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Effect of temperature and relative humidity on the rate of development, fecundity and life table parameters of the red spider mite *oligonychus mangiferus* (rahman and, sapra) (acari: tetranychidae)

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ABSTRACT

Studies on biology of *Oligonychus mangiferus* (Rahman and Sapra) at combination of eight constant temperatures and relative humidities (RHs) viz., 7.0°C with 85% RH, I0°C with 80% RH, 15.0°C with 75% RH, 23.0°C with 70% RH, 31.0°C with 65% RH, 34.0°C with 65% RH, 36.0°C with 60% RH and 40.0°C with 55% RH revealed that the optimal condition for the development of these mites are 15.0-31.0°C and 65-75% RH. The highest temperature and the lowest RH accelerated the rate of development and induced more reproduction of *O. mangiferus*. Its population also multiplied 30.81 times in a generation time of 27.36 days at 31.0°C and 65% RH, while the same population only increased 7.46 times in a generation time of 48.07 days at 15.0°C and 75% RH. Fecundity was highest at 31.0°C and 65% RH with 46.43 eggs per female. The highest intrinsic rate of natural increase was observed at 31.0°C as 0.125 per day.

INTRODUCTION

The red spider mite *Oligonychus mangiferus* (Rahman and Sapra) is one of the important pests of mango, loquat, peach, quince, pear, grapes, cotton and roses. It is widely distributed throughout the tropics, and it is recorded from India, Mauritius, Hawaii, Peru and Egypt (Jeppson *et al.* 1975). In Egypt, *O. mangiferus* is a pest of cotton and is considered the second serious pest on pomegranate (Moutia 1958; Mohamed 1963). In recent years, it increased rapidly on mango trees, especially the nurseries, the infestations occurred on the upper leaf surfaces where feeding produces a drying effect and premature leaf drop. Al-Azzazy (2005) mentioned that its populations reach their maximum in the first August and in mid October on Alphonso mango cultivar during two successive years (2003-2004), when temperatures and relative humidities (RHs) averaged 28°C and 59% RH and 33°C and 59% RH, as well as 24°C and 58% RH and 27°C and 51% RH, respectively.

However, so far, as the study on the biological aspects and the effect of constant temperature and RH on its life history is concerned, not much is known except in the study by Zaher and Shehata (1971) and Rai *et al.* (1988). In these studies, the effect of temperature and RH on the development and life table parameters of *O. mangiferus* was investigated, and the base therma1 requirement for development was determined.

MATERIALS AND METHODS

This study was taken up at eight different combinations of constant temperatures and RHs, viz, 7.0°C and 85% RH, 10.0°C and 80% RH, 15.0°C and 75% 23.0°C and 70% RH, 31.0°C and 65% RH, 34,0°C and 65% RH, 36.0°C and 60% RH, and 40.0°C and 55% RH, under laboratory conditions, and the stock culture was obtained from the heavily infested Alphonso mango leaves. The duration of developmental stages was studied on excised leaf discs in the laboratory. Leaf discs were made with fresh mango (*Mangiferae indica* L.) leaves. Before release of the mites, it was ensured that all unwanted organisms were removed from the leaves by thoroughly brushing the leaves and by examining under stereo binocular microscope Each disc was circular in appearance with 3 cm in diameter. The leaf discs were placed on a cotton bed in a Petri dish (5cm x 1cm) with the lower leaf discs facing upwards, a voiding the mites' escape. The cotton bed was soaked with water twice daily so that the discs remained fresh. Two adult female *O. mangiferus* were transferred from the stock culture to each disc for laying eggs.

On the fol1owing day, 5-10 eggs we re seen on each of the excised leaves, and thus 40-50 freshly laid eggs were available and all belonged to the same age. Thereafter, observations were recorded at 12 hourly intervals until the egg hatched, After hatching, the larvae were kept in separate Petri dishes for recording further observations regarding duration of different life stages, fecundity, longevity, etc. Whenever necessary, the old leaves were replaced with fresh ones. For determining the fecundity of unfertilized females, the female deutonymphs, before moulting Into adults were kept separately without allowing them to mate with the male, while determining the fecundity of fertilized females, each female deutonymph was kept with a male allowing it to fertilize it. The number of eggs laid was counted till the death of the adult. Data were subjected to the statistical analysis,

RESULTS AND DISCUSSION

Temperature and moisture play an important role in the development of population of *O. mal1giferus.* Eggs fail to hatch under temperature of 7°C with 80% RH; 10°C with 75% RH and 40°C with 60% RH. of 50 eggs tested, 9 eggs hatched when they were kept at constant temperature of 36°C and an RH of 60%; individuals, however, developed from larvae to deutonymphs, then died without teaching the adult stage. At 34°C and 65%, RH, the adults began to slow down and cease all activity, Thus, the optimal conditions for the development .of these mites are 15-31°C and 65-75% RH. According to Meyer (1981), eggs of the allied species *Oligonychus coffeae* (Nietner) did not hatch at a temperature of 34°C and an RH of 17%; the optimal conditions for the development were 2o-30°C and 50-90% RH.

The mean developmental periods, oviposition and survival rate at each of three optional temperatures and RHs are shown in Table 1. Egg duration decreased with an increase in temperature and decrease in RH up to 31°C and 65% RH. Egg duration at 15°C and 75% RH was about 2.7 times as long as that at 31°C and 65% RH. The present observations are in agreement with the results reported by Das (1959) and Saha *et a1*. (1999) for the red tea mite

O. coffeae. Nymphal durations behaved the same trend. Survival rate of the eggs was high at the same conditions. Extensive research had been done on the biology of different species of spider mites. Most of the works were related to the effect of temperature and RH. Among them, the important are of Sabelis (1981), Northcraft and Watson (1987), Deciyanto *et al*. (1989), Tsai *et al*. (1989), Al-Mallak and Abdalla (1990), Lehman (1998) and Haque *et al*. (2007). The result of the present investigation agreed with the findings of them. Their results showed the great effect of temperature on the development of different species of genera *Tetranychus* and *Oligonychus*. The higher temperature and lower RH of this experiment accelerated the developmental rate and reduced the duration of developmental stages. The life cycle of *O. mangiferus* completed within 12.98 days at 31°C and 65% RH and 31.79 days at 15°C and 75% RH (Table 1). Development was more rapid for males than females, but insignificant.

Table 1: Average duration (in days) of various stages and oviposition rate of *Oligonychus mangiferus* at different constant temperatures and RHs.

***O. mangiferus* (temperature and RHs)**				
Mite stage	**Sex**	**15°C and 75%**	**23°C and 70%**	**31°C and 65%**
Egg	Female	12.78±0.38	7.55±0.32	4.81±0.24
	Male	12.43±0.24	7.43±0.26	4.71±0.20
First stage larva	Female	5.68±0.24	5.20±0.17	2.37±0.20
	Male	5.37±0.20	4.87±0.16	2.14±0.16
Quiescent stage 1	Female	1.14±0.09	0.58±0.04	0.40±0.01
	Male	0.87±0.04	0.62±0.04	0.38±0.02
Second stage nymph	Female	5.26±0.24	3.88±0.11	2.31±0.16
	Male	5.25±0.24	3.81±0.13	2.14±0.12
Quiescent stage 2	Female	1.04±0.09	0.64±0.05	0.40±0.03
	Male	1.04±0.11	0.60±0.08	0.37±0.03
Third stage nymph	Female	4.73±0.16	3.83±0.16	2.25±0.12
	Male	4.93±0.18	3.50±0.11	2.14±0.09
Quiescent stage 3	Female	1.16±0.07	0.73±0.06	0.44±0.04
	Male	1.04±0.09	0.66±0.04	0.39±0.02
Total	Female	31.79±1.07[a]	22.41±0.86[b]	12.98±0.07[c]
	Male	30.93±1.14[a]	21.49±0.85[b]	12.27±0.55[c]
Pre-oviposition	Female	5.63±0.33	4.37±0.24	1.62±0.11
Oviposition	Female	27.89±1.24	25.77±1.03	26.06±0.64
Total fecundity	Female	11.63[a]	21.55[b]	46.43[c]
Post-oviposition	Female	8.57±0.43	6.55±0.32	3.75±0.16
Life span	Female	73.88±2.11[a]	59.10±2.13[b]	44.41±1.34[c]
	Male	65.99±1.86[a]	54.92±1.18[b]	42.34±2.41[c]
% Surviving	Female	100	89	100
Number of Observations	Male	100	100	100
	Female	20	18	20
	Male	10	10	10

All values are expressed as mean± S.D.

Different letters in horizontal columns (between females of different treatments and male of different treatments) denote significant difference *(F-test, P<0.05).*

Virgin females accepted copulation immediately after emergence, while

males spent a period from 9 to 21 hours. In few cases, males helped the females to come out of the nymphal skin. Generally, several males waited beside female deutonymphs and just after emergence, one succeeded to mate. Das (1959) mentioned that a female of *O. coffeae* never allowed more than one male to copulate her, while Saha *et al*. (1999) observed that at times, there was competition among males to have access to the same female and sometimes, the same female allowed more than one male to mate with her. During copulation, the male slipped beneath the female and upwardly curved its posterior genital organ. The copulation, on an average, lasted for 5-13 minutes being shorter at 31°C and longer at 15°C. Females deposit their eggs singly on leaf disc between veins and along the mid rib. Eggs were spherical and dark red in color when newly deposited and changed gradually to pale red then orange. Just before hatching, the embryo appeared in one side of the egg, while the other one became translucent. The egg was tightly glued to the leaf surface. It was noted that the mating process was essential for the maximum production of the females, as unmated females deposited lower numbers of eggs compared with the mated ones. Unfertilized females were found to produce only male off springs, while both males and females were produces by fertilized females. Female deposited an average of 11.63, 21.55 and 46.43 eggs during the average oviposition period of 27.89, 25.77 and 26.06 days, and then survived for 8.57, 6.55 and 3.75 days before death at 15°C and 75% RH, 23°C and 70% RH and 31°C and 65% RH, respectively (Table 1). The results obtained in the present study do not confirm with the observations of Rai *et al*. (1988), as they recorded lower fecundity (10.67 eggs per female) at range of temperatures (22-31°C). Thus, warm and humid climatic conditions are the most important factors favoring a population increase. This notation is supported by the large populations frequently recorded for *O. mangiferus* in summer and autumn months (Al-Azzazy 2005).

A life table parameter at three constant temperatures and RHs were constructed from the life-history data (Table 2). It showed that the intrinsic rate of natural increase (rm) increased with temperature to a maximum of 0.125 at 31°C and 65% RH; however, this value decreased to 0.040 at 15.0°C and 75% RH. The maximum rate is nearly equal to that of the two-spotted spider mite *Tetranychus urticae* Koch (rm = 0.143, Laing 1969) which is the most serious tetranychid mite pests in greenhouses and open fields. The population of *O. mangiferus* also multiplied 30.81 times in a generation time of 27.36 days at 31°C and 65% RH, while its population.

only increased 7.46 times in a generation time of 48.07 day, at 15°C and 75% RH. Consequently, the red spider mite is considered to be disastrous mite on Alphonso mango leaves, particularly in warm months. It could be concluded that the highest temperature and lowest RH accelerated the rate of development and induced more reproduction of *O. mangiferus.*

Table 2: Life table parameters of the red spider mite *Oligonychus*

***mangiferus* at different constant temperatures and RHs.**

***O. mangiferus* (temperature and RHs)**			
Parameters	**15°C and 75%**	**23°e and 70%**	**31°e and 65%**
Net reproduction rate (Ro)	7.46	13.05	30.81
Mean generation time (T)	48.07	36.60	27.36
Intrinsic rate of increase (rm)	0.040	0.070	0.125
Finite rate of increase (e^{rm})	1.040	1.072	1.133
50% mortality (in days)	71	57	44
Sex ratio (female/total)	20/30	18/30	20/30
Sex ratio (female: male)	2.00:1	1.5:1	2.00:1

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تأثير الحرارة والرطوبة النسبية علي نمو وتكاثر الحلم العنكبوتي الأحمر أوليجونيكس مانجيفيرس

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يعتبر الحلم العنكبوتي الأحمر واحدا من أهم وأخطر الأفات علي أشجار المانجو كما يتميز بالانتشار السريع علي مستوي العالم. حيث تؤدي الاصابة بة الي جفاف وسقوط أوراق المانجو.

تم تربية هذا النوع بنجاح علي 8 درجات حرارة ورطوبة مختلفة وهما 7 درجات ورطوبة 85%، 10 درجات ورطوبة 80% ، 15 درجة ورطوبة 75% ،23 درجة و رطوبة 70% ، 31 درجة ورطوبة 65% ، 34 درجة ورطوبة 65% ، 36 درجة ورطوبة 60 % و 40 درجة ورطوبة 55% .

أثبتت الدراسة فشل فقس البيض تحت درجة حرارة 7 ورطوبة 85 %وكذلك درجة 10 و رطوبة 75% ودرجة 40 ورطوبة 60 % . كما أوضحت تلك الدراسة أن درجة الحرارة المناسبة لنمو وتطور هذا الأكاروس هي من 15 الي 31 درجة ورطوبة من 65 الي 75% . و كانت دوة الحياة12.98يوم عند درجة حرارة 31 ورطوبة 65% وطالت هذه الفترة حتي بلغت 31.79 يوم عند درجة 15 درجة ورطوبة 75 %. كما كانت كمية البيض الموضوعة للانثي الواحدة هي 11.36 ، 21.55 و 46.43 . خلال فترة وضع البيض والتي استغرقت 27.89 ، 25.77 ، و 26.06 يوم علي درجات حرارة 15 درجة ورطوبة 75% ،23 درجة و رطوبة 70% ، 31 درجة ورطوبة 65% علي التوالي .

وعند دراسة معايير كفاءة الأفة وقدرتها علي احداث الضرر لعوائلها النباتية فقد اتضح أن معدل التكاثر الذاتي للانثي الواحدة يزداد يوميا زيادة مطردة مع زيادة درجات الحرارة حيث بلغ 0.125 عند درجة حرارة 31 درجة كما ان تعداد تلك الأفة يتضاعف علي الأوراق حتي بلغ 30.81 مرة في فترة جيل بلغت 27.36 يوم عند الدرجة 31 ورطوبة 65 % كما انخفض هذا التضاعف ليصل الي7.46 مرة في فترة الجيل التي طالت وبلغت 48.07 يوما عند الدرجة الصغري وهي 15 درجة ورطوبة **75 %.**

قام بتحكيم البحث

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