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## Biology of *Tetranychus urticae* Koch (Acarina: Tetranychidae) on carnation under laboratory condition

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### Abstract

An investigation on the Biology of *Tetranychus urticae* Koch (Acarina: Tetranychidae) on carnation under laboratory condition was undertaken at College of Agriculture, University of Agricultural and Horticultural Sciences (UAHS), Navile, Shivamogga during 2015-16. Studies on the biology of *T. urticae* revealed that both the sexes passed through five stages viz., Egg, larva, protonymph, deutonymph and adult with a short resting period known as quiescent stage termed as nymphochrysalis, deutochrysalis and teleo chrysalis, respectively. Morphology of all the stages, period of immature stages, longevity of adults and reproductive potential of *T. urticae* were also studied.

**Keywords:** *Tetranychus urticae*, carnation, egg, larva, protonymph, deutonymph, adult

### Introduction

Carnation (*Dianthus caryophyllus* L.) is one of the most important cut flowers in the world. It is also known as the divine flower, clove pink, gilly flowers etc. The genus name *Dianthus* means flower of zeus or divine. It belongs to the family Caryophyllaceae. Centre of origin for carnation is Mediterranean region.

Cultivation of carnation on a commercial scale for domestic and export purpose is relatively recent in India. This crop is being cultivated under polyhouse conditions (controlled environmental conditions), mainly in Karnataka (Bangalore, Belgaum), Tamil Nadu (Coimbatore), New Delhi, Maharashtra (Nasik, Pune), Himachal Pradesh (Solan, Shimla, Palampur) and Jammu (Srinagar), besides few other places like Uttar Pradesh, Punjab etc.

In India, annual production of carnation is 6 metric tonnes. Maximum production of carnation in India is in the state of Himachal Pradesh 2.75 metric tonnes followed by Uttarakhand 1.25 metric tonnes. In Karnataka production of carnation is 0.69 metric tonnes.

Major pests infecting carnations are mites (*Tetranychus urticae* Koch), thrips (*Taeniothrips dianthi*) and bud borer (*Helicoverpa armigera*). Amongst these pests, two spotted spider mite (*Tetranychus urticae*) is the most serious pest of carnation in polyhouse. It is being recorded worldwide infecting more than 150 different field and ornamental plants. The pest occurrence is regular on carnation plant and has become serious menace (Jhansi and Mohan, 1997) [4]. Mites usually colonize under surface of leaves and in severe condition, they were found on all parts of the plant. They prefer nitrogen rich young leaves, but in well established colonies, older leaves become heavily infected.

### Material and Methods

The study was conducted at the Department of Agricultural Entomology, University of Agricultural and Horticultural Sciences, College of Agriculture, Navile, Shivamogga at room temperature of  $27.79 \pm 4.4$  °C and relative humidity of  $79.84 \pm 5.75$  per cent.

### Mite culture

Initial culture was procured in the laboratory from heavily spider mite infested leaves collected from carnation plants grown at polyhouse, Abbalagere village. After provisional identification, the same culture has been used for mass multiplication of mites. Gravid female lifted carefully using camel hair brush from leaf and were transferred on fresh carnation leaf kept upside down on filter paper overlaying a wet cotton swab in Petri dish and such five sets were maintained.

The adults were removed after two days when sufficient numbers of eggs were laid. Beginning with these eggs, further rearing was done to have pure stock culture and constant supply of mites for various studies.

### Technique used

A method described by Rodriguez (1953) <sup>[14]</sup> and Gilstrap (1977) <sup>[3]</sup> of confining individual mite on leaf bit was adopted throughout the life span with little modification. The detail studies on the biology of this mite were carried out on excised bits of carnation leaf kept upside down on wet filter paper overlying a cotton wad in petri dish. Water was added periodically so as to keep cotton saturated and maintain leaf disc in turgid condition. The leaf bits were replaced every alternate day to avoid leaf deterioration and consequent poor nutrition. A standard ocular micrometer fitted to a stereoscopic binocular microscope was used for measurement of length and breadth of various stages after calibrating it with stage micrometer slide.

### Observation

Thirty gravid female mites from the mass culture were released on a carnation leaf bit maintained in turgid conditions and allowed to lay eggs overnight. Next day morning the number of eggs laid by these mites was counted and adults were removed from the leaf. Numbers of hatched and unhatched eggs were recorded to work out percentage of egg hatching. After hatching, the newly emerged nymph were carefully lifted using fine camel hair brush and kept on the leaf disc (@1 larvae/leaf disc). Critical observations on

behavior, shape, size, colour as well as the duration of different stages were made under stereo binocular microscope twice a day (8.00 A.M. and 4.00 P.M.) until the death of individual mite.

For studying the fecundity, a pair of adult mites (male and female) was separately released after emergence on the Petri plate having leaf disc and the eggs laid by the female was recorded. The adult female red spider mite is oval shaped, dark reddish in colour and blunt posterior ends with quite long hairs on the dorsal side. The male has a smaller, narrow, more pointed body than the female. The observation on life history viz., incubation period, larval period, protonymph, deutonymph, quiescent stages, pre-oviposition, oviposition, post oviposition periods, fecundity and longevity of adults were recorded.

### Results and discussion

The study on biology indicated that the *T. urticae* passed through a larval and two nymphal stages viz., protonymph and deutonymph. Each of these feeding stages were followed by a short period of quiescent stage termed as nymphochrysalis, deutochrysalis and teleo chrysalis.

### Egg

The eggs were large, measuring 0.11 to 0.14 mm with an average of  $0.13 \pm 0.01$  mm in length and 0.11 to 0.14 mm with an average of  $0.12 \pm 0.01$  mm in width. The incubation period ranged from 2.50 to 5 days ( $3.36 \pm 0.56$  days) and 3 to 4 days ( $3.21 \pm 0.43$  days) for female and male respectively (Table 1 and 2).

**Table 1:** Duration of various stages of *T. urticae* under laboratory condition

Sl. No.	Stage*	Duration (Days)			
		Minimum	Maximum	Mean $\pm$ SD	
1.	Incubation period	2.50	5.00	$3.36 \pm 0.56$	
2.	Larval period	Male	1.00	2.50	$1.79 \pm 0.64$
		Female	1.00	4.00	$2.79 \pm 0.57$
3.	Nymphochrysalis period	Male	0.20	1.20	$0.59 \pm 0.35$
		Female	0.20	1.50	$0.64 \pm 0.32$
4.	Protonymphal period	Male	2.00	3.50	$2.54 \pm 0.50$
		Female	2.00	4.00	$2.97 \pm 0.51$
5.	Deutochrysalis period	Male	0.20	1.40	$0.73 \pm 0.41$
		Female	0.20	1.50	$0.92 \pm 0.43$
6.	Deutonymphal period	Male	1.00	3.00	$2.11 \pm 0.76$
		Female	2.00	4.00	$2.80 \pm 0.63$
7.	Teleochrysalis period	Male	0.20	1.00	$0.70 \pm 0.26$
		Female	0.30	1.10	$0.77 \pm 0.24$
8.	Total developmental period (Combined larval, nymphal and quiescent period)	Male	4.60	10.92	$8.44 \pm 1.75$
		Female	8.49	14.14	$10.89 \pm 1.10$
9.	Adult period	Male	7.00	12.00	$10.00 \pm 1.41$
		Female	10.00	16.00	$12.60 \pm 1.43$
10.	Pre- oviposition period	Female	2.00	5.00	$2.69 \pm 0.68$
11.	Oviposition period	Female	5.00	11.00	$7.79 \pm 1.68$
12.	Post- oviposition period	Female	1.00	7.00	$2.26 \pm 1.11$
13.	Rate of egg laying/females/day	Female	2.00	11.00	$5.62 \pm 1.36$
14.	Fecundity	Female	38.00	106.00	$76.80 \pm 16.38$
		Male	18.60	24.20	$21.65 \pm 1.63$
15.	Total life period	Male	18.60	24.20	$21.65 \pm 1.63$
		Female	24.33	29.80	$26.85 \pm 1.15$

\*N=30

**Table 2:** Measurement of different stages of red spider mite, *T. urticae*

Sl. No.	Stage*	Length (mm)			Width (mm)		
		Minimum	Maximum	Mean $\pm$ SD	Minimum	Maximum	Mean $\pm$ S.D
1.	Eggs	0.11	0.14	$0.13 \pm 0.01$	0.11	0.14	$0.12 \pm 0.01$
2.	Larvae	0.13	0.16	$0.14 \pm 0.01$	0.08	0.11	$0.10 \pm 0.01$

3.	Nymphochrysalis	0.17	0.19	0.18 ± 0.01	0.10	0.12	0.11 ± 0.01
4.	Protonymph	0.17	0.22	0.19 ± 0.01	0.11	0.13	0.12 ± 0.01
5.	Deutochrysalis	0.18	0.23	0.22 ± 0.01	0.12	0.14	0.13 ± 0.01
6.	Deutonymph	0.26	0.36	0.30 ± 0.03	0.12	0.18	0.14 ± 0.01
7.	Teleochrysalis	0.25	0.38	0.37 ± 0.02	0.15	0.19	0.16 ± 0.02
8.	Adult						
	Male	0.36	0.47	0.41 ± 0.03	0.18	0.20	0.19 ± 0.01
	Female	0.45	0.50	0.48 ± 0.01	0.20	0.24	0.22 ± 0.01

The shape, size, colour and pattern of eggs laying recorded under the study were more or less similar to finding of Sejalía *et al.* (1993) [15] and Mukharjee *et al.* (1992) [10] who reported egg size of *T. cinnabarinus* on green gram to be 130 to 135 µ in diameter and incubation period as 3.12 ± 0.25 days. Similarly Singh and Singh (1993) reported the incubation period of *T. cinnabarinus* on lady's finger as 3.20 ± 0.27 days, which closely tally with the present findings.

### Larva

The present study indicated that the larval body measured 0.13 to 0.16 (0.14 ± 0.01) mm length and 0.08 to 0.11 (0.10 ± 0.01) mm in width. The larval period ranged from 1.00 to 2.50 days (1.79 ± 0.64 days) for male and 1.00 to 4.00 days (2.79 ± 0.57 days) for female (Table 1 and 2).

The present findings are similar to the findings of Singh and Singh (1993) [16] who reported that the size for *T. cinnabarinus* on lady's finger as 178.30 µ in length and 155.80 µ in width and larval period as 2.70 ± 0.83 days at 30°C and 35°C temperature and relative humidity 75 and 55 per cent. Further Mallik and Channabasavanna (1983) [7] who recorded almost similar size for *T. ludeni* on French bean as 185.49 µ and larval period as 32.5 hours at 27 ± 0.5°C temperature. Similarly Mukharjee *et al.* (1992) [10] reported that *T. cinnabarinus* took 2.18 ± 0.17 days as larval period on green gram while, on French bean it was 2.25 ± 0.09 days for larval duration of *T. urticae* (Mondal and Ara, 2006) [9]. The larva measured on an average 0.175 ± 0.007 mm in length and 0.129 ± 0.003 mm in width and larval period was 2.27 ± 0.24 days for male and 2.36 ± 0.35 days (March-April) for female *T. macfarlanei* on okra (Sejalía *et al.*, 1993) [15].

Similarly Kasap (2004) [5] reported the larval period of male *T. urticae* is 1.9 ± 0.10 days and female *T. urticae* is 2.1 ± 0.09 days on Apple at 25 °C temperature. Similarly Lall *et al.* (1965) [6] reported the larval size as 180.3 µ in length and 126.6 µ in breadth for *T. telarius*.

### Nymphochrysalis

The present path analysis revealed that on an average, nymphochrysalis measured 0.18 ± 0.01 mm in length and 0.11 ± 0.01 mm in width. The quiescent stage lasted 0.59 ± 0.35 days for male and 0.64 ± 0.32 day for female (Table 1 and 2). The present findings are in agreement with Davis (1961) [2] who reported quiescent stage to be 0.21 mm length and 0.16 mm width for *T. cinnabarinus*. This period for *T. macfarlanei* on okra was 0.54 ± 0.25 day and 0.66 ± 0.25 day for male and female, respectively during March and April (Sejalía *et al.*, 1993) [15].

### Protonymph

The present study indicated that the length and width of protonymph were 0.19 ± 0.01 mm and 0.12 ± 0.01 mm, respectively. This period varied from 2.00 to 3.50 days (2.54 ± 0.50 days) for male and 2.00 to 4.00 days (2.97 ± 0.51 days) for female (Table 1 and 2).

Present study was more or less similar to finding of Singh and

Singh (1993) [16] who reported size of protonymph as 242.30 µ length and 157.30 µ width and the protonymphal period was lasted for 3.00 ± 0.70 days for *T. cinnabarinus* on lady's finger at 30°C temperature. Sejalía *et al.* (1993) [15] recorded size for *T. macfarlanei* on okra as 0.25 ± 0.01 and 0.15 ± 0.005 mm in length and width, respectively. Further Kasap (2004) [5] found this period for *T. urticae* on apple to be 2.5 ± 0.11 days for male and 2.7 ± 0.07 days for female at 20°C temperature. While, the period for *T. urticae* on jasmine was 1.66 ± 0.37 and 2.33 ± 0.24 days for male and female, respectively (Rajkumar *et al.*, 2005) [13]. Mukharjee *et al.* (1992) [10] reported it to be 2.30 ± 0.35 days for *T. cinnabarinus* on greengram.

### Deutochrysalis

The observation of deutochrysalis revealed that the body measured 0.22 ± 0.01 mm in length and 0.13 ± 0.01 mm in width. This period varied from 0.20 to 1.40 days (0.73 ± 0.41 day) for male and 0.20 to 1.50 days (0.92 ± 0.43 day) for female (Table 1 and 2). Present information are closely tally with the findings of Davis (1961) [2] who found the size of deutochrysalis of *T. cinnabarinus* as 0.27 mm and 0.17 mm in length and width, respectively. Sejalía *et al.* (1993) [15] found this period for *T. macfarlanei* on okra to be 0.43 ± 0.25 day for male and 0.65 ± 0.23 day for female during March- April.

### Deutonymph

The present study indicated that the length and width of deutonymph was 0.26 to 0.36 (0.30 ± 0.03) mm and 0.12 to 0.18 (0.14 ± 0.02) mm, respectively. This stage lasted for 1.00 to 3.00 days (2.11 ± 0.76 days) for male and 2.00 to 4.00 days (2.80 ± 0.63 days) for female (Table 1 and 2).

The present findings are in agreement with the Singh and Singh (1993) [16] who reported that *T. cinnabarinus* deutonymph stage took more or less similar duration of 3.20 ± 0.57 days and 2.50 ± 0.35 days at 30° C and 35° C on lady's finger and it measured 395.00 µ in length and 197.50 µ in width. The *T. macfarlanei* on okra had 0.69 ± 0.52 and 0.06 ± 0.27 day for female and male, respectively during March-April and it measured 0.364 ± 0.021 mm in length and 0.203 ± 0.08 mm in width (Sejalía *et al.*, 1993) [15]. Further Mukharjee *et al.* (1992) [10] reported deutonymph period for *T. cinnabarinus* on green gram as 2.55 ± 0.38 days and it measured for 377.96 µ in length and 238.12 µ in width. This period was reported for *T. ludeni* was 49 hours at 27 ± 0.5°C and it was 355.60 µ long (Mallik and Channabasavanna, 1983) [7]. Similarly Davis (1961) [2] who reported it to be 0.35 mm in length and 0.20 mm in width for *T. cinnabarinus* whereas, as per Kasap (2004) [5] deutonymph period was 2.5 ± 0.11 days and 2.8 ± 0.10 days for male and female, respectively.

### Teleo chrysalis

It measured 0.25 to 0.38 (0.37 ± 0.02) mm in length and 0.15 to 0.19 (0.16 ± 0.02) mm in width. The teleo chrysalis period was 0.20 to 1.00 (0.70 ± 0.26) days in male while, 0.30 to

1.10 ( $0.77 \pm 0.24$ ) days in female (Table 1 and 2). The present investigation was in close agreement with the findings of Davis (1961)<sup>[2]</sup> who measured the telochrysalis of *T. cinnabarinus* length to be 0.38 mm in length and width to be 0.18 mm. This stage of *T. macfarlanei* on okra lasted  $0.56 \pm 0.27$  and  $0.67 \pm 0.28$  days for male and female, respectively during March- April and also recorded the duration of teleo chrysalis during July- August as  $0.66 \pm 0.39$  and  $0.50 \pm 0.33$  day for male and female, respectively (Sejalía *et al.*, 1993)<sup>[15]</sup>.

### Total developmental period

The total developmental period recorded was 4.60 to 10.92 ( $8.44 \pm 1.75$ ) days and 8.49 to 14.14 ( $10.89 \pm 1.10$ ) days for male and female, respectively. The male emerged as an adult a bit earlier than female in all cases (Table 1).

The present investigation was in close agreement with the total time for development of *T. ludeni* which was reported as 222 hours for female and 200 hours for male (Mallik and Channabasavanna, 1983)<sup>[7]</sup>. According to Singh and Singh (1993)<sup>[16]</sup> who reported that *T. cinnabarinus* on lady's finger took  $12.30 \pm 1.35$  and  $9.20 \pm 0.55$  days as development period from egg to adult at 30<sup>o</sup> C and 35<sup>o</sup> C with relative humidity 75 and 55 per cent, respectively. Further Sejalía *et al.* (1993)<sup>[15]</sup> who found that this period for *T. macfarlanei* on okra as  $5.69 \pm 1.55$ ,  $4.30 \pm 0.39$  days for male and  $6.13 \pm 0.41$ ,  $5.07 \pm 0.23$  days for female during March- April and July- August, respectively.

Similarly Kasap (2004)<sup>[5]</sup> who reported *T. urticae* on Apple took  $9.3 \pm 0.15$ ,  $8.1 \pm 0.22$  days for male and  $10.00 \pm 0.11$ ,  $8.3 \pm 0.18$  days for female as developmental period (eggs to adult) at 25 °C and 30 °C temperature, respectively. Mukharjee *et al.* (1992)<sup>[10]</sup> found developmental period (egg to adult) of *T. cinnabarinus* as  $10.16 \pm 0.48$  days at  $29 \pm 5$  °C temperature and relative humidity  $55 \pm 5$  per cent.

Further Rai *et al.* (1989)<sup>[12]</sup> who reported the duration of larval, nymphochrysalis, protonymphal, deutochrysalis, deutonymphal and teleo chrysalis to be 1.0 to 3.0 ( $1.94 \pm 0.63$ ), 0.31 to 1.0 ( $0.82 \pm 0.31$ ), 0.33 to 2.00 ( $0.91 \pm 0.56$ ), 0.66 to 1.00 ( $0.81 \pm 0.17$ ), 1.00 to 2.00 ( $1.38 \pm 0.52$ ) and 0.33 to 1.00 ( $0.78 \pm 0.35$ ) days in male and 1.00 to 5.00 ( $2.11 \pm 0.79$ ), 0.33 to 3.00 ( $0.89 \pm 0.36$ ), 0.33 to 4.00 ( $1.21 \pm 0.50$ ), 0.33 to 2.00 ( $0.85 \pm 0.32$ ), 0.66 to 3.00 ( $1.56 \pm 0.84$ ) and 0.33 to 1.00 ( $0.91 \pm 0.17$ ) days in female, respectively.

### Adult

The present study indicated that the average length and width of male was 0.36 to 0.47 ( $0.41 \pm 0.03$ ) mm and 0.18 to 0.20 ( $0.19 \pm 0.01$ ) mm, respectively, while the average length and breadth of female was 0.45 to 0.50 ( $0.48 \pm 0.01$ ) mm and 0.20 to 0.24 ( $0.22 \pm 0.01$ ) mm, respectively.

Thus, the total developmental period was 4.60 to 10.92 ( $8.44 \pm 1.75$ ) days and 8.49 to 14.14 ( $10.89 \pm 1.10$ ) days for male and female, respectively. In all the cases male emerged as an adult a bit earlier than female (Table 1 and 2).

The present investigation was in close agreement with Lall *et al.* (1965)<sup>[6]</sup> who recorded that the adult size of males as 345.14 μ in length and 163.62 μ in width and of females as 345.67 μ and 297.78 μ in length and width, respectively. According to Mallik and Channabasavanna (1983)<sup>[7]</sup>, female of *T. ludeni* measured 447.0 μ long and male 345.04 μ long. The adult males, averaged 0.33 mm in length and 0.18 mm in width and females averaged 0.43 mm length and 0.27 mm width (Davis, 1961)<sup>[2]</sup>. According to Sejalía *et al.*, (1993)<sup>[15]</sup> *T. macfarlanei* on okra took  $4.31 \pm 0.88$  days in case of male

and  $11.30 \pm 3.62$  days in case of female. The body measured  $0.362 \pm 0.13$  mm in length and  $0.206 \pm 0.005$  mm in width for male and  $0.411 \pm 0.009$  mm in length and  $0.243 \pm 0.009$  mm in width for female.

Also Singh and Singh (1993)<sup>[16]</sup> who reported that female lived longer ( $12.10 \pm 1.98$  to  $12.50 \pm 1.63$  days) than male ( $5.10 \pm 0.65$  to  $5.30 \pm 0.67$  days) in case of *T. cinnabarinus* on lady's finger. They also reported that the male were 364.00 μ in length and 175.00 μ in width, whereas female 538.50 μ in length and 301.40 μ in width. Mukharjee *et al.* (1992)<sup>[10]</sup> who found this period for male as  $4.75 \pm 1.04$  days and of female  $10.25 \pm 2.53$  days for *T. cinnabarinus* on greengram.

### Sexual behavior

Mating between male and female usually took place soon after shedding of the last nymphal skin. The female was held by two pairs of forelegs of the male in the process. Mating lasted for 2.5 to 4 minutes. A male has been observed to mate with 3 to 4 female. Almost similar mating behavior has been reported in case of *T. macfarlanei* with coupling time of 1.00 to 2.00 minutes (Sejalía *et al.*, 1993)<sup>[15]</sup>, 1.00 to 10.00 minutes of *T. cinnabarinus* (Davis, 1961)<sup>[2]</sup>, 3.00 to 5.00 minutes for *T. cinnabarinus* (Singh and Singh, 1993)<sup>[16]</sup> and 1.00 to 5.00 minutes of *T. cinnabarinus* (Mukharjee *et al.*, 1992)<sup>[10]</sup>.

### Pre- oviposition period

The pre- oviposition period was 2.00 to 5.00 ( $2.69 \pm 0.68$ ) days for female (Table 1). Which is more or less in conformation with the reports of Rai *et al.* (1989)<sup>[12]</sup>, Lall *et al.* (1965)<sup>[6]</sup>, Sejalía *et al.* (1993)<sup>[15]</sup>, Kasap (2004)<sup>[5]</sup>, Rajkumar *et al.* (2005)<sup>[13]</sup> and Sekhar *et al.* (2008). They reported pre oviposition period as  $1.82 \pm 0.40$  days.

### Oviposition period

The present study indicated that the oviposition period of female ranged from 5.00 to 11.00 ( $7.79 \pm 1.68$ ) days (Table 1) which is more or less similar with the report of Rai *et al.* (1989)<sup>[12]</sup>, Lall *et al.* (1965)<sup>[6]</sup>, Sejalía *et al.* (1993)<sup>[15]</sup> and Sekhar *et al.* (2008), oviposition period recorded by them was  $14.5 \pm 2.55$  days.

### Fecundity

The present study indicated that the female laid 2 to 11 eggs per day with an average of  $5.62 \pm 1.36$  eggs per day. The fecundity per female varied from 38 to 106 eggs with an average of  $76.80 \pm 16.38$  eggs (Table 1). Which is more or less similar with the findings of Rishi and Rather (1983) who reported the female laid eggs at an average rate of 60 to 120 at 25- 32<sup>o</sup>C and 60-70 per cent RH. Also Rai *et al.* (1989)<sup>[12]</sup> who reported that the rate of egg laying by the mated female was 1 to 12 ( $4.06 \pm 2.57$ ) eggs and the fecundity was 12 to 54 ( $30.79 \pm 11.48$ ) eggs. Mukharjee *et al.*, (1992)<sup>[10]</sup> who reported that average number of eggs by a single fertilized and unfertilized female produced during its life span was  $41.25 \pm 2.99$  and  $25.50 \pm 4.43$  eggs, respectively.

As per Lall *et al.* (1965)<sup>[6]</sup> a single female could lay up 61 to 74 eggs and eggs laid by unfertilized female averaged 25.8. An average fecundity of fertilized female was  $61.0 \pm 12.52$  and  $62.0 \pm 9.44$  of unfertilized female was  $31.4 \pm 15.67$  and  $25.0 \pm 10.60$  eggs at average temperature of 35 °C and relative humidity 55 per cent (Singh and Singh, 1993)<sup>[16]</sup>. Kasap (2004)<sup>[5]</sup> who reported an average number of total fecundity as  $87.2 \pm 9.77$  eggs whereas, female, on an average

laid  $104 \pm 3.19$  eggs in their ovipositional period (Rajkumar *et al.* 2005) [13].

#### Post- oviposition period

The observation of post oviposition period varied of female varied from 1.00 to 7.00 ( $2.26 \pm 1.11$ ) days (Table 1). This study was more or less similar to the findings of Rai *et al.* (1989) [12] who reported post- oviposition period of 3.00 to 10.00 ( $4.35 \pm 1.95$ ) days in mated female which is in close agreement with the present findings. Sejalina *et al.* (1993) [15] who reported it as  $2.73 \pm 1.19$  days and  $2.33 \pm 0.68$  days for unmated and mated female in July- August which is more or less in accordance with the present findings. However, Lall *et al.* (1965) [6] reported it to be 1.62 days and Kasap (2004) [5] observed it to be  $3.14 \pm 0.49$  days for mated female. As per Sekhar *et al.* (2008) post- oviposition period for mated female was 2.48 days.

#### Total life period

The total life period occupied by *T. urticae* varied from 18.60 to 24.20 ( $21.65 \pm 1.63$ ) days in male and 24.33 to 29.80 ( $26.85 \pm 1.15$ ) days in female (Table 1). The present investigation was in close agreement with the Kasap (2004) [5] who reported the total life period for female varied from  $29.9 \pm 1.50$  days and for male it varied from  $25.9 \pm 1.44$  days for *T. urticae* on apple at 20 °C.

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