Biology of the Cassava Mite, *Tetranychus truncatus* Ehara (Acari: Tetranychidae)

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Abstract

The duration of developmental stages of *Tetranychus truncatus* Ehara was studied at four different temperature regimes (20, 25, 30 and 35℃) on excised mulberry leaves. Longevity and fecundity of female and sex ratio were also observed at 30℃. Mites completed their development within this temperature range. *T. truncatus* eggs hatched to larvae in the shortest duration of 2.38 ± 0.06 days at 35℃ and the longest duration of 7.65 ± 0.05 days at 20℃. Development time for completion of the life cycle decreased significantly with increasing temperature. The longest (16.93 ± 0.11 days) and the shortest (5.34 ± 0.11 days) life cycle were observed at 20℃ and 35℃ respectively. The highest immature mortality was 13.94% at 35℃ followed by 10.35% at 20℃. A female mite laid 55.07 eggs during its oviposition period of 10.93± 0.29 days at 30℃. The oviposition rate was 5.13± 0.24 eggs/female/day at 30℃. The sex ratio of *T. truncatus* at 30℃ was 1 : 3.12 (male: female).

Key words: *Tetranychus truncatus*, biology, development, fecundity, temperature.

Introduction

Tetranychus truncatus Ehara is a polyphagous spider mite with 86 host plant species and mainly distributed in Asia and South East Asia (Migeon and Dorkeld 2006-2016). In some countries of East and Southeast Asia, the mite is one of the most important pests of agricultural crops (Sakunwarin et al. 2003; Pang et al. 2004). *Tetranychus truncatus* is also recorded as a serious pest of many plants in Thailand such as peach, papaya, cassava, yard-long bean, peanut and castor bean (Ehara and Wongsiri 1975).

This mite feeds on the lower leaf surface and produces webs that cover their eggs and immature stages. Feeding damage from *T. truncatus* appears first on the lower leaf surface and symptoms such as yellow spots appear on the upper leaf surface, then the leaf will lose its normal green color (Charanasri et al. 1982).

In Thailand, the optimal conditions for population growth of *T. truncatus* are found during the dry periods (Charanasri et al. 1993). Sakunwarin et al. (2003) reported that *T. truncatus* could develop and reproduce within a wide range of temperatures and the range 24-31°C was the most suitable for the development, survival rate and reproduction of this mite.

For successful management of any pest, a thorough knowledge about biology of the pest is necessary. In Myanmar, there is no information on biology and the effect of temperature on various biological parameters of *T. truncatus* in the literature. In these regards, the present study was conducted to study the biology of the *T. truncatus.*

Materials and Methods

This study was conducted in Experiment and Lecture Building, (ELB), (1), Department of Entomology and Zoology, Yezin Agricultural University during November 2016 and December 2016.

Rearing of stock culture

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Tetranychus truncatus was collected from greengram leaves at Yezin Agricultural University and then transferred and reared on fresh and clean mulberry leaves for several generations to provide a stock colony. Water saturated sponge was placed in a plastic box and a layer of water saturated cotton was placed over the sponge. Then fresh and clean mulberry leaves were placed on the top of cotton layer with the upper surface facing down. One adult female *T. truncatus* was picked up and placed separately on mulberry leaves to provide the same progeny. New leaf was replaced when the old leaf became wilted or showed the signs of deterioration.

Developmental stages

The duration of developmental stages of *T. truncatus* were studied on excised mulberry leaf discs at 4 different temperatures (20, 25, 30, 35 ˚C) and a photoperiod of 12:12 (L: D) in a growth chamber. Thirty leaf discs of about (2x2 cm) were prepared with fresh mulberry leaf without mite infestation. The leaf discs were placed on cotton bed in petri dish (10 cm in diameter) facing under surface upward. The cotton bed was kept wet by soaking with water twice daily so that the discs remained fresh.

Two adult females *T. truncatus* (those can be easily separated from male with their oval abdomen) were picked randomly from stock colony and were placed on each leaf disc for laying eggs. All mites and excess eggs were removed from each leaf disc after 24 hours and only 1 egg was left on each leaf disc. Observations were made every 6 hours until all mites reached adulthood. The number of stages and the duration for each developmental stage were recorded. The leaf discs were changed every 4 days to ensure their freshness. The immatures were transferred to new leaf discs very carefully with the help of hair brush.

Data on the developmental rate of the mite under different temperatures was analyzed using one-way analysis of variance (ANOVA) followed by LSD test (P= 0.05) to compare the means.

Longevity and fecundity

Longevity and fecundity of fertilized females was investigated on mulberry leaf discs (2 x 2 cm) at 30˚C and a photoperiod of 12:12 (L: D) in a growth chamber. One female teliochrysalis and 3 adult males were placed together on each of 30 mulberry leaf discs placed on cotton bed in petri dish (10 cm in diameter). Observations were made every 6 hours until the adulthood of the teliochrysalis. The data for female adult longevity, pre-oviposition, oviposition and post-oviposition periods and number of eggs for each female were recorded at 24 hour intervals. The leaf discs were changed every 4 days in the same way as described earlier.

Sex ratio

Sex ratio of the *T. truncatus* was studied on mulberry leaf discs (2 x 2 cm) at 30˚C and a photoperiod of 12:12 (L: D) in a growth chamber. To examine sex ratio, one female teliochrysalis and 3 adult males were placed together on each leaf disc. Thirty leaf discs were prepared. Leaf discs were checked every 24 hours. Males were removed after laying the first egg by the female. In this way, 30 leaf discs with ovipositing female were maintained for this experiment. All eggs laid by each female were kept and left to develop until the adulthood and then the number of males and females were counted.

Results and discussion

Developmental stages

Data on the development times of *T. truncatus* at 4 different temperatures are shown in Table 1. Female mites deposited on the under surface of the leaves especially near the midrib. Newly laid eggs were round in shape and translucent in colour. The incubation periods were significantly different between temperatures tested. *T. truncatus* eggs hatched to larvae in the shortest duration of 2.38 days at 35˚C and the longest duration of 7.65 days at 20˚C. The rate of development increased rapidly, 44% between 20 and 25 ˚C but slowly, 29% between 25 and 30˚C and 20% between 30 and 35˚C. Moreover, the egg stage was the longest at all temperatures, averaging 44-45% of total duration of the life cycle. This finding was similar to those for *Tetranychus truncatus* Eahara (41-46%) at 20, 24, 31 and 35˚C (Sakunwarin et al. 2003); *Eotetranychus cendanai* Limando (43-50%) at

Table 1. Development time of *Tetranychus truncatus* at 4 different temperatures

Stages		Mean* ± S E (days)			
		20 ˚C	25˚C	30˚C	35˚C
Egg		7.65 ± 0.05 a	4.21 ± 0.05 b	2.98 ± 0.05 c	2.38 ± 0.06 d
	(n)	(29)	(29)	(30)	(28)
Larva		1.88 ± 0.03 a	0.92 ± 0.03 b	0.72 ± 0.03 c	0.61 ± 0.03 d
	(n)	(28)	(29)	(30)	(28)
Protochrysalis		1.52 ± 0.03 a	0.81 ± 0.03 b	0.59 ± 0.03 c	0.44 ± 0.03 d
	(n)	(28)	(29)	(29)	(27)
Protonymph		1.17 ± 0.03 a	0.7 ± 0.02 b	0.5 ± 0.02 c	0.38 ± 0.03 d
	(n)	(28)	(29)	(29)	(26)
Deutochrysalis		1.41 ± 0.03 a	0.88 ± 0.02 b	0.59 ± 0.02 c	0.48 ± 0.03 d
	(n)	(27)	(28)	(29)	(26)
Deutonymph		1.46 ± 0.03 a	0.87 ± 0.03 b	0.65 ± 0.03 c	0.52 ± 0.03 d
	(n)	(27)	(28)	(29)	(26)
Teliochrysalis		1.79 ± 0.02 a	1.03 ± 0.02 b	0.74 ± 0.02 c	0.52 ± 0.02 d
	(n)	(27)	(28)	(29)	(26)
Life cycle		16.93 ± 0.11 a	9.43 ± 0.11 b	6.77 ± 0.11 c	5.34 ± 0.11 d
	(n)	(27)	(28)	(29)	(26)

***Means followed by the same letter are not significant different at 0.05 level**

28˚C (Thongtabet al. 2002); *Schizotetranychus celarius* (Banks) (44%) at 25˚C (Saito 1979). However, Saeidi and Nemati (2017) reported that the incubation period of *Schizotetranychus smirnovi* Wainstein corresponded to 55% of total development time at 25˚C.

Newly hatched *T. truncatus* larvae were pale yellow in colour with three pairs of leg. The larvae were active for 1.88, 0.92, 0.72 and 0.61 days at 20, 25, 30 and 35˚C respectively. Before transforming to protonymph it passed a quiescent period known as protochrysalis when the larvae stopped feeding. This stage ranged from 0.44-1.52 days. There was a significant difference in larval development times at all temperatures.

Yellow-orange protonymph started feeding immediately after molting. This stage lasted 1.17, 0.7, 0.5 and 0.38 days at 20, 25, 30 and 35˚C before the inactive deutochrysalis stage which lasted 0.48-1.41 days. The development time of protonymph decreased significantly with increasing temperature.

Deutonymphs of *T. truncatus* were orange in colour. Deutonymphs developed within 1.46, 0.87, 0.65 and 0.52 at 20, 25, 30 and 35˚C before entering the last resting stage, teliochrysalis. Sexes could be easily distinguished during this stage. This stage ranged from 0.52-1.79 days prior to molting to the adult stage. Adult mites were orange-red in colour.

Temperature had a direct effect on the life cycle of *T. truncatus*. The development time for completion of the life cycle decreased significantly with increasing temperature. Higher temperatures are known to decrease the duration of the life cycle in several spider mite species (Gupta et al. 1974; Tanigoshi et al. 1975). A similar result was also found in this study where the longest life cycle of *T. truncatus* (16.93 days) was at 20˚C and the shortest life cycle (5.34 days) was recorded at 35˚C. As in embryonic development, the rate of development from egg to adult increased rapidly, 44%, between 20 and 25˚C but slowly, 28% between 25 and 30˚C and 21% between 30 and 35˚C. Boudreaux (1963) men-

Table 2. Mortality rate (%) of each developmental stage of *Tetranychus truncatus* at 4 different temperatures

Stages	Mortality rate (%)			
	20 ˚C	25 ˚C	30 ˚C	35 ˚C
Egg	3.33	3.33	0.00	6.67
Larva	3.45	0.00	3.33	3.57
Protonymph	3.57	3.45	0.00	3.70
Deutonymph	0.00	0.00	0.00	0.00
Total	10.35	6.78	3.33	13.94

Table 3. Longevity and fecundity of female *T. truncatus* at 30˚C

Parameters	Mean* ± S E
	30˚C
Pre-oviposition	1.12± 0.05
Oviposition	10.93± 0.29
Post-oviposition	3.03± 0.12
Eggs/Female	55.07± 2.04
Eggs/Female/Day	5.13± 0.24
Female Longevity	15.08± 0.32

tioned that the development time decreased for each developmental stage as temperature increased was common for tetranychid mites and the most rapid development of many spider mite species occurred between 20 and 29˚C which agreed with the results of this study.

The highest mortality during development was 13.94% at 35˚C followed by 10.35% at 20˚C, mainly in the egg and larval stage (Table 2). Similar results were found at 20 and 35˚C for *T. truncatus* Ehara by Sakunwarin et al. (2003). Fu et al. (2002) found that survival rate of *T. piercei* decreased both at lower and higher temperatures which is similar to this study. Although *T. truncatus* showed highest mortality in the egg and larval stage, both low and high temperatures also caused mortality of the nymphal stages at 20 and 35˚C. The results showed that temperature between 25 and 30˚C was optimal for development of *T. truncatus*. Sakunwarin et al. (2003) reported that the favorable range of temperature for *T. truncatus* development was between 24-31˚C.

Longevity and fecundity

Copulation takes place almost immediately after female emergence from teliochrysalis. It was quite common to see 2-3 males guarding the same female. One female mite was able to copulate many times and the male mite would copulate with more than one female during its life span. Multiple mating (2 or more) was also observed in *Oligonychus perseae* Tuttle, Baker and Abbatiello (Aponte and McMurtry 1997).

Data on the longevity and fecundity of *T. truncatus* at 30˚C were shown in Table 3. The female mite started oviposition after 1.12 days of adult emergence. The oviposition period last 10.93 days and the female mites stopped laying eggs 3.03 days before dying. The oviposition period of *T. truncatus* in the present study was similar to those observed in other studies (Sakunwarin et al. 2003; Naher et al. 2008). In an experiment with *T. truncatus*, Sakunwarin et al. (2003) found the oviposition period of 10 days at 28˚C. Naher et al. (2008) reported that the reproductive period of *T. urticae* at 30.46˚C was 9.28 days.

A female *T. truncatus* laid 55.07 eggs at 30˚C which was lower than those of *T. truncatus* at 31˚C of 64.78 eggs but higher than those of 45.27 eggs at 28˚C (Sakunwarin et al. 2003). Fecundity of *T. truncatus* was low as compared to 156.8 eggs of *T. urticae* at 30˚C (Abd El-Wahed and El-Halawany 2012). The oviposition rate was 5.13 eggs/day at 30˚C which was higher than 3.09 eggs/day of *Eutetranychus orientalis* (Klein) (Imani and Shishehbor 2009) but lower than11.01 eggs/day of *T. urticae* at the same temperature (Naher et al. 2008).

Sex ratio

Fertilized eggs produced both male and female offspring and the sex ratio of *T. truncatus* at 30˚C was 1:3.12 male : female. The sex ratio of *T. truncatus* was strongly biased for females. These data are in line with the result of Imani and Shishehbor (2009) who stated that the sex ratio for *E. orientalis* at 30˚C was 1:3 male : female. Helle and Sabelis (1985) pointed out that the normal sex ratio for the Tetranychidae is 1: 3 male: female.

Conclusion

Tetranychus truncatus completed its life cycle within the tested temperature range of 20 to 35˚C. Temperature had a direct effect on the life cycle of *T. truncatus*. The high temperature accelerated the developmental rate and reduced the duration of developmental periods. Both low and high temperatures caused the highest mortality of the mite. Based on the results of this experiment, it can be concluded that temperature between 25 and 30˚C was optimal for development of *T. truncatus*.

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