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STHRESHOLD TEMPERATURES AND THERMAL REQUIREMENTS OF SESAMIA CRETICA LED (LEPIDOPTERA:NOCTUIDAE)

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ABSTRACT

The present investigation aimed to study the effect of four constant temperatures (20,25,30 and 35° C) on the developmental rates of different stages of the corn stem borer, Sesamia cretica. The incubation period,Larval duration. pupal duration, pre-oviposition period and duration of generation were estimated. The time required for development of different stages was increased as the temperature decreased.The threshold temperatures were 10.8 ° C for egg, 7.4° C for larvae,8.8° C for pupae ,12.6 ° C for pre-oviposition period and 8.7 ° C for generation The average thermal requirements needed for completing the development were 171,2 , 606,3 , 218,6 , 36,9 and 1029.2 degree-days for egg, larvae, pupae ,pre-oviposition period and generation, respectively.

INTRODCIION

The corn stem borer, Sesamia cretica Led., is a serious pest on sorghum in upper Egypt.It attacks the plant at different growth stages and consequently reduces its yield (EL Serwy & Saba, 1993; Ahmed,1996; Abd-ELrazek, 2009) Alethough the use of insecticides is still the most effective method to control pests , it is becoming increasingly important to design and develop an alternative program safe to human and / or environment.

The temperature is considered as an important environmental factor that affects the rate of development of the insects , and controlled the success of the insect to live in a given temperature, it was particularly as practical point of view interesting for economic insects to obtain a useful and good forecast and Prediction System of insect population. Heat reauirements for development of lepidopterous Insect pests attracted many wakers (Dahi & Abdel-Khalek 2006; AI-Allam etal, 2010; Dahi, 2010).

This work was pointed mainly to the following aspects such as the relationship between temperature and rate of development, which give a quantitive expression for this relationship, using thermal accumulation,also studying the biological aspects of S. cretica as a prior to limit its required heat units to be used through forecasting system to establish an IPM program for this insect and the thermal units required to complete the development of different stages to complete one generation, as well as helping in the design of development indexes used for determining the times required for these stages under fluctuating temperatures in the field.

MATERIALS AND METHODS

A- Biological studies of S.creticaLed.

A.1 Rearing technique:

A good number of S.cretica larvae were collected from the field of sorghum plants at Sohag Governorate. The larvae were reared on pieces of sorghum under laboratory conditions (27±1°C) for two generation to be homogenous strain (Ahmed, 1996)

A.2 Effect of different constant temperatures on the durations of the different developmental stages:

All S. cretica stages were kept under four constant temperature (20, 25, 30 and 35 ° C) to determine the rate of development. Eggs were transferred to glass vials (2.0 x 7.5 cm). Four replicates of 25 eggs were used for each degree of temp. to be tested. Observations were made daily to record the time of hatchability. The incubation period and the embryo development rates were estimated. To study the larval development 4 replicates of 25 newly hatched larvae were transferred, each in a separate glass tube (7.5x2.5 cm.) 25 larvae/replicate. The larvae were reared on pieces of sorghum. Daily observations were made to count the pupated larvae. Larval development rate and duration was estimated.

Newly formed pupae were collected daily and placed in a glass tube (one pupae/tube) plugged tightly with a piece of cotton. Four replicates (each of 25 pupae) were placed at each tested temperature and observed daily till adult emergence. After being sexed the newly emerged moths of each group resulted from the same temperature were isolated in pairs, one pair for each kept in a separate tube (15 cm long and 5 cm diam.) opened at each ends, contain a small piece of absorbent cotton wool previously soaked in 10% sucrose solution for adult feeding. The two ends of each tube were covered with cloth, secured with rubber band, and a small strip of muslin cloths as suitable site for oviposition. Five replicates, has 2 adults (1 male + 1female) were placed at each tested temperature. Daily observation were made to record the adult survival.

B-Estimation of lower threshold of development and accumulated heat units requirements of S. cretica:

Duration of different stages was recorded for each degree. Data obtain in the present work were subjected to statistical analysis by F test. The rate of development for S.cretica stages (incubation period, larval duration, pupal duration and pre-oviposition period and period of one generation) were determined by the simple formula (1/tx100) for the four constant temperatures. The obtained data concerning the effectiveness of different constant temperature degrees on both immature and adult stages of S. cretica were subjected to statistical analysis where the theoretical development thresholds (t0) and the accumulation thermal units (k) were determined according to the regression formula: (Dahi Abdel-khalek, 2006; Dahi, 2010)

$$Y = a + b x$$

$$t_0 = -a / b \text{ and } K = 1 / b$$

On the other hand, thermal units required for complete development of each stage was determined according to the equation of thermal summation:

$$K = y (T - t_0).$$

Where Y = developmental duration of a given stage: T= temperature in degree centigrade.

t_0 = lower threshold of development and K=thermal units (degree days).

RESULTS AND DISCUSSION

1. Estimation of lower threshold of development and accumulated heat units requirements of *S. cretica*:

1.1. Egg stage:

Data in Table (1) indicated that the average embryogenesis varied from 15.37 at 20° C to 6.24 days at 35° C. There are significant differences between the incubation periods recorded at 35° C. and the values at 20° C, 25° C and 30° C. The lower threshold of development (t_0) for the egg stage was10.83° C. as indicated in Fig.

(1). **The same Table showed that the average thermal units required for eggs development till hatching was 171.22 DD's as determinedly thermal summation equation k= y (T- 10.83).**

The four observed values for rate of eggs development at the four tested temperature degrees, gave also a remarkable good fit to the calculated temperature velocity line having the formula y= 0.659 x-7.141 (Fig. 1).

Table (1): Development of S. cretica eggs under different constant temperatures and its thermal requirements.

Temp. (°C)	Incubation period (Days)	Rate of development	t_0 (°C)	Degree days
20°C	15.37	6.50	10.83	171.22
25°C	11.73	8.52		
30°C	7.73	12.93		
35°C	6.24	16.02		
F value	1410.28			
$LSD_{05\%}$	0.33			
$LSD_{01\%}$	0.45			

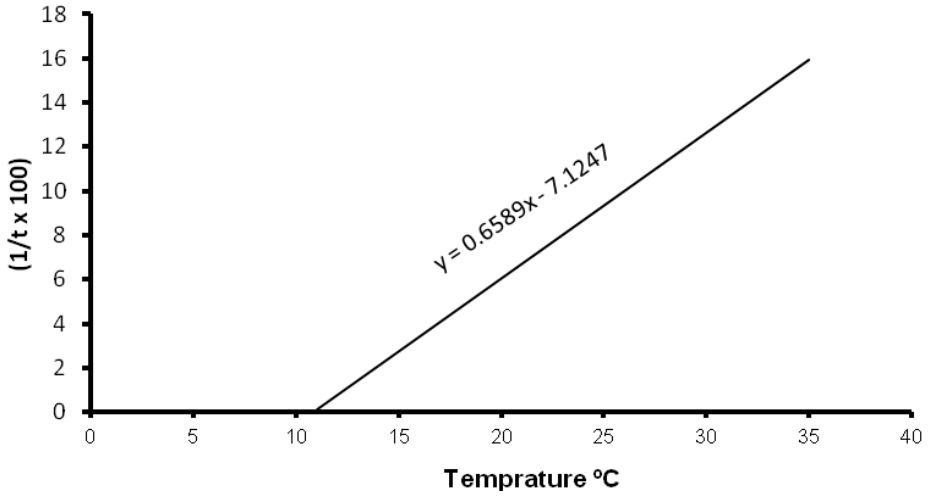

Fig. (1: The regression line of the relation between the rate of development of S.cretica eggs and different constant temperatures.

1.2. Larval stage

Concerning the effect of the four tested constant temperatures on the larval duration of S.cretica was noticed. However, the larval duration period decreased as temperature increased where the average durations were 44.67, 33.28, 21.62 and 21.14 days at 20, 25, 30 and 35° C. respectively (Table 2). Statistically there are significant differences between all the values of larval durations at all tested temperatures. The developmental zero for this stage was 7.41° C as illustrated graphically by extrapolation in Fig. (2). Data in the same Table refer that the average of thermal heat units for S.cretica larvae was 606.26 DD's as estimated by the thermal summation equation k = y (T-7.41).

The four observed values for the larval rate of development gave a remarkable good fit to the calculated temperature-velocity line having the formula Y= 0.18x-1.347 Fig. (28).

Table (2): Development of S. cretica larvae under different constant temperature and its thermal requirements.

Temp. (°C)	Larval duration (Days)	Rate of development	t_0 (°C)	Degree days
20°C	44.67	2.24	7.41	606.26
25°C	33.28	3.01		
30°C	21.62	4.63		
35°C	21.14	4.73		
F value	2168.33			
$LSD_{05\%}$	0.72			
$LSD_{01\%}$	0.99			

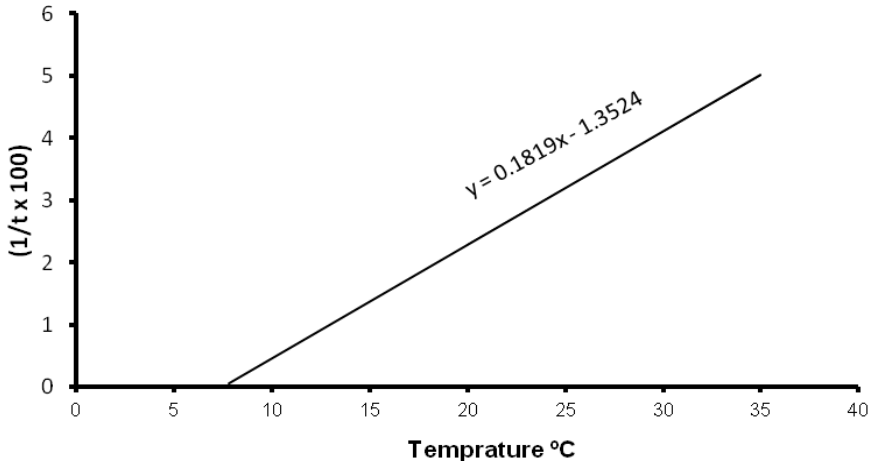

Fig. (2): The regression line of the relation between the rate of development of S.cretica larvae and different constant temperatures.

1.3. Pupal stage

Data in Table (3) and Fig. (3) show the effect of all tested temperatures on the pupal duration of S.cretica. The relationship as obvious occurred and indicated that the required time for completion of pupa development decreased as the temperature increased. The means of pupal duration were 18.82, 11.71, 8.44 and 7.82 days at 20, 25, 30 and 35° C. respectively (Table 3). Statistical analysis indicated that there are significant relationships between all values of pupal stage at all tested temperatures. The lower threshold of pupal development was calculated and illustrated in Fig. (3). It was found to be 8.82° C. The average of thermal units in degree-days required for the completion of development of this stage was 218.55 DD's. The four observed values of pupal rate of development at the constant temperature gave a remarkable good fit to the calculated temperature-velocity line having the formula Y = 0.52x- 4.54 (Fig. 3).

Table (3): Development of S. cretica pupae under different constant temperatures and its relation with thermal requirements.

Temp. (°C)	Pupal duration (Days)	Rate of development	t_0 (°C)	Degree days
20°C	18.82	5.31	8.82	218.55
25°C	11.71	8.54		
30°C	8.44	11.85		
35°C	7.82	12.79		
F value	3222.22			
$LSD_{05\%}$	0.27			
$LSD_{01\%}$	0.37			

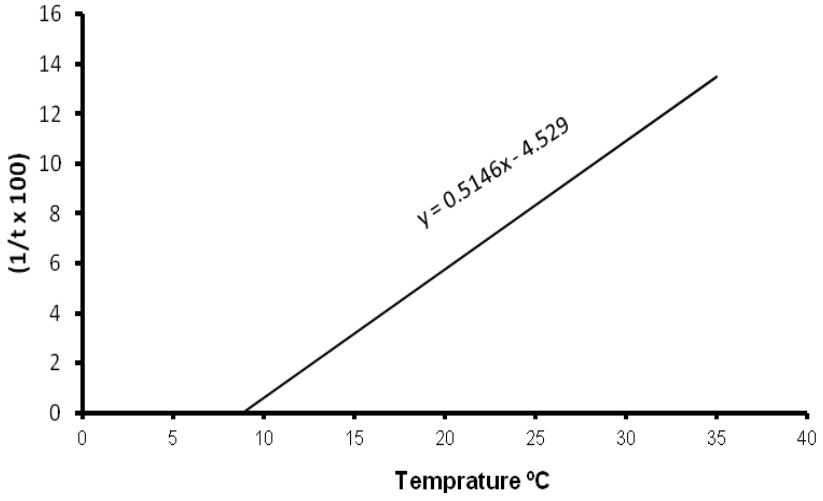

Fig. (3): The regression line of the relation between the rate of development of S.cretica pupae and different constant temperatures.

1.4. 1.4.Adult stage (Pre-oviposition period)

Data in Table (4) show that the mean time required for maturation of the ovaries and starting to egg laying, decreased as the temperature increased from 3.88 days at 20 ° C to 1.36 days at 35 °C. Statistically, there are significant differences between all the values of pre-oviposition period at all tested temperature degrees. The lower threshold temperature for development was 12.61 °C. The average of total thermal units was 36.86 DD's as calculated by thermal summation equation K= Y (T-t0). The four observed values for this period at the constant temperatures gave also a remarkable good fit to the calculated temperature- velocity line having the formula Y= 3.145x-39.649 (Fig.4).

Table (4): Duration of S. cretica pre-oviposition period under different constant temperatures and its thermal requirements.

Temp. (°C)	Pre-oviposition period (Days)	Rate of development	t_0 (°C)	Degree days
20°C	3.88	25.77	12.61	36.86
25°C	2.70	37.04		
30°C	1.96	51.02		
35°C	1.36	73.53		
F value	170.69*			
$LSD_{05\%}$	0.25			
$LSD_{01\%}$	0.34			

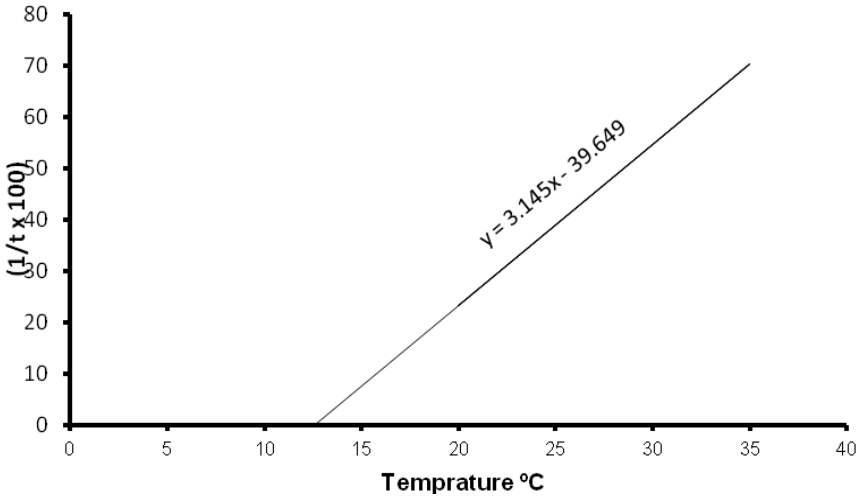

Fig. (4): The regression line of the relation between the rate of development of S.cretica pre-oviposition period and different constant temperature.

1.5. The generation

The mean duration of total period of generation at different constant temperature regimes could be calculated using the total of mean duration of different developmental stages (incubation period, larval stage, pupal stage and pre-oviposition period). Theoretically, the results obtained from this method show an approximate value for mean duration of generation at different constant temperature regimes. In the present study, the data in Table (5) indicate that the mean durations of generation for S. cretica were 82.74, 59.42, 39.75and 36.56 days at 20, 25, 30 and 35° C. respectively. Data revealed that increasing of temperature accelerated the development rate of S. cretica where it reached the maximum velocity at 35°C. Statistical analysis indicated that there are significant relationships between all values of mean generation periods at all temperatures.

The lower threshold of generation development was calculated and illustrated in Fig. (5). It was found to be 8.66° C. The average of thermal units in degree-days required for the completion of development of this stage was 1029.16 DD's. The four observed values of generation rate of development at the constant temperature gave a remarkable good fit to the calculated temperature-velocity line having the formula Y= 0.1082 x- 0.9409 (Fig. 5). The results in the present study are in agreement with those of (Ali et al., 1985) who reported that the rate of development of S. cretica seems to be temperature dependent.

Table (5): Duration of S. cretica generation under different constant temperatures and its thermal requirements

Temp. (°C)	Duration of generation (Days)	Rate of development	t_0 (°C)	Degree days
20°C	82.74	1.21	8.66	1029.16
25°C	59.42	1.68		
30°C	39.75	2.52		
35°C	36.56	2.73		
F value	6810.71*			
$LSD_{05\%}$	0.77			
$LSD_{01\%}$	1.07			

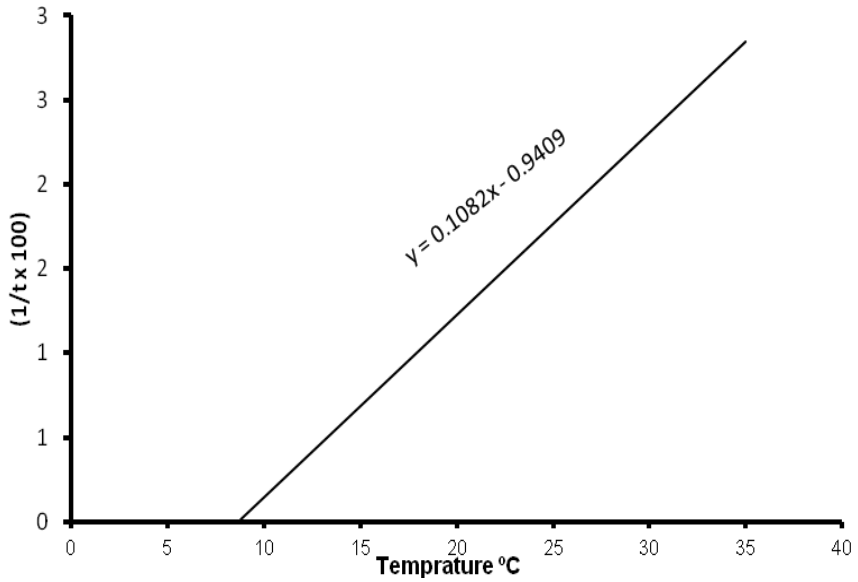

Fig. (5): The regression line of the relation between the duration of S. cretica generation and different constant temperatures.

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صفر النمو البيولوجى والإحتياجات الحرارية لحشرة دودة القصب الكبيرة

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الملخص :

تم دراسة تأثير أربع درجات حرارة ثابتة هى (٣٥,٣٠,٢٥,٢٠ درجة مئوية) عل مراحل النمو المختلفة لأطوار حشرة دودة القصب الكبيرة وتم حساب كل من فترات (حضانة البيضة) ، طور اليرقة ، طور العذراء ، فترة ما قبل وضع البيض وطول فترة الجيل وأظهرت الدراسة أن فترات النمو للأطوار المختلفة تطول كلما انخفضت درجة الحرارة وأوضحت النتائج المتحصل عليها أن صفر النمو البيولوجى للبيضة هو ١٠.٨درجة مئوية ومتوسط الوحدات الحرارية المطلوبة لتطور البيضة حتى الفقس هو ١٧١.٢ وحدة حرارية بينما كان صفر النمو البيولوجى لليرقة ٧.٤ درجة مئوية ومتوسط الوحدات الحرارية المطلوبة لتطور اليرقة هو ٦٠٦.٣ وحدة حرارية وأيضاً كان صفر النمو البيولوجى للعذراء ٨.٨ درجة مئوية ومتوسط الوحدات الحرارية المطلوبة لتطور العذراء هو ٢١٨.٦ وحدة حرارية وكان صفر النمو البيولوجى للحشرة الكاملة (فترة ما قبل وضع البيض) ١٢.٦ درجة مئوية ومتوسط الوحدات الحرارية المطلوبة لتطور الحشرة الكاملة ٣٦.٩ وحدة حرارية ،فى نفس الوقت كان صفر النمو البيولوجى لفترة الجيل ٨.٧ درجة مئوية ومتوسط الوحدات الحرارية المطلوبة لإتمام فترة الجيل ٢/.١٠٢٩ وحدة حرارية.