The Phytoseiid Mite, *Phytoseiulus macropilis* as a Biological Control Agent Against Tetranychid Mite Species in Egypt (Phytoseiidae-Tetranychidae)

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ABSTRACT

Phytoseiulus macropilis (Banks) Phytoseiidae developed and oviposited when provided immature stages of *Tetranychus cucurbitacearum* (Sayed), *Eutetranychus orientalis* (Klein) and *Oligonychus mangiferus* (Rahman and Sapra) (Tetranychidae), as prey at 25±2°C and 65±5% R.H. It was significantly affected by food source but a slight difference was noticed between females and males. The efficiency of the predator increased as advanced in development. Also, it developed faster (5.97 days for females and 5.38 days for males), lived longer (44.51 and 37.44 days for females and males, respectively and gave highest egg production (62.82 eggs) when fed on *T. cucurbitacearum* immatures. The number consumed of each prey predator female was significantly greater than that consumed by male. During the adult longevity the predator consumed higher numbers of *T. cucurbitacearum* (191.39 individuals / female and 158.76 individuals / male), than those of *O. mangiferus* (180.97 and 150.13 individuals for each sex, respectively.

Key words: Biology; *Phytoseiulus macropilis*; Biological control; Tetranychidae.

INTRODUCTION

Phytophagous mites, *Tetranychus cucurbitacearum* (Sayed), *Eutetranychus orientalis* (Klein) and *Oligonychus mangiferus* (Rahman and Sapra) (Tetranychidae), are the most important mite pests of agricultural crops in Egypt. Its population outbreaks cause serious damage and yield losses. The citrus brown mite, *E. orientalis* usually attacks citrus and is a persistent pest in Egypt, preferring citrus trees and other hosts including cotton, squash and grapevine (Kandeel *et al*., 1986). *O. mangiferus*, is a major mango pest in Egypt, damages leaves and affects the quality of the fruit (Abou-Awad *et al*., 2011). Traditionally, spider mites have been controlled with acaricides, resulting in problems of pesticides resistance and negative affect on natural enemies. Although natural enemies of phytophagous mites have been reported from several acarine families, yet those of the family Phytoseiidae are considered efficient biological control agents of tetranychids in a number of Egyptian cropping systems (El-Bagoury *et al.,* 1989; Momen and El-Borolossy, 1997 and Heikal and Ibrahim, 2013). The Predatory mite, *Phytoseiulus macropilis* has efficacy against phytophagous mites (Oliveira *et al*., 2009 and Fadini *et al.*, 2010). In Egypt, little information is known about the biological control potential, reproductive capacity and rate of development of *P. macropilis* under laboratory conditions (Ali, 1998). The objective of this research was to determine the biological parameters of *P. macropilis* using three tetranychid mite species as food sources under controlled laboratory conditions, to determine the predator's potential in an integrated pest management (IPM) program of phytophagous mites on different crops in Egypt.

MATERIALS AND METHODS

Cultures of the predatory mite and preys:

The original population of *T. cucurbitacearum* was collected from cucumber plants *(Cucumis sativus* L.), the citrus brown mite, *E. orientalis* from citrus orchards (*Citrus paradisi* Macf.), *O. mangiferus* from mango orchards (*Mangiferae indica* L) and the predaceous mite, *P. macropilis* from strawberry (*Fragaria ananassa* Weston) from the farm of Faculty of Agriculture, Suez Canal University, Ismailia, Egypt, reared in the laboratory and a stock culture was maintained throughout the course of this study under 25±2°C and 65±5% relative humidity with 16:8 L:D h. photoperiodic regime.

Effect of preys on development of *P. macropilis*:

The rearing arena (3 cm) of excised castor bean leaves was placed on water saturated cotton in plastic Petri dishes (9 cm). Water saturated, absorbent cotton strip, 1-cm wide, was placed around the edge of the leaf to prevent mites from escaping and to hold the leaf flat. Thirty *P. macropilis* eggs for each test were transferred individually with a fine brush to every arena, and the newly hatched larvae were supplied with the food resource to be evaluated. Developmental stages and survival rate were recorded twice daily. Consumed prey immatures were replaced daily by fresh ones to maintain an ample food supply.

Effect of preys on longevity and fecundity of *P. macropilis*:

Newly emerged and mated females were confined individually on test arenas, along with the food. A few strands of cotton wool were provided as an ovipositor site on each arena. Ovipositon and survival were recorded. Thirty females of singly *P. macropilis* in each experiment were observed three times daily. The data about duration of different stages, fecundity and longevity were analyzed by one way analysis of variance (ANOVA) and the means were separated using Duncan's Multiple Range test (CoStat® Statistical Software, 2005).

RESULTS AND DISCUSSION

Developmental periods:

Results in Table 1 revealed that *P. macropilis* developed to adult stage when reared on immatures of *T. cucurbitacearum*, *E. orientalis* and *O. mangiferus* under 25±2 °C and 65±5% R.H. The average period of *P. macropilis* egg durated 1.99 days when fed on *T. cucurbitacearum* being nearly the same (2.41 and 2.11 days) when fed on *E. orientalis* and *O. mangiferus*, respectively. This agree with those obtained by (Ali, 1998), and Shih *et al*. (1979) when *P. macropilis* fed on *T. urticae* eggs but longer than those obtained by (Prasad, 1967; 1.79 day). Mean female duration duration of different stages of *P. macropilis* was lowest (1.10, 1.11 and 1.77 days) for larvae, protonymph and deutonymph, respectively) when fed on *T. cucurbitacearum* as compared to fed on *E. orientalis* and *O. mangiferus*. Also, the developmental time was significantly affected by food source as it lasted 3.98, 4.27 and 4.64 days for females and 3.39, 4.04 and 3.7 for males with a slight difference noticed between both protonymphs sexes ($p = 0.05$). Larvae changed to protonymphs without feeding. This phenomenon was common in some phytoseiids (El-Badry *et al*., 1968; El-Bagoury *et al.*, 1989; Momen and El-Borolossy, 1997 and Ali, 1998). Immatures of *T. cucurbitacearum* accelerated the development than those of *E. orientalis* and *O. mangiferus*. Mean female longevity was significantly longer on *T. cucurbitacearum* than other preys (44.51 days) and oviposition period was also longer (Table 1). Males followed a similar trend; mean male longevity was significantly longer on *T. cucurbitacearum* (37.44 days) followed by *O. mangiferus* and *E. orientalis*, respectively. Total average of immature stages was shorter when the predator fed on *T. cucurbitacearum* than *E. orientalis* and *O. mangiferus*. Ali, (1998) reared *P. macopilis* on *E. orientalis* immatures at 25 °C, and found that the predator developed to adult within 4.0 days. Shih *et al.*, (1993) found that egg durations of predator mite, *Amblyseius ovalis* (Evans) fed on *O. mangiferus* and *E. orientalis* required 1.86 and 1.88 days while larvae lasted 0.87 and 1.01 days, protonymphs 0.99 and 1.01 days and deutonymphs 1.03 and 1.12 days taking 4.88 and 4.89 days to complete their immature stages, respectively. Variation concerning bionomics of different predators fed on the same preys, may be due to species differences. Momen and El-Borolossy, (1997) evaluated potential of nine phytoseiid species as predators of *E. orientalis*. They found that *Amblyseius barkeri* (Hughes), *A. olive* Nasr and Abou-Awad, *Typhlodromus atbiasae* Porath and Swirski and *T. transualensis* (Nesbitt) developed from larvae to adult when fed on *E. orientalis*; while development not complete in case of *A. badryi* Yousef and El-Badry, *A. cabonas* (Schicha), *A. lindquisti* Schuster and Pritchard, *T. balanites* El-Badry and *T. talbii* Athias-Hnriot.

Reproductive potential:

The pre-oviposition and oviposition periods were almost the same when the predator fed on the three tetranychid mites (Table1). The oviposition period was longer on *T. cucurbitacearum* (36.31 days) compared with other preys. The total number of deposited eggs was 62.82, 54.80 and 52.99 eggs/female when the predator fed on *T. cucurbitacearum*, *E. orientalis* and *O. mangiferus*, respectively. The female longevity was longer on immatures of *T. cucurbitacearum* (44.51 days), while being 39.34 and 40.76 days when fed on *E. orientalis*, *O. mangiferus* immatures, respectively. Female predator laid their eggs among the spider mite webbing, near the midrib. Oviposition period prolonged when the predator fed on *T. cucurbitacearum* (36.31 days). The Post-oviposition showed not significant differences (Table1). On the opposite (Ali, 1998), who found that the predator developed to adult when fed on *E. orientalis* immatures but the females failed to lay eggs and died within 2 or 3 days. The Oviposition period of *P. macropilis* in study of Shih *et al*., (1979) was 44 days when fed on *T. urticae* eggs. On the other hand, Khan and Afzal, (2005) found that the pre-oviposition of period *A. buntex* was 3.3 days, when fed on *E.orientalis*. El-Bagoury *et al*., (1989) found that feeding of *Amblyseius gossipi* El-Badry on immatures of *E.orientalis* gave longer ovipostion period and high female fecundity. Feeding on *T. cucurbitacearum* shortend adult longevity and increased female fecundity compared with the other preys. Similar results were obtained by (Al-Shammery, 2010), who noticed that feeding of *Euseius scutalis* (Athias-Henriot) on motile stages of *E. orientalis* caused highest rate of egg production (1.17 egg/female) and shortest adult female longevity (22.60 days). Ali, (1998) found that *P. macopilis* laid more eggs when fed on *T. urticae* than *E. orientalis* immatures, and suggested that *P. macopilis* is adapted to searching for *T. urticae* in their webbing. Shih *et al.* (1993) found that the predatory mite, *A. ovalis* produced 42.73 egg/female when reared on 25 °C and fed on *O. mangiferus*. On other hand, Khan and Afzal, (2005) found that maximum total fecundity (27.67 eggs/female) was observed when *Agistemus buntex*

Table1: Duration in days (Means ± SD) of different stages and reproductive rate of *P. macropilis* (n=30) fed on tetranychid mite species at 25±2°C and 65±5 R.H.

Predator stage	Prey					
	T. cucurbitacearum		*E. orientalis*		*O. mangiferus*	
	♀	♂	♀	♂	♀	♂
Egg	1.99 a±0.11		2.41 b±0.26		2.11 b±0.15	
Larva	1.10 a±0.05	1.07a±0.15	1.13a±0.05	1.09a±0.15	1.31a±0.11	1.06a± 0.10
Protonymph	1.11a±0.38	1.11a±0.00	1.23 a±0.10	1.12a±0.11	1.37a±0.38	1.31a±0.22
Deutonymph	1.77a±0.05	1.21a±0.05	1.91b±0.12	1.83a±0.12	1.96 a±0.05	1.33a±0.38
Total immatures	3.98 a±0.38	3.39b±0.38	4.27 b±0.11	4.04a±0.05	4.64 b±0.05	3.70b±0.11
Life cycle	5.97 a±0.10	5.38b ±0.05	6.68 b±0.31	6.45a±0.38	6.78 b±0.11	5.81b±0.09
Pre-oviposition	2.47a±0.15	-	1.72b±0.21	-	1.99b±0.05	-
Oviposition	36.31a±0.38	-	35.13a±0.05	-	35.33a±0.25	-
Post-oviposition	393a±0.23	-	3.51a±0.41	-	3.92a± 0.34	-
Longevity	44.51a±0.11	37.44a±0.14	39.34b±0.38	33.17b±0.38	40.76b±0.15	36.09a ±0.51
Daily fecundity	1.73a±0.66	-	1.56a±0.05	-	1.51a± 0.11	-
Total fecundity	62.82a±.06	-	54.80b±1.43	-	53.35b±0.38	-

Means in the same row followed by the same letter are not statistically different, *p* = 0.05 Duncan's Multiple Range test.

Table 2: Feeding capacity (average ± SD) of *P. macropilis* fed on different prey species

Predator stage	Sex	Average number of consumed preys:					
		T. cucurbitacearum		*E. orientalis*		*O. mangiferus*	
		T. a.	D. r.	T. a.	D. r.	T. a.	D. r.
Protonymph	♀	3.65a±0.23	3.03a±0.21	2.75b±0.38	2.24c±0.10	2.43b±0.61	2.43 b±0.11
	♂	3.15b±0.35	2.78a±0.11	2.45b±0.15	2.11a±0.15	2.35 a±0.12	1.73 a ±0.75
Deutonymph	♀	6.89a±0.26	3.83a±0.11	4.72a±0.38	2.47b±0.12	4.57b ±0.31	2.33 b ±0.15
	♂	6.53a± 0.41	3.50a±0.26	4.50b±0.25	2.46b±0.37	4.47 b ±0.32	2.13 b±0.01
Longevity	♀	191.39a±0.31	4.30a±0.10	183.72c±0.11	4.67a±0.05	180.97 b ±0.89	4.44 a± 0.17
	♂	158.76c±0.12	4.24a±0.15	151.59a±0.11	4.57 a ±0.89	150.13b± 0.38	4.16 a± 0.25

Means in the same row followed by the same letter are not statistically different at *p* > 0.05 Duncan's Multiple Range test)
T a = Total average; D r = Daily rate

Chaudhri fed on *E. orientalis*.

Predatory efficiency:

The consumption rate of the tested preys increased through the developmental stages of the predator, respectively. Protonymph and deutonymps fed on greater total average and daily rate of *T. cucurbitacearum* than those of *E. orientalis* and *O. mangiferus* (Table2). During the adult longevity the predator consumed higher number of *T. cucurbitacearum* (191.39 for females and 158.76 for males) than other preys; while the lowest consumed number was (167.98 for females and 141.66 for males) when fed on *E. orientalis*.

Females of *P. macropilis* preferred to feed on immatures of *T. cucurbitacearum* followed by those of *E. orientalis* and *O. mangiferus*. Similar findings were observed on *A. gossipi* (El-Badry *et al*., 1968) and on *Phytoseius solanus* El-Badry (El-Bagoury *et al*., 1989). Ali, (1998) found that female predator consumed 192.8 eggs with a daily rate 4.4 eggs, while male consumed 131.4 eggs with a daily rate 3.5 eggs. Fantinou *et al*. (2012) found that the phytoseiid, *Iphiseius degenerans* (Berlese) consumed more individuals of *E. orientalis* than of *T. urticae* at 25 ± 1°C and 60 % R.H. The importance of the predator, *P. macropilis* in the control of *T. cucurbitacearum*, *E. orientalis* and *O.mangiferus* has been indicated. However complementary studies should be conducted on this predator.

In conclusion, Our results showed that *P. macropilis* has been able to multiply rapidly and to succeed in the control of tetranychid mite species. It can be used in biological control programs in Egypt. Furthermore, the methods for mass rearing of this species are already known (Heikal *et al*., 2007; Heikal and Ibrahim, 2013).

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