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Life table parameters of tomato russet mite *Aculops lycopersici* (Acari: Eriophyidae) at different temperatures in Egypt

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Abstract:

The tomato russet mite *Aculops lycopersici* (Massee) (Acari: Eriophyidae) successfully developed from egg to adult stage when reared on safeera tomato cultivar at different constant temperatures and 45 % RH. The effect of temperature on the development, reproduction and population growth was investigated. At least of 21.50 % of generation time was spent in the egg stage at 31 ˚C. Fecundity was highest at 31 ˚C with 64.2 eggs per female. Life table parameters showed that the population of *A. lycopersici* on safeera tomato cultivar leaves multiplied 41.18 times in a generation time of 15.17 days at 31 ˚C and multiplied 25.53 times in a generation time of 24.22 days at 18 ˚C under the same conditions.

Introduction

Tomato russet mite (TRM) *Aculops lycopersici* (Massee) (Acari: Eriophyidae) is an important pest of tomato *Solanum lycopersicum* Mill and can be considered on exception to the general statement that eriophyoid mites are highly specialized plant parasite (Lindquist and Oldfield, 1996). It has been first discovered in Australia (Tryon, 1937) and until 1986 there were 47 countries which have reported the occurrence of TRM (Nemato, 2000). Now it has become a worldwide serious pest with tomato plants as main host. The exception is in southern and northern latitudes below and above 60 degrees, respectively (Perring, 1996). Adult stage very small, requiring a 14 X hand lens to be observed. This eriophyid mite is tapered, and wedge shaped, with only two pairs of legs at the brooder head end and two long hairs on the tapered, posterior end. Generally, translucent and yellowish, or pink in color.

The acquisition of data on TRM biology has been ascribable to a wide range of climatic or laboratory conditions. It seems able to tolerate considerable variations. In temperature and relative humidity (Fisher and Mourrut- Salesse, 2005). The effect of temperature can be described by specific rate functions of temperature on survival, reproduction, population growth and developmental growth (Ray *et al.,* 2002). Most of the fundamental studies on TRM biology are same tens of years old. Badey and Keifer (1943) observed that at 21 ˚C, TRM females laid about 15 eggs in their life time. The life cycle was 6.5 days under optimal

conditions (21 ˚C and 30 % RH.) (Rice and Strong, 1962). Experimental conditions of 25 ˚C and 70 % RH., males developed in 4.62 days and females in an average of 5.15 days mentioned by Abou-Awad (1979) . Al-Azzazy and Alhewairini (2018) reported that the population of TRM multiplied 18.14 times in a generation time of 14.45 days at 32 ˚C and lowered to 4.25 times in a generation time of 26.38 days at 11 ˚C under the same conditions.

The current work aims to study the life history and life table parameters of TRM at different temperatures.

Material and methods

A stock culture of *A. lycopersici* was collected from heavily infested leaves of safeera tomato cultivar (*S. lycopersicum*) at the farm of Modern Agriculture Company (PICO-Group), Tahrir province, El-Behera Governorate. Clean disc 1.5 cm in diameter of excised well developed uninfested tomato leaves were carefully examined, placed upper surfaces downwards on water saturated cotton, in a large uncovered petri dishes, 15 cm in diameter. Forty new adult stages were obtained from the aforenamed heavily infested tomato leaves and placed singly on the discs by mean of a human eyebrow, fastened to a handle.

Each female could deposit 1-2 eggs, and then it was removed. Leaf discs were placed in the incubator at different constant temperatures (18, 23, 31 and 45 % relative humidity) and a 16 / 8 light / dark period. Rearing leaf discs were removed every four or five other days, and some drops of water were added daily by drop bottle in petri dishes. Mite development was observed twice daily. After the last of either sex and to insemination by spermatophores produced by males, each newly emerged female was transferred, for 24 h., to a leaf disc previously inhabited by an adult male, then females and males were transferred back to their original leaf discs. Keifer (1954) used three steps recipes for fixation and embedding. Life table parameters were calculated according to Hulting *et al.* (1990).

Results and discussion

Adults and nymphs of the tomato russet mite *A. lycopersici* have piercing sucking mouthparts and feeding on the undersides of lower leaves and on petioles and stems, produces a greasy appearance, which becomes bronzed. Leaves may yellow, curl upwards, dry out and drop. Damage starts at the bottom of plants and moves upwards and may be confused with nutritional deficiencies, plant disease on water stress. TRM was able to develop successfully from egg to adult through the entire life history at constant temperatures between 18 and 31 ˚C and 45 % RH. Eggs are spherical, yellowish, and translucent when first laid, latter becoming opaque as a result of development of the embryo. The fertilized female lays eggs scattered on the lower surface of the leaf, particularly alongside the veins. An embryo develops within the egg which then hatched into a first instar nymph which resembles the adult in many respects, but it is smaller, without external genitalia. The first nymph is translucent, 73–81 μm long. It passes through a nymphocrysalis before molting into the second instar nymph, which is very similar to the first, yellow white in clear, 137–143 μm long and more active (Figure 1).

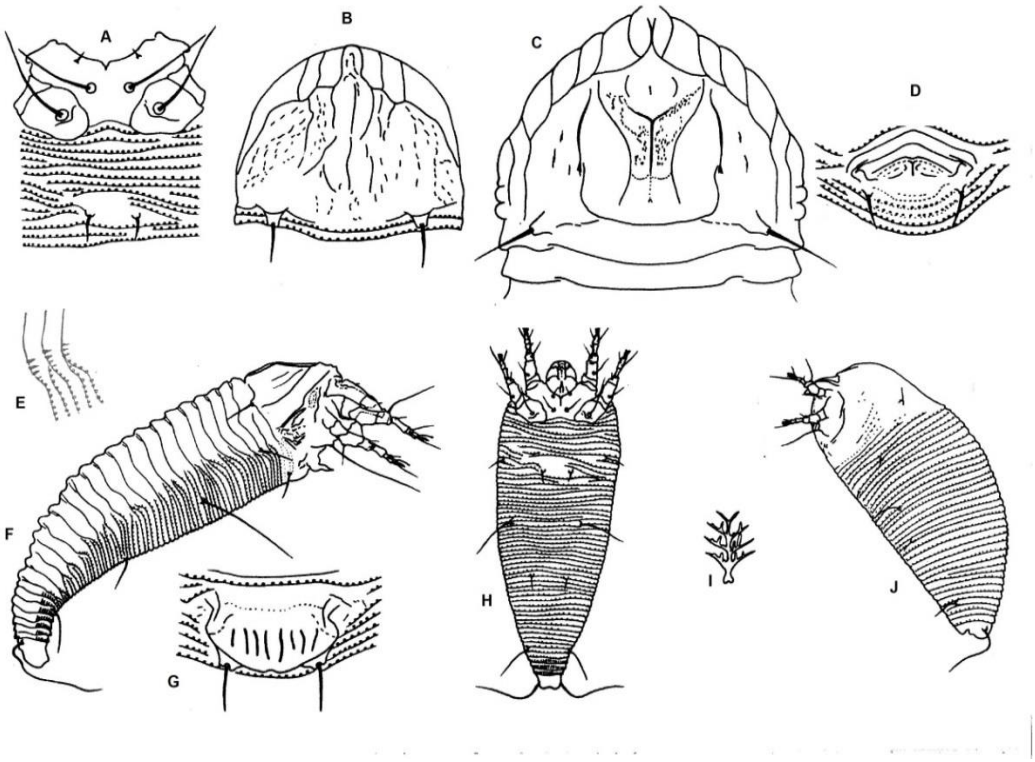

Figure (1): Nymphs and adult stage of the tomato russet mite *Aculops lycopersici* . A: Anteroventral view of second nymph; B: Cephalothoracic shield of second nymph; C: Cephalothoracic shield of female; D: Male genitalia; E: Side skin structure; F: Side view of female; G: Female genitalia; H: Ventral view of second nymph; I: Featherclaws and J: Side view of first nymph.

The second nymph passes through an imagochrysalis before molting, giving rise to the adult; 207 – 223 µm long, 55 – 57 µm wide; spindle form, narrowed posteriorly, arched strongly in lateral view. Unfertilized females, fertilized females and the molting behavior of TRM were like the olive rust mite *Tegalophus hassani* (Keifer) (Abou– Awad *et al.,* 2005). The mean developmental times of *A. lycopersici* at each of three constant temperatures are shown in Table (1). Egg duration decreased with an increase in the temperature up to 31 ˚C. Nymphal durations also gradually decreased with an increase in temperature up to 31 ˚C. The total life cycle was completed in 12.79 and 11.51, 9.41 and 8.14 and 5.35 and 4.82 days for females and males at 18.23 and 31˚C, respectively. Males developed faster. The life cycle results of Barkė *et al.* (1972) on the peach silver mite *Aculus cornutus* (Banks), Easterbrook (1979) on the apple leaf mite *Aculus schlechtendoli* (Nalepa) and Abou-Awad *et al.* (2005) on the olive rust mite *T. hassani* are nearly in agreement at some of the previous temperatures. A generation tock 12.41 days at 23˚C, an increase of 8 ˚C reduced this time by only 5.06 days, where as a decrease of 5˚C increased it by 4.92 days; at least of 21.5 % of the generation time was spent in the egg stage at 31 ˚C. Barkė *et al.* (1972) mentioned that at 29.5 ˚C, the mite was extremely active, and by 31 ˚C the adults began to slow down and cease all activity. In the present study, mites appeared to show normal behavior at 31 ˚C and the difference between 23 and 31˚C of the generation time was significant.

Table (1): Average duration (in days) of various stages and oviposition rate of *Aculops lycopersici* surviving on safeera-tomato cultivar at different constant temperatures and 45 % RH.

		Aculops lycopersici Mean ± SD Temperatures (˚C)		
Mite stage	**Sex**	**18**	**23**	**31**
Egg	Female	4.92±0.38a	3.63±0.21b	1.58±0.09c
	Male	4.46±0.37a	3.04±0.22b	1.57±0.10c
First instar nymph	Female	3.83± 0.24a	3.00±0.21b	2.04±0.19c
	Male	3.46±0.25a	2.64±0.20b	1.89 ±0.17c
Nymphochrysalis	Female	0.48±0.12a	0.40±0.11b	0.37±0.12b
	Male	0.36±0.13a	0.18±0.11b	0.14±0.10c
Second instar nymph	Female	3.10± 0.16a	2.08±0.17b	1.15±0.12c
	Male	2.86±0.18a	2.00±0.16b	1.00±0.09c
Imagochrysalis	Female	0.46±0.11a	0.29±0.07c	0.21±0.06d
	Male	0.38±0.09a	0.29±0.10b	0.21±0.07c
Life cycle	Female	12.79±0.43a	9.41±0.36b	5.35±0.24c
	Male	11.51±0.41a	8.14±0.31b	4.82±0.21c
Preoviposition	Female	4.54±0.31a	3.00±0.28b	2.00±0.19c
Generation	Female	17.33±0.61a	12.41±0.40b	7.35±0.36c
Oviposition	Female	10.98±0.45a	13.46±0.38b	16.24±0.41c
Postoviposition	Female	4.39±0.31a	4.06 ±0.24 a	3.56 ±0.23 b
Longevity	Female	19.91±0.25a	20.53±0.21b	21.80±0.24c
	Male	17.71±0.24a	18.82±0.20b	19.43±0.23c
Life span	Female	32.70±0.64a	29.94±0.51b	27.16±0.41c
	Male	29.22±0.53a	26.96±0.43b	24.2±0.42c
% surviving	Female	100	100	100
	Male	100	100	100
Number of observations	Female	26	26	25
	Male	14	14	15

Mean marked with the same letters in a horizontal column are not significantly different (F-test, P < 0.05, < 0.01).

The longevity of ovipositing females decreased with increased temperature. Longevity at 18 ˚C was 19.91 days, about 0.91 times as long as at 31 ˚C. Total fecundity gradually increased with an increase in temperature. Females deposited an average of 38.90, 48.90 and 64.20 eggs, during an oviposition period that averaged 10.98, 13.46 and 16.24 days; while Abou-Awad *et al.* (2010) reported that total fecundity of the peach silver mite *Aculus fockeui* (Nalepa and Trouessart) (Acari: Eriophyidae) gradually increased with an average in temperature up to 29 ˚C, but at 32 ˚C, it again decreased. Females of TRM survived for 4.39, 4.06 and 3.56 days at the same temperatures, respectively (Table 1). The highest number of eggs per female was observed to be 64.2 at 31 ˚C and decreased with a decrease in temperature. It could be concluded that 31 ˚C as an optimum temperature accelerated the rate of development and induced greater production of *A. lycopersici*. The greatest fecundity, as well for ovipositing females of the tomato rust mite *A. lycopersici* was 51.7 eggs at 25 ˚C (Haque and Kawai, 2003). It is possible, however, that the reproductive capacity of an eriophyid mite might be better under favorable conditions. The life history took 32.70 and 29.22, 29.94 and 26.96 and 27.16 and 24.20 days for females and males at the same temperatures, respectively. In general, life histories studied by Putmann (1939), Keifer (1942), Minder (1957), Abou-Awad *et al*. (2000 and 2005) in agreement. A few days after fertilization by spermatophores, the progeny was predominantly females, with a sex ratio of 2:1, while unfertilized females produced only

males. This is an agreement with the results reported for this work (Table, 2). Similar findings were reported on *Phyllocoptrata oleavera* (Ashmead) and *Aculus pelekassi* Keifer (Burditt *et al.*, 1963), on *Aceria ficus* (Cotte) (Abou-Awad *et al.*, 2000) and on *Aceria oleae* Nalepa and *T. hassani* (Abou-Awad *et al* ., 2005).

Table (2): Life table parameters of the tomato russet mite *Aculops lycopersici* survived on safeera- tomato cultivar at different temperatures and 45 % RH.

Parameters	*Aculops lycopersici* Temperatures (˚C)		
	18	**23**	**31**
Net reproduction rate (R_o)	25.53	31.39	41.18
Mean generation time (T.)	24.22	18.90	15.17
Intrinsic rate of increase (r_m)	0.134	0.182	0.245
Finite rate of increase (e^{rm})	1.143	1.201	1.278
50 % mortality (in days)	30.00	28.00	26.00
Mean total fecundity	38.90	48.9	64.2
Mean daily rate	3.54	3.63	3.95
Sex ratio (Female / total)	26/40	26/40	25/40
Sex ratio (Female : male)	2.00:1	2.00:1	2.00 :1

Parameters of population growth of *A.lycopersici* at three temperatures are shown in Table (2). The intrinsic rate of increase (r_m) increased with temperature to a maximum of 0.245 at 31˚C. Net reproductive rate (R_o) was the largest (41.18 times) and the generation time was the shortest (7.35 days) at the same previous temperature and 45 RH. It is of interest to note that not only temperature but also humidity affects the population growth of eriophyoid mites. The population growth rate of *P.oleavora* decreased as the humidity dropped (Hobza and Jepson, 1974). A suitable temperature in the field as well as better food conditions and an absence of a natural enemy would have brought about a rapid population growth of the tomato russet mite *A.lycopersici* which is disastrous mite on tomato cultivars.

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