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Life tables, functional and numerical responses of predatory mite *Phytoseius finitimus* (Ribaga) (Acari: Phytoseiidae) to different densities of two eriophyoid mites *Aceria ficus* and *Rhyncaphytoptus ficifoliae*, infesting fig orchards.

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Phytoseius finitimus (Ribaga) (Acari: Phytoseiidae) is a small sized predator and has a tendency to inhabit pubescent plants like fig orchards, where the efficiency of other larger predatory mites may be impeded. Bioassays were conducted in the laboratory at 26°C and 65% R.H. Mobile stages of the fig bud mite *Aceria ficus* Cotte (Eriophyidae) and the fig leaf mite *Rhyncaphytoptus ficifoliae* Keifer (Diptilomiopidae) were offered as prey at densities 10, 20, 40 and 80 individuals. The results showed that the type of eriophyoid prey significantly affected development, female longevity, sex ratio, fecundity and predatory efficiency of *P. finitimus*. *A. ficus* ranked the most suitable prey followed by the fig leaf mite. At density 40 individuals, a higher fecundity was reported on *A. ficus* (43.68 eggs) followed by *R. ficifoliae* (31.47 eggs). At the same density, population of the predator could multiply 43.68 and 31.47 (R_0=43.68 and 31.47) in a generation time of 15.64 and 15.98 days (T=15.64 and 15.98) when predator fed on both previous prey, respectively. The attack rate (a) / the handling time (T_h) or (a/T_h) values indicate that *P. finitimus* was the most effective against eriophyoids prey. The calculated maximum number of consumed prey/predator/day (K) for *A. ficus* and *R. ficifoliae* were 200 and 66.67 individuals, respectively. Pollen grains of *Zea mays* (corn) are a better diet for predator than *Ricinus communis* (castor bean) in terms R_0, T, rm, e^{rm}, GRR, DT and ARI. These results suggest that *P. finitimus* could effectively regulate populations of harmful eiophyoid mites in fig orchards.

Keywords: Biology, *Phytoseius finitimus*; Phytoseiidae; *Aceria ficus*; *Rhyncaphytoptus ficifoliae*; figs; pollen alternative diets.

INTRODUCTION

Eriophyoid mites are much more intimately attacked to their plant hosts. The fig bud mite *Aceria ficus* Cotte (Eriophyidae) and the fig leaf mite *Rhyncaphytoptus ficifoliae* Keifer (Diptilomiopidae) occurs whenever fig trees are cultivated. Most familiar symptoms by the two aforenamed species are leaf chlorosis, bud blasting, bud distortion, impedance of new growth and severe browning of the undersides of leaves. Severe infestations may result in defoliation of branches or of whole trees (Abou-Awad et al. 2000).

The generalist predatory mite *Phytoseius finitimus* (Ribaga) (Acari: Phytoseiidae) is one of the most common phytoseiid mites on fruit trees and ornamental plants in Egypt (Gommaa & Reda 1985). *Phytoseius* species have recorded worldwide on several economically crops, as well such as apple, pear, grapevine, hazelnut and citrus orchards (Tsolakis et al., 2000, Praslička et al., 2009; Mailllouxet al., 2010). Different species of the genus are usually found in association with tetranychid, eriophyoid, tenuipalpid and tarsonemid mites (Rasmy & Elbanhawy 1974; El-Laithy 1998; Tixier et al., 1998; Mailloux et al., 2010; Vassiliou et al., 2012). Eriophyoid mites don't produce webs, and probably this fact may make predation easier. Predator's size, relative to their eriophyoid prey, is very important and considered a key factor in predation efficiency. Moreover, an increase in the number of prey killed with an increase in densities of prey is due to stimulation (Sandness & McMurtry 1970).

Other species for the same genus survive and reproduce on alternative food sources, such as plant pollens, that have a high nutritional value and low cost (McMurtry & Croft 1997). A question usually raised is whether predatory of phytoseiid mites may reduce high densities of phytophagous mites. Studying the functional response (relationship between the number of the prey attacked at different prey densities) and numerical response (produced offspring per unit time or other change in predator density) may help to answer the question.

The present study aimed to evaluate the potential of biological control of *P. finitimus* preying on the two eriophyoid fig mites *A. ficus* and *R. ficifoliae* through the study of the functional and numerical responses, in addition to studying the life table parameters, were to predict the mechanisms predator-prey behaviour and to improve the practical predictive potential of predator candidates for biocontrol.

MATERIALS AND METHODS

We firstly estimated certain life-history traits such as immature survival, development, life table parameters, functional and numerical responses to evaluate the suitability of the two eriophyoid fig mites for the development and reproduction of the predatory mite *P. finitimus*. Next, we recorded the consumption rates on the two preys at different densities by both immature and adult stages. Finally, we evaluated two kinds of pollen grains as alternative diets for the predator.

The effectiveness of *P. finitimus* as an eriophyoid phytoseiid predator was tested in the laboratory against the fig bud mite *A. ficus* and the fig leaf mite *R. ficifoliae* separately. It was collected from abandoned fig leaves (*Ficus carica* var. soltani) at Benha city, Qaluibia Governorate, North of Cairo and transferred to rearing substrates consisting of clean succulent fig leaves, supplied with small discs of fig leaves heavily infested with the previous eriophyoid prey. Gravid females were left for 24 h to lay eggs. Eggs were then isolated for the different biological testes. Clean fig succulent leaf discs, free of infestation, 1.5 cm in diameter, were used as rearing arenas in Petri dishes with upper surfaces downwards on water saturated cotton wool. Discs were encircled with a thin layer of wet cotton as a barrier to confine the mites.

Eggs were transferred singly, to the rearing discs and the newly hatched larvae (30 for every test) were supplied daily with eriophyoid prey at densities of 10, 20, 40 and 80 individuals of motile stages for both of the two aforementioned preys. Each density treatment was replicated 30 times. Other discs were supplied with freshly pollen grains of *Ricinus communis* (castor bean) and *Zea mays* (corn) diets using a 2 zero brush. The prey or other diets were replaced daily and the development, food consumption and reproduction were recorded twice a day. Arenas, as a control, were maintained with the same densities of each prey but without predators to record the natural mortality of eriophyoid prey.

Due to the difficulty in transferring the individuals of the two prey species, 0.5 cm in diameter of fig leaves infested with both prey species were carefully examined and the nontarget was removed. This led to two types of infested discs, each one having a single species, then the total number of individuals for each disc was estimated before introducing it into the arena. An abundance of fresh prey or pollens was replenished daily at the same previous densities of prey or quantities of pollens. Every day, dead preys were replaced by new ones.

After the last moulting, the male partners were put with the females for mating. Males were then transferred to new arenas. This was repeated during oviposition period for several times, with resting periods (3-day-intervals). Observations of the development were done twice a day and reproduction, survival and food consumption once a day. Feeding on pollens, reproduction lasted for only 10 consecutive days. Every 5-6 days, the predator was transferred to new arenas, while its eggs were removed daily from the arenas. Experiments were conducted at 26±1°C and 65±1% R.H.

To test the sex ratio, 30 eggs were confined, singly in new arenas and the hatched larvae were reared until maturity.

Data Analysis

Life Tables

Date of the developmental time, survival of two sexes and female daily fecundity of *P. finitimus* individuals were analysed based on the age-stage, female and male life tables (Chi and Liu, 1985; Chi, 1988) using the computer program TWOSEX-MSC hart (Chi, 2015a). The population parameters (the net reproductive rate, R_0; the intrinsic rate of increase, rm, the finite rate of increase, e^{rm} and the mean generation time, T) were calculated in sequence.

The net reproductive rate is defined as the mean number of offspring that an individual can produce during its lifetime and is calculated as:

$$\text{Ro} = \sum_{x=0}^{x} \text{lxmx}$$

The intrinsic rate of increase (rm) was estimated from the Euler Lotka formula using the method of iterative biosection with the age indexed from 0 (Goodman, 1982) as:

$$\sum_{x=0}^{x} e^{-r\,(x-1) lxmx=1}$$

The finite rate of increase is calculated as:

$$\lambda = e^{rm}$$

The mean generation time is the time length that a population needs to increase to R_o-fold of its size as the population reaches the table age-stage distribution and is calculated as:

$T = L_nR_0/r$

The gross reproductive rate (GRR) is calculated as:

GRR = $\sum m_x$ (May, 1976; Carry, 1993), doubling time DT = l_n2/r^m (Birch, 1948; Andrewartha and Birch, 1954 and Southwood, 1978) and annual rate of increase AIR = $2^{365/DT}$.

The bootstrap method was used to estimate the standard errors of the population parameters, the differences of the bootstrap-values between treatments were compared using the paired bootstrap test based on the confidence interval of difference (Efron and Tibshirani 1993). Means followed by a different letter are significantly different between treatments using the paired bootstrap test at the 5% significance level (Smucker et al., 2007). The bootstrap subroutine is included in the TWOSEX-MSChart (Chi 2015b).

Data on developmental times, adult life span, fecundity and daily temperature were analysed using oneway ANOVA followed by Tukey's test (P<0.05) (SPSS Inc., 2012).

Functional Responses to Different Prey Densities:

Data were analysed in Microsoft Excel ((http://www.microsoft.com)). The functional responses determining by fitting the data to the Holling disc equation (Holling 1959), Ha=$\frac{a.H.T}{1+a.H.Th}$ where: Ha=number of prey items attacked (number of prey consumed), a=attack rate (searching efficiency), H=prey density (number prey density), T=total available searching time and Th=handling time (day or more).

The parameters a and Th were calculated using a linear regression technique when 1/Ha was regressed on 1/H. a is the reciprocal of the slope and Th is the intercept. The a/Th value indicates the effectiveness of predator. Maximum predation rate (K) was calculated as T/Th.

Numerical Responses to Different Prey Densities:

After graved virgin female predator was introduced onto the arena fig leaf disc, the number of eggs laid by the predator was recorded every day through oviposition period. Dead prey replaced with new ones every day.

The results of numerical response and oviposition were fitted to regression equations. Different regression curves tested to fit the data are presented in this paper. The regression model whose R^2 value was closer to 1 was selected to fit the data.

RESULTS AND DISCUSSION

Data presented in Tables (1 and 2) indicated that the predatory phytoseiid mite, *P. finitimus* was able to develop successfully from larva to adult stage when fed on the motile stages of the two eriophyoid fig mites *A. ficus* and *R. ficifoliae* at different densities (10, 20, 40 and 80 individuals); as well as on the pollen grains of *R. communis* castor bean and *Z. mays* corn. Feeding on the fig bud mite *A. ficus* and the fig leaf mite *R. ficifoliae* led to the shortest developmental period of predatory immatures at densities 80 and 20 individuals and longest at density 10 individuals for both prey, respectively. On pollen grains, the same previous period was longer compared eriophyoid fig prey. Mating was essential, in most phytoseiid, to induce oviposition and multiple mating was important for maximum eggs output (Zaher et al., 1969; Amano and Chant, 1978; Overmeer et al., 1982; Momen, 1997; Rasmy et al., 2003). Preoviposition period was shorter (2.0 & 2.20 days) at density 80 and longer (2.47 & 2.53 days) at density 10 individuals for both preys, respectively. Feeding on *A. ficus* led to the longest longevity (37.40 days) at density 80 individuals, compared to feeding on *R. ficifoliae*(32.00 days) at the same density, respectively. Development of the predatory males was faster and showed almost similar trends when fed on the aforementioned eriophyoid fig prey.

It worth be mentioned that type of food significantly affects the different of biological aspects. Predatory larvae developed to protonymphal stage without feeding on eriophyoid prey. This result coincides with those reported by several workers (i.e. Amano and Chant, 1986; Dicke et al., 1990; Abou-Awad et al., 1998a). At density 40, immature stages of females and males devoured a daily average of 27.68 & 22.93 and 17.01 & 14.37 individuals of *A. ficus* and *R. ficifoliae*, respectively. Adult female also consumed a daily average of 87.08 & 74.29 individuals of the aforementioned prey, respectively (Table 3). Predatory mite species belonging to genus *Phytoseius* sp. are often recorded on plants with highly pubescent leaves (Walter, 1992; McMurtry and Croft, 1997). *Phytoseius plumifer* (C. & F.) and *Phytoseius finitimus* Ribaga are found in higher densities on such host plants (Rasmy and El-Banhawy, 1974; Tixier et al., 1998; Duso and Vettorazzo, 1999). In the same time, the small size of *P. finitimus* possibly related to reduced physical strength if compared to other predatory species of phytoseiids (Pappas et al., 2013).

Eriophyoid fig prey species were suitable diets for the pradator. The fig bud mite *A. ficus* ranked the most suitable prey followed by the fig leaf mite *R. ficifoliae*. At density 40 individuals, a higher fecundity was reported on former prey (43.68 eggs) followed by latter ones (31.47 eggs) (Table 4). Similar results on other phytoseiid species were recorded by Reda & El-Bagoury, 1986; Abou-Awad & El-Banhawy, 1986; Momen & El-Sawy, 1993; Abou-Awad et al., 1998 a; and Momen& Hussein, 1999. The sex ratio of the progeny in favoured of predatory females. Since females are in excess of males, a high and long lasting fertility of the males is to be expected (Schulten et al., 1978; El-Sawy&Abou-Awad, 1992; Abou-Awad et al., 1998b).

Feeding on pollen grains sustained the development of *P. finitimus.* Predator fed on two types of pollen offered. Corn pollen stimulated oviposition greater than that obtained with castor bean through a period only of 10 successive days (Table 5). It is therefore concluded that pollen grains of *Zea mays* are a better diet for *P. finitimus*. Several kinds of pollen are clearly an acceptable food resource for the predatory phytoseiid mites, promoting oviposition rates equal to or greater than those obtained with eriophyid diets (James, 1989). Evidently, pollen still remains as the most adequate substitute for harmful phytophagous mite prey.

The effect of prey density of the fig bud mite *A. ficus* and the fig leaf mite *R. ficifoliae*, as well as two types of pollen grains on the life table parameters of the predatory mite *P. finitimus* are shown in Tables 4 and 5. At density 40 individuals for both prey, population of the predator could multiply 43.68 and 31.47 (R_0=43.68 and 31.47) in generation time of 15.64 and 15.98 days (T=15.64 and 15.98) when pytoseiid predator *P. finitimus* fed on *A. ficus* and *R. ficifoliae*, respectively. At the same conditions, the intrinsic rate of increase (rm) was 0.24 and 0.22 individuals/female/day; while the finite rate of increase (e^{rm}) was 1.27 and 1.24 female daughters/female/day, respectively. Moreover, at aforementioned density of both injurious eriophyoid preys, the gross reproductive rate (GRR) was the highest (43.68 eggs) when the predator fed on *A. ficus* and the lowest (32.75 eggs) was on *R. ficifoliae*. While the doubling time (DT) and the annual rate of increase (ARI) were (2.89 & 3.15 days) and ($1.05x10^{38}$ & $1.63x10^{34}$) at the same density of both prey, respectively (Table 4). These results revealed that the type of prey significantly affects the different of biological aspects and the fig bud mite ranked the most suitable eriophyid prey followed by the fig leaf mite. Similar studies indicated several phytoseiid mites as major predators of eriophyids (McMurtry and Scriven1964; Rasmy and El-Banhawy 1974; Easterbrook 1982; Abou-Awad 1983; Momen and El-Sawy 1993; Abou-Awad et al., 1998b; Rasmy et al., 2003.

The effect of pollen type on life table parameters for 10 successive days is shown in Table 5. Results, as well showed that pollen grains of *Z. mays* are a better diet for predator than *R. communis* in terms R_0, T, rm, e^{rm}, GRR, DT and ARI. Similar results were also recorded by Rasmy et al., 2000 on *Amblyseius deleoni* (Muma& Denmark). Thus, pollen grains of corn *Z. mays* stimulated the predator efficiency significantly more than pollen grains of castor bean *R. communis*.

Functional Response of *P. finitimus* to Different Densities of Mobile Stages of Two Eriophyoid Prey:

Table 1: Developmental times (days) of the predatory phitoseiid mite, *Phytoseius finitimus* reared on different densities of *Aceria ficus* and *Rhyncaphytoptus ficifoliae* at 26 ± 1°C and 65 ± 1 % R . H.

Stages of *P. finitimus*	Sex	Eriophyoid prey							
		Density of *A. ficus* Mean ± S.D.				Density of *R. ficifoliae* Mean ± S.D.			
		10	20	40	80	10	20	40	80
Egg	Female	2.00± 0.00 a	2.00±0.00 a	2.00±0.00 a	1.60±0.13 b	2.00± 0.00 a	2.00±0.00 a	2.00±0.00 a	2.00±0.00 a
	Male	2.00±0.00a	2.00±0.00a	2.00±0.00a	2.00±0.00a	2.00±0.00 a	2.00±0.00 a	2.00±0.00 a	2.00±0.00 a
Larva	Female	1.73± 0.12 a	1.53±0.13 a	1.40±0.13 a	1.40±0.13 a	2.00± 0.00 a	1.53±0.12 ab	1.67±0.13 ab	1.73±0.13 b
	Male	1.67±0.13 a	1.53±0.13 a	1.47±0.13 a	1.47±0.13 a	1.73±0.12 a	1.47±0.13 a	1.53±0.13 a	1.67±0.13 a
Protonymph	Female	2.67±0.13 a	2.33±0.13a b	2.20±0.11b	2.00±0.00b	3.00±0.00 a	2.20±0.12 ab	2.46±0.13 bc	2.73±0.11c
	Male	1.67±0.13 a	1.60±0.13 a	1.53±0.13 a	1.47±0.13 a	1.73±0.23 a	1.53±0.13 a	1.53±0.13 a	1.60±0.13 a
Deutonymph	Female	2.33±0.13a	2.00±0.00b	2.00±0.00 b	2.00±0.00 b	2.60±0.13 a	2.33±0.13 a	2.40±0.13 a	2.47±0.13 a
	Male	2.00±0.00a	2.00±0.00a	2.00±0.00 a	2.00±0.00a	3.00±0.00 a	2.40±0.13b	2.40±0.13 b	2.53±0.13 b
Total	Female	8.73±0.13a	7.87±0.17b	7.67±0.13 b	7.00±0.14 c	9.60±0.13 a	8.07±0.15 b	8.53±0.13 bc	8.93±0.15 c
	Male	7.33±0.13a	7.13±0.19 a	7.00± 0.20 a	6.93±0.15 a	8.47±0.17 a	7.40±0.16 b	7.47± 0.13 b	7.80±0.20 b
Preoviposition	Female	2.47±0.13a	2.40±0.13ab	2.27±0.12ab	2.00±0.00 b	2.53±0.13 a	2.40±0.13 a	2.27±0.12 a	2.20±011 a
Generation	Female	11.20±0.15a	10.27±0.21b	9.87±0.19b	9.00±0.14 c	12.13±0.19 a	11.33±0.23 b	10.80±0.11bc	10.27±0.21 c
Oviposition	Female	24.13±0.22 c	26.40±0.29 b	25.87+0.36b	32.40±0.22 a	19.07±0.23 c	24.20±0.22 b	23.60+0.23b	27.07±0.29 a
Postoviposition	Female	4.47±0.13 a	3.93±0.21 b	3.00±0.00 c	3.00±0.00 c	4.53±0.13 a	3.60±0.13 b	3.33±0.13 b	2.73±0.12 c
Longevity	Female	31.07±0.27 c	32.73±0.38 b	31.14±0.37a	37.40±0.23 c	26.13±0.34 d	30.20±0.30 b	29.20±0.33a	32.00±0.35 c
	Male	30.40±0.32 c	31.33±0.27 b	36.07±0.23 a	28.60±0.29d	24.13±0.22 d	28.40±0.34 b	30.80±0.33 a	26.67±0.21 c
Life-span	Female	39.8±0.28 c	40.60±0.42 b	38.81±0.43a	44.40±0.26 c	37.07±0.72 c	39.93±0.53 ab	37.73±0.32 a	40.93±0.88 bc
	Male	37.73±0.28b	38.47±0.31b	43.07±0.35 a	35.53±0.37c	32.60±0.21 d	36.20±0.41 b	38.27±0.32 a	34.07±0.37 c
No. of replicates		24	25	28	27	25	25	27	26
% Surviving		80	83	93	90	83	83	90	87

Different letter (s) in the horizontal row denote significant difference (F-test, P > 0.01)

Table 2: Developmental times (days) of the predatory phytoseiid mite, *Phytoseius finitimus* reared on pollen grains of *Ricinuns communis* (Castor bean) and *Zea mays* (Corn) at 26 ± 1°C and at 65 ± 1% R.H.

Stages of *P. finitimus*	Sex	Pollen grains Mean ± S.D.		t-value
		R. communis	*Z. mays*	
Egg	Female	2.20± 0.11a	2.00± 0.00a	1.871NS
	Male	2.00±0.00	2.00±0.00	0.000
Larva	Female	2.00± 0.00	2.00± 0.00	0.000
	Male	2.00±0.00 a	1.60±0.13 b	3.055**
Protonymph	Female	3.47±0.13 a	3.00±0.00b	3.500**
	Male	3.00±0.00 a	2.53±0.13b	3.500**
Deutonymph	Female	3.60±0.13 a	3.27±0.12 a	1.890NS
	Male	3.33±0.13 a	3.27±0.12 a	0.386NS
Total	Female	11.27±0.18 a	10.27±0.12 b	4.613**
	Male	10.33±0.13 a	9.40±0.13 b	5.137**
Preoviposition	Female	2.80±0.11 a	2.73±0.12 a	0.418NS
Generation	Female	14.07±0.27 a	13.00±0.17 b	3.378**
Oviposition	Female	10.00±0.00	10.00±0.00	0.000
N. of replicates		27	29	
% Surviving		90	97	

** Highly significant NS= Insignificant

The functional responses to two eriophyoid prey densities by the predatory mit *P. finitimus* were convex (type II), where of killed prey grows with the prey density but begins to decrease in reaching a maximum point (Figure 1, A & B). Type II response curve was also noted by Laing and Osborn (1974) for the predatory phytoseiid mites *Galendromus occidentalis* (Nesbit), *Phytoseiulus persimilis* Athias-Henriot and *Neoseiulus chilenensis* (Dosse) feeding on the two-spotted spider mite *Tetranychus urticae* Koch. The linear regression of predator can be represented by the equation Y=1.042X+0.005 and Y=1.006X+0.015 for the fig bud mite *A. ficus* and the leaf fig mite *R. ficifoliae*, respectively (Figure 2, A & B). From the coefficients of the linear regression, the attack rate (a) was estimated to be 0.9597 and 0.9940, the handling time (T_h) as well, was 0.005 and 0.015 for both prey, respectively. a/T_h values indicate that *P. finitimus* was most effective against mobile stages of both aforementioned eriophyoid prey. The calculated maximum number of consumed prey/predator/day (K) for both prey were 200 and 66.67 individuals, respectively. Sabelis (1985) mentioned that predation by phytoseiid mites is generally not limited by handling time but by digestion rate.

<u>Numerical Responses of *P. finitimus* to Different Densities of Mobile Stages of Two Eriophyoid Prey:</u>

The total number of eggs laid by the predatory mite *P. finitimus* significantly increased with increase in eriophyoid prey densities. The correlation between densities of the fig bud mite *A. ficus* and the fig leaf mite *R. ficifoliae* and the number of eggs laid by the predator (Figure 3, A & B) are expressed respectively by the following regression equations:

$y = -0.000x^2 + 0.040x + 0.758$

$R^2 = 0.987$

$y = -0.000x^2 + 0.021x + 0.778$

$R^2 = 0.814$

Where: y is the rate of oviposition, and x is the prey density. The maximum egg numbers of the predatory mite *P. finitimus* (1.69) and (1.33) eggs per day were obtained at density of 40 individuals for both *A. ficus* and *R. ficifoliae* prey, respectively. The regression model whose R^2 value was closer to 1 was selected to fit the data.

Results indicated clearly that *P. finitimus* can be considered efficient predator at different densities of mobile stages of harmful eriophyoid fig mites and to contribute for reduction of the *A. ficus* and *R. ficifoliae* prey populations on fig trees, where commonly it is present.

Table 3: Number of preys consumed (daily rate) when *Phytoseius finitimus* was maintained on different densities of *Aceria ficus* and *Rhyncaphytoptus ficifoliae* at 26 + 1°C and 65 +1 % R.H.

Parameters	Sex	Eriophyoid prey							
		Density of *A. ficus* Mean + S.D.				Density of *R. ficifoliae* Mean + S.D.			
		10	20	40	80	10	20	40	80
Protonymph	Female	6.70+0.15 d	7.75+0.16 c	11.94+ 0.10 b	13.20+0.17 a	4.98+0.07 c	5.50+0.40 c	7.87+0.11 b	9.45+0.13a
	Male	5.73+0.15 d	6.47+0.10 c	10.70+0.12 b	11.70+0.14 a	3.77+0.07 d	4.6+0.11 c	6.1+0.09 b	8.10+0.09 a
Deutonymph	Female	7.61+0.10 d	9.50+0.11 c	15.73+0.15 b	16.63+0.10 a	6.22+0.06 d	7.60+0.08 c	9.15+ 0.11 b	13.20+0.12 a
	Male	6.43+0.11 d	7.97+0.11 c	12.23+0.17 b	14.40+0.15 a	5.31+0.08 d	6.23+0.10 c	8.27+0.07 b	12.23+0.36 a
Total	Female	14.31+0.18 d	17.25+0.16c	27.68+0.18 b	29.83+0.20 a	11.20+0.09 d	13.48+0.12 c	17.01+0.17 b	22.64+0.18 a
	Male	12.17+0.17 d	14.43+0.16 c	22.93+0.24 b	26.10+0.20 a	9.08+0.11 d	10.83+0.13 c	14.37+0.08 b	20.37+0.39 a
Preoviposition	Female	8.17+0.09 d	14.22+0.17 c	24.24+0.20 b	36.83+0.19 a	7.05+0.08 d	12.81+0.11 c	23.32+0.19 b	26.20+ 0.15 a
Generation	Female	22.48+0.17 d	31.47+0.23 c	51.92+0.24 b	66.67+0.20 a	18.24+0.12 d	26.29+0.19 c	40.33+0.26 b	48.84+ 0.27 a
Oviposition	Female	9.67+0.06 d	16.06+0.09 c	34.32+0.17 b	50.34+0.26 a	8.04+ 0.11 d	15.08+0.03 c	26.19+0.05 b	30.13+0.07 a
Postoviposition	Female	8.77+0.10 d	14.27+0.20 c	28.51+0.19 b	39.02+0.12 a	7.46+0.08 d	11.98+0.13 c	24.78+0.14 b	25.57+0.14 a
Longevity	Female	26.59+0.17d	44.54+ 0.29c	87.08+0.33 b	126.20+ 0.39 a	22.55+0.14 d	39.87+0.16 c	74.29+0.25 b	81.91+0.24 a
	Male	24.66+0.28 d	39.75+0.18 c	66.97+0.16 b	93.87+0.07 a	20.24+0.06 d	28.09+0.19 c	51.46+0.18 b	59.45+o.28 a
Life-span	Female	40.91+0.19d	61.79+0.28 c	114.75+0.39b	156.03+0.35 a	33.75+0.15 d	53.35+ 0.21c	91,30+0.29 b	104.55+0.37 a
	Male	36.83+0.37 d	54.18+0.18 c	89.91+0.33 b	119.97+0.20 a	29.23+0.11 d	38.92+ 0.21 c	65.83+ 0.21 b	79.82+ 0.53 a

Different letters in the horizontal row denote significant difference (F-test, P > 0.01)

Table 4: Effect of prey density of *Aceria ficus* and *Rhyncaphytoptus ficifoliae* on the life table parameters of *Phytoseius finitimus* at 26 + 1°C and at 65 + 1 % R.H.

Parameters	Eriophyoid prey							
	Density of *A. ficus* Mean + S.D.				Density of *R. ficifoliae* Mean + S.D.			
	10	20	40	80	10	20	40	80
Net reproductive rate(R_0)	27.55+0.41d	35.67+0.28c	43.68+0.52 a	38.25+0.39b	19.47+0.35d	25.06+0.38c	31.47+0.30a	29.33+0.37b
Mean generation time (T)	15.74+0.17a	14.98+0.20b	15.64+0.17a	13.31+0.16c	15.91+0.17a	16.19+0.18a	15.98+0.16a	15.10+0.19b
Intrinsic rate of increase (rm)	0.21+ 0.002c	0.24+0.003b	0.24+0.003b	0.27+0.003a	0.19+0.002c	0.20+0.002b	0.22+0.002a	0.22+0.002a
Finite rate of increase e^{rm}	1.24+0.003c	1.27+0.004b	1.27+0.003b	1.31+0.004a	1.21+0.003c	1.22+0.003b	1.24+0.002a	1.25+0.003a
Gross reproductive rate (GRR)	28.66+0.26c	38.12+0.65b	43.68+0.52a	38.27+0.39b	20.62+0.47d	26.71+0.44c	32.75+0.35a	30.47+0.24b
Doubling time (DT)	3.30	2.89	2.89	2.57	3.65	3.47	3.15	3.15
Annual Rate of Increase(ARI)	1.98×10^{33}	1.05×10^{38}	1.05×10^{38}	5.6×10^{42}	3.81×10^{29}	3.15×10^{31}	1.63×10^{34}	2.94×10^{35}
Fecundity	27.55+44d	35.69+0.28c	43.68+0.49a	38.25+0.31b	19.47+0.32 d	25.06+0.37 c	31.47+0.31 a	29.33+0.34 b
Sex ratio female : male	1.2 : 1	1.2 : 1	1.4 : 1	1.3 : 1	1.2 : 1	1.3 : 1	1.4 : 1	1.3 : 1

Different letters in the horizontal row denote significant difference (P > 0.05)

Table 5: Effect of pollen grains of *Ricinuns communis* (Castor bean) and *Zea mays* (Corn) on the life table parameters of *Phytoseius finitimus* at 26 ± 1°C and at 65 ± 1 r.h .

Parameters	Pollen grains	
	R. communis	***Z. mays***
Net reproductive rate(R_0)	9.86±0.21	12.47±0.27
Mean generation time (T)	17.44±0.24	16.18±0.12
Intrinsic rate of increase (rm)	0.13±0.002	0.16±0.002
Finite rate of increase e^{rm}	1.14±0.003	1.17±0.002
Gross reproductive rate (GRR)	10.36±0.25	12.83±0.33
Doubling time (DT)	5.33	4.33
Annual Rate of Increase(ARI)	6.47×10^{20}	5.27×10^{24}
Fecundity (for 10 days)	9.86±0.21 a	12.47±0.27 b**
Sex ratio female : male	1.2 : 1	1.4 : 1

** Highly significant

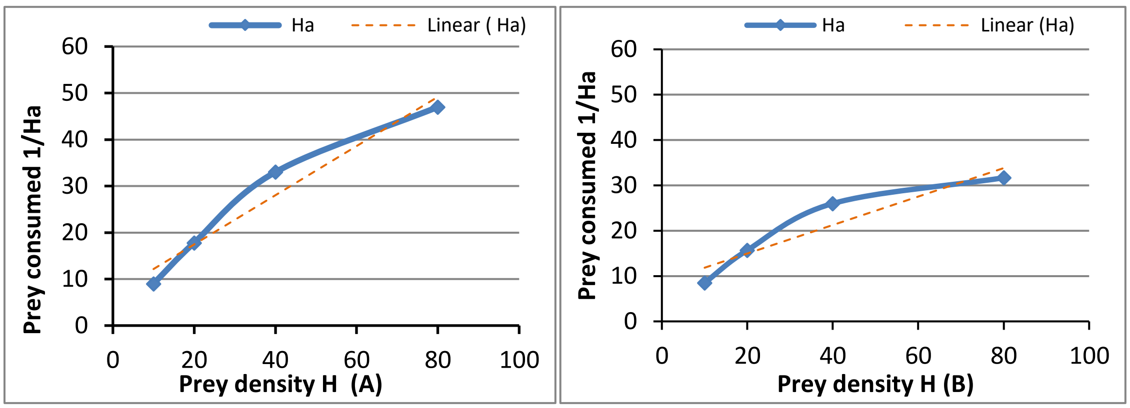

Figure 1: **Type II functional response of the predatory mite *Phytoseius finitimus* feeding on different densities of the fig bud mite *Aceria ficus* (A) and the fig leaf mite *Rhynchaphytoptus ficifoleae* (B).**

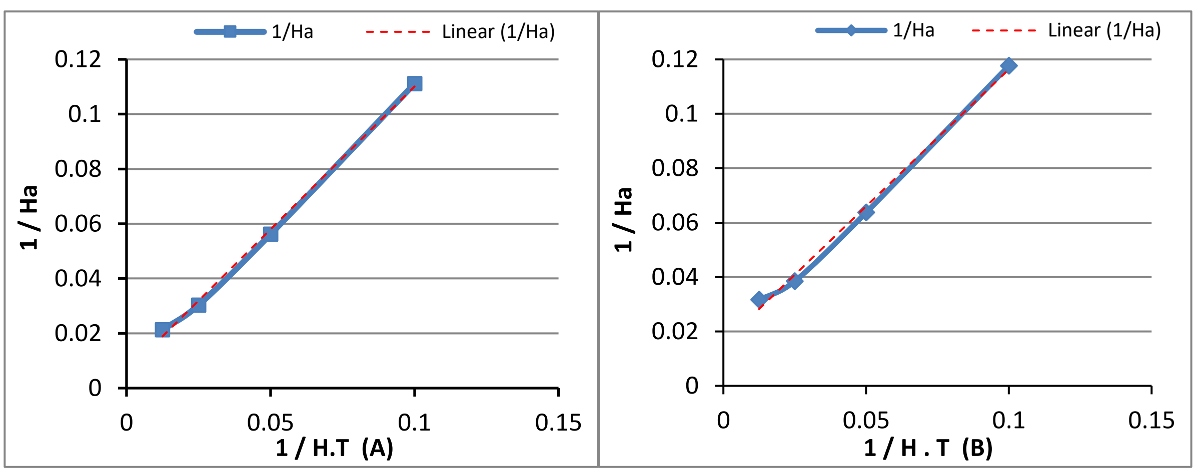

Figure 2: **The linear regression for parameters estimation of the predatory phytoseiid mite *Phytoseius finitimus* feeding on the fig bud mite *Aceria ficus* (y= 1.042x +0.005) (A) and the fig leaf mite *Rhynchaphytoptus ficifoliae* (y=1.006x+0.015) (B).**

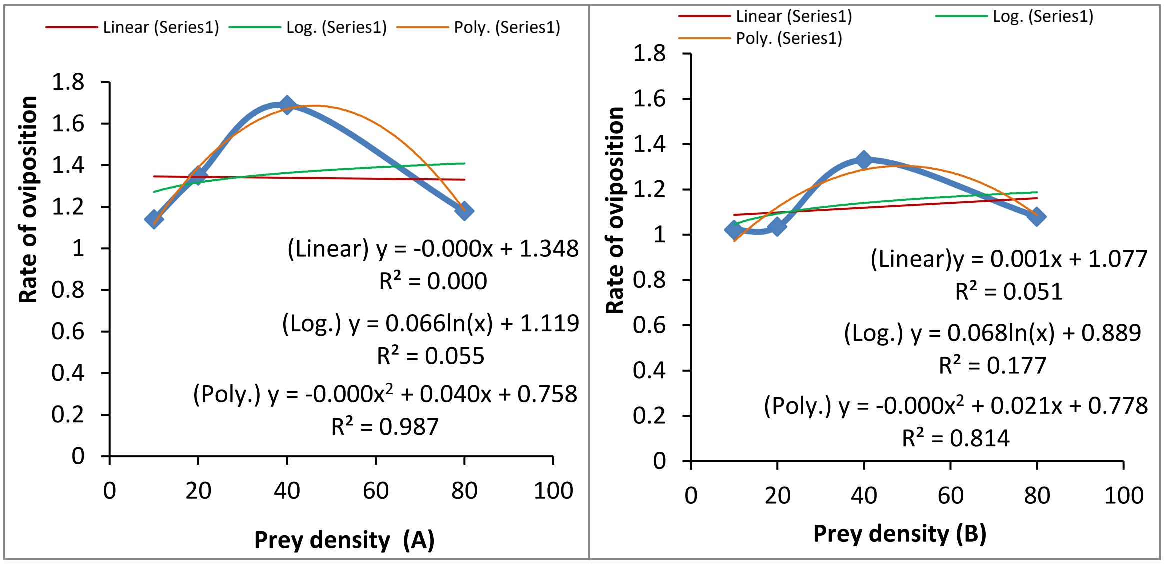

Figure 3: **Regression models for the relationship between density of *A. ficus* (A) & *R. ficifoliae* (B) and rate of oviposition of the predatory mite *P. finitimus*.**

CONCLUSION

Our data provide information and idea as to how the predatory phytoseiid mite *P. finitimus* responds to a change in eriophyoid prey densities. Results showed that adult female of the predator reflected type II functional response and type of food significantly affects different biological aspects. Life table parameters in terms R_0, T, rm, e^{rm}, GRR, DT and ARI were estimated when *P. finitimus* fed on harmful eriophyoid fig prey *A. ficus* and *R. ficifoliae* at densities 10, 20, 40 and 80 individuals of both prey, respectively or/and two types of pollens *Z. mays* and *R. communis*. Furthermore, the fig bud mite *A. ficus* ranked the most suitable eriophyid prey followed by the fig leaf mite *R. ficifoliae*. Pollens *Z. mays* (corn) was also found to be a suitable alternative diet for predator rearing. However, this investigate may help to provide a better understanding of the efficacy and probabilities of utilization of *P. finitimus* as a facultative predator in the biological control in the frame of the integrated pest management (IPM).

CONFLICT OF INTEREST

This study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

BA, designed and wrote the manuscript. AA and SI performed the experiment; AA analysed the data and SI reviewed the manuscript. All authors read and approved the final version.

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