

Responses of the Two-Spotted Spider Mite *Tetranychus urticae* Koch (Acari: Tetranychidae) and Predatory Mite *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) to Some Pesticides

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ABSTRACT

Trial was carried out under laboratory conditions to evaluate the responses of the two-spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae) and the predatory mite *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) as a Turkish strain against some pesticides, which were selected from different groups. The responses (mortality, sensitivity) of mite populations against pesticides were estimated by calculating the median Lethal Concentration (LC₅₀). According to LC₅₀ values, toxicity of pesticides to the adult of two-spotted spider mite showed that bifenthrin was the highest toxic than dimethoate and hexythiazox in order. The predatory mite, *P. persimilis* was more sensitive than *T. urticae* against bifenthrin and dimethoate. Toxicity of bifenthrin and dimethoate was classified as a harmful effect according to IOBC toxicity classes. Hexythiazox was the least toxic than the other pesticides and was evaluated as harmless after 24 hours and moderately harmful after 72 hours to *P. persimilis*. For this reason, hexythiazox is suggested to be suitable in IPM program and ensure the preservation of predatory strains into local agroecosystem.

Keywords: Pesticides Toxicity, Bioassay Tests, *Tetranychus urticae*, *Phytoseiulus persimilis*.

INTRODUCTION

The predatory mite, *Phytoseiulus persimilis* is an important natural enemy to tetranichid mites in the garden and in greenhouses (Hamlen, 1978; Sabelis, 1981). This predatory mite was recorded as a natural enemy along the Mediterranean coast of Turkey (Şekeroğlu and Kazak, 1993). Turkish (Hatay) strain of *Phytoseiulus persimilis* A.H (Acari: Phytoseiidae) was

being used a few years ago in biological control against spider mites, which are an important and highly polyphagous pest on cultivated areas in Turkey (Kazak *et al.*, 1997; Çakmak *et al.*, 2005). Pesticides have direct and indirect effects on natural enemies so that, the choice of less toxic pesticides can be preserved for the natural enemies.

The aim of this study was to determine the sensitivity ratio of two-spotted spider mite and its predatory mite, *P. persimilis* against three pesticides the three pesticides were bifenthrin, dimethoate and hexythiazox, which were selected from different groups. In addition, the study aims at evaluating the toxicity of pesticides to predatory mite by using the IOBC (International Organization for Biological Control) classes.

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Materials and Methods

Chemicals

Two insecticides-acaricides, bifenthrin (Talstar® 10 EC, 100 g a.i. L⁻¹, Bayer) as a pyrethroid pesticide and dimethoate (Poligor® EC, 400 g a.i. L⁻¹, Hektaş) as an organophosphate pesticide and a selective acaricide as mite growth regulator hexythiazox (Twister® 5 EC, 50 g a.i. L⁻¹, Hektaş) were used in bioassay.

Source of Mites

Populations of *Tetranychus urticae* were collected from the greenhouse in the Faculty of Agricultural, Plant Protection Department of Ankara University/Turkey. Spider mite was reared on bean plants (*Phaseolus vulgaris* cv. Barbunia) at 25± 1 °C and 60± 10% RH under a 16-h light regime.

The predatory mite *Phytoseiulus persimilis* population (Turkish strain) was collected from fields in Hatay/Turkey and was reared at 25± 1 °C and 60± 5 % RH under 16-h light regime on bean plants, which infested with two-spotted spider mites.

Bioassay

Leaf-Spray method, which is accepted by the IOBC/WRPS Working Group on 'Pesticides and Beneficial Arthropods' as a standard routine test, was used in this test (Helle and Overmeer, 1985). Bean leaf was placed on wet cotton wool in a Petri dish (9 cm diameter) and was surrounded with Vaseline to prevent the escape of mites. Twenty female adult spider mites were transferred to leaf and sprayed (2 ml solution) by a Potter

spray tower (Auto-Load; Burcard® Scientific) at one bar. Concentrations of pesticides that caused 10-90 % mortality were applied with three replicates and control (water). The Petri dishes were stored in a cabinet at 25° C, 60± 5 % RH, 16 L: 8D light regime. For predatory mites, the same method (Leaf-Spray method) was applied and 10 adults were used in these treatments. For feeding the predatory mites *T. urticae* as a prey was used on leaf after spraying. Mortality was recorded after 24 hours for bifenthrin and dimethoate, 24 hours and 72 hours for hexythiazox because the activity of hexythiazox (mite growth regulator) on adult mites takes a few days.

According to LC₅₀ values, toxicity of pesticides to predatory mite was classified by IOBC category where; < 30 % mortality is harmless or slightly harmful (N), 30-79 % mortality is moderately harmful (M) and >79 % mortality is harmful (T) (Boller *et al.*, 2006). LC₅₀ value with a 95 % confidence limited and slopes ±SE of the regression were estimated by using the computer program POLO plus (LeOra Software, 1994). Hypothesis of parallelism for slopes of responses linear was evaluated by chi-square test.

Results

According to LC₅₀ values, toxicity of pesticides to adult of two-spotted spider mites indicated that bifenthrin was (1.82 ppm) the highest in toxicity compared to dimethoate (107.06 ppm) and hexythiazox (175.75 (24 h); 537.45 (72 h) ppm), respectively (Table 1).

Table 1. LC₅₀ values (ppm) and statistics for *T. urticae* and *P. persimilis* adult against tested pesticides

Pesticides	<i>T. urticae</i>		<i>P. persimilis</i>	
	LC ₅₀ (95%CL)	Slope± SE	LC ₅₀ (95%CL)	Slope± SE
Dimethoate	107.06 (73.24- 166.97)	0.64±0.12 b*	5.54 (3.99- 7.51)	1.53±0.24 a
Bifenthrin	1.82 (1.30 - 2.57)	0.97±0.11 a	0.025 (0.017- 0.034)	1.66±0.33 a
Hexythiazox (24 h)	537.45 (453.47 - 648.69)	1.68±0.18 a	184.48 (123.80 – 307.50)	1.13±0.21 a
Hexythiazox (72 h)	175.75 (128.24 - 265.83)	1.10±0.14 b	28.92 (22.50- 38.03)	1.90±0.27 a

* Means with different letters within a line were significant different (Chi- square Test)

While toxicity of pesticides to adult of predatory mite, *P. persimilis*, bifenthrin (0.025 ppm) was the highest in toxicity compared to dimethoate (5.54 ppm) and hexythiazox (184.48 (24 h); 28.92 (72 h) ppm). Toxicity of hexythiazox for all mite populations by 24 hours and 72 hours after application showed tremendous differences. These differences depend on the mite growth regulator activity of this chemical. Generally, toxicity of hexythiazox

to all adult mites was the least than bifenthrin and dimethoate. However, toxicity of bifenthrin to tested mites was the highest than the other pesticides.

Sensitivity ratio of *P. persimilis* for *T. urticae* against dimethoate, bifenthrin and hexythiazox (24 and 72 hours) were 19.30, 72.68 and 2.91 (after 24 hours); 6.07 (after 72 hours) times, respectively (Table 2).

Table 2. Sensitivity ratio of *P. persimilis* for *T. urticae* adult to tested chemicals.

Mite population	Dimethoate		Bifenthrin		Hexathiazox			
	LC ₅₀	S. ratio	LC ₅₀	S.ratio	LC ₅₀	S.ratio	LC ₅₀	S.ratio
	(24/h)		(24/h)		(24/h)		(72/h)	
<i>T. urticae</i>	107.06	1	1.82	1	537.45	1	175.75	1
<i>P. persimilis</i>	5.54	19.30	0.025	72.68	184.48	2.91	28.92	6.07

S. ratio: Sensitivity ratio

To evaluate correctly the concentration-mortality relationship, the curve of concentration-mortality was transformed into a straight one by using the logarithm of concentrations of pesticide against mortality %. The slope values of the straight line of concentration-

mortality indicate the sensitivity of the test mite population to pesticides. Therefore, the mortality of adults of predatory mite to concentrations of dimethoate and hexythiazox (after 72 hours) was faster than the mortality of spider mite adult so that, response linear

between concentration-mortality (slope of toxicity) for spider and predatory mite showed non-parallelism and

there was not significant difference between slopes of linear (Table 1, Figure 1, 2).

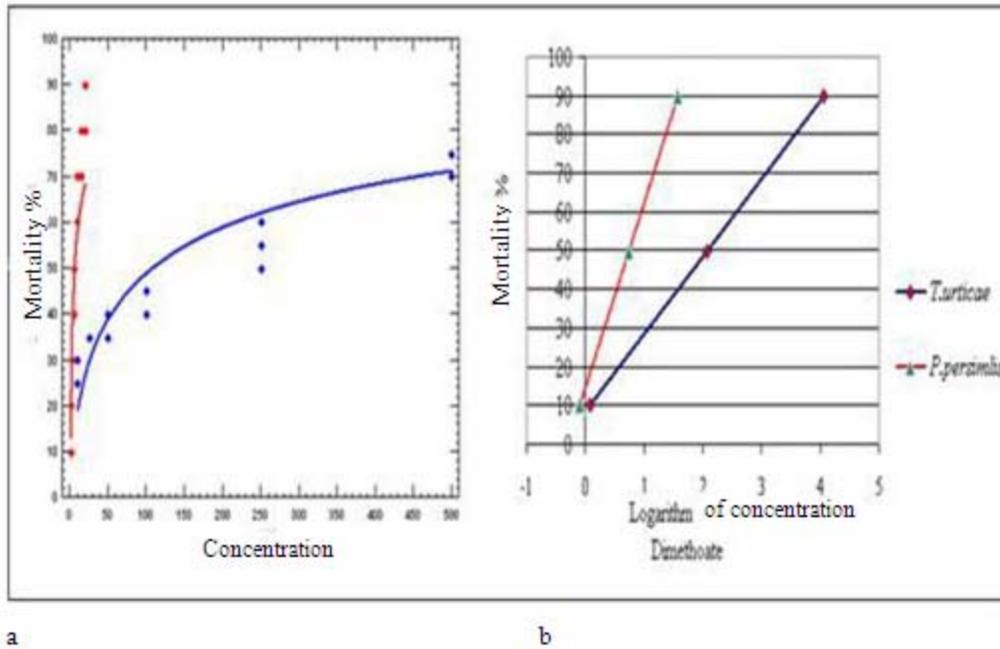


Figure 1. a. Concentration-mortality curve b. linear of log concentration-mortality to mite adults against dimethoate.

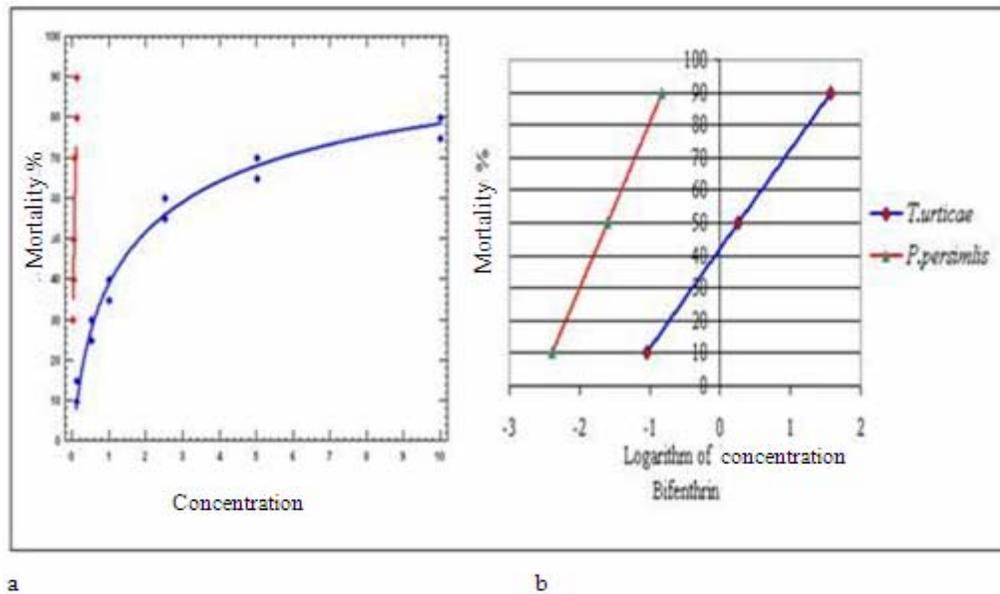


Figure 2. a. Concentration-mortality curve b. linear of log concentration-mortality to mite adults against bifenthrin.

Therefore, any increase in concentration will make the mortality of predator greater than spider mite. This relationship is not useful in the control of spider mites by biological agent. While the response of predatory mite

adults to concentrations of bifenthrin and hexythiazox (after 24 hours) showed parallel linear when compared with mortality of spider mite adults and there was a significant difference between slopes of linear (Table 1, Figure 3, 4).

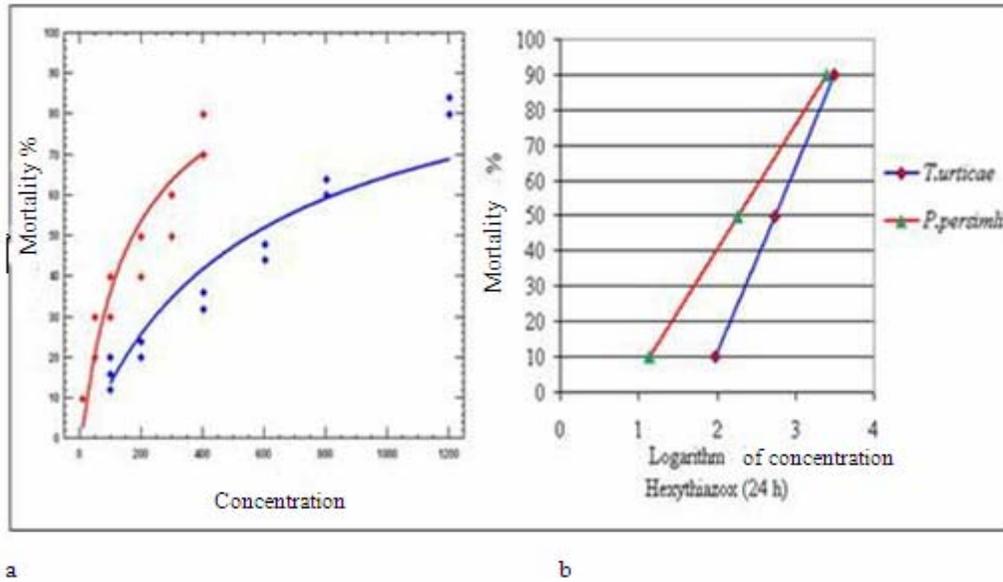


Figure 3. a. Concentration-mortality curve b. linear of log concentration-mortality to mite adults against hexythiazox after 24 hours.

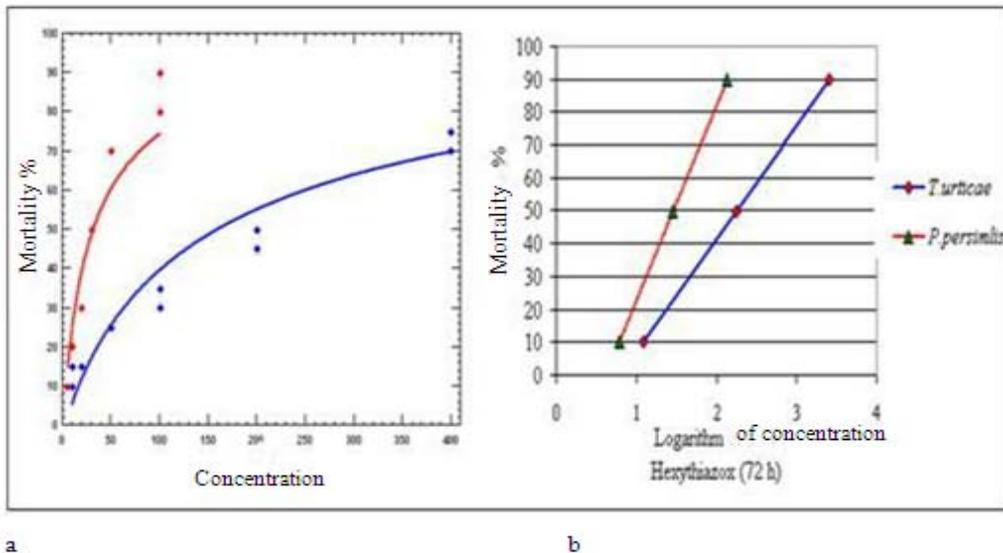


Figure 4. a. Concentration-mortality curve b. linear of log concentration-mortality to mite adults against hexythiazox after 72 hours.

Toxicity of pesticides to predatory mite, *P. persimilis* showed that bifenthrin and dimethoate were with harmful effect but hexythiazox was with harmless effect

after 24 hours while moderately harmful after 72 hours (Table 3).

Table 3. Classification of pesticides toxicities against predatory mite, *P. persimilis* according to IOBC criteria and lethal concentration values

Pesticides	LC value (ppm)	Classification
Dimethoate: label dosage is 450 ppm (112.5 ml/100L)	<i>P. persimilis</i> : LC ₉₉ = 181.43 ppm < 450 ppm	T
Bifenthrin: label dosage is 60 ppm (60 ml/100L)	<i>P. persimilis</i> : LC ₉₉ = 0.62 ppm < 60 ppm	T
Hexythiazox: label dosage is 50 ppm (100 ml/100L)	<i>P. persimilis</i> : LC ₃₀ = 63.75 ppm > 50 ppm	(24 hours) N
	<i>P. persimilis</i> : LC ₇₀ = 54.56 ppm > 50 ppm	(72 hours) M

N: slightly harmful, M: moderately harmful, T: harmful

Discussion

There are many different ways to test the effect of a pesticide or other compounds on mites, beginning with a Slide-Dip study, Leaf-Spray method and progressing in complexity to a field-scale study (Hassan and Oomen, 1985; Hassan *et al.*, 1985). Dose-response curves are used to derive dose estimates of chemical substances. A common dose estimate for acute toxicity is the LD₅₀ (Lethal Dose 50%). This is a statistically derived dose at which 50 % of the individuals will be expected to die.

Results indicated that predatory mite, *P. persimilis* showed more oversensitivity against bifenthrin and dimethoate when compared with *T. urticae*. Generally, natural enemies are usually more susceptible to the effects of pesticides than their plant-feeding hosts or prey owing to their generally smaller size, searching habits, usually less-developed enzyme-based detoxification systems (Charlet, 1995). Bostanian and Akalach (2006) reported that the contact toxicity of dimethoate, abamectin and insecticidal soap to

Amblyseius fallacis (Garman), *Phytoseiulus persimilis* Athias-Henriot and nymphs of *Orius insidiosus* (Say) was very toxic to all three beneficial adults. Kenneth *et al.* (2002) reported the effects of acaricide residues on *P. persimilis* and *T. urticae* using a leaf disk system. Bifenthrin residue was toxic to *P. persimilis* at all times after application.

Hexythiazox was the least toxic than the other pesticides and was evaluated as harmless after 24 hours and moderately harmful after 72 hours to *P. persimilis*. Kenneth *et al.* (2002) found that abamectin, Gowan 1725, hexythiazox, horticultural oil, neem oil, pyridaben, and spionosyn residues caused no mortality to *P. persimilis* 1, 3, 7, or 14 days after application, and that *T. urticae* mortality from hexythiazox and spinosad residues was not significantly greater than the control; and bifenthrin and chlorfenapyr residues were toxic to *P. persimilis*.

However, hexythiazox can be suggested in IPM program and can be combined successfully with

releasing of predatory mite to control spider mite population. Alzoubi and Çobanoğlu (2007) reported that the combination of hexythiazox with releasing of *P.*

persimilis gave well control on spider mite, *T. urticae* when compared with chemical and predatory mite alone under greenhouse conditions.

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***Tetranychus urticae* Koch(Acari: Tetranychidae)**

(Acari: Phytoseiidae) *Phytoseiulus persimilis* Athias-Henriot

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Tetranychus () *Phytoseiulus persimilis* A.H :
() *urticae* Koch
(LC₅₀)
(IOBC)
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IPM
Tetranychus urticae :
Phytoseiulus persimilis

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