Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 833-835

Received: 07-05-2020
Accepted: 09-06-2020

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Biology and morphometry of mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) on Cotton

S Thangavel and N Ganapathy

Abstract
The biology and morphometry studies of *Phenacoccus solenopsis* (Tinsley) were studied on cotton genotypes CO 14 and LRA 5166 under laboratory conditions. The duration of first, second and third instar nymphs were 6.20 ± 0.83, 8.40 ± 0.54 and 11.60 ± 0.54 days in CO 14 and 4.40 ± 0.70, 6.00 ± 0.70, 10.40 ± 0.54 days in LRA 5166 with nymphal period 26.20 ± 1.91 and 20.80 ± 1.94 days, respectively. The adult longevity in CO 14 and LRA 5166 was 12.20 ± 0.44 and 9.80 ± 0.83 days, respectively. Average oviposition period was7.40 ± 0.54 and 6.20 ± 0.83 days in CO 14 and LRA 5166, respectively. The average number of eggs per female on cotton genotypes CO 14 and LRA 5166 was 242.60 ± 11.01 and 349.40 ± 22.23 respectively. The total developmental period in CO 14 and LRA 5166 was 38.40 ± 2.35 and 30.60 ± 2.77 days, respectively.The length of first, second, third instar and adult were 11.36 ± 0.51 mm, 12.18 ± 0.65 mm, 13.62 ± 0.79 mm and 15.46 ± 0.52 mm respectively. The width of first, second, third instar and adult were 0.52 ± 0.42 mm, 6.09 ± 0.41 mm, 8.13 ± 0.44 mm and 11.92 ± 0.27 mm, respectively. The antennal length of first, second, third instar and adult were 1.48 ± 0.07 mm, 1.42 ± 0.07 mm, 1.35 ± 0.07 mm and 2.36 ± 0.09 mm, respectively.

Keywords: Biology, developmental period, fecundity, morphometry, *Phenacoccus solenopsis*

1. Introduction
Cotton, *Gossypium* spp. is one of the most commercially important fibre crops in the world and occupies a desirable place amongst the commercial crops of India. Introduction of transgenic *Bt* cotton for commercial cultivation in India during 2002 was a boon to cotton growing farmers and who started harvesting good yields with maximum returns. Cotton is damaged by an array of insect pests from sowing to harvest since the crop duration is long. Sucking pests *viz.*, leafhopper, thrips, aphids, whitefly, mirid bug, mealybug and dusky cotton bugs cause 22.85% yield reduction (Satpute *et al.*, 1990) [11]. Cotton mealybug, *P. solenopsis* (Tinsley) (Hemiptera: Pseudococcidae) is soft bodied insect that sucks the leaf sap and causes total destruction of the crop. The mealybug has a wide geographical distribution with its origin in Central America (Williams and Granara de Willink, 1992) [12]. It has recently emerged as an important pest of cotton which also attacks several vegetables, fruits and ornamental crops. It has been described as a serious and invasive pest of cotton (Hodgson *et al.*, 2008) [5]. The avoidable loss in seed cotton yield due to this mealybug infestation was estimated to be 25.02 per cent (Pawar *et al.*, 2011) [9]. In Tamil Nadu, cotton is grown in 1.40 lakh ha with production of 6 lakh bales and 729 kg/ha productivity (Anonymous, 2019) [3]. Understanding of the pest biology is essential to identify the most susceptible stage of the pest species for the efficient and economic management. Hence, we studied the biology and morphometry of mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) on Cotton.

2. Materials and Methods
2.1 Mass culturing of *Phenacoccus solenopsis* Tinsley
Studies on biology and morphometrics of *P. solenopsis* were carried out in the Biocontrol laboratory, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during 2016-17 at 23 ± 2ºC and relative humidity 69.9 ± 5.5% respectively. *P. solenopsis* was mass reared on potato sprouts at Insectary, under controlled condition and it was utilized for the experiment.

2.2 Studies on biology

Mealybug sample was collected from unsprayed cotton fields at the experimental plot. Twigs of cotton plants infested with reproducing females of *P. solenopsis* were brought to the laboratory; females were separated, and fed on cotton leaves in Petri plates. For biology study, newly emerged first instar crawlers from culture were released into cotton leaves using camel hair brush (Series No.68) @ 10 numbers per petridish with three replications and the released crawlers were investigated. Cotton leaves were replaced daily. Observation were made daily on the development of crawlers. The number and the interval between moultings were examined by the presence of exuviae using a hand lens of 10x magnification. The exuviae were removed after each moulting. All stages of live *P. solenopsis* (first instars, second and third instars of nymphs and adult females) (Fig.1) were separated from the rearing colonies on cotton and morphometrics parameters (length and width) were observed for under Motic Zoom microscope (Leica). The data obtained from laboratory experiments were subjected to data transformation and analyzed using AGRES software.

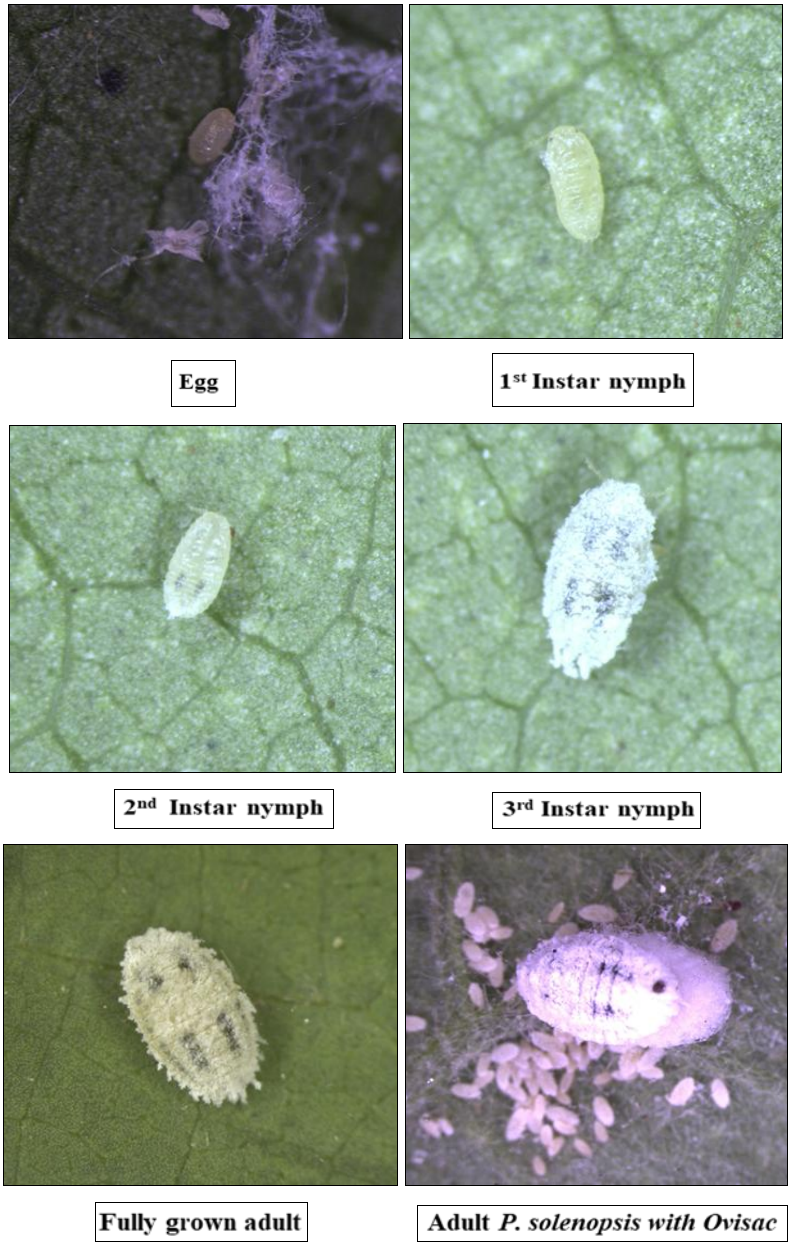

Fig 1: Life stages of mealybug, *Phenacoccus solenopsis* (Tinsley)

3. Results and Discussion

3.1 Comparative biology and morphometric observation of *Phenacoccus solenopsis* (Tinsley) on cotton (cv. CO 14 and LRA 5166) genotypes

Both the cultivars, CO 14 and LRA 5166 of cotton had profound influence on the biology of *P. solenopsis.* The results indicated that life cycle of *P. solenopsis* was comparatively shorter on LRA 5166 than CO 14.

3.1.1 First instar

The duration of first instar and third instar nymphs were longer (6.20 ±0.83 days) on CO 14 while it was shorter on LRA 5166 (4.40 ±0.70 days) (Table 1). Dhawan and Saini (2009) [4] reported the average duration of first instar nymph of female and male as 4.60 ± 1.10 days. The nymphs lacked mealy wax coating, oblong in shape; light yellow in colour and highly mobile without permanent feeding site. The body had a total length and width of 11.36 ± 0.51 mm and 0.52 ± 0.42 mm, respectively. The filiform antennae had 8 to 9 segments with a length of 1.48 ± 0.07mm (Table 2). However, Nikam *et al.* (2010) [8] reported it as 0.66 to 0.87 mm in length and 0.28 to 0.40 mm in breadth.

Table 1: Comparative biology of *Phenacoccus solenopsis* (Tinsley) on cotton genotypes

Life stage	Developmental period* (days) (n=10) (Mean ± SD)	
	CO14	LRA 5166
I instar nymphal period	6.20 ± 0.83	4.40 ± 0.70
II instar nymphal period	8.40 ± 0.54	6.00 ± 0.70
III instar nymphal period	11.60 ± 0.54	10.40 ± 0.54
Total nymphal period (days)	26.20 ± 1.91	20.80 ± 1.94
Adult longevity (days)	12.20 ±0.44	9.80 ± 0.83
Total life cycle (days)	38.40 ± 2.35	30.60 ± 2.77
Oviposition period (days)	7.40 ±0.54	6.20 ± 0.83
Fecundity (No. of offspring's/bug)	242.60 ±11.01	349.40 ± 22.23

* Mean of three replications

Table 2: Morphometrics of *Phenacoccus solenopsis* (Tinsley) on cotton (cv. CO 14)

Life stage	Length* (mm)	Width* (mm)	Antennal length* (mm)
Nymph/ Ist instar	11.36 ± 0.51	0.52 ± 0.42	1.48 ± 0.07
2nd instar	12.18 ± 0.65	6.09 ± 0.41	1.42 ± 0.07
3rd instar	13.62 ± 0.79	8.13 ± 0.44	1.35 ± 0.07
Adult	15.46 ± 0.52	11.92 ± 0.27	2.36 ± 0.09

*Mean ± SD of three replications

3.1.2 Second instar
The duration of second instar nymph was 8.40 ± 0.54 and 6.00 ±0.70 in CO 14 and LRA 5166 respectively. The crawlers settled mostly on the undersurface of the tender leaves in large numbers. This stage was devoid of mealy coating and yellow in color. The total body had a length and width of 12.18 ± 0.65 mm and 6.09 ± 0.41 mm, respectively. The antennae were 8 segmented with a length of 1.42 ± 0.07mm. The present finding is in accordance with Aheer *et al.* (2009) [1].

3.1.3 Third instar
The duration of third instar nymph in CO 14 and LRA 5166 was 11.60 ± 0.54 and 10.40 ± 0.54 days. The crawlers had white mealy wax coating all over the body, oval in shape, dark yellow in color and aggregated largely on stems. The body measured 13.62 ± 0.79 mm in length and 8.13 ± 0.44mm in width. The filiform antennae were 8 segmented and1.35 ± 0.07 mm in length (Table 2).

3.1.4 Adult female
Survival of adult female was highest on CO 14 (12.20 ± 0.44 days) and shortest on LRA 5166 (9.8 ± 0.83 days). Similar trend was observed for oviposition period on CO 14 (7.40 ± 0.54 days) and LRA 5166 (6.20 ± 0.83 days). Adult female body was oval, somewhat rounded in lateral view, light to dark yellow in appearance, covered by thin mealy wax, with dark dorso sub medial bare spots on inter segmental areas of thorax and abdomen, these areas forming one pair of dark longitudinal lines on dorsum considerably in size of 4.50 mm and 3.45 mm wide. Adult has 18 pairs of lateral wax filaments, posterior pairs longest, up to 1/4th length of the body. The total body length and width of slide mounted specimen of the adult female measured about 15.46 ± 0.52 mm and 11.92 ± 0.27 mm. The head had a pair of 8 to 9 segmented filiform antennae which recorded a length of 2.36 ± 0.09 mm (Table 2). The morphological character of the adult female reported in the present investigation was in consonance with findings of Miller *et al.* (2005) [6] who observed that the live appearance of *P. solenopsis* had paired dark spots or stripes dorsally with short lateral wax filaments and slightly longer terminal wax filaments (less than half as long as the body). The fecundity of adult female was high on LRA 5166 (349.4 ± 22.23 nymphs) when compared to CO 14 (242.60 ±11.01 nymphs). The total life span of *P. solenopsis* was completed in 38.40 ± 2.35 and 30.60 ± 2.77 days on CO 14 and LRA 5166 respectively (Table 1).According to Mohammad (2008) [7], *P. solenopsis* nymphs feed and develop into adults in approximately 30 days. The female mealy bug produces 10-15 generations per year in colonies of 500-600 eggs. The insect has a life cycle of 24 to 30 days. Akintola and Ande (2008) [2] determined life history and documented that there were three nymphal stages which lasted for six, eight and 10 days in female and the adult stages. The total number of days from egg to adult longevity was 37 days. Results were also in line with Prithiva (2019) [10] wherein biology and morphometric analysis revealed that developmental duration of nymphal instars were high in AE 65 than AE 26 and Pusa Sawani (Susceptible check). Adult longevity and fecundity was maximum in AE 26 compared to AE 65. Hence total life cycle was comparatively more in AE 65. Morphometrics of leafhopper *viz.*, body length, body width, antennal length in susceptible and resistant genotype was not much variable.

4. Conclusion
The present study provides the knowledge on biology of mealy bug on cotton cultivars wherein, growth and development of mealy bug was comparatively higher in resistant genotype. This information evokes that use of resistant or moderately resistant genotype paves the way for better management of mealy bug in cotton. Variation in growth and development may be due to morphological or physiological bases of resistance which is to be further explored. Thus, it is proved that host plant resistance serves as a major tool in integrated pest management.

5. Acknowledgements
The authors thank the Dean, School of Post Graduate Studies (SPGS), Director, Centre for Plant Protection Studies, and Professor and Head, Department of Entomology, Tamil Nadu Agricultural University for assistance and facilities.

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