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STUDY ON THE DEVELOPMENTAL STAGES OF SPIDER MITE (*TETRANYCHUS URTICAE* KOCH) INFESTING COUNTRY BEAN

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Abstract

The duration of developmental stages of *Tetranychus urticae* Koch was studied in different months of a year at room temperature. In addition fecundity of this mite was also observed in winter, autumn and summer seasons. *T. urticae* eggs hatched to larvae in the shortest duration of 1.07 ± 0.26 days and the longest duration of 11.67 ± 2.33 days in April and January, respectively. The larval period of *T. urticae* took the shortest time of 0.55 ± 0.50 days in May and 2.93 ± 1.07 days in December. The protonymph transformed to deutonymph in 0.89 ± 0.32 day in May and 3.71 ± 1.94 in December and January. The deutonymph required the shortest duration of 0.92 ± 0.41 days in August and the longest of 10.26 ± 1.48 days in January. The temperature played significant ($P<0.001$) role on the duration of developmental stages of *T. urticae*. The high temperature accelerated the developmental rate and reduced the duration of developmental periods. Its life cycle completed within 4.22 ± 0.46 days at 28.53 ± 3.17°C but 28.33 ± 2.36 days at 13.78 ± 2.36°C. A female *T. urticae* deposited 82.46 ± 4.11 eggs in autumn, 62.96 ± 12.09 eggs in summer and 58.21 ±1 3.65 eggs in winter.

Key words: Developmental stages, *Tetranychus urticae*, temperature, fecundity

Introduction

Tetranychus urticae Koch is one of the most serious pests of various crops and vegetables in agriecosystem. It is also a serious pest of ornamental plants and fruit trees in both greenhouse and field. *T. urticae* was first reported from the USA by Tuttle and Baker (1968). It has wide host range including vegetables, ornamentals, herbaceous and woody landscape plants, and has been recorded to feed more than 180 plant species (Johnson and Lyon 1991).

The life cycle of *T. urticae* is typical of warm weather spider mites. It completes development from egg to adult within 7 – 8 days at 27.5 – 32.5ºC and all the life stages present throughout the year, depending on the environmental conditions (Helle and Sabelis 1985). Development proceed more slowly when temperature is minimum, requiring upto four weeks for total life span. Host plants, plant nutrition, leaf age, and moisture stress also influence development of *T. urticae*. Many generations passes in each year, depending on the species of spider mites. Some species of spider mites, the Southern red mite and the European red mite occurring on conifers and broad-leaved evergreen plants are called cool weather pests. They feed heavily and reproduce quickly in spring and fall (Helle and Sabelis 1985).

T. urticae abundantly occurs on bean plants in the City Corporation area of Rajshahi. This mite causes serious damage to bean plants (Naher 2005). Its control is very much essential to get maximum and quality yield of bean. For successful management of any pest, a through knowledge about biology of the pest is necessary. Keeping this in mind an experiment was designed to study the biology and fecundity of *T. urticae* infesting country bean plants, *Lablab purpureusi* L.

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Materials and Methods

Developmental stages: The duration of developmental stages was studied on excised leaf disc in the Integrated Pest Management (IPM) laboratory, Institute of Biological Sciences, Rajshahi University from March 2002 to January 2003. Leaf discs were made with fresh country bean (*L. purpureus*) leaf without mite infestation. Each leaf disc was circular in appearance with 2cm diameter. Thirty leaf discs were prepared. The leaf discs were placed on cotton bed in petri dish (5 cm X 1 cm) facing under surface upward. The cotton bed was kept wet by soaking with water twice daily so that the discs remained fresh.

Two adult female *T. urticae* (those can be easily separated from male with their oval abdomen and absence of aedeagus) were transferred to each leaf disc for laying eggs. The adult female mites were collected from the laboratory maintained in the Institute Biological Sciences by rearing *T. urticae* on potted bean plants for more than one year.

The discs containing adult females were checked after two hours of mite transfer. The mites were removed if at least one egg was found. In this way 30 eggs were collected on leaf discs. Keeping only one egg on each disc the others were destroyed by pin. There was always a gap between bottom dish and lid. The discs were checked after every 24 h and the stages of mite development were noted till the appearance of their adulthood. The leaf discs were changed after 3 to 4 days to ensure their freshness. The immatures were transferred to new disc very carefully with the help of camel hair brush. The room temperature and relative humidity was recorded twice daily.

The duration of hatching, larval, protonymphal and deutonymphal period was recorded for 11 generations with the mean temperature and relative humidity of 25.82°C, 67.48% (March); 27.46°C, 76.75% (April); 28.53°C, 82.90% (May); 29.60°C, 85.49% (June); 30.06°C, 87.41% (July); 29.41°C, 85.82% (August); 29.36°C, 85.92% (September); 27.07°C, 82.31% (October); 23.32°C, 80.35% (November); 18.59°C, 81.83% (December) and 13.78°C, 80.21% (January). But every times the eggs were collected from fresh adult female maintained in the laboratory culture. The developmental successes of various developmental stages in different generations were calculated.

Fecundity of T. urticae: Deutonymphs of *T. urticae* were collected from the potted bean plants of laboratory culture. Five to six deutonymph were transferred on each leaf disc. The disc containing deutonymphs were observed twice daily at 6 AM and 6 PM. The time of adulthood of the deutonymphs was recorded. All the mites were removed keeping one male and one female on each disc. The male was also removed after laying the first egg by the female. In this way more than 30 discs with ovipositing females were maintained for this experiment. The discs were checked after every 24 hours interval with the aid of a stereo binoculor microscope. The leaf discs were also changed after every three days in the same way as described earlier. All the discs were checked and the number of eggs laid was counted till the death of the adult. The room temperature and relative humidity was recorded twice daily. The experiment was conducted in three seasons viz., summer, autumn and winter at temperature and relative humidity 30.46°C, 82.78%; 25.23°C, 83.91%; and 13.88°C°C, 80.35% respectively.

Results and Discussion

Developmental stages: T. urticae passes four developmental stages with resting or quiescent stages at the end of larval and nymphal development. The duration of various developmental stages of *T. urticae* in different generations maintained in different months (Table 1).

T. urticae eggs hatched to six legged larvae in the shortest duration of 1.07 $\pm$ 0.26 days in the month of April. It took the longest duration of 11.67 $\pm$ 2.33 days in the month of January (Table 1). The eggs of *T. urticae* hatched rapidly in April when the temperature was 27.46 $\pm$ 3.17°C (Table 3). But the eggs hatched slowly in January when the temperature was 13.78 $\pm$ 3.21°C (Table 3). *T. urticae* larvae transformed to eight legged protonymph after a while. Before transforming to protonymph it passed a short inactive period which called

crysalis. It left an exuvie during this transformation. The larval period was the shortest in duration compared to all other developmental stages. It took 0.55 ± 0.50 (Table 1) days in the month of May. The protonymphal duration of *T. urticae* was also the shortest in the month of May. It took 0.89±0.32 days from protonymph to deutonymph. The highest duration was 3.71 ± 1.94 days in December and January. The deutonymph is the last immature stage of *T. urticae* life cycle. It required the shortest duration of 0.92 ± 0.41 days in August and the longest 10.26 ± 1.48 days in January. During May the average temperature was 28.53 ± 3.17°C (Table 3) and was very favourable for mite development. The lowest average temperature 13.78 ± 3.21°C was prevailed in the month of January retarded the developmental rate and lengthened the transformation of deutonymph to adult.

The effect of temperature and relative humidity on the duration of developmental stages are studied and the calculated 'r' values are presented in Table 2. Duration of developmental stages is highly influenced by temperature. The increase of temperature accelerated the developmental rate. During high temperature the duration of developmental stages are shortened and transformed to adult rapidly. It took only 4.22 days from egg to adult during the hot month (Table 1).

Table 1. Duration (day ± S E) of various developmental stages of *T. urticae* in different months reared on country bean leaf under laboratory condition.

Months (Temp.°C)	Egg to larva	Larva to protonymph	Proto- to deutonymph	Deutonymph to adult	Egg to adult
Mar-02 (25.82)	3.50^{a}±1.00	2.00^{a} ±0.72	1.89^{a} ±0.42	2.24^{a} ±0.44	9.62^{a}±1.56
Apr-02 (27.46)	1.07^{a}±0.26	1.21^{a} ±0.42	1.81^{a} ±0.40)	1.68^{a} ±0.48	5.77^{a}±0.75
May-02 (28.53)	1.62±0.49)	0.55^{a} ±0.50	0.89^{a} ±0.32	1.15^{a} ±0.37	4.22^{a}±0.46
Jun-02 (29.60)	1.60^{a} ±0.58	1.00^{a} ±0.00	1.09^{a} ±0.29	1.18^{a} ±0.40	4.87^{a}±0.81
Jul-02 (30.06)	2.10^{a} ±0.66	1.14^{a} 0.36)	1.14^{a} ±0.36	1.68^{a} ±0.56	6.07^{a}±0.80
Aug-02 (29.41)	2.66 ^{a} ±0.67	1.00 ^{a} ±0.00	1.04 ^{a} ±0.19	0.92 ^{a} ±0.41	5.61^{a}±0.48
Sep-02 (29.36)	2.07 ^{a} ±0.49	0.93 ^{a} ±0.26	1.00 ^{a} ±0.00	1.44 ^{a} ±0.51	5.44^{a}±0.75
Oct-02 (27.07)	2.62 ^{a} ±0.70	1.63 ^{a} ±0.65	1.79 ^{a} ±0.42	2.09 ^{a} ±0.43	8.11^{a}±0.95)
Nov-02 (23.32)	4.89 ^{a} ±0.81	2.46^{b}±0.51	2.17 ^{a} ±0.38	2.70 ^{a} ±0.47	12.21^{a}±1.23
Dec-02 (18.59)	11.40^{b}±2.01	2.93^{b}±1.07	3.71^{b}±1.94	8.89^{b}±2.08	26.93^{b}±2.45
Jan-03 (13.78)	11.67^{b}±2.33	2.69^{b}±1.05	3.71^{b}±1.75	10.26^{b}±1.48	28.33^{b}±2.36
F value	355.66***	47.88***	37.44***	319.51***	875.39***
LSD	5.46	1.17	1.78	4.28	10.99

Mean followed by same letter have no significant difference, *** = P>0.001.

Table 2. Effect of temperature and relative humidity on the duration of different developmental stages of *T. urticae.*

Environmental factors	Temperature		Relative Humidity
Developmental stage	'r' value	Equation	'r' value
Egg	-0.952***	Y = -0.695X+22.001	-0.126
Larva	-0.884***	Y = -0.136X+5.094	-0.395
Protonymph	-0.960***	Y = -0.187X+6.675	-0.322
Deutonymph	-0.958***	Y = -0.597X+18.476	-0.134
Adult	-0.968***	Y = -1.617X+52.254	-0.181

The developmental success of different developmental stages are calculated and presented in Table 3. The developmental success was not significantly different among months. At all conditions the developmental success of egg, larva and protonymph was more than 92%. The developmental success of deutonymph was somewhat reduced in December and January when the average temperature was below 20°C. The survivability from egg to adult was also abruptly reduced in December and January. The above findings shows that the cold temperature affect the survivability of late stages only.

Table 3. Developmental success of different stages of *T. urticae* as influenced by temperature and relative humidity.

Month	Developmental success					Temp. (°C)	Relative Humidity (%)
	Egg	Larva	Proto-nymph	Deuto-nymph	Egg to adult		
March	0.966	1.000	1.000	0.929	0.897	25.82	67.48
April	1.000	1.000	0.929	0.962	0.893	27.46	76.75
May	0.967	1.000	0.931	0.963	0.867	28.53	82.90
June	0.926	0.960	0.917	1.000	0.815	29.60	85.49
July	1.000	0.933	1.000	0.893	0.833	30.06	87.41
Aug	1.000	0.966	0.964	0.889	0.828	29.41	85.82
Sept	1.000	0.967	0.966	0.964	0.900	29.36	85.92
Oct	0.929	0.923	0.958	0.957	0.786	27.07	82.31
Nov	0.964	0.963	0.923	0.958	0.821	23.32	80.35
Dec	1.000	0.967	0.966	0.643	0.600	18.59	81.83
Jan	1.000	0.967	0.966	0.679	0.633	13.78	80.21

F value = 0.95

Fecundity of T. urticae: The mean number of eggs laid by a female, the daily fecundity and average duration of reproductive period during winter, autumn and summer is presented in Table 4. A female *T. urticae* laid 82.46 ± 4.11 eggs during autumn at average temperature of 25.23 ± 2.65°C (Table 4) but it laid 58.21 ± 13.65 eggs during winter with prevailing temperature 13.88 ± 1.89°C. The eggs deposited per day was only 1.35 ± 0.36 in winter but it was higher (11.01 ± 1.92) during summer when the average temperature was 30.46±2.61°C.

Extensive research had been done on the biology of different species of spider mites. Most of the works are related to the effect of temperature. Sabelis (1981) reported that a female *T. urticae* develop from egg to adult in 6.5 days at 30^{0}C. Helle and Sabelis (1985) found that a female *T. urticae* lays as many as 60 eggs in five days. Shih (1999) observed *T. urticae* laid maximum 100 eggs in 10 days. He stated that the temperature 23–30^{0}C was the optimal for the development of *T. urticae*. The larval and nymphal stage lasted 16 days at 20^{0}C but only seven days at 31^{0}C. The present investigation shows that *T. urticae* develop from egg to adult in 4.22 and 28.33 days at temperature 28.53 and 13.78^{0}C respectively. A female laid 62.96 ±12.09 eggs during summer.

Table 4. Fecundity and reproductive period of *T. urticae* in winter, autumn and summer seasons.

Season	Egg/female ± S E	Egg/female/day ± S E	Reproductive period day ±S E
Winter	58.21 ± 13.65	1.35 ± 0.36	29.11 ± 1.85
Autumn	82.46 ± 4.12	4.80 ± 0.55	18.75 ± 1.07
Summer	62.96 ± 12.09	11.01 ± 1.92	9.28 ± 1.17
F value	50.45***	12.95***	1140.01***

*** = P>0.001.

The effect of five constant temperatures (15-37^{0}C) at 80% relative humidity on the biology of *T. neocaledonicus* Andre in the laboratory was studied by Pande and Sharma (1986). They observed that *T. neocaledonicus* could not survive beyond 37^{0}C, but with the increase of temperature above 20^{0}C, development was faster. They also added that 30^{0}C was the optimal temperature for the development of *T. neocaledonicus***.** Northcraft and Watson (1987) studied the developmental biology of *T. cinnabarinus* at three fluctuating temperatures having the means 22.7, 26.6 and 30.5^{0}C. They reported that the developmental time, longevity and survival rate of adult females significantly decreased with the increase of temperature. Preoviposition periods and rate and duration of oviposition also tended to decrease with the increase of temperature. The mean generation time was 17.7, 14.3 and 11.6 days, respectively at 22.7, 26.6 and 30.5^{0}C. Deciyanto *et al*. (1989) studied the life cycle of *Tetranychus* sp. on six cultivars of *Mentha piperita* and *M. arvensis*. They found that the life cycle averaged within 10.6 to 14.4 days and a female laid 35.2 to 77 eggs. They also observed that the life cycle was the longest on *M. piperita* Newzealand but shortest on *M. arvensis* Jombang. Tsai *et al*. (1989) studied the duration of developmental stages of *T. kanzawi* infesting tea at 15, 20, 25 and 30^{0}C**.** They found the lowest development at the lowest temperature and highest development at the highest temperature. The duration of the developmental stages were shorter at 30^{0}C but longer at 15^{0}C. *T. kanzawi* was short lived at 30^{0}C but long lived 15^{0}C. A female laid 27.8 eggs at 15^0 C but 76.0 eggs at 30^{0}C. The mean generation time ranged from 12.4 days at 30^{0}C and 53.9 days at 15^{0}C. Al-Mallak and Abdalla (1990) studied the biology of strawberry mite, *T. turkestani* in laboratory condition at 25^{0}C and 60% R. H. They reported the average egg laying capacity was 81.7±1.17 per female. The larval, nymphal and adult stages lasted 6.2, 6.1 and 13.3 days respectively.

The result of present investigation agreed with the findings of the above results. All above results shows the great effect of temperature on the development and fecundity of *T. urticae* and other species of *Tetranychus* This experiment also found the significant effect of temperature on the developmental stages of *T. urticae*. The higher temperature accelerated the developmental rate and reduced the duration of developmental stages. In the present investigation the fecundity was also higher at 25.23 ± 2.65^{0}C. At 30.46^{0}C the oviposition period was 9.28 days but it was 18.75 days at 25.23^0 C. The life cycle of *T. urticae* completed within 4.22 days at 28.53^{0}C. So the present results suggest that favourable temperature of *T. urticae* was 25.23^{0}C to 28.53^{0}C, which is very similar to the findings of other investigators on different species of spider mites.

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