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Biology and life cycle of cotton mealy bug, *Phenacoccus solenopsis* on potato sprouts

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Abstract
The biology of cotton mealybug, *Phenacoccus solenopsis* Tinsley was studied on potato sprouts in the laboratory. Nymphs of first, second, third and fourth instar (only in male) recorded durations of 6.32±1.22 days, 11.64 ±1.35 and 9.36±0.74 in female and male respectively, 13.36 ± 1.44 days and 14.92 ±0.79 days in female and male respectively and 17.48±1.20 days in the fourth instar of male. Total life cycle in females and males was found to be 27-25 days and 43-53 days respectively. Survival rates of the instars were 75.6% for the first instars, 69.1%, 73.5% for the females bugs in the second and third instars, while it was 68.7%, 65.4% and 77.8% for the males in the second, third and fourth instars.

Keywords: *Phenacoccus solenopsis*, mealybugs, potato sprouts, cotton mealybug

Introduction
Phenacoccus solenopsis has been described as a serious and invasive pest of cotton in Pakistan and India [1] and on *Hibiscus rosa-sinensis* in Nigeria [2]. Latest report on the invasiveness of *P. solenopsis* has been from the Eastern region of Sri Lanka [3] on ornamentals, vegetable crops, and weeds, and in China [4, 5] on cotton. They are polyphagous in nature and infest 154 plant species of 53 families comprising of 20 field and horticultural crops, 45 ornamentals, 64 weeds and 25 bushes and trees [6]. *P. solenopsis* Tinsley, has been found as a new and invasive pest of sesame. It has been described as a serious and invasive pest of cotton in Pakistan and India [7]. Initially the nymphs suck the sap from the underside of leaves, twigs, stems and fruiting bodies also. The plant may get stunted, leaves are wrinkled and finally yields are drastically reduced. To manage the pest, it is required to study its life cycle under natural conditions and in the laboratory. However, not much literature is available on rearing *P. solenopsis* in the laboratory. Hence the present study was undertaken to study the biology of the pest on potato sprouts, which are now being used to rear the mealy bugs.

Materials and Methods
The study was carried out between August-November, 2015 in the laboratory of AICRP on Biological Control scheme, ARI Rajendranagar, Hyderabad, Telangana State with a view to understand the biology and life cycle of *P. solenopsis* on potato sprouts. Potatoes were placed in plastic tubs, and sand was used to cover the potatoes. They were watered sparsely daily to maintain wetness. They sprouted in a week and when they were of 15 cm height, 10 first instar nymphs of *P. solenopsis* collected from the field were placed onto each sprout using Camel hair brush and 4 such tubs were set up to make the total number of first instar to be 40. They were set at 20-30 ^{0}C and a humidity level of 30-65%. Mylar sheets were wound around the sprouts to prevent the escape of the mealybugs leaving a distance of 10 cm. The open ends of the mylar sheet at the top was covered with a cloth bound by a rubber band. As the sprouts withered in a week, nymphs were transferred to a new sprout (Figs.3 and 4.). Duration of each instar was noted down for all the 40 nymphs and presence of moulted skin indicated moulting of the nymph. After each moult, a designated number of nymphs were used for studying the instar. They were allowed to develop on the sprouts until they turned into adults. Survival rates were also worked upon by observing the number of nymphs of each instar that went on successfully to the next instar. Temperature and relative humidity were recorded daily.

Results and Discussion
P. solenopsis is sexually dimorphic, having short-lived, winged males and longer-lived, wingless, larviform females. It has shown sexual reproduction, producing live young ones

instead of laying eggs by a phenomenon of ovoviviparity [8]. It reproduces mostly parthenogenetically, female lays eggs in ovisacs containing 150-600 eggs. The nymphs were pale yellow to orange in colour and oblong in shape. A sub-marginal line of dark mark on thorax and abdomen were observed [9]. Eighteen pairs of short to medium sized waxy filaments around the body were observed. Studies on the biology of the mealy bug on potato sprouts are presented in table 1 and showed that females had three instars and males recorded four instars. Longer developmental duration of males compared to females was due to an additional moulting and prepupal processes. While the longer developmental period of the 2nd instar of males along with their high mobility could be the reason for their lower survival, it was not observed in the fourth instar due to the scarce population of males, together with the difficulty of observation of any sex related differences during early crawler stages [10].

First instar nymphs recorded a duration of 4-8 days with a mean of 6.32±1.22 days and survival rate of 75.6% in both males and females. Duration of second instar in females was 9-13 days, while in males it was 8-11 days with mean of 11.64 ±1.35 and 9.36±0.74 respectively. Survival rate of second instar female nymph was 69.1% and 68.7% in in female and male respectively. The third instar took 12-16 days with a mean of 13.36 ± 1.44 days to complete in female with 73.5% survival rates and 15-19 with a mean of 14.92 ± 0.79 days to complete in males with 65.4% survival rate. In male a fourth instar or pre-pupal stage was seen which lasted 16-19 days with a mean of 17.48±1.20 days and a 77.8% survival rate was observed. Total life cycle in females and males was found to be 27-25 days and 43-53 days respectively (Figs.1 and 2). Similar results were obtained by [11] who reported mean duration of 1st, 2nd,3rd instars of female nymphs to be 5.2 ±3.67, 9.47 ± 1.58, 15.10 ±1.00 days respectively and that of 2nd, 3rd and 4th instars of male nymphs to be 10.56 ± 0.84, 15.25 ± 0.82 and 18.13 ± 0.82 days respectively [12] reported the duration of 1st, 2nd and 3rd instar female nymphs to be 4.64 ± 0.64, 4.36 ± 0.64 and 4.52 ±0.71 days and that of 1st, 2nd instar male nymph and pupa to be 4.67 ± 0.62, 4.87 ± 0.83 and 7.27 +1.3 days [13] reported mean duration of 4.6,4.8 and 6.2 days for the first, second and third instar nymph female and it was 4.67 ± 0.62, 4.87 ± 0.83 and 7.27 ±1.3 days.

Table 1: Life stages duration of female and male nymphs of *Phenacoccus solenopsis* Tinsley

Particulars	Duration of each instar and total life cycle							
	Female				Male			
	Ist instar	2nd instar	3rd instar	Total lifecycle	2nd instar	3rd instar	4th instar	Total lifecycle
Range	4-8	9-13	12-16	27-35	8-11	15-19	16-19	43-53
Mean	6.32	11.64	13.36	31.32	9.36	14.92	17.48	48.08
(+SD)	1.22	1.35	1.44	2.33	0.74	0.79	1.20	2.50
No. of insects	25	25	25	25	25	25	25	25
Temperature (^{0}C)	20-30	20-30	20-30	20-30	20-30	20-30	20-30	20-30
RH (%)	30-65	30-65	30-65	30-65	30-65	30-65	30-65	30-66
Survival (%)	75.6	69.1	73.5	-	68.7	65.4	77.8	-

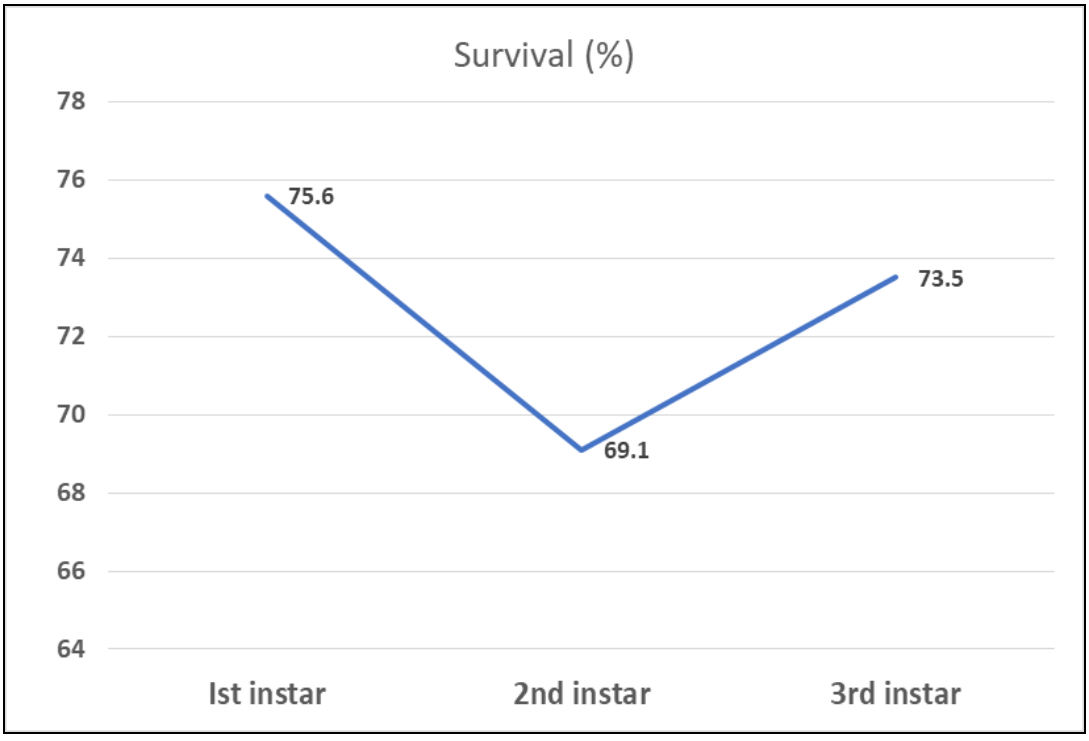

Fig 1: Survival rate of different instars of female bug

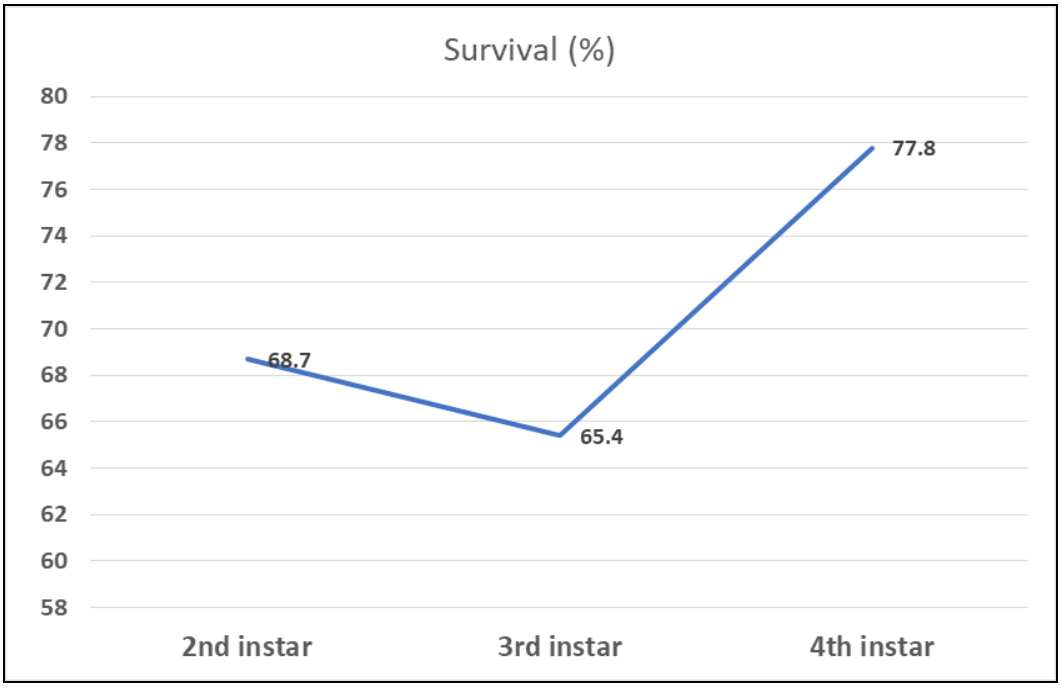

Fig 2: Survival rate of different instars of male bug

Fig 3: A view of the experimental set up in the laboratory

Fig 4: A single trough with the sprouted potato plants

Conclusion

Studies on life cycle and survival of instars helps to understand the suitability of a host plant for insect culture. Survival was higher in the first (75.6% and 68.7%) and third instar (73.5% and 77.8%) for the male and female respectively compared to that in the second instar (69.1% and 65.4% respectively for female and male respectively. Total lifecycle was 27-35 days in the female, while it was 43-53 days in the male due to an added prepupal stage or 4th instar. The ability to feed on diverse plants assists the mealybug in finding suitable hosts shortly after being introduced to a new region, helping it become established and rapidly increase its population [14]. Hence, the pest could thrive well on many cultivated crops in the country within a few years of its introduction. However, its life cycle on different hosts seems to vary with change in host nutrition. Studies like these given an insight to researcher and help to select the most suited host for laboratory culture. Also, since this pest is a key pest in cotton, biological control measures using *Cryptolaemus montrouzieri* play a very important role in its management. The present study helps to plan further research on mass multiplication of *Cryptolaemus montrouzieri*, an important predator on the mealybugs.

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