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Biology of *Raoiella indica* Hirst. (Acari: Tenupalpidae) on Arecanut Leaves under Laboratory Conditions

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ABSTRACT

Biology of *Raoiella indica* Hirst was studied under laboratory at 27 ± 2°C temperature and 79 ± 5.75 percent RH. The finding showed that life cycle of *R. indica* consisted of five stages *viz.*, eggs, larva, protonymph, deutonymph and adult. The eggs incubation period of *R. indica* was 9.790 ± 1.94 days. The larval body measured 0.09 and 0.13 mm in length and 0.08 to 0.10 mm in width and lived for 8.35 ± 0.84 days. The total developmental period of female was 29.80 ± 2.73 days and male took 31.27±40 days. Mated female lived for longer time and laid higher number of eggs than unmated female.

Key words: Arecanut, Arecanut leaves, Biology, *Raoiella indica,* Tenupalpidae.

INTRODUCTION

Areca catechu L. is commonly known as arecanut or betel nut is a very widely cultivated plant in Eastern countries like India, Bangladesh, Sri Lanka, Malaysia, the Philippines and Japan. The importance of this nut is due to its use for chewing purposes. Chewing increases production of saliva, gastric juice and also strengthens gums. It is a common masticatory nut, consumed by all sections of the population, cutting across caste, class, region, religion, age and gender in India. Arecanut forms a major source of income along with other agricultural crops. However, the farmers encountered considerable crop losses intermittently, owing to lack of knowledge on the bionomics, relative distribution pattern and ecological aspects of the pests. Arecanut is attacked by an array of insect and non-insect pests. The pests infest all parts of the palm *viz.,* stem, leaves, inflorescence, root and nuts. As many as 102 insect and non-insect pests have been reported to be associated with arecanut palm (Nair and Daniel, 1982), among which few cause considerable economic loss to the crop. Of these, *Raoiella indica* is the serious one, mainly in young areca plantations and active infestation of leaves occurs after the onset of hot weather (Patel and Rao, 1958). *Raoiella indica* feeds on the underside of palm fronds of various hosts in the orders Arecales and Zingiberales. The mite attained economic significance when it was first reported as an invasive species in the Caribbeans in 2004 (Flechtmann and Etienne, 2004). It was reported as a serious pest of economically important fruit-producing trees like the coconut, *Cocos nucifera* and banana, *Musa* spp (Nagesha-Chandra and Channabasavanna, 1984; Welbourn, 2006) and it formed the first mite species in which feeding was observed through the stomata of its host plants (Ochoa *et al.,* 2011). Through this specialized feeding habit, *R. indica* interfere with the photosynthesis and respiration processes of its host plants. Mite infested palms display stunted growth and withering of leaves (Puttarudraiah and Channabasavanna, 1956). Hence, it was felt necessary to undertake studies on its biology that would help in future pest management programmes.

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MATERIALS AND METHODS

Stock culture of *Raoiella indica* was started from field collected specimen infesting arecanut palm. The mites were reared on two year old potted arecanut palm which is kept outdoor but sheltered from wind and rain. The mites were transferred from these palms to study the various aspects of biological parameters through leaf bit technique at 27±2°C temperature maintained in B.O.D incubator.

For recording the incubation period, 10 gravid females taken from mite culture were released on ventral surface of each leaf-disc (2.0 cm^2 diameter) to obtain sufficient number of eggs. After 24 hrs of releasing, females were removed and eggs were counted and subsequently observed daily for their hatching. Number of eggs hatched at different intervals were counted for calculating the average incubation period. For studying different parameters of development of mite, one newly emerged larva per leaf-disc was released such 30 leaf discs prepared for studying mite development. The observations regarding larval, proto- and deutonymphal periods were recorded twice daily. The females obtained from the development study were individualized and a male

was introduced for mating. After 24 hours male was removed confirming first intercourse. Observations regarding preoviposition, oviposition and postoviposition periods, longevity and fecundity were recorded daily. Fecundity was calculated by counting the total number of eggs laid by a female during her life span and the longevity was calculated by counting the period between emergence of adult from quiescent deutonymph till the last day of its survival. Total life duration (immature + adult) was also recorded. For all these biological studies, stereo binocular microscope was used. Measurements (mm) of the different stages were made with an ocular micrometer.

RESULTS AND DISCUSSION

Egg

The eggs of *R. indica* are smooth, ovoid in shape with orange to reddish in colour. The freshly laid eggs usually adhere to the lower leaf surface with a fine slender hair like structure as long as or longer than the egg, is present at one end that may be coiled have a droplet of water adhering to it (Hoy *et al.,* 2010). The egg measured an average about 0.10±0.010 length and 0.08± 0.003 mm in width (Table 1). The incubation period ranged from 9 to 11 days with an average of 9.790 ±1.94 days.

Larva

Newly hatched larvae are oval and reddish in colour often develops a blackish tinge on the posterior end of the dorsum after feeding. The larva measures between 0.09 and 0.13 mm in length and 0.08 to 0.10 mm in width with only three pairs of legs. The larval period ranged from 6 to 9 days with a mean of 8.35 ± 0.84 days (Table 1 and 2).

Protonymph

Immediately after larval moulting, a reddish protonymph emerges with four pairs of legs. They are usually larger than the larvae measures around 0.12 to 0.13 mm long and 0.08 to 0.09 mm wide. The protonymphal period of male occupied 4 to 6 days with a mean of 5.88 ± 0.27 days and female protonymph occupied 4 to 6 days with an average of 5.30±1.54 days, respectively (Table 1 and 2). Female protonymphs are ovoid in shape while the male is almost triangular.

Deutonymph

Deutonymphs are larger than protonymphs but resemble protonymphs with regard to feeding and other habits. They are usually measures around 0.15 to 0.17 mm in length and 0.09 to 0.11 mm in width. The deutonymph period of male was 7.14 ±0.95 days, while 6.25±1.54 days for female (Table 1 and 2).

Adults

Females of *R. indica* average 0.23 to 0.30 mm long and 0.17 to 0.19 mm wide, they are oval and reddish in colour. Females develop dark markings on the dorsum of the body after feeding. The dorsum is smooth, except for the presence of punctae (sculptured depressions). The male is smaller than female (0.15 to 0.20 mm in length and 0.12 to 0.14mm in width) except for having a tapering of the posterior end of the body measures (Table 1 and 2).

Table 1: Morphometrics of different life stages of *R. indica* reared on arecanut leaves under laboratory condition.

Stage	No. observed	Length (mm)			Width (mm)		
		Min.	Max.	Avg. ± SD	Min.	Max.	Avg. ± SD
Egg	10	0.10	0.12	0.10±0.010	0.08	0.09	0.08±0.003
Larva	10	0.09	0.13	0.09±0.027	0.08	0.10	0.08±0.010
Protonymph	10	0.12	0.13	0.11±0.005	0.08	0.09	0.07±0.005
Deutonymph	10	0.15	0.17	0.14±0.010	0.09	0.11	0.08±0.010
Adult							
Male	10	0.15	0.20	0.16±0.025	0.12	0.14	0.11±0.010
Female	10	0.23	0.30	0.24±0.030	0.17	0.19	0.16±0.010

Table 2: Duration of various life stages of *R. indica* under laboratory condition.

Stage	Sex	Developmental period in days	
		Range	(Mean ± SD)
Egg	-	9-11	9.90 ±1.94
Larva	-	6-9	8.35 ±0.84
Protonymph	Male	4-6	5.88 ±0.27
	Female	4-6	5.30± 1.54
Deutonymph	Male	3-8	7.14±0.95
	Female	3-8	6.25±1.54
Total Developmental period	Male	31-35	31.27 ±40
	Female	29-32	29.80 ±2.73

n=30

Table 3: Life history parameters of adult of *R. indica* on arecanut leaves

Periods	Sex	Duration in days Mean±SD
Preoviposition	Mated female	4.60±0.79
	Unmated female	2.46±0.51
Oviposition	Mated female	12.13 ±2.77
	Unmated female	9.73±2.63
Postoviposition	Mated female	6.13±1.70
	Unmated female	6.20±1.20
Total Fecundity (eggs/female)	Mated female	8.13±3.20
	Unmated female	6.93±2.54
Longevity	Mated female	*23.53±5.08*
	Unmated female	18.40±2.89

n=30

Total development period

It was duration from egg till the emergence of an adult stage which was less in case of female 29.80 ±2.73 days as compared to male 31.27±40 days (Table 2).

Mating

Males and females are sexually mature when they emerge and males actively seek out females, suggesting there is a sex pheromone involved (Pena *et al.,* 2006). When a male locates a female deutonymph in the quiescent stage, it was settle close to it and wait for up to two days for her to moult. When female deutonymphs begin to moult, the male becomes active and moves under her, bending his posterior up and forwards to mate. Mites remain in the mating posture for about 16 minutes.

Pre oviposition period

The mated and unmated female laid eggs only after a lapse of certain period which lasted for 4.60±0.79 days in case mated female while it lasted for 2.46±0.51 days in case of unmated females (Table 3). As the females fertilized immediately after emergence the pre copulation period was very negligible in case of mated females.

Oviposition period

The egg laying period of mated and unmated females lasted for somewhat longer period compared with its total developmental period. In case of unmated females it took 9.73±2.63 days for laying eggs whereas mated females required a little longer time *i.e.*, 12.13±2.77 days respectively (Table 3).

Fecundity

The average fecundity of mated female was 8.13±3.20 eggs, while unmated female had an average of 6.93± 2.54 eggs, the daily egg production by mated female was 1.82±0.50 eggs, while it was 1.61±0.61 eggs for unmated females (Table 3).

Post oviposition period

Post oviposition period in mated females lasted for 6.13 ±1.70 days and for unmated females it lasted for 6.20 ±1.20 days (Table 3).

Longevity

The average longevity of mated female was 23.53±5.08 days and 18.40±2.89 days for unmated female (Table 3).

Few studies have been performed on the biology of *R. indica* in several countries. However, it was difficult to compare the present results with others as the experimental conditions (temperature, humidity and host plant) were different. However, Moutia (1958) found that *R. indica* required 18 to 26 days to develop from eggs to adult at 24.2°C on coconut leaves, while Hoy *et al*. (2010) reported that the total developmental time for immature was 23-28 days (for females) and 20 to 22 (for males). In our finding, the development time was 29.80±2.71 days for female and 31.27± 40 for males. (Table 1) these results were found to be in close agreement with Galano- Flores *et al*. (2010) who reported longer development time of *R. indica* (29.72 days for females and 32.70 days for males) at 25.4°C on arecanut leaves.

The present study showed that the egg was the longest immature stage of *R. indica* for both the sexes, representing 31 per cent of the total duration, while that of protonymph was the least. Of the two nymphal states, the deutonymph takes longer, this is logical if one considers that in this phase the morphological; changes that result in the adult occur. This result was in agreement with the report of Hoy *et al.* (2010). Larval and protonymphal stages developed the fastest among the immature stages.

The pre oviposition period lasted an average of 4.60 for mated female and 2.46 days for unmated female. While the oviposition period for mated and unmated female was 12.13 and 9.73 days respectively. The average longevity of mated female was 23.53 days and 18.40 day for unmated female. These results were in close conformity with Vasquez *et al*. (2015) at 29°C (21.5 days). However, the present study was far shorter than the report from Galano- Flores *et al*. (2010) who mentioned that oviposition period was up to 17 days and female longevity an average of 30 days on arecanut leaves. Similarly Hoy *et al*. (2010), who propose an oviposition period of 40 days and longevity of 48 days. Nageshchandra and Channabasavanna (1984) mentioned that the mite longevity was 48.60 to 50.90 days on coconuts.

These variations in duration could be due to the influence of host plant and experimental conditions.

The average fecundity of mated female was 8.13±3.20 eggs, while unmated female had an average of 6.93±2.54 eggs, the daily egg production by a mated female was 1.82±0.50 eggs, whereas 1.61±0.61 eggs. These results are in agreement with Galano- Flores *et al*. (2010) who reported that the average fecundity of female was 7.0±3.46 eggs, with a daily average of 0.25±0.15 days. However, the present study was far lower than some literature. According to Nageshchandra and Channabasavanna (1984) fecundated females oviposit an average of 22 eggs, while virgin females have an average of 18.40 eggs; Welbourn (2006) mentioned that *R. indica* could produce 28 to 38 eggs throughout its life. Pena *et al*. (2006) also reported that the fecundity of *R. indica* could reach 50 eggs per female. From the study, it was revealed that *R. indica* did not express all reproductive potential, which could be given, among the other factors, by the influence of the host plant.

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