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Toxicological and biological studies of some compounds against the two spotted spider mite, *tetranychus urticae* and its predatory mite, *amblyseius gossipi* on different host plants

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ABSTRACT

The present study was carried out to evaluate the toxic effect of five compounds; three specific acaricides; (Abamectin, Fenpyroximate and Etoxazole); one pyrethroid insecticide (Cypermethrin) and one mineral oil (Supermasrona), against the eggs and adult females of the two spotted spider mite, *Tetranychus urticae* (Koch) and adult females of predatory mite, *Amblyseius gossipi* (El-Badry) on three different host plants (castor bean, green beans and tomato) using leaf-disc dip technique. The effect of sublethal doses of these compounds on some biological and behavioral characteristics of this mite and its predator was also examined. The results indicated that, Abamectin has a special position in mite chemical control or in integrated mite management because of its high toxic effect and its high toxicity index between different tested mite control agents. Etoxazole is the safest compound to adult females of predator mite *A. gossipi* on the three hosts. Cypermethrin is the most effective compound tested on egg deposition of *T. urticae* on castor bean leaf discs but fenpyroximate is the most effective compound tested on egg deposition on green beans and tomato leaf discs. In addition, Cypermethrin was the most effective compound decreasing egg hatchability especially on castor bean and green beans leaf discs. The pyrethroid compound (Cypermethrin) and the acaricide compound (Abamectin) are the most effective that decreased prey egg consumption, decreased predator egg production and caused high decrease in egg hatchability of the predator *A. gossipi* on the three host plants.

Keywords: Pesticides, *Tetranychus urticae, Amblyseius gossipi,* toxicity, host plants, biological aspects.

INTRODUCTION

Tetranychid mites are common pests in agricultural systems, causing in many cases, greater economic losses than any other arthropod pests. The two spotted spider mite, *Tetranychus urticae* is considered as one of the major pests attacking different agricultural crops such as field crops, vegetables, fruits and ornamental plants. The infestation by mites caused a great damage to these infested plants followed by a secondary infestation by various pathogens such as virus, bacteria and fungi. The two-spotted spider mite *T. urticae* (Koch) has been extensively studied and the early work was reviewed by Huffaker *et al*. (1969). *T. urticae* infests a wide range of economic plants in the field such as cotton (Leigh *et al* ., 1968) , strawberry (Sances *et al*., 1982), cucumber (De-ponti, 1980), tomato (Rodriguez *et al*., 1972) , peanuts (Boykin and Campbell, 1982) , peppermint (Hollingsworth, 1980). Tobacco, cucumber, beans and tomato are also attacked under glass houses (Patterson *et al*., 1974), together with numerous ornamental plants (Hamlen and Lindquist, 1981). Fruit orchards may also be infested and damage has been reported on apple, peach, pear, almond and walnut (Hoy *et al*., 1980 and Penman and Chapman, 1980).

The use of predators had proved to be effective control method for tetranychid mites and the most effective predators were found in the family. phytoseiidae (Abou Awad and El-Banhawy, 1985). *Amblyselus fallacis* (Garman) is an important phytoseiid mite on various crops (Croft and McGroarty, 1977), and it is a key predator for managing spider mites (Specht, 1968). In addition, *A. gossipi* (El-Badr) is one of the faster developmental rates and has high oviposition and predation rates (EL-Badry, 1967). The possibility of controlling phytophagous mites by a combination of biological and chemical methods had proved a less costly and more permanent method of control than had pesticides alone (Hosny *et al*., 2003 and Magouz and Saadoon, 2005).

Keratum and Hosny (1994) found that the predatory mite, *Phyloseiulus persimilis* showed significant reduction in feeding and oviposition on discs treated with fenvalerate, deltamethrim, permethrin (WP) and cypermethrin (EC). The effect was greater with dilutions of technical fenvalerate and deltamethrin compared with formulated permethrin (WP) and cypermethrin (EC). Hosny and Keratum (1995) studied the sublethal effects of deltamethrin on feeding and oviposition of *A. fallacis* on chemically treated surfaces *A. fallacis* showed decreased feeding and oviposition compared with control. Saied *et al.* (2002) found that Vertimec caused high initial kill (81.75 %) against two spotted spider mite population on cotton. They found that supermasrona cause high residual effect (87.61 %) against two spotted spider mite population in cotton crops.

Recently, Magouz and Saadoon (2005) showed that the high reduction in hatchability of produced eggs (59.70 %) was found when females of *T. Cucubitacearum* treated with LC_{50} value of Natcom 20/5, while the lowest reduction (14.21%) was obtained in case of the treatment with LC_{50} of Alkanz 2000. The treatment of *T. cucurbitacearum* females with LC_{50} values of the tested compounds prolonged of total immature stages and the duration of life cycle.

The present study was carried out to examine the toxic effect of five tested compounds against the eggs and the adult females of the two spotted spider mite *T. urticae* (Koch) and its predatory mite *A. gossipi* (El-Badry) on three host plants. The side effects of sublethal doses of tested compounds on some biological aspects of spider mite *T. urticae* and its predatory mite *A. gossipi* were also evaluated.

MATERIALS AND METHODS

Prey Cultures: Colonies of the two-spotted spider mite, *Tetranychus urticae* (Koch) (Acarina: Tetranychidae), were obtained from castor bean plants from Kafr El-Sheikh, Governorate and reared under laboratory conditions according to Dittrich (1962). The prey culture was kept at 25 ± 2 ^{o}C under 16 hrs photoperiod to encourage plant growth, and 70 ± 5 R. H. The same culture of *T. urticae* was reared on tomato and green beans using the same technique.

Predator culture: The predator *Amblyseius gossipi* (El-Badry), (Acarina: Phytoseiidea), was reared on pollen grains of castor oil (*Ricinus cominunis*) plants as described by Overmeer *et al.* (1982). The culture was kept under the same conditions of temperature, humidity and photoperiod as *T. urticae* culture.

Chemical used: Five compounds were used. All tested compounds were in the formulated form and the dosages were calculated on the basis of ppm of active ingredient. The structure and chemical names for the tested compounds are as follow: Fenpyroximate (5 % S.C.) tert-butyl (E)-∝- (1,3–dimethyl-5- phenoxy pyrazol-4- y1- methylene-amino-oxy) p-toluate. Cypermethrin (25 % EC) (RS)– ∝ -cyano-3-phenoxy –benzyl (IRS, 3 RS; IRS,3 RS) –3- (2,2-dichlorovinyl) –2,2- dimethyl cyclopropane carboxylate. Abamectin (1.80% EC); a mixture containing a minimum of 80 % avermectin B_1a (5-0 dimethyl avermecin A_1a) and a maximum of 20 % avermectin B_1 b [5-0-dimethyl – 2,5 –d (1 methyl – propyl)–25- (1-methyl ethy) avermectin A_1 a]. Etoxazol (10 % S.C.) (RS) –s- tert-butyl–2-[2-(2, 6- difluorophenyl) –4,5- dihydro- 1.3 oxazol-4-y1] phenetole. Supermasrona: formulated mineral oil supplied by El-Nasr of Petroleum Com. as 94 % EC.

Experimental techniques:

1-Toxicity of tested compounds to adult female mites *T. urticae* and its predator *A. gossipi*: The toxic effects of tested chemicals to the adult female mites, *T. urticae* and its predator *A. gossipi* were evaluated by the leaf disc dip technique according to (Siegler, 1947). Mortality counts were made 24 hours after treatment. Correction for the control mortality was made by using Abbott's formula (1925). Data were plotted on log dosage probit papers and statistically analyzed according to Litchfield and Wilcoxon (1949).

2-Effect of tested compounds on *T. urticae* eggs: The effectiveness of the tested compounds on *T. urticae* eggs was examined using the method of Staal *et al.,* (1975).

3-Effect of tested compounds residues on *T. urticae* egg laying and its hatchability: The residual effect of each tested chemical at LC_{25} level on adult prey mites was evaluated according to Keratum *et al.,* (1994).

4-Effect of compounds residues on egg consumption and egg laying and its hatchability by predatory mite *A. gossipi*: The method which was adopted by Keratum *et al.,* (1994) was used to evaluate the effect of tested compound residues on egg consumption and egg laying and its hatchability by the predatory mite *A. gossipi*.

Equations used in the present study:

1- Abbott's formula (1925): was used to correct % mortality according to natural mortality:

Mortality(%)=

$$\frac{\text{Mortality \% of the treatment - Mortality \% of the control}}{\text{100 - Mortality \% of the control}} \text{X 100}$$

2- The toxicity lines were statistically analyzed according to Litchfield and Wilcoxon (1949) as follow: $Y = a + bx$

Where: Y= probit unit, a= constant value, b= slope of line and X= log concentration

3- Egg mortality: The percentage of mortality was calculated as follow:
Egg mortality = (a/b) X 100

Where: a= unhatched eggs b= number of total eggs which counted before treatment with toxicant

4- Toxicity index of tested compounds were determined according to Sun (1950) as follow:

Toxicity index=(LC_{50} of the most effective compound/LC_{50} of the tested compound) X 100

5- To evaluate the percentage of reduction, Handerson and Telton (1955) formula was used as follow:
% reduction = [1-(population in the control before spraying/population in the control after spraying) x (population in the treatment after spraying/population in the treatment before spraying)] x 100

RESULTS AND DISCUSSION

1. Toxicity of tested compounds against adult females of two-spotted spider mite *T.urticae* on different host plant discs: Three acaricides (fenpyroximate, abamectin and etoxazole), one pyrethroid (cypermethrin) and one mineral oil (Supermasrona) were tested for their toxicity to adult stage of laboratory strain of two-spotted spider mite *T. urticae* by the leaf disc technique using different three host plant discs. Based on LC_{50} values, the data (Table 1) showed that abamectin was the most toxic compound, followed by fenpyoximate to adult females of *T. urticae* on the three host plant discs with LC_{50} values of 0.003, 0.0011, 0.0003, 103.59, 89.87 and 75.12 ppm for castor bean, green beans and tomato respectively. While cypermethrin and supermasrona have a moderate toxicity to adult females of *T.urticae* on the three host plant discs with LC_{50} values of 166.95, 139.74, 122.99, 1480.60, 13336.48 and 1157.05 ppm for castor bean, green beans and tomato, respectively.

Table (1): Toxicity of different compounds to adult females of two - spotted spider mite, *T. urticae* on three host plants

Compounds	LC_{50} (ppm)	Confidence Limit		Slope value	Toxicity Index*
		Lower	upper		
		Castor bean			
Abamectin	0.003	0.0011	0.0063	0.53	100
Fenpyroximate	103.59	89.09	122.83	2.87	0.0024
Etoxazole	6251.9	5236.86	7665.74	2.43	0.00004
Cypermethrin	166.95	140.89	205.43	2.54	0.0015
Supermasrona	1480.60	1230.76	1811.63	2.35	0.0002
		Green bean			
Abamectin	0.0011	0.0004	0.0035	0.42	100
Fenpyroximate	89.87	76.56	104.76	2.88	0.0012
Etoxazole	5234.99	4413.24	4135.88	2.74	0.00002
Cypermethrin	139.74	116.63	167.93	2.28	0.0008
Supermasrona	1336.48	1092.85	1627.89	2.26	0.00008
		Tomato			
Abamectin	0.0003	0.0001	0.0008	0.44	100
Fenpyroximate	75.12	63.67	86.02	3.25	0.0004
Etoxazole	4485.71	3663.13	5311.33	2.55	0.0000007
Cypermethrin	122.99	100.94	146.90	2.43	0.0002
Supermasrona	1157.05	931.25	1390.57	2.32	0.00003

*Toxicity index was calculated with repect to abamectin as the most effective compound

Etoxazole was the least toxic compound to adult females of *T.urticae* with LC_{50} values of 6251.9, 5234.99 and 4485.71 ppm for castor bean, green beans and tomato respectively. The data in Table (1) indicated that, fenpyroximate has the highest slope value in all tested compounds with the three host plant discs. It is known as reported by Hoskins and Gordon (1956) that the slope value of log concentration probit line is considered as a reaction indicator between the chemical and the effected organism. In other words the highest slope value means more homogeneity in response of the organism towards the pesticide and in the same time the pesticide is acting as a selection factor producing an organism strain as pure genetically as possible, while the low slope value indicates heterogeneous mite population, in its response to the chemical.

The data in Table (1) indicate that abamectin was the most toxic compound to adult females *T. urticae* with toxicity index of 100 for the three host plants, followed by fenpyroximate with toxicity indexes of 0.0024, 0.0012 and 0.0004 for castor bean, green bean and tomato, respectively, while cypermethrin and supermasrona have a moderate toxic effect to adult females of *T. urticae* with toxicity indexes of 0.0015, 0.0008, 0.0002, 0.0002, 0.00008 and 0.00003, respectively for the three host plants. Etoxazole was the least toxic compound to adult females *T. urticae* with toxicity indexes of 0.00004, 0.00002 and 0.0000007 respectively for the three host plants.

This experiment was carried out not only to pick the most toxic compound, but also to record the continuous variations in the reaction of different chemicals towards the main pest belong to phytophagous Tetranychidae. No doubt that these studies resemble one of the important steps necessary for successful IPM programmes. The obtained results are in agreement with those obtained by Green and Dybas (1984) who found that abamectin had intrinsic toxicity to *T. urticae* adult under laboratory conditions with LC_{90} value 0.03 ppm which is toxic to all mite stages. The results are also in agreement with Camargo and Arruda (1987) who found that LC_{50} of abamectin was 0.1 ppm against *T.urticae* and more toxic than propargite to this mite. EL- Monairy *et al*. (1994) found that LC_{50} vaule of Vertimec (abamectin) against adult stage of *T. urticae* was 0.21 ppm. Park *et al.* (1996) indicated that abamectin solution killed all *T. urticae* females within 24 hrs after dipping.

Gamieh *et al.* (2000) showed that Vertimec (abamectin) (40ml / 100L water) was satisfactory in controlling the mite *T.cucurbitacearum* on soybean. Also, Saied *et al.* (2002) found that Vertimec (abamectin) caused high initial kill (81.75 %). against two spotted spider mite population on cotton.

2. Toxicity of tested compounds to eggs of two – spotted spider mite *T.urticae* on different host plant discs: The tested compounds were evaluated for their toxicity to one day old eggs of two spotted spider mite *T. urticae* under laboratory conditions. Tests were done as leaf disc residue technique using three different host plants. The data in Table (2) indicated that abamectin was the most toxic compound against the egg stage of spider mite with LC_{50} values of 0.016, 0.008 and 2.88 ppm for castor bean, green bean and tomato, respectively. Fenpyroximate and Cypermethrin were of moderate ovicidal effect with LC_{50} values of 23.44, 28.67, 21.03, 26.51, 18.80 and 24.36 ppm, respectively. Etoxazole as an acaricide may be classified in another category of ovicidal effect with LC_{50} values of 251.66, 224.75 and 193.79 ppm respectively then come Supermasrona (mineral oil) in a category of least effective compound on the egg stage with LC_{50} values of 312.40, 263.83 and 240.48 ppm respectively on the three hosts.

Table (2): Toxicity of different compounds to eggs of two -spotted spider mite, *T. urticae* on three host plants

Compounds	LC_{50} (ppm)	Confidence Limit		Slope value	Toxicity Index*
		Lower	upper		
		Castor bean			
Abamectin	0.016	0.0078	0.0316	0.44	100
Fenpyroximate	23.44	20.84	26.48	2.61	0.066
Etoxazole	251.66	203.80	316.58	1.43	0.006
Cypermethrin	28.67	25.60	32.15	2.75	0.054
Supermasrona	312.40	290.49	338.73	4.13	0.05
		Green bean			
Abamectin	0.008	0.004	0.016	0.46	100
Fenpyroximate	21.03	18.55	23.75	2.52	0.39
Etoxazole	224.75	183.46	227.64	1.51	0.004
Cypermethrin	26.51	23.63	29.65	2.76	0.031
Supermasrona	263.83	234.81	295.27	2.74	0.003
		Tomato			
Abamectin	2.88	0.88	16.32	0.47	100
Fenpyroximate	18.80	16.55	21.09	2.65	5.32
Etoxazole	193.79	157.49	236.41	1.53	0.49
Cypermethrin	24.36	21.58	27.25	2.73	11.82
Supermasrona	240.48	212.83	269.02	2.73	1.20

*Toxicity index was calculated with repect to abamectin as the most effective compound

Supermasrona has the highest slope value (4.13) on caster bean leaf discs while cypermethrin and Supermasrona have the highest slope values on green bean and tomato leaf discs (2.76, 2.74, 2.73 and 2.73), respectively. Abamectin has the lowest slope values on the three hosts (0.44, 0.46 and 0.47), respectively.

The data in Table (2) confirmed that, abamectin was the most toxic to eggs of spider mite with toxicity index of 100 on the three hosts, while etoxazole was the least toxic to eggs of spider mite with toxicity indexes of 0.006, 0.004 and 0.49 respectively on the three hosts.

These results can be supported with those obtained by several investigators. Keratum (2001) indicated that fenpyroximate was the most potent compound against eggs of *T.urticae*, followed by Vertimec. Also, Hosny *et al*., (2003) indicated that, abamectin was the most toxic to eggs of *T.urticae* and fenpyroximate had the next position in integrated mite management. Also, they indicated that cypermethrin was one of the most effective compounds on eggs of *T.urticae*.

3. Toxicity of tested compounds to predatory mite *A. gossipi* using different host plant discs: The same five compounds that were tested for their toxicity to adults' stage of *T. urticae* were tested again against the adults' stage of the predatory mite *A. gossipi* under laboratory conditions. Tests were done using leaf disc residue technique with three different host plants.

The data in Table (3) showed that abamectin was the most effective compound on adult females of predatory mite *A. gossipi* with LC_{50} of 0.0002, 0.0001 and 0.0001 ppm respectively on the three host plants, followed by fenpyroximate with LC_{50} of 57.56, 50.05 and 42.77 ppm, respectively. Cypermethrin and supermasrona were of moderate toxic effect with LC_{50} of 101.81, 699.81, 93.80, 678.87, 88.23 and 569.51 ppm, respectively. Etoxazole was the least toxic compound to the adult predator with LC_{50} of 2007.79, 1524.53 and 1305.06 ppm respectively on the three host plants.

It appears that cypermethrin has the highest slope value on castor bean (0.83). Abamectin has lowest slope value on the three host plants (0.20, 0.21 and 0.21), repectively. The data in Table (3) confirmed that abamectin was the most effective compound to adult females of predatory mite, *A. gossipi* of toxicity indexes 100 for the three hosts. Supermasrona was the least toxic compound to *A. gossipi* with toxicity index of 0.0000003 on castor bean leaf discs, while etoxazole was the least toxic compound to the adult predator on green beans and tomato leaf discs with toxicity indexes of 0.000007 and 0.000008, respectively.

Table (3): Toxicity of different compounds to adult females of predatory mite *A. gossipi* on the three host plants

Compounds	LC_{50} (ppm)	Confidence Limit		Slope value	Toxicity Index*
		Lower	upper		
		Castor bean			
Abamectin	0.0002	0.0001	0.0003	0.20	100
Fenpyroximate	57.56	44.26	76.23	0.60	0.0003
Etoxazole	2007.79	1420.39	3023.67	0.44	0.00001
Cypermethrin	101.81	83.15	129.79	0.83	0.0002
Supermasrona	699.81	518.45	959.44	0.57	0.0000003
		Green bean			
Abamectin	0.0001	0.0001	0.0002	0.21	100
Fenpyroximate	50.05	37.04	65.08	0.58	0.0002
Etoxazole	1524.53	1108.04	2021.91	0.45	0.000007
Cypermethrin	93.80	76.61	114.01	0.83	0.0001
Supermasrona	678.87	509.16	901. 84	0.58	0.00001
		Tomato			
Abamectin	0.0001	0.0000003	0.0001	0.21	100
Fenpyroximate	42.77	31.20	53.90	0.58	0.0002
Etoxazole	1305.06	881.08	1771.34	0.43	0.000008
Cypermethrin	88.23	70.54	106.49	0.83	0.0001
Supermasrona	569.51	399.59	745.23	0.56	0.00002

*Toxicity index was calculated with repect to abamectin as the most effective compound

The safest compound against the predator and in the same time the most toxic to the prey mite is the most suitable compound that must be advised to be involved in an integrated pest management.

Reviewing the above results about the toxic effect of different tested compounds to adult females of predatory mite *A. gossipi* on the three hosts, the following points could be concluded:

1- Etoxazole is the most safe coumpound to adults of predatory mite *A.gossipi* .

2- Cypermethrin can be recommended in IPM programmes.
3- Supermasrona and fenpyroximate were the next compounds after cypermethrin, but supermasrona has a special position and considered promising oil in mite control programs.
4- Abamectin makes us to keep it in mined under certain conditions (in case of rare predators with high level of phytophagous mites).

Several investigators showed the toxicity of the tested compounds against adult of predatory mites. Tsolakis *et al*. (1993) found that abamectin was considered to be not very harmful against all stages of predatory mite *A. andersoni*. Biddinger and Hull (1995) showed that abamectin was toxic to larvae and adult of predatory mite *Stethorus punctum*, while Park *et al.* (1995) found that abamectin did not significantly affect the survival and mobility of *A. womersleyi* female adults at a concentration of 0.12 ppm. Kim *et al.* (1996) indicated that abamectin was much less toxic to *A. womersleyi* than to the spider mite *T. urticae*.

The tested mineral oil was appeared to be of high safety index which means that it is of low toxicity against the predatory mite, this is an advantage required for integrated pest management. Osman (1997) showed that Shokrona and Shokrona super were of little adverse effect on predacious mite *A. gossipi* comparing with synthetic acaricides.

4. Effect of compound residues on biology of two – spotted spider mite *T.urticae*:

4.1. Effect of compound residues on egg deposition by the adult females of *T. urticae* on different host plants: The effect of sublethal concentrations of tested compounds (LC_{25}) on eggs deposited by the adult females of *T. urticae* was studied. Five adult female mites of *T. urticae* were allowed to oviposite on different compounds-treated leaf discs for a period of 5 days. The deposited eggs were counted daily for five days. Each treatment was replicated four times on different host plant discs.

The data in Table (4) indicated that cypermethrin was the most effective compound on egg deposition followed by abamectin on castor bean leaf discs. While Supermasrona, fenpyroximate and etoxazole had a moderate reduction effect on that character and had similar effect in reducing mite fecundity. The results suggested that fenpyroximate and cypermethyrin were the most effective compounds on egg deposition followed by supermasrona on green bean and tomato leaf discs. While etoxazole and abamectin were a moderate effect on that character.

Several studies carried out on the effect of different compounds on mite biology indicated that these compounds always showed positive effect on egg deposition of the prey.

Table (4): Effect of different compound residues on egg biology of *T. urticae* on different host plant leaf discs

Compounds	Mean No. of eggs deposited/ 5 adults	Unhatched eggs	% of hatchability
	Castor bean		
Control	26.95±0.25	6.10±0.58	75.6
Abamectin	17.85±0.44	11.40±0.16	54.4
Fenpyroximate	22.10±0.48	13.90±0.82	44.4
Etoxazole	23.50±0.26	11.15±0.30	55.4
Cypermethrin	6.60±0.16	17.15±0.38	31.4
Supermasrona	22.35±0.21	14.10±0.12	34.6
	Green beans		
Control	26.85±0.34	11.55±0.82	53.8
Abamectin	16.40±0.28	16.40±0.65	34.4
Fenpyroximate	8.50±0.34	15.45±0.53	38.2
Etoxazole	16.20±0.54	17.95±0.41	28.2
Cypermethrin	8.70±0.35	19.35±0.72	22.6
Supermasrona	14.50±0.48	17.35±0.72	30.6
	Tomato		
Control	28.50±0.38	9.20±0.28	63.2
Abamectin	16.10±0.38	15.55±0.72	37.8
Fenpyroximate	11.25±0.19	16.95±0.55	32.2
Etoxazole	21.40±0.16	11.60±0.57	53.6
Cypermethrin	12.55±0.53	15.90±0.50	36.4
Supermasrona	13.20±0.43	15.85±0.68	36.6

The oviposition in mites is known to be related to feeding and the antifeeding properties of some pesticides especially the pyrethroids that will indirectly affect egg laying. Fenvalerate deposit reduced oviposition in

T. urticae due to the antifeeding properties of pyrethroid residues (Keratum, 1993).

The obtained results are in agreement with that recorded by Keratum, (1993); Ayyappath *et al.,* (1997); Hosny *et al.* (1998) and Derbalah (1999). They showed that fecundity was highly reduced by bromopropylate followed by fenpyroximate and dicofol and no significant difference among them in their effects was observed. It is interesting to note that the results of sterilizing effect which had shown by Hosny *et al.,* (1977) on *T. cinnabrinus* is apparent in the present results Sterilization means one or both of two aspects, few eggs and / or less hatchability. Tedion treated-discs showed fewer oviposition than shown on untreated discs (4.6 and 6.5 eggs / day / female, respectively).

From the above results about the biological effects of the tested compounds on egg deposition the following points could be concluded:

1- Cypermethrin is the most effective compound tested on egg deposition on castor bean leaf discs, which is beneficial for some IPM programs away from predators' employments. While on the other two hosts occupies the next position after fenpyroximate.
2- Etoxazole has the least effect on egg deposition on the castor bean leaf discs that confer a chance to produce eggs enough for predation including egg mite, the preferable stage, for some predators.
3- Abamectin is considered ideal from the biological point of view since it decreased egg deposition to a suitable level and the character is needed for any integrated mite management program on the three hosts.
4- Fenproximate is the most effective compound tested on egg deposition on green beans and tomato leaf discs which is beneficial for some IPM programs away from predators' employment.
5- Supermasrona, the hydrocarbon oil, is the best compound that has a moderate effect on egg deposition of spider mite which gives this oil special importance in integrated mite management.

The effect of host plant on the toxicity of different pesticides in the present study, to spider mite could be discussed. It is clear from data in Table (1) that there were appearent differences between toxicity of the same compounds to adult spider mite, *T. urticae* on the three different plants, castor bean, green beans and tomato. All compounds (With an exception case of etoxazole) were toxic to the adult female spider mite *T. urticae* on castor bean followed by green beans and then tomato. The toxicity of etoxazole was higher on tomato than the other two plants.

It is known that the spider mite strains used in this study were reared on three different host plants. The leaf discs used for tests of pesticides toxicity were taken from the same host plants used for rearing the spider mite strains. If the differences in host plant nature (especially the physical and morphological features) are taken in consideration, the differences in quality and quantity of plant juice sucked by spider mite individuals are expected. The nutritional quality, presence or absence of toxins or digestibility–reducing compounds, and leaf water–nitrogen composition are secondly of important role encouraging the mite individuals to suck more plant juice which is poisonous in case of pesticide treatments. There is no doubt that the presence of pesticide residues is expected to complicate mite response to suck a certain quantity of poisonous juice in addition to another amount picked by the mite body from disc surface. So, the total amount of the acaricide which is expected to be picked by mite individuals from plant discs is difficult to determine. This amount is decided by all the above factors. The data in Table (6) indicate the NPK rate in different host plants used in this study. The data show that tomato contained the highest rates of the three nutritives nitrogen, phosphorous and potassium comparable to the other two host plants, i.e, castor and green beans. It is of interest to observe that the toxicity of the tested acaricides is negatively correlated to the rate of the three nutritive elements in the three host plants as meq / 100 gm .d.w.

The toxicity of different tested compounds to the egg stage of spider mite *T. urticae* on discs from different host plants was shown in Table (2). The data indicate, in most cases, that there was no appearent difference between toxicities of the same compound against egg stage on the three host plants, castor bean, green beans and tomota. The nature of the egg stage and the used technique to determine the toxic effect against egg stage (in which the discs containing eggs were dipped in the pesticide solution) lead us to expect no difference in toxicity due to different plant discs from the three host plants.

The differences between different host plant leaves are not, high enough to be, a responsible factor for variability in egg toxicity.

The data in Table (4) indicate the effect of different pesticide residues on spider mite egg production on different host plant discs. In case of control treatment the mean number of eggs laid / 5 adult females / day ranged from 26.95 in castor bean to 28.5 in tomato. While this mean ranged from 6.6 - 23.5 in different pesticide treatments on different three hosts plant discs. The range was the widest in case of fenpyroximate where it was about 14 between castor bean leaf disc (22.10) and green beans leaf disc (8.5). The host plant selection is considered as the outcome of processing appropriate external stimuli and the mites own internal events. The behavioral responses to plant stimuli with varying proportions of visual, mechanical, olfactory and gustatory characteristics are of importance.

Espelie *et al.,* (1991) mentioned that when the chain of host – selection activities is not interrupted, the insect remain on the host plant for feeding and oviposition. The pesticide would be a source of interruption on the host plant discs. The interaction between the chemicals (pesticides) and the plant components must be considered as an oriental factor. Thus the spider mite may change their behavior in feeding and oviposition. So the rate of NPK for the three different host plants is not necessary to be standard or optimum measure that relate to feeding and egg production. Singer *et al.* (1988) suggested that oviposition preference and larval performance may be correlated with populations and may vary among individuals such that females prefer the plant species on which their larvae should have the greatest chance of surviving during their first 10 days of growth.

The host plant selection is highly complex and involves many orientation factors most of which are concerning with feeding, ovipositional, plant nutrients and allelochemical factors. Therefore, the technologies that must be developed are to isolate and identify the molecular basic of host plant preference and to analyze the relevant biological systems to focus on how insect or mite pests of economic crop plants can be managed.

4.2. Effect of compound's residues on number of eggs hatched of two –spotted spider mite *T. urticae* on different host plants: This experiment was carried out to determine the toxic effect of the tested compounds at LC_{25} level on mite eggs of *T. urticae*. The chemical treatments were applied for the leaf discs before egg laying of the prey mite. Then five adult female mites were placed on each disc for egg laying for 24 hrs, then they were removed. Hatchability was counted 72 hrs after egg laying for successive five days. Each treatment was replicated four times and the three host plants were used.

The data in Table (4) indicated that all compounds caused decrease in egg hatchability comparable to the control treatment. However, the following points could be concluded:

1- Most of the compounds tested proved good ovicidal effect on the three hosts.
2- Etoxazole exhibited the least effective ovicidal action especially on castor bean and tomato leaf discs, but on green beans leaf discs etoxazole occupies the next position as an ovicide after cypermethrin.
3- The hydrocarbon oil (supermasrona) exhibited about the same ovicidal action against the egg stage of spider mite on the three hosts.
4- Fenpyroximate ovicidal effect was about the same against the egg stage of spider mite on the three hosts.
5- Cypermethrin was highly toxic compound that caused the highest decrease in egg hatchability especially on castor bean and green beans leaf discs, but on tomato leaf discs, it occupies the next position after fenpyroximate.

Hosny *et al.* (1998) indicated that egg hatchabiltiy of *T. urticae* was decreased with increasing period of egg deposition on the same disc. Many investigators found similar results to that of the present experiment. El- Banhawy and Reda (1988) found that the susceptibility of *T. urticae* egg increased progressively with increasing age for synthetic pyrethroids (cypermethrin 500 ppm and pyridaphenthion 10 ppm) while abamectin was effective only on older eggs.

No doubt that the compounds that have an ovicidal effect may act to prevent the embryo formation or if this embryo has already formed in the next day after egg treatment, the compound may be toxic to the developmental larval stage in the egg membrane before hatching.

Practically in nature where egg stage of mites receives direct pesticide spray or as residue in the field one can not expect an importance for egg – age variations. The scientific importance of this point is just to pick the suitable selective compound that differentiate between different egg stages of mite that exposed for its sprays in integrated mite programes. Park *et al.* (1995) found that abamectin significantly affect the hatchability of one–day-old eggs of *T. urticae* at 0.06 – 0.6 ppm. Four days-old-eggs were much more susceptible to abamectin than one day–old-eggs. Abamectin at selective sublethal concentration (i. e., 0.012 –0.06 ppm) could be of value in adjusting predator / prey ratios in the integrated mangement of *T. urticae.*

Wu- Yuoing *et al.* (1997) found that no effect against eggs was observed after the adult females were treated with abamectin at the LC_{50} level.

The hydrocarbon oils are known to be used as insecticides, ovicides, herbicides and as emulsifiable carriers of oil – soluble pesticides. In such cases the oils assist the main toxicant to penetrate into lipid surfaces since it is absorbed in and thereby softens and disrupts the waxy layer in leaves, insect cuticle or fungal spore walls and mite egg wall. The nature of physical toxicity of the hydrocabon oils make them safe compounds from the environmental point of view, they are of low chemical reactivity, so relatively they could be used at concentrations much higher than those which would have been chemically toxic. Amer *et al.* (2001) found that KZ-oil was more toxic to *T. urticae* during the egg stage than to adult female.

The data in Table (4) indicate the effect of pesticide residues on hatchability of spider mite eggs on different host plant discs. The least hatchability was exhibited on green beans plant discs while eggs on castor bean discs had the highest hatchability, eggs on tomato occupied in between. The ovicidal effect of the tested compounds may be discussed among different compounds according to their action as ovicides and this is what the investigator did in the above secsion. The interaction between the tested compounds, in their specific formulation, and the plant materials of the three host plants would be undetermined, but the final different results concerning egg hatchability on the three host plant discs are expected in this experiment. The mite eggs on different host plant discs are expected to be equal in complete coverage with the compound tested according to the technique used in these experiments, but the residues of the same compound on different host plant discs would be different and expected to affect the final results. Now it is known that the residues of the pesticides and the adjutvants include in the pesticide formulation are very important factors that improve the residual effect on the egg stage in its different ages according to the mechanism of action on the egg shell or the embryo inside the egg. So the hatchability of mite eggs could be arranged ascendingly on the three host plants as follow: green beans < tomato< castor bean.

5. Effect of compound residues on biology of predatory mite *A. gossipi*: A pesticidal effect on predatory mites has been shown by several investigators. The role of the predaceous mite deals with the feeding capacity on prey mite and oviposition capacity of predatory mite to produce number enough to minmize the phytophagous mite population to tide economic injury level beside other control agents is well known. So, the spider mite *T. urticae* eggs were introduced on pesticides treated leaf discs to adult predaceous mite, *A. gossipi* to record the effect of pesticide residues on prey egg consumption by adult females of predaceous mite. The oviposition capacity of the predatory mite and its hatchability were also recorded.

5.1. Effect of compound residues on feeding capacity of predatory mite *A.gossipi* on different host plants: This technique was used to examine the effect of tested compound residues on egg consumption by predatory mite, *A. gossipi*. The chemical treatments were applied for the leaf discs before egg laying of the prey mite. The discs were dipped in LC_{25} concentration of each tested compound, then left to dry. 10 adult females *T. urticae* of known age were transferred to each disc to oviposite for 24 hours. Then adult females were removed and the oviposited eggs were counted with equal number of eggs of prey mite *T. urticae* on each disc. One adult female of predator mite was transferred to each treated disc. Each treatment was replicated four times. The numbers of prey eggs eaten were recorded after 24 and 48 hours on different host plant discs. The data in Table (5) indicated that most of tested compound's residues caused a decrease in prey egg consumption comparable to the control treatment. It is apparent from the calculated average number of eggs consumed by one adult predator through the first and second days, that abamectin and cypermethrin were the most effective compounds that reduced the prey egg consumption (5.88, 6.25, 4.61, 5.63, 4.63 and 5.38 eggs / adult / day), respectively on the three hosts comparable to control of 18.50, 15.63 and 15.38 eggs / adult / day respectively on the three hosts, followed by fenpyroximate (8.50, 9.63 and 8.75 eggs / adult / day), respectively. Supermasrona and etoxazole were the least effective compounds in this respect but not similar to control treatment (11.25, 15.50, 10.50, 14.13, 11.00 and 14.13 eggs / adult / day) respectively.

The data exhibited, in most cases, that there were insignificant differences between the consumed prey polluted eggs on different host plant discs for the same compound. The control treatment showed a pronounced variation between the consumed eggs from the discs of the three host plants. The average number consumed by one adult predator / day was 18.50 in case of castor bean while that of tomato was 15.38. The presence of a pollutant (pesticide) and the morphological features of the host plant may disturb the searching activates of the predator to find its food material (egg stage) in spite of the egg stage of spider mite is the main food of the predator *A. gossipi.* The leaf surface may have negative or positive chemical stimuli that determine or evaluate the contact process. Renwich and Redke (1988) stated that visual stimuli may play a role in landing process on plant leaves. This step may also decide, for a certain extent, the rate of egg consumption of the prey mite by the predator.

Table (5): Effect of different compound residues on biology of the predatory mite *A.gossipi* on different host plant leafs

Compounds	Average No. of consumed eggs/ adult / day	Deposited eggs/adult/ day	Unhatching eggs	% Hatchability
		Caster bean		
Control	18.50±0.41	2.88±0.48	0.25±0.29	95
Abamectin	6.25 ± 0.50	0.50±0.00	4.63±0.25	7.4
Fenpyroximate	8.50± 0.41	1.38±0.48	1.88±0.25	62.4
Etoxazole	15.50±0.71	2.75±0.29	1.38±0.25	72.4
Cypermethrin	5.88± 0.63	0.63±0.25	4.00±0.00	20
Supermasrona	11.25±0.50	1.63±0.25	3.63±0.25	27.4
		Green beans		
Control	15.63±0.25	2.38±0.48	0.33±0.48	93.4
Abamectin	5.63± 0.75	0.50±0.41	4.25±0.50	15
Fenpyroximate	9.63± 0.25	1.75±0.29	1.88±0.25	62.4
Etoxazole	14.13±0.48	2.13±0.25	1.38±0.48	72.4
Cypermethrin	4.61± 0.26	0.63±0.25	4.25±0.29	15
Supermasrona	10.50±0.71	1.75±0.50	2.88±0.48	42.4
		Tomato		
Control	15.38±0.63	1.75±0.29	1.00±0.41	80
Abamectin	5.38 ± 0.63	0.38±0.25	4.75±0.29	5.0
Fenpyroximate	8.75 ± 0.50	1.38±0.48	1.88±0.48	62.4
Etoxazole	14.13±0.48	1.75±0.29	1.75±0.29	65
Cypermethrin	4.63±0.25	0.63±0.48	4.25±0.50	15
Supermasrona	11.00± 41	1.75±0.65	3.38±0.48	32.4

5.2. Effect of compound residues on oviposition capacity of predatory mite *A. gossipi* on different host plants: The data in Table (5) indicated that the predators eggs deposited under the chemical effect through two successive days were less than that deposited under normal conditions (untreated). The average number of predator egg production through two days indicate that abamectin and cypermethrin were the most effective chemicals which caused a decrease in eggs deposited by adult females of predatory mite comparable to control (0.50, 0.63, 0.50, 0.63, 0.38 and 0.63 eggs / day), respectively comparable to control treatment of 2.88, 2.38 and 1.75 eggs / day), respectively on the three host plants, followed by fenpyroximate and Supermasrona which have a moderate effect (1.38, 1.63, 1.75, 1.75, 1.38 and 1.75 eggs / day), respectively, while etoxazole has a little effect on egg deposition by predatory mite comparable to other tested compounds (2.75, 2.13 and 1.75 eggs / day), respectively and was not significantly different from control.

These data indicate no difference between eggs deposited by the adult female predators on different host plants in the control treatment, and the differences in case of pesticides treatments are not pronounced. It is well known that there is a positive correlation between the prey egg consumption and predator oviposition. This relation may take the linear appearance if it was free from any disruptive factors. The presence of pesticides on leaf discs may be coincide with the unsuitable structures of the host plant leaves to increase the above mentioned disruption leading to disturbed relation between egg consumption and predator egg deposition. These results concluded that the host plant of spider mite is not a critical factor for egg consumption and predator egg production.

5.3. Effect of compound residues on number of eggs hatched of the predatory mite *A. gossipi* on different host plants: Hatchability of eggs laid by predatory mite *A. gossipi* was recorded 4 and 5 days after egg laying on different host plants.

The hatchability of predator eggs was shown in Table (5) and exhibited that the most safe compounds were etoxazole and fenpyroximate (72.4, 62.4, 72.4, 62.4, 65.0 and 62.4), respectively on the three host plants that allowed the predator's eggs to hatch to produce the next stages necessary to complete the biological agent to minimize prey populations. The data in Table (6) also indicate that abamectin, cypermethrin and supermasrona were the most effective compounds on hatching of eggs produced by the predator mite (7.4, 20.0, 27.4, 15.0, 15.0, 42.4, 5.0, 15.0 and 32.4%), respectively comparable to control treatment (95.0, 93.4 and 80.0 %), respectively on the three hosts.

It could be noticed that successful biological control depends upon several factors concerning the predator's biology. One of these important factors is the rate of prey consumption. Certainly low concentration level of chemicals such as LC_{25} for adult mites which do not cause enough mortality can affect other responses such as functional response, and this is why the prey egg consumption was recorded under chemical treatments. The decrease in feeding capacity by *A. gossipi* exposed to chemicals-contaminated eggs on leaf discs could arise a non toxic influence of a change in the nature of the surface on which predator fed. It is interesting to know that the deposited eggs were not in a relation with the eaten ones. The existence of relationship between feeding and oviposition and between feeding and mite activity; and connection between the levels of these elements and the nature of the surface on which mites were placed suggest that disturbances in all these patterns of behaviour could be triggered by the effects of sensory detection of the chemical on the surface. Mite activity can be influenced by the nature of the substrate of the surface (Blommers *et al.,* 1977 and Everson, 1980). The activity pattern of *A.gossipi* which was not measured in the present study may be responsible for the non-correlated relation between feeding and oviposition in the predatory. The presence of chemicals in low levels, on the leaf surface may be irritant enough to make the adult females predator in contact with the contaminated prey eggs and accordingly the consumed eggs seemed to be almost at the same level of untreated control.

The suffering adult females are expected to stop oviposition in spite of the stored food (Prey eggs eaten) that was enough for oviposition process in a normal number of eggs. Hosny and Keratum (1995) found decreased feeding and oviposition in *A. fallacis* when deltamethrin was used on prey *T. urticae*.

The obtained results are in agreement with those recorded by many investigators, who showed high effect of biological nature of chemicals on predatory mite. Abou-Awad and El-Banhawy (1985) found that residues of the synthetic pyrethroids (cypermethrin, flucythrinate, fenvalerate and cyfluthrin) even at a non toxic level to predaceous mite *A.gossipi* interrupted oviposition and reduced reproduction markedly. The increase in the daily consumption of prey *T.urticae* treated with cypermethrin caused an increased mortality at high prey density.

Keratum (1989) reported that when subjected to chemically treated surfaces with deltamethrin, *A.fallacis* showed decreased feeding and oviposition compared with control. Also, Ford *et al.*, (1989) found that there was a reduction in the number of eggs eaten by *A. fallacis* on treated discs by deltamethrin with a decrease in the predator's oviposition.

The success of any integrated pest management depends on the judicious use of chemicals applied to control key pests and diseases .The importance of avoiding adverse effects on predatory species was reflected by the fact that chemicals which might be used on certain crops must be subjected to routine screening to assess their toxicity to beneficial arthropods to pick the safer compounds. The rate of development of resistance to insecticides in the predaceous mites would be another important evaluation, which must be taken in consideration in IPM programmes.

The safe compound (chemical or biological) means, according to author's look for the present study that has the following features:

1- Moderate toxicity to the prey mite and its egg stage.
2- Selective toxicity that keep the predator alive necessary for biological control.
3- Keep the predator's appetite normal enough to consume prey eggs (the preferable stage for adult female predator mite).
4- Allow the predator to translate the egg consumption to egg production to keep the predator populations in numbers enough to play their role in integrated pest management preogram.
5- Keep the predator egg viability at its maximum rate.

The data in Table (5) exhibit the effect of pesticide residues on hatchability of predator's eggs on different host plant discs. Some of the effective factors in this test may be common with those in case of hatchability of prey egg *T.urticae* and the others are specific for the predator egg. The egg stage of the predator may receive double dose of the pesticide, one through the poulated prey eggs ingested by the adult female predator and the other through the residue on the plant discs .If the structural differences of the plant leaves are added to the final result as hatchability may take the same trend of hatchability of spider mite eggs. Thus, the hatchability of predator eggs on different host plant discs may be arranged discendingly as follow: castor bean >green beans> tomato. This conclusion is reversed in case of the mineral oil supermasrona.

The effect of host plant on pesticide toxicity to spider mites and on the relation between the prey mite *T. urticae* and its predator *A. gossipi* on different host plants, is one of the important factors that must be studied through integrated pest management of spider mite .The host plant searching behavior is an active process while phytophagous pests must recognized and select suitable substrates for food, mites, and oviposition.

Some investigators found that the supply and absorption of minerals were always positively correlated with pest infestation and that analysis of the host leaves may be valuable in nutrition studies of phytophagous pests (Highland and Roberts, 1984 and Roinien and Tahvanaien 1989).

Thus, the determination of such minerals as nitrogen, potasium and phosphorus in different host plant leaves used to rear or to test the acaricidal effect of chemicals was one of the aims of the present study just to detect if there are differences in mite response due to the type of host plant or not. The data in Table (6) illustrate the rate of NPK for three host plants castor bean, green beans and tomato. It is clear that tomato has the highest rates of the three elements under study. While castor bean plants have the lowest rates in the three elements. The rate of potassium as meq/ 100 gm.d.w. in the three host plants was tomato > green beans > castor bean (2.949, 2.179 and 1.731, respectively). The rate of nitrogen as NO_3 meq / 100 gm.d.w. in the three host plants was tomato > green beans> castor bean (7.50, 6.75 and 4.75, respectively). The rate of phosphorus as meq /100 gm.d.w. in the three host plants was tomato > green beans > castor bean (0.832, 0.433 and 0.277, respectively).

Table (6): The rate of NPK for castor bean, green beans and tomato leaves

The host plant	The rate of K as meq/100 g.d.w	The rate of No3 as meq/100 g.d.w	The rate of P as meq / 100 g.d.w
Castor bean	1.731	4.75	0.277
Green bean	2.179	6.75	0.433
Tomato	2.949	7.50	0.832
$LSD_{0.05}$	0.6098		

The following points can be concluded:

1- The toxicity of different compounds on adult spider mite was in general higher on tomato discs than on the other two host plants. No relation between toxicity of the same compound on different hosts and the quantity of the three elements in host plants. The difference in toxicity may be attributed to other characterstics in the host plants other than the determined elements such as physiological and morphological ones.
2- The ovicidal effect of the tested materials is not clearly influenced by the host plant in this study.
3- The toxicity of the tested materials against the predatory mite *A.gossipi* on different host plant discs may categorized to:
   a. Toxicity was not influenced by host plant type (abamectin).
   b. Toxicity was influenced by host plant type, that it was high on castor bean in most cases.
4- The egg deposition of adult females *T. urticae* was not affected by the untreated host plant discs, while it was affected by host plant discs treated by different materials.
5- Hatchability of *T. urticae* eggs was affected by different host plant discs.
6- Egg production by the predator mite *A.gossipi* was not influenced by type of untreated host plants while it was influenced by host plant when treated by different chemicals, to a little extent.
7- Hatchability of predatory eggs on different untreated host plant was about the same while it was influenced when these host plants were treated by different chemicals.

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