Egyptian Journal of Plant
Protection Research Institute
www.ejppri.eg.net

Field evaluation to control *Tetranychus urticae* (Acari: Tetranychidae) infesting pea crop at Menoufia Governorate in Egypt

Samah, Z. Elkholy; Asmaa, R. Abdel-Khalik and Ahmed, I. Amer
Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

ARTICLE INFO
Article History
Received: 23/1 /2023
Accepted:20 /3 /2023

Keywords

Biocontrol, essential oil, plant feeding, mites, red paper, senna and gall oak.

Abstract

Tetranychus urticae Koch (Acari: Tetranychidae) is a dangerous phytophagous mite causing economic losses to field crops. The aim of the study was to evaluate the effect of the two predatory mites *Amblyseius swirskii* Athias-Henriot and *Phytoseiulus persimilis* Athias-Henriot (Phytoseiidae), and commercial of three essential oils red paper, senna and gall oak on pea crops under field conditions. The two predatory mites were released at three levels (1:10, 1:20 and 1:30 predator: prey). The three oils were used at the rate of 100ml L^{-1} of water. Two applications were carried out in early November and December during 2020–2021season.The results indicated that all treatments reduced *T. urticae* populations compared to un control treatment. The maximum reduction in *T. urticae* population 63.57, 63.39 and 62.54% for red pepper, the predatory mite *P. persimilis* at level (1:30) and gall oak, respectively with non-significant differences. While, the lowest reduction in *T. urticae* population was 48.17% for the predatory mite *A. swirskii* at level (1:10). The results obtained in the current study indicated that *P. persimilis* is an important factor for the population reduction of *T. urticae* on pea plants under field conditions. Further studies in the combination of predatory mites and essential oil active ingredients will represent a more efficient biological control strategy for *T. urticae*.

Introduction

Pea, *Pisum sativum* L. (Leguminosae) is one of the most important and popular legume vegetable crops grown in Egypt. Field pea is largely consumed by humans or used as cattle feed. It includes high levels of lysine and tryptophan, two amino acids that are relatively low in cereal grains, as well as significant levels of carbohydrates (McKay *et al.*, 2003). One of the most dangerous pests in many agricultural systems around the world is *Tetranychus urticae* Koch (Acari: Tetranychidae). Vegetables, fruits, crops, and a number of ornamentals are among its host plants over 1161 species (Migeon and Dorkeld, 2022). It feeds on tender tissues, usually on the lower leaf surface, sucking out cell chloroplasts and other contents. At low densities, stipplings are distinct from green tissues, but as mite feeding continues, they may join up and become brownish or yellow-brown. At high densities, mite webbing may cover the leaves,

flowers and fruits, or the entire plant. Severe damage induces the leaves to dry and drop, and the plant may die (Saito, 1985).

Chemical control is a widely used method for managing arthropod and pest disease, but it can lead to pesticide resistance. To address this, biological control agents (Parasitoids and predators) should be used in an Integrated Pest Management (IPM) program. *T. urticae* is the major pest mite on crop fields (van Lenteren, 2000 and El-Laithy *et al.*, 2021). The predatory mite *Phytoseiulus persimilis* is released in the field at various release ratios to control *T. urticae*, in many crop areas (Sato *et al.*, 2011). McMurtry *et al.* (2013) classified this species as a Category 1 lifestyle, specialized mite predator, Subtype 1a - Specialized predators of *Tetranychus* species. The successful application of *P. persimilis* against *T. urticae* was studied by many authors (Rasmy and El-Laithy, 1988; El-Laithy *et al*., 1994; El-Laithy, 1996; Fawzy *et al.*, 2005; El-Ghobashy, 2006; Metwally *et al*., 2010 and Abdallah *et al*., 2014). The predatory mite *Amblyseius swirskii* (Athias-Henrio) is a generalist predator known to feed on many pests, e.g. phytophagous mites, whitefly, thrips, lepidopteran eggs (McMurtry and Croft, 1997 and Momen and El-Saway, 1993).

Many researchers have been conducted to identify eco-friendly, economical, and effective alternative approaches to the management of phytophagous mites, such as essential oils and their active ingredients (Walash, 2015; Elhalawany and Dewidar, 2017; Elhalawany *et al*., 2019 and Ata *et al*.,2023). Some essential oils had harmful effects on insects and mites. Consequently, red pepper has served as a source of biologically active chemicals such as flavonoids, phenols, carotenoids, capsaicinoids, and vitamins. Pepper is applied dried or fresh in a variety of pharmaceutical treatments (Cantrill, 2008; Fatima *et al.*, 2015 and Walash, 2015).

The main objectives of this study aim to control *T. urticae* on pea crops under field conditions using the two predatory mites *P. persimilis* and *A. swirskii* and commercial of three essential oils red paper, senna and gall oak.

Materials and methods

The 'Master B' pea cultivar was planted in the field to study control the two-spotted spider mite, *T. urticae* by using two predatory mite species, *Phytoseiulus persimilis* and *Amblyseius swirskii* and three essential oils; red pepper fruit, *Capsicum annuum* L. (Solanaceae), Alexandrian senna leaves, *Senna alexandrina* Mill. (Leguminosae) and gall oak stem, *Quercus infectoria* G. Olivier (Fagaceae) at Shebeen El-Kom, Menoufia Governorate, Egypt, during 2020–2021 season. The minimum and maximum temperatures during the study are between 10.50 and 21.60˚C and between 22.8 and 35.2˚C, respectively.

1. Mass rearing of the two predatory mites *Phytoseiulus persimilis* and *Amblyseius swirskii*:

The two predacious mites *P. persimilis* and *A. swirskii* were collected from strawberry plants at Shebeen El-Kom, Menoufia governorate. The colonies were maintained at room temperature under laboratory conditions in large plastic boxes (70x30x40 cm). Water was added when needed. Excised bean leaves highly infested with *T. urticae* were provided every day as a prey source for the predatory mite these methods according to **Elhalawany *et al*. (2019).**

2. Plant water extracts:

The three oils red pepper fruit, Alexandrian senna leaves and gall oak stem were extracted by aqueous method. 100 g dry powders of the required parts of plants were added to 1000 ml distilled water, and autoclaved at 120 °C for 20 min. The aqueous extracts were considered as slandered solution kept for 100 % for further dilutions. The three oils each aqueous extract was used at 10 % of concentration for application.

3. **Experimental design:**

An area of about 1050 m^2 was cultivated with pea plants 175 m^2 for each treatment (Two plots for release, three plots for essential oils and one plot for check with three replicates); each replicate consisted of four rows (12m long). Plants were spaced 20cm within rows

and 30cm between rows, and a one meter long distance was used to separate each block. Pea seeds were sowed on 1st of October 2020. Normal agricultural practices were followed except for keeping, the whole area free from any pesticide treatment.

4. Release of the predacious mite:

The two predatory mites were released at three levels (1:10, 1:20 and 1:30 predator: prey) for *T. urticae*. The two predators were released twice per season after 30 days of plantation in early November and December during 2020–2021 seasons. Releasing of phytoseiid mite was conducted by using soybean plants containing predator mites.

5. Application of essential oils:

The three oils were used at rate of 100ml L^{-1} of water. The three oils were sprayed two times per season after 30 days of plantation in early November and December during 2020–2021. Weekly samples of 10 pea twigs per treatment were collected for pest inspection. Motile stages of *T. urticae* and two predatory mites on pea twigs were counted. Reduction percentages of motile stages of pests were calculated according to equation by Henderson and Tilton (1955).

6. Statistical analysis:

Mean number of two prey diets and predatory mite were analyzed using two-way ANOVA. Means were compared by LSD test at 0.05 level using SAS statistical software (Anonymous, 2003).

Results and discussion

The first application was carried out in early November 2020 after one month of plantation. The number of motile stages of *T. urticae* was counted in a sample of 10 twigs of pea crops collected from different treatments. Data in (Table 1) it was found that the highest reduction percentage were 74.43 and 73.45; 74.43 and 74.95 for red pepper and gall oak after one and two weeks of first application, respectively. Efficiency of essential oils treatments decreased with an increase in data collecting interval. While, the efficacy of the two predatory mites increased with an increase the time after application the two predatory mites *P. persimilis* and *A. swirskii*.

After four weeks of application significant differences between reduction percentages of treatments, it can be divided into four categories. The highest reduction percentages ≥64% of *T. urticae* were recorded at treatments of red pepper, gall oak and *P. persimilis* at a rate of (1:30 predator: prey), they averaged 70.89, 68.63 and 64.34% after four weeks, respectively. The moderate reduction percentages (59.79%) were recorded for Alexandrian senna, followed by *P. persimilis* at level (1:20), *A. swirskii* at level (1:30) and *P. persimilis* at level (1:10). The lowest reduction percentages (> 70%) of *T. urticae* were recorded at treatments of *A. swirskii* at level (1:10) with averaged 48.60%. The second application of treatments was done in early December 2020. The reduction percentage of *T. urticae* population as a result releasing the two predators at three rates and spraying of three oils after four weeks of application showed significant differences between reduction percentages of treatments compare to un-treated control (Table 2). The highest reduction percentage of *T. urticae* population was recorded at treatments *P. persimilis* at rate (1:30) was 62.44%, followed by gall oak 56.46% and red pepper 56.25% without significant differences. The lowest reduction percentage was recorded at *A. swirskii* at level (1:10) with averaged 47.73%.

In general, the results showed that all treatments reduced *T. urticae* populations compared to control after two applications (Table 3). The maximum reduction in *T. urticae* population was 63.57, 63.39 and 62.54% for red pepper, the predatory mite *P. persimilis* at level (1:30) and gall oak, respectively with non-significant differences. While, the lowest reduction in *T. urticae* population was 48.17% for the predatory mite *A. swirskii* at level (1:10).

Table (1): Mean number and reduction percentage of *Tetranychus urticae* infesting pea crop after first application of different treatments under field conditions season 2020–2021.

Treatments	Pre-count	Mean number and reduction percentage of individuals/10 twigs after								Mean reduction %
		1st week		2nd week		3rd week		4th week		
		Mean	R%	Mean	R%	Mean	R%	Mean	R%	
***Phytoseiulus persimilis* (1:30)**	65.67	51.00	51.22 c	43.00	66.55 b	40.33	73.43 a	54.33	66.14 a	64.34 bc
***Phytoseiulus persimilis* (1:20)**	77.67	55.33	42.71 d	47.33	59.38 cd	44.67	67.24 abc	59.33	60.74 abcd	57.52 de
***Phytoseiulus persimilis* (1:10)**	76.33	46.00	37.50 de	38.00	56.32 d	35.33	64.96 bcd	50.33	57.47 cd	54.06 def
***Amblyseius swirskii* (1:30)**	67.67	59.33	41.54 d	51.33	58.49 cd	46.33	68.04 ab	59.67	62.05 abc	57.53 de
***Amblyseius swirskii* (1:20)**	71.33	58.67	33.81 ef	50.67	52.61 de	45.67	63.54 bcd	58.67	57.77 bcd	51.93 ef
***Amblyseius swirskii* (1:10)**	76.67	55.67	29.40 f	47.67	49.36 e	43.00	61.00 cd	56.67	54.66 d	48.60 f
Red pepper	74.00	23.33	74.43 a	26.33	75.97 a	39.33	69.38 ab	51.33	63.78 ab	70.89 a
Alexandrian senna	70.33	34.33	60.22 b	36.67	64.75 bc	49.33	59.63 d	61.33	54.55 d	59.79 cd
Gall oak	68.67	22.67	73.45 a	25.67	74.95 a	39.67	66.96 abc	54.33	59.16 bcd	68.63 ab
Control	74.0	92.0	-	111.0	-	130.0	-	144.0	-	-
F-value		58.0		16.19		3.43		3.57		11.36
P-value		<.0001		<.0001		0.6981		0.0016		<.0001
LSD at 0.05		6.55		6.92		6.92		6.29		6.24

Different letters in same column denote significant difference (P < 0.05). R% = reduction percentage

Table (2): Mean number and reduction percentage of *Tetranychus urticae* infesting pea crop after second application of different treatments under field conditions season 2020–2021.

Treatments	Pre-count	Mean number and reduction percentage of individuals/10 twigs after								Mean reduction %
		1st week		2nd week		3rd week		4th week		
		Mean	R%	Mean	R%	Mean	R%	Mean	R%	
***Phytoseiulus persimilis* (1:30)**	54.33	35.67	45.44 b	30.67	58.96 b	27.33	69.56 a	27.67	75.79 a	62.44 a
***Phytoseiulus persimilis* (1:20)**	59.33	39.67	38.28 c	32.67	50.32 c	29.33	57.85 ab	26.67	63.44 ab	52.47 bcd
***Phytoseiulus persimilis* (1:10)**	50.33	29.67	39.32 c	22.67	49.01 c	18.00	57.05 ab	15.00	58.53 bcd	50.98 bcd
***Amblyseius swirskii* (1:30)**	59.67	41.67	38.70 c	36.67	48.02 cd	33.33	55.90 ab	30.67	61.75 b	51.09 bcd
***Amblyseius swirskii* (1:20)**	58.67	40.67	36.09 c	35.67	45.20 d	32.33	53.06 b	29.67	58.90 bc	48.31 cd
***Amblyseius swirskii* (1:10)**	56.67	37.67	35.63 c	32.67	44.61 d	29.33	52.43 b	26.67	58.24 bcd	47.73 d
Red pepper	51.33	25.00	55.31 a	19.67	65.37 a	26.33	55.65 ab	32.33	48.69 cd	56.25 ab
Alexandrian senna	61.33	30.00	55.12 a	24.67	63.72 a	32.00	55.08 ab	41.00	45.79 d	54.93 bc
Gall oak	54.33	31.00	47.57 b	25.67	57.31 b	23.18	64.95 ab	30.18	56.00 bcd	56.46 ab
Control	144.0	157.0	-	160.3	-	170.0	-	178.0	-	-
F-value		18.63		43.43		1.15		4.03		3.63
P-value		<.0001		<.0001		0.3843		0.0085		0.0010
LSD at 0.05		5.37		3.58		15.82		12.90		6.82

Different letters in same column denote significant difference (P < 0.05). R% = reduction percentage

Table (3): Reduction percentage of *Tetranychus urticae* after two applications.

Treatments	Reduction percentage of individuals/10 twigs after
***Phytoseiulus persimilis* (1:30)**	63.39 a
***Phytoseiulus persimilis* (1:20)**	54.99 bc
***Phytoseiulus persimilis* (1:10)**	52.52 cde
***Amblyseius swirskii* (1:30)**	54.31 bcd
***Amblyseius swirskii* (1:20)**	50.12 de
***Amblyseius swirskii* (1:10)**	48.17 e
Red pepper	63.57 a
Alexandrian senna	57.36 b
Gall oak	62.54 a
F-value	12.10
P-value	<.0001
LSD at 0.05	2.18

Different letters in same column denote significant difference (P < 0.05).

The results of the current study showed that the predatory mite, *P. persimilis* at level (1:30) showed an effective on the *T. urticae* on pea crops. The efficiency of *P. persimilis* was significantly influenced by the release rate. Similar results were detected by Metwally *et al.* (2010) indicating that the release of *P. persimilis* reduced the percent of *T. urticae* in apple seedlings. *Euseius scutalis* (A.-H.) releases and anise essential oil as alternative strategy to control of *Eutetranychus orientalis* (Klein). Ten individuals per citrus seedlings of the phytoseiid mite *E. scutalis* released gave the highest reduction (84.95%) of *E. orientalis* population (Ata *et al.,* 2023). Abdallah *et al*. (2014) showed that the mean reduction percentage of the spider mite populations on pea plants by *P. persimilis* was significantly highest (95.2%). Tiftikçi *et al.* (2020) emphasized that *P. persimilis* has the potential to effectively control *T. urticae* on the tomato. At release ratios 1:10 and 1:20 predator: prey, *T. urticae* populations on tomatoes reached 76.0 and 39.4 per leaf, respectively, and decreased by half after eight weeks.

Our results showed red pepper gave highest reduction followed by gall oak similar results were obtained by Walash (2015) found that red pepper extract exhibited a high degree of efficiency against adult female of *T. urticae*. Under field conditions 10% of red pepper extract sharply decreased the numbers of *T. urticae* moving stages from 3.78 individuals/ leaf to 0.11 individuals / leaf., no infestation was recorded after two weeks of application, reduction percentages were 97.44, 98.88 % after 1 and 10 days of application. Senna leaves decreased the number from 4.11 before spray to 0.11 individuals / leaf after 14 days of application.

Pepper oil has a toxic effect on against *T. urticae* and 1st instars larvae of the cotton leaf worm (Cantrill, 2008). Red chilli and the combination of garlic and red chilli were as effective as dimethoate 40% EC in suppressing mite infestation over the 12 weeks period (Fatima *et al.*, 2015).

At all treatments, there was a reduction in the density of *T. urticae* after release and spray oils. The lowest reduction rate of *T. urticae* was at the density of *A. swirskii* at level (1:10). In addition, *P. persimilis* at level (1:30), red pepper and gall oak oils gave the highest reduction of the population of *T. urticae*. Thus, the results obtained in the current study indicated that *P. persimilis* is an important factor in the population reduction of *T. urticae* on pea plants under field conditions. Further studies in the combination of predatory mites and essential oil active ingredients will represent a more efficient biological control strategy for *T. urticae*.

References

Abdallah, A.A.; Al-Azzazy, M.M; Mowafi, M.H.; El-Saiedy, E.M. and Pastawy, M.A. (2014): Control of the two-spotted spider mite, *Tetranychus urticae* Kochon kidney bean and pea plants. ACARINES, 8(1): 43-48.

Anonymous (2003): SAS Statistics and Graphics Guide, Release 9.1. SAS Institute, Cary, North Carolina 27513, USA.

Ata, M.M.; El-Shahawy, G.Z; Fawzy , M.H.; Abdel-Baki, A.S.; Al-Quraishy, S.; Hassan, A.O. and Abdel-Tawab, H. (2023): Bioefficacy of essential oils emulsion and predatory mite, *Euseius scutalis* (Athias-Henriot) (Acari: Phytoseiidae) for the management of citrus brown mite, *Eutetranychus orientalis* (Klein) (Acari: Tetranychidae). Journal of King Saud University Science, 35(2):102471.

Cantrill, R. (2008): Paprika extract chemical and technical as assessment (CTA) for the 69th jecfa. Available at

http://www.fao.org/ag/ AGN /agns /jecfa /cta /69 paprika extract A_69.

El-Ghobashy, M.S. (2006): Efficacy of *Phytoseiulus persimilis* (A.-H.) in control the two spotted spider mite *Tetranychus urticae* Koch on Young Peach trees at Beihera Governorate. Journal of Agriculture Science Mansoura University, 31(5): 3203–3207.

Elhalawany, A.S. and Dewidar, A.A. (2017): Efficiency of some plant essential oils against the two-spotted spider mite, *Tetranychus urticae* Koch and the two predatory mites *Phytoseiulus persimilis* (A.-H.), and *Neoseiulus californicus* (McGregor). Egyptian Academic Journal of Biological Sciences A. Entomology, 10 (7): 135–147.

Elhalawany, A.S.; Abou-Zaid, A.M. and Amer, A.I. (2019): Laboratory bioassay for the efficacy of coriander and rosemary extracted essential oils on the citrus brown mite, *Eutetranychus orientalis* (Actinidida: Tetranychidae). ACARINES: Journal of the Egyptian Society of Acarology, 13:15–20.

Elhalawany, A.S.; Sanad, A.S. and Khalil, A.K. (2019): Field trials to control *Thrips tabaci* (Thysanoptera: Thripidae) infesting onion crop. Egyptian Journal of Plant Protection Research Institute, 2(4): 724–733.

El-Laithy, A.Y. (1996): Integrated control of the two spotted spider mite, *Tetranychus urticae* on cucumber grown under plastic house conditions in Egypt. Entomophaga, 41(3/4): 485–491.

El-Laithy, A.Y.; Elseedy, E.M. and Hussein, H.E. (2021): Efficacy of the predatory mite *Cydnoseius negevi* (Swirskii & Amitai) (Acari: Phytoseiidae) as a shared predator for sucking pests on sweet pepper in a net house in Egypt. Systematic & Applied Acarology, 26 (10): 1856–1866.

El-Laithy, A.Y.M.; El-Halawani, M.E. and Abou-Donia, G.M. (1994): Effectiveness of three phytoseiid predatory mite for biocontrol of *Tetranychus urticae* koch on cucumber on arid soils in Egypt. Proceeding of IX Intern. Cong. Acarology the Ohio State University, Columbus Ohio, USA, 11–21 July, pp. 191–194.

Fatima, K.; Lovejoy, T. and Wisdom, K. (2015): Efficacy of garlic *(Allium sativum*) and red chilli pepper (*Capsicum annum)* extracts in the control of red spider mite (*Tetranychus urticae*) in tomatoes (*Lycopersicon esculentum*). Asian Journal of Applied Sciences, 3(1): 124–131.

Fawzy, M. M.; El-Ghobashi, M. S. and Abd El-Wahed, N. M. (2005): Biological control of the two-spotted spider mite *Tertranychus urticae* Koch by the Phytoseiid mite *Phytoseiulus persimilis* A.-H. in Cantaloup field in Sharkia Governorate (Acari, Phytoseiidae& Tetranychidae). Egyptian Journal of Agriculture Research, 84(2): 355 –362.

Henderson, C.F. and Tilton, W.A. (1955): Test with acaricides against the wheat mite. Journal of Economic Entomology, 49: 157–161.

McKay, K.; Schatz, B. and Endres, G. (2003): Field pea production. North Dakota University of Agriculture and Science, Fargo, North Dakota, pp. 1–8. Retrieved from http://www.ag.ndsu.nodak.edu

McMurtry, A.J.; De Moraes, G.J. and Sourassou, N.F. (2013): Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. Systematic & Applied Acarology, 18(4): 297–320.

McMurtry, J.A. and Croft, B.A. (1997): Life-styles of phytoseiid mites and their roles in biological control. Annual Review Entomology, 42:291–321.

Metwally, A.M.; Ibrahim, G. A. and Elhalawany, A.S. (2010): Biological control of *Tetranychus urticae* Koch using the phytoseiid mite, *Phyoseiulus persimilis* A.–H. on apple seedlings. Egyptian Journal of Agriculture Research, 88 (2): 369–376.

Migeon, A. and Dorkeld, F. (2022): Spider mites web: a comprehensive database for the Tetranychidae. Available from http://www1.montpellier.inra.fr/CBGP/spmweb (Accessed 1/10/2022)

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

Rasmy, A.H. and El-Laithy, A.Y.M. (1988): Introduction of *Phytoseiulus persimilis* for two spotted spider mite control in greenhouses in Egypt (Acari: Phytoseiidae, Tetranychidae). Entomophaga, 33: 435–348.

Saito, Y. (1985): Life types of spider mites. In: Helle, W. and Sabelis, M.W. (eds) Spider Mites: Their Biology, Natural Enemies and Control. World Crop Pests, Volume 1A. Elsevier Science, Amsterdam, pp. 253–264.

Sato, M.M.; Moraes, G.J. and Wekessa, V.W. (2011): Effects of trichomes on the predation of *Tetranychus urticae* (Acari: Tetranychidae) by *Phytoseiulus macropilis* (Acari: Phytoseiidae) on tomato, and the interference of the webbing. Experimental & Applied Acarology, 4: 21–32.

Tiftikçi, P.; Kök, S. and Kasap, I. (2020): Biological control of two spotted spider mites *Tetranychus urticae* Koch (Acari: Tetranychidae) using *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseidae) at different ratios of release on field-grown tomatoes. Biological Control, 151: 104404.

van Lenteren, J.C. (2000): A greenhouse without pesticides: fact or fantasy? Crop Protection, 19: 375–384.

Walash, E.H. (2015): Effect of some plant extracts on certain mite species. Ph. D. Thesis Agricultural Sciences (Agricultural Zoology), Menoufia University.