J. Plant Prot. and Path., Mansoura Univ., Vol. 3 (10): 1079 - 1087, 2012

INCIDENCE OF THE PREDATORY MITES INHABITING GRAPEVINES IN SHARKIA GOVERNORATE, EGYPT AND FUNCTIONAL RESPONSE OF *Euseius metwallyi* IN PREYING *Tetranychus urticae* (ACARI : PHYTOSEIIDAE : TETRANYCHIDAE)

Awad, Salonaz E. ; M. E. Mahrous ; A. E. Basha and E. M. Mostafa
Plant Protection Dept., Faculty of Agric., Zagazig Univ., Zagazig, Egypt.

ABSTRACT

A survey conducted recently in Sharkia governorate, Egypt indicated the presences of 11 species of predatory mites on grapevines. These species belong to families Phytoseiidae (8 species), Cunaxidae (one species), Cheyletidae (one species), Stigmaeidae (one species). Frequency occurrence of the collected species was discussed. A logistic regression of the proportion of prey consumed as a function of initial prey density was conducted to identify functional response types. Nonlinear least-squares regression and the random predator equation were used to estimate attack rates and handling times . Overall, adult females *E. metwallyi* exhibited a type 2 functional response to *T. urticae*. Whereas, attack rate and handling time of *E. metwallyi* recorded 0.10 , 0.28 and 0.07 and 0.99 , 1.47 and 4.59 when offering eggs , males , females of *T. urticae,* respectively. Generally, these results indicated that the predator *E. metwallyi* may be considered as biocontrol agent against the two-spotted spider *T. urticae*.

Keywords: Predatory mites, Acari: *Euseius metwallyi*; grapevines, functional response.

INTRODUCTION

Mites occur in vast numbers on grapevines. Several species are phytophagous and well known as worldwide damaging pests. Others are predaceous and their presence may be of considerable benefit in reducing pest infestations (Whitney and James 1996 ،Servin *et al*. 1997 and Mostafa 2004).

Predatory mites of the family Phytoseiidae have become dominant species among beneficial arthropods inhabiting grapevines and many species are well known as important biological control agents of the phytophagous mites and various small insects that are agricultural pests, so that they could be used in a program of integrated control (Sabelis, 1985).

In Egypt, the most widespread phytoseiid mite species is *Euseius metwallyi* Basha , Yousef & Mostafa , where it occupy a wide variety of agricultural crops at Sharkia governorate, including grapevines is association with various agricultural pests (El-Garhy *et al.,* 2008).

This species preferentially attack the phytophagous mite *Tetranychus urticae* Koch that has recently become one of the most damaging pests associated with grapevines (Barber *et al.* 2003 and Opit *et al*. 2004) .

Basha (2005) studied development, fecundity and predaceous capacity of *E. metwallyi* when fed on immature stages of *T. urticae* . Generally the functional response of some

phytoseiid species to various agricultural pests is a subject of considerable interest and importance (Shih & Wang chainJi 2001; Koveos & Broufas 2000 and Osman & Tawfik 2010) .Nothing is known about the functional response of this phytoseiid mite to the principal pest of grapevine *T. urticae.*

The aim of this study is to review phytoseiid mite frequencies in three different locations at Sharkia governorate, Egypt to determine the environmental factors that could have an impact on the abundance of these predators. The functional response of the phytoseiid mite *E. metwallyi* to eggs and adult stages of *T. urticae* also was investigated.

MATERIALS AND METHODS

Sampling and Identification :

Samples of 50 grapevine leaves were collected from each of Abo-Hammad, Zagazig and Salhia districts at Sharkia governorate, Egypt throughout two successive years 2008-2009. Samples were examined under stereomicroscope. Mite identification was done under a phase contrast microscope after clearing in lacto phenol and mounting on glass slides in Hoyer's medium. Mites were classified according to Chant & McMurtry (1994) for the family Phytoseiidae , Summers (1960) for the family Cheyletidae and Smiley (1975) for the Cunaxidae family. The taxa collected were categorized using the criteria frequency of occurrence. All the mites listed have been deposited in the collection of the Acarology , Plant Protection Department, Faculty of Agriculture, Zagazig University.

Functional response :

To study the functional response of the phytoseiid mite *E. metwallyi* to the tetranychid mite *T. urticae*, laboratory cultures of the predator were initiated on grapevine leaves *Vitis vinifera*, 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 developmental stages of *T.urticae* three times per week.

Experimental design :

Experiments were conducted on mulberry leaf discs *Morus nigra* of about 2.5 cm in diameter each as rearing arenas as the method described by Yousef & El-Halawany (1982). Leaf discs were placed singly upside down on cotton wool pads socked with water in open 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).

According to Badii *et al.* (2004) , a three days old mated female predation that have been starved for 24h immediately prior to the experimental was exposed singly to densities of 1,2,4,8,16 and 32 newly emerged individuals of different prey items (eggs – males and females) on the aforementioned rearing arenas. Each density was replicated 15 times. The exposure time was 24h after counting the spider mite individuals eaten.

Data analysis:

The experimental data were analyzed following Juliano (2001). The functional response type was determined by a logistic regression of the proportion of prey consumed as a function of initial prey number. Then, the data were fitted by an appropriate equation by the nonlinear least-squares regression. The polynomial equation was used to fit the data on the proportion of prey consumed:

$$\frac{N_a}{N_0} = \frac{\exp(P_0 + P_1 N_0 + P_2 N_0^2 + P_3 N_0^3)}{1 + \exp(P_0 + P_1 N_0 + P_2 N_0^2 + P_3 N_0^3)} \quad \textbf{(1)}$$

Where, N_a is the number of prey eaten, N_0 is the initial number of prey, and P_0 , P_1 , P_2 and P_3 are the intercept, linear , quadratic and cubic coefficients, respectively . These parameters can be estimated using the CATMOD procedure in SAS (Juliano 2001). The logistic regression was used to obtain the maximum likelihood estimates of parameters P_0 to P_3 . The functional response type was determined by the sign of the linear coefficient from equ. (1) and the significance of the parameters from the logistic model was evaluated by log likelihood tests . If $P_1 < 0$, it describes a type 2 functional response . If $P1 > 0$ and $P_2 < 0$, it present a type 3 functional response (Juliano 2001). Because logistic regression analysis indicated that the present data fit the type 2 response , further analysis was restricted to the type 2 response .

In a second step , a nonlinear least squares regression of number of prey eaten vs. number offered was used to estimate and compare parameters of functional responses following the NLIN procedure in SAS . Functional response data were fitted to the random predator equation equ . (2) Royama (1971) to describe the type 2 functional response:

$$Na = N\{1 - \exp[-aT / (1 + a T_h N)]\} \quad \textbf{(2)}$$

Where *Na* number of prey attacked per predator during experimental period T (24 h) ; *N* the initial prey density ; *a* is the attack rate , T_h is the handling time of prey by the predator and T is the total time during which prey and predator are exposed to each other . The parameters *a* (the rate of successful attack) and T_h (the time required to handle a prey item) were calculated using least-squares non-linear regression . Whereas, T_h values were used to regression. Whereas, T_h values were used to calculate maximum attack rate as T/ T_h (Hassell, 1978), this represent the maximal number of prey individuals that could be consumed by *E. metwallyi* during 24 hr .

RESULTS AND DISCUSSION

A survey of the predatory mites fauna found on grapevines in 3 districts at Sharkia governorate, Egypt comprises 11 species belonging to 4 families: Phytoseiidae (8 species), Cheyletidae(1) , Cunaxidae (1) and Stigmaeidae (1) . Frequency occurrence of these species is shown in Table(1). The two phytoseiid mite species *E. metwallyi* and *T. capsicrum* were constant, with the highest values of percent frequency of occurrence (72.50 and 67.50 % respectively). Each of phytoseiid mite species *N. semindus* , *P.sharkensis* and *N. neovinifera*, the stigmaeid mite species *A. exsertus* , the cheyletid mite species *H. bakeri* and cunaxid mite species *Cunaxa* sp. were accidental and represented the least frequency of occurrence percentages recording 20,15,10,17.5,12.5 and 7.5%, respectively.

Table (1): Frequency occurrence of predatory mite species found on grapevine at three districts of Sharkia governorate, Egypt.

Mite species	% Frequency of occurrence			
	Abo-Hammad	Salhia	Zagazig	Total collected samples
Family:Phytoseiidae				
1-*Bawus aegypticus*	15.38 (Ac)	33.33 (A)	33.33 (A)	27.50 (A)
2-*Cydnoseius vitis*	00.00 (Ac)	33.33 (A)	46.67 (A)	27.50 (A)
3-*Euseius metwallyi*	76.92 (C)	66.67 (C)	73.33 (C)	72.50 (C)
4-*Neoseiulella neoviniferae*	00.00 (Ac)	16.67 (Ac)	13.33 (Ac)	10.00 (Ac)
5-*Neoseiulus seminudus*	23.08 (Ac)	16.67 (Ac)	20.00 (Ac)	20.00 (Ac)
6-*Proprioseiopsis sharkeinsis*	30.77 (A)	16.67 (Ac)	00.00 (Ac)	15.00 (Ac)
7-*Typhlodromips capsicum*	53.85 (C)	83.33 (C)	66.67 (C)	67.50 (C)
8-*Typhlodromus malus*	38.46 (A)	33.33 (A)	33.33 (A)	35.00 (A)
Family:Cheyletidae				
Hemicheyletia bakeri	00.00 (Ac)	16.66 (Ac)	20.00 (Ac)	12.50 (Ac)
Family:Cunaxidae				
Cunaxa sp.	00.00 (Ac)	16.66 (Ac)	6.66 (Ac)	7.50 (Ac)
Family:Stigmaidae				
Agistemus exsertus	23.08 (Ac)	00.00 (Ac)	26.66 (A)	17.50 (Ac)

Frequency: a species is classified as constant (C), accessory (A) or accidental (Ac) if it occurs in > 50 %, 25-50 % or < 25 % of the total number of samples, respectively .

Previous investigations showed that the predaceous phytoseiid mites are important control agents of pest mites affecting many crops in different parts of the world (Helle & Sabiles 1985). In the case of grapevines phytoseiid mites were found to be the most frequent and important predatory mites, other predatory mite species are common and play a considerable role in suppressing pest populations. Our results are in accordance with the fact that these mite species are generally of the most important and frequent predatory mites associated with grapevines mainly prey on the phytophagous mites and various small insects (Hadam *et al*., 1986; Duso & Sbrissa, 1990 ; Papaioannou-Souliotis *et al*., 1994 and Duso *et al.,*1997). Generally, the phytoseiid mite species *E. metwally* and *T. capsicum* proved to be the most frequent predatory phytoseiid mites on grapevine at Sharkia governorate, Egypt, where they recorded the highest frequency of occurrence (%) in all the investigated areas. These species may be considered as biological control agents among the promising phytoseiid mites in controlling the phytophagous mites attacking grapevine in Egypt. Other identified species were found with moderate or low frequency of occurrence, percentages.

Data presented in Table (2) showed that the outcome of the logistic regression of *E. metwallyi* adult female to eggs, males and females of *T.urticae* reflected a type Π functional response , in all cases the sign of the linear term was negative.

Table (2) : Results of logistic regression analysis, indicating estimates and standard errors of linear , quadratic and cubic coefficient for the proportion of prey eaten by *E. metwallyi* against initial preys number offered at 28 ºC .

Prey stage	Coefficient	Estimate	S.E.	Chi-Square	P
Egg	Intercept P_0	4.9818	1.0987	20.56	< 0.0001
	Linear P_1	- 0.8301	0.2733	9.22	< 0.0024
	Quadratic P_2	0.0520	0.0186	7.77	< 0.0053
	Cubic P_3	- 0.00096	0.000350	7.55	< 0.0060
Male	Intercept P_0	3.2253	1.0238	9.92	< 0.0016
	Linear P_1	- 0.0303	0.2847	0.01	< 0.9151
	Quadratic P_2	- 0.00968	0.0205	0.22	< 0.6361
	Cubic P_3	0.000229	0.000393	0.34	< 0.5599
Female	Intercept P_0	2.8769	0.5734	25.22	< 0.0001
	Linear P_1	- 0.6999	0.1632	18.39	< 0.0001
	Quadratic P_2	0.0398	0.0120	11.08	< 0.0009
	Cubic P_3	- 0.00070	0.000233	9.06	< 0.0026

A significant negative estimate for the parameter P1 indicate that the slope of the functional response curve is declining , thus a type Π functional response .

Whereas, the type of functional response can be determined based on the sign of the linear coefficient : negative for type Π , positive for type Ш (Juliano , 1993) . Type Π functional response is the most common functional response of the phytoseiid species to an increasing density of spider mites (Fernando and Hassell, 1980 ; Sabelis , 1985 ; Shipp and Whitfield , 1991 and Skirvin and Fenlon , 2003) .

The functional response data of *E. metwallyi* on eggs, males and females of *T. urticae* were successfully fitted to the Royama (1971) equation (Table 3). The attack rate of *E. metwallyi* increased from 0.10 on eggs to 0.28 on males but declines on females of *T. urticae* to 0.07. Whereas, handling time (T_h) of *E. metwallyi* was 0.99, 1.47 and 4.59 when offering eggs, males and females of *T. urticae*, respectively. The expected maximum consumption (T / T_h) of *E. metwallyi* was 24.24 eggs, 16.32 males and 5.22 females per day of *T.urticae* .

Table (3) : Effect of *T. urticae* stage on the attack rate (A) , handling time T_h and maximum number of consumption (T / T_h) on *E. metwallyi.*

Prey stages	*A*	Asymptotic 95% CI		T_h	Asymptotic95 % CI		T / T_h
		lower	upper		lower	upper	
Egg	0.10±0.01	0.08	0.12	0.99±0.06	0.86	1.11	24.24
Male	0.28±0.05	0.18	0.38	1.47±0.04	1.37	1.56	16.32
Female	0.07±0.01	0.04	0.09	4.59±0.24	4.10	5.07	5.22

T_h is the handling time of prey by the predator.
T is the total time during which prey and predator are exposed to each other.
***a* (the rate of successful attack).**
T/ T_h represent the maximal number of prey individuals that could be consumed by *E. metwallyi* during 24 hr.

The level of functional responses are affected by the life stages of prey supplied. For example, Fernando and Hassell (1980) showed that the maximum number of *T. urticae* consumed by phytoseiied predator *P. persimilis* decreased in the order: egg, larva, protonymph and deutonymph . Still further, phytoseiied mites very seldom prefer to feed on adult mites but most often they feed on immature stages (Sabelis, 1985). Blackwood *et al*. 2001 reported that adult females of phytoseiied predator *P. persimilis* preferred *T. urticae* eggs over the larvae. In contrast, Popov and Kondryakov (2008) reported that adult females of *P. persimilis* consumed more males of *Tetranychus* spp. than the eggs or females. These contrasting results may be related to differences in experimental design and number of prey provided. It should be realized that predation by phytoseiid mites is generally not limited by handling time but by digestion rate (Sabelis, 1985) .

Generally, the presented results showed that *E. metwallyi* females were more effective at low densities of different prey stages. Also, increase predation rate and short handling time of *E. metwallyi* females as function of *T. urticae* eggs; lead authers to release *E. metwallyi* earlier on low prey densities. It was noticeable that and the best time were achieved when the prey is in egg stage.

AKNOWLEDGEMENTS

We would like to thank Dr. M. A. Osman Department of Agricultural Zoology , Faculty of Agriculture , Mansoura University , Egypt for his cooperation in support of data analysis.

REFERENCES

Badii, M.H.; E. Hernandez-Ortiz; Adriana E. Flores and J. Landeros (2004). Prey stage preference and functional response of *Euseius hibisci* to *Tetranychus urticae* (Acari: Phytoseiidae, Tetranychidae). Exp. Appl. Acarol. 34 (3/4): 263-273.

Barber, A.;C.A.M. Campbell; H. Crane; R. Lilley and E. Tregidga (2003): Biocontrol of two spotted spider mite *Tetranychus urticae* on dwarf hops by the phytoseiid mites *Phytoseiulus persimilis* and *Neoseiulus californicus*. Biocontrol Science and Technology 13 (3): 275-284.

Basha, A.E. (2005): Biological studies on the predatory mite *Euseius metwallyi* (Acari: Gamasida, Phytoseiidae). Egypt. J. Agric. Res. 83 (1): 57-68.

Blackwood, J.S.; P. Schausberger and B.A. Croft (2001). Prey stage preferences in generalist and specialist phytoseiid mites (Acari: Phytoseiidae) when offered *Tetranychus urticae* (Acari:Tetranychidae) eggs and larvae. Enviro. Entom. 30:1103 -1111.

Castagnoli, M. and S. Simoni (1999): Effect of long–term feeding history on functional and numerical response of *Neoseiulus calisfornicu* (Acari: Phytoseiidae). Exp. Appl. Acarol. 23: 217-234.

Chant, D. A. and J. A. Mc Murtry (1994): A review of the subfamilies Phytoseiinae and Typhlodrominae (Acari: Phytoseiidae). Int.J.Acarol. 20 (4) : 223 – 310.

Duso, C. & Sbrissa, F., (1990) .Gli: Acari Fitoseidi (Acari: Phytoseiidae) del melo nell'Italia settentrionale: distribuzione, biologia, ecologia ed importanza economica. Boll.Zool.Agric.Bachic. 22(1): 53-89.

Duso, C. , Malagnini, V. and Paganelli A., (1997) . Indagini preliminari sul rapporto tra polline e *Kampimodromus aberrans* su *Vitis vinifera* L. Allionia, 35:229-239.

El- Garhy, T.A.A., (2008): Studies on some mite species associated with certain fruit orchards at Sharkia governorate . M. Sc. Thesis , Faculty of Agriculture, Zagazig University.

Fernando, M. and M. Hassell, (1980) . Predator – prey responses in an acarine system. Res. Popul. Ecol. 22:301- 322.

Hadam (J. J.), Aliniazee (M. T.) & Croft (B. A.), (1986). Phytoseiid mites of major crops in Willamette Valley, Oregon and pesticide resistance in *Typhlodromus pyri* Scheuten. Environ. Entomol. 15(6): 1255-1263.

Hassell, M.P., (1978). The dynamics of arthropod predator prey system monographs. In: Population biology: Princeton, N.J (eds), pp: 1- 237. Princeton University Press.

Helle W. and M.W. Sabelis (1985): World crop pests. Spider mites, their biology, natural enemies and control. Vol. 1B. Elsevier, Amsterdam.

Juliano, S.A., (1993). Nonlinear curve fitting :predation and functional response curves. In: Design and Analysis of Ecological Experiments . Scheiner, S.M. and Gurevitch, J. (eds) , Pp .159-182.New York: Chapman & Hall, pp .159-182.

Juliano, S.A.,2001 .Nonlinear curve- fitting : predation and functional response curves. In: Scheiner SM, Gurevitch J,(eds), Design and analysis of ecological experiments, 2nd edn. Oxford University Press, New York, Pp 178- 196 .

Koveos , D.S. and G.D. Broufas (2000).Functional response of *Euseius finlandicus* and *Amblyseius andersoni* to *Panoncyhus ulmi* on apple and peach leaves in the laboratory .Exp. Appl. Acarol. 24: 247-256 .

Mostafa , E.M.(2004). Studies on mites of the family Phytoseiidae at Sharkia Governorate. Ph.D. Thesis , Fac. Agric., Zagazig univ.

Opit, G.P.; J.R. Nechols and D.C. Margolies (2004): Biological control of two spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae) using *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) on ivy geranium assessment of predator release ratios. Biological Control 29 (3): 445-452.

Osman, M.A.and A.A. Tawfik , (2010). Functional response of *Phytoseiulus persimilis* Athias – Henriot to different stages of the two- spotted spider mite (Acari: Tetranychidae). Acarine 4: 57 - 61.

Papaioannou-Souliotis , P.,Ragusa Di Chiara S. and Tsolakis H., (1994). Phytophagous mites and their predators observed on cultivated plants in Greece during 1975- 1990. Ann. Institut Phytopathol. Benaki (NS) 17:35-87 .

Popov, S.Y.and A.V. Kondryakov, (2008). Reproductive tables of predatory phytoseiid mites (*Phytoseiulus persimilis* , *Galendromus occidentalis* and *Neoseiulus cucumeris*). Entomological Review 88: 658- 665.

Royama, T. 1971. A comparative study of models for predation and parasitism . Res. Popul. Ecol. 1: 1-91.

Sabelis , M. W., (1985). Predator – prey interaction: predation on spider mite. In: Helle W., Sabelis M.W. (eds) World crop pests 1B . spider mites: their biology , natural enemies and control. Elsevier, Amsterdam. 103-129.

Servin , R.; Aguilar, R. and Tejas ,A. (1997). Phytophagous mites present on fruit trees in Baja California Sur, Mexico. Southwestern Entomologist , 22(1):103-107.

Shih , C.T. and Wang ChainJi (2001). Functional responses of *Amblyseius ovalis* (Evans) Acari:Phytoseiidae on *Tetranychus urticae* Koch (Prostigmata:Tetranychidae):effects of prey stage .CSIRO publishing 498 – 505.

Shipp, J. and Whitfield, G.,(1991). Functional response of the predatory mite, *Amblyseius cucumeris* (Acari: Phytoseiidae) ,on western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae) . Environ. Entomol. 20: 694- 699.

Skirvin, D.J. and Fenlon, J.S.,(2003). The effect of temperature on the functional response of *Phytoseiulus persimilis* (Acari : Phytoseiidae). Exp. Appl. Acarol., 31, 37- 49.

Smiley , R. L. 1975. A generic revision of the mites of the family Cunaxidae (Acarina) . Annals of the Entomological Society of America 68 : 227-244.

Summers, F.A. (1960): *Eupalopsis* and *eupalopsellid* mites (Acarina : Stigmaeidae ,Eupalopsellidae). Flor. Ento. 43 (3) : 119 – 133.

Whitney, J. and James, D.G. (1996).The phytoseiid fauna of grapevines in Australia. Int. J. Acarol. 22 (4) : 279-284.

Yousef, A.A. and M.E. El-Halawany (1982): Effect of prey species on the biology of *Amblyseius gossipi* El-Badry (Acari: Mesostigmata: Phytoseiidae): Acarologia, 23 (2): 113-117.

تواجد بعض انواع الحلم المفترس على اشجار العنب فى محافظة الشرقية بمصر والاستجابة الوظيفية للحلم *Euseius metwallyi* لمكافحة الحلم العنكبوتى الاحمر ذو البقعتين *Tetranychus urticae* (أكارى: فيتوسيدى : تترانكيدى)

سالوناز السيد عوض ، مصطفى النبوى محروس ، عبد العزيز النشرتى باشه و السيد محمود مصطفى
قسم وقاية النبات – كلية الزراعة – جامعة الزقازيق

أسفرت دراسة الحصر التى اجريت حديثا فى محافظة الشرقية بمصر عن وجود احد عشر نوعا من الحلم المفترس تم تسجيلها على اشجار العنب . وتنتمى هذه الانواع الى فصائل Phytoseiidae (ثمان انواع) ، Cunaxidae (نوع واحد) ، Cheyletidae (نوع واحد) ، Stigmaeidae (نوع واحد) .تم مناقشة تكرار التواجد للانواع التى تم جمعها.

كما تم حساب الاستجابة الوظيفية للحلم المفترس *Euseius metwallyi* حيث حسب كل من معدل الافتراس وكذلك فترة الافتراس للحلم المذكور واتضح من النتائج ان الاناث الكاملة لهذا المفترس تتبع النوع ٢ من الاستجابة الوظيفية حيث سجلت النتائج معدلات الافتراس و فترات الافتراس للحلم المفترس *E. metwallyi* ٠.١٠ ، ٠.٢٨ و ٠.٠٧ وكذلك ٠.٩٩ ، ١.٤٧ و ٤.٥٩ عند تقديم البيض- الذكور والاناث من الحلم العنكبوتى *T. urticae* على التوالى .

تشير هذه النتائج الى انه يمكن اعتبار النوع المفترس محل الدراسة من اهم عوامل المكافحة الحيوية للحلم العنكبوتى الاحمر ذو البقعتين .

قام بتحكيم البحث

أ.د / عمر عبد الحميد نصار	**كلية الزراعة – جامعة المنصورة**
أ.د / جاد حماده حسن راضى	**كلية زراعة مشتهر – جامعة بنها**