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Biology of rice leaf mite, *Oligonychus oryzae* (Hirst) (Prostigmata: Tetranychidae)

T. Aswin*, Haseena Bhaskar and Madhu Subramanian

Department of Agricultural Entomology, College of Horticulture, Kerala Agricultural University,Vellanikkara, Thrissur 680656, Kerala, India. E-mail: aswincoh@gmail.com

ABSTRACT: Biology of *Oligonychus oryzae* was studied under laboratory condition using rice leaf bits. The immature stages were followed by short quiescent stages namely, nymphochrysalis, deutochrysalis and teliochrysalis. Male (9.87) recorded shorter developmental period from egg to adult compared to female (10.47). Both sexual and parthenogenetic reproduction was recorded in *O. oryzae*. Progeny of mated female include male and female in the ratio 1: 3, while parthenogenetic female produced only male progeny. Pre-oviposition period of 0.89 and 1.02 days, oviposition period of 6.27 and 7.31 days and post oviposition period of 2.08 and 1.12 days were recorded, respectively for mated and unmated female. Mated and unmated female recorded fecundity of 21.27 and 17.18 eggs, respectively. Adult recorded longevity of 8.00 10.34 and 12.10 days,respectively for male, mated female and unmated female.

KEY WORDS : Biology, rice leaf mite, *Oligonychus oryzae*, reproductive biology

INTRODUCTION

Mites have emerged as serious pests of rice causing considerable damage, particularly in South India.The rice leaf mite,*Oligonychus oryzae* (Hirst) (Acari: Tetranychidae) and the sheath mite, *Steneotarsonemus spinki* Smiley (Acari: Tarsonemidae) are considered as major mite pests of rice (Laksmi *et al*., 2008). Among these, the rice leaf mite, *O. oryzae* is the predominant one.

It was first reported from South India by Cherian (1931). Later it was reported to damage rice from different regions of India. Large number of different stages of the mite colonise the undersurface of the leaves and desap causing white speckles on the upper surface which eventually turn yellow and dry up. When the mite population increases, they also colonise the upper surface of leaves and cause similar damage.A reduction of yield of upto 25 per cent has been estimated due to the severe infestation of this mite (Misra and Israel, 1968). Sporadic occurrence of leaf mite has been reported recently from rice growing areas of Palakkad, Kerala where intensive cultivation of rice is being practiced (Bhaskar and Thomas, 2011). Now the mite is emerging as a regular pest of rice during post monsoon season in the rice growing tracts of Palakkad district of Kerala (Annual Report, 2013). Hence, there is a need to develop a suitable management strategy against this pest which calls for a thorough understanding of the biology of the pest.

MATERIALS AND METHODS

Biology of rice leaf mite, *Oligonychus oryzae* was conducted in the Acarology laboratory, Department of Agricultural Entomology during July-August, 2014 at 27 $\pm$ 3^{0}C and 70.2 $\pm$ 7 per cent relative humidity, using the rice variety Jyothi. *Oligonychus oryzae* collected from infested rice fields of Nenmara, Palakkad district was mass multiplied in the laboratory on thirty days old rice seedlings raised

* Author for correspondence

in plastic pots after confirming the species identity(Gupta and Gupta, 1994)

The developmental periods of *O. oryzae* were studied using rice leaf bits. (Nayak *et al.*, 2008). Leaf bits of 4×1cm^2 area were cut from leaves of healthy plants maintained in pots in poly house and placed upside down on wet cotton pad in Petri plates of 150 mm diameter that were covered with lid after leaving a slight gap to prevent excessive moisture build up in Petri plate (Plate 1). In each Petriplate, five leaf bits were maintained. Sixty gravid females from the laboratory culture were transferred to individual leaf bit at the rate of two females per bit for oviposition. Six replications were maintained. After 48 hours, one day old eggs were retained for further observations and other eggs and gravid females were removed. Leaf bits were changed once in every five days.The morphology as well as development of immature stages of the mite was observed with the help of a stereo binocular microscope (Leica EZ4 HD with 8x - 35 x magnification) at 2 h interval until they reached maturity.

Newly emerged males and females were maintained on separate leaf bits to determine their longevity. Longevity of mated female was determined by placing a newly emerged female on a leaf bit onto which four males were released and males were removed 24 hours later. Ten replications each were maintained for males, mated females and unmated females to work out the longevity which was expressed as mean days $\pm$ Standard Deviation (SD).

To determine the duration of sexual development of mated female, one female teleiochrysalis was transferred to a leaf bit and four adult males were released onto the leaf bit and allowed to mate with the freshly emerged female. The males were removed 24 hours after the emergence of the female. The reproductive biology of unmated female was also studied by releasing only one teleiochrysalis on to leaf bit that moulted to female. Fifteen replications each were maintained for both mated and the unmated females. Observations on pre-oviposition, oviposition and post-oviposition periods were recorded. The numbers of eggs laid by the mated as well as the unmated females were recorded till death of the female by replacing the old leaf bits with fresh leaf bits at 24 h interval until the female stopped laying eggs.

Sex ratio and hatchability of eggs were studied following the method described by Gotch and Nagata (2001). The eggs laid by each mated as well as unmated female for the first five days were maintained and the viability was determined by counting the number of eggs that hatched out to larvae. The emerging mites were sexed out after reaching adulthood to determine the sex ratio. Ten replications each were maintained for both mated and unmated females.

RESULTS AND DISCUSSION

The life cycle of rice leaf mite consisted of five different stages such as egg, larva, protonymph, deutonymphand adult (Plate 2). In between the stages from larva to adult, short quiescent intervals called nymphochrysalis, deutochrysalis and teleiochrysalis were also observed.

Morphology and developmental duration of immature stages of *O. oryzae*

Eggs were laid singly or in small groups of 10-12 on the under surface of leaf bits by gravid females. The eggs were spherical in shape and transparent. They were like tiny drops of water when freshly laid. Two dark reddish coloured eye spots, which resembled the simple eye of larvae, were clearly visible on the eggs. But the eggs turned dull white in colour and gradually turned to brown prior to hatching. The mean incubation period was 3.80 days (Table 1).

Larva

The eggs hatched out to larvae with 3 pairs of legs. Newly hatched larva was white in colour.It was spherical and small in size and crawled around for sometime. The body colour changed to pale green upon feeding. The simple eyes on the dorsum of propodosoma were clearly distinguishable. The mean larval period recorded was 1.37 days for male and 1.40 days for female (Table 1).

Nymphochrysalis

Nymphochrysalis is the intermediate quiescent

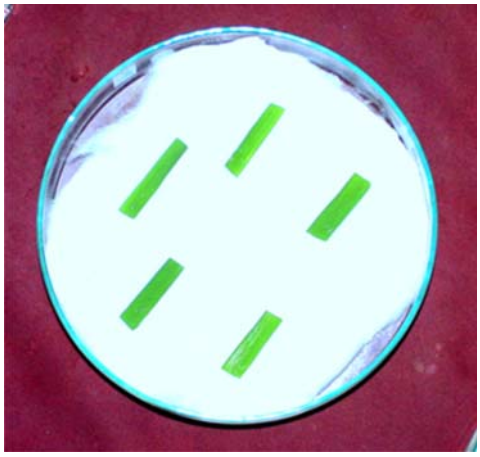

Plate 1. Leaf bits on wet cotton pad in petriplate to study the biology of *O. oryzae*

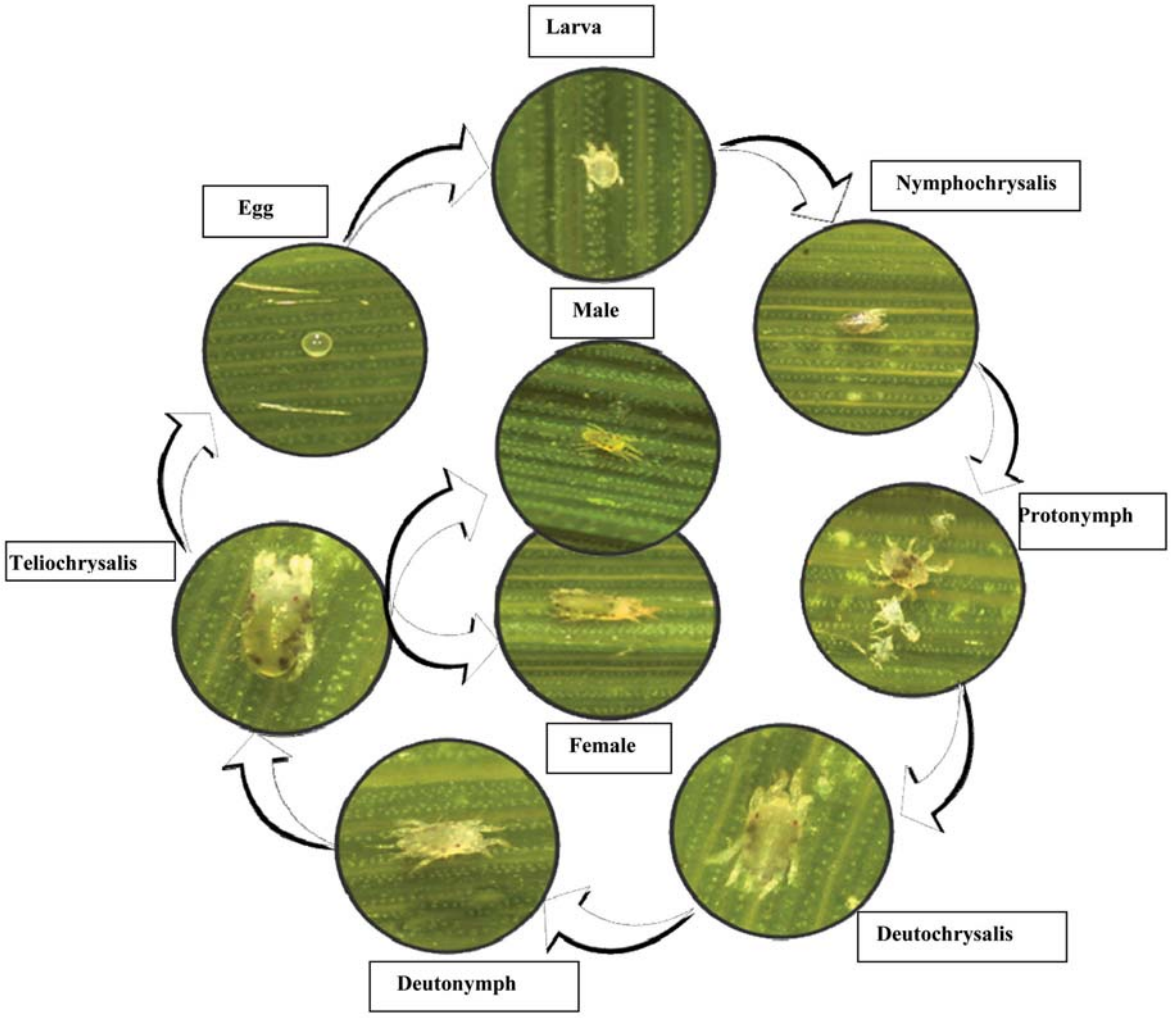

Plate 2. Life cycle of *Oligonychus oryzae*

Plate 3. Adult male of *O.oryzae*

Plate 4. Adult female of *O.oryzae*

stage between larva and protonymph. During this stage, larva stopped feeding, remained attached to leaf surface and entered into quiescence, with the anterior two pairs of legs kept forward and close towards the body and the posterior legs were extended backwards and held close to the sides of opisthosoma. This stage was immediately followed by moulting. Average duration of nymphochrysalis stage was 0.73 days for male and 1.03 days for female (Table 1)

Protonymph

Protonymph stage was the first nymphal stage that came out by splitting open the larval skin. Protonymph was oval shaped, deep amber coloured and larger in size compared to that of larva, with four pairs of legs. The mean protonymph period lasted for 0.91 days for male and 1.04 days for female (Table 1).

Deutochrysalis

Protonymph entered into deutochrysalis which was the second quiescent stage. It remained attached to the leaf surface and on an average, lasted for 0.69 days in the case of male and 1.12 days in the case of female (Table 1).

Deutonymph

Deutonymph was the second nymphal stage and emerged from deutochrysalis after moulting. They were actively moving and feeding. Deutonymph was greyish green in colour when emerged and became dark green later on. During the stage, sexes could be differentiated apparently by body size. Female deutonymph was larger and broader than their male counterpart while male deutonymph was elongate.

Table 1. Developmental duration of *Oligonychus oryzae* on rice

Stage	Developmental period (Mean days ± SD)*	
	Male	Female
Egg	3.80±0.70	3.80± 0.70
Larva	1.37± 0.68	1.40± 0.31
Nymphochrysalis	0.73± 0.40	1.03± 0.90
Protonymph	0.91± 0.35	1.04±0.40
Deutochrysalis	0.69± 0.30	1.12± 0.57
Deutonymph	0.98± 0.28	1.30± 0.37
Teleiochrysalis	1.15± 0.38	1.20± 0.47
Total	**9.87 ±0.72**	**10.47±0.51**

***mean of 50 observations*

Table 2. Adult longevity of *Oligonychus oryzae*

Sex		**Duration (Days ± SD)***
Male		8.00 ± 1.00
Female	Mated	10.34 ± 0.04
	Unmated	12.10 ±0.14

**Mean of ten observations*

The mean deutonymph period was 0.98 days for male and 1.30 days for female (Table1).

Teleiochrysalis

Teleiochrysalis was the third quiescent stage immediately after deutonymph. This period on an average lasted for 1.15 days for male and 1.20 days for female(Table 1)

Adult

Adult mite emerged after the final moult from teleiochrysalis. The mite exhibited sexual dimorphism in the adult stage. Male was smaller in sizewith light green hysterosoma and body tapering posteriorly to a blunt point(Plate 3). Female mite was white, larger and plumper with longer setae all over the body and legs, and turned dark green after mating (Plate 4). Both male and female possessed bright red eye spots on the dorso-lateral propodosoma.

Total developmental period

The total developmental period from egg to adult emergence recorded a mean of 9.87 days for male and 10.47 days for female (Table 1).

Adult longevity

Adult male recorded a mean longevity of 8.00 days while the corresponding figures for mated and unmated females were 10.34 and 12.10 days, respectively (Table 2).

The duration of development of various life stages of *O. oryzae* recorded in the present study was found to be shorter compared to that reported by Nayak *et al*. (2008) who reported development period of 10.58 + 1.50 days for male and 12.64 + 1.57 days for female in a laboratory study at Raichur during kharif season (June to November).

The results indicate that male *O. oryzae* completes development from egg to adult faster than female. This trend was also reported by Nayak *et al*. (2008) in *O. oryzae* where, males on an average took only 10.58 days in comparison to 12.64 days in females. Longer developmental duration in females was also reported in different species of tetranychid mites by several workers (Nazeh and Ashraf, 2012, Rajkumar, 2003). Similarly, the males of two spotted spider mite,*Tetranychus urticae* Koch recorded a shorter development period of 6.73 days compared to 7.52 days in females on okra (Krishna and Bhaskar, 2014).

Table 3. Pre-oviposition, oviposition and post-oviposition period of *Oligonychus oryzae*

Parameters		Duration (Mean ± SD)*
Mating period		1.00 ± 0.36 minutes
Pre-oviposition period	Mated female	0.89 ± 0.03 days
	Unmated female	1.02 ± 0.05 days
Oviposition period	Mated female	6.27 ± 0.06 days
	Unmated female	7.31 ± 0.26 days
Post-oviposition period	Mated female	2.08 ± 0.03 days
	Unmated female	2.12 ± 0.06 days

**Mean of ten observations*

Table 4. Fecundity, sex ratio and egg viability of *Oligonychus oryzae*

	Fecundity (No. of eggs)	Male: Female ratio	Egg viability (%)
Mated female	21.27 ±4.54*	1 : 3	89.67
Unmated female	17.18 ±3.54*	1 : 0	81.69

**Mean of ten observations*

Pre-oviposition, oviposition and post-oviposition period of females

The life span of adult female mites consisted of pre-oviposition period, oviposition period and post-oviposition period and the duration of life span was found to be longer in unmated females. The mean pre-oviposition period in mated and unmated females lasted for 0.89 and 1.02 days, respectively. Oviposition and post-oviposition periods lasted for 6.27 days and 2.08 days in mated females and 7.31 days and 2.12 days in unmated females, respectively (Table 3).

Fecundity, sex ratio and egg viability

Mated females on an average laid 21.27 eggs whereas unmated females laid only 17.18 eggs. Mated female produced a progeny consisting of both males and females in the ratio 1:3, whereas unmated females produced only males. The eggs of *O. oryzae* recorded a viability of 89.67 per cent

for mated females and 81.69 for unmated females (Table 4).

The shorter duration of unmated female in the present study is also in line with previous studies. For instance, the negative influence of mating on the life expectancy of females in tetranychid mites was reported earlier by several workers (Krishna and Bhaskar, 2014; Manujunatha and Puttuswamy 1989).

Laboratory studies carried out at Tamil Nadu Agricultural University on biology of *O. oryzae* at five different temperatures namely 20, 25, 28, 30 and 35°C revealed that the duration of development of various stages as well as total duration of *O. oryzae* decreased with increase in temperature (Radhakrishnan and Ramaraju, 2009). At 20°C, the mite took on an average, 16.10 days for development from egg to adult. The total development period was 13.65, 8.88, 8.35, 8.33 days at temperatures 25, 28, 30 and 35° C, respectively. The present study was carried out at a temperature of 27 + 3°C in the laboratory and hence the development duration (9.87 days for male and 10.47 days for female), which falls between 13.65 and 8.88 days corresponding to 25°C and 28°C respectively, is in agreement with earlier findings. Temperature was also found to have a profound impact on the duration of development stages of the red spider mite,*Oligonychus coffeae* Nietner on tea, as the mite completed its development in a shorter duration of 6.85 days at 32°C, while the same duration was prolonged to 14.47 days at 22.5°C (Mazid *et al*., 2013).

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