BIOLOGICAL STUDIES ON THE SEYCHELLES FLUTED SCALE MEALY BUG, *Icerya seychellarum* (WESTWOOD)ON SEEDLINGS OF MULBERRY (*Mours alba* L.) Under Laboratory Conditions

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ABSTRACT

This study was suggested to determine some biological aspects of this pest under laboratory conditions on Mulberry seedlings. Obtained results can be summarizes as follows: The first, second and third nymphal instars lasted for 13-48, 9-65 and 23-88 days, respectively according to generation. Pre-ovipostion, oviposition and post-oviposition periods were 20-49, 48-199 and 7-29 days, respectively. Oviposition periods greatly influenced with prevailing laboratory temperature and humidity. Pre-oviposition period was negatively affected with temperature and vice versa for each of oviposition period and post-oviposition period. Highest fecundity per female recorded in the second generation whereas lowest one took place in the first generation. The longest longevity average occurred in first generation followed by that in the second generation.. Incubation period averages were nearly similar in both generations. Total life cycle completed in 217-376 days in first generation and 180-384 in that of the second generation.

Key words: Biological studies, mealy bug, *Icerya seychellarum,* Mulberry, *Mours alba* L.

INTRODUCTION

The seychelles fluted scale mealy bug, ***Icerya seychellarum*** (Westwood) has a wide range of distribution throughout most Governorates of Egypt ;coastal and interior. It found not only on fruit trees but on a large number of alternate host plants as well, some of which provide good protection to and are important in the survival of the pest. *I. seychellarum* consider one of the most important economic insects of mulberry trees. This insect pest causes serious problems to silk industry in Egypt. The studies reported here undertaken to explore some biological aspects of *I. seychellarum* under laboratory conditions throughout summer, autumn, winter and spring seasons to evaluate the effect of Mulberry (*Mours alba* L.) on the initial life history of *I. seychellarum*.

Unfortunately, little attention has been given to *I. seychellarum*, thus, very little information could be gathered on the biological aspects of this insect pest. **Aly (1980)** in Egypt, observed two generations for *I. seychellarum* per year when it was reared on palm trees and on sprouting potato under laboratory conditions. No parasites were observed on the different stages .The predator *R. cardinals* (Muls.) (Coleoptera, Coccinellidae) was found attacking this mealy bug. More biological studies were reported on *I. purchasi* Maskell by **Kuwana, 1922,** in Japan, recorded that the incubation period ranged 21-27 days. The durations of different instars were 14-21, 14-21 and 12-50 days for

1st, 2nd and 3rd nymphal instars, respectively. The life cycle of this insect lasts about four months under favorable conditions. **Schrader (1930)** in Pennsylvania, recorded that the longevity of adult lasts two or three months. **Peng (1935)** in China, found that the incubation period ranged 9-27 days. Generation duration varies according to temperature and lasted 43-240 days. **Geier and Baggiolini (1950)** in Switzerland, reported that the period of which the ovisac is completely deposited lasted about 70 days and the incubation period was 36 days. **Bodenheimer (1951)** in Palestine, recorded that the pre-oviposition period ranged from 11 to 17 days during July 19-30, June and July 19-31. The incubation period gave a range of 16-35 days. The three Instars lasted 12-19, 18-40 and 11-24 days in the 1st, 2nd and 3rd nymphal instars, respectively. **Ezz (1965)** in Egypt, gave an observation on the bionomics of the mealy bug *I. aegyptiaca* (Doulgas) which was reared in the laboratory on sprouting potato tuburs. The pre-oviposition period ranged 10-20 days, the oviposition period was 42.3 days, the incubation period ranged between 4-17 days. The three nymphal instars ranged 10-46, 7-30 days and 10-48 days. The average of longevity was 66 days at 28 °C and 58% R. H. and this period increased to an average of the 120 days at 23.7°C and 62% R.H. **Azab *et al* (1969)** in Egypt, also studied the mealy bug *I. aegyptiaca*, in the laboratory on sprouting potato tubers at 29.0, 25.6 and 22.9°C. The pre-oviposition periods averaged 15,14.2 and 16.6 days, respectively. Females laid an average of 70 eggs (maximum 183) at 24.1°C and 143 eggs (maximum 247) at 27.3°C. The eggs hatched in 4.17 days, averaging 8.6 days at 29.7°C and 10 days at 24°C. The three nymphal instars lasted 19, 9.8 and 20.7 days, respectively at about 29.7 °C. The complete life cycle averaged 105.4 days at 26.4 °C and 87.2 days at 28.7 °C in the field. *I. aegyptiaca* probably has two generations a year and a partial third; one-generation occurred in spring and one in autumn.

MATERIALS AND METHODS

Experiments were conducted under laboratory conditions located at Plant Protection Research Institute (ARC), Dokki, Giza Governorate throughout mid July 2000 till late August 2001, at day-maximum temperature average 37.7±0.9°C,and night minimum temperature average 25.1 ± 0.2 °C. the daily mean relative humidity ranged 44.5–54.5%.The amount and intensity of incident light varied with the seasons.

Rearing

Single seedlings of Mulberry (*Mours alba* L.) were used in rearing of the seychelles fluted scale mealy bug, *I. seychellarum*. The seedling were about 4-5 months old, planted in 30-50 cm. clay pots the could reliably produce 7-10 leaves (Fig. 1) seedlings were kept in isolation from any insect infestation using with wire screen.

Fig (1): Seedlings of Mulberry (*Morus alba* L.) used in rearing seychelles fluted scale mealy bug, *I. seychellarum*

Insect Source

In order to have a good supply of Seychelles fluted scale mealy bug a colony was made available for different aspects of the work and maintained under a routine rearing method in the lab. Reproducing scales obtained from different field at different periods were allowed to settle on Mulberry seedlings by collecting leaves and branches of Mulberry trees heavily infested with scales of *I. seychellarum*, carefully separated under a stereomicroscope .

To infest Mulberry seedlings in the lab. five newly hatched nymphs (crawlers) were transferred carefully to each clean seedling of Mulberry using a fine moistened camel's hair brush (5%). The seedlings were observed every 24 hours until the crawlers settled on different leaves. Dead crawlers were replaced with newly hatched ones.

Only one crawler was allawed on each leaf. The location of each crawler was marked with a circle using indelible ink.

Daily inspection of infested leaves were made and all until producing another progeny. Records were taken for each crawler to record the durations of the three nymphal stages. The prevailing laboratory day-max.temp., night-min. temp. and daily mean relative humidity were daily recorded.

To evaluate the pre-oviposition, oviposition and post-oviposition periods, a ten seedlings were used and kept each in a suitable wooden cage surround by muslin. Newly emerging females (one/leaf) were transferred carefully the seedlings were daily inspected, until insects settled on the leaves, then daily observed to obtain the pre-oviposition, oviposition and post-oviposition periods as well as fecundity ,and adult longevity .

Fecundity of female was calculated as the sum of deposited and un-deposited eggs. Undeposited eggs were counted by dissecting dead mature females under the stereoscopic binocular,

The incubation period was determind as the period between the deposition of the first egg and the emergence of the first crawler. This period was estimated by inspecting 40 individual eggs deposited in female egg sac with the aid of a 20 X hand lens twice a day for newly hatched crawler. After mother scale forming egg sac, the female posterior was elevated to follow up eggs production. The generation period was also estimated.

Obtained data were subject to statistical analysis using the (ANOVA) and the Duncan's multiple range as described by **Snedecor (1970).**

RESULTS AND DISCUSSION

Duration of the nymphal stage

The durations of the three nymphal instars during the two successive annual generations, under prevailing laboratory conditions are presented in Table (1) and Fig. (2). The 1st, 2nd and 3rd instars lasted for 13-48, 9-65 and 23-88 days, respectively, according to generation. The shorter durations occurred during the first generation (14.4±0.14, 12.9±0.34 and 32.05±0.15) as compared with to the second one with 37.35±0.91, 51.65±1.45 and 63.97±0.94 average.The total nymphal period (from egg hatching until adult emergence was 45days in the 1st generation and 201 days in the 2nd generation. The nymphal average duration was shorter in first generation (59.35±1.63 days) as compared with that in the second one (152.97±4.29). Significant differences were attained between duration periods of nymphal instars and between generations. Nymphs reared on Mulberry seedlings during the first generations

at 34.1±0.26 °C (D. Max. T), 32.9±0.23 °C as well as 50.5±0.78 % (D. M. R. H.) developed to adult females significantly faster than those reared at 27.0±0.76 °C (D. Max. T), 26.1±0.75 °C and 52.5±5.68 % (D. M. R. H.). The mean developmental period for nymphal instars and thus nymphal stage were inversely proportional with the increas in temperature. For instance, when the nymphal stage duration was shorter (59.35 days) during 1st generation, the daily mean temp.was high (33.5 °C) in comparison with the respective period during the second generation.These results were compairable with those by several authors on *I. purchasi* **Kuwana (1922)** in Japan stated that the durations of different nymphal instars lasted 14-21, 14-21 and 12-50 days for 1st, 2nd, and 3rd nymphal instars, respectively; **Bodenheimer (1951)** in Palestine 12-19, 40- 18 and 11-24 days in the three nymphal instars, respectively; **Monastero and Zaazmi (1959)** in France stated that the three instars were 22-45, 15-25 and 35-37 days respectively. On the other hand, **Ezz (1965)** in Egypt found that three nymphal instars of *I. aegyptiaca* (Doulgas) ranged 10-46, 7-30 days and 10-48 days; **Azab *et al* (1969)** in Egypt recorded 19, 9.8 and 20.7 days, respectively for three nymphal instars of *I. aegyptiaca*. Such differences in results may be due to prevailing laboratory conditions, differences in insect species and host plants.

Table (1): Durations of *I. seychellarum* nymphal instars on Mulberry seedlings during the two successive annual generations of 2000-2001 under laboratory conditions.

Generations	DURATION OF Nymphal INSTARS							
	1ST nymphal instar		2nd nymphal instar		3rd nymphal instar		nymphal stage	
	Range (Mean ± S.E) (days)	First and last dates of Occurrence	Range (Mean ± S.E) (days)	First and last dates of Occurrence	Range (Mean ± S.E) (days)	First and last dates of Occurrence	Range (Mean ± S.E) (days)	First and last dates of Occurrence
First	13-16 (14.4 ± 0.14) A	16/7 till 31/7	9-18 (12.9 ± 0.34) A	28/7 till 16/8	23-54 (32.05 ± 0.15) A	6/8 till 30/9	45-88 (59.35 ± 1.63) A	16/7 till 30/9
Second	28-48 (37.35 ± 0.91) B	25/9 till 27/12	35-65 (51.65 ± 1.45) B	20/10 till 1/3	41-88 (63.97 ± 0.94) B	30/11 till 10/5	104-201 (152.97 ± 4.29) B	25/9 till 10/5

Initial numbers used for each nymphal instar were 40

Means within a column followed by different letter are significantly differ at 5%

Oviposition Periods & Fecundity

Table (2) based on the oviposition periods of *I. seychellarum* during the two successive annual generations reveal the followings:

The non-fertilized females started to lay eggs 20-49 days after their third molting. Statistical analysis showed that the pre-oviposition period was significantly different in generations tested, being less 21.8±0.84 days in the

1st generation at 32.15°C and 51.2% R.H. than that during the 2nd generation (38.27±1.19 days) at 26.4°C and 50.3% R.H. This period decreased with temperature increase.

Unfertilized females continued to lay eggs for 48-199 days. Significant differences were obtained in oviposition period between, generations, being shorter (75.7±1.9 days) in 2nd generation at 30.0°C and 49.8±0.0.97 % R. H. while longer (182.67±211 days) in the 1st generation at 26.95 °C and 52.0±0.40 % R. H. Fecundity of females on Mulberry ranged 50-136 eggs per female in 1st generation and 78 to 326 eggs/female in the 2nd generation. These differences were significant .The. highest fecundity was recorded in the 2nd generation (222.08±12.66 eggs/female) .

The post-oviposition period varied from 7 to 29 with differences between post-oviposition periods significant. The shorter differences between generation period (11.17±0.37 days)was observed in 1st generation at 27.9°C and 44.4% R.H., and the longer period (13.7±0.63 days) occurred in the 2nd generation at 32.8 °C and 51.6 % R. H.

Results in Table (2) also showed that the oviposition period was greatly influenced by the prevailing laboratory temperature. The pre-oviposition period was negatively affected, whereas the oviposition period and post-oviposition period.were positively affected. Similar results for oviposition periods and fecundity were reported **by Bodenheimer (1951)** in Palestine, **Ezz (1965)** in Egypt **and Azab *et al* (1969)** in Egypt.

Female Longevity

Longevity of females shown in Table (3) ranged between 68 and 264 days according to conditions with significant differences between the two annual generations. The longest longevity averaged 232.11±4.35 days at 28.95°C and 49.1% R.H. in 1st generation, while that in the 2nd generation averaged 111.2±3.39 days at 29.7°C and 50.5% R.H. Therefore, longevity of females was negatively correlated with temperature contrary to the average number of eggs/female (fecundity).

In this respect **Schrader (1930)** in Pennsylvania reported that the longevity of adult of *I. purchasi* lasted two or three months.

Incubation period

Results given in Table (3) showed that this period ranged 6-24 days in the 1st generation and 8-29 days in the 2nd one, with no significant differences.

However, the egg incubation period averages were nearly similar in both generations being 14.32±0.57 days and 14.97±0.75 days respectively with temperatures averaged 30.6 and 27.35°C. These results are in agreement with those obtained on *I. purchasi* by **Kuwana (1922)** in Japan, (21-27 days), **Peng (1935) in China**, (9-27 days), **Geier and Baggiolini (1950)** in Switzerland, (36 days) **Bodenheimer (1951)** in Palestine (16-35 days), **Monastero and Zaazmi (1959)** in France, (15-30 days), **Ezz (1965)** in Egypt, found that the incubation period of *I. aegyptiaca* ranged between 4-17 days and **Azab *et al* (1969) in Egypt** pointed out that eggs of *I. aegyptiaca* hatch, 8.6 days at 29.7°C and 10 days at 24°C.

Table (2): Oviposition periods of *I. seychellarum* on Mulberry seedlings during the two successive annual generations of 2000-2001 under laboratory conditions.

GENERATIONS	OVIPOSITION PERIODS															
	Pre-oviposition period					Oviposition period						Post-oviposition period				
						Duration	Total no. of eggs / female (Fecundity)	First and last dates of Occurrence	Laboratory conditions averages							
	Range (Mean ± S.E) (days)	First and last dates of Occurrence	Laboratory conditions averages			Range (Mean ± S.E) (days)	Range (Mean ± S.E) (eggs)					Range (Mean ± S.E) (days)	First and last dates of Occurrence	Laboratory conditions averages		
			D. Max. T. °C	N. Min. T. °C	D. M. R. H. %				D. Max. T. °C	N. Min. T. °C	D. M. R. H. %			D. Max. T. °C	N. Min. T. °C	D. M. R. H. %
First	21-31 (21.8 ± 0.84) A	29/8 till 27/10	32.6 ± 0.12	31.7 ± 0.17	51.2 ± 0.60	139-199 (182.67 ± 2.11) B	50-136 (83.12 ± 2.80) A	20/9 till 30/4	27.5 ± 0.18	26.4 ± 0.18	52.0 ± 0.40	7-16 (11.17 ± 0.37) A	20/3 till 10/5	28.3 ± 0.22	27.5 ± 0.19	44.4 ± 0.65
Second	20-49 (38.27 ± 1.19) B	11/1 till 23/5	26.9 ± 0.22	25.9 ± 0.19	50.3 ± 0.67	48-94 (75.7 ± 1.9) A	78-326 (222.08 ± 12.66) B	9/3 till 28/8	30.5 ± 0.34	29.5 ± 0.29	49.8 ± 0.97	8-29 (13.7 ± 0.63) B	10/6 till 31/8	33.4 ± 0.11	32.3 ± 0.07	51.6 ± 0.37

Initial numbers used were 40 (adult females)
Means within a column followed by different letter are significantly differ at 5%

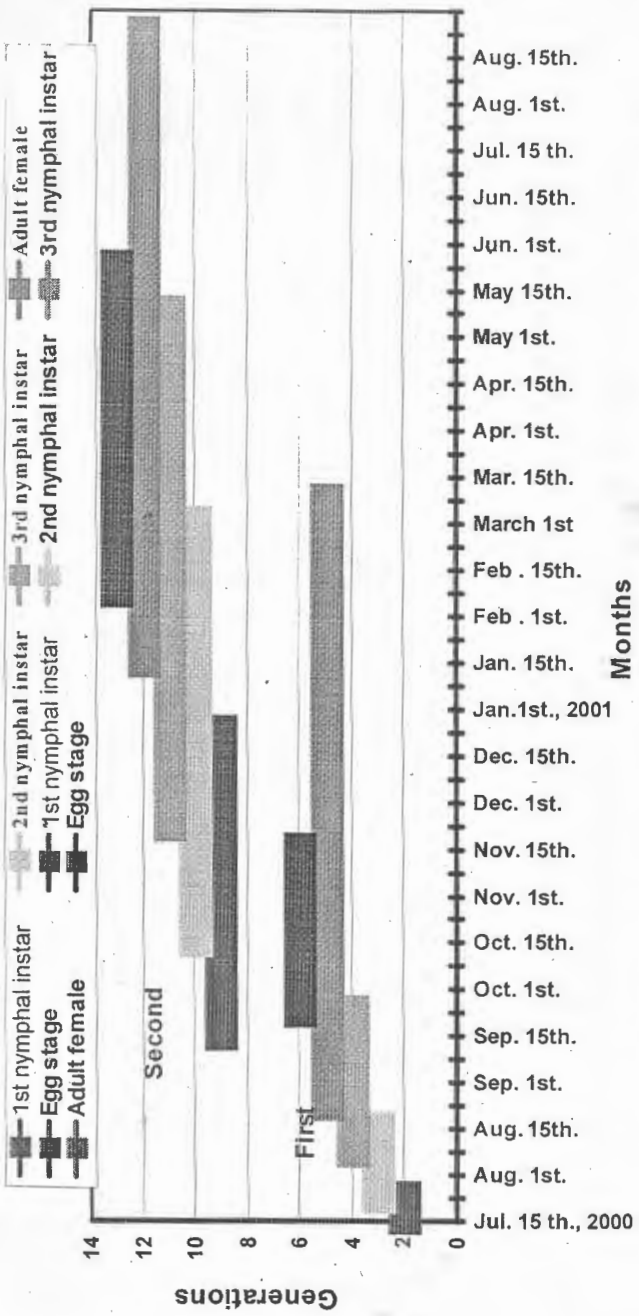

Fig. (2): Periods of occurrence of *I. seychellarum* different stages during the two successive annual generations of 2000-2001 under laboratory conditions.

Table (3): Female longevity, incubation period and total life cycle of *I. seychellarum* on Mulberry seedlings during the two successive annual generations of 2000-2001 under laboratory conditions.

GENERATIONS	Female longevity					Incubation period					Total life cycle				
	Range (Mean ± S.E) (days)	First and last dates of Occurrence	Laboratory conditions averages			Range (Mean ± S.E) (days)	First and last dates of Occurrence	Laboratory conditions averages			Range (Mean ± S.E) (days)	First and last dates of Occurrence	Laboratory conditions averages		
			D. Max. T. °C	N. Min. T. °C	D. M. R. H. %			D. Max. T. °C	N. Min. T. °C	D. M. R. H. %			D. Max. T. °C	N. Min. T. °C	D. M. R. H. %
First	166-264 (232.11 ± 4.35) B	29/8 till 10/5	29.4 ± 1.29	28.5 ± 1.32	49.1 ± 1.95	6-24 (14.32 ± 0.57) A	20/9 till 15/11	31.1 ± 0.21	30.1 ± 0.20	51.4 ± 0.54	217-376 (305.79 ± 21.76) B	16/7 till 10/5	31.7 ± 1.01	30.6 ± 0.96	50.1 ± 0.95
Second	68-154 (111.2 ± 3.39) A	11/1 till 28/8	30.2 ± 1.54	29.2 ± 1.51	50.5 ± 0.44	8-29 (14.97 ± 0.75) A	9/2 till 31/5	27.8 ± 0.24	26.9 ± 0.22	48.3 ± 0.60	180-384 (279.14 ± 8.43) A	25/9 till 28/8	28.5 ± 0.93	27.5 ± 0.91	51.0 ± 0.65

Initial number used was 40

Means within a column followed by the different letter are significantly differ at 5%

Total life cycle

In Table (3) results revealed that the life cycle was completed in 217-376 days in 1st generation and 180-384 in the 2nd generation. Temperature and RH had significant effect. The life cycle was longer (305.79±21.76 days) at mean temp. 31.5°C with 50.1±0.95% RH and 279.14±8.43 days was at mean temp. 28.0°C. with 51.0±0.65% RH. In this respect, **Kuwana (1922)** in Japan, recorded four months for *I. purchasi* under favorable conditions to complete life cycle: **Ramachandra and Cherian (1944)** in Switzerland reported that the generation duration of *I. purchasi* varied according to temperature and lasted 43-240 days; **Azab *et al* (1969)** in Egypt recorded 105.4 days at 26.4 °C and 87.2 days at 28.7 °C for *I. aegyptiaca* **Khalaf (1987)** in Fars, found that the life cycle of *I. purchasi* lasted from 70-140 days; and **Ulusoy *et al* (1999)** in Turkey, determined that the developmental times of *Pseudaulacaspis pentagona* on the citrus host plants from egg stage to adult were 16.1, 16.1, 19.2, 20.0, 24.4 and 29.3 days on lemon, mandarin, grapefruit, sweet orange, sour orange, and trifoliate, respectively whereas the developmental times on the non-citrus host plants were 15.7, 20.4, 20.8, 23.8 and 26.4 days on grapevine, peach, rose, mulberry and pomegranate, respectively.

Generations

Determination of the number of annual generations of *I. seychellarum* under laboratory conditions was carried out throughout the period from mid July 2000 to late August 2001.Two overlapping generations could be reared in the lab. as shown in Table (4). The 1st generation lasted for about four months from mid-July until mid-Nov. 2000 under mean tem. 31.5°C and 50.1% R.H. The average durations of nymphs, adult females and incubation periods (Tables 1 & 3) were 59.35±1.63, 232.11±4.35 and 14.32±0.57 days, respectively. Under mean lab. temp.28.0 °C and 51.0 % R. H., the 2nd generation lasted for about eight months between late Sept 2000 and late May 2001. Under these conditions, nymphal, adult females and egg stages lasted 152.97±4.29, 111.2±3.39 and 14.97±0.75 days.respectively.

Generation duration depended on the prevailing temperature with negative correlation. The present results are in agreement with the findings **of Azab *et al* (1969) and Aly (1980)** in Egypt reporting two annual generations for *I. aegyptiaca* and for *I. seychellarum*. **Khalaf (1987)** Fars, found that *I. purchasi has* 4 generations year.

Table (4): First and last occurrence of different stages of *I. seychellarum* on Mulberry seedlings during the two successive annual generations of 2000-2001 under laboratory conditions.

Generations		First and last occurrence of					Laboratory conditions averages		
		Nymphal stage			Adult female	Egg stage	D. Max. T. °C	N. Min. T. °C	D. M. R. H. %
		1st instar	2nd instar	3rd instar					
First	From	16/7/2000	28/7/2000	6/8/2000	29/8/2000	20/9	31.7 ± 1.01	30.6 ± 0.96	50.1 ± 0.95
	To	31/7/2000	16/8/2000	30/9/2000	10/5/2001	15/11			
Second	From	25/9/2000	20/10/2000	30/11/2000	11/1/2001	9/2/2001	28.5 ± 0.93	27.5 ± 0.91	51.0 ± 0.65
	To	27/12/2000	1/3/2001	10/5/2001	28/8/2001	31/5/2001			

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بعض الدراسات البيولوجية على حشرة بق السيشيلارم الدقيقي على شتلات توت تحت الظروف المعملية

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نظراً لقلة المعلومات المتوفرة عن بق السيشيلارم الدقيقي، فلقد أجريت هذه الدراسات بهدف تقديم معلومات عن بعض المظاهر البيولوجية لهذه الآفة تحت الظروف المعملية على شتلات التوت . ويُمكن تلخيص أهم النتائج التي تم التوصل إليها فيما يلي:

١- تم وصف ودراسة سلوك الأطوار المُختلفة لهذه الآفة بإيجاز.

٢- إستغرقت فترات كُلٍ من العُمر الأول، الثاني والثالث للحورية ١٤ – ٤٨، ٩ – ٦٥ و ٢٣ – ٨٨ أيام على التوالي. وتراوحت مدة طور الحورية من ٤٥ إلى ٢٠١ يوماً، كما كانت هنـــاك علاقة عكسية بين مدة طور الحورية والزيادة في درجةِ الحرارة.

٣- عندما تم حجز الأنثى على أوراق شتلات التوت، إستغرقت فترات ما قبـــل وضـــع البـــيض، وضع البيض و بعد وضع البيض ٢٠-٤٩، ٤٨-١٩٩ و٧-٢٩ أيام على التوالي، ولقد تأثرت تلك الفترات بدرجة كبيرة بدرجات الحرارة والرطوبة السائدة في المعمل، حيث تأثرت فترة ما قبل وضع البيض عكسياً بارتفاع الحرارة بينما حدث العكس لكُلٍ من فترة وضع البيض وفترة ما بعد وضع البيض.

٤- تراوحت الخصوبة (العدد الكليّ من البيض الناتج من كل أنثى) من ٥٠ – ٢٣٦ بيضة حسب الجيل، حيث سُجلت أعلى خصوبة للأنثى في الجيل الثاني بالمُقارنة بالجيل الأول.

٥- تفاوتت مدة حياة الأنثى من ٦٦ – ٢٦٤ أيام حسب الظروف المعملية الـــسائدة، حيـــث كـــان متوسط أطول فترة لحياة الأنثى في الجيل الأول بالمقارنة بالجيل الثاني.

٦- تراوحت مدة حضانة البيض من ٦ – ٢٩ أيام، مع عدم وجود فروق معنويـــة بـــين فتـــرات الحضانة في كلا الجيلين.

٧- إستغرقت فترة دورة الحياةِ ٢١٧ – ٣٧٦ أيام في الجيل الأول، و ١٨٠ – ٣٨٤ أيام في الجيل الثاني. وأوضح التحليل الإحصائي وجود تأثير لدرجة الحرارة على متوسط دورة الحياة بينما لم يكن للرطوبة النسبية أي تأثير.

٨- تمت تربية جيلين لهذه الآفة على شتلات التوت في المعمل. ولقد إستغرق الجيل الأول حوالي أربعة شهور من مُنتصف يوليو حتى مُنتصف نوفمبر ٢٠٠٠، بينما إستغرق الجيـــل الثـــاني حوالي ثمانية شهور من أواخر سبتمبر ٢٠٠٠ حتى أواخر مايو ٢٠٠١.