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Influence of Some Host Plants and Temperature on Biological Aspects of the Citrus Brown Mite, *Eutetranychus orientalis* (Klein) (Acari: Actinedida: Tetranychidae)

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Abstract

The citrus brown mite (CBM), *Eutetranychus orientalis* (Klein, 1936) is a key pest of citrus, date palm, filed crops and ornamentals. Development time, reproduction and life table parameters of *E. orientalis* were studied on leaves of six host plants: castor bean, date palm, Indian laburnum, mulberry, plum and sweet potato under laboratory conditions of 25 and 30±2°C; 65±5% R.H. and photoperiod of 16L: 8D. Results indicated that the highest life cycle was 19.95& 9.38 and 19.31& 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& 16.75 days for male and female at 25°C, and 6.31& 8.43days 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 25ºC, and from 9.9 to 16.9 days at 30ºC. 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. The sex ratio % (female/ total) ranged from 65 to 76%. The highest intrinsic rate of increase (r_m) was 0.143 on Indian laburnum at 25ºC 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 ºC (12.38 days) on date palm. The mean generation time (T) and generation doubling time (DT) values decreased with temperature increase. This mite favored high temperature; castor bean and Indian laburnum were more favorable hosts than others.

Key words: Biology, life table, Temperature, *Eutetranychus orientalis*, host plants.

Introduction

Eutetranychus orientalis (Klein) commonly known as oriental red mite, citrus mite and citrus brown mite was described by Klein (1936) under the name *Anychus ricini*. *E. orientalis* is an important pest of citrus and is a persistent pest in Upper Egypt. It also infests a wide variety of other crops including apple, peach, grape, guava, papaya, date palm, grapevines, quince, cotton, eggplant, cucurbits and a variety of ornamentals. The mites colonize the upper side of leaves where they feed, and their damage develops as yellow-grey stippled spots which cause leaf wilting and drop. Heavy infestations can cause fruit drop and the death of upper branches, and next-years blossoming may be severely affected. All active stages of the mite cause damage **(Rasmy, 1977; Jeppson *et al.* 1975; Zaher, 1984, Elhalawany, 2001, El-Halawany *et al.* 2001, Abdelgayed *et al.* 2017)**.

Comparing the life table parameters is the most suitable method to study the effect of host plant on mite suitability. Several studies on the biology of spider mites on their host plants have been published thus far **(Al-Gboory, 1991, Assari, 2001, Dingxu *et al.* 2006, Imani and Shishehbor, 2009 and Sangeetha *et al.* 2013)**

The objective of this study was to study the effect of different host plants and temperature on the biology and life table parameters of *E. orientalis*, under laboratory conditions. The obtained data of these experiments were used to understand the mechanism of population build-up of mite, *E. orientalis* on different hosts.

Material and methods

Mite collection:

Experiments were conducted at Qaha Agriculture Research Station (ARC), Qalyubia governorate, Egypt. Six test plants were used for studied the biological aspects of citrus brown mite, *E. orientalis* on castor bean (*Ricinus communis* L.), date palm (*Phoenix dactylifera* L.), Indian laburnum (*Cassia fistula* L.), mulberry (*Morus alba* L.), plum (*Prunus domestica* L.), sweet potato (*Ipomoea batatas* L.).

Biological study of citrus brown mite *E. orientalis:*

Laboratory colonies of *E. orientalis* were collected from infested castor bean plants Qaha Agriculture Research Station (ARC), Qalyubia governorate, Egypt in June 2017. Seeds of castor bean plants were planted in pots containing soil and leaf compost. After suitable growth, plants were infected with *E. orientalis*. The stock colony was maintained in small greenhouse 5X5m^2. After several generations, mites from the stock colony were used for the tests. The identity of Identification of *E. orientalis* was conducted using the key given by (**Krantz and walter, 2009, Zaher, 1984)**. The

specimens were deposited in the (PPRI- ARC) Plant Protection Research Institute, Giza, Egypt.

Rearing *E. orientalis* on leaf of different host plants:

The study of the mite life cycle was carried out on six previous mentioned plants at 25 and 30±2°C, 65±5% R.H, and photoperiod of 16L: 8D. Six holes (2 cm diameter) were opened in a Petri dish (15 cm diameter) plastic cover. Small other holes in the cover were made to provide water with the help of a medical syringe. Six discs of six different host plants (leaves) (2.5 cm.) were put on cotton piece in Petri-dish. All leaves were placed ventral-side up. Discs were replaced when needed to maintain the level of nutrition and vitality, A piece of cotton dampened with water put between the cover plate and around the edges of the disk and painted with vaseline to prevent mites escape. About 50 pairs of newly molted females and males from the stock culture were introduced each to a leaf disc. After mating on the leaves in the laboratory, females were allowed to lay eggs for 12-h periods. One egg was transferred for each disc using a brush 00 and up to 30 replicates were made for each treatment. Petri dishes were examined twice daily to record the different developmental stages. This method was proposed by **(Elhalawany, 2013)**.

To study the parthenogenesis the first 10 quiescent female deutonymphs that molted to females and laid their first batch of eggs. Observation these eggs to complete life cycle of the individual mites were traced for mated females and virgin females.

During developmental period, mortalities of different stages and sex ratio of progeny were specified. Oviposition by result at females was recorded daily for each female. Life table parameters were estimated according to **(Birch 1948)** using the Life48, BASIC Computer programmed **(Abou-Setta *et al.* 1986)**. Parameters were determined by the following formula:

$$\max \Sigma_0 \, Lx \, m \, x / \exp. \, r_m \, x = 1$$

Where "m_x" is the number of daughters produced per female during the interval "x". "L_x" is the fraction of lively females at age "x". The values of "r_m" is a natural logarithm of the intrinsic rate of increase and indicates the number of times of population multiplication in a of time unit. The net reproductive rate (R_0) is the mean for female multi-placation in one generation (. "T" is the mean length of generation period, expressed in days, while DT means time of population to double, and "GRR" means Gross reproduction rate calculated. These definitions were presented by **Birch (1948)**. $R_0 = \Sigma(lx \times m_x)$; $T = \Sigma(x \times l_x \times m_x) / \Sigma(l_x \times m_x)$; $r_m = Ln (R_0)/T$; $DT = Ln (2)/ r_m$, $\lambda = \exp(r_m)$ and $GRR = \Sigma mx$.

Statistic 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

Developmental time and longevity

The life cycle of citrus brown mite, *E. orientalis* is completed and passed throughfour developmental stages with quiescence stages at the end of larval and nymphal stages. The development times of immature stages of (CBM) are given in Tables (1, 2, 3 and 4). Development time decreased as temperature increased for both females and males. Generally development times were shorter for males than females.

Significant differences for each stage were found between the mean developmental times at the different temperatures and host plants. Obtained results presented in (Tables 1&2). Differences between the incubation periods of females were small. Significant differences were found between the six rearing plant hosts. The shortest female incubation period, larva, protonymphal, deutonymphal stages, total immature stages and life cycle were 6.68, 3.6, 3.23, 10.08 and 16.75 days at 25°C on castor bean; while the longest were 7.29, 4.33, 3.95, 3.75, 12.03 and 19.31 days on date palm; respectively. The longest developmental time of immature stages of male were 11.7 & 11.75 days on date palm and mulberry at 25°C; while the shortest were 9.75, 10 and 10.15 days at 25°C on castor bean, Indian laburnum and sweet potato; respectively. There were non-significant differences between incubation period, larva and deutonymphal stages of males reared on six host plants Table (2).

Female longevity of *E. orientalis* ranged from 13.53 to 15.13 days at 25ºC; while life span ranged from 31.35 to 33.35 days. Whereas, male longevity and life span ranged from 11.65& 29.1 to 13& 31.6 days at 25ºC, respectively (Tables 1&2).

Applying the same tests as shown in (Table 3&4) indicated that differences between the six plant hosts were small at 30°C. All female and male immature stages developed faster on Indian laburnum, but slowed on date palm and mulberry. The female longevity was longest on castor bean (16.9 days), followed by Indian laburnum (14.5 days), and were shortest on date palm, mulberry and plum (10.6, 9.9 and 10 days), respectively. A similar trend was observed for both female and males. The female life span ranged from 19.03 to 25.6 days, while the male life span ranged from 17.94 to 25.38 days.

Adult female generation, longevity and fecundity

The emergence of females after moulting immediately followed copulation and active feeding prior to the beginning of oviposition. Males either wandered actively, searching for females for mating. Mated females of *E. orientalis* ovipositor eggs which

developed into both males and females. On the other hand, the eggs deposited by virgin females forever developed into males only this phenomenon is called Arrhenotoky female these observations are in agreement with **Sangeetha *et al.* 2013**.

The aforementioned results in (Table 5) clarified that generation time (from egg to egg) of the (CBM) fed on castor bean, Indian laburnum and sweet potato were the shortest and significantly shorter than of those fed on date palm and mulberry at 25 and 30°C.

Significant difference was observed for the duration of pre-oviposition, oviposition and post-oviposition periods. The shorter periods were recorded on castor bean, Indian laburnum and the longest periods were found on date palm and mulberry at 25 and 30°C (Table 5).

E. orientalis female deposits eggs singly in a linear fashion on the upper leaf surface, mostly along the midrib near the lateral veins. Significant differences were found in fecundity the highest being in those fed on, Indian laburnum 19.45eggs/♀, followed by those fed on castor bean 18.2eggs/♀, while the lowest fecundity was 8.15eggs/♀ fed on date palm at 25°C. Similar results was recorded at 30°C the highest fecundity found on castor bean followed by Indian laburnum and the lowest number obtained when mite fed on date palm. In addition, the daily rate of female has significant affected by host plant the highest rate when female fed on castor bean, Indian laburnum were 1.66 and 1.78 eggs/♀/ day at 25°C, while the highest values at 30°C were 1.63 and 1.56 eggs/♀/ day when mite fed on plum and mulberry, respectively.

The obtained results are in harmony with that detected by **Siddig and Elbadry, 1971** who study the biology of *E. sudanicus* Elbadry on citrus, results indicated that the incubation period averaged 5.7 and 4.3; larval period 3.7 and 2.9; protonymphal period 2.4 and 1.7; deutonymphal female period 2.7 and 2.2; and deutonymphal male period 2.4 and 2.0 days, in winter and summer, respectively. The pre-oviposition, oviposition, and post-oviposition periods averaged 2.4 and 1.0, 12.2 and 10.4, and 3.0 and 2.4 days, in winter and summer, respectively. **Atwa *et al.* 1987** 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. **Badii *et al.* 2003** found that the durations of *E. banksi* for pre-oviposition, oviposition and post-oviposition periods, as well as adult longevity, decreased with rising temperature in the range of 25-30°C. With the exception of the pre-oviposition period, temperature of 20°C had an opposite effect on the durations of the remaining adult phases.

The mean total and mean daily fecundities generally but irregularly declined with ascending temperatures. The influence of host species of deciduous fruit trees, like apple, peach, plum, cherry and apricot, on the development and reproduction of the hawthorn spider mite *Tetranychus viennensis* Zacher in the laboratory . They indicated that plum might be the best suitable plant for the spider mite among the plants tested due to shorter developmental period and higher intrinsic rate of increase, whereas cherry and apricot were least suitable due to their long developmental duration and low intrinsic rates of increase **(Dingxu *et al.* 2006). Imani and Shishehbor, 2009** studied the life history of *E. orientalis* on Lebbek tree at four constant temperatures (20°, 25°, 30° and 35°C). Developmental time of female from egg to adult ranged from 22-32 days at 20°C to 12.43 days at 30°C. Mean longevity of female ranged from 16.57 days at 20°C to 7.50 days at 30°C. Mean total fecundity ranged from 14.56 to 16.33 eggs/ female. These results are lower than those recorded by **Abdel-Wahed and Elhalawany, 2012** they denoted that the effect of temperature and host plant on biological aspects of *Tetranychus urticae* Koch. 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). In the next year, **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.

Factorial analysis of obtained biological aspects of *E. orientalis*

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

Table 1. Mean developmental times in days (± SD) of *E. orientalis* females reared on different host plants at 25ºC

Host plant	Egg	Larva	Protonymph	Deutonymph	Immature stages	Life cycle	Longevity	Life span
Date palm	7.29±0.9 a	4.33±0.75 a	3.95±0.71 a	3.75±0.87 a	12.03±1.68 a	19.3±1.73 a	13.53±1.2 c	32.84±1.6 ab
Mulberry	7.0±0.71 ab	4.20±0.66 ab	3.85±0.76 a	3.65±0.78 ab	11.70±1.37a	18.7±1.86 ab	14.65±1.9 ab	33.35±1.9 a
Plum	6.78±0.85 ab	3.80±0.62 bc	4.15±0.93 a	3.50±0.56 ab	11.45±1.32 a	18.23±1.5 bc	14.83±1.4 ab	33.05±2.7 ab
sweet potato	6.93±0.83 ab	3.55±0.60 c	3.35±0.54 b	3.48±0.57 ab	10.38±1.04 b	17.3±1.41 dc	14.05±1.3 bc	31.35±2.3 c
Indian laburnum	6.78±0.80 ab	3.53±0.70 c	3.30±0.68 b	3.48±0.62 ab	10.30±1.32 b	17.08±1.53 d	15.13±1.1 a	32.2±2.4 abc
Castor bean	6.68±0.69 a	3.60±0.64 c	3.23±0.69 b	3.25±0.68 b	10.08±0.99 b	16.75±1.03 d	15.00±1.6 ab	31.75±2.3 bc
F-value	1.50	5.53	5.86	1.24	8.15	8.60	3.73	2.69
Probability	0.1953	0.0001	0.0001	0.2944	0.0001	0.0001	0.0036	0.0244
LSD at 5%	0.50	0.41	0.45	0.43	0.81	0.96	0.89	1.33

The means are followed by different letters in the same columns are significantly divergent ($P < 0.05$, Duncan).

Table 2. Mean developmental times in days (± SD) of *E. orientalis* males reared on different host plants at 25ºC

Host plant	Egg	Larva	Protonymph	Deutonymph	Immature stages	Life cycle	Longevity	Life span
Date palm	6.8±0.92 a	4.2±0.67 a	3.9±0.61 a	3.6±0.91 a	11.7±1.55 a	19.95±2.25 a	11.65±1.29 b	31.6±2.14 a
Mulberry	6.6±0.74 a	4.2±0.66 a	3.85±0.78 ab	3.7±0.79 a	11.75±1.4 a	18.35±1.68 b	12.1±1.45 ab	30.45±2.7 ab
Plum	7.0±0.82 a	3.65±0.63 a	3.55±0.6 abc	3.5±0.71 a	10.7±1.11 ab	17.7±1.23 bc	13±1.25 a	30.7±1.55 ab
sweet potato	6.6±0.52 a	3.75±0.82 a	3.2±0.48 c	3.2±0.48 a	10.15±1.16 b	16.75±1.4 c	12.5±0.97 ab	29.25±1.7 b
Indian laburnum	6.8±0.43 a	3.55±0.72 a	3.3±0.54 bc	3.15±0.53 a	10±0.78 b	16.8±0.75 c	12.3±0.82 ab	29.1±0.97 b
Castor bean	6.7±0.54 a	3.55±0.55 a	3±0.58 c	3.2±0.59 a	9.75±0.79 b	16.45±1.07 c	12.9±1.45 a	29.35±1.7 b
F-value	0.49	2.00	3.58	1.21	5.58	8.03	1.70	2.82
Probability	0.7787	0.0935	0.0072	0.3181	0.0003	0.0001	0.1503	0.0245
LSD at 5%	0.61	0.64	0.54	0.62	1.04	1.32	1.10	1.69

The means are followed by different letters in the same columns are significantly divergent ($P < 0.05$, Duncan).

Table 3. Mean developmental times in days (± SD) of *E. orientalis* females reared on different host plants at 30ºC

Host plant	Egg	Larva	Protonymph	Deutonymph	Immature stages	Life cycle	Longevity	Life span
Date palm	4.70±0.66 a	2.13±0.78 a	1.50±0.32 a	1.48±0.3 ab	5.10±0.93 a	9.80±0.92 a	10.60±1.34 d	20.40±1.71 c
Mulberry	4.65±0.71 a	1.93±0.63 ab	1.58±0.47 a	1.63±0.48 a	5.13±0.96 a	9.78±1.33 a	9.90±1.28 d	19.68±1.94 c
Plum	4.73±0.62 a	1.50±0.32 c	1.33±0.34 a	1.48±0.38 ab	4.30±0.71 b	9.03±1.01 b	10.00±0.9 d	19.03±1.28 c
sweet potato	4.43±1.03 ab	1.70±0.41 ab	1.55±0.51 a	1.50±0.51 ab	4.75±0.73ab	9.18±1.08 ab	12.75±2.65 c	21.93±2.88 b
Indian laburnum	4.18±0.92 ab	1.98±0.55 ab	0.98±0.34 b	1.30±0.44 b	4.25±0.94 b	8.43±1.02 b	14.50±2.75 b	22.93±2.49 b
Castor bean	4.08±0.96 b	1.50±0.32 c	1.58±0.41 a	1.55±0.51 ab	4.63±0.93 ab	8.70±1.07 b	16.90±1.46 a	25.60±2.05 a
F-value	2.28±	4.86	6.82	1.18	3.73	5.07	45.78	26.31
Probability	0.051	0.0005	0.0001	0.3229	0.0036	0.0003	0.0001	0.0001
LSD at 5%	0.52	0.33	0.25	0.27	0.54	0.69	1.17	1.33

The means are followed by different letters in the same columns are significantly divergent ($P < 0.05$, Duncan).

Table 4. Mean developmental times in days (± SD) of *E. orientalis* males reared on different host plants at 30ºC

Host plant	Egg	Larva	Protonymph	Deutonymph	Immature stages	Life cycle	Longevity	Life span
Date palm	3.81±0.37 a	3.00±0.53 a	1.25±0.27 b	1.31±0.26 a	5.56±0.78 a	9.38±0.95 a	8.56±1.12 d	17.94±1.68 c
Mulberry	3.56±0.5 a	2.19±0.53 bc	1.31±0.26 b	1.50±0.27 a	5.00±0.6 ab	8.56±0.86 a	10.13±1.41 d	18.69±1.31 c
Plum	3.50±0.46 a	2.44±0.42 b	1.31±0.26 b	1.44±0.42 a	5.19±0.75 a	8.69±0.92 a	10.19±1.56 d	18.88±2.07 c
sweet potato	2.69±0.37 bc	1.75±0.46 c	1.31±0.37 b	1.25±0.27 a	4.31±0.75 bc	7.00±0.76 b	12.13±2.46 c	19.13±2.5 bc
Indian laburnum	2.38±0.44 c	1.69±0.37 c	1.00±0.38 b	1.25±0.38 a	3.94±0.73 c	6.31±0.75 b	14.81±1.96 b	21.13±2.17 b
Castor bean	2.94±0.42 b	2.06±0.5 bc	2.13±0.52 a	1.44±0.42 a	5.63±0.64 a	8.56±0.86 a	16.81±1.49 a	25.38±2.26 a
F-value	13.80	8.46	9.29	0.79	7.34	14.87	26.82	14.64
Probability	0.0001	0.0001	0.0001	0.5604	0.0001	0.0001	0.0001	0.0001
LSD at 5%	0.43	0.47	0.35	0.34	0.72	0.73	1.73	2.05

The means are followed by different letters in the same columns are significantly divergent ($P < 0.05$, Duncan).

Table 5. Mean generation, longevity and fecundity of *E. orientalis* under different temperatures and six host plants.

Parameter	Temp.	Date palm	Mulberry	Plum	sweet potato	Indian laburnum	Castor bean	LSD
Generation time (T)	25°C	22.64 a	21.89 a	20.47 b	19.0 c	19.16 c	18.61 c	1.03
	30°C	11.68 a	11.76 a	10.61 b	10.74 b	9.42 c	10.16 bc	0.81
Pre-oviposition period	25°C	3.43 a	3.15 a	2.23 b	1.73 c	2.15 bc	1.85 bc	0.41
	30°C	1.9 a	2.0 a	1.53 b	1.5 b	1.0 c	1.43 b	0.30
Oviposition period	25°C	8.15 e	9.4 d	9.95 cd	10.4 bc	10.95 ab	11.15 a	0.7
	30°C	7.15 d	6.43 d	6.9 d	9.8 c	11.68 b	13.05 a	1.12
Post-oviposition period	25°C	1.95 b	2.1 b	2.65 a	1.93 b	2.03 b	2.0 b	0.46
	30°C	1.55 b	1.48 b	1.58 b	1.45 b	1.83 b	2.43 a	0.34
Mean total fecundity (egg/♀)	25°C	8.15 d	9.55 c	11.0 c	14.05 b	19.45 a	18.2 a	1.40
	30°C	9.45 d	9.7 d	10.95 c	12.1 b	12.6 b	14.1 a	1.02
Daily rate (egg/♀/day)	25°C	1.02 c	1.03 e	1.12 c	1.37 b	1.78 a	1.66 a	0.17
	30°C	1.36 b	1.56 a	1.63 a	1.32 b	1.13 c	1.08 c	0.18

The means are followed by different letters in the same rows are significantly divergent ($P < 0.05$, Duncan).

Effect of host plant:

The results illustrated in (Table 6) proved that the mean duration of all developmental stages were longer on date palm and mulberry followed by plum and sweet potato and the shortest duration were recorded on Indian laburnum and castor bean plants. Significant differences were found between developmental periods of (CDM) exposed to different source of food. The shortest life cycle and generation time were on Indian laburnum and castor bean plants; while the longest of these periods were on date palm and mulberry. Significant differences were also found between adult female longevity, oviposition period and life span. The castor bean plants were more favored to the mite followed by Indian laburnum more than date palm and mulberry. Moreover, significant differences occurred between the six hosts fecundity was the highest on Indian laburnum and castor bean plants and the lowest on date palm and mulberry. These results are agreement with finding by **(Singh *et al.* 2000)** found that development of this mite has been recorded much faster on castor and can actively grow on temperate fruits like apple and pear during March to June.

Effect of temperature:

The optimum temperature for development was 30°C, being faster than 25°C. Significantly differences occurred between all stages at the two levels of temperatures.

The highest fecundity at 25°C was 13.4eggs/female, while the lowest was at 25°C was 11.48eggs/female (Table 6).

These findings are more or less similar to that detected by **(Rasmy 1977)** who reported that *E. orientalis* was reared on leaves of sour orange, orange and mandarine. Variation was noted in the fecundity was distinctly affected: The sour orange leaves promoted a high number of eggs, whereas rearing on mandarine leaves led to the poorest fecundity. In addition, *Eutetranychus banksi* (McGregor) developed from egg to adult in 13.1, 11.6, 11.7 and 9.6 days compared to 12.0, 10.1, 10.8 and 8.5 days for males at 25, 28, 30 and 32°C on . Developmental times were significantly different between the two sexes at each temperature **(Childers *et al.* 1991)**. Also, **Elhalawany, 2013** indicated that immature stages of date palm dust mite *Oligonychus afrasiaticus* (Mc.G.) was fastest on karmry stage (10.60 days) followed by yellow khelal (12.35 days) then inner fronds (12.71 days). The shortest generation time was 9.5, 11.32 and 16.04 days at 35°C, while the longest was 22.74, 26.74 and 26.68 days at 25°C & 70% R.H. on karmry, yellow khelal stage and inner frond; respectively.

Life table parameters

The life table parameters of *E. orientalis* at two constant temperatures and six host plants are shown in (Table 7). Mean generation time (Tc) declined with increasing temperature. The shortest doubling generation time (DT) the time required to double the number of the individual mites, occurred on Indian laburnum and castor bean were 4.81 and 5.02 days at 30°C and the longest period on date palm was 12.38 days at25°C.

Gross reproduction rate (GRR) recorded the highest value at 25°C on Indian laburnum was 33.7eggs/ individual and the lowest value 6.42eggs/ individual on date palm. While these values ranged from 8.6 to 12.5 eggs/ individuals at30°C.

The net reproductive rate (R_o) increased from 3.68 times/ individual/ generation on date palm to 12.25 times/ individual/ generation at 25°C; whereas at 30°C (R_o) increased from 4.29 to 7.18 times/ individual/ generation at the same hosts.

The maximum intrinsic rate of natural increase (r_m) was recorded at 25°C on Indian laburnum (0.143individuals/♀/ day), and on castor bean at 30°C was (0.138 individuals/♀/day). Whereas, the lowest values were (0.056 and 0.077 individuals/ ♀/day) on date palm and mulberry at 25 and 30°C, respectively. The finite rate of increase (**λ**) ranged from 1.05offspring/ individual/day at 20°C on date palm to 1.15 offspring/ individual/day at 30°C on Indian laburnum. The population of this mite is reduced by half (50% mortality) from 27 to 29 days at 25°C and from 16to 22 days at 30°C. The sex ratio ranged from 0.65 to 0.76 female/ total not affected by temperature and host plant.

Age specific survivorship (l_x) and fecundity (m_x) curves for *E. orientalis* are shown in Fig. (1) The daily age-specific survival rate was highest at 25ºC and decreased as the temperature increased on six host plants. The maximum number of eggs produced on castor bean was at 25ºC (day 22: 1.76 egg/♀/day), the lowest value was obtained at 25ºC (day 22: 0.81 egg/♀/day) on date palm. The highest survival rate of females was 0.9% on castor bean at 25°C, while lowest value was 0.65% on date palm and plum plants at 30°C.

These results are in accordance with that of **(Childers *et al.* 1991)** who suggested that the intrinsic rate of increase (r_m) of *E. banksi* was 0.066, 0.123, 0.179, 0.210, 0.224 and 0.190 at 15, 20, 25, 28, 30 and 32°C. Sex ratio was strongly biased toward females (< 80%) between 20 and 30°C and declined to 68% at 15°C and 61% at 32°C. The maximum net reproductive rate (R_o) was 31.26 at 28°C followed by 26.06 at 30°C and 25.29 at 25°C. It has appears to have a higher intrinsic rate of increase between 28-30°C. **Elhalawany, 2001** found that, the high fecundity of female (128.05 eggs/♀) was recorded at 30˚C. In addition, the highest intrinsic rate of increase (r_m) (0.29) was obtained at 30˚C when *Tetranychus urticae* fed on Black michen fig variety, and lowest fecundity 32.68 eggs/♀ and the lowest (r_m) (0.040) was obtained at 15°C on Gizi fig variety.

Table 6. Factorial analysis of obtained biological aspects of *E. orientalis* as affected by temperature and host plant.

Factor level	Host plant						LSD.	Temperature		LSD.
	Date palm	Mulberry	Plum	sweet potato	Indian laburnum	Castor bean		25°C	30°C	
Egg	5.99 a	5.83 ab	5.75 abc	5.68 abc	5.48 bc	5.38 c	0.35	6.91 a	4.46 b	0.20
larval	3.23a	3.06 a	2.65 b	2.63 b	2.75 b	2.55 b	0.26	3.83 a	1.79 b	0.15
Protonymph	2.73 a	2.71 a	2.74 a	2.45 ab	2.14 c	2.40 bc	0.27	3.64 a	1.42 b	0.16
Deutonymph	2.61a	2.64 a	2.49 a	2.49 a	2.39 a	2.40 a	0.25	3.52 a	1.49 b	0.14
Immature stages	8.56 a	8.41 a	7.88 b	7.56 bc	7.28 c	7.35 bc	0.50	10.99 a	4.69 b	0.29
Life cycle	14.56 a	14.24 a	13.63 b	13.24 bc	12.75 c	12.73 c	0.59	17.89 a	9.15 b	0.34
Generation	17.22 a	16.81 a	15.50 b	14.85 bc	14.33 c	14.36 c	0.67	20.30 a	10.73 b	0.39
Pre-oviposition	2.66 a	2.58 a	1.88 b	1.61 bc	1.58 c	1.64 bc	0.27	2.42 a	1.56 b	0.15
Oviposition	7.65 d	7.91 d	8.43 d	10.10 c	11.31 b	12.10 a	0.76	10.0 a	9.17 b	0.44
Post-oviposition	1.75 b	1.79 b	2.11 a	1.69 b	1.93 ab	2.21 a	0.30	2.11 a	1.72 b	0.17
Longevity	12.06 d	12.28 d	12.41 d	13.40 c	14.81 b	15.95 a	0.90	14.53 a	12.44 b	0.52
Fecundity	8.80 d	9.63 d	10.98 c	13.08 b	16.03 a	16.15 a	1.06	13.40 a	11.48 b	0.61
Daily rate	1.19 b	1.30 ab	1.37 ab	1.36 ab	1.46 a	1.38 a	0.16	1.33 a	1.35 a	0.09
Life span	26.62 bc	26.51 bc	26.04 c	26.64 bc	27.56 ab	28.68 a	1.12	32.42 a	21.59 b	0.65

The means are followed by different letters in the same rows are significantly divergent ($P < 0.05$, Duncan).

Table 7. Life table parameters of *E. orientalis* under different temperatures.

Parameter	Temp.	Date palm	Mulberry	Plum	Sweet potato	Indian laburnum	Castor bean
Mean generation time (T_c) [a]	25°C	23.12	22.9	22.84	22.23	22.44	21.74
	30°C	12.99	22.84	12.99	13.39	13.31	14.28
Doubling time (DT) [a]	25°C	12.38	10.3	9.0	7.3	4.85	6.03
	30°C	6.19	9.0	6.19	5.13	4.81	5.02
Net reproductive rate (R_o) [b]	25°C	3.68	4.72	5.92	8.34	25.06	12.25
	30°C	4.29	5.92	4.29	6.17	6.80	7.18
Intrinsic rate of increase (r_m) [c]	25°C	0.056	0.067	0.077	0.095	0.143	0.115
	30°C	0.112	0.077	0.112	0.135	0.114	0.138
Finite rate of increase (λ)[c]	25°C	1.05	1.07	1.08	1.10	1.15	1.12
	30°C	1.11	1.08	1.11	1.14	1.15	1.14
Gross reproduction rate (GRR)[b]	25°C	6.42	7.06	8.65	11.4	33.7	15.4
	30°C	8.6	7.85	8.6	11.2	12.2	12.5
50% mortality [a]	25°C	27	29	28.7	28	29	29
	30°C	17	16	17	17	18	22
Survival rate %	25°C	0.7	0.75	0.77	0.80	0.85	0.9
	30°C	0.65	0.77	0.65	0.75	0.75	0.72
Sex ratio (♀/total)	25°C	0.65	0.66	0.70	0.75	0.76	0.75
	30°C	0.7	0.7	0.7	0.68	0.72	0.7

[a] Days [b] per generation [c] Individuals/female/ day

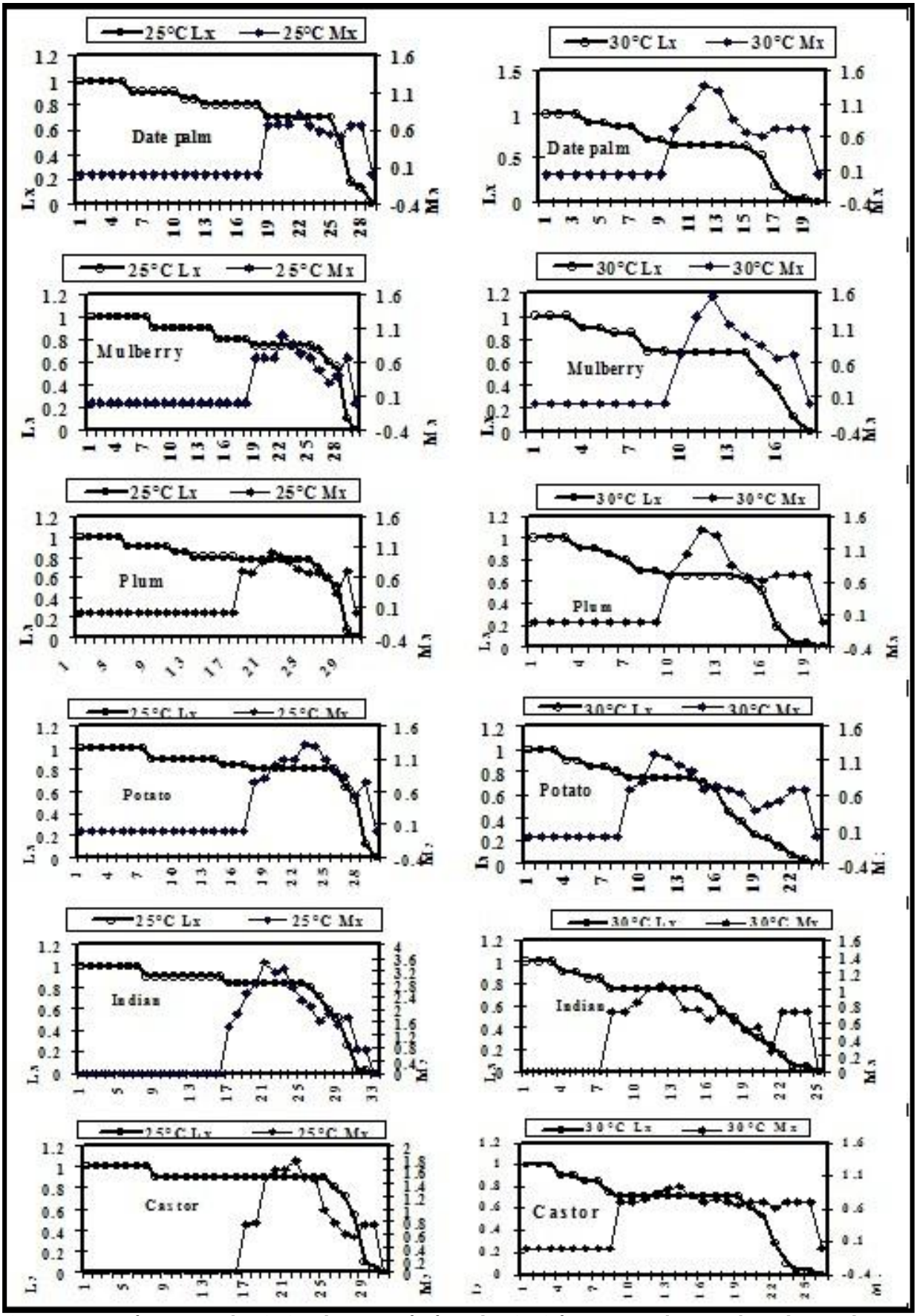

Fig. 1. Age specific survivorship (Lx) and age specific fecundity (Mx) for *E. orientalis* on six host plants and two different temperatures.

Badii *et al.* 2003 studied the effect of five different constant temperatures on the life history and life table parameters of *E. banksi* on Sweet orange leaves. The intrinsic rates of natural increase were -0.0649, 0.1723, 0.1759, 0.1973 and -0.0711; net reproductive rates, 0.30, 8.25, 7.24, 9.21 and 0.44; mean generation times, 19.21, 12.79, 11.74, 11.52 and 11.64 days at 20, 25, 30, 32.5 and 35°C, respectively. **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 **(Imani and Shishehbor, 2009). Sangeetha *et al.* 2013** reared *E. orientalis* on neem leaf discs at 35°C, development times from egg to adult stage were 9.48days, oviposition period averaged 7.7 days and Fecundity averaged 30.1 eggs/ female. However, **Elhalawany and Abdel-Wahed, 2013** reported that *T. urticae* maximum value of intrinsic rate of increase (r_m) 0.243 and 0.297 individuals/♀/ day, and maximum net reproductive rate (Ro) 47.51 and 63.47 individuals/♀ on Kostata and Hachiya varieties at 30 °C, respectively. Maximum fecundity was obtained on Kostata variety at 30ºC at day 15 was 8.93 eggs/♀/day. Finally, **Dingxu *et al.* 2006** studied the influence of host species of deciduous fruit trees, like apple, peach, plum, cherry and apricot, on the development and reproduction of the hawthorn spider mite *Tetranychus viennensis* Zacher in the laboratory. They indicated that plum might be the best suitable plant for the spider mite among the plants tested due to shorter developmental period and higher intrinsic rate of increase, whereas cherry and apricot were least suitable due to their long developmental duration and low intrinsic rates of increase.

Conclusion

As a results of the above findings, it can be concluded that 30°C is favorable than 25°C for population build-up of *E. orientalis* on Indian laburnum and castor bean are affected the developmental time, especially egg duration and fecundity of that mite. Observations made under laboratory conditions can be valuable in understanding population dynamics and integrated pest management.

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تأثير بعض العوائل النباتية و الحرارة على المظاهر البيولوجية لأكاروس الموالح البني *Eutetranychus orientalis* (Klein) (Acari: Actinedida: Tetranychidae)

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أكاروس الموالح البني *Eutetranychus orientalis* (Klein) هو أحد الآفات الرئيسية التي تصيب الموالح والنخيل والمحاصيل الحقلية ونباتات الزينة. تم دراسة فترة التطور والتكاثر وجداول الحياة لأكاروس الموالح البني عند التغذية على ستة من العوائل النباتية: الخروع، والنخيل، وخيار شنبر، والتوت، والبرقوق والبطاطا تحت الظروف المعملية على درجتي حرارة 25، 30 ± 2°م، رطوبة نسبية 65 ± 5% وفترة إضاءة (16: 8). وتشير النتائج إلى أن أطول دورة حياة كانت 19.95& 9.38 يوماً، 19.31& 9.8 يوماً لكل من الذكور والإناث على النخيل عند 25، 30°م، و أقصر دورة حياة على الخروع سجلت 16.45 & 16.75 يوماً للذكور والإناث على درجة حرارة 25°م، بينما استغرقت 6.31& 8.43 يوماً للذكور والإناث عند 30° م على خيار شنبر على التوالي. تراوحت فترة حياة أنثى أكاروس الموالح البني من 13.53 إلى 15.13 يوماً عند 25°م، ومن 9.9 إلى 16.9 يوماً عند 30° م. وكان أعلى معدل للخصوبة الكلية 19.45 ، 14.1 بيضة / أنثى على الخيار شنبر و الخروع عند 25، 30 °م على التوالي. تراوحت النسبة الجنسية (إناث / إجمالي) من 65 إلى 76٪. كان أعلى معدلاً للزيادة الذاتي (r_m) 0.143 على الخيار شنبر عند 25°م ، 0.138 (فرد / أنثى / يوم) على الخروع عند 30 °م. كان لدى الأفراد القدرة على التضاعف في أقصر وقت عند 30°م (4.81 يومًا) على خيار شنبر وأطول وقت عند 25°م (12.38 يومًا) على نخيل التمر. انخفض متوسط فترة الجيل (T) والوقت اللازم لتضاعف الجيل (DT) مع زيادة درجة الحرارة. هذا الأكاروس يفضل ارتفاع درجة الحرارة. وكانت نباتات الخروع و الخيار شنبر أكثر العوائل تفضيلا عن غيرها من العوائل تحت الدراسة.