Effect of temperature on the life history of the old world date mite, *Oligonychus afrasiaticus* (Acari: Tetranychidae)

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Oligonychus afrasiaticus is considered one of the major pests threatening the production of dates in Iraq. It causes between 50-80% yield loss in years of dry, dusty, stormy weather. The biology of this mite was studied at four constant temperatures (20, 25, 30, and 35 °C), 50-60% relative humidity, and L16:D8 photoperiod. No development was observed at 15 and 40 °C. Incubation period peaked at 20 °C (7.6 days) and reached a minimum at 35 °C (2.7 days), development of larva, protonymph, and deutonymph took 5.3, 4.3, and 4.5 days at 20 °C, and 1.9, 1.3, and 1.4 days at 35 °C, respectively. Number of eggs/female was 12.5 at 20 °C and 27.2 and 35 °C. Longevity of female and male was 33.2 and 29.1 days at 20 °C, and 11.5 and 10.1 days at 35 °C, respectively. The results were used to establish a life table of this mite.

Key words: Old world date mite, *Oligonychus afrasiaticus*, Iraq, date palm

The production of dates in Iraq is threatened by many pests (Abdul-Hussein, 1963). The old world date mite (Ghobar mite) *Oligonychus afrasiaticus* (McGregor) is one of the major pests causing 50-80% yield loss in years of dry, dusty and stormy weather in Iraq (Al-Jboory, 1999). Observations have been done on the biology of this mite in Iraq and in Tunisia. These revealed that the fecundity ranged between 30-100 eggs/female at 35 °C and 50% r.h., incubation period 3 days, larval period 2 days, nymphal period 4-7 days, and generation time 8-14 days (Abdul-Hussein, 1985; Al-Haidari et al., 1982, 1986; Al-Jboory, 1999; Dhouibi, 2000). Studies on the life history of the tea mite, *Oligonychus coffeae* (Nietner) showed a trend similar to that of the old world date mite (Das & Das, 1967). High temperature reduces longevity and increases female fecundity in some tetranychid species (Nickel, 1960; Das & Das, 1967; Tanigoshi et al., 1975; Carey & Bradley, 1982). Al-Haidari et al. (1982) concluded that 30 °C was the optimum temperature for the development of old world date mites.

This paper is one of three publications on this mite investigating the effect of various temperatures and a constant relative humidity on the life history of *O. afrasiaticus.*

MATERIALS AND METHODS

Various mite stages were collected from an infested date palm tree, *Phoenix dactylifera* L., and transferred to date palm seedlings (1-9 weeks old) kept at 29-33 °C in the laboratory. Two substrates for rearing have been used, date palm leaflets and immature dates.

Date palm leaflet. Four circular holes of 2 cm diameter were drilled in the cover of a plastic Petri dish plus a small hole close to them for injection of water, to keep the dish sufficiently humid (Fig. 1). A piece of sponge, 9 cm in diameter and 1.5 cm thick, was placed in the Petri dish, covered by filter paper. A piece of palm leaflet (5.5 × 2.5 cm) is placed on the top of the filter paper underneath two of the holes drilled. The cover was fixed by small pins at the edges of the dish. The leaflets were replaced from time to time whenever they turned yellowish. A piece of moistened cotton was placed over the edge of the leaflet in such a way that it causes the leaflet to be slanted, thereby enabling the mite to secrete and deposit its silk under an angle. After copulation, a single egg was transferred to each replicate (n = 30). The Petri dishes were incubated under constant temperature (15-40 °C, at 5-degree intervals), 50-60% r.h., and L16:D8, to assess progress in development.

Immature dates (Khalal stage). Plastic containers with a cover of 10 cm in diameter and 3.5 cm deep were used for mite rearing (Fig. 2). Two circular holes of 2 cm diameter were drilled in each cover and the container was filled with moistened sand. An immature yellow stage date (Khalal stage) was inserted in each hole and 2/3 of the fruit was exposed. A ring of Vaseline oil applied to the date's base served to prevent the mites from escaping. A single egg was transferred to each fruit and incubated at 35 °C, 50-60% r.h., and L16:D8 (n = 30).

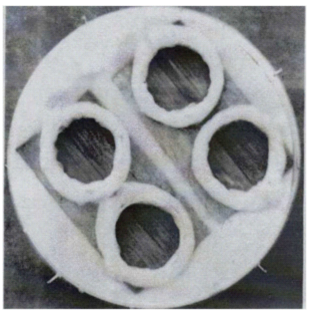

Figure 1 Rearing of *Oligonychus afrasiaticus* on date palm leaflet.

In the laboratory the life cycle, fecundity, pre- and post-oviposition periods, and longevity of female and male mites were assessed. Also, the offspring sex ratio was determined by following the eggs laid by each female at each temperature, and counting the females and males resulting from these eggs. Sex ratio was calculated among all offspring that reached maturity.

A completely randomized design was used and the data were analyzed by ANOVA followed by Duncan's Multiple Range Tests (Duncan, 1955; Steel & Torrie, 1960).

RESULTS AND DISCUSSION

Overall, the duration of all active and quiescent stages decreased with increasing temperature (Table 1). Egg incubation took 7.6 days at 20 °C, significantly longer than at 25, 30, or 35 °C. Freshly laid eggs, 0.5-1 day old, were negatively affected at 15 and 40 °C. They shriveled and died, or reached the pre-larval stage and then failed to hatch and died. A temperature as high as 36 °C was also harmful for the desert mite *Tetranychus desertorum* Banks, especially at low humidity where it led to decreased hatchability (Carey & Bradley, 1982).

The average developmental time of the active larval stage was 3.8 days at 20 °C, significantly longer than at the other temperatures. In general, the quiescent larva lasted shorter than the active larva (viz., about half as long), in agreement with results reported for the two-spotted spider mite *Tetranychus urticae* Koch, the strawberry mite *T. turkestani* (Ugarov & Nikolskii), and the Pacific mite *T. pacificus* McGregor on cotton (Carey & Bradley, 1982).

Active and quiescent protonymph stages period were 2.8 and 1.5 days at 20 °C respectively and this results doesn't show any significant differences at 25 and 30 °C (Table 1). The average time spent in the active and quiescent protonymphal stage peaked at 4.3 days at 20 °C, significantly longer than at the other temperatures. The response of the deutonymhal stage to temperature was similar to that of the protonymph.

Development from egg to adult at 20 °C required 21.5 days, significantly longer than at the other temperatures (Table 1). Egg-to-adult development was significantly fastest at 35 °C. Also Dhouibi (2000) found that the optimal temperature for development of *O. afrasiaticus* was 35 °C. The longest period for development of males and females was at 20 °C (19.9 and 22.4 days, respectively), significantly longer than at the other temperatures (Table 2). Also males of the grass mite *O. pratensis* (Banks) develop 1-2 days faster than the females (Tan & Ward, 1977).

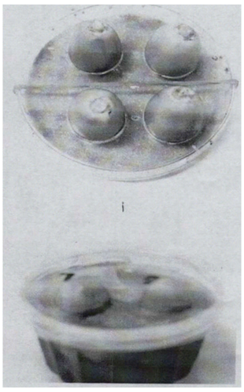

Figure 2 Rearing of *Oligonychus afrasiaticus* on immature date fruit (yellow Khalal stage).

Table 1 Effect of constant temperature on mean (±SE) developmental time (days) of immature *Oligonychus afrasiaticus*.

Temperature (°C)	Egg incubation	Larva			Protonymph			Deutonymph			Egg-adult
		Active	Quiescent	Total	Active	Quiescent	Total	Active	Quiescent	Total	
20	7.6±0.71a	3.76±0.5a	1.52±0.42a	5.29±0.68a	2.76±0.53a	1.55±0.41a	4.31±0.65a	2.88±0.61a	1.62±0.41a	4.5±0.62a	21.55±1.54a
25	5.23±0.68b	2.3±0.81b	1.18±0.29a	3.4±0.86b	1.94±0.57ab	1±0.17ab	2.94±0.75b	2±0.79ab	1.03±0.27ab	3.3±0.85ab	14.33±1.77b
30	3.9±0.66bc	2.5±0.5b	0.95±0.22a	3±0.52b	1.6±0.33ab	0.93±0.25ab	2.53±0.39bc	1.87±0.34ab	0.83±0.24ab	2.7±0.4bc	12.1±1.24b
35	2.67±0.47c	1.28±0.4b	0.68±0.24a	1.95±0.44b	0.68±0.2b	0.6±0.2b	1.28±0.25c	0.83±0.24b	0.58±0.19b	1.42±0.25c	7.28±0.71c

Means within a column followed by different letters are significantly different (Duncan's multiple range test, $P<0.05$).

Table 2 Effect of constant temperature on mean (±SE) egg-to-adult developmental time (days) and longevity (days) of adult male and female *Oligonychus afrasiaticus*.

Temperature (°C)	Male		Female	
	Egg-to-adult	Longevity	Egg-to-adult	Longevity
20	19.93±0.68a	29.14±1.96a	22.36±1.16a	33.23±2.61a
25	13.14±0.99b	18.71±2.19b	15.35±1.63b	20±2.72b
30	11.4±1.36b	11.4±1.36c	12.45±1.01b	14.3±1.74bc
35	6.57±0.32c	10.14±1.64c	7.64±0.64c	11.55±2.02c

Means within a column followed by different letters are significantly different (Duncan's multiple range test, P<0.05).

Table 3 Effect of constant temperature on mean (±SE) pre-oviposition period (days) and oviposition rate (no. eggs/female) of *Oligonychus afrasiaticus*.

Temperature (°C)	Pre-oviposition period	Oviposition rate
20	3.27±0.5a	12.54±1.12b
25	1.9±0.37b	17.5±2.17b
30	1.55±0.35b	19.5±2.92b
35	0.68±0.24b	27.2±5.05a

Means within a column followed by different letters are significantly different (Duncan's multiple range test, P<0.05).

Table 4 Offspring sex ratio of *Oligonychus afrasiaticus* at various constant temperatures.

Temperature (°C)	Total no. eggs	No. males	No. females	Male : female
20	153	37	116	3.14 : 1
25	163	46	117	2.54 : 1
30	181	56	125	2.23 : 1
35	253	94	159	1.69 : 1

Table 5 Effect of different food and rearing methods on mean (±SE) developmental time (days) of *Oligonychus afrasiaticus* at 35 °C.

Developmental stage	Yellow Khalal	Leaflet
Egg	1.87±0.39	2.67±0.47
Larva	2.08±0.40	1.95±0.44
Protonymph	1.38±0.28	1.28±0.25
Deutonymph	1.5±0.18	1.42±0.25
Egg-to-adult	6.77±0.67	7.28±0.71

Means within a column did not differ significantly (Duncan's multiple range test, P>0.05).

Females and males live shorter with increasing temperature; at 20 °C they lived 29-33 days, but at 35 °C this was only 10-12 days (Table 2). In general, males lived 1.5-4 days shorter than females. This agrees with the findings for the red tea mite *O. coffeae* (Palevsky et al., 2003).

The longest pre-oviposition period was 3.3 days at 20 °C, significantly longer than at higher temperatures (Table 3). The number of eggs per female increased from 12.5 at 20 °C to 27.2 at 35 °C. Temperature also affected the sex ratio of *O. afrasiaticus*: the ratio of females to males ranged from 3.1 (20 °C) to 1.7 (35 °C) (Table 4). Thus, the proportion of males in the offspring increased with increasing temperature. Palevsky et al. (2003) stated that the sex ratio of *O. afrasiaticus* was highly female-based, usually being above 0.85 (proportion of females).

There were no significant differences in the period needed for life cycle completion between the two rearing methods (Table 5), suggesting that palm leaflet and immature fruit did not differ as a food source for *O. afrasiaticus*.

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