BIONOMIC AND LIFE TABLE PARAMETERS OF OLIVE PSYLLID, *EUPHYLLURA STRAMINEA* ON OLIVE SEEDLINGS UNDER THREE CONSTANT TEMPERATURES

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ABSTRACT: Bionomic and life table parameters of *Euphyllura straminea* Loginova were carried out at three constant temperatures (20°C, 25°C and 30°C) on olive seedlings throughout one complete generation. Durations and percentage of mortalities for different developmental stages were estimated. Results revealed that egg incubation period, durations of nymphal stage and the five nymphal instars were decreased as temperature increased from 20°C to 30°C. Moreover, the highest percentage of mortality was occurred throughout 1st nymphal instar at 30°C, while the lowest percentage was occurred throughout 4th nymphal instar. The values of zero of development for different developmental instars were 11.96, 13.30, 13.40, 13.10, 15.40 and 14.50 for egg 1st, 2nd, 3rd, 4th and 5th nymphal instars and nymphal stages, respectively. Results showed that the highest percentage of adults' emergence and sex ratio were occurred at 25°C being 92.6 % and 1: 1.8, respectively. Also, results revealed that temperature had highly significant effects on durations of pre-oviposition, oviposition and post-oviposition periods as well as adult longevity for both sexes. These durations were decreased as temperature increased from 20°C to 30°C. Female fecundity and egg hatchability were affected by prevailing temperature. The highest numbers of deposited eggs was 277.2 eggs/ female and egg hatchability was 87.66 % occurred at 25°C. Results of life table parameters showed that the highest percentage of egg hatchability and the lowest percentages of apparent and real mortality as well as the highest numbers of adult's survival were occurred at 25°C. The highest net reproductive rate (R) was occurred at 25°C being 88.91 eggs / female. The shortest generation time (GT) was 46.66 day occurred at 30°C. Both intrinsic rate of increase (r_m) and finite rate (λ) were occurred for those reared at 25°C and 30°C. Both values were 0.03 and 1.03 occurred at the two tested temperatures. The shortest population doubling time (Dt) was occurred at 25°C being 27.95 days. All these parameters revealed that 25°C seemed to be optimal temperature for rearing *E. straminea*.

KEY WORDS: *Euphyllura straminea,* bionomic, life table parameters.

Olive groves are widely distributed allover the world specially Mediterranean Basin and Western Asia. In Egypt the olive groves are distributed in North West coastal region, Sinai, West delta, Fayoum, Sewa and New valley. Olive groves are attacked by many pests which cause considerable reduction in quantity and quality of olive fruit yield. These pests are scale insects, olive fruit fly, stem borers, lepidopterous worms, olive thirips, mites and root-knot nematode. During the last decade of the twentieth century olive Psyllid, *Euphyllura straminea* Loginova was recorded as new pest on olive trees in El-Arish (Nada, 1994). Afterwards, this species was widely distributed allover the country and began to be a key pest in some localities.

Biological information about this new pest are relatively scarce i.e. Ali & Ahmed (1984) in Iraq and Hamza (2007) in Egypt.

The present work aimed at studying bionomic and life table parameters for *E. straminea* under three constant temperatures on olive seedlings to investigate the optimum temperature for this insect.

MATERIALS AND METHODS

A stock culture of *Euphyllura straminea* Loginova on olive seedlings was maintained under insectary conditions. Also stocks of olive seedlings "Tophahy" cultivar about 40–45 cm. height were cultivated in plastic pots 15 cm. diameter and kept free of infestation under insectary conditions. After adults emerged one pairs (male + female) were taken from the stock culture and placed on olive seedlings (10 seedlings). Each seedling was put inside plastic chimney which fixed firmly at the lower end at the soil pot, while the upper end was covered with muslin which fixed by rubber band. These pots were examined daily until female deposited eggs. All biological experiments were carried out under laboratory conditions inside incubators at three constant temperatures, 20°C, 25°C and 30°C and relative humidity 55 ± 5 % and illuminated with florescent lamp for 12 hrs. daily.

To determine incubation period, percentages of eggs hatchability and zero of development, seven hundred and fifty eggs which deposited in the same days were collected from the ten pairs found on olive seedlings. These eggs were divided into 3 groups each 250 eggs. Each group was divided into five replicates (each 50 eggs) and placed on a black cloth inside Petri dishes. These dishes were put at the three tested temperatures. These eggs was examined twice daily by using stereoscopic microscope. Incubation periods and percentages of hatchability were recorded. Their means and standard error were calculated.

Three groups of olive seedlings free of infestation, each five seedlings were used to estimate duration and mortality percentages of different nymphal instars as well as nymphal stages at the three tested constant temperatures. Newly hatching nymphs from eggs which used to estimate incubation period were transferred gently by aid of fine camel hair brush to the corresponding temperatures to the five olive seedlings. After settling nymphs on the seedling, a sketch of each one was made and numerated. Each seedling was examined daily by using USB microscope. Duration and mortality were recorded for the five nymphal instars as well as means and slandered error were calculated.

After adults emergence, they were collected and sexed from each group, sex ratio was calculated. Ten pairs for each tested temperatures were used to estimate duration of both sexes and fecundity for females. Each pair was transferred to a clean olive seedling covered with plastic chimney and kept at the corresponding temperatures. Each seedling was provided with few drops of honey solution for adult feeding. Adult males were observed until death and longevity was calculated.

The adult females were observed daily until death. Also, pre-oviposition, oviposition and post-oviposition periods as well as fecundity were estimated. The means and standard error of the above mentioned durations and fecundity were calculated. Results obtained were subjected to statistical analysis of variance using SAS program and mean mortality percentages were transformed to arc-Sine before analysis (Anonymous, 1990).

Zero of development of different stages was calculated according the equation proposed by Stinner et al. (1974).

$$\text{Rate of development} = 1/ t \times 100$$

Where: t = duration in days.

Thermal units required for different development stages were determined according Price (1984) using the following equation:

$$K = di \times (ti - a)$$

Where: a: zero of development; ti: Temperature of incubation; di: Mean number of days in incubation and K: Thermal unit.

Life tale parameters were constructed according Anderwartha & Birch (1984) for the three constant temperatures. Results of life table parameters were subjected to computer program proposed by Abou Setta et al. (1984).

RESULTS AND DISCUSSION

Results obtained about bionomic parameters at three constant temperatures (20°C, 25°C and 30°C) of *Euphyllura straminea* are given in Tables (1 to 7). It found more convince to discuss results for each stage separately.

1. Egg stage:

Results of incubation period, percentage of egg hatchability, zero of development, rate development and thermal constant are given in Table (1).

These results revealed that temperature had highly significant effect on egg incubation period of *E. straminea*. Egg incubation period was decreased gradually as the temperature increased from 20°C, 25°C and 30°C. Mean incubation periods of egg stage were 11.02, 8.90 and 5.20 days at 20°C and 30°C, respectively. Also, results showed that temperature had highly significant effect on percentage of eggs hatchability. The highest egg hatchability percentage (87.66 %) was occurred at 25°C, followed by those at 30°C being 83.50 %, while the lowest percentage (74.00 %) was occurred at 20°C.

Moreover, results showed that zero of development for egg stage was 11.96. Results showed that of development was increased gradually as the temperature increased from 20°C to 30°C. These rates were 9.07, 11.23 and 19.23 at 20°C, 25°C and 30°C, respectively. Also, results revealed that thermal constant units required for development of egg stage were greatly affected by prevailing temperature. The highest thermal units needed was occurred at 25°C 116.06 DD's, while the lowest thermal units needed was occurred at 20°C being 89.60 DD's.

From these results it could be stated that 25°C seemed to be the optimum temperature for egg stage of *E. straminea*. At this degree the highest hatchability percentage as well as the highest thermal constant was needed. These results are in harmony with those obtained by Ksantini et al. (2002). They stated that optimal temperature for egg of this species was 25°C.

2. Nymphal stage:

Nymphal stage of *E. straminea* is passed throughout five nymphal instars. Results obtained about the effects of the three constant temperatures and durations of the five nymphal instars as well as nymphal stage and their percentage of mortality are given in Table (2).

These results showed that the three tested temperatures had highly significant effects on mean durations of the five nymphal instars as well as duration of nymphal stage. Means duration of the five nymphal instars and mean duration of nymphal stage were decreased gradually as the temperature increased from 20°C to 30°C.

The shortest means duration were occurred at 30°C being 3.09, 5.50, 3.73, 4.31, 3.92 and 20.55 days for 1st, 2nd, 3rd, 4th, 5th and nymphal stage, respectively. While, the longest mean for both instar and nymphal stage were occurred at 20°C being 8.07, 9.40, 8.11, 9.90, 8.50 and 43.98 days for the five instars and stage, respectively. Moreover, results revealed that temperature had highly significant effects on the percentage of mortalities of the five nymphal instars as well as

nymphal stage. The highest percentage of mortalities was occurred at 30°C for the 1st nymphal instar being 17.32, 11.76, and 24.04 at 20°C, 25°C and 30°C, respectively. The general average of mortality percentage for this instar was 17.70% at the three tested temperatures. While, the lowest percentage of mortality were occurred at the 4th nymphal instar being 1.50, 4.00 and 10.26 % at 20°C, 25°C and 30°C, respectively. The general average of percentage of mortality was 5.25 % at the three tested temperatures. Also, the highest mortality percentage for nymphal stage was occurred at 30°C being 14.34 % followed by those at 20°C being 8.90 %, while, the lowest percentage of mortality was occurred at 25°C being 6.80 %.

From these results it could be stated that the highest percentage of mortality was occurred throughout the 1st nymphal instar. While, the lowest percentage was occurred throughout the 4th nymphal instar. Moreover, it could be stated that 25°C seemed to be the most favorable when the lowest percentages of mortality were occurred throughout the five nymphal instar as well as nymphal stage.

These results are closely related by these obtained by Hamza (2007) he stated that duration of nymphal stage of *E. straminea* ranging 23 - 25 days at 25°C. Also, he added that the highest percentage of mortality was occurred in the first nymphal instar being 2.5–6.8 %, while, the lowest percentage was occurred in the fourth nymphal instar.

Results of zero of development for the five nymphal instars as well as nymphal stage and effects of temperature rate of development and thermal constant units are given in Table (3).

These results revealed that zero of development for the five nymphal instars and nymphal stage were 13.3, 13.4, 13.1, 13.9, 15.4 and 14.5°C for the 1st, 2nd, 3rd, 4th, 5th and nymphal stage, respectively. Moreover, results revealed that both rate of development and thermal units for nymphal instars as well as nymphal stage were obviously affected by prevailing temperatures. Rate of development was increased gradually as the temperature increased from 20°C to 30°C. The lowest rate was occurred at 20°C (2.27) followed by 25°C (2.86); while, the highest rate was occurred at 30°C (4.87). Also, results revealed that thermal constant required for development of nymphal stage of *E. straminea* were greatly affected by changes of prevailing temperature. The highest value of needed thermal units was occurred at 25°C being 326.43 DD's, while the lowest thermal value of needed temperature was occurred at 20°C being 189.11 DD's. From these results it could be stated that 25°C seemed to be the most favorable temperature for rearing nymphal stage.

3. Adult stage:

Adults emergence was occurred usually at afternoon. After emergence the males began to move around the female, then they stand side by side in V-shape position, then copulation was take place. After copulation process the fertile females passed throughout three periods, pre-oviposition, oviposition and post-oviposition periods.

Results in Table (4) summarized the effects of three constant temperatures on percentage of adult emergence, sex ratio and mean durations of different periods of adult female as well as female fecundity and percentage of egg hatchability.

Percentage of adult emergence and sex ratio:

Results revealed that the three constant temperatures were highly significant affected on both percentage of adults emergence as well as sex ratio. The highest percentage of adult emergence was occurred at 25°C being 92.6 % and sex ratio male : female was 1: 1.8, followed by those at 30°C being 92.4 % and 1: 1.7, while,

the lowest percentage of adult emergence and sex ratio were occurred at 20°C being 87.8 % and 1: 1.6, respectively.

From these results it could be stated that 25°C seemed to be the most favorable temperature of adults emergence as well as sex ratio. These results are similar to those obtained by Ali & Ahmed (1984) they stated that sex ratio of *E. straminea* under laboratory conditions was 1: 1.4 with slight predominance to females. Also, Hamza (2007) recorded sex ratio was 1: 1.7 for the same species.

Pre–oviposition period:

Results of statistical analysis showed that the three constant temperatures had highly significant effects on mean duration of pre- oviposition period. These results revealed that means of pre- oviposition periods were decreased when temperature increased from 20 to 30°C. The longest period was occurred at 20°C being 16.5 days followed by those at 25°C being 9.5 days. While, the shortest period was occurred at 30°C being 4.5 days.

Oviposition Period:

Results showed that oviposition period found to be the longest period followed by pre - oviposition period, while, post- oviposition period was the shortest period. Results of statistical analysis revealed that the three tested temperatures had highly significant effects on mean duration of oviposition period. Mean durations of this period were decreased when temperature increased. The longest mean was occurred at 20°C being 33.10 days, followed by those reared at 25°C being 29.4 days. While, the shortest mean was 22.5 days occurred for females reared at 30°C.

Post-oviposition Period:

Results of statistical analysis showed that temperature had highly significantly effects on mean durations of post oviposition period. Mean durations of this period were decreased as temperature increased from 20°C to 30°C. The longest mean duration was occurred at 20°C being 10.50 days, followed by those reared at 25°C being 6.10 days. While, the shortest mean was occurred at 30°C being 3.30 days.

Female Fecundity:

The reproductive potentiality is expressed as total numbers of deposited eggs per female during its longevity.

Data obtained about female fecundity of *E. straminea* which reared at the three constant temperatures are given in Table (4). Results of statistical analysis revealed that temperature had highly significant effects on female fecundity. The highest mean fecundity was occurred at 25°C being 277.2 eggs / female, followed by those at 30°C being 214.8 eggs / female. While, the lowest mean was occurred for those reared at 20°C being 101.1 eggs / female.

From those results it could be stated that 25°C seemed to be the most favorable temperature for rearing *E. straminea* under laboratory conditions.

These results are in harmony with these obtained by Ksantini et al. (2002) they stated the optimum temperature for female fecundity of *E. olivine* was 25°C. While, female fecundity was decreased with increasing when temperature exceeded to 32°C inhibition of ovary activity was occurred.

Egg Fertility:

Egg fertility is represented by percentage of egg hatchability of deposited eggs. Data in Table (4) showed percentages of egg hatchability of *E. straminea* when reared under the three tested temperatures. Results of statistical analysis showed that temperature had highly significant effects on percentage of egg hatchability. The highest mean of egg hatchability 87.66 % was occurred at 25°C followed by

those reared on 30°C being 83.50 %.While, the lowest mean was occurred at 20°C being 74.00 %.

These results confirmed that 25°C seemed to be optimal temperature for rearing *E. straminea* under laboratory conditions.

Adults Longevity:

Longevity of both male and female are represented by time elapsed between adults emergence from fifth nymphal instar until death. Data obtained about the effects of the three tested temperatures on longevity for both sexes and mean durations of generation are given in Table (5). Results of statistical analysis showed that the three tested constant temperatures had highly significant effects on means longevity of both sexes.

The female longevity was longer than male longevity at the three tested temperatures. These results revealed that means longevity for both sexes were decreased as temperature increased. Means male longevity were 42.40, 39.70 and 28.50 days at 20°C, 25°C and 30°C, respectively. Also, means female longevity were 60.10, 45.00 and 30.30 days for the same temperatures, respectively.

Duration of Generation:

Duration of generation is the time elapsed from egg deposition till the first deposited egg (from egg to egg). This duration was calculated by summing egg incubation period, duration of nymphal stage and duration of pre oviposition period.

Data obtained are given in Table (5). Results revealed that mean duration of generation was decreased as temperature increased from 20°C to 30°C. Mean durations were 71.50, 53.50 and 30.25 days at 20°C, 25°C and 30°C, respectively.

4. Life Table Parameters:

Life table analysis of *E. straminea* was carried out at three constant temperatures (20°C, 25°C and 30°C) on olive seedlings. Each tested temperature was started with 250 eggs. Data obtained were used to investigate survival for each nymphal instar, adult female, fecundity, generation time and other life table parameters at the three tested temperatures.

4.1. Immature stages:

Results obtained for percentage of apparent and real mortalities for the five nymphal instars are given in Table (6). These results revealed that both apparent and real mortalities were differed from stage to another as well as from instar to another according to the prevailing temperature. Regarding the percentages of egg mortalities (apparent and real) at the three tested temperatures, the highest percentage of mortality was occurred at 20°C being 26.00 % followed by those incubated at 30°C being 16.80 %. While, the lowest percentage was occurred for those incubated at 25°C being 11.60 %.

Results of percentage of apparent mortalities of the five nymphal instars revealed that the highest percentage was occurred at those reared at 30°C being 24.0% followed by those at 20°C being 17.3%, while, the lowest percentage was occurred at 25°C being 11.8%. Also, percentage of real mortalities of the first nymphal instar nearly followed the same trend; these percentages were 20.0, 12.80 and 10.40% at 30°C, 20°C and 25°C, respectively. The percentages of apparent mortalities for the second nymphal instar were 5.2, 5.6 and 13.9% for those reared at 20°C, 25°C and 30°C, respectively. Also, the percentages of real mortalities were 3.20, 4.40 and 8.80% at the three tested temperatures, respectively. The percentages of both apparent and real mortalities of the third nymphal instar were followed the same trend. The highest percentages were

occurred for those reared at 30°C being 13.9 and 7.60%, followed by those reared at 25°C being 8.30 and 4.80%, while, the lowest percentages were occurred for those reared at 25°C being 4.90 and 3.60% for apparent and real mortalities, respectively. Moreover, percentages of apparent and real mortality percentages of fourth nymphal instar followed the same trend. The highest percentages were occurred for those reared at 30°C being 10.30 and 4.80% followed by these reared at 25°C being 4.0 and 2.80 %, while the lowest percentages were occurred for those reared at 20°C being 1.50 and 0.80%, for the fourth nymphal instar, the apparent and real mortalities, respectively.

Moreover fifth nymphal instar the both percentages showed that the highest percentages were occurred for those reared at 20°C being 12.20 and 6.40% followed by those reared at 30°C being 9.50 and 4.00%, while the lowest percentages were occurred for those reared at 25°C being 7.70 and 5.20% for appeared and real mortalities, respectively.

The survival for nymphal stage to adult revealed that the highest numbers of adult were obtained from those reared at 25°C being 155 adults, followed by those reared at 20°C being 115 adults, while, the lowest number was obtained for those reared at 30°C being 95 adults only.

From these results it could be stated that 25°C seemed to be the optimum temperature for rearing *E. straminea* on olive seedlings. The highest percentage of eggs hatchability and the lowest percentages of apparent and real mortality most nymphal instars as well the highest number of adults survival were occurred at this degree.

4.2. Survival and Fecundity of Adults:

Table (7) summarized life table parameters of *E. straminea* reared at three constant temperatures (20°C, 25°C and 30°C) on olive seedlings.

4.2.1. Net reproduction rate (R):

Results indicated that net reproductive rate of *E. straminea* female gave the highest birth average at 25°C being 88.91 eggs / female followed by those reared at 30°C being 26.40 eggs / female, while the lowest rate was occurred by those reared at 20°C being 4.92 eggs / female.

4.2.2. Generation time (Gt):

Results revealed that generation time was varied at the three tested temperatures. The shorted generation time was occurred at 30°C being 46.66 days, followed by those reared at 25°C being 61.71 days. While, the longest generation time was occurred by these reared on 20°C being 68.75 days.

4.2.3. Intrinsic rate of increasing (r_m):

The intrinsic rate of increase ($\mathbf{r_m}$) refers to the rate of daily population growth and is also considered an important index of potential population performance. The calculated values of (r_m) showed that these rates were affected by the prevailing temperatures. The highest intrinsic rates individual / days were obtained for those reared at 25°C and 30°C being 0.03 and 0.03 individual / day, while lowest rate was occurred for those reared at 20°C being 0.01 individual / day.

4.2.4. Finite rate of increase (λ):

The finite rate of increase or (exp r_m) is considered as the discrete version of (r_m). The calculated values of finite rate of increase of *E. straminea* followed the same trend which occurred for the intrinsic rate of increase. The highest values were 1.03 and 1.03 female / days for those reared at 25°C and 30°C, while the lowest value was 1.01 female / day for those reared at 20°C.

4.2.5. Population double time (Dt):

Results revealed that population of *E. straminea* reared at 20°C recorded the longest double generation value being 86.32 days followed by those at 30°C being 28.47 days. While, the shortest double generation value was occurred for those reared at 25°C being 27.93 days.

From the above mentioned results it could be concluded that 25°C seemed to be the optimum degree of temperature for rearing *E. straminea* on olive seedlings. At this degree female fecundity, net reproduction rate, intrinsic rate of increase and finite rate of increase recorded their maximum values. Also, population doubling time was recorded its minimum value. These results are in harmony with those obtained by Arambourg (1985) who stated that favorable temperature for *E. olivine* was ranged between 20°C - 25°C. He added that extreme temperatures above 27°C decreased oviposition and low temperature caused a significant drop in egg laying.

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Table 1. Effects of three constant temperatures on egg incubation period, percentage of hatchability of olive Psyllid, zero of development, rate of development and thermal constant units of egg stage of *E. straminea*.

Temp. °C	Incubation Period/day	Hatching %	Zero of development	Rate of development	Thermal constant
20	11.02 ± 0.59 **a**	74.00 ± 1.41 **c**	11.96°C	9.07	89. 60
25	8.90 ± 0.22 **b**	87.66 ± 0.99 **a**		11.23	116.06
30	5.20 ± 0.45 **c**	83.50 ± 2.78 **b**		19.23	93.81
Average	8.37	81.72			
" F "	216.18**	68.27**			
LSD	0.62	2.57			

Table 2. Effects of three constant temperatures on means duration and mortality percentages of the five nymphal instars and nymphal stage of olive Psyllid, *E. straminea*.

Temp.°C.	Mean duration / days Percentages of Mortality					
	1st instar	2nd instar	3rd instar	4th instar	5th instar	Nymphal stage
20	8.07 ± 0.5 **a**	9.40 ± 0.8 **a**	8.11 ± 0.5 **a**	9.90 ± 0.5 **a**	8.50 ± 0.5 **a**	43.98 ± 1.75 a
	17.32 **b**	5.23 **b**	8028 **b**	1.50 **c**	12.20 **a**	8.90 **b**
25	7.12 ± 0.5 **b**	7.02 ± 0.5 **b**	6.41 ± 0.4 **b**	7.20 ± 0.5 **b**	7.35 ± 0.5 **b**	35.10 ± 0.89 b
	11.76 **c**	5.64 **b**	4.89 **c**	4.00 **b**	7.74 **c**	6.80 c
30	3.09 ± 0.5 **c**	5.50 ± 0.5 **c**	3.73 ± 0.4 **c**	4.31 ± 0.5 **c**	3.92 ± 0.5 **c**	20.55 ± 1.20 c
	24.04 **a**	13.92 **a**	13.97 **a**	10.26 **a**	9.52 **b**	14.34 a
Average duration	6.19	7.31	6.08	7.13	6.92	33.21
Average % mortality	17.70	8.26	9.04	5.25	9.82	10.10
"F" For Mean duration	80.00**	17.10**	40.00**	20.00**	26.67**	412.90**
LSD	0.69	0.74	0.49	0.08	0.69	1.84
"F" For % Mortality	45.62 **	138.10**	170.50**	521.60**	43.90**	28.10*
LSD	2.80	1.30	1.10	0.61	1.00	1.15

Table 3. Effects of three constant temperatures on rate of development and thermal constant units of the five nymphal instars duration of *E. straminea*.

Temp. °C.	Nymphal instars stages	Nymphal instars duration	Rate of development (t.)	Thermal constant units (DD's)
20	1st	8.07 ± 05	12.39	54.07
	2nd	9.40 ± 08	10.63	62.04
	3rd	8.11± 05	12.33	55.96
	4th	9.90 ± 05	10.10	60.39
	5th	8.50 ± 05	11.76	39.10
	stage	**43.98 ± 1.75**	**2.27**	**189.11**
25	1st	7.12 ± 05	14.04	154.50
	2nd	7.02 ± 05	14.25	81.43
	3rd	6.41 ± 04	15.60	76.28
	4th	7.20 ± 05	13.89	79.92
	5th	7.35 ± 05	13.61	70.56
	stage	**35.10 ± 0.89**	**2.85**	**326.43**
30	1st	3.09 ± 05	32.36	51.60
	2nd	5.50 ± 05	18.18	91.30
	3rd	3.73 ± 04	26.81	63.04
	4th	4.31 ± 05	23.20	69.39
	5th	3.92 ± 05	25.51	57.23
	stage	**20.55 ± 1.20**	**4.87**	**293.87**

Zero of development for the five nymphal instars and nymphal stage: 1st = 13.3 °C / 2nd = 13.4 °C / 3rd = 13.1 °C / 4th = 13.9 °C / 5th = 15.4 °C / Nymphal stage = 14.5°C

Table 4. Effects of three constant temperatures on adults emergence, sex ratio and mean durations of pre-oviposition, oviposition, post-oviposition periods, female fecundity and percentage of egg hatchability of *E. straminea*.

Temp. °C	% Adult emergence	Sex ratio		Mean duration of adult female / days				
		Male	Female	Pre-oviposition	oviposition	Post-oviposition	Female fecundity Eggs/female ± s.e.	% Egg hatchability
20	87.8 ± 2.56 **c**	1	1.6	16.5 0.5 **a** (15.5 – 16.5)	33.1 0.61 **a** (32 – 33.5)	10.5 0.61 **a** (9.5 - 11)	101.1 ± 11.43 **c** (86 – 112)	74.00 ± 1.41 **c** (73.5 – 76)
25	92.6 ± 0.55 **a**	1	1.8	9.5 0.5 **b** (8.5 – 9.5)	29.4 0.1 **b** (28 - 30)	6.01 0.1 **b** (4.5 - 7)	277.2 ± 30.03 **a** (231 – 301.5)	87.66 ± 0.99 **a** (86.6 – 89.2)
30	90.4 ± 4.51 **b**	1	1.7	4.5 0.94 **c** (3 - 5)	22.5 ± 0.71 **c** (21 – 23)	3.30 0.71 **c** (2.5 - 4)	214.8 ± 20.51 **b** (196 – 244)	83.50 ± 2.78 **b** (80.9 – 88)
" F"	**248.95** **			**92.0****	**248** **	**396.36**	**83.03****	**68.27****
LSD	**1.21**			**1.13**	**1.09**	**0.93**	**30.21**	**2.57**

Table 5. The effects of three constant temperatures on means longevity and durations of generation of *E. straminea*.

Temp. °C	Male longevity	Female longevity	Mean incubation period/days	Mean duration of nymphal /days	Mean duration of pre-oviposition/day	Mean duration of generation
20	42.40 ± 2.12 (39.5 – 44) **a**	60.10 ± 0.79 (57.5 – 71.5) **a**	11.02 ± 0.59	43.98 ± 1.75	16.50 0.5	71.50
25	39.70 ± 2.15 (36 – 42.5) **b**	45.00 ± 1.27 (41.5 – 50.4) **b**	8.90 ± 0.22	35.10 ± 0.89	9.50 0.5	53.50
30	28.50 ± 2.24 (25.7 – 31.3) **c**	30.30 ± 1.46 (28.5 – 37.5) **c**	5.20 ± 0.45	20.55 ± 1.20	4.50 0.94	30.25
Average			8.30	33.21	10.17	51.75
" F "	58.21**	164.57**				
LSD	1.97	1.66				

Table 6. Some life table parameters of *E. straminea* from egg stage to adults reared on three constant temperatures.

Temp °C	Stages	Number of dead individuals	% Apparent mortality	% Real mortality
20	Egg	45	26.00	26.00
	1st instar	32	17.30	12.80
	2nd instar	8	5.20	3.20
	3rd instar	12	8.30	4.80
	4th instar	2	1.50	0.80
	5th instar	16	12.20	6.40
	Total	**115**	**70.50**	**46.00**
	Adult (♀ + ♂)	**115**	----	----
25	Egg	42	11.60	11.60
	1st instar	50	11.80	10.40
	2nd instar	22	5.60	4.40
	3rd instar	19	4.90	3.60
	4th instar	12	4.00	2.80
	5th instar	10	7.70	5.20
	Total	**155**	**45.60**	**38.00**
	Adult (♀ + ♂)	**155**	----	----
30	Egg	29	16.80	16.80
	1st instar	26	24.00	20.00
	2nd instar	11	13.90	8.80
	3rd instar	9	13.90	7.60
	4th instar	7	10.30	4.80
	5th instar	13	9.50	4.00
	Total	**95**	**88.40**	**62.00**
	Adult (♀ + ♂)	**95**	----	----

Table 7. Summary of life table parameters for *E. straminea* reared at three constant temperatures.

Temp. °C	Net reproductive rate (R_o)	Generation time /day (Gt)	Intrinsic rate of increase (r_m)	Finite rate of increase (λ)	Population doubling time (Dt)
20	4.92	68.75	0.01	1.01	86.32
25	88.91	61.71	0.03	1.03	27.93
30	26.40	46.66	0.03	1.03	28.47