The Effect of Some New Acaricides on The Two Spotted Spider Mite *Tetranychus urticae* on Water Melon and Their Side Effect on Spiders (Araneae)

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ABSTRACT

The efficiency of different groups of pesticides to suppress the population of the two spotted spider mite, *Tetranychus urticae* Koch on water melon plants was studied. The pesticides include three biochemical compounds: Yurmak 1.8% EC (Abamectin), Veto 5% EC (Abamectin), and Biofly 30x10^3 WP (*Beauvaria bassiana*); three acaricides: Ortus 5% SC (Fenpyroximate), Acarots 5% EW (Fenpyroximate) and Prince 10% EC (Hexythiazox) and two mixture compounds: Nest 20% SC (Abamectin 2% + Spirodiclofen 18 %) and Perfect 12% EW (Abamectin 2% + Chlorfenapyr 10%). They were applied for one time to control *T. urticae* infesting water melon plants during the experimental period. The different acaricides formulations were effective to control *T. urticae* for two weeks after application. Abamectin (biochemical) was more effective in reducing TSSM population than true spiders and revealed less effect on associated predators; while Hexythiazox was the most harmful acaricide in reducing true spider populations. The results will be helpful to develop IPM Programs with true spiders in agricultural crops.

Key Words: Abamectin, acaricide, *Beauvaria bassiana*, Chlorfenapyr, Hexythiazox Fenpyroximate, Shannon Wiener Index, Simpson Index.

INTRODUCTION

Several acaricides including flufenoxuron, fenpyroximate and abamectin are currently used in Egypt; however, the side effects of the acaricides to natural enemies are unidentified.

Many efforts have been undertaken to manage TSSM problems in agricultural crops such as the application of new acaricides with the lower concentrations to save predatory mites and true spiders. Failure of chemical control of *T. urticae* caused by resistance was reported in several countries for compounds such as Hexythiazox (Herron & Rophail, 1993), Abamectin (Beers *et al.*, 1998) and Fenpyroximate (Sato *et al.*, 2004).

Ahn *et al.* (2004) found that miticides were more toxic to TSSM than to its predator, *Phytoseiulus persimilis*. Also, some previous studies examined the effects of some acaricides on non-target soil fauna and beneficial species such as spiders (Amalin *et al.* 2000; Rizk *et al.* 2004 & 2005 Kim and Yoo 2002).

In the present study, the effect of eight acaricides frequently employed in Egypt to control TSSM such as Abamectin, Fenpyroximate, Hexythiazox and *Beauvaria bassiana* product and their harmful effect on population density of true spiders on water melon crop were studied using topical applications and time exposure of pests. The acaricide concentration tested initially approximated field rates as recommended in 2012 by Agricultural Research Center, Ministry of Agriculture.

MATERIALS AND METHODS

The study area:

The experiment of 2012 season was conducted in Fayoum governorate. Watermelon plant was sown on 1st June; an area of 2100 m^2 was divided into 36 equal plots, each of 58 m^2 that received 8 acaricides of four replicates for each treatment and control. Plots were distributed in a randomized block design. Synthetic acaricide treatments were initiated based on state recommendations. The evaluated acaricides rates and order of spray in treatments were as follow:

Trade name	Active ingredient	Rate / 100 L.	Type
Biofly 30x10^3 WP	*Beauvaria bassiana*	250 cc	Biochemical
Yurmak 1.8% EC	Abamectin	50 cc	Biochemical
Veto 5% EC	Abamectin	15 cc	Biochemical
Ortus 5% SC	Fenpyroximate	50 cc	Acaricide
Acarots 5% EW	Fenpyroximate	50 cc	Acaricide
Prince 10% EC	Hexythiazox	20 cc	Acaricide
Nest 20% SC	Abamectin 2% + Spirodiclofen 18 %	20 cc	Mixture
Perfect 12% EW	Abamectin2% + Chlorfenapyr 10%	30 cc	Mixture

Pest assessment:

Application of the tested compounds was conducted on 11 July; pre-treatment count was recorded before spraying for each treatment. Ten

leaves were randomly collected from each plot (replicate) and movable stages of spider mites were counted in 1 inch^2 area before spraying and after one day, 3, 7, 14 and 21 days. Percentage of reduction was calculated according to Henderson and Tilton (1955)

$$\text{Percentage of reduction} = \frac{[1 - \text{Ta x Cb}]}{\text{Tb x Ca}} \text{ X100}$$

Where: Ta: number after treatment in treated plot.
Tb: number before treatment in treated plot.
Ca: number after treatment in check plot.
Cb: number before treatment in check plot.

Survey of true spiders in water melon fields:

Methods used to evaluate the side effect of this synthetic acaricides on true spider population. Samples of true spider fauna were collected weekly by pit-fall trap method as described by Southwood (1978) and Slingsby &Cook (1986). Fourty five traps were placed in the water melon field according to the arrangement of acaricides used.

Frequency and abundance values:

The frequency values of the most abundant species were classified into three classes according to the system adopted by Weis Fogh (1948); "Constant species" more than 50% of the samples, "accessory species" 25-50 % of the samples and "accidental species" less than 25%. On the other hand, the classification of dominance values were done according to Weigmann (1973) system in which the species were divided into five groups based on the values of dominance in the sample; Eudominant species (> 30% individuals), dominant species (> 10-30% individuals), subdominant (5-10% individuals) recedent species (1-5% individuals) and subrecedent species (1% individuals).

Species diversity:

The biodiversity of ground spiders collected was estimated by using equilibrium. Diversity of collected spiders was determined for samples pooled over one summer season by a lot of different acaricides used to control spider mite. It was measured in each tested acaricide plots by diversity index that reflected the number of species (richness) in the samples. Two common indices were computed, Shannon-Wiener index "H" and Simpson index "S". They were calculated as described by Ludwig and Reynolds (1988). $H' = -\sum (ni / n) \ln (ni/ n)$ and $S = \sum (ni/n)^2$.

Where *ni* is the number of individuals belonging to the ith of "S" taxa in the sample and "n" is the total number of individuals in the sample. "H" is more sensitive to changes in number of species and diversity, while "S" is more responsive to changes in the most dominant species (Ludwig & Reynolds, 1988).

RESULTS AND DISCUSSION

The effect of tested compounds on *T. urticae* population:

Data in Table (1) show the effect of acaricides on the two spotted spider mite populations. All the compounds tested significantly reduced spider mite popoulation on water melon plants compared with the check. Regarding the initial effect (one day after spraying), the chemical acaricide, Prince 10 % EC (Hexithiazox) was more effective in controlling the spider mite mobile stages than other compounds resulting in 96.28 % reduction followed by the mixture compounds, Perfect (90.93%) and Nest (89.12%); while the lowest reduction percentage of spider mite mobile stages recorded 50.36% and 61.46% for the acaricides, Ortus (applied at 50cc/100 L. H_2o) and the biochemical compound Yurmak (applied at 50cc/100 L. H_2o), respectively, being insignificantly with other compounds treatments and significantly with the check.

Table (1): Effect of tested materials on *Tetranychus urticae* on water melon crops, 2012

Acaricides	No. of mites pretreatment / leaf	Initial effect After 1 day	R %	No. of mites after treatment / leaf (Residual effect)				Total	Mean	R %
				3 days	7 days	14 days	21 days			
Biofly	15.6	2.4	88.84	2.8	7.6	8.8	15.6	34.8	8.7	85.5
Yurmak	12.8	6.8	61.46	3.2	0.8	1.6	2.4	8.0	2.0	95.9
Veto	8.0	2.4	78.24	3.8	2.4	2.4	7.2	15.8	3.95	87.13
Nest	16.0	2.4	89.12	1.6	0.2	0.4	1.1	3.3	0.83	98.7
Perfect	16.0	2.0	90.93	0.3	0.4	0.8	4.0	5.5	1.38	97.75
Ortus	7.6	5.2	50.36	0.2	1.2	0.8	2.8	5.0	1.25	95.7
Acarots	12.0	2.0	87.91	0.3	0.4	0.6	3.2	4.5	1.13	97.55
Prince	15.6	0.8	96.28	1.6	0.8	10.4	4.8	17.6	4.4	92.65
Control	14.8	20.4	—	22.0	59.2	62.0	84	227.2	56.8	—

LSD at 5 % = 8.2

Table (2): Effect of different acaricides on spiders collected by pitfall trap under water-melon plants at Fayoum.

Families & taxa names	Biofly			Yurmac			Veto			Nest			Perfect			Ortus			Acarots			Prince		
	♂	♀	J	♂	♀	J	♂	♀	J	♂	♀	J	♂	♀	J	♂	♀	J	♂	♀	J	♂	♀	J
Lycosidae																								
Wadicosa fidelis	13	5	6	8	3	15	10	7	-	13	3	1	9	3	3	12	4	25	13	2	4	3	1	3
Pardosa spl	2		2		1	3	2	1	30	1	-	-	4	-	1	1	-	-	2	1		1	-	-
Pardosa sp2	6	1	-	4	1	1		1	-	2	-	2	-	1	13	2	-	-	1	-	1	2	-	-
Hogna ferox	1		-	1	1		2	2	-	3	1	52	-	-	-	-	-	-	1	-	-	-	-	-
Philodromidae																								
Philodromius sp.	6	-	1	1	-	1	2	-	-	2	-	3	1	-	2	3	1	-	2	1	1	2	-	-
Linyphidae			1				1																	
Prinerigone vagans	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miturgidae																								
Cheiracanthium sp.	-	1	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gnaphosidae																								
Zelotes sp.	2	1	-		2	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Salticidae									1															
Phlegra flavipes	-	-	-		-	-	-	-	-	2	-	-	-	-	-	1	-	-	2	-	-	1	-	-
Pellenes sp.	-	-	-		-	-	-	-	-	-	-	-	1	-	-	-	-	-		-	-	-	-	-
Thomisidae		-																						
Thomisus spinifer	-	-	-		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Theridiidae																				1	1			
Steatoda erigoniformis	-	-	-	2	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Total	30	8	10	16	8	20	18	11	32	25	4	59	16	4	19	20	5	25	21	5	7	9	1	4
Grand Total		48			44			61			88			39			50			33			14	

Table (3): The dominance-frequency relationship of spider communities (2012)

Fam.	Biofly				Yurmac				Veto				Nest			
	Total	F.%	Freq.	Dom.	Total	F.%	Freq.	Dom.	Total	F.%	Freq	Dom.	Total	F.%	Freq	Dom.
A	36	75	C	E	38	86.3	C	E	55	90.2	C	E	78	88.6	C	E
B	7	14.6	A	D	2	4.5	A	R	2	3.3	A	R	5	5.7	A	Sd
C	1	2.1	A	R	-	-	-	-	1	1.6	A	R	-	-	-	-
D	1	2.1	A	R	-	-	-	-	-	-	-	-	-	-	-	-
E	3	6.3	A	Sd	2	4.5	A	R	1	1.6	A	R	1	1.1	A	R
F	-	-	-	-	-	-	-	-	1	1.6	A	R	2	2.3	A	R
G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	-	-	-	-	2	4.5	A	-	1	1.6	A	R	2	2.3	A	R
Total		48				44				61				88		

Fam.	Perfect				Ortus				Acarots				Prince			
	Total	F.%	Freq.	Dom.	Total	F.%	Freq.	Dom.	Total	F.%	Freq	Dom.	Total	F.%	Freq	Dom.
A	34	87.2	C	E	44	88	C	E	25	75.8	C	E	10	71.4	C	E
B	3	7.7	A	Sd	4	8	A	Sd	-	12.1	A	D	2	14.3	A	D
C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	1	2.6	A	R	-	-	-	-	-	-	-	-	-	-	-	-
F	-	2.6	A	R	1	2	A	R	2	6.1	A	Sd	1	7.1	A	Sd
G	-	-	-	-	1	-	A	R	-	-	-	-	1	7.1	A	Sd
H	-	-	-	-	-	-	-	-	2	6.1	A	Sd	-	-	-	-
Total		39				50				33				14		

A : Lycosidae ; B : Philodromidae ; C : Linyphiidae ; D : Miturgidae ; E : Gnaphosidae
F : Salticidae ; G : Thomisidae ; H : Theridiidae

Frequency (abundance), by Weis Fog

> 50 % = Constant (C) ; 25 - 50 % = Accessory (ac) ; > 25 % = Accidental (A)

Dominance, by Weigmann

> 30 % = Eudominant (E); 10 - 30 % = Dominant (D); 5 - 10 % = Subdominant (sd)
1 - 5 % Recedent (R); > 1 % = Subrecedent (Sr)

After 3, 7, 14 and 21 days of spray, the reduction percentages of spider mite increased with the time elapsed after treatment. All the tested compounds significantly reduced the spider mite compared with the population check except of plot treated with Biofly, the efficacy of the compound decreased from 88.84% to 85.5% which indicate that Biofly caused spider mite populations rebounds; this may be due to some abiotic factors.

Moreover, the mean counts of reduction percentage of the tested compounds throughout 3, 7, 14 and 21 days recorded that both mixture compounds Nest 20% SC (Abamectin 2% + Spirodiclofen 18 %) and Perfect 12% EW (Abamectin 2% + Chlorfenapyr 10%) showed the highest reduction 98.7 and 97.75%, respectively, compared to other compound treatments; followed by the acaricide Acarots (97.55%) being significantly with untreated check and insignificant with other compounds. While the biochemical compounds Biofly and Veto gave the lowest mean percentage of reduction (85.5 and 87.13%), respectively, being significantly with untreated check and insignificant with other compounds.

Spider assemblages:

As shown in Table (2), a total number of 377 spiders were collected during this experiment; belonged to 8 families, 11 genera and 12 species. Juvenile comprised 46.7%; while males and females were 53.3%. The sex ratio was 1 ♀: 3.4 ♂.

The highest percent of their occurrence was presented by *Wadicosa fidelis* Octavius (166 individuals), *Hogna ferox* Lucas (64), *Pardosa sp1* (52) and *Pardosa sp2* (38) all of family Lycosidae. Rizk *et al.* (2004) indicated that spiders of family Lycosidae are more frequent in pitfall traps and showing a certain degree of resistance to acaricides. Family Salticidae was represented by 2 genera (*Phlegra flavipes* Denis & *Pellenes* sp.). Members of the remaining families Philodromidae (*Philodromus* sp) Miturgidae (*Cheiracanthium* sp.), Linyphidae (*Prinerigone vagans* Savigny), Gnaphosidae (*Zelote* sp.), Thomisidae (*Thomisus spinifer* O.P.) and Theridiidae (*Steatoda erigoniformis* O.P.) were noted in few numbers by only a single species for each.

Effect of tested compounds on spiders associated with *T. urticae*:

Different compounds influenced spider abundance. The effect of tested compounds against predators (spiders) associated with the red spider mite *T. urticae* is presented in Table (2). Results showed that the acaricides Prince (Hexythiazox) and Acarots 5 % E W (fenpyroximate) were the most effective pesticides on predators, whereas the total numbers of collected spiders were lower than other tested compounds recording 14 and 33 individuals, respectively. The results are in harmony with results reported for fenpyroximate by Abd-Elhady *et al.* (2011). They reported that the use of this compound in the field would probably result in severe reduction of the predator, *P. persimilis*; while the lowest numbers in male, female and juvenile of the spiders found in plot treated with Prince, recorded 14 individuals belonged to 6 species and 4 families. John (1988) studied the toxicity of hexythiazox to mite eggs and their larval stage and registred the microscopic examination of eggs treated with lethal dose of Hexythiazox showed that embryos reach an advanced stage of development before dying. Rizk *et al.* (2004) cited the dangerous of acaricides use on the biodiversity of the true spider fauna.

The highest numbers of individuals (88) was recorded in the plot treated with Nest (Abamectin + Spirodiclofen) decreased to 39 individuals in plot treated with Perfect(Abamectin + Chlorfenapyr). These results agreed with Maeyer *et al.* (2002) who proved that Spirodiclofen provided excellent control to *Lepidosaphes ulmi* L. and showed no adverse effect on natural predators of pear Psylla (Anthocoridae). While the higher dose of chlorfenapyr (125 g /ha) was at par in reducing the predatory population level to the tune of 31.13 as proved by Sarkar and Samanta (2010) and also they concluded that, chlorfenapyr at 75g /ha was safe for the natural enemies in chilli eco-system. In this respect, it is recorded that Nest had the lowest toxic effect against predators associated with the red spider mite *T. urticae* and was the most toxic pesticide against the red spider mite.

The microbial pesticides Biofly and Veto showed intermediate reduction percentage of predator's population. This result is in agreement with the findings of Sabra *et al.* (2005) who indicate that Biovar was moderately effective against *Thrips* but less effective against associated predators. Moreover, Gillespie, A.T. (1986) proved that *Thrips tabaci* susceptible to *Beauvaria bassiana* which killed all treated insects within 4 days.

Plots treated with the biochemical compounds, the Veto (Abamectin 15 cc) received 61 individuals decreased to 44 individuals in plot treated with

Table (4): Estimation of Shannon-Wiener and Simpson Indices of diversity in different cover cultivations

Type of index	Biofly	Yurmak	Veto	Nest	Perfect	Ortus	Acarots	Prince
Shannon-Wiener Index	0.83	0.55	0.47	0.4	0.5	0.46	0.80	0.89
Simpson Index	0.59	0.75	0.82	0.79	0.77	0.78	0.59	0.5

Yurmak (Abamectin 50 cc); Miranda *et al.* (2005) found that the predators, *Anthicus* sp., *Orius sp.*, *Xylocopa sp.*, and Straphillinid populations were severely reduced by excessive pesticides, Abamectin and Chlorothalonil applications in water plant plantations.

In general, the chemical compounds Prince and Acarots revealed high toxic effects against the two spotted spider mite, *T. urticae* and reduced spider population; while the mixture compound Nest, the biochemical Veto and the acaricide Ortus showed the highest total number of individuals of 88, 61, and 50 individuals, respectively with less effective against associated predators.

Frequency and abundance values:

Table (3) showed the frequency and abundance values of the most abundant spiders. Family Lycosidae was considered constant according to the system adopted by Weis Fogh (1948) under different application in all plots and it recorded 75, 86.3, 90.2, 88.6, 87.2, 88, 75.8, & 71.4 % in plots treated with Biofly, Yurmak, Veto, Nest, Perfect, Ortus, Acarots and Prince, respectively. *Wadicosa fidelis* Octavius was the most common member recorded Eudominant in all treatments except of plots treated with Veto and Nest recorded dominant. Families Philodromidae, Linyphidae, Miturgidae, Gnaphosidae, Salticidae, Thomisidae and Theridiidae were considered Accidental families under different applications in all plots.

This result agreed with Rizk *et al.* (2012) who indicated that members of Lycosidae were represented by three most common species, *Wadicosa fidelis* Octavius, *Pardosa injucanda* and *Pardosa* sp. and all their developmental structure were collected by pitfall traps below the four examined plants(the spearmint, castor bean, roselle and red pepper). Also, Shuang-lin, J. and Bo-ping L.(2006) indicated that Lycosidae was dominant families and occupied more than 60 % of individual community.

Species diversity:

The biodiversity of spiders in the eight plots treated by different acaricides is compared using Shannon Wiener "H" and Simpson "S" Indices of diversity (Table 4). The cover plantation of water melon in different plots varies in their species richness; the plot treated with Nest recorded the highest population of total number 88 individuals (Table 2). Its ecosystem is made of 5families, 7 genera and 8 species; followed by Veto recorded spider population of 61 individuals, belonging to 6 families, 8 genera and 8 species. While the plot treated by the acaricide, Prince and Acarots recorded the least species richness of 14 and 33 individuals, respectively.

The biodiversity index calculation indicates that Biofly, Acarots and Prince were the most diverse; the species richness of spiders in different families and their equitability (evenness) were higher.

According to Simpson Index which is a measure of dominance (responsive to changes for the most dominant species), it was found that Veto and Nest included the highest number of dominant species of values 0.82 and 0.79, respectively.

The relative toxicity of pesticides to pests, predators and immature stages of the predators should provide an adequate indicator for selectivity of pesticides, which is essential for development of pest management programs (Jeppson *et al.* 1975).

Results showed that treatments of acaricides revealed a higher rate of *T. urticae* mortality compared with non treated plot and also affect the activity density of spider. *T. urticae* numbers on plots treated with acaricides were significantly lower than plots treated with Biofly and Control.

Among the acaricides evaluated, Prince (Hexythiazox) was harmless to true spiders; Nadimi *et al.* (2008) indicated this result with *P. persimilis*; while the two products of Fenpyroximate (Acarots and Ortus) gave different effect on spider, Acarots was more harmful to spider than Ortus. The present results are consistent with that reported by (Blumel & Hausdrof, 2002) and Nadimi *et al.* (2008).

Also, spider has responded differently to the two products of Abamectin. Results obtained reveal the reduction of true spiders in plots treated with Yurmak more than that obtained from Veto. Also, the compound Nest (Abamectin + Spirodiclofen 18%) was harmless to true spiders and might cause

hatching of eggs which result in increase the total number of individuals. This result confirmed by Nadimi *et al.* (2008) which proved that Abamectin was moderately harmful to spider.

As Abamectin, Fenpyroximate and Biofly are very effective they should be used carefully and may be classified as IPM compatible acaricide in integrated pest management programs against *T. urticae* in Egypt.

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