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Effect of Different Constant Temperatures on Biological and Life Table Parameters of *Autographa gamma* L.

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Abstract: The present study was carried out to investigate the effect of three constant temperature degrees (20, 25 and 30°C ±1°C and 65±5% R.H.) on *Autographa gamma* L. biological and life table parameters. The duration period of immature stages, pre-oviposition, oviposition and post-oviposition periods and fecundity of *A. gamma* were significantly affected by temperature. The results showed that biological parameters had the shorter periods at 30°C than the other two temperatures. The net reproduction rate (R_0), the mean generation time, the generation doubling time, the intrinsic rate of increase (r_m) and finite rate of increase (λ) were higher at 30°C than at 20 and 25°C.

Key words: *Autographa gamma* · Biological · Life table parameters

INTRODUCTION

The larva of the moth is a general feeder on many herbaceous weeds and crops including vegetable, fruit and ornamental hosts. Its crop hosts include cauliflower, chrysanthemum, corn, crucifers, geraniums, greenhouse crops, legumes, soybeans, potato, strawberries and tomato. So, it posses threats on vegetables especially tomato. It has eight generations in laboratory and nine generations a year in nature [1, 2].

Integrated pest management programs (IPM) demonstrates a total system approach to the suppression of pest population, which depend on the importance of the predicting the seasonal abundance of insects, which has led to the formulation of many mathematical models that describe the developmental rates as a function of temperature [3].

The aim of the current study is to evaluate the effect of different constant temperatures on the biological and life table parameters of *A. gamma*.

MATERIALS AND METHODS

Eggs and larvae of *A. gamma* were collected from leaves of tomato and reared in the laboratory in jars, which covered with pieces of thin mesh fixed in place with a rubber band. Larvae were fed on leaves of tomato until pupation. Pupae were transferred to a larger container until adults were appeared. Moths were placed in pairs in plastic containers (15 cm long) contain a small piece of absorbent cotton wool held in place by a rubber band, over the top and supplied with a 20% honey solution [4]. The newly laid eggs were divided into three groups, each group put in an incubator. The temperatures were 20, 25 and 30°C and 65±5% R.H. They reared by the method mentioned above. The biological aspects of the pest in each temperature were studied.

For calculating the life table, the daily laid eggs were evaluated and counted carefully in three groups for each temperature.

Results were analyzed by life table program according to Abou- Setta [5] and data were analyzed by using one-way ANOVA [6].

RESULTS AND DISCUSSION

Data presented in Table (1) showed that the incubation period, larval instars and pupal stage were decreased with increasing temperature from 20 to 30°C. The incubation period was 4.5, 3.5 and 2.5 days at 20, 25 and 30°C, respectively. The larval stage at 20, 25 and 30°C were 27.26, 19.15 and 13.06 days, respectively. In addition, the life cycle was 43.05, 32.68 and 22.73 days at 20, 25 and 30°C, respectively.

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Table 1: Effect of the three temperature degrees on the life cycle of *Autographa gamma* L. at 65±5% R.H under laboratory conditions.

Temperature	Incubation	Average period of larval instars (in days±SD)									
°C	period	1st	2nd	3th	4th	5th	6th	Larval stage	Pre- pupa	Pupa	Life cycle
20	4.8±0.6 a	8.0±0.56 a	4.32±0.22 a	5.23±0.16 a	4±0.26 a	3.89±0.35 a	5.77±0.35 a	27.26±0.66 a	1.5±0.29 a	8.85±0.41 a	43.05±5.27 a
25	3.4±0.6 b	5.0±0.27 b	3.6±0.26 b	3.6±0.26 b	3.85±0.23 a	3.36±0.66 b	3.86±0.26 b	19.15±0.43 b	1.4±0.17 a	7.74±0.35 b	32.68±3.96 b
30	2.7±0.5 c	3.78±0.51 b	1.72±0.18 c	1.77±0.18 c	1.66±0.17 b	1.66±0.15 c	2.42±0.08 c	13.06±0.37 c	0.65±0.15 b	6.6±0.27 c	22.73±2.55 c

Means followed by the same small letters in a column among temperatures are not significantly different at the 5% probability level (ANOVA, Student- Newan-Keuls Test).

Table 2: Effect of the three temperature degrees on the longevity and life span of both males and females of *Autographa gamma* at 65±5% R.H under laboratory conditions

	Longevity (in days±SD)					
	Female					Male
Temperature°C	Pre-oviposition	Oviposition period	Post-oviposition	Longevity	Fecundity rate	Longevity
20	6.24±0.23 a	3.0±0.18 a	2.3±0.18a	11.54±0.93a	18.55±1.91 a	6.68±0.55a
25	5.0±0.21ab	2.0±0.23ab	1.7±0.18ab	8.70±0.88 b	57.67±15.76 b	4.77±0.23 ab
30	2.2±0.18 b	1.5±0.15b	1.3±0.08b	5.00±0.28 c	106.67±6.67 c	3.86±0.18 b

Means followed by the same small letters in a column among temperatures are not significantly different at the 5% probability level (ANOVA, Student- Newan-Keuls Test).

Table 3: Effect of the temperature on female fecundity of *Autographa gamma* at 65±5% R.H.

	Fecundity (No.±SD)	
Temperature°C	No. of deposited Eggs	Fecundity rate
20	19.53±1.92 c	6.17±0.02 c
25	58.66±16.78 b	28.86±0.01b
30	108.65±6.64 a	88.87±0.14a

Means followed by the same small letters in a column among temperatures are not significantly different at the 5% probability level (ANOVA, Student-Newan-Keuls Test).

The obtained results are in agreement with those reported by Miyashita [7] and Rao [8] who mentioned that the developmental effects of constant and alternating temperatures on *Spodoptera litura* Fab. addressed only the development of rates and estimation of thermal constants. However, they did not consider the temperature-dependent immature mortality, adult senescence and female fecundity that are considered highly important in understanding pest population density [9, 10]. The current study also similar to Fand [11] who revealed that *S. litura* could sustain under constant temperatures ranging between 20°C and 30°C, however favorable temperature range observed was only between 25°C and 30°C.

The significant effect of three constant temperatures (20, 25 and 30°C±1°C and 65±5% R.H.) on the duration period of immature stages, pre-oviposition, oviposition, post-oviposition periods and fecundity of *Chrysodeixis chalcites* (Esper) were also proved by Abd Allah [12].

Data in Table (2) also demonstrated that longevity and fecundity of females and male longevity were decreased with increasing temperature. The female longevity was 11.54, 8.70 and 106.67 days for 20, 25 and 30 °C, respectively, while the male longevity was 6.68, 4.77 and 3.86 days for 20, 25 and 30 °C, respectively. The same results were observed by Rao [8] who also did not get *S. litura* oviposition at constant high temperatures of 35°C and 37°C, however, only deviation that existed for low temperature of 15°C, where they reported egg laying [3].

Fand [11] indicated that at higher constant temperature (> 35°C), the life span of female adults of *S. litura* was approximately 4-5 times less than life span at low constant temperature (15°C), leading to substantial shortening of reproductive phase.

Data arranged in Table (3) indicated that the total average of deposited eggs was increased with increasing temperature. The total average of deposited eggs was 19.53, 58.66 and 108.65 for 20, 25 and 30 °C, respectively. Similar results were described by Taha [3].

The fecundity and fecundity rate of *S. litura* were found highly temperature-dependent. A curvilinear response was observed for fecundity with a maximum at 25°C (1, 234.9 eggs/female) and decreasing at temperatures below and above this temperature. This demonstrates that prevalence of optimum temperature can play a bigger role in determining the suitability of climate for the mating and oviposition of *S. litura* adults. Fairly similar trend in temperature-

Table 4: Effect of three temperatures (20, 25 and 30°C) on life table parameters of *Autographa gamma* at 65±5% R.H.

Life table parameters	20°C	25°C	30°C
Net reproduction rate (R_o)	67.16	19.04	33.94
Mean generation time (T)	42.52	33.06	23.02
Intrinsic rate of increase (r_m)	0.26	0.37	0.55
Finite rate of increase (λ)	1.30	1.44	1.74
Doubling time (in days)*	2.77	2.32	1.91

*Doubling time (days) = $\ln_2 / r_m$

dependent fecundity of *S. litura* was reported by earlier workers, who found temperatures between 25-30°C as suitable range for *S. litura* reproduction and temperatures >33°C were highly detrimental [13-16].

Oviposition and its rate are crucial components on which depends an insect population density and hence detailed knowledge on temperature-dependent age-specific fecundity is imperative for developing pest-forecasting models [9].

Data in Table (4) showed that the net reproduction rate (R_0) was 67.16, 19.04 and 33.94 for 20, 25 and 30°C. The mean generation time was 42.52 at 20°C followed by 33.06 at 25°C and 23.02 at 30°C. Therefore, the doubling time was 2.77 days at 20°C followed by 2.32 and 1.91 days at 25 and 30°C, respectively. However, the intrinsic rate of increase (r_m) was 0.26, 0.37 and 0.55 at 20, 25 and 30°C, respectively. In addition, finite rate of increase (λ) was 1.30, 1.44 and 1.74 at 20, 25 and 30°C, respectively.

The effects of constant temperatures on the life table parameters of *S. litura* have been reported in many studies [17, 20]. However, Manimanjari [16] addressed a range of constant temperatures within the ecologically relevant limits for *S. litura* development. They reported slightly higher Means for the life table parameters of *S. litura* reared on sunflower at six constant temperatures between 20-35°C. These results are largely consistent with literature reports. However, discrepancies occurred between r_m and R_o predicted from this study and those reported in literature [11]. It seems that these discrepancies are largely due to the deviations from the selected sub-model for development and mortality of immature stages and total fecundity per female, which are considered to be the most variable factors [10, 21, 22].

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