

ASSESSMENT OF BIOLOGICAL CHARACTERISTICS OF RED SPIDER MITE (*Tetranychusurticae*) KOCH

ONBRINJAL

ABSTRACT

Red spider mite, *Tetranychusurticae* Koch passed through five stages viz., egg, larva, protonymph, deutonymph and adult with three short resting stages known as quiescent stages which termed as nymphochrysalis, deutochrysalis and teleiochrysalis. The incubation period of egg was 3.28 ± 1.10 days with 0.13 ± 0.01 mm diameter in size. The average length and breadth of larva, nymphochrysalis, protonymph, deutochrysalis, deutonymphs, teleiochrysalis, adult male and adult female stage were 0.14 ± 0.01 and 0.10 ± 0.01 ; 0.19 ± 0.01 and 0.12 ± 0.01 ; 0.20 ± 0.01 and 0.12 ± 0.01 ; 0.24 ± 0.02 and 0.13 ± 0.01 , 0.29 ± 0.02 and 15 ± 0.02 , 0.35 ± 0.03 and 0.18 ± 0.01 , 0.43 ± 0.04 and 0.19 ± 0.01 ; and 0.47 ± 0.02 and 0.22 ± 0.01 mm, respectively. The mean duration of male and female larva, nymphochrysalis, protonymph, deutochrysalis, deutonymphs, teleiochrysalis and adult was 2.07 ± 0.73 and 2.36 ± 0.22 , 0.58 ± 0.32 and 0.68 ± 0.22 , 2.23 ± 0.35 and 2.92 ± 0.81 , 0.70 ± 0.35 and 0.76 ± 0.39 , 2.12 ± 0.44 and 2.56 ± 0.51 , 0.77 ± 0.19 and 0.87 ± 0.37 and 7.12 ± 0.93 and 11.08 ± 0.86 days, respectively. Female of *T. urticae* occupied 2.48 ± 0.96 , 5.32 ± 0.99 and 2.35 ± 0.84 days as pre-oviposition, oviposition and post-oviposition period, respectively. Total life period of male and female was 19.14 ± 2.06 and 23.85 ± 1.65 days, respectively. The average fecundity and hatching percentage were 47.60 ± 6.13 days and 91.11 ± 4.14 per cent, respectively with 1 : 2.50 sex ratio.

Keywords: *Tetranychusurticae*, egg, larva, nymph, adult and morphometrics

INTRODUCTION

Vegetables play a major role in agricultural diversity, as well as in the food and nutritional security of our huge vegetarian population supplying minerals, micronutrients, vitamins, antioxidants and dietary fibers as the key components required for the human health. Vegetable farming is an important component of the national agricultural economy (Anon., 2001).

Brinjal commonly known as egg plant, is a popular solanaceous vegetable crop. The brinjal is widely cultivated in India, Bangladesh, Pakistan, China, and

Philippines. It is also popular in Egypt, France, Italy and the United States. Except high devoted area, it is an important vegetable crop grown in India. It also suitable to many agro-climatic areas as an annual crop (Anon., 2015).

Mite is microscopic creature belong to the class Arachnida and sub-class Acari. It classified as predatory, parasitic, phytophagous and stored product mite on the basis of their feeding habit. The red spider mite, commonly referred to as *Tetranychusurticae*, is a notorious agricultural pest known for its significant impact on a wide range of crops and ornamental plants. The red spider mite is the most important non insect pest causing considerable loss in a wide range of horticultural, ornamental and agronomical crops across the world (James and Price, 2002).

. Characterized by its tiny size and its distinctive red or orange coloration, this mite feeds on plant sap, causing stippling and discoloration of leaves. Its preference for warm, dry environments and rapid reproduction make it a formidable pest, leading to reduced crop yields and plant health. Members of the family Tetranychidae are the major crop pests worldwide.

MATERIAL AND METHODS

Study of different biological attributes of *T. urticae* the research work was carried out in the laboratory of the Agricultural Entomology, Chimanbhai Patel College of Agriculture, SardarkrushinagarDantiwada Agricultural University, Sardarkrushinagarduring the year 2021-2022. The culture of red spider mite collected from Horticultural Instructional farm, SardarkrushinagarDantiwada Agricultural University, Sardarkrushinagar. Fifteen pairs of mite were collected with the help of fine camel hair brush from infested plants and released on brinjal leaves kept in Petri dish separately. To maintain turgidity of leaf wet cotton was used in Petri dish. The adults were removed from Petri dish after three days as sufficient numbers of eggs were laid. The eggs were allowed to hatch. Thus, a pure culture of *T. urticae* was raised for mass culturing. The mite individuals were transferred from old to fresh leaf evenly 2 days. The stock culture was maintained throughout the study tenure (Plate I).

Leaf bit technique

The leaf bit technique was used for rearing the mite, *T. urticae* on brinjal. Each leaf bit (2 cm × 2 cm) was placed on a filter paper having wet cotton swab at bottom in a glass Petri dish. Water was sprinkled periodically to maintain turgidity of leaf bits. The leaf bits were replaced on every alternate day to meet nutritional

requirement(Plate I). The mites obtained from mass culture were used for the further study under stereoscopic binocular microscope. Measurement on length and breadth of different life stages viz., egg, larva, nymphochrysalis, protonymph, deutochrysalis, deutonymph, teleiochrysalis and adult were recorded with the help of a stereozoom microscope (Euromax software).

RESULT AND DISCUSSION

To study the different biological attributes of *T. urticae* the research work was carried out in the laboratory of the Agricultural Entomology, Chimanbhai Patel College of Agriculture, SardarkrushinagarDantiwada Agricultural University, Sardarkrushinagarduring the year 2021-2022. For that different life stages of red spider mite, *T. urticae* viz., egg, larva, nymphochrysalis, protonymph, deutochrysalis, duetonymph, teleiochrysalis and adult observed critically and their measurement and duration were presented in Table 1 and 2, respectively and graphically depicted in Figure 1.

Egg

The eggs were smooth, soft, spherical, translucent white in colour and laid singly, mostly on the lower surface of leaves. Just before hatching the egg turned brownish in colour(Plate II). Two red spots on egg surface corresponding to simple eyes of the developing embryo were clearly visible under high magnified microscope(10X to 80X).The diameter of egg ranged between 0.11 and 0.14 mm with an average of 0.13 ± 0.01 mm. The incubation period of *T. urticae* varied from 2.00 to 5.00 days (Av. 3.28 ± 1.10 days).

Siddhapara and Virani (2018) observed that the freshly laid eggs were smooth, spherical in shape and translucent white in colour laid singly on under surface of leaf. Satishe *et al.* (2018) recorded the egg diameter of *T. urticae* ranged between 0.101 and 0.162 mm (Av. 0.130 ± 0.002 mm). The incubation period of *T. urticae* was 3.92 ± 0.41 days. The variation in the incubation period of *T. urticae* might be due to different food(okra and soybean) on which *T. urticae* reared and environmental condition of the locations.

Larva

The newly hatched larva possessed three pair of legs, spherical in shape and whitish straw in colour. Later it became elongated, pale yellow in colour and developed greenish shade on the body. Two bright prominent eye spots appeared on

each side near the margin of dorsal propodosomal region (Plate II). The length and width of larva of *T. urticae* ranged from 0.13 to 0.15 mm (Av. 0.14 ± 0.01 mm) and 0.09 to 0.12 mm (Av. 0.10 ± 0.01 mm), respectively. The larval duration ranged from 1.00 to 3.00 days (Av. 2.07 ± 0.73 days) in case of male and 2.00 to 4.00 days (Av. 2.36 ± 0.22 days) in case of female of *T. urticae* when reared on brinjal leaves.

Siddhapara and Virani (2018) observed that newly emerged larva of *T. urticae* was spherical in shape, creamy in colour with two prominent red spots on the dorsal propodosomal region. Patil *et al.* (2014) recorded that the length and breadth of *T. urticae* larva was 0.14 ± 0.01 mm and 0.10 ± 0.01 mm, respectively. Thus, the findings of above workers are in closely supported the results obtained during present findings.

Nymphochrysalis (First quiescent stage)

The mature larva entered in quiescent stage by anchoring itself with the leaf surface. The front two pairs of legs projected forward and the hind pair projected backward held closed to the body (Plate III). During this stage, the mite suspended its all activity of feeding. In the act of moulting, integument split transversely from mid line of body and posterior portion came out first and pulled out anterior body portion afterward where white exuviae remained attached to the leaf surface. The length and breadth of nymphochrysalis stage ranged from 0.17 to 0.21 mm (Av. 0.19 ± 0.01 mm) and 0.10 to 0.13 mm (Av. 0.12 ± 0.01 mm), respectively. The duration of male and female nymphochrysalis stage varied from 0.20 to 1.00 days (Av. 0.58 ± 0.32 days) and 0.20 to 1.00 days (Av. 0.68 ± 0.22 days), respectively when reared on the brinjal leaves.

In past, Satishet *al.* (2018) and Siddhapara and Virani (2018) also reported that larva stopped feeding and moved to a suitable place on the leaf and entered into first quiescent stage. Nymphochrysalis stage measured as 0.18 ± 0.01 mm in length and 0.12 ± 0.01 mm in breadth. The duration of nymphochrysalis stage from 0.55 to 0.71 days and 0.59 to 0.83 days for male and female, respectively. Thus, the findings documented by above workers are closely related with the observations of present study.

Protonymph (First nymphal stage)

The protonymph was oblong to oval in shape and possessed four pair of legs, amber in colour when freshly formed and changed to greenish post feeding.

Two red spots were present on either side of cephalothorax. The dark specks were present on the dorsum. It was slightly bigger in size than the larval stage (PlateII).The length and width of protonymph stage ranged from 0.18 to 0.23mm (Av.0.20 ± 0.01 mm) and 0.11 to 0.14mm (Av. 0.12 ± 0.01 mm), respectively.The duration of protonymphal stage ranged between 1.00 and 3.00 days(Av. 2.23 ± 0.35 days) in case of male and 2.00 to 4.00days (Av. 2.92 ± 0.81 days) in case of female.

In past, Patil *et al.*, (2014) and Reddy and Rajasekar (2017) observed that the newly emerged protonymph was oval shaped and greenish in colour, length and width of protonymph stage of mite as 0.19 ± 0.01 mm and 0.12 ± 0.01 mm, respectively. Protonymph duration of *T. urticae* was 2.54 ± 0.50 days in male and 2.97 ± 0.51days in female, which clearly supported the findings of present research work.

Deutochrysalis (Second quiescent stage)

Matured protonymph stage again entered into the quiescent stage second time. The fore and middle pair of leg projected forward and the hind pair of leg projected backwards and held close to the body. This stage became inactive and suspended all the activities and remained anchored to the leaf surface. It contracted the body and reduced in size (PlateIII).The perusal of data on length and width of deutochrysalis stage indicated that the length and width of deutochrysalis stage was ranged between 0.19 and 0.25 mm (Av. 0.24 ± 0.02 mm) and 0.12 to 0.15 mm (Av. 0.13 ± 0.01 mm), respectively. The duration of deutochrysalis male and female varied from 0.20 to 1.00days (Av. 0.70 ± 0.35 days) and 0.20 to 1.20days (Av. 0.76 ± 0.39 days), respectively.

The present results are in conformity with the findings of Siddhapara and Virani (2018) who observed the similar behaviour of deutochrysalis stage as second quiescent stage of *T. urticae*, length and width of deutochrysalis stage as 0.22 ± 0.02mm and 0.13 ± 0.01 mm, respectively and duration of deutochrysalis stage of male and female *T. urticae* consumed 0.74 ± 0.42days and 0.96 ± 0.42 days, respectively.

Deutonymph (Second nymphal stage)

The deutonymph stage found larger and broader in shape and size than the protonymph. Initially, the moulted deutonymph looked amber coloured and later turned to reddish in colour. Two red spots on either side of cephalothorax were clearly visible (PlateII).The size of deutonymphal stage was 0.25 to 0.31mm (Av. 0.29 ± 0.02 mm) in length and 0.13 to 0.18 mm(Av. 0.15 ± 0.02 mm) in width.The duration of

deutonymph was varied from 1.00 to 3.00 days (Av. 2.12 ± 0.44 days) in male and 2.00 to 4.00 days (Av. 2.56 ± 0.51 days) in case of female.

The present findings are in conformity with the results recorded by Reddy and Rajasekar (2017), Satishet al. (2018) and Siddhapara and Virani (2018) who observed that newly emerged deutonymphal stage was red in colour and larger in body size compared to protonymph.

Teleiochrysalis (Third quiescent stage)

The deutonymph stage entered in quiescent stage before moulting to adult stage. The fore and two middle pair of legs projected forward and the hind pair projected backward and held tight with the body. This stage remained inactive, suspended all the activities and anchored to leaf surface (Plate III). The moulting of teleiochrysalis resulted in the emergence of adult stage. Thus, it was recorded as the third quiescent stage in the life cycle of mite, *T. urticae*. The length and width of teleiochrysalis stage varied from 0.29 to 0.38 mm (Av. 0.35 ± 0.03 mm) and 0.15 to 0.19 mm (Av. 0.18 ± 0.01 mm), respectively. The duration of teleiochrysalis stage ranged from 0.40 to 1.00 days (Av. 0.77 ± 0.19 days) in male and female it lasted for 0.50 to 1.40 days (Av. 0.87 ± 0.37 days).

In past, Reddy and Rajasekar (2017) and Satishet al. (2018) also observed the similar features of teleiochrysalis stage which conformed the results of present findings.

Total developmental period

The period of development of red spider mite from egg to emergence of adult was considered as total developmental period. It ranged from 5.00 to 10.00 days (Av. 8.76 ± 1.16 days) in male and 7.00 to 12.00 days (Av. 10.45 ± 1.58 days) in female adult.

In past, Siddhapara and Virani (2018) recorded the total development period of *T. urticae* as 7.81 ± 1.40 days for male and 10.66 ± 1.28 days for female when reared on okra. Thus, the little variation found in the total developmental period might be due to hosts on which *T. urticae* was reared.

Pre-oviposition, oviposition and post-oviposition period

The duration between the emergence of female and commencing egg laying considered as pre-oviposition period. This period was 1.00 to 3.00 days with an average of 2.48 ± 0.96 days. The period of commencing of egg laying till the ceasing of egg laying considered as oviposition period. It lasted from 3.00 to 6.00 days with

an average of 5.32 ± 0.99 days. The period between ceasing of egg laying and death of the adult female considered as post-oviposition period. The post-oviposition period ranged from 1.00 to 3.00 days with an average of 2.35 ± 0.84 days in *T. urticae*.

In past, Patil *et al.* (2014) who reported that the pre-oviposition, oviposition and post-oviposition duration in *T. urticae* were 2.69 ± 0.68 days, 7.79 ± 1.68 days and 2.20 ± 1.03 days, respectively. Thus, the results extracted during present study on pre, post and oviposition period of *T. urticae* was clearly in association with the finding of above workers.

Adult

The newly emerged female was oval in shape, bright red in colour with broad body and blunt posterior end having four pairs of legs on propodosomal region. Later it turned to dark after continuous feeding. The matured male found lighter in colour with narrow body and distinctly pointed abdomen compared to female (Plate II). The length and width of male ranged from 0.39 to 0.47 mm (Av. 0.43 ± 0.04 mm) and 0.17 to 0.20 mm (Av. 0.19 ± 0.01 mm), respectively. While, it was 0.44 to 0.50 mm (Av. 0.47 ± 0.02 mm) and 0.19 to 0.24 mm (Av. 0.22 ± 0.01 mm), respectively in female when reared on brinjal host. The duration development of male and female *T. urticae* varied from 5.00 to 8.00 days (Av. 7.12 ± 0.93 days) and 10.00 to 12.00 days (Av. 11.08 ± 0.83 days), respectively. The observations recorded during present investigation clearly confirmed the findings with Reddy and Rajasekar (2017) and Sathish *et al.* (2018).

Total life span

The total life span occupied by *T. urticae* varied from 16.00 to 23.00 days (Av. 19.14 ± 2.06 days) in male and 18.00 to 29.00 days (Av. 23.85 ± 1.65 days) in female.

Patil *et al.* (2014) reported that the total life period of male and female of *T. urticae* was 22.28 ± 1.54 days and 26.85 ± 1.15 days, respectively when reared on carnation. Thus, the results recorded by above workers are more or less similar with the present findings.

Fecundity

The rate of egg laying per female varied from 38 to 54 eggs/female with an average of 47.60 ± 6.13 eggs/female.

In past, Meena *et al.* (2013) reported that a female of *T. urticae* laid 36 to 52 eggs/female (Av. 44.53 ± 2.71 eggs/female). Thus, the results recorded by above workers are more or less in accordance with the findings of present study.

Hatching (%)

Hatching percentages of *T. urticae* varied from 84.91 to 96.72 per cent with an average of 91.11 ± 4.14 per cent.

In past, Siddhapara and Virani (2018) observed the hatching per cent of *T. urticae* from 83.33 to 97.67 per cent (Av. 91.06 ± 3.84 per cent) when reared on okra. Thus, the results obtained during present study are in close association with that observed by above worker.

Sex ratio

The male to female sex ratio of *T. urticae* was 1:2.50 during the period of investigations when reared on brinjal.

In past, Siddhapara and Virani (2018) calculated the sex ratio of *T. urticae* as 1:2.55. Thus, the results documented by above workers on male to female sex ratio of *T. urticae* are highly uniform with the findings of present study.

CONCLUSION

The eggs were smooth, soft, spherical, translucent white in colour. The average diameter and incubation period of egg was 0.13 ± 0.01 mm and 3.28 ± 1.10 days, respectively. The newly hatched larvae possessed three pair of legs. The average length and width of larva was 0.14 ± 0.01 and 0.10 ± 0.01 mm, respectively. The average larval duration was 2.07 ± 0.73 days in case of male and 2.36 ± 0.22 days in case of female of *T. urticae*. The mature larva entered in quiescent stage and anchored itself with the leaf surface. The average length and width of nymphochrysalis stage was 0.19 ± 0.01 and 0.12 ± 0.01 mm, respectively. While, duration of male and female nymphochrysalis was 0.58 ± 0.32 and 0.68 ± 0.22 days, respectively. The protonymph was oblong in shape and possessed four pair of legs, amber in colour when freshly formed and changed to greenish afterward. Two red spots were observed on either side of cephalothorax. The average length and width of protonymph was 0.20 ± 0.01 and 0.12 ± 0.01 mm, respectively. The protonymphal duration was 2.23 ± 0.35 days in case of male and 2.92 ± 0.81 days in case of female. The average length and width of deutochrysalis was 0.24 ± 0.02 and 0.13 ± 0.01 mm, respectively. The average duration of male and female was 0.70 ± 0.35 and 0.76 ± 0.39 days, respectively. The deutonymph found larger and broader in shape and size than the protonymph. The average length and width was 0.29 ± 0.02 and 0.15 ± 0.02 mm, respectively. While, mean duration was 2.12 ± 0.44 days in male and 2.56 ± 0.51 days in case of female. The average length and width of teleiochrysalis stage was 0.35 ± 0.03 and 0.18 ± 0.01 mm, respectively while, duration was 0.77 ± 0.19 days in male and 0.87 ± 0.37 days in female. The total developmental period of *T. urticae* was 8.76

± 1.16 days in male and 10.45 ± 1.58 days in female. An average pre-oviposition, oviposition and post-oviposition period was 2.48 ± 0.96 , 5.32 ± 0.99 and 2.35 ± 0.84 days, respectively. The newly emerged female adult was oval in shape bright red in colour with broad body and blunt posterior end having four pairs of legs on their propodosomal region of the body. Later, it changed to dark with continuous feeding. The adult male found lighter in colour with narrow body and distinctly pointed abdomen. The length and width of male was 0.43 ± 0.04 and 0.19 ± 0.01 mm, respectively. While, in case of female it was 0.47 ± 0.02 and 0.22 ± 0.01 mm, respectively. The male and female lived for 7.12 ± 0.93 and 11.04 ± 0.83 days, respectively. The total life span occupied by *T. urticae* was 19.14 ± 2.06 days in male and 23.85 ± 1.65 days in female. The average fecundity was 47.60 ± 6.13 eggs and hatching per cent was 91.11 ± 4.14 per cent with 1:2.50 sex ratio.

DISCLAIMER (Artificial intelligence)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Table 1: Measurement of life stages of *T. urticae* reared on brinjal leaves n=25

Stage		Diameter (mm)					
		Minimum		Maximum		Av. ± S.D.	
Egg		0.11		0.14		0.13 ± 0.01	
Larva		Length (mm)			Width (mm)		
		Minimum	Maximum	Av. ± S.D.	Minimum	Maximum	Av. ± S.D.
		0.13	0.15	0.14 ± 0.01	0.09	0.12	0.10 ± 0.01
Nymph	Nymphochrysalis	0.17	0.21	0.19 ± 0.01	0.10	0.13	0.12 ± 0.01
	Protonymph	0.18	0.23	0.20 ± 0.01	0.11	0.14	0.12 ± 0.01
	Deutochrysalis	0.19	0.25	0.24 ± 0.02	0.12	0.15	0.13 ± 0.01
	Deutonymph	0.25	0.31	0.29 ± 0.02	0.13	0.18	0.15 ± 0.02
	Teleiochrysalis	0.29	0.38	0.35 ± 0.03	0.15	0.19	0.18 ± 0.01
Adult	Male	0.39	0.47	0.43 ± 0.04	0.17	0.20	0.19 ± 0.01
	Female	0.44	0.50	0.47 ± 0.02	0.19	0.24	0.22 ± 0.01

Table 2: Duration (day) of life stages of *T. urticae* reared on brinjal n=25

Stages		Minimum	Maximum	Av. ± S.D.	
Egg		2.00	5.00	3.28 ± 1.10	
Larva	Male	1.00	3.00	2.07 ± 0.73	
	Female	2.00	4.00	2.36 ± 0.22	
Nymph	Nymphochrysalis	Male	0.20	1.00	0.58 ± 0.32
		Female	0.20	1.00	0.68 ± 0.22
	Protonymph	Male	1.00	3.00	2.23 ± 0.35
		Female	2.00	4.00	2.92 ± 0.81
	Deutochrysalis	Male	0.20	1.00	0.70 ± 0.35
		Female	0.20	1.20	0.76 ± 0.39
	Deutonymph	Male	1.00	3.00	2.12 ± 0.44
		Female	2.00	4.00	2.56 ± 0.51
	Teleiochrysalis	Male	0.40	1.00	0.77 ± 0.19
		Female	0.50	1.40	0.87 ± 0.37
	Total development	Male	5.00	10.00	8.76 ± 1.16
		Female	7.00	12.00	10.45 ± 1.58
Adult	Pre-oviposition		1.00	3.00	2.48 ± 0.96
	Oviposition		3.00	6.00	5.32 ± 0.99
	Post oviposition		1.00	3.00	2.35 ± 0.84
	Adult longevity	Male	5.00	8.00	7.12 ± 0.93
		Female	10.00	12.00	11.08 ± 0.86
	Total life span	Male	16.00	23.00	19.14 ± 2.06
		Female	18.00	29.00	23.85 ± 1.65
	Fecundity (Eggs/female)		38.00	54.00	47.60 ± 6.13
	Hatchability (%)		84.91	96.72	91.11 ± 4.14
Sex ratio (Male : Female)		1:2.50			

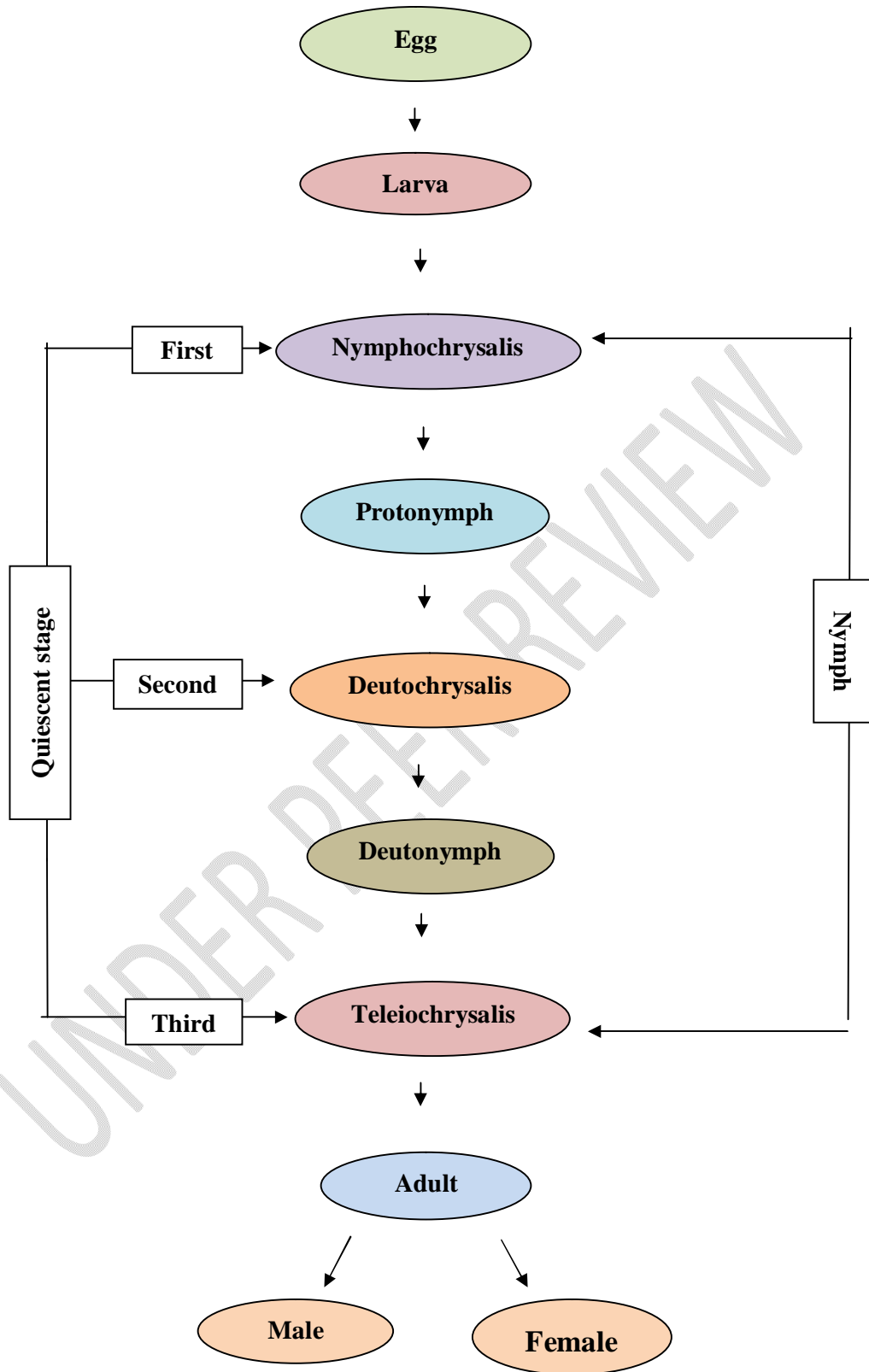


Figure 1: Schematic diagram of life stages of *T. urticae*



A. Mother culture

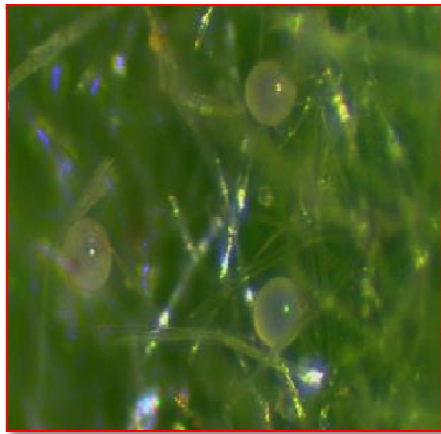


B. Mass culture



C. Leaf bit rearing technique

Plate I: Rearing technique of *T. urticae* on brinjal



Eggs



Larva



Protonymph

Nymph



Deutonymph



Female

Adult

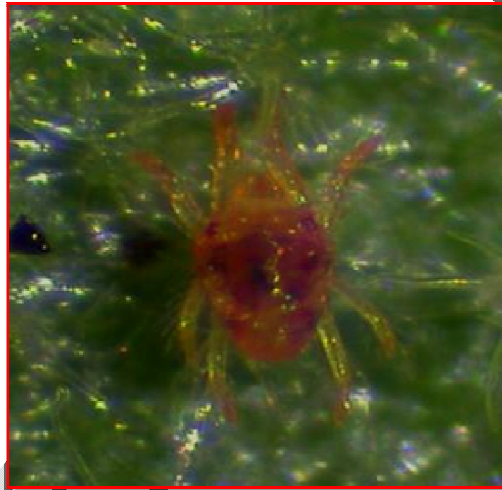


Male

Plate II: Active life stages of *T. urticae*



Nymphochrysalis(Between larva and protonymphal stage)



Deutochrysalis(Between protonymph and duetonymphal stage)



Teleiochrysalis(Between duetonymph and adult stage)

Plate III: Resting life stages of *T. urticae*

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