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Biology of Cotton Mealybug, *Phenacoccus solenopsis* (Tinsley) on some Vegetable Crops in the Gazira State, Sudan

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***Abstract*—** *The recent out-break of cotton mealybug, Phenacoccus solenopsis (Tinsley) (Hemiptera: Pseudococcidae) on many crops belong to different families making a real worry for both farmers and research scientists. The objective of this study was to determine total life cycle of the cotton mealybug from the first instar to the death of adult. The study focused on the biology of P. solenopsis (Tinsley) on tomato and eggplant under laboratory conditions at the Entomology Section, Agriculture Research Corporation (ARC), Sudan during the period from January to March 2016. The results showed that the developmental period for the 1st, 2nd and 3rd instars, adult female longevity and duration of life cycle were recorded as 4.5±1.29, 6.6±2.07, 6.0±2.16, 3.2±1.31, 3.7±1.77, 2.9±1.12 and 26.9±9.72 days respectively, on tomato and 6.0±1.56, 9.5±2.87, 10.3±3.29, 3.0±0.9, 4.33±1.72, 2.66±0.85 and 35.79±11.22 days respectively, on eggplant. That means the life cycle of mealybug on eggplant was longer more than on tomato*

***Keywords*— Biology of cotton mealybug, Eggplant, Phenacoccus solenopsis (Tinsley), Tomato.**

I. INTRODUCTION

Cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera : Pseudococcidae) has been reported from 35 localities of various ecological zones of the globe [1]. It has a wide range of variation in morphological characters, biological adaptation and ecological adjustability [2]. *P. solenopsis* has been shown to be sexually dimorphic, having short life cycle winged males and longer-lived, wingless females. A survey was made in the Gezira and Khartoum states showed at least 26 host plant species belonging to 16 plant families were infested with citrus mealy bug (CMB) and reported from Gezira, Khartoum, Sennar, Gedarif, Kassala, White Nile and Blue Nile, Northern state and River Nile states, and the mealybug was identified as *P. solenopsis* (Tinsley) [3].

It was found to reproduce sexually, producing off-springs instead of laying eggs. The eggs are retained in the body until they are ready to hatch, a phenomenon known as ovoviviparity [4]. The study concluded that *P. solenopsis* occurred more commonly on the roots, stems and foliage close to the soil line in dry climates compared to settling on the upper foliage of the plant in more humid areas. The feeding habit of mealybug causes yellowing, defoliation, reduces plant growth and finally plant death at sever stage [5].The objective of this study was to determine the developmental stages, pre-oviposition, oviposition, post-oviposition and life span of cotton mealybug *P. solenopsis* (Tinsley) on tomato and eggplant.

II. MATERIAL AND METHODS

This study was conducted at Entomology Section, Crop Protection Research Center, Agriculture Research Corporation (ARC), Gezira state, Sudan during January – March 2016. The laboratory has an average temperature range between 25 - 45ºC and the relative humidity ranging between 20 - 40%. Special leaf or plant cage were used. These cages made from disposable plastic containers, in each cage a leaf of tomato or eggplant was placed with one adult female. This was replicated fifteen times. Cages were observed daily for egg-laying during the life span of the adult female.

The same individual adult in the cage was shift to another leaf in the same leaf (eggplant) or branch (tomato) cage, daily after counting the ovisacs, nymph observed. Soft camel hair brush and the eye - lens of binocular microscope (5x) were used in counting the neonates of the mealybug. First, the adult was removed gently by the brush to a new leaf and the counted individuals of neonate were excluded gently by using the brush and the magnifying lens. The number of ovisacs observed and nymphs were recorded and subjected to analysis.

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The number of eggs per ovisac for each insect was recorded using binocular microscope (5x) and replicated over one hundred times.

Five newly hatched crawlers of mealybug (first nymphal instar) were enclosed in a separate leaf cage of tomato or eggplant with 20 replicates. The nymphal period was observed every 24hrs using a magnifying hand lens (5x). The nymph was considered passing to another stage when a change in size, presence of exuvia or deposition of wax was observed.

The newly hatched crawlers were reared to the adult stage which determined by the sign, presence of exuvia or deposition of wax, then the total life span for the adult was monitored.

Collected data were subjected to descriptive analysis using Microsoft Excel.

III. RESULT AND DISCUSSION

3.1. Determination of ovisacs/female

Table (1) shows the number of ovisacs laid by each of the 20 females. The results showed that each female had formed only one ovisac during its entire life time.

Table (1) Number of ovisacs laid by each female of *P. solenopsis* on tomato and eggplant

Female experimented	Number of ovisac laid by female
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
Total	**20**
Mean	**1**

3.2. Number of nymphs / ovisack

Table (2) shows the number of nymphs/ovisac on both host plant i.e. tomato and eggplant. Among the 130 ovisacs tested, the highest mean number of nymphs/ovisac was found to be 459 nymphs/ovisac, while the lowest mean number was 70 nymphs/ovisac with an average of 167 nymph/ovisac i.e. 21715 nymph observed in 130 ovisacs, lowest and highest mean number/ovisac was 70, 459 and 167, respectively. Also this table illustrated that more than 38% of the examined an ovisacs contain 100–200 nymphs, while 6% of them contain 400–500 nymph. That means the nymphs laying capacity of this species was high i.e. 100-200 or 400-600 nymphs/ovisac when compared with the previous results obtained by Radadia *et al.*, (2008) who found the mean 150-600 egg/ovisac and the total number of egg/female 310-625 with mean of 470 eggs/female by Tanwar *et al.*, (2007).

Table.2: Number of nymphs / ovisac of cotton mealybug P. solenopsis on tomato and eggplant

Number of nymphs / ovisac	Ovisac		Total	Mean
	Number	%		
0 - 100	43	33.1	3038	70.6
101- 200	50	38.5	7252	145
201 – 300	20	15.4	4658	232.9
301 – 400	9	6.9	3091	343.4
401 – 500	8	6.1	3676	459.5
Total	**130**	**100**	**21715**	**1251.4**
Average nymphs / ovisac			**167**	

Number and life time of nymphal instars

Table (3) shows that the CMB has only three nymphal instars. The periods (days) taken by the first, second and third nymphal instars were (4.5±1.29, 6.0±1.56), (6.6±2.07, 9.5±2.87) and (6.0±2.16, 10.3±3.29) on tomato and eggplant, respectively. Also hereunder appendices and Table (4) show the pre-oviposition, oviposition, post ovipositon and total life cycle as (3.2±1.31, 3±0.90), (3.7±1.77, 4.33±1.72), (2.9±1.12, 2.66±0.85) and (26.9 ±9.97 , 35.79±11.22) on tomato and eggplant, respectively. The time required for growth and development was longer on eggplant compared to tomato. However similar results were shown by Sharma (2007) who found that the period of development from crawler to adult stage is approximately 25-30 days, depending on the weather and temperature. Mean development period were 4.9±1.4, 4.5±0.6 and 5.9±1.1 days, respectively for the first, second and third instars of female and 15.3±1 days mean development from crawler to adult stage (Mohammed, 2015). While the same trend was observed for the pre-, post- and oviposition period but with low rate. The results of this study here were similar to that was obtained by Dhawan and Saini (2009), who were found that the female of CMB have three nymphal instars, the first instar nymph lasted for 4-6 days, the second was also 4-6 days and the third instar nymph lasted 5-7 days and the adult female period lasted for 13-17 days, while

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the pre-oviposition, oviposition and post- oviposition were 3-5, 8-9 and 2-3 days, respectively.

4. Life time of the adult female

Tables 4 and 5 show that the duration of the pre-oviposition, oviposition and post-oviposition period of 31 studied adult females of cotton mealybug on tomato and 20 ones on eggplant. The pre-oviposition period was determined starting with completion of the third instar stage to the appearance of the ovisac out of the female ovipositor.

Table.3: Period (days) required for growth and development for various stages of P. solenopsis on tomato and eggplant

Stage	Days (Mean± SD)	
	Tomato	**Eggplant**
First instar	4.5±1.29	6.0±1.56
Second instar	6.6±2.07	9.5±2.87
Third instar	6.0±2.16	10.3±3.29
Pre-oviposition	3.2±1.31	3.0±0.90
Oviposition	3.7±1.77	4.33±1.72
Post-oviposition	2.9±1.12	2.66±0.85
Total life cycle	26.9±9.72	35.79±11.21

Table.4: Pre-oviposition, oviposition and post-oviposition period (days) of P. solenopsis on tomato

Number of adult female studied	Pre oviposition period (days)	Oviposition period (days)	Post ovipositon period (days)
4	2	3	2
1	2	7	2
1	2	3	7
2	2	5	3
1	2	4	2
1	2	2	3
1	2	6	2
2	3	5	2
2	3	7	3
2	3	1	3
1	3	1	4
3	3	3	2
1	4	3	2
1	4	5	3
2	4	2	2
1	4	3	4
2	5	3	2
2	5	4	3
1	5	3	5
Total	**60**	**70**	**56**
Range	1-5	1 - 7	2 – 7
Mean ± SD	3.2±1.31	3.7±1.77	2.9±1.12

IV. CONCLUSION

From the above results, the following conclusion was obtained; firstly, the cotton mealybug, *Phenacoccus solenopsis* ***(Tinsley)***, has three nymphal instars, and the developmental stages need more time on eggplant than on tomato. Secondly, each female of cotton mealybug lays only one ovisac during its entire life span. The total life span of Cotton mealybug on tomato and eggplant completed in 26.9±9.7 and 35.7±11.2, respectively. Eventually, tomato and eggplant not be intercropped when the cotton mealybug was expected to occur during the season or even subsequent and/or overlapping each other in the cropping system.

Table.5: Pre-oviposition, oviposition and post-oviposition period (days) of P. solenopsis on eggplant

Number of adult female studied	Pre oviposition period (days)	Oviposition period (days)	Post oviposition period (days)
1	2	7	2
1	2	6	2
1	2	3	2
2	2	3	3
3	2	5	3
1	3	4	2
1	3	3	5
1	3	6	2
1	3	2	3
1	3	3	2
3	4	4	3
1	4	4	2
1	4	8	2
1	4	3	3
1	4	4	4
Total	**45**	**65**	**40**
Range	2-4	2-8	2-5
Mean ±(SD)	3±0.90	4.33±1.72	2.66±0.85

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