cotton leafworm, Biological parameters , Cotton cultivars

INTRODUCTION

Cotton (*Gossypium barbadense* L.) is one of the most commercial agricultural crops in Egypt, where cotton is the maximum cash crop for the industry and exportation, because of its importance, as one of the most essential fiber crops in the world. Cotton leafworm, *Spodoptera littoralis* (Bosid.) considers one of the greatest destructive polyphagous and foliage- feeding pests (Kandil *et al*., 2003). This insect causes different injuries not only for cotton plants but for a big range of field crops as well, vegetables and several fruits in Africa, Europe and Asia (El-Aswad *et al*., 2003; Ragaei and Sabry, 2011 and Hosny *et al*., 1986).

Insecticides provide the first line of defense against insect pests, but their extensive use has resulted in side effects such as killing the beneficial insects, environmental pollution and residues in foods (Pedigo and Rice, 2006; Stevens *et al*., 2012 and Ehab, 2012), hazard in human health and pest resistance problems (Nderitu *et al*., 2020). Therefore, it is necessary to develop new and eco-friendly strategies of pest management as host plant resistance (Sharma, 2007). Plant resistance against insect pests, as a main component of integrated pest management ,has a better potential than any other way of pest decrease. Using pest resistant varieties has contributed immensely to sustainable crop protection (Panda and Khush 1995). Plant resistance was historically sought in regions and for crops which was the only possible way of plant protection (Hober, 1972 and Mohamed *et al*., 2019).

Besides the infestion done by *S. littoralis* varies relying on the type of cotton varieties (Kamel, 1965). Quantitative analysis of the eating of host plants by *S. littoralis* is a main element for a research study of larval preferences to plant genotypes (Scriber and Slansky, 1981).

The biology of *S. littoralis* and the effect of different host plants on its development and reproductive capacity was studied (Rizk *et al*., 1988 and Adham *et al*., 2009). host plant susceptibility to infestation differs according to genotype suit for the pest so, during feed on low-quality plants, this may decrease insect growth, size, weight, longevity, and reproduction (Kianpour *et al*., 2014). In addition, the period of short development and great level reproductive on a host show rightness of the tested plants to insect attack (Van Lenteren and Noldus 1990). Also, food amount and quality affect the growth and fecundity of insect (Scriber and Slansky, 1981). According to Naranjo and Ellsworth, 2005 and He *et al*.(2021) biological studies are important to predict pest activity. Furthermore, they aid to determine suitable time of insecticide application (Xue *et al*., 2010; Nandhini and Deshmukh, 2023). The primary target of this study was to determine the effect of three different cotton varieties on the biological aspects of the cotton leafworm, *Spodoptera littoralis*.

MATERIALS AND METHODS

Tested plants

Seeds of the tested cotton varieties (Giza 92, Giza 94 and Giza 96) were obtained from Cotton Research Institute, Sakha, Kafr El-Sheikh. Seeds of each variety were sown at Sakha Agricultural Research Station Farm in April 2022 with an area of 12 m^2 (3 × 4 m) as a source for feeding the insect larvae in the laboratory.

Insect strain

Sensitive strain of *S. Littoralis* was reared for more than 10 generations on castor bean leaves, *Ricinus communis* L. at 25± 2oC and 65% ± 5 RH, at laboratory of Plant

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Protection Research Institute, Sakha, Kafr El-Sheikh (EL-Defrawei *et al*., 1964).

Insect laboratory rearing

Newly hatched first-instar larvae of *S. littoralis* were used during this experiment. Six replicates for each variety of reared larvae (10 larvae / rep.) were used. In glass jars (250 ml each) covered with muslin, the larvae were kept. The number of larvae in each of the jars was reduced to five since larvae developed in instars .New leaves of the varieties were provided daily, and larvae were checked every day for determining their period and mortality among diverse instars till pupation. Then, the pupae were individually kept in vials till the moth emergence.

Development indices

One pair of recent emerging adults was kept in glass jars and offered 10% sugar solution as a food stimulation.

Each of the jars was supplied with a small branch of oleander, *Nerium oleander* (L.) to act as a fitting site for insect oviposition. The deposited egg masses were accumulated daily and the sum of eggs laid per female was recorded.

The effect of various checked varieties on fecundity (total number of eggs / female), fertility (hatchability percentage of eggs), and the longevity of adults for each sex was determined. T

he sex cups were checked daily, and the total numbers of eggs/female for each insect coupling and egg hatchability were calculated. Additionally, larval growth index was calculated using the equations of Pretorius (1976) and Itoyama *et al.* (1999):

Larval growth index = pupation % / duration of larvae (day)

Percentage of pupation, deformed pupation, and emergence were calculated using the following formulae:

% Pupation = (number of pupae / total number of larvae) ×100

% Deformed Pupation =

(number of deformed pupae / total number of pupae) ×100

% Emergence =

(number of emerging moths / total number of larvae) ×100

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using COSTAT and significantly different means were separated by Duncan's multiple range test (DMRT) (Duncan, 1955),at 0.05 probability.

RESULTS AND DISCUSSION

***Spodoptera littoralis* immature durations**

Larval stage

The current study shows the effect of various cotton varieties on some biological aspects of *S. littoralis*. Data presented in Table (1) clear that the cotton varieties had significant effects on the duration of larval stage indices of *S. littoralis*, as the larval duration gradually increased from 1st to 6th instar. The longest larval duration (21.66 days) was that of Giza 92 ,while the shortest one (18.16 days) was that of Giza 96. Differences in larval durations fed on the three varieties proved to be significant. Such difference may be attributed to leaf morphology or to the chemical leafy contents. The obtained results are in line with the findings of Khedr *et. al.* (2015) who reported that the maximum significant time taken for the larval duration of *S. littoralis* was recorded on Suvin, Giza 86 and Giza 92 cotton varieties (12.56, 11.76 and 11.04 days, respectively), and the minimum significant value was on H10 cotton variety (10.70 days).

In addition, El-Aw and Hashem (2004) reported that *S. littoralis* larvae fed on summer plants lasted for 15.66 days in case of castor leaves , to reach the pupal stage, but when fed on cotton or corn, they had 16.92 and 19.76 days, respectively. In winter season, *S. littoralis* had 15.36, 16.26 and 18.09 days to reach the pupal stage when fed on castor, clover and cabbage, respectively. In the same concern, Salama *et al.* (2009) concluded that feeding *S. littoralis* larvae on castor and cotton leaves reduced the insect stage duration, while feeding on sweet potato prolonged it.Results of Mohamed *et al.*(2019) revealed that *S. littoralis* larvae fed on clover leaves lasted shorter period (18.00 days), compared to those fed on sugar beet leaves (25.20 days).

Table 1. Larval, pre-pupal and pupal duration of *Spodoptera littoralis* reared on three cotton varieties

Cotton variety	Mean of larval instars (day) 1st	2nd	3rd	4th	5th	6th	Larval duration (day)	Pre-pupal duration (day)	Pupal duration (day)
Giza 96	2.00± 0.00	2.50± 0.18	3.00± 0.00	3.50±0.00	3.50± 0.18	3.66±0.21	18.16 ± 0.45^b	1.16 ± 0.11^a	6.50± 0.18^c
Giza 94	2.00± 0.00	2.83± 0.11	3.33± 0.42	3.66±0.11	4.20± 0.20	4.66±0.21	20.68± 0.49^a	1.33±0.21^a	9.33± 0.21^b
Giza 92	2.00± 0.00	3.00± 0.00	3.66± 0.21	4.00±0.36	4.00± 0.36	5.00±0.31	21.66± 0.77^a	1.5 ±0.00^a	10.33±0.21^a

Number of initial larvae was 60 larvae per variety. Means within a column denoted by the same letter (s) are not significantly different at 5% level according to DMRT (1955).

Pre- pupal and pupal stages

The obtained results in Table (1) showed that pupal duration was different from one variety to another and the differences were significant. It was longest on Giza 92 (10.33 days), followed by Giza 94 (9.33 days), and the shortest on Giza 96 (6.50 days). However, pre-pupal durations did not differ significantly among evaluated varieties El-Aw and Hashem (2004) concluded that the survivorship of *S. littoralis* pupae fed on corn leaves was less than those fed on cotton or castor.

Effect of three cotton varieties on percentage of pupation, adult emergence and sex ratio

Among the tested cotton varieties, the maximum significant pupation percentage was recorded on Giza 96 (95.00%) and the minimum significant value was 88.33% on Giza 92 variety. The larval food had some effect on the period of pupae as recorded by Bader (1967). The percentage of deformed pupation, adult emergence and sex ratio were insignificantly different between tested varieties (Table, 2) El-Aw and Hashem (2004) indicated that host plants affect the pupal weight of *S. littoralis*. As the larvae fed on castor produced heavier pupae than those reared on cotton or corn.

Longevity of moths

The results summarized in Table (3) indicated that moth longevity was significantly affected by cotton variety offered to larvae. Females emerging from larvae fed on leaves of Giza 96 had the longest significant longevity (7.00 days) ,while the shortest longevity (5.00 days) was that of G 92. In addition, the longevity of females was longer than that of males for all varieties.

Table 2. Biological aspects of *Spodoptera littoralis* reared on cotton varieties

Cotton variety	Pupation %	Deformed Pupation %	Adult emergence %	Sex ratio%	
				Male	Female
Giza 96	95.00± 2.23[a]	3.33 ± 0.51[a]	91.66± 3.07[a]	50.73 ±2.51[a]	49.26± 2.51[a]
Giza 94	91.66 ± 3.07[ab]	3.93 ± 0.53[a]	88.33± 4.77[a]	53.63±5.02[a]	46.36 ±5.70[a]
Giza 92	88.33± 3.07[b]	4.16 ± 0.45[a]	85.00± 5.00[a]	46.19± 5.70[a]	53.80±05.02[a]

Means within a column denoted by the same letter(s) are not significantly different at 5% level according to DMRT (1955).

Table 3. Reproductive parameters of *Spodoptera littoralis* reared on cotton varieties

Cotton variety	Pre-oviposition (day)	Oviposition (day)	Post oviposition (day)	Adult – longevity	
				Female	Male
Giza 96	3.33±0.21[a]	2.66± 0.21[a]	1±0.00[a]	7.00 ±0.36[a]	5.66 ±0.21[a]
Giza 94	2.33±0.21[b]	3± 0.00[a]	1± 0.00[a]	6.33±0.21[a]	5.00± 0.00[a]
Giza 92	2.33±0.21[b]	1.66± 0.21[b]	1± 0.00[a]	5.00 ±0.36[b]	4.83± 0.30[a]

Means within a column denoted by the same letter (s) are not significantly different at 5% level according to DMRT (1955)

Effect of tested cotton varieties on reproductive capacity

From the data summarized in Table (4), it is observed that food of larvae has a noticeable effect on number of eggs laid by moths. Giza 96 proved to be the most favorable variety for larval feeding. Moths produced from larvae reared on Giza 96 laid the highest number of eggs (503.66 eggs/female), while lower number of eggs (300 eggs/female) resulted from moths reared from larvae fed on Giza 92 variety. Egg incubation didn't differ significantly among the evaluated cotton. Egg fertility varied significantly among cotton varieties. Moths resulting from Giza 96 had the highest significant fertility (87.17 %) followed by Giza 94 (78.30%) and Giza 92 (71.37%)

Table 4. Mean of fecundity, egg incubation and fertility of *Spodoptera littoralis* reared on cotton varieties

Cotton variety	Fecundity (No. of eggs/ female)	Egg incubation (day)	Fertility (Egg hatchability %)
Giza 96	503.66± 9.11[a]	3± 0.00[a]	87.17 ± 0.91[a]
Giza 94	392.66±11.92[b]	3± 0.00[a]	78.30 ± 1.34[b]
Giza 92	300.00±5.32[c]	3± 0.00[a]	71.37 ± 2.64[c]

Means within a column denoted by the same letter (s) are not significantly different at 5% level according to DMRT (1955).

Larval growth index

The growth rate of *S. Littoralis* larvae reared on some cotton varieties are presented in Table (5). Results cleared that the highest larval growth indices were on Giza 96 (5.23%) followed by Giza 94 (4.43%), while the lowest (4.14%) was on Giza 92. The obtained results are consistent with those of Khedr *et al.* (2015) who reported that the highest larval growth index observed in *S. Littoralis* correlated with a higher larval survival rate and shorter larval period. This is in agreement with results of AL-Ameer *et al.* (2010) who found that the varieties; Giza 86, Seuvin and Giza 92 recorded the lowest green boll infestation by *Heliothis armigera.* Therefore, Giza 96 and Giza 94 may be suitable as hosts for feeding and development of *S. littoralis.* Also, El-Refaie *et al.* (2024) found that caterpillars fed on castor bean had the highest rates of mature emergence, weight of fully grown larvae, number of eggs laid by a female, and percentage of hatchability , food consumption, relative growth rate, and food utilization efficiencies. Contrarily, larvae fed on cucumber displayed the lowest rates of food consumption, egg-hatched percentage and relative growth rate.

Finally, the cotton variety Giza 92, showed pronounced effects against biological aspects of *S. littoralis* and caused a reduction in the growth rate. Furthermore, this variety can reduce fertility of *S. littoralis* .Therefore, the females resulting from this cotton variety will deposit less fertile eggs, which can reduce population outbreaks of this pest.

Obtained results are encouraging and establish our hypothesis that the eating of cotton varieties, less suitable for rearing the cotton leafworm, can impair its growth, survival, fertility. So, less preferred cotton varieties to *S. littoralis* may be recommended as host plant resistance strategy.

Table 5. Larval growth index of *Spodoptera littoralis* larvae reared on cotton varieties

Cotton variety	Larval period (day)	Pupation %	Larval growth index %
Giza 96	18.16 ± 0.45[b]	95.00± 2.33[a]	5.23
Giza 94	20.68± 0.49[a]	91.66 ± 3.07[ab]	4.43
Giza 92	21.66 ± 0.77[a]	88.33± 3.07[b]	4.07

Means within a column denoted by the same letter (s) are not significantly different at 5% level according to DMRT (1955).

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السمات البيولوجية لدودة ورق القطن المرباة على اصناف القطن

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الملخص

القطن المصري .Gossypium barbadense L يعتبر محصولًا هام جدًا في مصر، ويمثل مصدرًا حيويًا للعملة الأجنبية. أجريت الدراسة الحالية لتقييم تأثير ثلاثة أصناف من القطن المصري وهى جيزة 92، جيزة 94، جيزة 96 على بعض الجوانب البيولوجية لدودة ورق القطن (.Spodoptera littoralis (Bosid تحت الظروف المعملية بمحطة بحوث الزراعية بسخا. أوضحت النتائج أن اليرقات المرباة على ورق قطن لصنف جيزة 92 وجيزة 94 كانت مدة طورهما اليرقي (21.66 و 20.68 يومًا على التوالي) أطول من تلك التي تغذت على ورق قطن جيزة 96 (18.16 يومًا). علاوة على ذلك، تم تسجيل الحد الأقصى والحد الأدنى لمدة طور العذراء في صنف جيزة 92 وجيزة 96 (10.33 و6.50 يومًا على التوالي. كما أن فراشات اليرقات المرباه على صنف جيزة 96 وضعت أكبر عدد من البيض (503.66 بيضة/أنثى) وكان أقل عدد (300 بيضة/أنثى) ناتج عن الفراشات اللاتي يرقاتها تغذت على صنف جيزة 92. ولوحظ أعلى مؤشر لنمو اليرقات في صنف جيزة 96 (5.23%)، يليه صنف جيزة 94 (4.43%)، و صنف جيزة 92 (4.07%). وفقاً لهذه الدراسة، أشارت المؤشرات البيولوجية لـ S. littoralis في هذه الأصناف إلى معدلات نمو وخصوبة أعلى في صنف جيزة 96 وجيزة 94، بينما كانت اقل في صنف جيزة 92. لذلك، يمكن استخدام هذه النتائج كمؤشر محتمل لتطوير استراتيجيات صديقة للبيئة، لإدارة هذه الآفة من خلال عنصر مقاومة النبات العائل.