INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCE AND ENGINEERING (IJESE)
Vol. 2: 93-100
http://www.pvamu.edu/texged Prairie View A&M University, Texas, USA

Integrated control of the twospotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae) on faba bean *Vicia faba* (L.) in an open field at Behaira Governorate, Egypt

M. M. E. Elmoghazy[1]; E. M. A. El-Saiedy[2] and Amal H. M. Romeih[3]

1- Agric. Zoology and Nematology Dept., Fac. of Agric., Al-Azhar Univ., Cairo, Egypt.
2- Plant protection Dept., National Research Center, Dokki, Giza, Egypt
3- Agric. Zoology and Nematology Dept., Fac. of Agric., Cairo Univ., Giza, Egypt.

ARTICLE INFO

Article History
Received: Nov. 18, 2011
Accepted: Dec. 25, 2011
Available online: March, 2012

Key words:
Neoseiulus californicus,
Typhlodromips swirskii
Tetranychus urticae
Biological control
Biocide

ABSTRACT

The efficacy of two predatory mites namely *Neoseiulus californicus* (McGregor) and *Typhlodromips swirskii* (Athias-Henriot), with Vertimec® 18EC and Challenger 36% Sc biocides were evaluated as control agents for *Tetranychus urticae* Koch on two cultivars of the faba bean *Vicia faba* (L.) ($Sakha_1$ and $Sakha_3$) in open field at Elnoubarya- Behaira Governorate during season 2008. Results revealed that the reduction percentage of different stages of *T. urticae* was achieved after releasing *N. californicus* and *T. swirskii* at prey-predator ratio of 7/1.

After releasing the two predatory mites and spraying biocide, *N. californicus* gave the highest reduction percentage of *T. urticae* on the faba bean $sakha_1$ cultivar, followed by *T. swirskii*, Vertimec® 18EC and Challenger 36% Sc. On the other hand, *N. californicus* gave the highest reduction percentage of *T. urticae* on the faba bean $sakha_3$ cultivar, followed by Vertimec® 18EC, *T. swirskii* and Challenger 36% Sc. So *N. californicus* obviously reduced the population density of *T. urticae* on both faba bean as compared with *T. swirskii*. The release of *N. californicus* and *T. swirskii* represents a useful management strategy for *T. urticae*.

1. INTRODUCTION

Spider mites represent economically important pests in many ornamentals and vegetables grown in greenhouses and fields all over the world (Helle and Sabelis, 1985 and CAB International, 2007). Spider mites problem increased when natural enemies are destroyed by applications of broad spectrum insecticides, applied against other pests (Mainul Haque *et al.,* 2010). Spider mites have been rapidly developing resistance to a series of acaricides (Croft and van de Baan, 1988) and have recently assumed a new aspect of multiple resistance (Pree *et al.,* 2002; Van Leeuwen *et al.,* 2004 and Kim *et al.,* 2006). Biological control means the control of pests with predators, parasites and pathogens. Several species of naturally occurring insects and mites prey on spider mites. Successful biocontrol can be obtained in many cases (Brødsgaard and Enkegaard, 1997; Messelink *et al.,* 2005 and 2006).

Corresponding author e-Mail: drelmoghazy@yahoo.com
ISSN 2156-7549

T. swirskii is a polyphagous predator capable of preying on a number of spider mites (Swirski *et al.,* 1967; El-Laithy and Fouly 1992; Momen and El-Saway 1993 and van Houten *et al.,* 2007a). Meanwhile, *N. californicus* is a widespread Type II phytoseiid mite (McMurtry and Croft 1997 and Luh and Croft 2001) that is native to Japan (Ehara and Amano 1998). This species is one of the most effective phytoseiid mites used for spider mite management in many agricultural crops and fruit orchards (Castagnoli *et al.,* 1995). *N. californicus* can also develop and establish a fair population using pollen as a food source (Castagnoli and Simoni, 1999).

The extensive use of pesticides can promote negative impacts on human health and on ecosystems, besides reducing the number of species and density of natural enemies, developing resistance and increasing production costs. To reduce these problems, it is necessary to minimize the chemical control by replacement of such pesticides by using biocides with releasing predatory mites. So this work aimed to evaluate the efficacy of two predatory mite species namely: *Neoseiulus californicus* (McGregor) and *Typhlodromips swirskii* (Athias-Henriot), with two of common biocides (Vertimec® 18EC and Challenger 36% Sc) as control agents against *Tetranychus urticae* Koch infesting two cultivars of faba bean *Vicia faba* (L.) ($Sakha_1$ and $Sakha_3$) in an open field at Elnoubarya- Behaira Governorate during season 2008.

2. MATERIALS AND METHODS

2.1 Experimental design:

Four experimental treatments were conducted. Each treatment was replicated three times. The replicate consisted of four lines area for each 0.5 meters width x 10 meters long. The experimental design comprised complete randomized blocks. Two species of faba bean were chosen in this work namely: $sakha_1$ and $sakha_3$.

2.2 Sampling Procedure:

Samples were taken weekly from the four treatments on the two cultivars. Thirty leaves were randomly collected, kept in paper bags, tightly closed with rubber bands, then kept in an ice box and transferred to laboratory for examination, using a stereomicroscope. The stages of *T. urticae* and the predatory mites were counted and recorded.

2.3 Biological control:

To study the effect of different types of biocontrol agents, four treatments were carried out on two cultivars of faba bean, using the two predatory mites *Typhlodromips swirskii*, *Neoseiulus californicus* and the biocide Vertimec® 18EC and Challenger 36% Sc. The forementioned experimental results were compared with a control group.

2.4 Rearing of *Tetranychus urticae:*

Rearing of *Tetranychus urticae* was carried on potted beans *Phaseolus vulgaris* L. in an isolated compartment 1.5 x 2.0 m. In an experimental glasshouse. The strain of *T. urticae* originated from infested leaves of Castor oil collected at Giza Governorate.

2.5 Rearing of the predatory mites:

The predatory mites *T. swirskii* and *N. californicus* were reared using methods modified from McMurtry and Scriven (1965), large plastic boxes 26 x 15 x 10 cm. were used, with a cotton pad placed in the middle of each box, leaving a space provided with water as a barrier to prevent predatory mites from escaping. Excised bean leaves highly infested with *T. urticae* were provided every day as a food source for mites and plastic boxes were kept in an incubator at 2525±2ºC and 65±10%R.H.

2.6 Mass rearing of the predatory mites:

For mass rearing of the predatory mites the potted bean *P. vulgaris* was served as plant host reared in a small glasshouse divided into three isolated parts (a) Clean bean plants, (b) Clean plants at 12 leaves stage infested with *T. urticae* (c) Bean plants

infested with five gravid females of the predatory mites for every plant (El-Saiedy, 2003 and El-Saiedy and Romeih, 2007). Temperature in the glasshouse ranged from 18 to 25ºC. and relative humidity from 50 – 60%.

2.7 Releasing of the Predatory mites:

Mites releasing started as the population density of *T. urticae* built upon faba bean at the beginning of invasion. Samples average from 20 - 25 individuals / leaf. The ratio between predator and prey ranged between 1: 7.The required population size of the predatory mite individuals were calculated according to the following formula:

$$\text{Released number} = \frac{\text{Total number of } T. \text{ urticae} \text{ /experimental area}}{\text{Proposed predator / prey percentage}}$$

Bean leaves with predator mites were transferred in an ice - box (10□±□3ºC) to faba bean fields. Distribution was carried out on infested faba bean plants. Repetitions of releasing samples were taken weekly, *Tetranychus urticae* stages were calculated as well as the predatory mites.

2.8 Biocide control:

-Vertimec® 18EC and Challenger 36% Sc.

-Formulation Type: Emulsifiable concentrate

-Vertimec® 18EC - is a commercial formulation of abamectin - 100 Cm^3 /100 Liter water + 250 Cm^3 oil kaby.

-Challenger 36% Sc - is a commercial formulation of chlorfenapyr which is pyrrole acaricide - 75 Cm^3 /100 Liter water + 250 Cm^3 oil kaby.

2.9 Statistical analysis:

The obtained data of mite numbers were subjected to the analysis of variance test (ANOVA) with mean separation at 5% level of significance according to the method of Snedecor and Cocharn (1967). Percentage reduction of the mite population were calculated according to the equation of Henderson and Tilton (1955) and Fleming and Retnakaran (1985).

3. RESULTS AND DISCUSSION

Results in Tables 1 and 2 shows the mean number after the release of the two predatory mites *Neoseiulus californicus* and *Typhlodromips swirskii* and spraying of Vertimec® 18EC and Challenger 36% Sc on faba bean cultivars on the 8th of January when the twospotted spider mite *T. urticae* average number ranged from 6.0 to 6.55 and 6.38 to 6.8 individual / leaf on faba bean $Sakha_1$ and $Sakha_3$ cultivars, respectively during the experiment.

From the obtained results, it was generally noticed that *N. californicus* reduced the population density of *T. urticae* on both faba bean $Sakha_1$ and $Sakha_3$ cultivars as represented by their mean average number being 2.50 and 4.00 *T. urticae*/ leaf $Sakha_1$ and $Sakha_3$ respectively, (Tables 1 and 2).

These results were in agreement with Rhodes *et al.* (2006) who observed that among the combination treatments, the *Phytoseiulus persimilis* / *N. californicus* treatment significantly reduced twospotted spider mite numbers compared with the control, but was not as effective as *N. californicus* alone.

Table 1: Mean number of *Tetranychus urticae* / leaf on faba bean $Sakha_1$ under field conditions affected by releasing two predatory mites and spraying with two biocides at Behaira Governorate during 2008 season.

Sampling date	Biological control		Biocide control		Control
	A	B	C	D	
8/1/2008	6.55	6.0	6.48	6.21	5.01
15	4.35	8.44	0.23	1.65	7.11
22	4.25	10.43	0.58	2.18	12.23
29	3.98	9.30	2.19	4.50	11.18
5/2/2008	3.45	10.20	4.55	7.58	13.17
12	3.00	9.32	6.93	8.43	20.25
19	2.49	12.40	0.40	1.00	17.44
26	3.44	9.44	1.58	2.14	20.33
3/3/2008	2.52	10.35	2.18	3.96	28.18
10	2.50	8.56	3.64	5.44	22.25
17	1.20	7.44	4.84	7.00	20.23
23	1.04	6.55	6.44	8.48	18.18
30	0.89	5.38	7.98	9.43	16.10
7/4/2008	0.32	4.83	9.14	11.36	25.13
15	0	3.22	10.83	12.24	24.14
22	0	1.87	11.68	13.86	23.11
mean	2.50	7.73	4.98	6.5913	17.75

A= *Neoseiulus californicus* B= *Typhlodromips swirskii* C= Vertimec® 18EC D= Challenger 36% Sc

Table 2: Mean number of *Tetranychus urticae* / leaf on faba bean $Sakha_3$ under field conditions affected by releasing two predatory mites and spraying with two biocides at Behaira Governorate during 2008 season.

Sampling date	Biological control		Biocide control		Control
	A	B	C	D	
8/1/2008	6.38	6.8	6.44	6.54	11.7
15	6.40	8.44	0.38	1.00	12.11
22	6.29	9.35	0.56	1.83	14.13
29	2.20	11.25	1.44	2.90	20.11
5/2/2008	5.44	11.89	2.38	3.48	19.23
12	5.56	12.9	4.12	5.98	21.3
19	6.20	14.56	0.11	0.82	23.06
26	5.30	13.40	0.65	2.00	24.1
3/3/2008	4.58	15.22	2.00	3.11	25.2
10	4.60	13.54	2.98	6.33	34.5
17	3.89	16.20	4.13	7.44	26.11
23	3.55	11.33	6.84	8.19	28.7
30	3.10	12.90	8.19	11.35	28.14
7/4/2008	0.55	10.54	10.22	13.18	30.3
15	0	8.24	11.85	15.00	31.5
22	0	6.34	12.83	16.85	22.14
mean	4.00	11.43	4.70	6.63	23.27

A= *Neoseiulus californicus* B= *Typhlodromips swirskii* C= Vertimec® 18EC D= Challenger 36% Sc

Data presented in Table 3 shows reduction percentages as a result of releasing the two predatory mites and spraying biocide. (A) *N. californicus* gave the highest reduction percentage of *T. urticae* (87.22) on faba bean $sakha_1$, followed by (B) *T. swirskii*, (C) Vertimec® 18EC and (D) Challenger 36% Sc, where reduction percentages were (57.49, 48.84 and 40.90) respectively.

Table 4 shows that the (A) *N. californicus* gave the highest reduction percentage of *T. urticae* (74.22) on faba bean $Sakha_3$ cultivar, followed by (C) Vertimec® 18EC (48.82), (B) *T. swirskii* (41.51) and (D) Challenger 36% Sc (41.26).

The high reduction percentage with Vertimec® 18EC is in agreement with Abd-Elhady and Heikal (2011) who observed that abamectin (Vertimec® 18EC) gave long time to control *T. urticae* mite till 30 days after application by two field rates, they explained that by that Abamectin gave long time residual side effect against predatory mite *P. persimilis* after 30 days by field rate.

Also these results show difference in the role of *T. swirskii* in controlling *T. urticae* between faba bean $Sakha_1$ and $Sakha_3$ cultivars. this was in agreement with Xu and Enkegaard (2010) who studied prey preference of the predatory mite, *Amblyseius swirskii* between first instar western flower thrips *Frankliniella occidentalis* and nymphs of the twospotted spider mite *T. urticae* on bean seedlings and they reported that *A. swirskii* consumed the same amount of the various types of spider mite nymphs except of the active deutonymphs of which significantly fewer were consumed. The latter is presumably in part a reflection of deutonymphs being larger and more active and thus more difficult to conquer and in part a reflection of a more pronounced congregating and web producing habit of deutonymphs compared to protonymphs thereby hampering the movements of *A. swirskii*. The latter is in accordance with observations by van Houten *et al.* (2007a) that *A. swirskii* was hardly found in the webbing of *T. urticae*.

Table 3: Reduction percentage (%) of *Tetranychus urticae* / leaf on faba bean $Sakha_1$ under field conditions affected by releasing two predatory mites and spraying with two biocides at Behaira Governorate during 2008 season.

Sampling date	Biological control		Biocide control	
	A	B	C	D
15/1/2008	52.62	21.23	94.29	85.22
22	72.96	27.56	92.79	76.83
29	72.38	29.31	86.99	85.57
5/2/2008	79.79	34.61	77.51	67.62
12	88.56	42.20	64.85	49.77
19	88.92	39.21	97.53	87.33
26	86.87	60.66	86.05	70.44
3/3/2008	91.43	62.20	58.96	56.04
10	91.65	67.57	55.34	34.64
17	92.78	69.0	18.22	0
23	95.58	69.70	0	0
30	95.75	71.97	0	0
7/4/2008	99.01	83.90	0	0
15	100	88.81	0	0
22	100	94.44	0	0
mean	87.22	57.49	48.84	40.90

A= *Neoseiulus californicus* **B=** *Typhlodromips swirskii* **C=** Vertimec® 18EC **D=** Challenger 36% Sc

Table 4: Reduction percentage (%) of *Tetranychus urticae* / leaf on faba bean $Sakha_3$ under field conditions affected by releasing two predatory mites and spraying with two biocides at Behaira Governorate during 2008 season.

Sampling date	Biological control		Biocide control	
	A	B	C	D
15/1/2008	36.16	21.10	94.29	85.22
22	41.66	19.79	92.79	76.83
29	43.57	17.27	86.99	74.20
5/2/2008	70.15	38.80	77.51	67.25
12	69.89	30.10	64.58	49.77
19	67.60	28.62	97.53	87.33
26	74.71	40.20	86.05	70.44
3/3/2008	79.06	34.75	58.96	56.04
10	79.81	44.24	55.34	34.64
17	80.59	34.65	18.22	17.13
23	85.01	43.26	0	0
30	87.08	52.57	0	0
7/4/2008	97.98	63.90	0	0
15	100	72.63	0	0
22	100	80.80	0	0
Mean	74.22	41.51	48.82	41.26

A= *Neoseiulus californicus* **B=** *Typhlodromips swirskii* **C=** Vertimec® 18EC **D=** Challenger 36% Sc

Table 5 shows the mean average numbers of the two released predators. Weekly mean number of the two predatory mites after their release in the field were 2.54, 3.62 for *N. californicus* and 2.14, 1.90 for *T. swirskii* individuals/ leaf on faba bean sakha$_1$ and sakha$_3$ cultivars. On the other hand, the predatory mite *N. californicus*, reached their highest number at the 11th and 12th week after release 4.30 and 3.95 individuals / leaf Sakha$_1$ cultivar, and at the 5th and 6th week after release on Sakha$_3$ cultivar 5.52 and 5.88 individuals / leaf. This was in agreement with Rhodes *et al.* (2006) who stated that *N. californicus* mites were observed in the mid and early-late season.

Table 5: Mean number of the predatory mites *Neoseiulus californicus* and *Typhlodromips swirskii* after their release on two faba bean cultivars in open field conditions at Behaira Governorate during 2008 season

Sampling date	Sakha$_1$		Sakha$_3$	
	N. californicus	*T. swirskii*	*N. californicus*	*T. swirskii*
15/1/2008	0.89	0.61	1.4	0.60
22	1.30	0.84	1.89	0.84
29	2.35	0.95	3.56	0.55
5/2/2008	3.88	1.4	4.30	0.93
12	3.20	1.35	5.52	1.6
19	3.00	1.61	5.88	1.8
26	2.56	1.81	4.28	1.01
3/3/2008	2.90	1.31	5.30	1.4
10	2.80	1.82	4.23	1.60
17	2.72	2.20	3.22	1.48
23	4.30	2.30	3.54	1.34
30	3.95	3.10	3.9	2.04
7/4/2008	2.10	3.20	2.8	3.45
15	1.16	3.60	2.5	3.8
22	1.03	3.80	2.01	4.2
mean	2.54	2.14	3.62	1.90

The predatory mite *T. swirskii* reached their highest number (3.80 and 4.2 individuals/ leaf Sakha$_1$ and Sakha$_3$ cultivars) at the 14th week after release.

In these experiments, *Neoseiulus californicus* has proved to be a promising candidate for biological control of *Tetranychus urticae* compared with of *Typhlodromips swirskii* on faba bean sakha$_1$ and sakha$_3$ cultivars in open field.

4. REFERENCES

Abd-Elhady, H. K. and Heikal,H. M. M. (2011). Selective toxicity of three acaricides to the twospotted spider mite *Tetranychus urticae* and predatory mite *Phytoseuilus persimilis* in apple orchards. Journal of Entomology, 8: 574-580.

Brødsgaard, H. F. and Enkegaard, A. (1997). Interactions among polyphagous anthocorid bugs used for thrips control and other beneficials in multi-species biological pest management systems. In: Pandalai SG, editor. Recent Research Development in Entomology 153-160. Research Signpost, Trivandrum

CAB International (2007). Animal Health and Production Compendium. CAB International.

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

Castagnoli, M.; Simoni, S. and Pintucci, M. (1995). Response of a laboratory strain of *Amblyseius californicus* (McGregor) (Acari Phytoseiidae) to semi-natural outdoor conditions. Redia (Firenze), 78: 273–282.

Croft, B. A. and van de Baan, H. E. (1988). Ecological and genetic factors influencing evolution of pesticide resistance in tetranychid and phytoseiid mites. Exp Appl Acarol, 4: 277–300.

Ehara, S. and Amano, H. (1998). A revision of the mite family Phytoseiidae in Japan (Acari, Gamasina), with remarks on its biology. Species Divers 3: 25-73.

El-Laithy A. Y. M. and Fouly, A. H. (1992). Life table parameters of the two phytoseiid predators *Amblyseius scutalis* (Athias-Henriot) and *A. swirskii* A.–H. (Acari, Phytoseiidae) in Egypt. Journal of Applied Entomology, 113(1): 8-12.

El-Saiedy, E. M. A. (2003). Integrated control of red spider mite *Tetranychus urticae* Koch on strawberry plants. Ph.D.Thesis, Fac. Agri., Cairo Univ., 171 pp.

El-Saiedy, E. M. A. and Romeih, A. H. M. (2007). Comparative studies between predatory mites and pesticides in controlling *Tetranychus urticae* Koch on strawberry plants at Qalubyia Governorate. J. Agrc.Sci., Mansoura Univ., 32 (4): 2601- 2608.

Fleming, R. and Retnakaran, A. (1985). Evaluating single treatment data using Abbott's formula with reference to insecticides. J. Econ. Ento., 78: 1179-1181.

Helle W. and Sabelis M. W. (1985). Spider mites. Their biology, natural enemies and control. 1: 75- 90, Elsevier, New York.

Henderson, C. E. and Tilton, E.W. (1955). Tests with acaricides against the brown wheat mites. J. Econ. Entomol., 84: 157-161.

Kim, Y.; Park, H.; Cho, J. and Ahn, Y. (2006). Multiple resistance and biochemical mechanisms of pyridaben resistance in *Tetranychus urticae* (Acari: Tetranychidae). J. Econ. Entomol., 99: 954 - 958

Luh, H. and Croft, B. A. (2001). Quantitative classification of life-style types in predaceous phytoseiid mites. Exp Appl Acarol, 25:403–424.

Mainul Haque, M.; Ali Asgar, and Mursalin Parvin (2010). Voracity of three predators on two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) and their developmental stages Research Journal of Agriculture and Biological Sciences, 6(1): 77-83.

McMurtry J. A. and Croft, B. A. (1997) Life-styles of phytoseiid mites and their roles in biological control. Annu Rev Entomol., 42:291–321. doi: 10.1146/ annurev. ento. 42. 1. 291.

McMurtry, J. A. and Scriven, G. J. (1965). Insectory production of *Phytoseiulus persmilis*. J. Econ. Entomol., 58: 282-284.

Messelink, G. J.; van Steenpaal, S. E. F. and Ramakers. M. J. (2006). Evaluation of phytoseiid predators for control of western flower thrips on greenhouse cucumber. Biocontrol, 51(5): 753- 768.

Messelink, G.; van Steenpaal, S. and van Wensveen, W. (2005). *Typhlodromips swirskii* (Athias-Henriot) (Acari: Phytoseiidae): a new predator for thrips control in greenhouse cucumber. IOBC/wprs Bulletin 28(1): 183-186.

Momen, F. M. and El-Saway, S. A. (1993). Biology and Feeding-Behavior of the Predatory Mite, *Amblyseius swirskii* (Acari, Phytoseiidae). Acarologia, 34(3): 199-204.

Pree, D. J.; Bittner, L. A. and Whitty, K. J. (2002). Characterization of resistance to clofentezine in populations of European red mite from orchards in Ontario. Exp Appl Acarol., 27:181–193.

Rhodes, E. M.; Liburd, O. E.; Kelts, C.; Rondon S. I. and Francis, R. R. (2006). Comparison of single and combination treatments of *Phytoseiulus persimilis, Neoseiulus californicus* and Acramite (bifenazate) for control of twospotted spider mites in strawberries. Exp. Applied Acarol, 39: 213-225.

Snedecor, G.W. and Cochran, G. (1967). Statically methods 6th. ed, lowa state Univ., Press lowa, USA, 560 pp.

Swirski, E.; Amitai, S. and Dorzia, N. (1967). Laboratory studies on the feeding, development and reproduction of the predacious mites *Amblyseius rubini* Swirski and Amitai and *Amblyseius swirskii* Athias (Acarina: Phytoseiidae) on various kinds of food substances. Israel J. Agricult. Res., 17: 101–119.

Van Houten, Y. M.; Hoogerbrugge, H. and Bolckmans, K. J. F. (2007a). Spider mite control by four phytoseiid species with different degrees of polyphagy. IOBC/wprs Bulletin, 30(5): 123-127.

Van Leeuwen, T.; Stillatus, V. and Tirry, L. (2004) Genetic analysis and cross-resistance spectrum of a laboratory selected chlorfenapyr resistant strain of two-spotted spider mite (Acari: Tetranychidae). Exp Appl Acarol, 32:249–261.

Xu, X. and Enkegaard, A. (2010). Prey preference of the predatory mite, *Amblyseius swirskii* between first instar western flower thrips *Frankliniella occidentalis* and nymphs of the twospotted spider mite *Tetranychus urticae* Journal of Insect Science, 10 (149): 1-11.