Pattern of Pink Bollworm Diapaused Larval Exit from the Last Season Cotton Bolls and their Biological Parameters

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ABSTRACT

The present study was carried out to investigate the patterns of pink bollworm (PBW), *Pectinophora gossypiella*, diapaused larval exit from cotton bolls, % larval mortality after leaving bolls and the development as well as some biological parameters of living larvae. Diapaused larval exit began at March and the number of emerged larvae from immature green cotton bolls collected from El-Behira (ranged from 22.3 to 106.7 larvae) is significantly higher than the number of emerged larvae from immature green cotton bolls collected from Alexandria(numbers ranged from 17.7 to 82.3 larvae) during the investigated period. Percent larval mortality in exited larvae at March, April and May from Alexandria cotton bolls (70.3, 64.7 and 52.1%, respectively) is significantly higher than the percent larval mortality from El-Behira (66.5, 57.8 and 46.4%, respectively). The PBW %adult emergence in El-Behira strain is significantly higher than the PBW %adult emergence in Alexandria strain during March and April. Fecundity (No. laid eggs / female) and fertility (%egg hatching) are significantly higher in the moths which emerged from El-Behira strain than from Alexandria strain. This study represents important information about the pattern of PBW diapaused larval exit from the last season cotton bolls which can help in the PBW infestation prediction and mangement.

Keywords: *Pectinophora gossypiella*, Diapause, Biological parameters.

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is considered to be one of the most injurious cotton pests. It was described in 1843 from specimens damaging cotton in India (Noble, 1969). From India the pink bollworm apparently reached Egypt in infested cottonseed shipped in 1906 or 1907, and subsequently reached the western hemisphere in infested cottonseed shipped from Egypt to Mexico between 1911 and 1913 (White, 1960). Under cool dry conditions, *P. gossypiella* larvae may undergo diapause in a small cocoon in partially opened bolls in cotton lint, stored seed or in the soil. This cycle, particularly if entered into late in the season after cold weather begins, ordinarily lasts until the following cotton crop is again fruiting. Only a small part of the overwintering population survives to infest cotton of the following year (Beasley and Adams, 1995). Several sprays have been needed for its control, which leads to outbreaks of secondary pests, otherwise regulated by natural enemies (Lykouressis *et al.*, 2005).

The heavy use of pesticides, besides, creating problems of health hazards, and environmental pollution has also resulted in the development of insect resistance to insecticides (Ahmad and Khan, 1991; Sorejani, 1998), and elimination of natural

biological control agents (Hamburg and Guest, 1997), consequently, upsetting the natural balance of these insect pests. But, hatching PBW larvae can penetrate flowers or bolls within 20–30 min (Hutchison *et al.*, 1988) or within 2 h (Ingram, 1994). Therefore, timing of insecticides spraying affects the insect control process. So, the time of PBW larval exit from the last season cotton bolls and its development has become extremely important. This can help in the PBW infestation prediction and management. Therefore, the present study was carried out to investigate the patterns of diapause larval exit from cotton bolls, %larval mortality after leaving bolls and the development & some biological parameters of living larvae.

MATERIALS AND METHODS

Cotton bolls collection

Two thousand immature green cotton bolls were collected from each El-Amria, Alexandria governorate and Abou-Elmatameer city, Elbehira governorate cotton fields at October 2015. The immature green bolls from each place were transferred to the laboratory and each was divided to 4 groups (500 green bolls each) and kept in ventilated place. Bolls were first examined for PBW emergence on March 1, 2016 and weekly thereafter until 1 July. All living and dead larvae and pupae and adults were recorded. Living larvae and pupae were collected and placed individually in 28-ml capacity glass cups with about 15 ml of agar base artificial PBW diet (Rashad and Ammar, 1985) to provide moisture. Glass cups were examined each week for mortality and the % larval mortality was calculated. The living larvae were followed to pupation and adult emergence. Adults were sexed and placed in glass cups provided with a folded sheet paper as oviposition site. Two adult males were kept with one adult female to maximize the probability of successful mating. Laid eggs were counted and followed until hatching. The %pupation, %adult emergence, fecundity (No. laid eggs/ female) and fertility (% egg hatching) also were calculated.

Statistical Analysis

Average numbers of dead larvae and dead pupae on each sampling month were recorded and percentage mortalities of the total numbers of PBW for each month calculated. All data were replicated four times and the values are expressed as mean ± standard error. The SAS 8.0 software was used for analysis of the data and the means were tested for significant differences using analysis of variance (ANOVA) test (LSD at $P < 0.05$) (SAS Statistical software, 1999).

RESULTS AND DISCUSSION

The PBW is considered to be one of the most injurious cotton pests, because it is difficult to control with insecticides (Lykouressis *et al.*, 2005). The infestation of cotton bolls by the PBW larvae was initiated by moths emerged from overwintered larvae (Slosser and Watson, 1972). Therefore, adopting an IPM program for PBW control is very important. The prediction by the diapaused larval exit from the last cotton season and the infestation of the present cotton season is an important part of the IPM program of PBW.In the present study, diapaused larval exit began at March and numbers ranged from 17.7 to 82.3 at Alexandria and from 22.3 to 106.7 at El-Behira during the investigated period from

March to July (Table 1). It is also clear that, the number of emerged larvae from immature green cotton bolls collected from El-Behira is significantly higher than the number of emerged larvae from immature green cotton bolls collected from Alexandria. Percent larval mortality in exit larvae from Alexandria cotton bolls is significantly higher than the percent larval mortality from El-Behira cotton bolls during March, April and May. While the %larval mortalities in exit larvae from El-Behira cotton bolls were 66.5, 57.8, 46.4, 45.2 and 18.6% of larvae exiting at March, April, May, June and July, respectively, the %larval mortalities in exit larvae from Alexandria cotton bolls were 70.3, 64.7, 52.1, 47.9 and 15.2% of larvae exiting at the same periods, respectively (Table 2). The percent pupation of PBW larvae did not significantly differ between Alexandria strain and El-Behira strain during the investigation period. The % of pupation ranged between 54.0 to 69.4% at Alexandria and 52.2 to 65.2% at El-Behira at the study period (Table 3). While the PBW %adult emergence in El-Behira strain is significantly higher than the PBW %adult emergence in Alexandria strain during March and April, there is no difference in adult emergence between the two strains during May, June and July (Table 4). While the PBW %adult emergence in El-Behira strain is significantly higher than the PBW %adult emergence in Alexandria strain during March and April, there is no difference in adult emergence between the two strains during May, June and July (Table 4). Fecundity (No. laid eggs / female) and fertility (%egg hatching) are significantly higher in the moths which emerged from El-Behira strain than from Alexandria strain (Tables 5 and 6). The number of laid eggs / female is ranged from 180.5 to 290.6 in Alexandria strain and is ranged from 195.5 to 366.8 in El-Behira strain during the investigation period (Table 5). The percent of egg hatching is ranged from 67.1 to 76.5% in Alexandria strain and is ranged from 71.3 to 81.7% in El-Behira strain during the investigation period (Table 6).

Table (1): Number of live diapausing pink bollworm larvae emerged from immature green cotton bolls collected from Alexandria and El-Behira governorates

Location	No. emerged larvae at different dates ± SE				
	March	April	May	June	July
Alexandria	30.0±1.8b	74.5±5.1b	80.3±4.7b	82.3±3.5b	17.7±1.3b
El-Behira	41.0± 2.4a	92.3 ±4.3a	91.7 ±6.4a	106.7±5.8a	22.3±1.9a

Numbers within a column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at $P < 0.05$).

Table (2): % of dead pink bollworm larvae after emergence from immature green cotton bolls collected from Alexandria and El-Behira governorates

Location	%Dead larvae after emergence from green cotton bolls at different dates ± SE				
	March	April	May	June	July
Alexandria	70.3±4.5a	64.7±3.1a	52.1±2.5a	47.9±3.5a	15.2±1.2a
El-Behira	66.5±2.6b	57.8 ±2.8b	46.4±2.2b	45.2±2.6a	18.6±1.5a

Numbers within a column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at $P < 0.05$).

Table (3): % of pupation of pink bollworm larvae after emergence from immature green cotton bolls collected from Alexandria and El-Behira governorates

Location	%Pupation of pink bollworm larvae at different dates ± SE				
	March	April	May	June	July
Alexandria	54.0±3.2a	63.4±4.2a	67.8 ±3.9a	70.3±5.8a	69.4±4.3a
El-Behira	52.2±3.8a	67.9 ±5.1a	70.5±3.7a	68.6±3.6a	65.2±3.7a

Numbers within a column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

Table (4): %Adult emergence of pink bollworm from pupae after emergence from immature green cotton bolls collected from Alexandria and El-Behira governorates

Location	%Adult emergence of pink bollworm at different dates ± SE				
	March	April	May	June	July
Alexandria	30.2±2.5b	45.6±3.8b	55.4±2.9a	50.8±4.3a	48.7±3.6a
El-Behira	39.5±2.1a	51.8±4.1a	53.1±3.5a	56.2±2.9a	53.4±4.7a

Numbers within a column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

Table (5): Fecundity of pink bollworm adults emerged from immature green cotton bolls collected from Alexandria and El-Behira governorates

Location	Fecundity (No. laid eggs / female) ± SE				
	March	April	May	June	July
Alexandria	180.5±15.5b	185.2±8.6b	224.0±14.5b	295.5±23.0b	290.6±16.3b
El-Behira	200.3±17.3a	195.5±13.8a	260.8±18.2a	370. ±27.4a	366.8±13.8a

Numbers within a column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

Table (6): Fertility of pink bollworm adults emerged from immature green cotton bolls collected from Alexandria and El-Behira governorates

Location	Fertility (%egg hatching) ± SE				
	March	April	May	June	July
Alexandria	69.5±3.2a	67.1±2.9b	74.2±2.7b	76.5±2.7a	75.0±1.9b
El-Behira	71.3±2.8a	73.7±1.6a	81.7±2.0a	80.2±3.2a	81.5±2.5a

Numbers within a column with a letter in common are not significantly different according to analysis of variance (ANOVA) test (LSD at P < 0.05).

Although it may not be obvious in many insects, diapause does not entail a complete cessation of development. As evidenced by characteristic temporal patterns of gas exchange, nutrient metabolism, stress resistance, and gene expression, diapause is a dynamic process. Besides that, environmental and hormonal regulators of diapause have been reasonably well defined (Denlinger, 2002; Hodek, 2002). Diapausing insects pass through a graded series of physiologically distinct developmental stages including induction, preparation, initiation, maintenance, termination, and sometimes post-diapause quiescence (Kostal, 2006). The termination of diapause is accompanied by a rapid decline in expression of the diapause-upregulated genes and, conversely, an elevation in expression of many genes that were downregulated during diapauses (Denlinger, 2002). Results of the present study indicated increasing in

the mortality percentages of the exit diapused larvae, a lower fecundity and lower fertility. It has been recorded previously a lower post-diapause survival and reduced fecundity (Ellers and van Alphen, 2002; Williams *et al.*, 2003; Munyiri *et al.*, 2004; Matsuo, 2006).

Finally, PBW is the key pest in the cotton-producing areas of the world which affects the cotton yield in several ways. In severe infestations, damaged squares and small bolls may be shed, leaving no visible evidence of reduced yield on the plant itself. The preferred food of the larva is the kernel of the seed. Usually the tiny larva, upon entering a boll, travels a short distance just under the inner surface of the covering, making a typical path commonly referred to as a mine. It soon leaves the lining of the boll and cuts through the immature lint to a seed. It devours the inside of the seed; then the small worm proceeds to the next seed, ruining the lint as it passes through it. Many larvae are heavy feeders and eat out all the seed of a lock or cell of the boll before they reach maturity (Lohag and Nahyoon, 1995, Ahmad *et al.*, 2003). The high costs of chemical control, continuing economic losses, secondary pest problems and environmental considerations suggest the need for ecologically oriented PBW management strategies. Extensive research has emphasized the need for early monitoring, biological control, cultural, behavioural, genetic and host plant resistance methods that can serve as a base for the formulation of integrated PBW management systems (Henneberry and Naranjo, 1998). This study represents important information which can help in the PBW infestation prediction and implementation of IPM programs.

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نمط خروج اليرقات الساكنة لدودة اللوز القرنفلية من لوزالموسم السابق لمحصول القطن وبعض العوامل البيولوجية لها

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الملخص العربى

تم إجراء هذ البحث بهدف دراسة نمط خروج يرقات دودة اللوز القرنفلية الساكنة فى لوز محصول القطن من الموسم السابق ، نسب موت اليرقات بعد خروجها ، بالإضافة إلى دراسة بعض العوامل البيولوجية لهذه اليرقاتفى محافظتى الأسكندرية والبحيره. بدأ خروج اليرقات فى شهر مارس وكان عدد اليرقات الذى خرج من اللوز الأخضر الغير ناضج المجموع من محافظة البحيره (تراوح بين ٢٢.٣ إلى ١٠٦.٧ يرقه) أكبر بصوره معنوية من عدد اليرقات الذى خرج من اللوز الأخضر الغير ناضج المجموع من محافظة الأسكندريه (تراوح بين ١٧.٧ إلى ٨٢.٣ يرقه) أثناء فترة الدراسة. نسبة موت اليرقات التى خرجت من اللوز فى سلالة محافظة الأسكندرية فى أشهر مارس وأبريل ومايو (٧٠.٣ ، ٦٤.٧ ، ٥٢.١%) كانت أعلى بصوره معنوية من نسبة موت اليرقات التى خرجت من اللوز فى سلالة محافظة البحيره (٦٦.٥ ، ٥٧.٨ ، ٤٦.٤%). نسبة خروج الحشرات الكاملة من عذارى سلالة محافظة البحيره كانت أكبر وبصوره معنوية من نسبة خروج الحشرات الكاملة من عذارى سلالة محافظة الأسكندرية خلال شهرى مارس وأبريل. عدد البيض الذى تم وضعه / أنثى فراشة وكذلك نسبة فقس البيض فى فراشات سلالة محافظة البحيره كان أعلى بصوره معنوية من فراشات سلالة محافظة الأسكندرية. هذه الدراسة تقدم معلومات مهمة عن نمط خروج يرقات دودة اللوز القرنفلية الساكنة فى اللوز الأخضر الغير ناضج لمحصول القطن من الموسم السابق من الممكن أن تساعد فى التنبأ بالإصابة بدودة اللوز القرنفلية وبالتالى مكافحتها.