The effect of different temperatures on *Chrysomphalus aonidum* and *Parlatoria blanchardii* (Hemiptera Diaspididae)

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ABSTRACT

The Florida red scale *Chrysomphalus aonidum* and date palm scale *Parlatoria blanchardii* (Hemiptera Diaspididae) are considered as a sever insect pests on the ornamental plants in different gardens in Egypt. This work aimed to study the biology of these pests on their host plants; Madagascar dragon tree *Dracaena tricolor* and Butchers broom *Ruscus aculeatus* under different temperatures (22, 25, 27 and 30°C). The obtained results showed that increase in temperature reduced the developmental time for all stages of both species. The duration of *C. aonedium* female nymphs at 22, 25, 27, 30 ºC ranged between 33.8±3.3 days at 30ºC and 36.5±4.5 days at 22 ºC. The total male nymph's duration periods were 46.2±7.6, 42.6±3.0, 42.0 ±6.5 and 39.1±4.1 days at 22, 25, 27 and 30oC, respectively. The adult female lived for 18.2±2.5, 17.3±1.9, 15.9±2.8, and 15.5±2.5 days at 22, 25, 27 and 30ºC respectively. While the duration of female nymphs' stage of *P. blanchardii* were 39.5±2.8, 27.9±2.3, 27.3±1.9and 25.5±2.4 days at 22, 25, 27 and 30°C respectively. The longest of developmental time of male nymphs (24.2±2.7 days) which was recorded at 22°C while the shortest one was 19.8±3.6 days, which obtained at 30°C. The adult female longevity was 48.6±2.8, 47.7±3.4, 46.7±5.1, and 45.0±3.2 days at 22, 25, 27 and 30ºC respectively.

Key words: *Chrysomphalus aonidum, Parlatoria blanchardii,* biological studies, temperatures, Egypt.

INTRODUCTION

Scale insects (Hemiptera: Coccoidea) comprise a lot of the world pests of a wide varieties of plants. The family Diaspididae, commonly known as armored scales or hard scales for their hard waxy scale cover, is the largest family in the group with over 2500 species, which represents about one third of the total number of scale insect species (Ben-Dov *et al*. 2012). *Chrysomphalus aonidum* (=*ficus*) L. (Hemiptera: Diaspididae) is a hard scale insect infesting many species of plants, it is a highly polyphagus insect with host range of 192 plant genera belonging to 77 unrelated families (Hlavjenková & Šefrová (2012).

Host list includes 234 species, 226 genera and 95 families. Principal hosts are Citrus, Dracaena and palms (USDA, 2014). The presence of insects on leaves blocks the photosynthesis operation, which leads to plant weakness. Sap sucking insects causes a lot of damages during feeding. It grows on leaves, green twigs and fruits causing leaves turn yellow, premature leaves, fruits drop and stem dieback (Watson, 2005). A heavy infestation can cause stunting of corresponding plant parts. Woody plants infested for long periods of time can wilt and their young shoots can die (Smith-Pardo *et al*. 2012). The first instar nymphs, which are short-lived in the absence of suitable feeding sites, are the primary dispersal agents through short-term crawling, dispersal through wind, and attachment to birds or mammals. Movement of contaminated plant material or horticultural tools is potentially a significant mechanism of dispersal of this pest (Anonymous 2017).

Date palm scale *Parlatoria blanchardi* (Targioni Tozzetti) (= *Apteronidia blanchardi* (Targioni Tozzetti)) (Hemiptera: Diaspididae) occurs widely in the warmer parts of the world, it feeds on palms. It is a serious and widespread pest of commercial date palm orchards and ornamental palms. This pest is oligophagous on palms but has occasionally been found on non-palm hosts. The number of its generations varies between two and five depending on the weather conditions. For example, it has two generations per year in Egypt, and five in Iraq. The crawlers are the main natural dispersal stage. It can be difficult to detect as even large populations can be completely hidden beneath the overlapping leaf bases. (Miller & Davidson 2005). These insects as a pest of ornamental plants cause malformation for leaves, branches and stem which is considered the fortune of the plants that lead to decrease in quality and marketing value of the plant; these insects infest ornamental plants mostly inside green houses. So, it was important to study such insects and recognize its biological aspects inside laboratory to specify the proper timing for control.

MATERIAL AND METHODS

Scale insects and host plants:

The life history/cycle, oviposition, feeding, growth and reproduction of the two scale insect species were investigated in the laboratory. Each of the host plant species were collected and cleaned from the nursery of Al-Zohria botanic garden at Cairo and Garden of Al-azhar University at Nasr city. These seedlings were *Dracaena tricolor* for *C. aonedium* and *Ruscus aculeatus* for *P. blanchardii*.

Experiments:

Four replicates were used for the two plant species, which were chosen as the most infested plants to study under the influence of room temperature as well as under the influence of a constant temperature at a temperature of 25° C. In order to conduct the experiments, we need a rearing of *C. aonedium* and *P. blanchardii* in laboratory. Hence, a technique was adopted; it consisted in putting infested materials in contact with clean vegetal material in order to transfer infestation to this latter; once infested materials become dried, new emerged crawlers will move to the fresh materials, choosing hence better suitable site for their settlement and feeding. Infested leaves with *C. aonedium* and *P. blanchardii* were collected and kept to the laboratory. Small pieces of leaves containing gravid females were cut, infested leaves were attached to different clean leaves of plants by clips until the crawlers moved to the clean leaves and then removed. Twenty settled crawlers were randomly selected on leaves of plants; they were assigned a number and the settling date was recorded. The plants were watered twice a week. Experiments at different temperatures were run, and the plants were monitored periodically for study pest development. Mean development duration and survival in each immature stage as well as in each adult stage for both females and males was recorded each 2 days at the target temperatures. Dead specimens were replaced by new ones in the same or similar development stage if the total number of surviving specimens entering a stage was below 15 individuals. The incubation period of eggs was determined by using one day old egg of a mother of the California red scale. Fifty eggs from each host plant were spread on blotting paper in a small Petri dish. This Petri dish was in turn placed within a bigger dish containing some distilled water. The latter dish was covered with fine muslin so as to give maximum humidity to the eggs. The eggs were observed daily with a stereomicroscope (X 15) for the emergence of the crawlers Hoda and Abd-Rabou (2010). To calculate the fecundity and fertility of *C. aonedium* and *P. blanchardii,* it was not possible to observe the eggs laid and the egg hatching process of this insect because eggs are laid under the scale cover and removing the cover causes the death of the female. Hence, the reproduction capability of each female, we referred to the number of crawlers (offspring) that emerge. Therefore, all gravid females were encircled with glue (Tanglefoot) in order to catch emerged crawlers by this sticky substance. Emergence of crawlers was monitored twice a week and their number was recorded at each day of observation. When no more crawlers emerged, the scale cover was removed for all females, and their status was noted counting also the number of un-hatched eggs and crawlers died under the scale to determine fecundity. As it was to determine the sex ratio in stages. The experiment of biology started at 15 of April 2019 and continued through three generations of selected scale insects.

RESULTS AND DISCUSSION

Effect of temperature on the development time of *C. aonedium* stages:

Incubation period of eggs:

The mean incubation periods of eggs at 22, 25, 27, 30 °C were 10.1±1.9, 9.6±0.9, 8.1±0.7 and 7.9±1.2 days respectively (Table1). The longest mean incubation period of eggs was recorded at room temperature 22 °C and the shortest at 30 °C. with significant difference between the duration at 22 and 30°C. These results according to Uyakup *et al.* (2018) who reported that hatching time of this pest was 10 days and life span was 62 days.

Biological parameters of C. aonedium female nymphs:

As shown in Table (1) The duration of first instar of female nymphs reared on *Dracaena tricolor* at temperatures 22, 25, 27, 30 °C were19.9±0.6, 20.1±1.5, 19.2±1.1 and 17.9±1.1 days respectively. There were significant differences between the duration on temperature 30 ºC and the duration at temperature 22, 25 and 27 ºC. The longest mean duration of the second instar of female nymphs (16.9±0.9 days) was recorded at 27 ºC while the shortest one was at 30ºC15.9±1.0 days. There was a significant difference between them. The total *C. aonedium* female nymph’s stages at the tested tempertures 22, 25, 27, 30 ºC ranged between 33.8±3.3 days at 30ºC and 36.5±3.3 days at 22 ºC.

Biological parameters of the male nymphs:

Durations of the first instar were 20.5±1.0, 20.4±0.5, 18.5±1.4 and 18.7±1.1 days at 22, 25, 27 and 30 ºC, respectively (Table. 1). The second instar lasted for 10.7±0.4, 10.2±0.8, 10.3±1.0 and 10.3±1.2 days at 22, 25, 27 and 30 ºC, respectively. While pre-pupae durations were 5.8±0.5, 4.8±0.4, 6.5±1.4 and 5.0±0.6 days at 22, 25, 27 and 30oC, respectively. There were significant differences between the duration on temperature 27 ºC and the durations obtained at the other temperatures. Duration of pupae ranged between 5.1±1.2 and 9.2±0.5 days at 30 ºC and 22 ºC, respectively, with significant differences between them. The total male nymphal developmental period was 46.2± 7.6, 42.6±3.0, 42.0±6.5and 39.1±4.1 days at 22, 25, 27 and 30 º C, respectively. (Gill, 1997) reported that eggs hatch under the scale and the first-instar nymphs or crawlers walk about to find a suitable feeding site before settling to a sessile lifestyle. The second-instar nymphs are the main feeding stage in both sexes. Development to adult takes 7-16 weeks according to temperature. In California, USA, *C. aonidum* has up to six generations per year

Adult longevity and fecundity:

After reaching maturity, the adult female beings to lay eggs after a pre-oviposition period that varied with the different tested temperature; being in respective 5.3±0.8, 5.8±0.7, 5.7±1.1 and 6.3±0.8 days at 22, 25, 27 and 30 ºC respectively, with significant difference between the duration at 22 and 30°C. The longest period was recorded at highest temperature 30 ºC (6.3 days), while the shortest one was at 22 ºC (5.3 days) .The oviposition period was also affected by the tested temperature. The shortest period (6.7±1.0) days was reported at 30 ºC. While the longest (8.5±0.7 days) was at 22 ºC. with significant difference between the duration of oviposition period at 22 ºC and the durations at the tested temperatures; 25ºC, 27 and 30ºC. The longest post oviposition period was at constant temp.; 25 ºC (4.7±0.6 days) while the shortest one at 30 ºC (2.7±0.7) days, with high significant difference between the duration at 22 and both of 25 ºC and at 30°C. The adult female lived for 18.2±2.5, 17.3±1.9, 15.9±2.8, and 15.5±2.5 days at the respective temperature of 22, constant 25, 27 and 30ºC. The daily crawler’s production at 22, constant 25, 27 and 30°C ranged between 10.4±0.8 and 12.6±0.6 crawlers per day. There were significant differences between the daily crawler’s production at temperature 27 ºC and that at temperatures 22, 25 and 30 ºC. Rose and DeBach, (1978) reported that each adult female lays about 50-150 oval eggs under the scale over a period of 1-8 weeks, depending on the part of the infested plant (those on the leaves being less fecund than those infesting fruits). Also, The sex ratio was affected by temperatures. At 22, 25, 27 and 30 ºC, presents of females among the progeny were in respective 62.5%, 72.2%, 76.5% and 58.8%. Nur (1990) mentioned that the sex ratio in *C. aonidum* has been found to be biased in favor of females. Salama (1970) suggested that optimum development temperature and relative humidity for *Chrysomphalus dictyospermi* was 22-25ºC and 50-58%.

Effect of temperature on the development time of *Parlatoria blanchardii* stages

Incubation period of eggs:

The incubation periods were 12.4±1.1, 10.7±0.6, 10.1±0.8 and 9.8±0.3 days at 22, 25, 27 and 30°C, respectively. There were significant differences between the duration on temperature 22 ºC and the duration on temperature 25, 27 and 30 ºC.(Table. 2)

Biological parameters of female nymphs:

The durations of the first instar of female were 12.1±.17, 10.5±1.4, 10.7± 1.1and 9.6±1.4 days at 22, 25, 27 and 30°C, respectively, with significant differences between the duration at 22 ºC and the duration at 25, 27 and 30 ºC. Nymphs of second instar were 18.4±1.1, 17.4±0.9, 16.6±0.8 and 15.9±1.0 days, respectively, with high significant difference between the duration at 22 and 30 ºC. The total female nymphs’ period were 39.5±2.8, 27.9±2.3, 27.3±1.9 and 25.5±2.4 days at 22, 25, 27 and 30°C respectively. (Table. 2)

Biological parameters of male nymphs:

Duration of the first instar of male were 14.2±1.0, 13.7±1.2, 13.2±.09 and 11.8±1.6 days at 22, 25, 27 and 30°C respectively. The shortest second instar was 3.3±1.0 days at 30°C and the longest period was 4.4±0.8 at 22°C. Pre-pupa ranged between 2.8±0.8 days at27°C and 3.5±0.5days at 30°C, with significant differences between the duration at temperature 27 ºC and the duration at temperature 30 ºC. The pupal period was 2.4±0.5, 2.7±0.8, 2.2±.07 and 2.3±0.5 days at 22, 25, 27 and 30°C respectively. The longest total period of male nymphs was 24.2±2.7 days at 22°C and the shortest was 19.8±3.6 days at 30°C.

Adult longevity and fecundity:

As shown in (Table 2) the longest pre-oviposition period (6.3±1.0 days) occurred at 22 °C. Also, the longest oviposition time was 39.8±1.2 days also at 22°C while the shortest (36.5±1.8 days) was at 30°C., with significant differences between the duration at temperature 22 ºC and the duration at temperature 27 ºC and 30 ºC. The longest post-oviposition time was 3.5±0.8 days at 25°C. There were significant differences between the duration at temperature 25 ºC and the duration at the other three temperatures. The adult female longevity was 48.6±2.8, 47.7±3.4, 46.7±5.1, and 45 ±3.2 days at 22, 25, 27 and 30ºC respectively. The daily crawler's production at 22, 25, 27 and 30°C ranged between 1.2±0.1 and 1.7±0.3 crawler per day, with significant differences between the duration at 30 ºC and the duration at 22 ºC and 25 ºC. Fecundity ranged between 39.4±2.7egg/female at 22°C and 50.2±3.0 egg/female at 30°C. The sex ratio was affected by temperature. At 22, 25, 27 and 30 ºC, presents of females among the progeny were in respective 68.7%, 64.7%, 70.5% and 72.2%. The results of the present work agree with Bodenheimer (1951) who reported that a single female that oviposited for a period of 76 days, laying 1 or 2 eggs per day, the reproduction is exclusively sexual. The average number of eggs laid by each female is about 88, and hatching may require up to 2 weeks. Kozár and Ben-Dov (1997) pointed out that the environment can influence the phenotypic variation in life history structure and microscopic body features among multivoltine genotypes.

CONCLUSION

It is important to study these insects and learn about their biological aspects in the laboratory to determine the appropriate time to control them. These insects, as a pest for ornamental plants, cause deformation of leaves, twigs and stems, which in turn leads to a decrease in the quality and marketing value of the plant. These insects mostly infect ornamental plants indoors. And through the study it was found that. Through the study, it was found that the increase in temperature reduced the growth time for all stages of both types.

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Table 1: Effect of different temperature on the duration time of *Chrysomphalus aonedium* stages reared on *Dracaena tricolor.*

Parameter	Temperature				LSD 0.05
	22ºC	25ºC	27ºC	30ºC	
Female					
Egg	10.1±1.9a	9.6±0.9ab	8.1±0.7ab	7.9±1.2b	1.4
First instar nymphs	19.9±0.6 a	20.1±1.5 a	19.2±1.1 a	17.9±1.1 b	1.7
Second Instar nymphs	16.6±1.2 a	16.2±0.9 ab	16.9±0.9 ab	15.9±1.0 b	1.2
Total period	36.5±4.5	36.3±3.3	36.1±2.7	33.8±3.3	
Male					
Egg	10.1±1.9a	9.6±0.9ab	8.1±0.7ab	7.9±1.2b	1.4
First instar nymphs	20.5±1.0 a	20.4±0.5 a	18.5±1.4 a	18.7±1.1 a	1.5
Second Instar nymphs	10.7±0.4 a	10.2±0.8 a	10.3±1.0 a	10.3±1.2 a	1.5
Pre-pupae	5.8±0.5 b	4.8±0.4 b	6.5±1.4 a	5.0±0.6 b	1.1
pupae	9.2±0.5a	7.2±0.4 ab	6.7±2.0 ab	5.1±1.2 b	2.3
Total period	46.2±7.6	42.6±3.0	42.0±6.5	39.1±4.1	
Pre - oviposition	5.3±0.8 b	5.8±0.7 ab	5.7±1.1 ab	6.3±0.8 a	1.4
Oviposition	8.5±0.7 b	6.9±0.6 a	6.8±0.8 a	6.7±1.0 a	1.0
Post - oviposition	4.4±1.0 a	4.7±0.6 a	3.4±0.9 b	2.7±0.7 c	1.0
Female longevity	18.2±2.5	17.3±1.9	15.9±2.8	15.5±2.5	
Fecundity	86.5±3.6 a	62..4±6.2 b	84.5±0.6 a	88.0±4.1 a	5.9
Daily crawlers production	12.3±0.5 a	12.5±1.2 a	10.4±0.8 b	12.6±0.6 a	0.9
sex ratio (% female)	62.5	72.2	76.5	58.8	

Table 2: Effect of different temperature on the duration time of *Parlatoria blanchardii* stages *reared on ruscus aculeatus.*

Parameter	Temperature parameters				LSD
	22°C	25°C	27°C	30°C	
Female					
Egg	12.4±1.1b	10.7±0.6 a	10.1±0.8a	9.8±0.3 a	2.1
First instar nymphs	12.1±1.7a	10.5±1.4b	10.7±1.1b	9.6±1.4b	1.6
Second instar nymphs	18.4±1.1a	17.4±0.9b	16.6±0.8bc	15.9±1.0c	1.6
Total period	39.5±2.8	27.9±2.3	27.3±1.9	25.5±2.4	
Male					
Egg	12.4±1.1 b	10.7±0.6a	10.1±0.8a	9.8±0.3a	2.1
First instar nymphs	14.2±1.0a	13.7±1.2a	13.2±0.9a	11.8±1.6b	1.4
Second instar nymphs	4.4±0.8a	3.7±1.2a	4.0±1.0a	3.3±1.0a	1.5
Pre-pupae	3.2±0.4ab	3.3±0.5ab	2.8±0.8b	3.5±0.5a	0.8
pupae	2.4±0.5a	2.7±0.8a	2.2±0.7a	2.3±0.5a	0.7
Total period	24.2±2.7	23±3.7	22.2±3.4	19.8±3.6	
pre- oviposition	6.3±1.0a	5.9±0.8a	6.2±1.0a	5.6±0.7a	1.4
Oviposition	39.8±1.2a	38.3±1.8ab	37.3±3.6b	36.5±1.8b	3.5
Post - oviposition	3.0±0.6b	3.5±0.8a	2.6±0.5b	2.5±0.7b	0.9
Adult female longevity	48.6±2.8	47.7±3.4	46.7±5.1	45±3.2	
Fecundity	39.4±2.7b	44.8±3.4c	48.2±2.4ab	50.2±3.0a	4.3
Daily crawlers production	1.2±0.1b	1.4±0.1b	1.5±0.1ab	1.7±0.3a	0.3
sex ratio (% female)	68.7	64.7	70.5	72.2	

تأثير درجات الحرارة المختلفة على الحشرة القشرية السوداء وعلى حشرة نخيل التمر القشرية

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الملخص العربى

تعتبر الحشرة القشرية السوداء وحشرة نخيل التمر القشرية من الآفات الحشرية التي تصيب نباتات الزينة بشدة فى حدائق مصر المختلفة . يهدف هذا العمل إلى دراسة حياتية هذه الآفات على النباتات العائلة لها كشجرة تنين مدغشقر *Dracaena tricolor* وشجرة مكنسة الجزارين *Ruscus aculeatus* تحت تأثير درجات حرارة مختلفة 22 و 25 و27 و30 درجة مئوية. أظهرت النتائج المتحصل عليها أن الزيادة فى درجة الحرارة قللت من فترة النمو لجميع المراحل في كلا النوعين حيث تراوحت فترة نمو حوريات إناث الحشرة القشرية السوداء عند درجة حرارة 22 و25 و27 و 30 بين 33.8 يوم عند درجة حرارة 30 درجة مئوية وبين 36.5 يوم عند درجة حرارة 22 درجة مئوية .كانت فترات نمو حوريات الذكور 46.2 و42.6 و 42.5 39.1 يوما عند 22 و25 و27 و 30 على التوالى .كانت فترة حياة الأنثى البالغة 18.2 و 17.3 و15.9 و 15.5 يوما عند 22 و25 و27 و 30 درجة مئوية على التوالى. بينما كانت فترة نمو حوريات الإناث لحشرة نخيل التمر القشرية 39.5 و 27.9و27.3 و25.5 يوما عند 22 و25 و27 و 30 درجة مئوية على التوالى . سجلت أطول فترة نمو حوريات الذكر عند 24.2 يوم والتى سجلت عند 22 درجة مئوية بينما أقصرها كانت 19.8 يوم عند درجة حرارة 30 درجة مئوية .كان طول حياة الأنثى 48.6 و 47.7 و46.7 و 45 يوما عند 22 و25 و27 و 30 درجة مئوية على التوالى.

الكلمات الإسترشادية : الحشرة القشرية السوداء , حشرة نخيل التمر القشرية ,الدراسات الحياتية , درجات الحرارة , مصر.