

## Effect of Temperature Degrees on the Biology and Life Table Parameters of *Tetranychus urticae* Koch on Two Pear varieties

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### ABSTRACT

Developmental times and reproduction rates of the two-spotted spider mite *Tetranychus urticae* Koch were studied when fed on leaves of two pear varieties (i.e. Lacont and Hood varieties) under laboratory conditions of 15, 20, 25 & 30 ± 2°C, 70% ± 5% RH. The longest developmental stages reached 30.6 and 30.1 days for female and male at 15°C when the *T. urticae* was fed on Lacont pear variety, while when reared on Hood pear variety it was 34 and 32.1 days at the same temperature. The highest total mean fecundity rate was recorded at 30°C (156.8 and 143.6 eggs /female). Sex ratio was affected by temperature as proportion of female increased. In addition, the values of  $r_m$  and  $\lambda$  increased with temperature increase, while mean generation time (T) and generation doubling time (DT) values decreased with temperature increase, thus the reproduction of mites increased. This mite favored high temperature. The Lacont pear variety was more favored to this mite.

**Key Words:** *Tetranychus urticae*, Development, Life table, Temperature degrees, Pear varieties

### INTRODUCTION

The two-spotted spider mite *Tetranychus urticae* Koch is one of the serious mite pests infesting pear trees. The acarine mite pest *T. urticae* is considered a major economic pest, all stages of this mite, except eggs, are plant eating pests. It reduces the quantity and the quality of the production (Dhooria, 1994; Paternotte, 1998).

The importance of this mite pest is not only due to the direct damage of plants including defoliation, leaf burning and even in excessive outbreaks plant death but also to indirect damage of plants due to the decrease of photosynthesis and transpiration (Brandenburg and Kennedy, 1987). For complexation of such work for serving yield of pear fruit trees from being decreased year after year attention of the most intersecting research workers as specialists in pest control.

The present work introduces in detail the biology and life table of *T. urticae* when fed on the leaves of pear varieties Lacont and Hood under laboratory conditions at constant temperature at 15 , 20 , 25 and 30 °C and 70± 5% R.H.

### MATERIAL AND METHODS

#### (1) Rearing of *Tetranychus urticae* Koch:

A pure culture of *T. urticae* was propagated on two pear varieties. Seedlings were kept at laboratory in the Plant Protection Research Institute. One leaf of each variety of pear trees *Pyrus communis* L. (Lacont and Hood), was taken.

Testing the effect of host plant on the biology of *T. urticae*, the method proposed by Mohamed (1982) was used with some modifications, as one leaflet from the first fully expanding leaf at the top per plant of each variety was taken and then it was well washed with running water to remove any possible residuals or mites which may be

found on these leaves. Leaf discs of about one-inch in diameter were made and surrounded by tangle foot, which acts as a barrier to prevent mite individuals from escaping. These discs were placed on pieces of moisten cotton wool in Petri dishes of 10cm diameter and a couple (male and female) was placed on each disc, on the lower surface of the leaf, for each variety. These Petri dishes were kept at four different temperatures (15, 20, 25 and 30°C ± 2°C and 70 ± 5% R.H. ), for 24 hours to allow mating process between male and female. Thereafter, males were removed, while females served as a source for known-age eggs, which in turn produced known-age larvae. The moisture was kept constant by adding few drops of water to the cotton wool. About 60 hatching larvae were transferred and kept singly to a leaf of each variety and left to continue their life span. Newly emerged females were copulated and left to deposit their eggs. Examination was made twice daily, early in the morning and before sunset. Essential records were noted. To examine sex ratio of *T. urticae*, ten newly emerged females were placed and males were transferred and kept under the same conditions of temperature and R.H. %. From the eggs of each female, 50 eggs (25 eggs after two days and 25 eggs after one week) were deposited during female oviposition period. Eggs were left to develop until the second generation, then the number of males and females were counted for different temperatures and different hosts.

### (2) Life table parameters of the TSSM:

During developmental period, mortalities of different stages and sex ratio of progeny were determined. Oviposition by result at females was recorded daily for each female. Life table parameters were estimated using the Life48, BASIC Computer programmed (Abou-Setta *et al.*, 1986). Parameters were determined by the following formula:  $\max \sum_0 L_x m_x / \exp. r_m^x = 1$

The definitions of the abbreviations were presented by Birch (1948).

### (3) Statistic analysis:

Data were analyzed using Proc ANOVA and mean separation was conducted using Duncan's multiple range test ( $P \leq 0.05$ ). The multiple regression equation ( $Y = a \pm b_1 * \text{Temperature} \pm b_2 * \text{relative humidity}$ ) where  $a$  is the intercept and  $b$  is the slope. These analyses were conducted using SAS statistical software (SAS Institute, 2010).

## RESULTS AND DISCUSSION

The effect of four constant temperature degrees (15, 20, 25 and 30°C) on the biological aspects and demographic parameters ( $R_o$ ,  $G$ ,  $r_m$  and  $\text{expr}_m$ ) of *Tetranychus urticae* Koch was studied in the laboratory under controlled condition ±2°C and ± 5% R.H. .

### A-Developmental time and longevity of *T. urticae* on Lacont pear variety:

Data in Table (1) showed that, the mean incubation period of *T. urticae* decreased as temperature increased. It averaged 11.7, 8.1, 4.6 and 2.8 days for female at 15, 20, 25, and 30°C, respectively. For male it durated 11.5, 7.8, 4.3 and 2.7 days at same degrees of temperature, respectively. The shortest period of life cycle of female and male *T. urticae* was recorded as 6.5 and 6.3 days at 30°C, while the longest period was observed at 15°C as 30.6 and 30.1 days for female and male, respectively. The shortest duration of different stages, generation and life span was observed at 30°C, while the longest were recorded at 15°C. The highest mean fecundity of female was 156.8 egg / ♀ with a daily rate of 13.84 eggs / ♀ / day at

30°C, while the lowest was 43.6 eggs / ♀ with a daily rate of 2.4 eggs / ♀ / day at 15°C.

### B- Developmental time and longevity of *T. urticae* on Hood pear variety:

Obtained results are presented in Table (2). *T. urticae* larvae hatched after a shortest egg incubation period of 2.7 and 2.6 days at 30°C, for female and male respectively. It took the longest duration of 13.6 and 13.4 days at 15°C for female and male respectively. The longest duration of female and male larva, protonymphal and deutonymphal stages were (7.2 & 6.7) , (6.2 & 5.5) and (7 & 6.5) days at 15 °C respectively, while the shortest durations were (1.5 & 1.2) , (1.6 & 1.3) and (1.6 & 1.3) days at 30°C, respectively. Generation period and longevity increased as temperature decreased, the longest generation period was 39.2 days at 15°C, while the shortest period was 8.6 days at 30°C. The longest adult female longevity was observed at 15°C as 25.6 days, while the shortest was 8.2 days at 30°C for male. The highest mean number of eggs laid by female was 143.6 eggs / female with a daily rate of 16.7 eggs /♀/day at 30°C, while the lowest fecundity was 37.4 eggs /♀ with a daily rate of 2.4 eggs /♀/day at 15°C. These findings agree with those of Rishi and Rather (1983) and Takaugi and Kamibayashi (1984).

Table 1: Duration (days) of *Tetranychus urticae* Koch on Lacont Pear variety at constant temperature and relative humidity 70 % ± 5 %.

Developmental stage	15°C		20°C		25°C		30°C		L.S.D.
	F	M	F	M	F	M	F	M	
Incubation period	11.7a	11.5a	8.1b	7.8b	4.6c	4.3c	2.8d	2.7d	0.78
Larva	6.7a	6.8a	2.7b	2.5b	1.8c	1.7cd	1.2d	1.3cd	0.53
Protonymph	5.6a	5.5a	3.3b	2.7c	1.8d	1.5d	1.2d	1.2d	0.58
Deutonymph	6.6a	6.3a	3b	2.9b	1.8c	1.7c	1.3cd	1.1d	0.49
Immature stages	18.9a	18.6a	9b	8.1b	5.4c	4.9c	3.7d	3.6d	1.27
Life cycle	30.6a	30.1a	17.1b	15.9b	10c	9.2c	6.5d	6.3d	1.43
Generation	34.4a		18.6b		11.2c		7.2d		1.48
Pre-Oviposition	3.8a		1.5b		1.2bc		0.7c		0.51
Oviposition	17.5a		19.4b		14.4c		11.4d		1.66
Post-Oviposition	3.7a		1.5b		1.6b		1.3b		0.6
Longevity	25a	21bc	22.4ab	18.8cd	17.2dc	15ef	13.4fg	11g	2.63
Fecundity (eggs/♀)	43.6d		77.4c		109.4b		156.8a		10.35
Daily rate (eggs/♀/day)	2.48d		4c		7.63b		13.84a		1.24
Life span	55.6a	51.1b	39.5c	34.7d	27.2e	24.2e	19.9f	17.3f	3.07

Means in the same row followed by the same letter are not significantly different (P < 0.05).

M= male, F= female

Table 2: Duration (days) of *Tetranychus urticae* Koch on Hood Pear variety at constant temperature and relative humidity 70 % ± 5 %.

Developmental stage	15°C		20°C		25°C		30°C		L.S.D.
	F	M	F	M	F	M	F	M	
Incubation period	13.6a	13.4a	8b	7.7b	5c	4.7c	2.7d	2.6d	0.78
Larva	7.2a	6.7a	3.b2	2.9b	2c	1.9c	1.5cd	1.2d	0.64
Protonymph	6.2a	5.5b	2.c8	2.6c	2.1cd	1.6de	1.6de	1.3e	0.69
Deutonymph	7a	6.5a	3.b3	3.1b	2.3c	2.1cd	1.6de	1.3e	0.62
Immature stages	20.4a	18.7b	9.c3	8.6c	6.4d	5.6de	4.7ef	3.8f	1.55
Life cycle	34a	32.1a	17.b3	16.3b	11.4c	10.3c	7.4d	6.4d	2.25
Generation	39.2a		19.6b		12.8c		8.6d		2.69
Pre-Oviposition	5.2a		2.3b		1.4c		1.2c		0.59
Oviposition	15.6a		16.2a		11.8b		8.6c		1.85
Post-Oviposition	4.8a		2b		1.3c		0.8c		0.66
Longevity	25.6a	22.4b	20.5b	16.6c	14.5d	12.4e	10.6e	8.2f	1.98
Fecundity (eggs/♀)	37.4d		51.4c		101b		143.6a		9.54
Daily rate (eggs/♀/ day)	2.41c		3.18c		8.71b		16.77a		1.29
Life span	59.6a	54.5b	37.8c	32.9d	25.9e	22.7e	18f	14.6f	3.4

Means in the same row followed by the same letter are not significantly different (P < 0.05).

### C- Life table parameters of *T. urticae* under different rearing condition:

Results presented in Table (3) demonstrated that the shortest time for population density doubling (DT) was 2.66 days at 30°C on Hood pear variety, while the longest period was 16 days at 15°C on Hood pear variety too. The daily age-specific survival rates were higher on Lacont than on Hood. The 50% mortality of *T. urticae* occurrence was short as 15.07 days at 20°C on Hood, while the longest was 30.12 days on Lacont at 15°C.

Table 3: Life table parameters of *T. urticae* under different rearing conditions.

Variety	°C	DT <sup>a</sup>	Survival rate	50% mortality <sup>a</sup>	Sex ratio	R <sub>o</sub> <sup>b</sup>	r <sub>m</sub> <sup>c</sup>	λ
Lacont	15	12	0.52	30.12	0.58	11.27	0.05	0.05
	20	5.77	0.49	17.6	0.74	23.89	0.12	1.13
	25	3.46	0.78	18.34	0.70	30	0.20	1.22
	30	3.22	0.93	16.69	0.76	37.67	0.31	1.36
Hood	15	16	0.46	30.7	0.66	7.79	0.04	1.04
	20	9.9	0.47	15.07	0.50	8.71	0.07	1.08
	25	4.33	0.73	20.35	0.60	19.42	0.16	1.18
	30	2.66	0.91	16.00	0.76	27.88	0.26	1.29

<sup>a</sup> Days <sup>b</sup> Per generation <sup>c</sup> Individuals/female/day DT = Time for population double

Temperature affected on sex ratio (female / total) of the mite. The proportion of females in the offspring increased with temperature increase. The maximum value of nature increase (r<sub>m</sub>) and the finite rate of increase (λ) was obtained at 30°C on two targets. Minimum values were obtained at 15°C. The maximum net reproductive rate (R<sub>o</sub>) occurred at 30°C on Lacont. Effect of temperature on the biology of *T. urticae* (reported as r<sub>m</sub>, R<sub>o</sub>, and λ) increased as temperature increased, while DT and generation time decreased with temperature increase (Shih *et al.*, 1976; Wermelinger and Delucchi; 1990; Wermelinger *et al.*, 1990; Bonato 1997; Gotoh, 1997; Cao *et al.*, 1998; Bounfour and Tangoshi, 2001; Gotoh and Gomi, 2003; Tomaso *et al.*, 2007). The daily age-specific survival rate was highest at 15°C and decreased as the temperature increased on the two pear varieties. These results agree with Hoque *et al.*, 2008; Kasap, 2002; Lewis, 1994; Pietrosiuk *et al.*, 2003.

### D- Factorial analysis of obtained biological aspects of *T. urticae*:

This type of analysis considers the effect of each studied factor (i.e. temperature and variety) regardless of other factors.

#### 1- Effect of temperature:

The optimum temperature for development was 30°C followed by 25°C . Significantly differences occurred between all stages at the four levels of temperature. The highest fecundity and daily rate 30°C was 150.1 eggs/ female and 15.30 eggs/♀/day, while the lowest was at 15°C as 40.5 eggs/female and 2.44 eggs/♀/day (Tsai *et al.*, 1989; Liu and Tsai, 1998).

#### 2- Effect of variety:

The duration of all developmental stages on Hood was longer than on Lacont (Table 4). Significant differences were found between developmental periods of mites reared on different varieties.

The generation time, pre-oviposition and post-oviposition on Hood were longer than on Lacont. Significant differences were also found between adult female longevity and oviposition period (Hergstrom and Niall, 1989; Kasap, 2004; Greco *et al.*, 2006). The Lacont variety was more favored to this mite.

Table 4: Factorial analysis of obtained biological aspects of *T. urticae* as affected by temperature and variety.

Factor level		Egg	Larva	Protonymph	Deutonymph	Immature	Life cycle	Generation	Pre-oviposition	Oviposition	Post-oviposition	Longevity	Fecundity	Daily rate	Life span
Variety	Lacont	6.68b	3.08b	2.85a	3.08b	9.02b	15.71b	17.85b	1.80b	15.67a	2.02a	17.97a	96.75a	6.99b	33.68a
	Hood	7.21a	3.32a	2.96a	3.40a	9.68a	16.9a	20.05a	2.52a	13.05b	2.22a	16.35b	83.35b	7.77a	33.25a
Temp.	15°C	12.55a	6.85a	5.70a	6.60a	19.15a	31.70a	36.80a	4.50a	16.55b	4.25a	23.50a	40.5d	2.44d	55.20a
	20°C	7.9b	2.82b	2.85b	3.07b	8.75b	16.65b	19.10b	1.90b	17.8a	1.75b	19.57b	64.4c	3.54c	36.22b
	25°C	4.6c	1.82c	1.75c	1.97c	5.57c	10.22c	12.0c	1.30c	13.1c	1.45bc	14.77c	105.2b	8.17b	25.0c
	30°C	2.7d	1.30d	1.32d	1.32d	3.95d	6.65d	7.9d	0.95c	10.0d	1.05d	10.80d	150.1a	15.30a	17.45d

Means in the same column under the same factor not followed by the same letter are significantly different ( $P < 0.05$  using LSD in SAS).

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## ARABIC SUMMARY

تأثير درجات الحرارة على المظاهر البيولوجية وجداول الحياة للعنكبوت الأحمر العادي علي صنفين من الكمثري

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تم دراسة المظاهر البيولوجية للعنكبوت الأحمر العادي عند تربيته علي صنفين من الكمثري ( ليكونت- هود ) علي درجات حرارة 15 ، 20 ، 25 ، 30 م<sup>5</sup> ورطوبة نسبية 70%. تشير النتائج المتحصل عليها بأن أطول فترة لدورة الحياه هي 30.6 & 30.1 يوما للإناث والذكور علي التوالي وذلك عند درجة حرارة 15 م<sup>5</sup> عند التربية علي أوراق صنف الكمثري اللينونت أما عند التغذية علي أوراق صنف كمثري هود فكانت أطول فترة لدورة الحياه هي 34 & 32.1 يوما للإناث والذكور علي التوالي علي نفس درجة الحرارة، كما سجلت أعلي خصوبة للإناث علي درجة حرارة 30 م<sup>5</sup> حيث بلغت 156.8 & 143.6 بيضة/أنثي وكذلك أعلي معدل للزيادة الذاتي  $r_m$  هو 0,31 ، 0,26 عند صافي معدل تكاثر قدره 37,67 ، 27,88 وأيضا أقصر فترة جيل هي 7,2 ، 8.6 يوما علي صنفي ليكونت ، هود علي التوالي. أما بالنسبة لأطول فترة لتضاعف الجيل Generation doubling سجلت علي 15 م<sup>5</sup> حيث بلغت 12 ، 16 يوما عند تربية العنكبوت الأحمر العادي علي أوراق صنفي ليكونت ، هود علي التوالي. مما سبق يتبين أن الكمثري صنف ليكونت أكثر حساسية للإصابة بالعنكبوت الأحمر العادي من الكمثري صنف هود.