THRESHOLD OF DEVELOPMENT AND THERMAL CONSTANT FOR DIFFERENT STAGES OF THE SEYCHELLES FLUTED SCALE, *ICERYA SEYCHELLARUM* (WESTWOOD)

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ABSTRACT: Different biological features of *Icerya seychelarum* were carried out at three constant temperatures (25°C, 30°C and 35°C) on mulberry seedlings, *Morus alba* L. throughout one complete generation. Durations and rate of development percentage for different developmental stages were estimated. Results revealed that egg incubation period, durations of nymphal stage were decreased as temperature increased from 25°C to 35°C. Rates of development percentage of both egg and nymphal stages were increased as temperature increased from25°C to 35°C. Also, results revealed that temperature had highly significant effects on durations of female pre-oviposition, oviposition and post-oviposition periods. These durations were decreased as temperature increased from 25°C to 35°C. Hypothetical threshold (zero) of development was 12.25, 17.62. 21.9 and 21.4 days for egg, nymphal stage, pre-oviposition and oviposition periods; respectively. Mean thermal units were 86.75, 552.64, 84.58 and 204.92 degree/days for egg, nymphal stage, pre-oviposition and oviposition periods; respectively. All these parameters revealed that 25°C seemed to be optimal temperature for rearing the Seychelles fluted scale.

KEY WORDS: Zero of development, *Icerya seychelarum,* mulberry, thermal constant, mealybug, Seychelles fluted scale

The Seychelles fluted scale, *Icerya seychellarum* is polyphagous phloem-feeding. It was first recorded in Egypt by Ezz & Samhan (1965) on five ornamental plant species at Suez Governorate, since that time it was spread rapidly and infests many economic horticultural plants. Damage caused by *Icerya* sp. was described by several authors. Siddpapji et al. (1984) described the damage caused by *Icerya aegyptiaca* (Douglas) on mulberry in India. *I. seychellarum* feeds on the plant sap by sucking it from the tissues of the host plant. Plant sap contains few concentration of protein, so this insect sucks a great amount of the sap to collect sufficient amount of protein for its growth (Mogahed & Abbas, 2003). In addition to high population of *I. seychellarum* can reduce the vigor of the plant, making it susceptible to other pests (Osman, 2005). The present work aims at estimating of some bionomics parameters of the Seychelles fluted scale at different three constant temperatures on mulberry seedlings to investigate the optimum temperature for this insect.

MATERIAL AND METHODS

Biological studies of *I. seychellarum* on mulberry seedlings (*Morus alba*) were carried out under three different temperatures. A stock culture of *I. seychellarum* on mulberry seedlings were obtained by collecting some highly infested (25, 30 and 35°C) leaves and branches of mulberry trees with *I. seychellarum* from different areas and different periods in the field and transferred to another healthy mulberry seedlings transplanted in pots in the laboratory. To obtain

newly hatched crawler's, infested leaves and branches were placed in paper bags, brought to the laboratory, the female separated from them and examined daily with the aid of stereomicroscope to obtain newly hatched crawlers. Newly hatched crawlers were isolated from the ovipositing females and ovisacs and transferred to seedlings for about 4-6 months old and 40-45cm height were cultivated in plastic pots 15cm in diameter. These pots were filled with a mixture of sand and peat moss and kept inside a wooden cage. newly hatched crawlers of the same age were transferred to seedling by the aid of a fine moistened camel hair brush (one to two crawler per leaf). For studying the duration of adult females, the periods from the day of attaining these nymphs to the adult female stages till the death of these females were recorded. Duration of different developmental stages at three constant temperatures were used to estimate the zero of development for each stage as well as thermal requirements. Lower threshold of development for each stage was calculated according the equation of (Stinner et al., 1974).

The rate of development % was calculated from the following formula:

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

Where: t = duration of considered stage in days .

The thermal units (degree-days) required for complete development of each stage was determined according to Campbell et al. (1974) and Ramadan (2008). The degree-days (DD′s) were calculated from the following equation:

$$DD = d\,(T - t_o)$$

Where: DD : Thermal units (degree-days) .

d: the developmental duration of a given developmental stage at constant temperature

T: Temperature of incubation.

t_o: threshold temp. in degree centigrade

RESULTS AND DISCUSSION

Influence of constant temperatures on the biological parameters of *I. seychellarum* and its relation to degree-days of *Icerya seychellarum* were carried out under three constant temperatures of 25, 30, 35 °C ±1 on mulberry seedlings throughout one complete generation inside incubators.

1. Egg stage: Incubation period of egg was decreased gradually as the temperature increased from 25 to 35°C with mean numbers of incubation periods of 7.45, 4.21 and 3.98 days at the three constant temperatures; respectively. The rate of development was increased gradually as the temperature increased from 25 to 35°C. which being 13.42, 23.75 and 25.13 at 25, 30 and 35°C., respectively. The lower developmental threshold (t_o) was 12.25°C. Also thermal units (k) expressed as degree-days required for complete embryonic development of incubation period for *I. seychellarum* eggs were 94.98, 74.73 and 90.54 DD′s with an average of 86.75 DD′s at 25, 30 and 35°C, respectively.

2. Nymphal Stage: Nymphal stage of *I. seychellarum* is passed throughout three nymphal instars. Results obtained about the effects of the three constant temperatures and durations of nymphal stage and their rate of development are given in Table 2 and Figure 1.

These results showed that the three tested temperatures had highly significant effect on mean duration of this stage whereas mean duration for nymphal stage was decreased gradually as the temperature increased from 25°C to 35°C. Mean durations were 72.74, 46.42 and 31.44 days at 25, 30 and 35°C; respectively. Rate of development was increased gradually as the temperature increased from 25 to 35°C. The lowest rate was occurred at 25°C (1.37) followed by 30°C (2.15);

while the highest rate was occurred at 35°C (3.18). The threshold of development (t_0) for nymphal stage was 17.62°C. The mean values of thermal units required for development of nymphal stage were 536.82, 574.68 and 546.43 DD′s at 25, 30 and 35 °C; respectively.

3. Adult stage: Females passed throughout three periods, pre-oviposition, oviposition and postoviposition periods. Results in Table (3) summarized the effects of three constant temperatures on mean durations of different periods of adult female.

3.1. Pre–oviposition period: Mean duration of pre-oviposition were 19.13, 14.77 and 5.77 at 25, 30 and 35°C; respectively. The lower threshold of development was 21.9 °C. The thermal units required for the development of ovary *I. seychellarum* at tested temperature were 58.92, 119.34 and 75.47 DD'S at 25, 30 and 35°C; respectively.

3.2. Oviposition period: Mean duration of oviposition period was decreased when temperature increased from 25 to 35°C being 49.70, 27.70 and 14.60 at 25, 30 and 35°C, respectively. The rate of development was increased gradually as the temperature increased from 25 to 35°C which being 2.01, 3.61 and 6.85 with an average of 4.16 days. The lower threshold of development was 21.4°C. The thermal units required for oviposition period of *I. seychellarum* at three constant temperatures were 178.42, 237.94 and 198.41 DD′S at 25, 30 and 35°C; respectively.

3.3. Post-oviposition period: Post oviposition period was found to be the shortest one mean duration of this period were 10.57, 8.80 and 3.83 at 25, 30 and 35°C; respectively. The rate of development was increased gradually as the temperature increased from 25 to to35°C which being 9.46, 14.70 and 26.11 at 25, 30 and 35°C; respectively.

These results are in harmony with those obtained by Abdel-Aleem (2008a) mentioned that the incubation periods in summer and winter were 5.2± 0.2 and 18.2± 1.2 days, respectively, the duration of nymphal stage was 25.2 ± 18 days in summer and 42.8 ± 1.8 days in winter. Duration of pre-oviposition increased in winter; being 22.3 days than summer which was 8.6 days. Duration of oviposition in winter reached 13.3 days; while in summer it was 7.6 days. post oviposition period was 16.5 days; while in summer it reached 9.6 days. Abdel-Aleem (2008b) calculated zero of development of *I. seychellarum* under four constant temperatures (15, 21.27, 27 and 33°C) was 9.2°C. Also, means of thermal units 85.5 degree days for incubation period. Sayed (2008) revealed that mean of egg incubation period were 14.42, 8.53 and 7.87 days at 20, 25 and 30°C respectively. Duration of pre-oviposition at 20,25 and 30°C were 102, 26 and 24 days, respectively. Mean duration of oviposition were 25.37, 49.10 and 56.50 days at 20, 25 and 30 °C; respectively. Post- oviposition period ranged between 8-26 days. Osman (2005) did not find big difference between the incubation periods at 30.6 and 27.3°C which were 14.32 and 14.97 day; respectively. nymphal stage duration was 59.35± 1.63 days at 34 °C; while it was 152.97± 4.29 days at 27°C. The period of pre-oviposition varied from generation to another being 21.8 days at 32°C and 38.27 days at 26°C. Post oviposition period was the shortest one (11-13 days) in the two generations. Nabil et al. (2013) found duration of pre-oviposition period were 27.5 and 20.4 days for winter and summer generation, respectively. Duration of oviposition was lasted 48.3 and 34.0 days during winter and summer generations, respectively. The post oviposition period were 12.0 and 11.3 days throughout winter and summer generations, respectively.

On the other hand , these results do not agree with Osman (2005) stated that the oviposition period was 182.26 days at 30°C; while it was 75.7 days at 26 °C.

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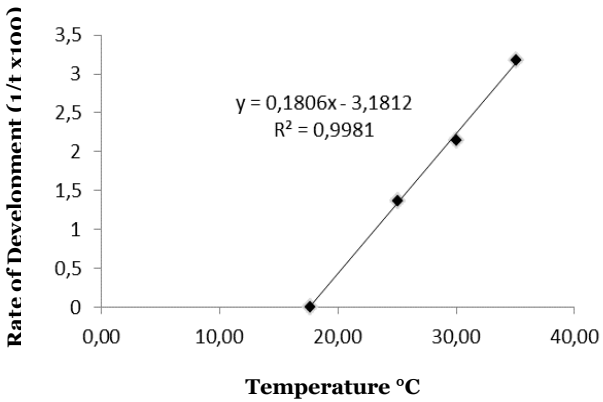

Figure 1. Relation between the constant temperature and rate of development of the nymphal stage of *I. seychellarum*.

Table 1. Effect of three constant temperatures on egg incubation period of *I. seychellarum,* rate of development and thermal constant units.

Temp. (°C).	Incubation period/day.	Rate of Development %	T_o (°C).	Thermal constant (DD'S)
25	7.45 ± 0.19 a	13.42		94.98
30	4.21 ± 0.26 b	23.75	12.25	74.73
35	3.98 ± 0.11 c	25.13		90.54
Average	5.21	20.77		86.75
" F "	271.38***			
LSD	0.39			

Table 2. Effect of three constant temperatures on nymphal stage of *I. seychellarum,* rate of development and thermal constant units.

Temp. (°C).	Duration of nymphal stage	Rate of Development %	T_0 (°C).	Thermal constant (DD'S)
25	72.74 ± 3.8 a	1.37	17.62	536.82
30	46.42 ± 1.84 b	2.15		574.68
35	31.44 ± 0.9 c	3.18		546.43
Average	50.2	2.23		552.64
" F "	74.93**			
LSD	10.22			

Table 3. Effect of three constant temperatures on mean durations of pre- oviposition, Oviposition and Post-oviposition periods of *I. seychellarum*.

Temp. (°C).	Pre-oviposition				Oviposition				Post-oviposition	
	Duration	R %	T_0	DD'S	Duration	R %	T_0	DD'S	Duration	R %
25	19.13 ± 2.11 a	5.23	21.9	58.92	49.70 ± 2.36 a	2.01	21.4	178.42	10.57± 0.79 a	9.46
30	14. 77± 0.97 b	6.77		119.34	27.70 ± 3.49 b	3.61		237.94	6.80 ± 0.45 b	14.70
35	5.77 ± 0.99 c	17.33		75.47	14.60 ± 4.88 c	6.85		198.41	3.83 ± 0.20 c	26.11
Average	13.22	9.78		84.58	30.67	4.16		204.92	3.4	16.76
"F"	107.14***				86.74***				13.31***	
LSD	3.03				5.45				1.52	