

## Effect of Light and Dark Conditions on some Biological and Physiological Aspects of *Helicoverpa armigera* (Hübner)

El-Sayed, A. A. A.; A. E. A. Amer; A. A. A. Zaki and M. E. M. A. Hegab

Plant Protection Research Institute, ARC, Dokki, Giza, Egypt



### ABSTRACT

Experiments were carried out in Bollworms Research Department, Plant Protection Research Institute, Sharkia Branch to study effect of light (14L : 10Dh) and dark (24 Dh) on the biological and physiological aspects of *Helicoverpa armigera* (Hübner). The obtained results showed that, at the biological aspects, the larvae and pupae of *H. armigera* reared under light condition gave higher weights compared with those reared under dark condition. Under light the larval and pupal duration were shortened and larval & pupal mortality percentages were lowest. The highest adult emergence percentage, average number of deposited eggs/female and hatchability percentages were recorded for that reared in light condition compared with those reared in dark condition. At physiological aspects, *H. armigera* reared under light condition, its contents of total soluble protein and carbohydrate was increased and decreased of total lipid compared with those reared under dark condition. The results indicated that the increasing in the total contents of protein and carbohydrates in the larvae reared under light condition will be lead to increase the number of eggs/female and hatchability percentage.

**Keywords:** *Helicoverpa armigera*, dark and light conditions, biological and physiological aspects

### INTRODUCTION

The American bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is a polyphagous insect that infest over one hundred plant species including widespread and economically important crops such as tomato, maize, cotton, pigeonpea, tobacco and chickpea (Talekar *et al.*, 2006). The life cycles of insects are regulated by environmental cues such as photoperiod and temperature (Zaslavski, 1988). The photoperiods were not affected the incubation period and the hatchability percentage of *Spodoptera littoralis* (Boisd.). The shortest photoperiod (8L:16D), caused delay in larval and pupal periods and increased pupal weight and number of deposited eggs. The longest photoperiod (16L:8D) decreased the larval and pupal weight and number of deposited eggs (Zohdy and Abou-Elela, 1975). Males of *Agrotis ipsilon* (Hufnagel) reared under short days showed higher percentages of response than did males reared under long days (Gemeno and Kenneth, 2001). Females of *Sesamia nonagrioides* resulted from a diapausing was deposited more eggs when exposed to long days after mating compared to those resulted from a non diapausing. The females resulted from a diapausing were deposited fewer eggs under short days compared to those under long days (Argyro *et al.*, 2004). Growth and development of insects were affected by proteins, lipids and carbohydrates (Beck, 1950; House, 1963 and Soo Hoo and Fraenkel, 1966). Decreased the total lipid in larvae of *Earias vittella* (Fab.) when reared on *Abutilon indicum* led to decrease the number of eggs and hatchability percentage (Sundararaj and David, 1987). The decreased in protein and total lipid of *Earias insulana* (Boisd.) larvae led to reduction in the fecundity and fertility of adult female (Kunkle and Nordin, 1985 and Kandil, 2013).

The aim of this work was to study the effect of light and dark conditions on some biological and physiological aspects of *H. armigera*.

### MATERIALS AND METHODS

The present work was carried out in Bollworms Research Department, Plant Protection Research Institute, Sharkia Branch during 2017 to study the effect of light (14L : 10Dh) and dark (24 Dh) conditions on some biological and physiological aspects of *H. armigera*. The experiment was

performed at constant temperatures  $26 \pm 1^\circ\text{C}$  and  $70 \pm 5\%$  R.H.

#### 1. Insect rearing:

The newly hatched larvae of *H. armigera* used in this study were supplied from the laboratory colony reared for several generations free from any insecticidal contamination at Bollworms Research Department, Institute, Sharkia Branch on artificial diet have been described previously by Amer and El-Sayed (2015).

#### 2. Effect of light and dark conditions on some biological aspects of the American bollworm:

Two hundred neonate larvae of American bollworm were transferred individually to glass tubes ( $2 \times 7.5$  cm) containing about 5-6 g artificial diet, each tube were plugged tightly with absorbent cotton and placed in two incubators, the first light (14L : 10Dh) and the second dark (24 Dh) under  $26 \pm 1^\circ\text{C}$  and 70-75% RH. Four replicates were used for each treatment (50 /replicate) Larvae were examined daily until pupation to record larval duration, larval mortality percentage and larval weight. Pupae were transferred to glass jars and examined daily until moth emergence to record pupation percentage, pupal weight, pupal duration and pupal mortality percentage. The moths were sexed to male and female and caged to eggs laying. Four replicated of five pairs / cage were used for each treatment. Moths were fed on 10 % sugar solution. The pre and post-oviposition periods, oviposition, fecundity and fertility and longevity of adult females and males.

#### 3. Effect of light and dark conditions on total soluble protein, carbohydrate and lipid contents of the American bollworm larvae:

The six larvae instar of the American bollworm were collected from light and dark conditions (three g /each treatment). It was homogenized in distilled water with jacket of crushed ice for 3 minutes. Homogenates were centrifuged at 35000 r.p.m for 10 minutes using a refrigerated centrifuge ( $5^\circ\text{C}$ ). The samples were kept in a deep freezer until used.

Determination of total soluble protein in American bollworm larvae were estimated according to Bradford (1976).

Total carbohydrates in American bollworm larvae were determined using the method of Miller, (1959).

Total lipids in American bollworm larvae were estimated using the method of Zollner and Kirsch (1962).

#### 4. Statistical analysis:

The obtained data were statistical analysis according to Little and Hills (1975).

### RESULTS

#### 1. Effect of light and dark conditions on biological aspects of the American bollworm:

##### Larval stage:

Data in Table (1) indicated that insignificant differences between larval duration reared in light and dark. The larval duration of *H. armigera* was shorter (17day), when that reared in light (14L: 10Dh) and prolonged to 18.50 days, when reared in dark (24 Dh). Insignificant differences were found between larval weights. The averages larval weights were 0.494 and 0.466 g, respectively. The larval mortality percentages recorded in dark was 8.00 % compared with 5.00 % for larvae reared in light.

##### Pupal stage:

The obtained results presented in Table (1) indicated that the duration of *H. armigera* pupae was shorter, when the larvae reared in light (12.00 days) and prolonged to 12.50 days when the larvae reared in dark. Insignificant differences were found between pupal duration. The pupal weights were 0.350 and 0.319 g for that reared in light and dark, respectively. The pupal mortality percentages in light were

significantly compared with those reared in dark, which recorded 6.32 and 10.87 %, respectively.

##### Adult stage:

Data in Table (2) cleared that highly significant differences between adult emergence percentages from reared under light and dark conditions. The adult emergence percentages were 93.68 and 89.13 %, respectively. The oviposition periods of *H. armigera* females resulted from larvae reared in light and dark were 7.00 and 4.00 days, respectively. Significant differences were found between oviposition periods of moths reared under light compared with those reared under dark. The pre and post-oviposition periods were significantly affected by light and dark conditions and lasted (2.00 and 4.00 days) and (2.00 and 3.50 days), respectively. The averages male longevity of *H. armigera* was 9.00 and 7.50 days, respectively. Insignificant differences were recorded between female longevity and lasted (11.00 and 11.50 days), respectively. The average numbers of laid eggs / female resulted from moths in light increased significantly than those reared in dark which recorded 430.00 and 195.00 eggs/female, respectively. Hatchability percentages were significantly differed as affected by light and dark. The hatchability percentages were 85.00 and 55.00 %, respectively.

**Table 1. Effect of light and dark conditions on some biological aspects of immature stages of American bollworm.**

Treatments	Larval duration (day)	Larval mortality %	Larval weight (g)	Pupation %	Pupal duration (day)	Pupal Weight (g)	Pupal mortality %
Light (14L :10Dh)	17.00	5.00	0.494	95.00	12.00	0.350a	6.32b
Dark (24Dh)	18.50	8.00	0.466	92.00	12.50	0.319b	10.87a
P	N.S.	N.S.	N.S.	N.S.	N.S.	0.0068**	0.030*
LSD <sub>0.05</sub>		0.030				0.017	3.86

**Table 2. Effect of light and dark conditions on adult longevity and reproductive potential of American bollworm**

Treatments	Adult emergence %	Pre-oviposition (day)	Oviposition (day)	Post-oviposition (day)	Female longevity (day)	Male longevity (day)	No. of eggs /female	Hatchability %
Light (14L :10Dh)	93.68a	2.00b	7.00a	2.00b	11.00	9.00a	430.00a	85.00a
Dark (24Dh)	89.13b	4.00a	4.00b	3.50a	11.50	7.50b	195.00b	55.00b
P	0.308*	0.0003***	0.001***	0.002**	N.S.	0.039*	0.002***	0.0003***
LSD <sub>0.05</sub>	3.87	0.45	0.45	0.58		1.37	51.32	0.86

#### 2. Effect of light and dark conditions on total soluble protein, carbohydrate and lipid contents of the American bollworm larvae:

Data in Table (3) showed that the changes in total soluble protein, lipid and carbohydrate contents of *H. armigera* larvae. The value of total soluble protein content of larvae reared under light condition (35.30 mg/g b.wt.) increased than those collected from dark treatment (14.35 mg /g b.wt.).

**Table 3. Effect of light and dark conditions on total soluble protein, carbohydrate and lipid contents of the American bollworm larvae.**

Treatments	Total soluble protein mg /g b.wt.	Carbohydrates content mg /g b.wt.	Lipids content mg /g b.wt.
Light (14 L :10 Dh)	35.30a	45.43a	84.05b
Dark (24 Dh)	14.35b	38.10b	92.72a
P	0.0004***	0.0127*	0.0141*
LSD <sub>0.05</sub>	5.31	4.73	5.77

There was increased in the level of total lipid of *H. armigera* larvae collected from dark treatment (92.72 mg /g b.wt.) than those collected from light treatment (84.05 mg /g b.wt.). The total carbohydrate was significant affected by light compared with dark. The total carbohydrate were 45.43 and 38.10 mg carbohydrate /g b.wt., respectively.

### DISCUSSION

The obtained results showed that the larvae and pupae reared in light condition (14L: 10Dh) recorded the highest weights, while, those reared in dark condition (24 Dh) gave the lowest weights. The lowest larval and pupal duration and larval & pupal mortality percentages recorded in light. The highest adult emergence percentage, average number of deposited eggs/female and hatchability percentages were recorded for the reared in light condition compared with those reared in dark condition. The life cycles of insects are regulated by environmental cues such as photoperiod and temperature (Zaslavski, 1988). The

photoperiods were not affected the incubation period and the hatchability percentage of *Spodoptera littoralis* (Boisd.). The shortest photoperiod (8L:16D), caused delay in larval and pupal periods and increased pupal weight and number of deposited eggs. The longest photoperiod (16L:8D) decreased the larval and pupal weight and number of deposited eggs (Zohdy and Abou-Elela, 1975). Males of *Agrotis ipsilon* (Hufnagel) reared under short days showed higher percentages of response than did males reared under long days (Gemeno and Kenneth, 2001). Females of *Sesamia nonagrioides* resulted from a diapausing was deposited more eggs when exposed to long days after mating compared to those resulted from a non diapausing. The females resulted from a diapausing were deposited fewer eggs under short days compared to those under long days (Argyro *et al.*, 2004).

Also, the obtained results showed that the highest value of total soluble protein and carbohydrate contents were recorded in larvae reared in light condition compared with those reared in dark condition. While, the lowest value of total lipid was recorded in dark condition. Also, the results showed the increasing in the total contents of protein and carbohydrates in the larvae reared under light condition will be lead to increase the number of eggs/female and hatchability percentage. Growth and development of insects were affected by proteins, lipids and carbohydrates (Beck, 1950; House, 1963 and Soo Hoo and Fraenkel, 1966). Decreased the total lipid in larvae of *E. vittella* when reared on *A. indicum* led to decrease the number of eggs and hatchability percentage (Sundararaj and David, 1987). The decreased in protein and total lipid of *E. insulana* larvae led to reduction in the fecundity and fertility of adult female (Kunkle and Nordin, 1985 and Kandil, 2013).

## REFERENCES

- Amer, E.A. and El-Sayed A.A.A. (2015): Lower threshold temperature and thermal unit of American bollworm, *Helicoverpa armigera* (Hübner) reared on pea and lettuce and its rearing on a new modified artificial diets. J. Product. & Dev. 20 (3): 273-284.
- Argyro, A.F.; Dionyssios, C.H.; Perdakis and Konstantina, F.Z. (2004): Reproductive responses to photoperiod and temperature by diapausing and non diapausing populations of *Sesamia non agrioides* Lef. (Lepidoptera–Noctuidae). Physiol. Entomol., 29, 169 – 175.
- Beck, S.D. (1950): Influence of nutritional factors on larval establishment and development on the corn plant. Ann. Ent. Soc. Amer., 49:582-588.
- Bradford, M.M. (1976): A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein dye binding Anal. Biochem., 72 : 248-254.
- Gemeno, C. and Kenneth, H.F. (2001): Impact of photoperiod on the sexual behavior of the black cutworm moth (Lepidoptera: Noctuidae). Environ. Entomol., 30 (2): 189-195.
- House, H.L. (1963): Nutritional diseases, p. 133-160. In Steinhiaus, E. A., ed., Insect Pathol., An Advanced Treatise 1, New Yourk, Acad. Press Inc.
- Kandil Mervat, A.A. (2013): Relationship between temperature and some biological aspects and biochemical of *Earias insulana* (Boisd.) (Lepidoptera: Noctuidae). Egypt. Acad. J. Biol. Sci., 6 (1): 11-20.
- Kunkle, J.G. and Nordin, J.H. (1985): Yolk proteins in comprehensive insect bioch. Physiol. and Pharmacol. (Edited by Kerkut G. A. and Gilbert. L. L.), 1: 83-111.
- Little, T. M. and Hills, F. J. (1975): Statistical Method in Agricultural Research. John WWiley and sons, New York, 350 pp.
- Miller, G.L. (1959): Use of dinitrosalicylic acid reagent for determination of reducing sugar. Anal Chem., 31: 426-428.
- Soo Hoo, C.F. and Fraenkel G. (1966): The consumption, digestion and utilization of food plants by a phytophagous insect, *Prodenia eridania* (Cramer). J. Insect Physiol., 12:711-730.
- Sundararaj, R. and David, B.V. (1987): Influence of biochemical parameters of different hosts on the biology of *Earias vittella* (Fab.) (Noctuidae: Lepidoptera). Proc. Indian Acad. Sci. (Anim. Sci.), 96:329-332.
- Talekar, N.S.; Opena, R.T. and Hanson, P. (2006): *Helicoverpa armigera* management: A review of AVRDC's research on host plant resistance in tomato. Crop Prot., 25: 461-467.
- Zaslavski, V.A. (1988): Insect development (photoperiodic and temperature control). Springer-Verlag, Berlin. 187 pp.
- Zohdy, N.Z. M. and Abou-Elel, A.R.G. (1975): Effect of photoperiod on the different developmental stages of *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). Z. Ang. Ent., 79: 52-56.
- Zollner, N. and Kirsch, K. (1962): Colorimetric method for determination of total lipids. Z. Ges. Exp. Med. 135, 545–550.

## تأثير ظروف الضوء والظلام على بعض الخصائص البيولوجية والفسيوولوجية لدودة اللوز الأمريكية على احمد احمد السيد ، عادل السيد على عامر ، احمد عطا عبدالله زكى و محمد السيد محمد على حجاب معهد بحوث وقاية النباتات – مركز البحوث الزراعيه- الدقى- جيزه – مصر

أجريت التجارب في معمل بحوث وقاية النباتات فرع الشرقيه لدراسة تأثير الضوء (١٤ ساعة إضاءة و ١٠ ساعة إظلام) والظلام (٢٤ ساعة إظلام) على بعض الخصائص البيولوجية والفسيوولوجية لدودة اللوز الأمريكية. أظهرت النتائج أن يرقات و عذارى دودة اللوز الأمريكية المرباه في الضوء أعطت أوزان عاليه بالمقارنه بتلك المرباه في الظلام. تحت الضوء قصرت مدة الطور اليرقى والعذري وقلت نسب الموت خلال الطور اليرقى والعذراء. سجلت أعلى نسب خروج للفراشات وأعلى عدد بيض موضوع لكل أنثى ونسب فقس البيض للحشره المرباه في الضوء بالمقارنه بالمرباه في الظلام. تربيته دودة اللوز الأمريكية تحت ظروف الضوء أدت الى زيادة المحتوى الكلى للبروتين والكربوهيدرات ونقص فى المحتوى الكلى للدهون مقارنة بالمرباه فى الظلام. أوضحت النتائج أن زيادة المحتوى الكلى للبروتين والكربوهيدرات لليرقات المرباه فى ظروف الضوء سببت زيادة فى عدد البيض الموضوع لكل أنثى ونسب فقس البيض