Toxicity of Seven Acaricides to Teranychid and Phytoseiid Mites in Apple Orchards and Under Laboratory Conditions

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ABSTRACT

The toxicity of seven acaricides (abamectin, amitraz, azocyclotin, fenbutatin oxide, propargite, pyrimidifin and spirodiclofen) to *Tetranychus urticae* Koch, *Panonychus ulmi* Koch (Acari: Tetranychidae) and the predatory phytoseiid mites (*Neoseiulus fallacis* German and *Typhlodromus cotoneastri* Wainstein) was evaluated in both laboratory and apple orchards in two different sites on the Syrian Coast (Shakrich- Lattakia and Premmant El-Masheik-Tartous). All tested acaricides were highly toxic to *T.urticae* and *P.ulmi*, except spirodiclofen, which was slightly to moderately toxic after 1day, and moderately to highly toxic after 7 days in field. For the phytoseiid mites; amitraz, azocyclotin and pyrimidifin were highly toxic in laboratory and field, abamectin was moderately toxic in both laboratory and field, fenbutatin oxide was moderately toxic in laboratory and non-toxic in field, propargite was moderately toxic in laboratory and slightly toxic in field, and spirodiclofen was slightly toxic in laboratory and non toxic in field.

Key Words: Apple, Acaricides, Toxicity, *T.urticae*, *P.ulmi*, Phytoseiids.

INTRODUCTION

The two-spotted spider mite *Tetanychus urticae* Koch and the European red mite *Panonychus ulmi* Koch are key pests in apple orchards on the Syrian Coast (Talhouk, 1969 and Halloum & Qerhaili, 2008). These mites cause serious damage consisting of bronzing, often followed by leaf drop and reduction of flowers and reduction in yield thereafter (Van de Vrie, 1985 and Liu *et al.*, 2005).

Current control measures of these spider mites in apple orchards depend, mainly, on acaricides (Van de Vrie, 1985 and Nauen *et al.*, 2001). Unfortunately; these mites have a tendency to build up resistance to most of available acaricides because of their high reproductive potential, and extremely short life cycle (allowing numerous generations in a growing season), combined with intensive use of acaricides during the growing season to keep the mite populations below economic thresholds (Devine *et al.*, 2001; Nauen *et al.*, 2001; Sato *et al.*, 2005; Hossain *et al.*, 2006 and Uesugi& Osakabe, 2007), and the loss of acaricide efficacy as a result of mite resistance problem is a major problem (Pree *et al.*, 1989; Kabir *et al.*,1993 and Stumpf & Nauen, 2002).

However, research efforts have been devoted to find alternative strategies to control tetranychiid mites in apple orchards, such as predatory mites of the family of Phytoseiidae, which are considered one of the most important biological control agent for these mites in many crops (McMurtry,1982), including apple orchards (Croft & Hoying, 1975 and Lester *et al.*, 2000). In Syria, many species of phytoseiid mites were found in apple orchards, such as (*Neoseiulus fallacis* German and *Typhlodromus cotoneastri* Wainstein) which might, naturally, control this pest without using acaricides. Therefore, it is important to use selective acaricides which are highly effective in controlling the target pest and, simultaneously, less harmful to phytoseiid predators in apple orchards.

No data have been reported about the toxicity of acaricides to the phytophagous and phytoseiid mites in apple orchards on Syrian Coast. Thus, the purpose of this study was to examine the toxicity of the commonly used acaricides in apple orchards in Syrian Coast to *T.urticae* and *P.ulmi*, and the adverse effect on the promising native phytoseiid mites, in order to find selective acaricides to be used in IPM programs.

MATERIALS AND METHODS

Seven acaricides were used in the present study (Table 1). These chemicals are used in fruit orchards in Syria to control spider mites.

Table (1): Active component%, formulation type and concentration rate of the tested acaricides

Acaricides	Active component% and formulation type	Concentration rate 100\l water
Abamectin	1.8 EC	160
Amitraz	20 EC	400
Azocyclotin	250 WP	120
Fenbutatin oxide	55 SC	110
Propargite	57 EC	100
Pyrimidifen	4 SC	100
Spirodiclofen	24 SC	40

Laboratory tests:

Populations of *T.urticae* and the Phytoseiid predators (*N. fallacis* and *T. cotoneastri*) were collected from apple orchards and reared in laboratory on bean leaves. The toxicity tests were conducted on the two phytoseiid species together because of the difficulty of differentiating between them, while *P. ulmi* populations was reared on apple leaves.

All tests were conducted on the second generation of the spider mites, under laboratory conditions (25±2°C, 50-60% R.H.). Adult females of spider mites were transferred to apple leaf discs (3cm in diameter) placed on moist cotton pads in plastic Petri-dishes (9cm in diameter). Each acaricide treatment and control was replicated five times (10 females/ replicate). Mites were sprayed with the tested pesticides ,while the control treatment was sprayed with water.

Mortality was recorded after 24 hrs. of treatment. Corrected mortality was calculated according to Abbott's formula (Abott, 1925).

Field tests:

The study was conducted in two different sites at the Syrian Coast; the first site was "Permmant El-Masheik"- Tartous- at 750 m above sea level, and the second was "Shakrieh"- Lattakia- at 450 m above sea level, during 2008 cropping season. The orchards of both sites were 15- 18 years old. The treatments (seven acaricides and control) were applied to individual apple trees. There were "guard" trees between plots to prevent contamination by spray drift. Ten trees were chosen for each treatment (each tree was a replicate), ten leaves were taken from each of the four sides of each canopy (100 leaves for each treatment). The numbers of *T.urticae*, *P.ulmi*, and phytoseiid predators were counted before, and after 1 and 7 days of spraying. Corrected mortality was calculated according to Hiderson and Tilton's formula (Hassan *et al.*, 1985).

For the determination of quantitative toxicity categories, measurements of International Organization for Biological Control for toxicity assessment to predatory and phytophagous mites in field trials were adopted: non toxic (<25 mortality), slightly toxic (25-50%), moderately toxic (51-75%), highly toxic (>75%) were applied (Hassan *et al.*, 1985).

The numbers of *T.urticae*, *P.ulmi*, and phytoseiid predators were compared among treatments in this study with the single factor analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Toxicity of the tested acaricides to phytophagous mites:

The data (Table 2) revealed that all tested acaricides were highly toxic (100% mortality) to the phytophagous mites *T.urticae* and *P.ulmi* in the laboratory. In the field, abamectin, amitraz, azocyclotin, propargite and pyrimidifin were highly toxic to phytophagous mites (mortality ranged between 79.64% and 100%) after one and seven days, in the two locations (Permmant El-Masheik and Shakrieh) (Tables 3and 4).

Fenbutatin oxide was moderately toxic to the phytophagous mites in the field after one day (mortality was 66.37 and 70.02 % to *T.urticae*, and 81.08 and 77.59% to *P.ulmi* in Permmant El-Masheik and Shakrieh; respectively). But after seven days the mortality 89.5% and 94.82 to *T. urticae*, and 95.04 and 100% to *P. ulmi*, respectively in Permmant El-Masheik and Shakrieh (Tables 3 and 4).

Spirodiclofen was slightly toxic to *T. uticae* in the field after one day in the both sites (mortality was 45.60 and 47.55% in Permmant El-Masheik and Shakrieh; respectively) and highly toxic after seven days (mortality was 83.9 and 91.07% in Permmant El-Masheik and Shakrieh; respectively). On other hand, it was slightly toxic to *P. ulmi* in Shakrieh (mortality was 33.33%) after one day and highly toxic (mortality was 100%) after seven days. But it was moderately toxic to *P. ulmi* in Permmant El-Masheik after one and seven days (mortality was 50.07 and 62,80%; respectively).

Toxicity of the tested acaricides to the phytoseiid mites:

Abamectin was moderately toxic (62.5 % mortality) to the phytoseiid mites in the laboratory (Table 2). In the field; it was moderately toxic after one day (mortality was 69.29% and 73.63% in Permmant El-Masheik

Table (2): Toxicity of seven acaricides to *T. urticae*, *P. ulmi* and the predatory mites in the laboratory

Acaricides	Mortality % after 24 hr.		
	T.urticae	*P.ulmi*	Phytoseiids
Abamectin	100[a]	100[a]	62.5[b]
Amitraz	100[a]	100[a]	100[b]
Azocyclotin	100[a]	100[a]	97.5[b]
fenbutatin oxide	100[a]	100[a]	57.5[a]
Propargite	100[a]	100[a]	60.00[a]
Pyrimidifin	100[a]	100[a]	100[b]
Spirodiclofen	100[a]	100[a]	42.5[a]

Means with the same letter in the column are not significantly different (p=0.05).

Table (3): Toxicity of acaricides to *T.urticae, P.ulmi* and the predatory phytoseiid mites in Shakrieh

Acaricides	Mortality%					
	T. urticae		*P. ulmi*		phytoseiid	
	after 1 day	after a week	after 1 day	after a week	after 1 day	after a week
Abamectin	95.99[a]	99.4[a]	94.42[a]	100[a]	73.63[a]	89.66[a]
Amitraz	100[a]	100[a]	87.45[a]	100[a]	95.85[a]	100[a]
Azocycltin	100[a]	100[a]	97.09[a]	88.36[a]	89.88[a]	100[a]
Fenbutatin oxide	70.02[b]	94.82[a]	81.08[a]	100[a]	22.90[b]	23.76[b]
Propargite	98.59[a]	99.66[a]	96.07[a]	100[a]	35.29[c]	48.38[c]
Pyrimidefen	100[a]	100[a]	100[a]	100[a]	100[a]	100[a]
Spirodiclofen	47.55[b]	91.07[a]	33.33[b]	100[a]	26.54[c]	18.48[b]

Means with the same letter in the column are not significantly different (p=0.05), Anova test.

Table (4): Toxicity of acaricides to *T. urticae, P. ulmi* and the phytoseiid predatory mites in Permmant El-Masheik

Acaricides	Mortality%					
	T. urticae		*P. ulmi*		phytoseiid	
	after 1 day	after a week	after 1 day	after a week	after 1 day	after a week
Abamectin	93.89a	100a	95.70b	100a	69.29a	86.36ab
Amitraz	100a	100a	100 b	100a	100b	100b
Azocycltin	80.91a	86.65a	89.4b	79.64a	76.37a	83.68b
Fenbutatin oxide	66.37a	89.5a	77.59b	95.06a	20.15a	23.88a
Propargite	98.98a	100a	97.04b	100a	25.64a	44.65a
Pyrimidefen	98.90a	100a	100b	100a	100b	100b
Spirodiclofen	45.60a	83.9a	50.07a	62.80a	18.94a	11.43b

Means with the same letter in the column are not significantly different (p=0.05), Anova test.

and Shakrieh; respectively), and mortality after seven days percentage increased to 86.36 and 89.66 % in Permmant El-Masheik and Shakrieh; respectively (Tables 3 and 4). Irrigary *et al.* (2007) found that abamectin was slightly toxic to *Metaseiulus occidentalis* in strawberry fields, but other studies showed that it was highly toxic to *Phytoseuilus pesimilis* (A. – H.) (Samoe-petersen, 1990 and Zhang &Sanderson, 1990), *Amblyseius californicus* (Amano *et al.*, 2004), *Amblyseius longispinosus* Evans (Ibrahim and Yee, 2000), *Amblyseius andersonii* (Chant) and *Neoseiulus fallacis* Garman (James, 2004).

Amitraz was highly toxic to the phytoseiid mites in laboratory and field (100% mortality) (Tables 2, 3 and 4). Pervious laboratory bioassays and field tests also revealed that amitraz was highly toxic to *Neoseiulus longispinosus* (Evans) (Kongchuensin and Takafuji, 2006), *A.californicus, A.womersley* (Amano *et al.*, 2004), and *P.persimilis* (Hassan *et al.*, 1978 and Oomen *et al.*, 1991).

Toxicity of azocyclotin to the phytoseiid mites was high in both laboratory and field (mortality ranged between 76.37 and 100%) (Tables 2, 3 and 4). These results are in agreement with those of Kim and Seo (2001) who mentioned that this acaricide was highly toxic to *A.womersleyi* Schicha.

Data presented in Table (2) revealed that fenbutatin oxide was moderately toxic to the predatory mites (57.5 % mortality) in laboratory, and non toxic (mortality less than 25%) in both sites (Tables 3 and 4). Previous laboratory tests showed that fenbutatin oxide was non toxic to *A.longispinosus* (kongchuensin and Takafuji, 2006), *P.pesrsimilis* (A. – H.) (Hassan 1987), *N.womersleyi* (Amano *et al.*, 2004), and to *Galendromus helveolus* (Chant) in citrus orchards (Chen *et al.*, 2003).

The present laboratory tests revealed that propargite was moderately toxic to the phytoseiid mites (mortality was 60%) (Table 2), but it was slightly toxic in the field after one and seven days of treatment in both sites (mortality ranged between 25.64 and 48.38 %). This agrees with some previous tests indicating that propargite was slightly toxic to *A.longispinosus* (Kongchuensin and Takafuji, 2006), *N.womersleyi* and *N.californicus* (Amano *et al.*, 2004), while it was highly toxic to *Euseius mesenbrinus* (Dean) in citrus orchards (Childers *et al.*, 2001).

Pyrimidifin was highly toxic to the phytoseiid mites in both laboratory and field (100% mortality) (Tables 3 and 4).

Spirodiclofen was slightly toxic to the phytoseiid mites in the laboratory (42.5% mortality) (Table 2). In the field, it was non toxic in Permmant El-masheik after one day (mortality 18.94%), and slightly toxic in Shakrieh (mortality was 26.54%). After seven days spirodiclofen became non toxic in

both spites (mortality was 11.43 and 18.48% in Permmant El-Masheik and Shakrieh, respectively). Raudonis (2006) mentioned that spirodiclofen was nontoxic to *A.andersoni* in strawberry fields, but it was toxic to *Typhlodromus pyri* Scheuten in apple orchards in Canada (Hardman *et al.*, 2003).

In conclusion, the present results of laboratory and field treatments revealed that amitraz, azocyclotin and pyrimidifin caused the highest mortality to the phytoseiid mites. Therefore, it is advisable to restrict their usage as much as possible.

On the other hand, results suggest that abamectin, fenbutatin oxide, propargite and spirodiclofen can be used as selective acaricides in integrated pest management programs where phytoseiid mites are the most prevalent natural enemies, as they appeared to be much more toxic to phytophagous mites than to phytoseiid mites.

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