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Laboratory Studies on *Euseius metwallyi* a Predator of the Spider mite *Tetranychus urticae* on Fruit trees in Egypt (Acarina: Phytoseiidae: Tetranychidae)

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ABSTRACT

Some biological data of the phytoseiid mite species *Euseius metwallyi* were investigated to evaluate its ability in controlling the two-spotted spider mite *Tetranychus urticae* Koch on certain fruit trees under laboratory condition of 28±2°C and 74±4% R.H. Adult *E. metwallyi* females were reared singly during their adulthood on apple, apricot, fig, grape and peach leaf discs and provided daily with constant number of *T. urticae* immature stages and adult females (5 preys/predator female). The predator appear more efficient on *T. urticae* immature stages. Adult female longevity, prey consumption and fecundity were significantly differed between leaves of the tested plants. The longest longevity (15.4 and 16.4 days), the greatest prey consumption (35.2 and 65.2 preys) and the highest fecundity (10.2 and 12.6 eggs) were recorded on peach leaves when feeding on *T. urticae* adult females and immature stages, respectively. On the other hand the shortest longevity (9.4 and 10.2 days), the lowest prey consumption (21.6 and 34.8 preys) and the least fecundity (3.8 and 4.2 eggs) were recorded on apricot leaves, when predator female fed on *T. urticae* adult females and immature stages respectively. The shortest duration period (4.4 days) and the highest prey consumption (18 preys) of *E. metwallyi* nymphal stages were recorded when feeding on *T. urticae* larvae. Predator female consumed significantly more preys (43.6 preys) and deposited significantly greater number of eggs (14.00 eggs) when feeding on *T. urticae* larvae than other prey stages. These results indicated that, plant leaf surface and prey stage are important factors affecting efficiency of this predator against the investigated prey pest.

Key words: Phytoseiidae, Tetranychidae, *Euseius metwallyi*, *Ttetranychus urticae*, plant leaf surface, prey stage

INTRODUCTION

The two-spotted spider mite *Tetranychus urticae* Koch is considered as worldwide damaging pest of fruit trees (Pringle *et al*., 1994; Kasap, 2003, 2004; Ma-Li *et al*., 2005; Liu *et al*., 2006). Several predaceous phytoseiid mite species are important biological control agents of pest mites affecting many crops in different parts of the world (Helle and Sabelis, 1985). There are different factors influence the efficiency of these predators, among these plant leaf characteristics (Ali *et al*., 1997; Krips *et al*., 1999; Koveos and Broufas, 2000; Kreiter *et al*., 2002; Elsawi and Alazzazy, 2007). Castagnoli and Simoni (1999) and Badii *et al*. (1999, 2004) studied prey stage preference and functional response of *Neoseiulus californicus* and *Euseius hibisci* to different stages of *T. urticae*.

In the fruit orchards of Sharkia Governorate, Egypt, the predatory mite *Euseius metwallyi* proved to be the most dominant species among plant inhabiting phytoseiid mites preferentially attack the two spotted spider mite *T. urticae* (Mostafa, 2004; Basha, 2005; Al-Garhy, 2008).

This study was carried principally to clarify influence of plant leaf surface as a factor affecting longevity, prey consumption and fecundity of *E. metwallyi* adult females when feeding separately on constant number of *T. urticae* immature stages and adult females daily (5 preys/predator female/day) on apple, apricot, fig, grape and peach leaves. Effect of prey stage on nymphal stages and adult female *E. metwallyi* when fed on constant number of different stages of *T. urticae* was also investigated.

MATERIALS AND METHODS

Laboratory cultures of the predatory mite *E. metwallyi* were maintained on grapevine leaves which were placed singly upside down on a wet cotton wool in opened Petri dishes. Cultures were kept at laboratory conditions and predator was fed on different stages of *T. urticae* three times per week (Pratt *et al.*, 1999). Laboratory cultures of the two-spotted spider mite *T. urticae* were established on bean leaves *Phaseolus vulgaris* L.

To study longevity, prey consumption and fecundity of *E. metwallyi* as influenced by plant leaf surface, the predator female was reared singly one apple (*Malus pumila* L.), apricot (*Prunus armnaea* L.) fig (*Ficus carica* L.), grape (*Vitis vinifera* L.) and peach (*Prunus persica* L.) leaf discs about of 3 cm in diameter as rearing arenas as method described by Yousef and El-Halawany (1982). Leaf discs were placed singly upside down on cotton wool pads soked in water in opened Petri - dishes. Each leaf disc was surrounded by a wet strip of cotton wool to prevent mite individuals from escaping and to supply them with water (Castagnoli and Simoni, 1999). Enough moisture in the cotton layer was maintained by adding few drops of water daily. A total of 30 mated females *E. metwallyi* from stock culture were individually isolated and placed singly on 30 replicated leaf discs for each plant tested. Predator females were fed singly during their adulthood on constant number of *T. urticae* adult females (first experiment) and immature stages (second experiment) (5 prey individuals/ predator female/day). All of experimental dishes were placed in transparent plastic containers and kept under laboratory conditions. Rearing female individuals were observed daily until all individuals died to determine their longevity. The number of consumed preys and deposited eggs per female were recorded. All consumed preys were replaced with other alive ones.

To study the effect of prey stage on duration and prey consumption of *E. metwallyi* nymphal stages, a total of 30 quiescent larvae were transvered individually and placed singly on 30 replicated grapevine leaf discs (as previously described) for each prey stage tested and provided daily with constant number of eggs, larvae, nymphs, males and females of *T. urticae* during nymphal stage (10 preys/leaf disc/day). Rearing individuals were examined twice a day and the duration of proto and deutonymphal stages was recorded for each prey stage. The devoured prey individuals from each prey stage were recorded and replaced by other alive ones.

Studying prey consumption and oviposition of *E. metwallyi* adult female as influenced by prey stage, predator female was reared singly on grapevine leaf discs (as previously described). A total of 30 newly mated females were transferred individually and placed singly on 30 replicated leaf disc for each of the abovementioned prey stages. Predator females were fed singly on constant number of each prey stage tested (10 preys/leaf disc/day). Observations were made daily and the number of consumed individuals of each prey stage and deposited eggs per female were registered for 10 days after mating. All consumed individuals were replaced with another alive ones. Basha *et al.* (2007) found that, the oviposition period of *E. metwallyi* did not extend beyond a mean of 11.17 days when fed on *T. urticae* females. Experiments were carried out under laboratory

conditions of 28±2°C and 74±4% R.H. Data were subjected to statistical analysis using F-test according to Snedecor (1966).

RESULTS AND DISCUSSION

Effect of plant leaf surface: Data presented in Table 1 and 2 show adult female longevity, prey consumption and fecundity of the predatory mite *E. metwallyi* on apple, apricot, fig, grape and peach leaf discs, when feeding separately on constant number of immature stages and adult females of *T. urticae* (5 preys/predator female/day) at 28±2°C and 74±4% R.H.

Adult female longevity: Average duration of *E. metwallyi* adult female longevity when fed separately on adult females and immature stages of the two- spotted spider mite *T. urticae* was significantly influenced by leaf surface of tested plants. The highest longevity was recorded on peach leaves. On contrary apricot and fig leaves resulted the lowest longevity. However apple and grape leaves gave moderate values. Duration of *E. metwallyi* adult female longevity when fed on adult females of *T. urticae* averaged 11.4, 9.4, 9.8, 12.6 and 15.4 days on apple, apricot, fig, grape and peach leaves, respectively (Table 1). Feeding on *T. urticae* immature stages, these values slightly increased to reach 12.8, 10.2, 10.4, 14.2 and 16.4 days on leaves of the aforementioned tested plants, respectively. These results nearly agree with the data which were obtained by Elsawi and Alazzazy (2007) on strawberry cultivars. Elsawi and Alazzazy (2007) mentioned that the longevity of *Euseius scutalis* (El-Badry) and *Typhlodromips swirskii* (Athias-Henriot) was greatest (31.92 and 28.48 days) on strawberry cultivar Yaeel (smooth slight hairy) and the

Table 1: Longevity, prey consumption and fecundity of *E. metwallyi* adult female on arenas of five fruit tree leaves when fed on constant number of *T. urticae* adult females

		Prey consumption		No. of deposited eggs	
Fruit tree	Longevity	T.a.	D. m.	T.a.	D. m.
Apple	11.40±0.87	27.20±2.06	2.39±0.03	6.40±0.98	0.55±0.05
Apricot	9.40±0.51	21.60±1.69	2.29±0.12	3.80±0.37	0.40±0.04
Fig	9.80±0.58	23.80±1.16	2.45±0.14	4.80±0.97	0.48±0.08
Grape	12.60±0.24	31.20±0.58	2.48±0.05	9.20±1.36	0.73±0.11
Peach	15.40±0.81	35.20±2.06	2.28±0.05	10.20±0.73	0.66±0.02
$LSD_{0.05}$	1.9389	4.4739	NS	3.0142	0.2199

Values are as Mean±SE, T.a.: Total average, D.m.: Daily mean, NS: Not significant

Table 2: Longevity, prey consumption and fecundity of *E. metwallyi* adult female on arenas of five fruit tree leaves when fed on constant number of *T. urticae* immature stages

		Prey consumption		No. of deposited eggs	
Fruit tree	Longevity	T.a.	D. m.	T.a.	D. m.
Apple	12.80±0.66	48.60±2.20	3.80±0.06	8.20±0.86	0.63±0.03
Apricot	10.20±0.58	34.80±0.80	3.44±0.15	4.20±0.37	0.41±0.02
Fig	10.40±0.51	35.60±2.98	3.43±0.25	5.40±0.51	0.52±0.03
Grape	14.20±0.49	55.20±2.54	3.89±0.13	10.80±1.43	0.75±0.08
Peach	16.40±0.93	65.20±4.65	3.98±0.18	12.60±1.75	0.76±0.08
$LSD_{0.05}$	1.9299	8.5946	0.4896	3.2956	0.1679

Values are as Mean±SE, T.a.: Total average, D.m.: Daily mean

shortest (19.40 and 15.50 days) on cultivar Vantana (rough dense hairy) for each predator, respectively. Al-Shammery (2010) found that immature stages of *T. urticae* significantly prolonged longevity time and caused the highest rate of egg production of the predatory mite *Euseius scultalis*.

Prey consumption: Data presented in Table 1 and 2 indicated that leaf surface of the tested plants showed significant differences in their effect on the ability of *E. metwallyi* adult females to consume adult females and immature stages of *T. urticae*. The mite appears more efficient when fed on immature stages of the introduced prey (Table 2). The greatest number of prey individuals consumed by predator female was recorded on peach leaf discs, as it consumed a total average of 35.2 and 65.2 prey individuals when fed on adult females and immature stages of *T. urticae*, respectively. On the other hand, the lowest averages of devoured preys were resulted on apricot and fig leaf discs, as it devoured a total average of 21.6 and 34.8 and 23.8 and 35.6 prey individuals when fed on *T. urticae* adult females and immature stages, respectively.

On grape and apple leaf discs, these averages were 31.2 and 55.2 and 27.2 and 48.6 prey individuals when fed on adult females and immature stages of the above mentioned prey, respectively (Table 1, 2). The daily mean of prey consumption of *E. metwallyi* ranged from 2.28 to 2.48 prey individuals when fed on adult females of *T. urticae* with insignificant differences between the tested plant leaves (Table 1). These values were slightly higher on *T. urticae* immature stages, with significant differences between the investigated plant leaves. The daily mean of prey consumption was lower (3.43 and 3.44) on fig and apricot leaves and higher on apple and grape leaves (3.8 and 3.89). The highest daily mean of prey consumption (3.98) was recorded on peach leaf discs (Table 2).

Results were obtained by Rasmy and El-Banhawy (1974), indicated that *Phytoseius plumifer* Canestrini and Franzago consumed a high number of *Tetranychus cinnabarinus* (Boisduval) nymphs when held on hairy leaves of fig (*Ficus carcia* L.) than on the smooth leaves of sour orange (*Citrus aurantium* L.). They assumed that the difference in consumption rate between the two plants could be to the higher disturbance of *P. plumifer* on the smooth sour orange leaf surface by the prey individuals which exhibit a higher walking activity than on the hairy fig leaves. The predation efficiency of *Amblyseius cucumeris* of *Frankliniella occidentalis* was higher on sweet pepper leaves than on cucumber leaves and assumed that this was due to the higher trichome density of the cucumber leaves (Shipp and Whitfield, 1991). Krips *et al.* (1999) reported that, the predation rate of adult female *Phytoseiulus persimilis* was affected by trichome density, particularly when prey density (*T. urticae* eggs) was low. These negative effect on searching efficiency and predation success at low prey density of *P. persimilis* suggest that biological control of *T. urticae* on gerbera may be hampered by leaf hairs. The host plant has a substantial effect on predation efficiency of the phytoseiids *Amblyseius andersoni* and *Euseius finlandicus* when they preyed on adult females but not when they preyed on larvae of *Panonychus ulmi* (Koveos and Broufas, 2000).

Female fecundity: Fecundity of *E. metwallyi* female was likewise affected significantly by leaf surface of the tested plants. The total ovisposition rate reached its maximum average of 10.2 and 12.6 eggs on peach leaf discs when predator female fed on adult females and immature stages of *T. uticae* respectively. This value was lowest (3.8 and 4.2, 4.8 and 5.4) on apricot and fig leaves when fed on adult females and immatures of the abovementioned prey, respectively. Predator female fed on *T. uticae* adult females and immature stages deposited 9.2 and 10.8 and 6.4 and 8.2 egg on grape and apple leaf discs, respectively (Table 1, 2).

Considering the daily ovisposition rate of *E. metwallyi* adult female as influenced by plant leaf surface, data in Table 1 and 2 showed that the daily oviposition rate differed significantly between leaves of the investigated plants, where it reached its highest maximum average of 0.73 and 0.75 egg/day on grape leaves when predator female fed on *T. urticae* females and immature stages, respectively (Table 1, 2), where it reached its highest maximum average of 0.73 and 0.75, eggs per day on grape leaves when predator female fed on *T. urticae* immature stages (Table 1, 2). On the other hand, the lowest daily ovisposition rate (0.40 and 0.41 egg/day) was observed on apricot leaves when the predator female fed on adult females and immature of *T. urticae*, respectively. Results obtained by Ali *et al.* (1997) indicated that, fecundity of *Phytoseiulus macropilis* (Banks) was the greatest (68.3 eggs) on thin smooth reticulated leaf of mulberry, while coarse Lantana leaf gave the least number of deposited eggs (24.3 eggs).

Effects of prey stages

Duration and prey consumption of *E. metwallyi* nymphal stages: Data presented in Table 3 indicated that duration of nymphal stages (proto and deutonymph) was significantly affected by stage of the introduced prey. The shortest period of proto and deutonymphal stages was 1.9 and 2.5 days when fed on larvae of the spider mite *T. urticae*. On contrary, the longest period of proto and deutonymphal stages was 2.5 and 3.1 days when feeding on *T. urticae* adult females.

In general, the duration of nymphal stage of the predator was shorter (4.4 and 4.7 days) when feeding on larvae and nymphs of *T. urticae* and longer (4.9 and 5.0 days) on eggs and adults male. The longest period of the nymphal stages was recorded on adult females of *T. urticae* (5.6 days).

Concerning prey consumption of *E. metwallyi* nymphal stages, it can be noticed in Table 3 that differences in the total prey consumption of proto and deutonymphal stages of *E. metwallyi* among the introduced stages of prey are significant.

Proto and deuto nymphal stages devoured higher numbers of preys when fed on larvae of *T. urticae* (7.4 and 10.6) than that when fed on another prey stages tested. Generally, during nymphal stages, the predator consumed greater number of prey individuals when fed on larvae (18) followed descendingly by eggs (16), nymphs (11.2), males (10) and females (7.8) of *T. urticae*. Badii *et al.* (1999) found that protonymphs and deutonymphs of *Phytoseiulus longipes* consumed mean minimums of 3.15 and 3.56 eggs of *T. urticae,* respectively to complete their development at prey density of 20 eggs per excised leaf arena. Average spider mite *T. urticae* larvae consumed by *Euseius finlandicus* (Oudemans) during immature stages were 9.18 for males and 11.85 for females. Adult *E. finlaudicus* females consumed an average of 166.38 spider mite protonyumphs during adult stage compared to an average of 66.55 by males (Abdallah *et al.*, 2001).

Table 3: Duration (in days) and prey consumption of *E. metwallyi* nymphal stages when fed on *T. urticae* different stages

	Durations (in days)			Total consumption		
Prey stage	Protonymph	Deutonymph	Total nymphal stages	Protonymph	Deutonymph	Total nymphal stages
Egg	2.1±0.19	2.8±0.12	4.9±0.19	7.0±0.32	9.0±0.63	16.0±0.45
Larva	1.9±0.19	2.5±0.16	4.4±0.29	7.4±0.75	10.6±0.75	18.0±1.00
Nymph	2.0±0.16	2.7±0.12	4.7±0.20	4.8±0.20	6.4±0.24	11.2±0.20
Male	2.2±0.12	2.8±0.12	5.0±0.22	4.4±0.40	5.6±0.24	10.0±0.63
Female	2.5±0.16	3.1±0.19	5.6±0.29	2.4±0.24	5.4±0.51	7.8±0.73
$L.S.D._{0.05}$	0.4847	0.4275	0.7166	1.2654	1.5272	1.9479

Values are as Mean±SE

Table 4: Prey consumption and oviposition of *E. metwallyi* adult female when fed on *T. urticae* different stages during 10 days after mating

Prey stage	Total prey consumption	Total deposited eggs
Egg	36.40±1.17	8.00±0.55
Larva	43.60±0.51	14.00±0.45
Nymph	26.80±0.58	13.00±0.32
Male	23.00±0.32	9.80±0.37
Female	20.80±0.49	10.80±0.20
$LSD_{0.05}$	2.0008	1.1652

Values are as Mean±SE

Prey consumption and oviposition of E. *metwallyi*: It can be noticed in Table 4 that the total average of devoured prey individuals and deposited eggs per predator female during 10 days after mating were significantly affected by stage of the introduced prey.

Predator female devoured a considerably greater number of prey individuals when fed on larvae (43.6) and eggs (36.4) than that when fed on nymphs (26.8), male (23.0) and females (20.8) of *T. urticae*.

During the 10 days experimental period, there were significant differences in the number of eggs laid by predator female between different stages of the introduced prey. Feeding on *T. urticae* larvae and nymphs resulted a considerably greater number of deposited eggs (14 and 13 eggs). The least number of deposited eggs (8.00) was recorded on *T. urticae* eggs. The total average of deposited eggs of predator female was 9.8 and 10.8 eggs when fed on *T. urticae* males and females, respectively (Table 4). Results obtained by Badii *et al.* (2004) indicated that *Euseius hibisci* (Chant) consumed significantly more *T. urticae* eggs than other prey stages. Shih and Ji (2001) showed that, among all the tested prey stadia, the female *T. urticae* gave the highest reproductive values, but the lowest predation rates of *Amblyseius ovalis* (Evans). The size activity and the webbing produced by prey females were assumed to be major factors preventing predation. These results indicated that, the phytoseiid species *E. metwallyi* may be considered as potential biological control agent of the phytophagous mite *T. urticae* infesting fruit trees. Plant leaf surface and prey stage are of important factors affecting the efficiency of this predator in suppressing populations of the phytophagous mite *T. urticae* on investigated fruit trees.

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