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EFFECT OF SOME BIOTIC AND ABIOTIC FACTORS ON THE BIOLOGY OF *TYPHLODROMUS ATHIASAE* (ACARI: PHYTOSEIIDAE)

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Abstract

Some biotic and abiotic factors affecting the biology of the predatory mite, *Typhlodromus athiasae* P. & S. were studied using immatures of *Tetranychus urticae* Koch as prey. Relative humidity 70%-85% were the optimum as shortened life cycle (8.4 and 9.1 days) and increased female fecundity (14.5 and 12.9 eggs/female/10 days) at 25°C. Single mated female gave the shortest longevity (40.5 days) and the smallest fecundity (12.8 eggs/female), while full companionship with male allover longevity (multiple mated) gave the longest longevity (48.6 days) and the greatest fecundity (46.3 eggs / female). *T.urticae* gave the greatest attractancy percentage (40%) (adults, 15%; immatures, 15%; eggs, 10%) in the shortest time (6.5, 8.5, 11.3 minutes, respectively) for fed predator female. Also, fed female was better than 24 hours starved and the latter better than 48 hours starved female. Low temperatures of 5 and 10°C increased egg incubation period as cold storage preceded. Total hatchability percentage decreased with increase of cold storage from one to four weeks with less percentage at 5°C (61% to 10%). Females proved to be better stored than eggs. Thin smooth reticulated plant leaves (Bauhinia) resulted in acceleration of development (7.8 days) and increase egg deposition (16.8 eggs/female/10 days) than coarse reticulated leaves (guava) (9.7 days and 10.7 eggs/female/10 days).

INTRODUCTION

The role of some phytoseiid mites in the biological control of many plant feeding mites has been the subject of many investigations in the recent years. Biological studies on *Typhlodromus athiasae* P. & S. a member of the family Phytoseiidae, carried out by some authors (Swiraki *et al.*, 1969; Hussein, 1977; El-Benhawy and El-Bagoury, 1991) indicated this mite to be a promising predator of tetranychids.

Nevertheless, previous works have not completed the studies on the different factors affecting its biology, habits and behaviour. Therefore, the present study deals with some biotic and abiotic factors that affect this predatory phytoseiid mite to gain more information on its importance as a biocontrol agent.

MATERIALS AND METHODS

Typhlodromus athiasae P. & S. was collected from samples of apple orchard variety Anna at El-Sadat city; new reclaimed land about 60Km north west of Cairo. The mite culture was established by placing a copulated female together with immatures of the two-spotted spider mite, *Tetranychus urticae* Koch as prey on a mulberry leaf *Morus alba* L. situated upside down on cotton wool soaked in water on a 9 cm diameter Petri-dish and left to deposit eggs. The edges of the leaf were also lined with a wet cotton barrier. Leaves were changed by fresh ones when needed (every 5-7 days) and few drops of water were added daily and all kept at 25°C. Five experiments were carried out as follows:

The first experiment was for testing the effect of relative humidity on egg hatchability and female life cycle and fecundity: Four treatments, each of thirty newly deposited predator eggs were transferred singly each to a mulberry leaf disc kept in a small Petri-dish 4 cm in diameter. Every hatched larva was supplied with immatures of *T.urticae* till reaching adulthood. Emerging females were mated with fresh males and each couple kept for 10 days on a leaf disc. Not less than 12 couples were tested. Experiment was undertaken in dissicators with different concentrations of glucose, NaCl, KCl, and H_2O to maintain four levels of relative humidities 55, 70, 85, and 95% at 25 ±1°C for the four treatments, respectively.

The second experiment to see the effect of multiple mating on female longevity, and fecundity: Four treatments were conducted, each with 10 newly emerged females confined singly to mulberry leaf discs of about 4 cm^2 diameter placed in Petri-dishes on wet cotton wool at 25 ±1°C and 70±5% R.H. First treatment: young male was introduced to each female until first copulation occurred, then removed and oviposition period and number of eggs laid by each female were recorded. Second treatment: young male was introduced to every female after five days of its first copulation then removed after the second copulation occurred. Oviposition periods as well as number of eggs laid were calculated. Third treatment: young male was introduced for 12 hours sporadically every five days; while in the fourth treatment the female was accompanied with a male allover her longevity.

The third experiment was for testing the attractancy to different foods. A Petri-dish of 9 cm in diameter was filled with a wet cotton wool pad upon which a large clean leaf of mulberry was placed upside down. A group of each prey stage: 10 adult females, 15 immatures, and 25 eggs of the tetranychid mites of *Tetranychus urticae* Koch, *T.cucurbitaceatum* (Sayed) and *Eutetranychus orientalis* (Klein), 30 individuals of mango leaf mite *Cisaberoptes kenyae* Keifer and 25 eggs of the scale insect *Parlatoria ziziphus* (Lucas) as well as date palm (*Phoenix dactylifera* L.) pollen grains were stuck on a small piece of a double scotch tape placed at equal distances of about 1 cm on the circumference of a circle, about 5 cm in diameter, on the plant leaf at 25±1°C and 70±5% R.H. Moving prey individuals were placed on its dorsum on the scotch tape. Ten predator females of each fed and starved for 24 and 48 hours were tested by introducing them singly in a successive order to the center of the circle and kept under observation till reaching its preferable food. Percentages of females that reached every food and began to feed upon were recorded as well as time to reach the food.

The fourth experiment to see effects of low temperatures on egg incubation period and hatchability and female survivability and fecundity: Sixteen groups of twenty five newly deposited eggs of the predator *T.athiasae* were collected from a culture and kept each in a cylindrical plastic cup (2.0 X 1.2 cm) with a filter paper at its bottom. Relative humidity was maintained by adding few water drops to the filter paper when needed. Eight cups were kept at 10°C and the other eight at 5°C. Two cups for every temperature were moved to room temperature (25°C) after one, two, three and four weeks. Also, two groups each of 25 newly emerged and mated females were confined singly to Munger cages at 10°C and 5°C. Each cage was composed of a glass slide 5 X 10 X 0.3 cm completely covered with filter paper on which a mulberry leaf was placed. A perspex block, 5 X 10 X 1 cm with a central circular hole 3.5 cm diameter rests on top of the glass slide. The predator mites were confined in these cages and repeatedly supplied with immatures of *T.urticae*. A second glass slide served as cover and the hole set was secured by rubber bands. Addition of few drops of water to the filter paper was daily practiced to delay daryness of the plant leaf. The cages were examined daily for 4 weeks.

The fifth experiment was for testing the effect of host plant leaf surface on development and oviposition: Leaf discs of some plants with different textures were put upside down on wet cotton wool pads in Petri-dishes. These leaf discs represented: thin smooth reticulated surface of Bauhinia (*Bauhenia variegata* L.), and mulberry (*Morus alba* L.); velvety surface of apple, cultivar Anna (*Malus sylvestris* Mill.), thick leathery with sooth waxy surface of a grapefruit leaves (*Citrus paradisi* (Mac Fad)) and new mango leaves (*Mangifera indica* L.) and coarsely reticulated surface of guava (*Psidium Juava* L.). Newly hatched larvae (N=30) of *T.athiasae* were confined singly together with surplus amount of *T.urticae* immatures as prey to each of these leaf discs at 25 ±1°C and 70±5% R.H. and left to develop and resulted females were mated and kept to reproduce.

RESULTS AND DISCUSSION

Experiment 1: Effect of Relative Humidity on Egg Hatchability, Female Life Cycle and Fecundity: The four tested relative humidities from 55% to 95% did not show any variable effect on egg hatchability, Table 1. On the other hand, at low R.H. (55%) as well as at high R.H. (95%), incubation period was significantly long (4.0 and 3.9 days); at 70% and 85% R.H., this duration was decreased to about 3 days only. Life cycle duration followed nearly similar trend, being the shortest at 70% and 85% R.H. (8.4 and 9.1 days) and the longest at 55% and 95% R.H. (11.0 and 10.8 days). Opposite to that mentioned in duration of egg incubation and life cycle, female fecundity was the greatest at moderate R.H. of 70% followed by 85% R.H. giving an average of 14.5 and 12.9 eggs / female in 10 days, respectively. The smallest average was obtained at 55% R.H. (8.3 eggs) followed by 95% R.H. (9.1 eggs). Caceres (1990) found no significant difference in the developmental time of *Galendromus helveolus* (Chant) at R.H. from 76% to 100% at 25ºC, while Aly (1994) found R.H. values for *Amblyseius swirskii* Athias-Henriot at 25 ºC similar to our findings.

The optimum relative humidity for *T.athiasae* was between 70% and 85%, while 55% and 95% R.H. gave unpleasant results.

Experiment 2: Effect of Multiple Mating on Female Longevity and Fecundity: The lowest number of eggs produced by female and the shortest longevity (12.9 eggs and 40.5 days) occurred with 12 hours male and female association which considered to be a single mating; highest fecundity and longest female longevity (46.3 eggs and 48.6 days) happened when male was present with female throughout her longevity, Table 2. This agrees with the findings of Overmeer *et al.* (1982) who reported that multiple mating increased female fecundity of *Typhlodromus pyri* Scheuten. A female with two associations of 12 hours with male came in between (29.2 eggs and 43.6 days), the other two groups (single and four associations). In the third group, when male was introduced to female four times (considered four matings), the number of eggs / female and female longevity (33.2 eggs and 44.5 days) came less than in the case of whole presence with male. This may be due to that the latter female had the opportunity for more matings that gave maximal egg production or the presence of male might induce female oviposition. Overmeer *et al.* (1982) stated that for *T.pyri* post-oviposition period was not seen to be characteristic when female had

Table 1. Effect of relative humidity on egg hatchability, female life cycle and fecundity of *T. athiasae* fed on *Tetranychus urticae* immatures at 25°C.

Relative humidity / Parameters	55%		70%		85%		95%	
	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD
Hatching percentage	30	100 ---	30	100 ---	30	100 ---	30	100 ---
Incubation period (days)	30	4.0 ± 0.5	30	3.0 ± 0.5	30	3.1 ± 0.3	30	3.9 ± 0.6
Female life cycle (days)	16	11.0 ± 0.8	18	8.0 ± 0.7	18	9.1 ± 0.7	18	10.8 ± 1.5
No. of eggs / female for 10 days	16	8.3 ± 1.1	18	14.5 ± 1.8	18	12.9 ± 1.5	15	9.1 ± 1.0

LSD 0.05:

Incubation period = 4.0
Life cycle = 0.8
No. of eggs = 0.1

Table 2. Effect of multiple mating on female longevity and fecundity of *T.athiasae* fed on *Tetranychus urticae* immatures at 25°C.

Mating regime	Longevity (days)		No. of eggs / female	
	N	Average*	Total average*	Daily rate
A single mating	10	40.5 ± 3.1	12.9 ± 1.7	1.1
Double associations	10	43.6 ± 2.8	29.2 ± 4.0	1.2
Four periodic associations	10	44.5 ± 2.4	33.3 ± 3.5	1.3
Female with male allover longevity	10	48.6 ± 3.0	46.3 ± 3.2	1.4

LSD 0.05: * Mean ± SD

Longevity = 1.0

Total eggs = 1.4

Daily rate = 0.1

the opportunity for optimal insemination. They also mentioned that 3 endospermatophores 2 in a spermathica and 1 in the other could be observed in female taken from laboratory culture. Endospermatophores usually disappeared in old females, yet in older females, some had another endospermatophore due to new copulation. Statistical analysis showed that multiple mating significantly increased longevity, egg deposition, as female association with one male allover her longevity, resulted in depositing the greatest number of eggs (46.3 eggs). This is supported by the findings of Schulten *et al.* (1978) on *Phytoseius persimilis* Athias-Henriot and *Amblyseius bibens* Blommers and Overmeer *et al.* (1982) on *T.pyri* Scheuten and *A.potentillae* (German).

Thus, it could be concluded that several matings increased *T.athiasae* population, especially during male companionship.

Experiment 3: Attractancy to Different Food Kinds and Types: Adult and immatures of *T.urticae* followed by those of *E.orientalis* gave comparatively the highest percent of attraction in the shortest time. Different stages of *T.cucurbitacearum*, eggs of *E.orientalis* and eggs of *P.zizyphus* gave lowest attraction, Table 3. Female predator reached adult prey in shorter time than prey immatures. Adult and immatures of *T.urticae* and those of *E.orientalis* gave 15% and 10% attraction, respectively of fed female predators in 6.5 and 8.3 minutes for both stages of the former and 12.7 and 14.5 minutes for those of the latter species, respectively. Date palm pollens showed median results. Starved predator females showed similar attitude as that of fed ones except reaching their targets in longer time than their fed counterparts. Here again, adults and immatures of *T.urticae* and *E.orientalis*, respectively, attracted 15 and 10% of the predator females, respectively. Females starved for 48 hours were lazier than those starved for 24 hours. This may be due to deficiency of fats and water contents of starved females which inturn decreases predator activities (Dicke & Groeneveld, 1986).

Experiment 4: Effect of Low Temperatures on Egg Incubation Period, Hatchability and Female Survivability and Fecundity: Data in Table 4 revealed that, in general, egg hatchability percentage decreased as cold storage increased. Total hatchability percentage decreased from 100% to 26% and from 61% to 10% after one to four weeks of cold storage at 10 and 5ºC, respectively. On the opposite incubation period and hatchability percentage of eggs through cold storage increased as storage proceeded. This was a result of the prolongation of cold storage period and consequently, hatchability percentage increased. Female percentage survivability decreased as time increased with great rate at the lower temperature, but

Table 3. Attractancy of *T.athiasae* to different food kinds and types.

Food Type	Fed female		Starved female for 24h.		Starved female for 48h.	
	Percentage of attracted females	Time in minutes	Percentage of attracted females	Time in minutes	Percentage of attracted females	Time in minutes
Tetranychus urticae						
Adults	15	6.5	15	8.2	15	11.2
Immatures	15	8.5	15	10.0	15	9.3
Eggs	10	11.3	10	13.7	10	14.5
Tetranychus cucurbitacearum						
Adults	5	16.5	10	20.5	5	23.0
Immatures	5	20.5	5	22.5	5	25.0
Eggs	5	26.0	5	39.0	5	56.0
Eutetranychus orientalis						
Adults	10	12.7	10	13.7	10	19.2
Immatures	10	14.5	10	18.7	10	21.0
Eggs	5	23.5	5	26.5	5	29.0
Cisaberoptes kenyae						
Active stage	7.5	45.7	5	53.0	7.5	60.7
Parlatoria zizyphus						
Eggs	5	70.0	5	81.0	5	91.0
Date palm						
Pollen grains	7.5	60.3	5	63.0	7.5	65.3

Table 4. Effect of low temperatures on egg incubation period, hatchability, female survivability and fecundity of *T.athiasae*.

Parameters	Cold storage time in weeks							
	10°C				5°C			
	1	2	3	4	1	2	3	4
Incubation period in days T.C.S.	4.0	5.7	7.9	12.8	5.0	6.5	8.6	14.2
Incubation period In days A.C.S.	1.9	1.6	1.4	----	3.8	3.0	1.4	----
Hatchability % T.C.S.	11	22	39	26	2	4	7	10
Hatchability % A.C.S.	89	66	11	----	59	49	23	----
Hatchability % Total	100	88	50	26	61	53	30	10
Survivability of Females	88	69	61	----	84	63	25	----
No. of eggs / female / 10 days	15.9	12.4	7.5	----	11.2	10.7	8.6	----

T.C.S. = Through cold storage.

A.C.S. = After cold storage, kept at room temperature.

being better at 10ºC. Number of female survivors decreased from 88% to 26% and from 84% to 0% when females stored for one to four weeks at 10 and 5ºC, respectively. The number of deposited egg / female also decreased from 15.9 to 8.6 eggs and from 11.2 to 0 eggs with increased storage for one to four weeks at the two aforementioned temperatures, respectively. However, females could be stored at low temperatures better than eggs as more than 60% of females survived and deposited a considerable number of eggs when stored for two weeks at 10 and 5ºC. This agrees with the findings of Gillespie and Ramey (1988) on *Amblyseius cucumeris* Oudemans.

Experiment 5: Effect of Host Plant Leaf Surface on Development and Oviposition: Results showed that host plant obviously affected development and female fecundity of the predatory mite, *T.athiasae,* Table 5. Bauhinia leaf discs representing thin leaf with smooth reticulated surface resulted in the shortest developmental period (7.9 days) and the greatest female fecundity (16.8 eggs/female/ 10 days), while those of guava that of coarse surface gave the longest developmental period (9.7 days) and the least female fecundity (10.8 eggs/female/10 days). Thus, results showed a tendency that smooth reticulated plant leaves resulted in acceleration of development and increase egg deposition. This might be, in part, due to plant leaf physical structure. Similar results were found for *Amblyseius gossipi* El-Badry (Rasmy, 1977 and Fouly, 1982). Thin velvet leaf of apple or with fine reticulation as that of mulberry gave good results near to that of bauhinia. On the opposite, leaf with coarse reticulation like that of guava prolonged development and decreased female fecundity.

Finally, it can be concluded that the optimum relative humidity for *T.athiasae* was 70%-85% R.H.; several matings increased population; adults and immatures of the two-spotted spider mite, *T.urticae* was the preferable food; females could be stored at low temperatures better than eggs and thin smooth reticulated plant leaves accelerated development and increased egg deposition.

Table 5. Effect of host plant leaf on development and female reproduction of *T.athiasae* fed on *Tetranychus urticae* immatures at 25°C.

Host plant	Life cycle (days)			No. of eggs / female / 10 days		
	N	Mean	SD	N	Mean	SD
Bauhenia veriegata L. (Bauhinia)	30	7.9	0.5	18	16.8	1.6
Malus sylvestris Mill. (Apple)	30	8.2	0.9	18	15.0	1.9
Morus alba L. (Mulberry)	30	8.3	0.6	17	14.9	1.2
Citrus paradisi (Mac Fad) (Grape fruit)	30	8.9	0.8	18	12.8	1.0
Mangifera indica L. (Mango)	30	9.8	0.5	17	11.3	1.3
Psidim juava L. (Guava)	30	9.7	0.8	17	10.8	2.9

LSD 0.05:

Life cycle = 0.3

Total eggs = 0.7

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تأثير بعض العوامل الحيوية وغير الحيوية علي بيولوجيا المفترس *Typhlodromus athiasae*

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بدراسة بيولوجيا المفترس الأكاروسي *Typhlodromus athiasae* P.&S. عند تغذيته علي الحلم العنكبوتي ذي البقعتين *Tetranychus urticae* Koch علي درجة حرارة ٢٥°م تبين الأتي:

١- تراوحت درجة الرطوبة النسبية المثلي بين ٧٠-٨٥٪ حيث قللت فترة تاريخ الحياة إلى ٨,٤ و ٩,١ يوماً و زادت من خصوبة الأنثى حيث وضعت متوسط يومي ١٤,٥ و ١٢,٩ بيضة علي الترتيب.

٢- عاشت الأنثى التي لقحت مرة واحدة اقل فترة (٤٠,٥ يوماً) و أعطت اقل كمية من البيض (١٢,٨ بيضة) مقارنة بالأنثى التي لقحت ٤ مرات و الأخرى التي ترك معها الذكر طيلة فترة حياتها حيث عاشت الأخيرة متوسط ٤٨,٦ يوماً ووضعت متوسط ٤٦,٣ بيضة.

٣- بالنسبة لانجذاب هذا المفترس لفرائسه المختلفة من الأكاروسات و الحشرات وجد أن أطوار الحلم العنكبوتي ذي البقعتين هي الأكثر جذبا لهذا المفترس في حين كان اقلها بيض الحشرة القشرية *Parlatoria zizyphus* (Lucas) .

٤- اتضح أن درجات الحرارة المنخفضة ٥°م و١٠°م أطالت مدة حضانة البيض كما قللت نسبة الفقس، كما أظهرت الأنثى الكاملة تحملا للبقاء علي درجات الحرارة المنخفضة اكثر من البيض.

٥- وجد أن الأوراق النباتية الناعمة مثل أوراق نبات *Bauhenia variegata* L. تعمل علي إسراع نمو و زيادة كمية البيض الموضوع لهذا المفترس الأكاروسي (٧,٩ يوم و ١٦,٨ بيضة) بالمقارنة بأوراق النباتات الخشنة مثل أوراق الجوافة (٩,٧ يوم و ١٠,٨ بيضة).