



## Comparative biology and life table parameters of citrus brown mite *Eutetranychus orientalis* (Acari: Tetranychidae) on different grapevine cultivars

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### ARTICLE INFO

#### Article History

Received: 26/ 1/ 2020

Accepted: 27/ 2 /2020

#### Keywords

Biological parameters, temperature, *Eutetranychus orientalis*, grapevine cultivars and *Vitis vinifera*.

### Abstract:

The influence of the three grapevine cultivars king rubi, crimson seedless and thompson seedless on biology and life table parameters of the citrus brown mite *Eutetranychus orientalis* (Klein) (Acari: Acariformes: Tetranychidae) was studied under laboratory conditions of 25 and 30±1°C and 70±5% R.H. The biology of *E. orientalis* consisted of egg, larvae, protonymph, deutonymph and adult stages. The total duration of female from egg to adult was found to be the least in king rubi (16.4 and 8.3 days) followed by thompson seedless (10.02 and 9.53 days) and maximum in crimson seedless (19.18 and 10.18 days) at 25 and 30°C, respectively. The highest fecundity was 35.4 and 29.8 eggs/ female on king rubi and the lowest fecundity was 26.6 and 23.4eggs/ female on crimson seedless at 25 and 30°C, respectively. The higher values of net reproductive rate ( $R_0$ ), intrinsic rate of increase ( $r_m$ ), finite rate of increase ( $\lambda$ ) the shortest mean generation time (T) was observed in king Rubi followed by thompson Seedless and crimson seedless. The results suggested that king rubi was the most suitable variety with higher survival rate of mites, shortest development time and higher fecundity while crimson seedless was the least suitable variety because of the lowest survival rate, longest development period and lower fecundity.

### Introduction

The grapevine, *Vitis vinifera* L. is an important commercial fruit crop in Egypt. In Egypt, grape occupies the second ranked fruit after citrus and it has a great importance and plays an important role in the agricultural economy (Abido

*et al.*, 2013). The total grapevine area in Egypt reached 778,950 hectares with an annual production of 1.703 million tons with an average of about 9.2 tons per feddan. In Gharbia Governorate, it occupies an area of about 10435 feddan

with annual production of 93722 tones according to the statistics of FAO (2017).

The citrus brown mite *Eutetranychus orientalis* (Klein) (Acari: Acariformes: Tetranychidae) is an important pest of citrus and is a persistent pest in Upper Egypt. It also infests a wide range of hosts including deciduous fruit trees, filed crops and ornamental plants. This tetranychid mite mostly feeds on the upper leaf surface, although feeding could extend to the lower leaf surface at high population levels. Damage in host plants is shown by a bronze tone on the leaves, which was shown to be associated with the rates of oviposition and female production (Jeppson *et al.* 1975; Zaher, 1984 and Elhalawany, 2019).

Despite the economic importance of grapevines in Egypt and the damage of phytophagous mites cause to them. Very little information is available on this pest though it is a polyphagous mite occurring on several cultivated plants all over Egypt. Thus, the aim of this study was to compare the effect of different grapevine cultivars and temperature on the biology and life table parameters of *E. orientalis*.

### **Materials and methods**

The field experiment was carried out at Gemmeiza Station, Gharbia Governorate during season 2019.

#### **1.Mite culture:**

The first population of *E.orientalis* was collected from infested grape, *V. vinifera* . The stock culture was maintained on grapevine leaves in a rearing chamber at 25 ±2oc; 70 ± 5% RH.

#### **2.Development and biology of *Eutetranychus orientalis* at different temperatures:**

Experiments were conducted on king rubi, crimson seedless and thompson seedless varieties leaf discs at 25 and 30 ± 1 °C and 70 ± 5% RH. One leaflet from each variety was chosen and washed with

running water to remove any possible residuals or mites. Leaf discs of about 2.5cm in diameter were made surrounded by tangle foot and placed lower surface down on of moisten cotton wool in Petri dishes of 15-cm diameter. Ten individuals of *E.orientalis* couple (male and female) were placed on each disc, for each variety. These petri dishes were kept at two temperatures, for 24 hours to allow mating, thereafter, males were removed, while female served as a source for known-age eggs, and larvae. About 50 hatching larvae were kept singly using a fine camel hair brush and released over the leaf discs and left to continue their life span, for each variety. The leaf discs were replaced at regular intervals before they dried out. Newly emerged females were copulated and left to deposit their eggs. Observation was conducted twice daily and essential records were noted. The observations on the survival and development of each life stage of mites were recorded. This method was proposed by (Elhalawany, 2019; and Elhalawany and Abdel-Wahed, 2013).

#### **3. Life table parameters of the *Eutetranychus orientalis* :**

The adult females emerged were collected and released over the leaf discs of the respective ciltivars for feeding and oviposition. The number of eggs laid, survival and fecundity by a female were recorded till the death of the last female. Life table parameters were estimated according to (Birch, 1948) using the Life 48, BASIC Computer program (Abou-Setta *et al.*, 1986).

#### **4. Statistical analysis:**

Data were statistically analyzed using one-way and two-way analysis of variance ANOVA and mean separation was conducted using Duncan's multiple range test ( $P \leq 0.05$ ). These analyses

were conducted using SAS statistical software (SAS Institute, 2003).

## Results and discussion

### 1. Developmental time and longevity at 25°C:

The life cycle of the citrus brown mite *E. orientalis* is completed and passed through four developmental stages with quiescence stages at the end of larval and nymphal stages. The duration of different developmental stages of *E. orientalis* on leaves of three grape cultivars: king rubi, thompson seedless and crimson seedless at 25°C and 70% RH. is presented in Table (1). There is significant difference between the three varieties during egg incubation period of female and male. Female incubation period was 6.20, 6.72 and 6.90 days and male incubation period was 5.95, 6.70 and 6.60 days on king rubi, thompson seedless and crimson seedless, respectively. Statistical analysis indicated that significant differences were found between the three rearing varieties. The shortest female larva, protonymphal, deutonymphal stages, total immature stages, life cycle and generation period

were 3.4, 3.5, 3.3, 10.2, 16.4 and 18.2 days at 25°C on king rubi variety; while the longest were 4.13, 3.95, 4.2, 12.28, 19.18 and 21.38 days on crimson seedless variety, respectively.

The longevity of adult female *E. orientalis* and the length of the oviposition, and post-oviposition periods differed significantly between the three grape varieties. The longest oviposition period was observed on king rubi was 13.0 days and the shortest period on crimson seedless was 9.7 days with significant differences. The king rubi had the highest longevity 16.75 and 11.95 days, while the lowest longevity was recorded on crimson seedless 13.40 and 10.20 days, for female and male, respectively at 25°C. The highest mean number of eggs laid by female was 35.4 eggs/female with a daily rate of 2.78 eggs/♀/day on King Rubi while, the lowest fecundity was 26.60 eggs/♀ on crimson seedless with a daily rate of 2.74 eggs /♀/day at 25°C. No significant differences between female and male life span on three hosts at 25°C.

Table (1): Mean developmental times and longevity in days of *Eutetranychus orientalis* females and males reared on selected cultivars at 25°C.

Biological aspects	Mean duration of female stages			L.S.D at 0.05	Mean duration of male stages			L.S.D at 0.05
	King Rubi	Thompson Seedless	Crimson Seedless		King Rubi	Thompson Seedless	Crimson Seedless	
Egg	6.20 b	6.72 a	6.90 a	0.37	5.95 b	6.70 a	6.60 a	0.62
Larva	3.40 b	3.70 b	4.13a	0.41	3.15 b	3.45 b	4.15 a	0.53
Protonymph	3.50 b	3.83 ab	3.95 a	0.39	3.40 a	3.65 a	3.80 a	0.53
Deutonymph	3.30 b	3.78 a	4.20 a	0.45	2.95 b	3.25 ab	3.60 a	0.59
Immature	10.20 c	11.30 b	12.28 a	0.62	9.50 b	10.35 b	11.55 a	0.98
life cycle	16.40 c	18.02 b	19.18 a	0.71	15.45 b	17.05 a	18.15 a	1.21
Generation	18.20 c	20.12 b	21.38 a	0.74	-	-	-	-
Preoviposition	1.80 a	2.10 a	2.20 a	0.39	-	-	-	-
Oviposition	13.00 a	10.85 b	9.70 c	0.87	-	-	-	-
Postoviposition	1.95 a	1.70 ab	1.50 b	0.26	-	-	-	-
Longevity	16.75 a	14.65 b	13.40 c	1.04	11.95 a	10.75 b	10.20 b	1.15
Fecundity	35.40 a	31.00 b	26.60 c	2.93	-	-	-	-
Daily rate	2.78 a	2.89 a	2.74 a	0.32	-	-	-	-
Life span	33.15 a	32.67 a	32.58 a	1.16	27.40 a	27.80 a	28.35 a	1.76

The means with the same letters at the same row are not significantly different at 0.05% level.

## 2. Developmental time and longevity at 30°C:

Data as shown in (Table, 2) indicated that significant differences between the three grape cultivars at 30°C. All female and male immature stages developed faster on king rubi than on thompson seedless and crimson seedless. Significant difference was observed for the duration of incubation period, larva, protonymph, deutonymph, immature stages and life cycle, the shortest period were recorded on king rubi and the longest periods were found on crimson seedless at 30°C. The shortest generation time of the *E. orientalis* fed on king rubi was (9.30 days) and significantly shorter than of those fed on

crimson seedless was (12.0 days) at 30°C.

The female longevity was longest on king rubi (14.25 days), followed by thompson seedless (13.43 days), and was shortest on crimson seedless (12.33 days) with significant differences. A similar trend was observed for males the longest on king rubi (10.40 days), followed by thompson seedless (10.3 days), and was shortest on crimson Seedless (9.0 days).

Significant differences were found in fecundity the highest being in those fed on, king rubi 29.8 eggs/♀, followed by those fed on thompson seedless 26.4 eggs/♀, while the lowest fecundity was 23.4 eggs/♀ fed on crimson seedless at 30°C (Table, 2).

**Table (2): Mean developmental times and longevity in days of *Eutetranychus orientalis* females and males reared on selected cultivars at 30°C.**

Biological aspects	Mean duration of female stages			L.S.D at 0.05	Mean duration of male stages			L.S.D at 0.05
	King Rubi	Thompson Seedless	Crimson Seedless		King Rubi	Thompson Seedless	Crimson Seedless	
<b>Egg</b>	4.15 b	4.25 b	4.60 a	0.30	3.80 a	3.90 a	3.80 a	0.33
<b>larva</b>	1.50 b	1.80 a	1.98 a	0.18	1.15 b	1.60 a	1.50 ab	0.37
<b>Protonymph</b>	1.38 b	1.75 a	1.85 a	0.23	1.25 a	1.40 a	1.60 a	0.39
<b>Deutonymph</b>	1.28 b	1.73 a	1.75 a	0.21	1.25 a	1.30 a	1.50 a	0.36
<b>Immature</b>	4.15 b	5.28 a	5.58 a	0.32	3.65 b	4.30 ab	4.60 a	0.70
<b>life cycle</b>	8.30 c	9.53 b	10.18 a	0.40	7.45 b	8.20 a	8.40 a	0.73
<b>Generation</b>	9.30 b	11.63 a	12.00 a	0.47	-	-	-	-
<b>Preoviposition</b>	1.00 b	2.10 a	1.83 a	0.34	-	-	-	-
<b>Oviposition</b>	11.80 a	10.00 b	9.40 b	0.82	-	-	-	-
<b>Postoviposition</b>	1.45 a	1.33 ab	1.10 b	0.32	-	-	-	-
<b>longevity</b>	14.25 a	13.43 ab	12.33 b	1.10	10.40 a	10.30 a	9.00 b	1.25
<b>Fecundity</b>	29.80 a	26.40 b	23.40 c	2.22	-	-	-	-
<b>Daily rate</b>	2.55 a	2.65 a	2.49 a	0.18	-	-	-	-
<b>Life span</b>	22.55 a	22.95 a	22.50 a	1.13	17.85 a	18.50 a	17.40 a	1.66

The means with the same letters at the same row are not significantly different at 0.05% level.

These results are agreement with finding by Atwa *et al.* (1987) who indicated that at 30°C, egg incubation period and immature stage development period and adult longevity were 3.57, 10.0 and 7.36 days, respectively. The egg to adult developmental time of the female was 12.43 days at 30°C. The longevity of the female ranges from 16.57 days at 20°C to 7.50 days at 30°C. The fecundity ranges from 14.56 to 16.33 eggs per female, and the sex ratio is 75–80% female. Al-Gboory (1991) found that developmental time of *E. orientalis* was 11.85 days on mandarin at 28 oc. The mean longevity of females was 8.75 days, whereas the female produced only 5 eggs during oviposition period. Assari (2001) reported that *E. orientalis* life span at 28 oc and 20 % relative humidity was 5 days for males and 8 days for females. These results are lower than those recorded by Elhalawany and Abdel-Wahed (2013) indicated that the reproduction, survival, and life table parameters of *T. urticae* on kostata and hachiya persimmon cultivars leaves were studied under laboratory conditions of 15, 20, 25 and 30°C, 70% RH. The shortest period of incubation, immature stages and female longevity were 3.27, 8.92 and 12.98 days, while these periods on males were 3.35, 7.8 and 11.8 days at 30°C on kostata persimmon variety, respectively. Elhalawany (2019) who studied the biology of *E. orientalis* on leaves of six host plants. The highest life cycle was 19.95 and 9.38 and 19.31 and 9.8 days for male and female on date palm at 25 and 30°C, while, the lowest value of this period was obtained on castor bean were 16.45 and 16.75 days for male and female at 25°C and 6.31 and 8.43 days for male and female at 30°C on Indian laburnum, respectively. Mean longevity of female *E. orientalis* ranged from 13.53 to 15.13 days at 25°C and

from 9.9 to 16.9 days at 30°C. The highest mean total fecundity was 19.45 and 14.1 eggs/ female on Indian laburnum and castor bean at 25 and 30°C, respectively.

### 3.Life table parameters of *Eutetranychus orientalis* on grape cultivars:

Results presented in Table (3) showed that, the shortest mean generation time ( $T_c$ ) was observed on king rubi was 21.63 and 13.12 days, while the longest were 23.51 and 14.39 days recorded on crimson seedless at 25 and 30°C, respectively. Whereas, the shortest time for population density doubling (DT) was 4.81 and 3.22 days at 25 and 30°C on king rubi variety while the longest period was 6.03 and 4.03 days at 25 and 30°C on crimson seedless cultivar.

The maximum net reproductive rate ( $R_o$ ) occurred at 25°C on king rubi recorded 22.56 individuals/ generation, followed by on thompson seedless was 18.46 individuals/ generation, while the lowest value on crimson seedless was 14.39 individuals/generation at 30°C.

The maximum intrinsic rate of natural increase ( $r_m$ ) the difference between birth rate and death rate was obtained at temperature of 30°C whereas, the lowest values were recorded at 25°C. These values were 0.144 and 0.215; 0.127 and 0.193 and 0.115 and 0.172 individuals/♀/day at 25 and 30°C on king rubi, thompson seedless and crimson seedless, respectively.

The finite rate of increase ( $\lambda$ ) ranged from 1.12 offspring/ individual/day at 25°C on crimson seedless to 1.24 offspring/ individual/day at 30°C on king rubi cultivar. Gross reproduction rate (GRR) recorded the highest value at 25°C on king rubi was 28.3 eggs/ individual and the lowest value 17.9 eggs/ individual on crimson

seedless. The sex ratio ranged from 0.7 to 0.75 female/ total not affected by temperature and host plant Table (3).

Table (3): Life table parameters of *Eutetranychus orientalis* under different temperatures.

Parameter	King Rubi		Thompson Seedless		Crimson Seedless	
	25°C	30°C	25°C	30°C	25°C	30°C
Mean generation time ( $T_0$ ) <sup>a</sup>	21.63	13.12	22.84	13.95	23.51	14.39
Doubling time (DT) <sup>a</sup>	4.81	3.22	5.45	3.59	6.03	4.03
Net reproductive rate ( $R_0$ ) <sup>b</sup>	22.56	16.81	18.46	14.79	15.24	14.39
Intrinsic rate of increase ( $r_m$ ) <sup>c</sup>	0.144	0.215	0.127	0.193	0.115	0.172
Finite rate of increase ( $\lambda$ ) <sup>c</sup>	1.15	1.24	1.13	1.21	1.12	1.18
Gross reproduction rate (GRR) <sup>b</sup>	28.3	24.2	25.2	22.9	20.2	17.9
Survival rate %	0.85	0.77	0.8	0.75	0.77	0.73
Sex ratio ( $\varphi$ /total)	0.75	0.70	0.72	0.72	0.70	0.70

<sup>a</sup> Days <sup>b</sup> per generation <sup>c</sup> Individuals/female/ day

Age specific survivorship ( $l_x$ ) and fecundity ( $m_x$ ) curves for *E. orientalis* are shown in Figure (1). The daily age-specific survival rate was highest at 25oc and decreased as the temperature increased on three host plants. The maximum number of eggs produced on thompson seedless was at 25oc (day 22: 2.92 egg/ $\varphi$ /day), the lowest value was obtained at 30oc (day 13: 2.38 egg/ $\varphi$ /day) on crimson seedless. The highest survival rate of females was 0.85 % on king rubi at 25°C, while lowest value was 0.73% on crimson seedless at 30°C.

These results agree with that of Imani *et al.* (2009) found that the mean generation time (T) is 22.83 days, the net reproductive rate ( $R_0$ ) is 154.08 and the intrinsic rate of increase ( $r_m$ ) is 0.221. The intrinsic rate of increase ( $r_m$ ) ranges

from 0.144 at 30°C to 0.094 individuals per female daily at 20°C. The population doubles in 4.79 days at 30°C and in 7.33 days at 20°C. Sangeetha *et al.* (2013) reared *E. orientalis* on neem leaf discs at 35°C, development times from egg to adult stage were 9.48 days, oviposition period averaged 7.7 days and Fecundity averaged 30.1 eggs/ female. Elhalawany (2019) indicated that the highest intrinsic rate of increase ( $r_m$ ) was 0.143 on Indian laburnum at 25°C and 0.138 (individuals/ female/ day) on castor bean at 30 oc. The individuals had the ability to double with the shortest time at 30oc (4.81 days) on Indian laburnum and the longest time at 25 °C (12.38 days) on date palm. The mean generation time (T) and generation doubling time (DT) values decreased with temperature increase.

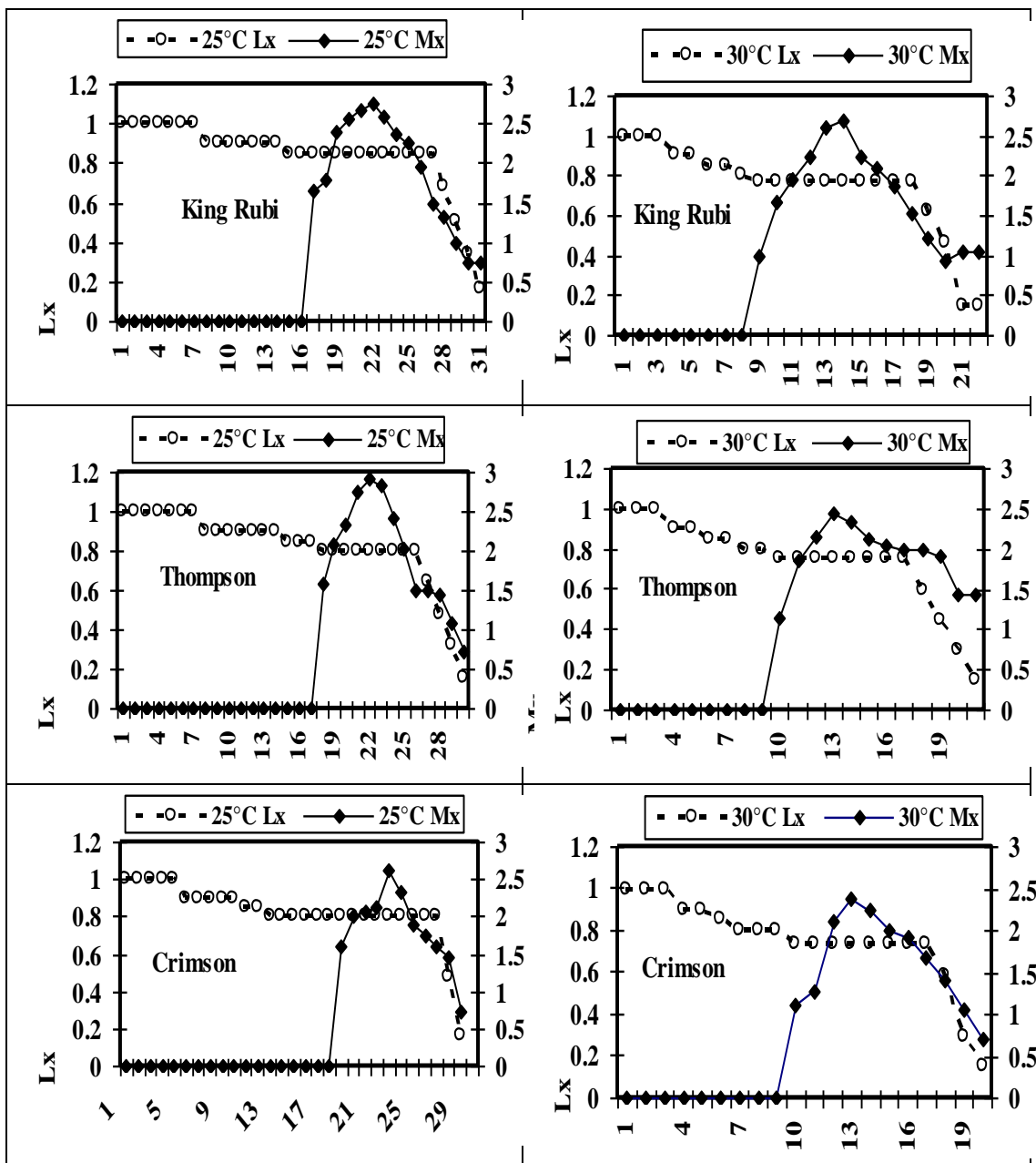


Figure (1): Age specific survivorship ( $L_x$ ) and age specific fecundity ( $M_x$ ) for *Eutetranychus orientalis* on grape varieties and two different temperatures.

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