

Biological Studies on the Cotton Mealybug *Phenacoccus solenopsis* Tinsley, (Hemiptera: Pseudococcidae) under the Laboratory Condition

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ABSTRACT

The cotton mealybug *Phenacoccus solenopsis* Tinsley (1989) (Hemiptera: Pseudococcidae) is one of the invasive species recently introduced to Egypt and nowadays it is wide spread among various parts of the country. The aim of this study shed light on certain biological aspects of the cotton mealybug and the effect of three host plant species i.e. ("potato", "tomato" and "cotton") as food source on certain biological aspects under the laboratory conditions. The results showed that the female and male of the cotton mealybug are not equal in numbers of moulting and nymphal duration. The life cycle of cotton mealybug was greater for males compared to females may be due to the additional moult and the pupal stage in the male, and it was significantly affected by different host plants, the females lasted 24.2 ± 2.7 , 22.1 ± 3.1 and 20.0 ± 2.7 days on potato, tomato and cotton plants leaves, respectively, while the males life cycle lasted 25.2 ± 2.6 , 22.9 ± 3.1 and 21.4 ± 2.9 days on potato, tomato and cotton plants leaves, respectively. Adult females lived longer than males, the female longevity lasted 31.2 ± 2.5 , 26.8 ± 3.6 and 23.1 ± 3.2 days on potato, tomato and cotton plants leaves, respectively, while males lived 3.1 ± 1.3 , 2.1 ± 0.9 and 2.0 ± 1.0 days on potato, tomato and cotton plants leaves, respectively. The cotton mealybug fecundity was significantly affected by different host plants; the females laid 163.3 ± 48.5 , 212.8 ± 55.1 and 265.8 ± 57.7 Eggs/female when adults reared on potato, tomato and cotton plants leaves, respectively. Sex ratio between females and males of *P. solenopsis* reared on potato, tomato and cotton plants leaves are not affected by the host plant. From the motioned results, it could be concluded that the cotton mealybug, *P. solenopsis* preferred cotton plant than the other two host plants. Key words: Cotton mealybug, *Phenacoccus solenopsis*, biological studies, Egypt.

INTRODUCTION

The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) is one of soft bodied insect pest which secretes honeydew which encourages the development of black sooty mold Hamlen, (1975) and Jagadish *et al.*, (2009). *Phenacoccus* is one of the largest genera in the family Pseudococcidae, as it currently contains more than 180 species (Ben-Dov, 1994).

P. solenopsis has a wide geographical distribution in many countries in the world with its origin in Central America Fuchs *et al.*, (1991) and Williams and Granara de Willink (1992), the first recorded in Ecuador and Caribbean by Ben-Dov (1994), in Brazil by Mark and Gullan (2005), in Argentina by Granara de Willink (2003) and in Chile by Larrain (2002). *P. solenopsis* has been described as an invasive and serious pest of the cotton plants in India and Pakistan by Hodgson *et al.*, (2008) and in Nigeria on *Hibiscus sp.*, by Akintola and Ande (2008). The latest record of *P. solenopsis* as an invasive pest in the Eastern region of Sri Lanka by Prishanthini and Laxmi (2009) on vegetable, ornamentals, weeds and on cotton in China by Wang *et al.*, (2009) and Wu and Zhang (2009).

In Egypt, the cotton mealybug *P. solenopsis* was recorded at the first time on weeds by Abd-Rabou *et al.*, (2010), and as a new pest on tomato plants, *Lycopersicon esculentum* by Ibrahim *et al.*, (2015) and recorded on cotton plants *Gossypium hirsutum* L. by El-Zahi *et al.*, (2016). It was first record as a new pest on tomato, pepper, eggplant and maize plants at Fayoum by Abd El-Wareth (2016) and on soybean plants by El-Sarand, (2017).

P. solenopsis recorded as one of the polyphagous insect pests that feed on a wide range of plant varieties by Kumar and Kontodim, (2012). It is a sap sucking insect and polyphagous attacks more than 183 plant species in 52 families by Ben-Dov *et al.*, (2009). The host range of *P. solenopsis* includes trees and plants such as fig, date palm, grapes, banana, apple, avocado, citrus, tomato, cucurbits, cotton, okra, mulberry and ornamentals plants as *Hibiscus sp.*, *Chrysanthemum sp.*, by Abbas *et al.*, (2010). The cotton mealybug has been recorded in 35 localities of various ecological zones of the globe by Ben-Dov *et al.*, (2009).

The cotton mealybug directly causes many damages to the host plants by sucking its sap, also causes indirect damage by secreting large amount of honeydew which encourages growth of the black sooty mold and decrease photosynthesis in plant leaves by Arif *et al.*, (2012). Furthermore, the cotton mealybug insects are suspected as plant diseases vector by Culik and Gullan, (2005).

Therefore, the present study was conducted to evaluate the influence of three host plant species on the biological aspects of the insect pest, so that the obtained information may be useful to formulate the management strategy of the pest.

MATERIALS AND METHODS

Sources of insect:

Studies on the biology of the cotton mealybug *Phenacoccus solenopsis* were carried out in the laboratory of Economic Entomology, Faculty of Agriculture, Damietta University using the population collected from unsprayed cotton plants *Gossypium sp.*, L. (Malvales: Malvaceae) at Agricultural Research Station, Kafr El-Sheikh, in August 2018.

Insect rearing:

The study was conducted between August and October 2018 under the laboratory condition, when the daily maximum, daily range, and daily minimum of temperature and daily mean of relative humidity were, (35.5°C , 10.3°C 24.3°C and 52.1%), respectively.

To rear the various stages of *P. solenopsis* and to carry out further biological studies, under laboratory conditions, Plastic Petri dishes 8 cm in diameter were used, each Petri dish containing a plant leaf. Plant leaves of potato, tomato and cotton free from insecticide and mealybug infestation, the leaves washed with tap water and shade dried then used as food source. The bases of the leaves petiole were individually covered with a water soaked cotton swab to prevent desiccation of the leaf. Specimens of mealybugs used in these studies were identified as *P. solenopsis* by the Insect Identification Service of Agricultural Research Institute, Cairo, Egypt. The biological data of different stages or instars of the insect were daily observed and recorded until they became adults using stereoscopic microscope.

Daily monitoring of nymphs moulting, the immature stages duration and nymphs complete its further molting and reached to the adult stage were done to determine the adult longevity, pre-oviposition, oviposition, post-oviposition periods and fecundity.

Total 100 newly hatched crawlers of *P. solenopsis* were reared on each host plant leaves up to third instar to determine the sex ratio. The third nymphal instar forming cocoons were separated as male and female and sex ratio was worked out.

Statistical analysis

Statistical analysis of the obtained data on *P. solenopsis* was analyzed using one way analysis of variance (ANOVA) and the means were compared for significance by Duncan's Multiple Range Test (Duncan 1955) at 0.05 probability level using SPSS system.

RESULTS AND DISCUSSION

The cotton mealybug *Phenacoccus solenopsis* was observed to be ooviviparous, females laid their eggs in cotty ovisac at posterior part of abdomen. Both eggs and crawler was observed in the ovisac and deposit eggs hatched within a short time (within 1 day). Therefor the egg incubation period and 1st nymphal instar was combined.

(Anonymous, 2008), mentioned that the eggs of *P. solenopsis* hatched after 4-6 hours.

The obtained results presented in Table (1), showed that the female and male of the cotton mealybug are not

Table 1. Influence of different host plant species on the life cycle of the cotton mealybug *P. solenopsis* under the laboratory conditions.

Host plants	Egg + I Instar	II Instar	Female	Female	Male pupa	Male
			III Instar	life cycle	III +IV Instars	life cycle
Potato	7.3±1.6 a	9.3±2.4 a	7.6±1.6 a	24.2±2.7 a	8.6±1.8 a	25.2±2.6 a
Tomato	6.5±1.6 a	9.0±0.7 ab	6.6±1.3 b	22.1±3.1 ab	7.4±1.4 a	22.9±3.1 ab
Cotton	6.1±1.5 a	7.9±1.1 bc	6.0±0.9 b	20.0±2.7 bc	7.4±1.4 a	21.4±2.9 bc
L.S.D 5%	1.31	1.30	1.06	2.35	1.28	2.39

Means with the same letter are not significantly different ($P=0.05$; Duncan's Multiple Range Test, Duncan, 1955)

The life cycle of the cotton mealybug was significantly affected by different host plants, the females lasted 24.2 ± 2.7 , 22.1 ± 3.1 and 20.0 ± 2.7 days on potato, tomato and cotton plants leaves, respectively, while the males life cycle lasted 25.2 ± 2.6 , 22.9 ± 3.1 and 21.4 ± 2.9 days on potato, tomato and cotton plants leaves, respectively, Table (1).

The obtained results are agreed with those obtained by Kamariya (2009), who found that the female nymphal stage passed through three instars, the duration of the 1st (crawler), 2nd and 3rd nymphal instars lasted 4.82 ± 1.12 , 5.64 ± 1.14 and 6.42 ± 1.14 days, respectively. The total nymphal period was minimum 12 days and maximum 21 days with 16.88 ± 2.11 days in average. The total life cycle duration of *P. solenopsis* female reared on cotton leaves was minimum 25 days and maximum 36 days with 31.12 ± 3.19 days in average.

Vennila *et al.*, (2010), recorded that the developmental duration of males longer than females because an additional moult and the pupal stage. Whereas the 2nd instar of males was the longer developmental duration and their high mobility could be the reason for decrease its survival, and it was not observed in the 4th instar due to the scarce of the male's population, and difficulty of observation of any sex related differences in early nymphal instars. Akintola and Ande (2008) showed that the developmental

equal in numbers of moulting and nymphal duration. The female nymph's moult three times and males four times.

The newly hatched nymphs for some time crawled over leaf surface searching about suitable place for feeding and then settled down.

The duration of combined egg incubation period and first nymphal instar lasted 7.3 ± 1.6 , 6.5 ± 1.6 and 6.1 ± 1.5 days on potato, tomato and cotton plants leaves, respectively, at daily max., daily range, and daily min. of temperature and daily mean of relative humidity 35.5°C ., 10.3°C ., 24.3°C ., and 52.1% R.H, respectively.

The longest nymphal instar is the second instar it was lasted 9.3 ± 2.4 , 9.0 ± 0.7 and 7.9 ± 1.1 days on potato, tomato and cotton plants leaves, respectively, Table (1). *P. solenopsis* male and female nymphs can be remarked from 3rd instar onwards. The male nymphs after 3rd moult formed a white silken cocoon, but in females such phenomenon not observed. The female nymphs continued to moult for remain in juvenile stage still. Male's cocoon was white in colour and cylindrical in shape.

Duration of male combined third and fourth instars lasted 8.6 ± 1.8 , 7.4 ± 1.4 and 7.4 ± 1.4 days on potato, tomato and cotton plants leaves, respectively, Table (1). Whereas the third nymphal instar as the last instar for female lasted 7.6 ± 1.6 , 6.6 ± 1.3 and 6.0 ± 0.9 days on potato, tomato and cotton plant leaves, respectively, Table (1).

periods for the 1st, 2nd and 3rd nymphal instars lasted 6, 8 and 10 days, respectively, for *P. solenopsis* nymphs reared on *H. rosa-sinensis* plants.

The data in Table (2) showed that the duration of the adult longevity of the cotton mealybug was significantly affected by different plant species. The longest pre-oviposition period was recorded on potato plant leaves with 10.7 ± 2.3 days. While the shortest pre-oviposition period was recorded on the cotton plant leaves with 7.5 ± 1.8 days, whereas, the tomato plant leaves showed moderate duration for the pre-oviposition period with 9.3 ± 1.8 days.

The oviposition period for this insect takes the same trend as in the pre-oviposition period, the oviposition periods were 11.8 ± 2.1 , 10.6 ± 1.2 and 9.8 ± 1.1 days for the adults reared on potato, tomato and cotton plants leaves, respectively. The fecundity of the cotton mealybug through the oviposition period was 163.3 ± 48.5 , 212.8 ± 55.1 and 265.8 ± 57.7 Eggs/female in average for the adults reared on potato, tomato and cotton plants leaves, respectively. The post-oviposition period also takes the same trend as in the pre-oviposition and oviposition periods, it was lasted 8.7 ± 1.2 , 6.8 ± 1.5 and 5.8 ± 0.9 days for the adults reared on potato, tomato and cotton plants leaves, respectively.

Results presented in Table (2), revealed that females of the cotton mealybug lived longer than males, the female

longevity lasted 31.2 ± 2.5 , 26.8 ± 3.6 and 23.1 ± 3.2 days on potato, tomato and cotton plants leaves, respectively, while the longevity of males lasted 3.1 ± 1.3 , 2.1 ± 0.9 and 2.0 ± 1.0 days on potato, tomato and cotton plants leaves, respectively, Table (2).

The effect of different host plants on *P. solenopsis* clearly appeared on the total life span periods for females and

males it was calculated from the egg laying to the death of adult stage. The total life span of *P. solenopsis* was the longest on potato it was 55.3 ± 3.2 and 28.3 ± 3.0 days for female and male while the shortest on cotton with 43.1 ± 4.8 and 23.4 ± 3.5 days whereas, the tomato showed moderate duration for the total life span period it was 48.8 ± 5.0 and 25.0 ± 3.2 days for female and male.

Table 2. Influence of different host plant species on the biological aspects of the cotton mealybug *P. solenopsis* adults under laboratory conditions.

Host plants	Pre-oviposition period	Oviposition period	Post-oviposition period	Female long. (d)	Male long. (d)	Female life span	Male life span	Fec./female (n)	Sex ratio ($\text{♀}:\text{♂}$)
Potato	10.7 ± 2.3 a	11.8 ± 2.1 a	8.7 ± 1.2 a	31.2 ± 2.5 a	3.1 ± 1.3 a	55.3 ± 3.2 a	28.3 ± 3.0 a	163.3 ± 48.5 a	1:0.23
Tomato	9.3 ± 1.8 a	10.6 ± 1.2 ab	6.8 ± 1.5 b	26.8 ± 3.6 b	2.1 ± 0.9 b	48.8 ± 5.0 b	25.0 ± 3.2 b	212.8 ± 55.1 b	1:0.26
Cotton	7.5 ± 1.8 b	9.8 ± 1.1 bc	5.8 ± 0.9 c	23.1 ± 3.2 c	2.0 ± 1.0 b	43.1 ± 4.8 c	23.4 ± 3.5 b	265.8 ± 57.7 c	1:0.29
L.S.D 5%	1.67	1.28	1.02	2.61	0.88	3.64	2.70	44.79	

Means with the same letter are not significantly different ($P=0.05$; Duncan's Multiple Range Test) Duncan, 1955

Sex ratio between females and males of *P. solenopsis* reared on potato, tomato and cotton plants leaves not affected by the host plant show similar percentage of sex ratio under the laboratory conditions. Culture revealed that out of 100 third instar nymphs for each host plant, 81, 79 and 77 were females and 19, 21 and 23 were males on potato, tomato and cotton plants leaves, respectively. Thus female to male ratio was 1: 0.23, 1: 0.26 and 1: 0.29 ($\text{♀}:\text{♂}$). The obtained results agreed with Prishanthini and Vinobaba (2009), they found that the sex ratio of *P. solenopsis* female to male was 1: 0.21 ($\text{♀}:\text{♂}$).

From the data presented in Tables (1 and 2), can concluded that the different host plants significantly affected on the duration of nymphal instars, total life cycle, adult longevity and fecundity of the cotton mealybug *P. solenopsis*. The longest durations were recorded on the potato plant leaves while the shortest one was observed on cotton plant leaves.

From the above motioned results, it could be concluded that the cotton mealybug, *P. solenopsis* preferred cotton plant than the other two host plants.

The obtained results are in agreement with Kamariya (2009), who found that the average of pre-oviposition, oviposition and post-oviposition period were recorded as 4.32 ± 0.8 , 8.0 ± 0.8 and 2.72 ± 0.79 days, respectively. The average egg laying capacity of the female was 427.68 ± 86.69 eggs. The average longevity of female adults was 13 to 18 days with an average of 15.52 ± 1.42 days. Also, Anonymous, (2008), recorded that the fecundity of mealybug was observed as 310-625 eggs/ female with average of 470 eggs/ female. 98-239 nymphs were observed in an ovisac. The incubation period was 4-6 hours. Mating period lasted for 10-45 minutes and the reproduction occurred 8-14 days after mating. The male nymphal period of 13-17 days was reported. The adult female was 4-5 mm long, oblong in shape. Male have no functional mouthparts and survived for 3-5 days. While, female adult survived for 30-48 days (Av. 40.7 days). In the present study majority of observations are match with the biological features of *P. solenopsis* on *Hibiscus rosa-sinensis* explained by Akintola and Ande (2008) from Nigeria and with the observations of Vennila *et al.* (2010) in cotton plants in India. Shoe flower and cotton and some of the other preferred hosts which are agricultural crops are of Family Malvaceae. Therefore the results would

be comparable to other crops and weeds act as host of *P. solenopsis*.

The total nymphal duration of 30, 46 and 66 days was recorded for a closely related species *Phenacoccus madeirensis* that reared under three different constant temperatures of 25°C , 20°C and 15°C respectively (Chong *et al.*, 2003).

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دراسات بيولوجية على بق القطن الدقيق (*Phenacoccus solenopsis* Tinsley, (Hemiptera: Pseudococcidae) تحت الظروف المعملية
طارق السيد عطا
قسم الحشرات الاقتصادية - كلية الزراعة - جامعة دمياط