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BIOLOGICAL STUDIES ON THE CITRUS MEALYBUG, *Planococcus citri* (RISSO) (HEMIPTERA: PSEUDOCOCCIDAE) UNDER LABORATORY CONDITIONS

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ABSTRACT: Biological studies were carried out in the laboratory of Scale Insects and Mealybugs Department, Plant Protection Research Institute, Sharkia Branch, Egypt during the period extended from 2010–2016 years on the citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) to study the effects of different host plants and temperatures on some biological aspects of the pest to use these useful information for mass rearing and designing a comprehensive pest management program and prediction models for the citrus mealybug. The accumulated degrees days (ADD) for male and female stages were also calculated. The obtained results obviously showed that there were significant effects on developmental periods, adult longevity, life cycle and generation period of *P. citri* when reared on pumpkin fruits compared with those reared on potato sprouts. The periods of citrus mealybug stages were significantly reduced gradually by increasing of rearing degree of the tested temperatures *i.e.* 20, 25 and 30˚C. The mathematical method showed that the accumulated degree days which required for completing one generation for females was 418.11 ADD unit.

Key words: Citrus mealybug, *Planococcus citri*, biological aspects, hosts, temperatures.

INTRODUCTION

The citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) is an important piercing sucking insect pest attacking several crops. It attacks new shoots and leaves of a wide range of plants including citrus, apple, avocado, ficus, gardenia, jasmine, oleander and persimmon (Angeles-Martinez *et al.*, 1991; Correa *et al.*, 2008; Ahmed and Abd-Rabou, 2010). It has piercing sucking mouthparts that remove plant fluids so plant damage is caused by loss of sap extracted by high numbers of mealybugs resulting in wilted, distorted and yellowed (chlorotic) leaves, premature leaf drop, stunted growth and occasionally death of infested plants or plant parts. The sticky sugary fluid excreted by mealybugs is called honeydew which provides a medium for the growth of black sooty mold fungi. Black sooty mold fungi are detrimental to plants because they cover leaves, thus reducing photosynthesis and inducing plant stress (Hill, 1983; Al-Ali, 1996; Smith *et al.*, 1997; Serrano *et al.,* 2001; Heinz *et al.*, 2004). The citrus mealybug is also known as a vector of some important plant viruses (Kubiriba *et al.*, 2001; Watson and Kubiriba, 2005).

Therefore, the main objective of this work aimed to study the development, longevity, reproduction and some biological parameters of *P. citri* on pumpkins and potato sprouts to choose the most effective host plant in mass production of *P. citri* in biological control studies. The study was also aimed to investigate the biological aspects of the tested pest at different temperatures and recorded the accumulated degree days for each stage to use the obtained information for designing a comprehensive pest management program and prediction models for the citrus mealybug.

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MATERIALS AND METHODS

The study was carried out in Scale Insects and Mealybugs Laboratory, Plant Protection Research Institute, Sharkia Branch, Egypt during the period extended from 2010–2016 years to study duration periods of immature and mature stages of *P. citri* on two different host plants and at three different temperature degrees (20, 25 and 30˚C) to study the effects of host plant and temperature on the development, longevity, reproduction and some biological parameters of *P. citri*.

Stock Culture

The stock culture of the citrus mealy bug, *P. citri* used in this study was originally collected from El-Qasaseen Experimental Station, Ismailia Governorate, Egypt, from infested citrus plants.

Effects of Two Host Plants on Some Biological Aspects

Rearing on pumpkin fruits

Citrus mealybug, *P. citri* was reared on pumpkin fruits, *Cucurbita pepo* L. (Cucurbitaceae). Pumpkins were washed in running water and then a neutral detergent was applied with a sponge moistened with water, followed by rinsing. The pumpkins were again washed in running water and dried at room temperature. Then the tested insects were transferred with the aid of camel hairbrush to the pumpkin fruits under laboratory conditions of 25 ± 1˚C, 65 ± 5% RH and photoperiod 12 hr., (L : D). The mealybug females settled on pumpkins started to egg laying. The crawlers emerged out and started feeding and developed to adults. The newly adult females were separated and placed on a new pumpkin fruits kept in the incubator under the same conditions with the help of fine camel hairbrush. Biological studies were started from the egg stage which laid from the second generation females. A total of 60 eggs laid from different females on the same day were observed and followed to study the biological aspects. The crawlers were observed daily in the morning by the aid of magnifying glass lens (X 10) to determine the nymphal instars duration with checking for exuvia which were visible through the loose waxy filaments. The preoviposition, oviposition and postovipostion periods for female were determined. Longevity, life cycle and generation periods were also calculated. The eggs laid by mealybug females were examined under binocular microscope and counted for calculating fecundity. The number of males out of the total population that survived to adult stage was calculated.

Rearing on potato sprouts

Potato tubers, *Solanum tuberosum* L. (Solanaceae) were washed in water and put on moistened plastic dishes 30 cm. Water was sprinkled daily to keep the plastic dishes moistened to encourage sprouting. After 28-30 days potatoes produced sprouts of 5-7 cm long. Then the insects were transferred with the aid of camel hairbrush to the potatoes sprouts and reared under laboratory conditions of 20, 25, 30 ± 1˚C, 65 ± 5% RH and a photoperiod 12 hr., (L:D). The mealybug females settled on potatoes sprouts started to egg laying. The crawlers emerged out and started feeding and developed to adults. The newly adult females were separated and placed on new potato sprouts kept under the same above mentioned laboratory conditions with the help of fine camel hairbrush. Biological studies were started from the egg stage which was laying from the second generation females. A total of 60 eggs laid from different females on the same day were observed and followed to study the biological aspects. The crawlers were observed daily in the morning by the aid of magnifying glass lens (X 10) to determine the nymphal instars duration with checking for exuvia which were visible through the loose waxy filaments. The preoviposition, oviposition and postovipostion periods for female were calculated. Longevity, life cycle and generation periods were also registered. The eggs laid by mealybug females were examined under binocular microscope and counted for calculating fecundity. The number of males out of the total population that survived to adult stage was calculated.

Accumulated Degree Days (ADD) Calculation

The lower developmental threshold (T_0) and the thermal constant (K) of *P. citri* stages were estimated using the thermal summation model, which describes the relationship between the developmental rate of insects and the ambient temperature in a linear regression equation, K (DD) = d (T- T_0) where K (DD) is the species (or stage-specific) thermal constant of the poikilothermic organism, T temperature, T_0 developmental zero temperature and d the duration of stage by days. This thermal constant provides a measure of the physiological time required for the completion of a developmental process and is measured in degree-days (DD). One popular method of estimating the previous parameters is to use a linearizing transformation of the above function by calculating the rate of development DR = 1/d. The linear degree-day model or as the x-intercept method which is simply derived after growth rate fitting to a simple linear equation and then extrapolated to zero: Y (DR) = a + bT. The lower theoretical temperature threshold is derived from the linear function as $T_0 = -a/b$ whereas 1/slope is again the average duration in degree days or thermal constant K. The equation simply means that the thermal constant is a product of time and the degrees of temperature above the threshold temperature (Campbell *et al.*, 1974; Haddad *et al.*, 1999; Bergant and Trdan, 2006).

Statistical Analysis

Data were statistically analysed of variance (ANOVA) using COSTAT Computer Program (2005). Means were compared using least significant difference (LSD) test.

RESULTS AND DISCUSSION

Effect of Two Host Plants on Some Biological Aspects

Females

Egg incubation period

Reults tabulated in Table 1 show that the mean incubation periods of female eggs (eggs that developed into females) on pumpkin fruits and potato sprouts ranged from 5 to 8 days. There was no significant difference among the mean incubation periods of *P. citri* female eggs on pumpkin fruits and potato sprouts. These results agree with those obtained by Asiedu *et al.* (2014) who studied the biology of *P. citri* on five yam varieties (*Disocorea* species) and reported that there were no significant differences among the mean incubation periods of *P. citri* female eggs on yam varieties.

Nympal instars

Results presented in Table 1 show that the first nymphal instar duration of *P. citri* female on pumpkin fruits and potato sprouts ranged from 3 to 7 days and from 4 to 6 days, respectively. The mean duration of the first nymphal instar was longer on potato sprouts (4.8 ± 0.11 days) than on pumpkin fruits (4.5 ± 0.15 days). There was a highly significant difference between the mean duration of *P. citri* female first nymphal instar on pumpkin fruits compared with potato sprouts.

The mean duration of *P. citri* second nymphal instar of female was shorter on pumpkin fruits than on potato sprouts with values of (5.8 ± 0.15 days) and (6.1 ± 0.18 days), consecutively. There was no significant difference among the mean duration of *P. citri* second nymphal instar of female on pumpkin fruits and potato sprouts. This result is in agreement with that of Asiedu *et al.* (2014) who studied the biology of *P. citri* on five yam varieties (*Disocorea* species) and reported that there was no significant difference between the duration of the second nymphal instar female bred on *D. rotundata* var. Muchumudu and *D. alata* var. Matches.

The duration of *P. citri* female third nymphal instar on pumpkin fruits and potato sprouts ranged from 4 to 8 days and 5 to 9 days, successively. The mean duration of the third nymphal instar was longer on potato sprouts (6.6 ± 0.19 days) than on pumpkin fruits (6.1 ± 0.16 days). There was a significant difference between the mean duration of *P. citri* female third nymphal instar on pumpkin fruits compared with potato sprouts.

Oviposition periods and eggs fecundity

Results illustrated in Table 1 mention that the adult female preoviposition period ranged from 3 to 6 days and 4 to 7 days on pumpkin fruits and potato sprouts, respectively. The mean duration of adult female preoviposition period was shorter on pumpkin fruits (4.5 ± 0.14 days) than on potato sprouts (5.7 ± 0.12 days). There was a highly significant difference between the mean duration of *P. citri* adult female preoviposition period on pumpkin fruits compared with potato sprouts.

Table 1. Developmental durations (mean ± SE) in days of *Planococcus citri* (Risso) reared on pumpkin fruits and potato sprouts under laboratory conditions of 25 ± 1˚C, 65 ± 5% RH and photoperiod 12 hr. (L:D)

Biological parameter		Pumpkin fruits			Potato sprouts			P	LSD
		No.	Durations by days		No.	Durations by days			
			Range	Mean ± SE		Range	Mean±SE		
Female	Egg incubation period	50	5-8	6.2 ± 0.13	50	5-8	6.3 ± 0.15	NS	
	Nymphs								
	1st instar	50	3-7	4.5 ± 0.15	50	4-6	4.8 ± 0.11	0.0054**	0.94
	2nd instar	50	4-8	5.8 ± 0.15	50	4-8	6.1 ± 0.18	NS	
	3rd instar	50	4-8	6.1 ± 0.16	50	5-9	6.6 ± 0.19	0.0204*	0.60
	Adult								
	Preoviposition period	50	3-6	4.5 ± 0.14	50	4-7	5.7 ± 0.12	0.0001**	0.42
	Oviposition period	50	4-7	5.4 ± 0.13	50	5-8	6.5 ± 0.16	0.0001**	0.44
	Postoviposition period	50	3-7	5.1 ± 0.15	50	4-7	5.8 ± 0.14	0.0018**	0.54
	Total number of eggs/ female (fecundity)	50	98-542	261 ± 13	50	100-503	239± 14	NS	
	Longevity	50	12-19	15 ± 0.25	50	15-21	18±0.21	0.0001**	0.73
	Life cycle	50	30-43	37.6 ± 0.5	50	34-50	41.8±0.58	0.0034**	1.25
	Generation	50	20-32	27.1 ± 0.45	50	22-36	29.5±0.49	0.0014*	1.37
Male	Egg incubation period	10	7-9	7.8 ± 0.25	10	7-9	8 ± 0.26	NS	
	Nymphs								
	1st instar	10	6-8	6.9 ± 0.28	10	6-9	7.4 ± 0.37	NS	
	2nd instar	10	7-9	8 ± 0.26	10	7-10	8.5 ± 0.34	NS	
	3rd instar	10	7-9	7.8 ± 0.25	10	7-10	8.4 ± 0.37	NS	
	Pupal stage	10	5-7	6.2 ± 0.25	10	5-7	5.8 ± 0.25	NS	
	Longevity	10	2-3	2.4 ± 0.16	10	2-4	2.9 ± 0.23	NS	

LSD : Least significant difference. P : Probability of ANOVA. NS : Not significant.

* : Significant. ** : Highly significant.

The adult female oviposition period ranged from 4 to 7 days and 5 to 8 days on pumpkin fruits and potato sprouts, consecutively. The mean duration of adult female oviposition period was shorter on pumpkin fruits (5.4 ± 0.13 days) than on potato sprouts (6.5 ± 0.16 days). There was a highly significant difference between the mean duration of *P. citri* adult female oviposition period on pumpkin fruits compared with potato sprouts.

The mean number of eggs laid per female (fecundity) was 261 ± 13 eggs/female on pumpkin fruits compared with 239 ± 14 eggs/ female on potato sprouts showing no significant difference. This result was similar with that obtained by Awmack and Leather (2002) who reported that host plant quality is a key determinant of the fecundity of herbivorous insects. Components of host plant quality such as carbon, nitrogen, and defensive metabolites affect potential and achieved herbivore fecundity.

The adult female postoviposition period ranged from 3 to 7 days and 4 to 7 days on pumpkin fruits and potato sprouts, successively. The mean duration of adult female postoviposition period was shorter on pumpkin fruits (5.1 ± 0.15 days) than on potato sprouts (5.8 ± 0.14 days). There was a highly significant difference between the mean duration of *P. citri* adult female postoviposition period on pumpkin fruits compared with potato sprouts.

Longevity, life cycle and generation periods

Results tabulated in Table 1 show that the adult female longevity period ranged from 12 to 19 days and 15 to 21 days on pumpkin fruits and potato sprouts, respectively. The mean duration of adult female longevity period was longer on potato sprouts (18 ± 0.21 days) than on pumpkin fruits (15 ± 0.25 days). There was a highly significant difference between the mean duration of *P. citri* adult female longevity period on pumpkin fruits compared with potato sprouts.

The adult female life cycle period ranged from 30 to 43 days and 34 to 50 days on pumpkin fruits and potato sprouts, consecutively. The mean duration of adult female life cycle period was longer on potato sprouts (41.8 ± 0.58 days) than on pumpkin fruits (37.6 ± 0.50 days). There was a highly significant difference between the mean duration of *P. citri* adult female life cycle period on pumpkin fruits compared with potato sprouts.

Generation period ranged from 20 to 32 days and 22 to 36 days on pumpkin fruits and potato sprouts, successively. The mean duration of generation period was longer on potato sprouts (29.5 ± 0.49 days) than on pumpkin fruits (27.1 ± 0.45 days).There was a significant difference between the mean duration of *P. citri* generation period on pumpkin fruits compared with potato sprouts.

Males

Egg incubation period

Results arranged in Table 1 show that the mean incubation periods of male eggs (eggs that developed into males) on pumpkin fruits and potato sprouts ranged between 7 and 9 days. There was no significant difference among the mean incubation periods of *P. citri* male eggs on pumpkin fruits and potato sprouts.

Nympal instars

Results presented in Table 1 show that the first nymphal instar duration of *P. citri* male on pumpkin fruits and potato sprouts ranged from 6 to 8 days and 6 to 9 days, respectively. The mean duration of the first nymphal instar was longer on potato sprouts (7.4 ± 0.37 days) than on pumpkin fruits (6.9 ± 0.28 days). There was no significant difference between the mean durations of male first nymphal instar of *P. citri* on pumpkin fruits and potato sprouts.

The mean duration of *P. citri* male second nymphal instar was shorter on pumpkin fruits than on potato sprouts with values of (8 ± 0.26 days) and (8.5 ± 0.34 days), consecutively. There was no significant difference between the mean duration of *P. citri* male second nymphal instar on pumpkin fruits and potato sprouts.

The mean duration of the third nymphal instar was longer on potato sprouts (8.4 ± 0.37 days) than on pumpkin fruits (7.8 ± 0.25 days). There was no significant difference between the mean durations of *P. citri* male third nymphal instar on pumpkin fruits and potato sprouts.

Pupal stage

Results tabulated in Table 1 show that the mean duration of male pupal stage was longer on pumpkin fruits (6.2 ± 0.25 days) than on potato sprouts (5.8 ± 0.25 days). There was no significant difference between the mean duration of *P. citri* male pupal stage on pumpkin fruits and potato sprouts.

Male longevity

Results presented in Table 1 show that the male longevity period ranged from 2 to 3 days and 2 to 4 days on pumpkin fruits and potato sprouts, respectively. The mean duration of male longevity period was longer on potato sprouts (2.9 ± 0.23 days) than on pumpkin fruits (2.4 ± 0.16 days). There was no significant difference between the mean duration of male longevity period on pumpkin fruits and potato sprouts. This result was confirmed by the findings of Asiedu *et al.* (2014) who studied the biology of *P. citri* on five yam varieties (*Disocorea* species) and reported that adult male lived for two to four days after the final nymphal molt.

Finally, the previous results cleared that developmental time, longevity, life cycle and generation period of *P. citri* affected when fed on different host plants.

Effect of Temperature Degrees on Some Biological Aspects

Females

Results presented in Table 2 show the effects of three temperature degrees (20, 25 and 30˚C) on the female developmental stages of citrus mealybug, *P. citri.*

The duration of incubation periods of female eggs (eggs that developed into females) were 9, 6.3 and 4.5 days under the temperatures of 20, 25 and 30˚C, respectively. The duration of nymphal instars at the temperatures of 20, 25 and 30˚C recorded 23.5, 17.5 and 12.0 days, consecutively.

Under the temperatures of 20, 25 and 30˚C the mean number of eggs laid per female (fecundity) were 215, 239 and 370 eggs/ female, successively. The average longevity of adult female of citrus mealy bug reared at 20, 25 and 30˚C were 20, 18 and 15.1 days, respectively. While, the adult female life cycle periods were 51.5, 41.8 and 35.4 days at the temperatures of 20, 25 and 30˚C, consecutively. Generation period of *P. citri* reared at the temperatures of 20, 25 and 30˚C were 38.6, 29.5 and 21.9 days, successively.

Our findings agree with the results of Chong *et al*. (2008) who studied the life history of the mealybug, *Maconellicoccus hirsutus* at constant temperatures and reported that the female longevity of *M. hirsutus* was the longest at 20ºC since the female survived for 28.2 days after adult eclosion. Also, Ahmed and Abd-Rabou (2010) studied the adult longevity of the citrus mealybug, *P. citri* at three different constant temperatures (18, 24 and 30ºC) on citrus and reported that there were 17.3, 13.1and 11.7 days for longevity durations, respectively.

Males

Reults arranged in Table 2 show the effect of three degrees of temperature (20, 25, and 30˚C) on the male developmental stages of citrus mealybug, *P. citri.* The duration of incubation periods of male eggs (eggs that developed into males) were 10.1, 8.0 and 7.6 days under the temperatures of 20, 25 and 30˚C, respectively. The duration of nymphal instars at the temperatures of 20, 25 and 30˚C recorded 28.6, 24.3 and 21.6 days, consecutively. The pupal stage periods were 6.8, 5.8 and 5.1 days at the temperatures of 20, 25 and 30˚C, successively. The average of longevity of adult male of citrus mealy bug reared at 20, 25 and 30˚C were 3.2, 2.9 and 2.4 days, respectively.

Generally, it could be mentioned that longevity, life cycle and some biological parameters reduced gradually by increasing the rearing degree of temperature.

These results are similar with those obtained by Goldasteh *et al.* (2009) and El-Aw *et al.* (2016) who mentioned that the male nymphal periods of citrus mealybug reared under laboratory conditions at 20˚C to 30˚C were reduced gradually by increasing the rearing degree of temperature for the tested nymphal instars.

Accumulated Degree Days (ADD) Calculation

Results in Table 3 show the values of lower developmental threshold temperature of the citrus mealybug, *P. citri* female. For egg stage, nympal stage, preoviposition and adult female longevity these values were 10.24, 10.04, 10.29

Table 2. Developmental durations (mean ± SE) in days of *Planococcus citri* (Risso) reared on potato sprouts at constant temperatures (20, 25 and 30) ± 1˚C, 65 ± 5% RH and photoperiod 12 hr. (L:D)

	Biological parameter	No.	20 ˚C		25 ˚C		30 ˚C		P	LSD
			Range	Mean±SE	Range	Mean±SE	Range	Mean±SE		
Female	Egg incubation period	50	6 – 11	9 ± 0.21	5 – 8	6.3 ± 0.15	3 – 6	4.5 ± 0.14	0.0001**	0.43
	Nymphs									
	1st instar	50	6 – 8	7.2 ± 0.10	4 – 6	4.8 ± 0.11	3 – 6	4.7 ± 0.14	0.0001**	0.73
	2nd instar	50	6 – 8	7.4 ± 0.08	4 – 8	6.1 ± 0.18	4 – 6	3.6 ± 0.14	0.0001**	0.42
	3rd instar	50	7 - 11	8.9 ± 0.12	5 – 9	6.6 ± 0.19	5 – 7	3.7 ± 0.10	0.0001**	1.33
	Adult									
	Preoviposition period	50	4 – 8	6.1 ± 0.13	4 – 7	5.7 ± 0.12	4 – 7	5.4 ± 0.15	0.0002**	1.07
	Oviposition period	50	5 – 9	7.3 ± 0.19	5 – 8	6.5±0.16	4 – 8	5.5 ± 0.19	0.0001**	1.37
	Postoviposition period	50	5 – 8	6.6 ± 0.10	4 – 7	5.8±0.14	2 – 6	4.2 ± 0.20	0.0001**	1.97
	Total number of eggs/ female (fecundity)	50	65-360	215 ± 11	100-503	239 ± 14	96–607	370 ± 18	NS	
	Longevity	50	15 - 23	20 ± 0.33	15 – 21	18 ± 0.21	11 – 20	15.1±0.40	0.0001**	1.05
	Life cycle	50	43 - 60	51.5± 0.62	34 – 50	41.8±0.58	28 – 43	35.4±0.68	0.0001**	1.09
	Generation	50	32– 42	38.6± 0.44	22 – 36	29.5±0.49	20 – 31	21.9±0.41	0.0001**	1.12
Male	Egg incubation period	10	8 – 12	10.1± 0.43	7 – 9	8.0± 0.26	6 – 9	7.6 ± 0.31	0.0093**	1.93
	Nymphs									
	1st instar	10	6 – 10	8.2 ± 0.39	6 – 9	7.4 ± 0.37	6 – 8	6.8 ± 0.25	NS	
	2nd instar	10	9 – 11	9.6 ± 0.22	7 – 10	8.5 ± 0.34	6 – 10	7.5 ± 0.38	0.360*	2.11
	3rd instar	10	9 – 12	10.8± 0.33	7 – 10	8.4 ± 0.37	6 – 9	7.3 ± 0.31	0.0006**	1.65
	Pupal stage	10	5 – 8	6.8 ± 0.34	5 – 7	5.8 ± 0.25	5 – 7	5.1 ± 0.26	0.0052**	0.41
	Longevity	10	2 – 4	3.2 ± 0.26	2 – 4	2.9 ± 0.23	2 – 3	2.4 ± 0.16	0.0036**	0.11

LSD : Least significant difference. P : Probability of ANOVA. NS : Not significant.

* : Significant. ** : Highly significant.

Table 3. Lower threshold temperature (T_0), duration (D) and accumulated degree days (ADD) of different stages of *Planococcus citri* (Risso)

Temperature		20˚C			25˚C			30˚C			Average of ADD
	Stage	D	T_0	ADD	D	T_0	ADD	D	T_0	ADD	
Female	Egg stage	9.0	10.24	87.84	6.3	10.24	92.99	4.5	10.24	88.92	89.92
	Nymphal stage	23.5	10.04	234.06	17.5	10.04	261.80	12.0	10.04	239.52	245.13
	Preoviposition period	6.1	10.29	59.23	5.7	10.29	83.85	4.4	10.29	106.43	83.17
	Generation	20.0	10.29	194.20	18.0	10.29	264.78	15.1	10.29	237.62	232.20
	Longevity			381.13			438.64			434.57	418.11
Male	Egg stage	10.1	11.39	86.96	8.0	11.39	108.88	7.6	11.39	141.44	112.43
	Nymphal stage	28.6	11.01	257.11	24.3	11.01	339.96	21.6	11.01	410.18	335.75
	Pupal stage	6.8	10.06	67.59	5.8	10.06	86.65	5.1	10.06	101.69	85.31
	Longevity	3.2	9.37	34.02	2.9	9.37	45.33	2.4	9.37	49.51	42.95

and 10.29˚C, respectively. The accumulated degree days (ADD) required for egg development till hatching was 89.92 DD unit. While, the ADD required for nymphs complete development was 245.12 DD unit. The ADD required for preoviposition period was 83.17 DD unit. While, the ADD required for adult longevity was 232.20 DD unit. Thus, generation period (egg stage plus nymphal stage and preoviposition period) required 418.11 DD unit to complete insect generation.

Results tabulated in Table 3 show the values of lower developmental threshold temperature of the citrus mealybug, *P. citri* male. The values respecting egg stage, nympal stage, pupal stage and adult male longevity were 11.39, 11.01, 10.06 and 9.37˚C, respectively. The accumulated degree days required for egg development till hatching was 112.43 DD unit.

While, The ADD required for nymphs complete development was 335.75 DD unit. The ADD required for pupal stage period was 85.31 DD unit, but the ADD required for adult longevity was 42.95 DD unit. So, the adult male required 576.44 DD unit to complete its life from egg to adult death.

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دراسات بيولوجية على حشرة بق الموالح الدقيقي *Planococcus citri* (RISSO) (Hemiptera: Pseudococcidae) تحت الظروف المعملية

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أُجريت هذه الدراسة بمعمل قسم بحوث الحشرات القشرية والبق الدقيقي في معهد بحوث وقاية النباتات فرع الشرقية – مصر خلال الفترة من ٢٠١٠ وحتى ٢٠١٦م على بق الموالح الدقيقي *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) لدراسة تأثير التربية على عوائل ودرجات حرارة مختلفة على بعض النواحي البيولوجية للحشرة لاستخدام تلك المعلومات في تربية الحشرة بأعداد كبيرة ضمن برامج التنبؤ والتحكم والسيطرة على الآفة، كذلك تم حساب الوحدات الحرارية المتجمعة اللازمة للأطوار المختلفة لكل من ذكور وإناث الحشرة، ولقد أوضحت الدراسات أن هناك إختلافات معنوية في فترات كل من دورة الحياة وعمر الحشرة الكاملة والجيل وفترات الأطوار المختلفة للحشرة عند تربيتها على ثمار القرع العسلي مقارنةً بتربيتها على درنات البطاطس المستنبتة، كذلك أوضحت الدراسات أن فترات الأطوار المختلفة تنخفض معنوياً مع إرتفاع درجات الحرارة المختبرة والتي كانت ٢٠، ٢٥ و٣٠ درجة مئوية، كما أظهرت الحسابات الرياضية أن درجات الحرارة المتجمعة اللازمة لاكتمال جيل واحد للإناث هي ٤١٨,١١ وحدة درجة حرارة متجمعة.

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