



Biology of Mealy Bugs, *Paracoccus marginatus* (Williams and Granara de Willink) and *Phenacoccus solenopsis* (Tinsley) on Sunflower under Greenhouse and Laboratory

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Experiments were carried out in the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during 2011 to study the biology of mealybugs viz., *Paracoccus marginatus* and *Phenacoccus solenopsis* infesting sunflower. The egg, first, second and third instar nymphal periods of *P. marginatus* were 6.33 ± 0.58 , 4.00 ± 1.00 , 3.67 ± 0.58 and 5.00 ± 1.00 days, respectively. Adult longevity of females and males were 20.33 ± 1.53 and 1.67

± 1.15 days, respectively. Total life cycle of *P. marginatus* was 39.33 ± 2.53 days for females and 24.00 ± 1.73 days for males. The oviposition period was 7.33 ± 0.58 days and fecundity was 329.33 ± 20.03 eggs on sunflower seedlings. Egg period of *P. solenopsis* was very short with an average of 48.33 ± 7.64 minutes. Duration of first, second and third instars were 6.33 ± 1.15 , 9.67 ± 0.58 and 6.00 ± 0.00 days respectively. Longevity of males was shorter by 1.33 ± 0.58 days compared to females (38.67 ± 3.06 days). Total life cycle of *P. solenopsis* was 60.67 ± 4.06 days for females and 30.33 ± 1.58 days for males. Oviposition period of adult female of *P. solenopsis* was 18.67 ± 0.58 days which was longer than for *P. marginatus*. Adult female of *P. solenopsis* recorded high fecundity with an average of 511.00 ± 131.73 eggs on sunflower seedlings.

Key words: Sunflower, *Paracoccus marginatus*, *Phenacoccus solenopsis*, biology

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Pest menace is one of the major constraints in sunflower production. More than one hundred insect species have been reported as pests on sunflower. The yield loss ranges from 35.7 to 51.3 per cent due to insect damage (Bakhetia *et al.*, 1997). Cotton mealy bug, *Phenacoccus solenopsis* and papaya mealy bug, *Paracoccus marginatus* pose serious threat to sunflower cultivation. Mealy bug infestation in sunflower results in yellowing, crinkling and curling of leaves, reduced plant growth and in some cases death of plants. Mealy bug infestations are typically observed in sunflower as clusters of cotton-like masses on the tender plant parts. Tender leaves become bunched and distorted. Mealy bugs produce huge volume of honey dew, resulting in black sooty mould on the infested vegetation (Meyerdirk *et al.*, 2004).

Understanding the biology of a pest insect is important in predicting its development, emergence, distribution, abundance and in pest management, especially when applying chemical and biological control methods. Details on biology and life cycle of papaya mealy bug and cotton mealy bug infesting sunflower are meager. Hence, this study was undertaken in order to develop a suitable bio intensive integrated pest management module.

Materials and Methods

In order to study the biology of mealy bugs under

greenhouse conditions, sunflower seedlings were raised in the insectary of the Department of Agricultural Entomology, TNAU, Coimbatore. The seeds of sunflower (CO 4) received from the Department of Oilseeds, TNAU, Coimbatore, were sown in earthen pots (25x21 cm) filled with mixture of soil and vermicompost (1:1) and mixed with adequate amount of fertilizers to raise healthy plants. The seedlings were covered with mylar cages (60x40 cm) to prevent infestation from other insect pests. Thirty days old seedlings were used for studies on biology.

Egg mass of *P. marginatus* with 150 eggs was released by using camel hair brush (Series No.68) @ one mass per plant with three replications. Observations were made daily on the development of eggs. The hatchability and the interval between moultings were recorded by examining exuviae using a hand lens of 10X magnification. The exuviae were removed after each moult. All the morphological observations were made for all the instars under a stereo zoom microscope. For the biology of *P. solenopsis*, newly emerged crawlers were released at the rate of ten per plant with three replications. The crawlers were observed daily under stereo zoom microscope for moulting, up to the next egg laying period. Biology of *P. marginatus* and *P. solenopsis* was also studied in Bio-control Laboratory in the Department of Agricultural Entomology, TNAU, Coimbatore, where the temperature and relative

humidity were in the range of 25 to 30°C and 75 to 80 per cent, respectively. Individual neonate crawlers emerging from females were used for the study. Base of the petiole of individual sunflower leaf was covered with a water soaked cotton swab to prevent desiccation and drying. A total of 50 crawlers of same age were transferred to petriplates containing sunflower leaves.

Crawlers were observed until they became adults. The developmental time of each instar was recorded by examining exuviae on the leaves. The crawlers were monitored daily until adult stage to determine the developmental period of each instar and the adults were monitored daily to determine the reproductive period and fecundity. The adults were transferred individually to new petri-plates for egg laying. When eggs were observed with the ovisac, they were separated along with the leaf discs and observed until they hatched. Time taken for egg hatching was recorded to compute incubation period. The developmental period of each nymphal period, pupal period, adult longevity for male and female, oviposition period, incubation period and fecundity were calculated based on the total number of observations made.

Results and Discussion

Green house studies

Developmental period of *Paracoccus marginatus*

The duration of egg period, first, second and third instar nymphs of mealy bug were 6.33 ± 0.58 , 4.00 ± 1.00 , 3.67 ± 0.58 and 5.00 ± 1.00 days, respectively. The males had an additional instar (pupa) with the mean development period of 3.33 ± 0.58 days. The females had yellow body covered with mealy wax not thick enough to hide body colour, without discrete bare areas on dorsum, with many short waxy filaments around body margin. The ovisac in females was developed behind the body. The adult males had elongate body with 1 mm long. The wings were approximately as long as the body length, with small basal vein. Adult longevity of female and male were 20.33 ± 1.53 and 1.67 ± 1.15 days, respectively. The total life cycle of *P. marginatus* was 39.33 ± 2.53 days for females and 24.00 ± 1.73 days for males. The oviposition period of adult female was 7.33 ± 0.58 days. The fecundity of adult female was 329.33 ± 20.03 on sunflower seedlings (Table 1).

Developmental period of *Phenacoccus solenopsis*

The duration of egg period or incubation period of *P. solenopsis* female was very short with an average of 48.33 ± 7.64 minutes (Table 1). The eggs were laid in cottony ovisac located at the posterior end of abdomen of adult female. The eggs were smooth, translucent, light creamy yellow and oblong with tapering ends. The duration of first, second and third instars were, 6.33 ± 1.15 , 9.67 ± 0.58 and 6.00 ± 0.00 days, respectively. Male and females of *P. solenopsis* nymphs can be distinguished from third instar onwards. The male nymphs formed a white silken cocoon after their third moult, but no such

Table 1. Biology of mealy bugs infesting sunflower (CO 4) under greenhouse conditions

Life stage	*Developmental periods (Days) (Mean \pm SD)	
	<i>P. marginatus</i>	<i>P. solenopsis</i>
Egg (incubation period)	6.33 ± 0.58 days	48.33 ± 7.64 minutes
I instar	4.00 ± 1.00	6.33 ± 1.15
II instar	3.67 ± 0.58	9.67 ± 0.58
III instar	5.00 ± 1.00	6.00 ± 0.00
Pupa or cocoon (Male)	3.33 ± 0.58	7.00 ± 1.00
Adult longevity	Male 1.67 ± 1.15	1.33 ± 0.58
	Female 20.33 ± 1.53	38.67 ± 3.06
Total life cycle	Male 24.00 ± 1.73	30.33 ± 1.58
	Female 39.33 ± 2.53	60.67 ± 4.06
Oviposition period	7.33 ± 0.58	18.67 ± 0.58
Fecundity (No.)	329.33 ± 20.03	511.00 ± 131.73

*Mean of three replications.

phenomenon was observed in females. The duration of fourth instar (cocoon) was 7.00 ± 1.00 days (Table 1). The longevity of males was shorter with an average of 1.33 ± 0.58 days than females (38.67 ± 3.06 days). The total life cycle of *P. solenopsis* was 60.67 ± 4.06 days for females and 30.33 ± 1.58 days for males. The oviposition period of adult female of *P. solenopsis* was longer (18.67 ± 0.58 days) than *P. marginatus* (7.33 ± 0.58 days). Adult female of *P. solenopsis* recorded high fecundity with an average of 511.00 ± 131.73 numbers when compared to that of *P. marginatus* on sunflower seedlings.

Laboratory studies

Developmental period of *P. marginatus*

The duration of egg period (incubation period) was observed as 7.20 ± 1.30 days. The duration of immature stages viz., crawlers (first instar), second instar, third instar and fourth instar (male pupa) was 4.00 ± 0.71 , 4.20 ± 1.30 , 4.80 ± 0.45 and 3.60 ± 0.55 days, respectively (Table 2).

Table 2. Biology of mealy bugs infesting sunflower under laboratory conditions

Life stage	*Developmental periods (Days) (Mean \pm SD)	
	<i>P. marginatus</i>	<i>P. solenopsis</i>
Egg (incubation period)	7.20 ± 1.30 days	80.00 ± 23.45 minutes
I instar	4.00 ± 0.71	5.80 ± 0.84
II instar	4.20 ± 1.30	7.20 ± 0.84
III instar	4.80 ± 0.45	4.40 ± 1.14
Pupa or cocoon (Male)	3.60 ± 0.55	6.40 ± 0.55
Adult longevity	Male 1.80 ± 0.84	1.20 ± 0.45
	Female 21.20 ± 2.77	37.00 ± 2.45
Total life cycle	Male 25.60 ± 2.32	25.00 ± 2.37
	Female 41.40 ± 3.87	54.4 ± 4.27
Oviposition period	8.20 ± 0.84	19.00 ± 0.71
Fecundity (No.)	380.00 ± 28.66	531.20 ± 65.10

*Mean of three replications.

Total life cycle of females was greater (41.40 ± 3.87 days) when compared to males (25.60 ± 2.32 days). Longevity of the adult males was lesser (1.80 ± 0.84 days) than adult females (21.20 ± 2.77 days). The oviposition period and fecundity of adult females were 8.20 ± 0.84 days and 380.00 ± 28.66 eggs, respectively on sunflower leaves.

Developmental period of *P. solenopsis*

The developmental period of immature stages of *P. solenopsis* was longer for the second instar

(7.20 ± 0.84 days) when compared to that of first and third instars. Males had an additional instar (pupal stage) with a mean development period of 6.40 ± 0.55 days (Table 2). The mean total developmental period for crawlers with three instars and four instars that developed into females and males, was 54.4 ± 4.27 and 25.00 ± 2.37 days, respectively. The incubation period of eggs was shorter with an average of 80.00 ± 23.45 minutes (Table 2). The reproduction by *P. solenopsis* was parthenogenetic and the off-springs were produced as crawlers and eggs through ovoviviparity and oviparity. The neonates or eggs were entangled in hyaline waxy thread-like structures inside an ovisac.

Fecundity was 531.20 ± 65.10 eggs per female. Oviposition period for adult females was 19.00 ± 0.71 days. The longevity of males was shorter with an average of 1.20 ± 0.45 days than adult females (37.00 ± 2.45 days). Adult males of *P. solenopsis* were delicate, slender and elongated in shape with ten segmented antennae. The body was yellowish brown with pale yellow abdominal region. A pair of well developed milky white wings and three pairs of well developed legs could be seen easily.

The female adults of *P. solenopsis* were oblong and light to dark having two pairs of black spots/stripes on dorsal side of body region. The soft body of females was well segmented and covered with white dusty secretion. Eight segmented filiform antennae and three pairs of reddish legs were observed in adult females.

Similar findings were reported by Amarasekare *et al.* (2008). Adult longevity of *P. solenopsis* of about 11.22 ± 0.22 days and 9.34 ± 0.05 days on cotton and potato was reported by Mahalakshmi (2009). The total life cycle of *P. marginatus* was recorded as 19.00 ± 1.00 days for females and 22.33 ± 0.58 days for males. The present findings conform to that of Yelitz Colmenarez *et al.* (2004). The total life cycle of *P. solenopsis* was about 22.00 ± 1.00 in females and in males 29.00 ± 1.00 days. Similar findings were reported by Vijay (2008). The oviposition period of adult female was 7.33 ± 0.58 days and 18.67 ± 0.58 days in *P. marginatus* and *P. solenopsis*, respectively. Mahalakshmi (2009) reported that oviposition period of *P. solenopsis* was about 8.16 ± 0.26 days in cotton and 6.48 ± 0.22 days in potato. The fecundity of *P. marginatus* adult was 329.33 ± 20.03, whereas in *P. solenopsis* it was about 511.00 ± 131.73. Fecundity of *P. solenopsis* was 273.62 ± 17.52 nymphs in cotton and 348.4 ± 11 nymphs in potato sprouts (Mahalakshmi, 2009).

Females of *P. marginatus* usually lay 100 to 600 eggs in an ovisac. Egg-laying usually occurs over the period of one to two weeks. Egg hatch occurs in about 10 days and nymphs or crawlers begin to search for feeding sites. Female crawlers have four instars and complete their life cycle within a month depending on temperature. Males have five instars

wherein the fourth instar is pupa and fifth instar is winged form of male capable of flying (Walker *et al.*, 2003). According to Yelitz Colmenarez *et al.* (2004), developmental period was shorter on papaya followed by bean, jatropha and cotton. Investigations carried out by Amarasekare *et al.* (2008) revealed that adult females of *P. marginatus* that developed on *Acalypha* and *Parthenium* emerged one day earlier than those that on hibiscus and plumeria.

Hodgson *et al.* (2008) studied and reported similar results on the biology of *P. solenopsis* infesting cotton in Pakistan. Akintola and Ande (2008) also studied the biology of *P. solenopsis* on *Hibiscus rosa sinensis* and reported that females underwent three nymphal instars. According to Singh and Ghosh (1970), reproduction of *P. solenopsis* was mostly parthenogenetic. But *M. hirsutus* was biparental also. (Ghose, 1971; 1972). According to Chong *et al.* (2003), *P. madeirensis* was oviparous and reproduced bisexually, whereas, *P. solani* showed thelytokous parthenogenesis (Lloyd, 1952).

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