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EFFICIENCY OF CERTAIN ACARICIDES AND BIOFLY IN AN INTEGRATED SPIDER MITE *TETRANYCHUS URTICAE* MANAGEMENT

Hosny, A.H.; M.M.F. El-Naggar; A.Y. Keratum and R. I. Magouz
Department of Pesticides, Faculty of Agriculture, Kafr El-Sheikh, Tanta University, Egypt.

ABSTRACT

Laboratory study was carried out to evaluate the toxic effect of six compounds; four acaricides (pyridaben, fenpyroximate, bromopropylate and abamectin); one pyrethroid (cypermethrin) and one biocide (Biofly) against adult females of both phytophagous mite *T. urticae* (Koch) and predatory mite *A. gossipi* (El-Badry). The effect of sublethal doses of these compounds on some biological and behavioural characteristics of *T. urticae* and its predator was also examined.

Abamectin had a special position in both mite chemical control or integrated mita management as: 1) It had high toxic effect and high selectivity index. 2) It decreased prey egg deposition to a suitable level and had a little effect on egg viability. 3) It was one of the most safer compounds that allow the predator to consume contaminated eggs and slightly affected predator egg production. Fenpyroximate had a high safety index and had the next position in integrated mite management. Cypermethrin may not be recommended if safety and selectivity indexes were taken in consideration, it was one of the most effective compounds on prey egg consumption by the predator *A. gossipi* and predator egg production. Pyridaben was the most effective on egg hatchability. Ovicidal effect of bromopropylate was decreased as egg-age increased. Biofly did not exhibit any trend concerning its ovicidal effect on different egg stages.

INTRODUCTION

Phytophagous mites are major pests of the main food crops and their potential for damage has become increasingly evident during the last few decades (Amano and Chant, 1977). A wide range of chemicals have been marked for controlling the two-spotted mite. The wide use of the chemical compounds has resulted in many problems such as population outbreaks and chemical resistance, endangering human health and wealth. For all that, world are going to reduce chemicals use and trying to introduce predators and the entomopathogens such as virus, bacteria and fungi in I.P.M. programmes.

Controlling phytophagous mites by a combination of biological and chemical methods has proved a less costly and more permanent method of control than have pesticides alone (Hislop and Prokopy, 1981). Sublethal effects can supplement mortality in several ways, for example, by causing the organism to avoid treated surfaces, by reducing the reproductive potential (Jackson and Wilkins, 1985), and by interfering with feeding and oviposition (Hajjar and Ford, 1989).

Keratum and Hosny (1994) found that the predatory mite, *Phytoseiulus persimilis* showed significant reduction in feeding and oviposition on discs treated with *fenvalerate, deltamethrin, permethrin* (WP) and cypermethrin (EC). Hosny and Keratum (1995) studied the sublethal effects of deltamethrin on feeding and oviposition of *A. fallacies* on chemically treated surfaces. A. fallacies showed decreased feeding and oviposition compared with control.

Gamieh and Saadoon (1998) evaluated the influence of sublethal concentrations (LC_{25}) of the tested acaricides (*Neron, Sanmite, Ortus*, Vertemic and Biomide) on some biological aspects of *T. cucurbitaceaum*. All compounds had the ability to elongate the pre-oviposition period, while they were able to decrease the adult female longevity, oviposition and post oviposition periods. Egg viability and female fecundity were adversely affected by all compounds, however, vertimic was more harmful compared with the other compounds in this respect. Hosny *et al.*(1998) found that the pyrethroids fenvalerate and deltamethrin were highly effective in decreasing spider mite fecundity.

Abdel-Samed (1998) studied the efficiency of the biocide compound, Biofly (3 x 10^7 conidia, at 100 cc/100 L of water) on different egg stages and adult females of *Tetranychus urticae* (Koch). The biological aspects of *T. urticae* were also studied. The obtained results showed that the effect of this compound against egg stage was higher than against adult females. Moreover, three days old eggs were the most effectual of the others. The biological aspects of *T. urticae* when treated as an one day old eggs with Biofly indicated that the average number of deposited eggs per female decreased to 95.9%. Moreover, it caused 90% mortality during immature stages.

The present study was carried out to examine the toxic effect of four acaricides, one pyrethroid and one biocide against adult females of the two-spotted spider mite *T. urticae* and its predator mite *A. gossipi*. The side effects of sublethal doses of tested compounds on some biological aspects of spider mite and its predatory one were evaluated.

MATERIALS AND METHODS

Prey cultures

Two-spotted spider mite, *Tetranychus urticae* (Koch) (Acarina: Tetranychidae) colonies were collected from castor bean plants from Kafr El-Sheikh Governorate and reared under laboratory conditions according to Dittrich (1962).

Predator culture

The predator *Amblyseius gossipi* (El-Badry) was reared on pollen grains of castor oil (*Ricinus communis*) plants according to the technique used by Overmeer *et al.*(1982).

Chemical used

Six compounds were used: Pyridaben: 2-tert-butyl-5-(4-tert-butyl-benzylthio)-4-chloro pyridazin-3-(2H)-one as 20% W.P., *Fenpyroximate*: tert-butyl-(E)-α-(1,3-dimethyl-5-phenoxy pyrazol-4-yl-methylene-amino-oxy)=ptoluate as 5% S.C., Bromopropylate: isopropyl-4,4-dibromo-benzilate as 50% E.C., Abamectin: a mixture containing a minimum of 80% avermectin B,a-(5-O-demethyl avermectin-A,a) and a maximum of 20% avermectin-B,b-[5-O-demethyl-25-de-(1-methyl-propyl)-25-(1-methylethyl) avermectin-A,a] as 1.8% E.C., cypermethrin. [(RS)-α-cyano-3-phenyloxy-benzyl (IRS, 3RS; IRS, 3RS)-3-(2,2-dichlorovinyl)-2,2-dimethyl cyclopropane carboxylate] as 25% EC, and Biofly: a trade name of the entomopathogenic fungus, *Beauvaria bassiana* (Balasamo) as a liquid containing $3x10^7$ conidia/ml.

Experimental techniques

1. Toxicity of tested compounds to adult female mites; *T. urticae* and its predator *A. gossipi*

The toxic effect of tested compounds 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).

2. Effect of compound 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).

3. Effect of different compounds on hatchability of *T. urticae* eggs at different ages

The effectiveness of the tested compounds on *T. urticae* eggs of different ages was examined using the method of Staal *et al.* (1975).

4. Effect of compound 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*.

Duncan's (1955) multiple range test at the 5% level was used for statistical analysis of significant differences among treatments.

Equations

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

$$\text{Mortality (\%)} = \frac{\text{Mortality \% of treatment - mortality \% of control}}{\text{100 - mortality \% of control}} \times 100$$

2. Selectivity ratio of tested compound on predator mite *A. gossipi* was determined as follows according to Wilkinson (1976):

$$\text{Selectivity ratio (S.R.)} = \frac{LC_{50}\text{ of the compound on predator}}{LC_{50}\text{ of the compound on prey}}$$

3. $\text{Selectivity index} = \dfrac{\text{S.R. of the tested compound}}{\text{S.R. of the most selective compound}}$

(compound of the highest S.R. value)

4. Toxicity index of tested compound was determined according to Sun (1950) as follows:

$$\text{Toxicity index} = \frac{LC_{50} \text{ of the most effective compound}}{LC_{50} \text{ of the tested compound}} \times 100$$

5. Safety index of tested compound on predator mite was determined according to Aref (1997) as follows:

$$\text{Safety index} = \frac{LC_{50} \text{ of tested compound on predator}}{LC_{50} \text{ of the least effeetive eompound on predator}} \times 100$$

RESULTS AND DISCUSSION

Toxicity of tested compounds to adult females of two mite species, *T. urticae* and *A. gossipi*

The contact and stomach toxicities of tested compounds to both mite species were determined using the leaf-disc dip technique (Table 1). Abamectin was the most toxic compound (LC_{50} = 0.33 ppm) while fenpyroxymate was the least toxic one (LC_{50} = 420 ppm) and had the highest slope value of 6.45. Hoskins and Gordon (1956) postulated the fact that one of the first signs in the development of a resistant strain is the decrease in the slope of the dosage mortality line, therefore, one expect that compound with low slope value may lead to development of resistance if used successively. Abamectin was found to be of intrinsic toxicity to tetanychid mites (Green and Dybas, 1984; Camargo and Arruda, 1987; El-Monairy *et al.*, 1994 and Gamieh and Saadoon, 1998).

The toxicity index was determined to confirm the toxicity as LC_{50} values. In fact, this value is more useful when different effects of a certain compound is measured relatively to other materials, in this case the pool effect (such as the effects against different mite stages) will express about its efficiency in general.

The results indicate that pyridaben was the most toxic material against the predaceous mite species *A. gossipi*, while fenpyroximate was the least toxic one exhibiting that this acaricide is the most safe chemical to the predaceous mite. The selectivity index is considered the most precise value that indicates how the compound behave towards both species of mites. Abamectin was the most selective material in spite of its low safety index. This result agreed with those of many investigators (Tsolakis *et al.*, 1993; Biddinger and Hull, 1995; Park *et al.*, 1995 and Kim *et al.*, 1996).

Table (1): Toxicity of some acaricides, cypermethrin and Biofly to adult female mites *T. urticae* (Koch) and its predator *A. gossipi* (El-Badry).

Compound	*T. urticae*				*A. gossipi*				Toxicity parameters		
	LC_{50}* (ppm)	C.L.**	Slope value	Toxicity index	LC_{50} (ppm)	C.L.	Slope value	Toxicity index	Safety index	Selectivity Ratio (S.R.)	Selectivity index
Pyridaben	200	153.9-260.0	1.92	0.165	4.8	3.75-6.14	3.38	100	0.26	0.024	0.057
Fenpyroximate	520	472.7-572.0	6.45	0.064	1850	1321.43-2590.0	2.13	0.26	100	3.56	8.39
Bromopropylate	37	28.03-48.8	1.83	0.89	10	8.77-11.4	1.59	48	0.54	0.27	0.64
Abamectin	0.33	0.243-0.436	2.0	100	14	9.66-20.3	1.35	34.29	0.76	42.42	100
Cypermethrin	265	210.3-333.9	1.97	0.13	20	14.29-28.0	1.74	24	1.08	0.08	0.19
Biofly*	66000	55462.2-78540.0	2.0	-	84000	60869.6-115987.6	1.81	-	-	1.27	-

* LC_{50} was determined as conidia/ml.

** C.L. : Confidence limits.

Fenpyroxymate, the most safe material in the present study against the predaceous mite was found to be very useful in several IPM programs because of its safety against the different predaceous mite species (Park *et al.*, 1996; El-Adaway *et al.*, 2000 and Keratum, 2000).

Cypermethrin was used for its known characteristics such as knockdown for treated organisms and its repellent effect (Hurcova, 1984), its low mammalian toxicity and its environmental safety are what promote the awareness to be included in IPM studies. It had a moderate toxicity to adult prey and its predator species and of very low selectivity index (0.19) and this why cypermethrin can not be recommended in certain IPM programs.

Finally, abamectin had a special position in both mite chemical control or in integrated mite management, and fenpyroximate had the next position in this respect.

Effect of compounds residues on prey egg deposition and its hatchability

When sublethal concentrations of the tested compounds (LC25 values) were used on the adult females of *T. urticae* the data (Table 2) indicated that all chemical treatments caused high reduction in egg deposition. The most effective materials were bromopropylate and cypermethrin. It is apparent that the eggs deposited increased as the pesticide residue decreased on the leaf discs. The chemical residues on the leaf discs are expected to be decreased with passing days. The number of eggs deposited on discs at zero time after treatment was less in general than those deposited at 24 hrs after treatment ~48 to 72 hrs. These results coincide those of Stafford and Fukushima (1970), Keratum, 1993, Ayyappath *et al.*, 1997 and Hosny *et al.*, 1998).

Table (2): Egg deposited by adult female mite *T. urticae* during 3 days on different pesticides - pretreated leaf discs and its hatchability.

Compound	No. of eggs deposited at indicated time after treatment				% Hatchability			
	zero time	24 hrs	48 hrs	72 hrs	zero time	24 hrs	48 hrs	72 hrs
Pyridaben	51	135	134	114	zero	zero	zero	zero
Fenpyroximate	67	113	70	104	10.5	11.5	5.7	15.4
Bromopropylate	5	175	176	115	20	57.1	35.7	17.4
Abamectin	48	171	97	102	87.6	77.8	89.8	65.7
Cypermethrin	12	55	35	59	16.7	40.1	45.8	17
Biofly*	76	150	274	181	64.5	56	55 1	58
Control	550	550	550	550	91.8	91.8	91.8	91.8

Hatchability of eggs deposited at different times of treatments was highly affected. Abamectin was the least effective compound, while pyridaben was the most effective that gave complete unhatchability for eggs deposited at different periods after treatment. Egg viability (hatchability) was found to be reduced in different degrees by chemicals (Stafford and Fukushima, 1970; Spadafora and Lindquist, 1972 and Hosny *et al.*, 1977). It is concluded from these results that abamectin is considered ideal from the biological point of view since it decreased egg deposition, in the same time it had a little effect on egg viability, these two characters are needed for any integrated mite management program.

Ovicidal effect of tested compounds on different egg-ages

The hatchability of eggs treated at different ages was exhibited in Table (3). The data indicate that all compounds caused decrease in egg hatchability. Abamectin was of least effect in this respect in general (9.1-50%) from egg of 24 hrs to that of 72 hrs. Pyridaben and fenpyroximate did not exhibit any egg viability through the three egg ages (24, 48 and 72 hrs). Cypermethrin and Biofly exhibited about the same effect on egg hatchability. Generally, the effect of egg viability was decreased as egg age increased.

The viability of mite eggs may be affected at any of egg ages due to the nature of the used chemical and the developmental steps of the embryo and accordingly the time of treatment of mite eggs. So, variability in egg response to the chemical is expected. This is what many investigators had achieved (El-Banhawy and Reda, 1988; El-Atrouzy *et al.*, 1989; Park *et al.*, 1995; Hosny *et al.*, 1998 and Gamieh *et al.*, 2000).

Table (3): Ovicidal effect of different pesticides on hatchability of eggs at different ages.

Compound	% Hatchability at indicated egg ages		
	24 hrs	48 hrs	72 hrs
Pyridaben	zero	Zero	zero
Fenpyroximate	zero	zero	zero
Bromopropylate	0.7	4.5	24.9
Abamectin	9.1	50.8	50.0
Cypermethrin	11.9	11.5	17.7
Biofly	11.8	1.4	19.8
Control	76.3	76.1	88.5

Pesticidal effect on feeding capacity and egg production of predaceous mite

From data in Table (4), it was exhibited that all tested compounds caused a decrease in prey egg consumption relative to the untreated control. The main features of the data in this table could be indicated in the following:

1. The most effective compounds on prey egg consumption as an average of two successive days are fenpyroximate and cypermethrin of 7.25 and 9.13% compared to control of 32.38.
2. The most safe compounds that allowed the adult predator to consume the contaminated eggs were bromopropylate and abamectin.
3. The predator egg production was slightly affected by the above two compounds.

Table (4): Prey egg consumption and egg deposition of predatory mite *A. gossipi* feeding on different pesticides - pretreated prey eggs introduced at different times after treatment.

Compound	Time elapsed between treatment and egg introduction								
	Zero time			24 hrs			48 hrs		
	Average No. of consumed eggs/adult /day	Average deposited eggs/adult /day	Hatchability (%)	Average No. of consumed eggs/adult /day	Average deposited eggs/adult /day	Hatchability (%)	Average No. of consumed eggs/adult /day	Average deposited eggs/adult /day	Hatchability (%)
Pyridaben	10	0.13	0.0	8.63	0.0	0.0	8.75	0.25	100
Fenpyroximate	7.25	0.25	100	29.88	1.0	38	18.63	0.38	100
Bromopropylate	21.38	0.63	60.3	15.63	0.0	0.0	10.38	0.38	65.79
Abamectin	15.38	0.63	39.7	18.0	0.88	71.6	29.75	0.25	100
Cypermethrin	9.13	0.0	0.0	3.5	0.0	0.0	4.5	0.0	0.0
Biofly	13.13	0.25	0.0	26.38	0.5	100	18.63	0.38	100
Control	32.38	1.25	100	30.5	0.88	100	29.63	1.13	100

4. The hatchability of predator eggs deposited on contaminated discs was highly affected by cypermethrin and pyridaben.
5. The time elapsed before introducing the contaminated prey eggs to the adult predator is partially responsible for prey egg consumption and accordingly the predator egg production.
6. According to the nature of the tested compound, the eggs consumed may be increased or decreased with time elapsed between egg contamination and egg introduction to adult predator.

It is interesting to know that the deposited eggs by the predator were not in a relation with the eaten ones. Mite activity can be influenced by the nature of the substrate of the surface (Blommers *et al.*, 1977 and Everson, 1979, 1980). The activity pattern of *A. gossipi*, which was not measured in this study, may be responsible for the non-correlated relation between feeding and oviposition in the predator. The presence of chemicals in low levels on the leaf surface may be irritant enough to make the female predator in contact with the contaminated prey eggs and accordingly the consumed eggs seemed to be almost of the same level of untreated control.

In general, any chemical is expected to be in most cases a causative agent to prevent partially or completely egg feeding, but what was unexpected the predator egg production which decreased enough to make the relationship between the number of eggs eaten and laid by the predator unlinear. Barrit (1984) found this relationship linear on *A. fallacies*, the result which is in accordance with those of Hassan and Shereef (1986), Ford *et al.*(1989) and Hosny and Keratum (1995). The authors are satisfied that this relationship could be linear under the normal conditions. The contamination by the chemicals is responsible for the unlinearity because of abnormal conditions surrounding the living organism.

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كفاءة بعض المبيدات الأكاروسية والمبيد الحيوى بيوفلاى فى المعالجة المتكاملة للأكاروس تترانيكس أورتيكا

عبدالعزيز حسنى ، محمد النجار ، عطية قريطم ، رفت المعجوز
قسم المبيدات - كلية الزراعة بكفر الشيخ - جامعة طنطا

أجريت دراسة معملية لتقييم التأثير السام لستة مركبات وأربعة مبيدات أكاروسية هى (بيريدابن - فينبيروكسميات - بروموبروبايلات - أبامكتين) وأحد البيروثرويدات (سيبرميثرين) ومبيد حيوى (بيوفلاى) ضد إناث العنكبوت الأحمر (تترانيكس أورتيكا) وإناث العنكبوت المفترس (أمبليسيس جوسيباى). أختبر أيضا تأثير الجرعات تحت المميتة على بعض الصفات البيولوجية والسلوكية لنوعى الأكاروس والمحددة بدورها فى المعالجة المتكاملة للأكاروس المتطفل على النبات.

أظهر مركب أبامكتين وضعا خاصا سواء فى المكافحة الكيماوية أو المتكاملة للأكاروس - ذو سمية عالية ودليل إختيارى عالى ويخفض وضع البيض الضحية لمستوى مناسب وذو تأثير منخفض على حيوية البيض وأنه من أحد أفضل المركبات أمانا التى تسمح لإستهلاك البيض الملوث به بواسطة المفترس وقليل التأثير على وضع بيض المفترس. أظهر مركب فينبيروكسميات دليل أمان عالى وشغل المركز التالى بعد أبامكتين فى المعالجة المتكاملة للأكروس. لايوصى بإستخدام سيبرميثرين إذا أخذت فى الأعتبار قيم كل من دليل الأمان، والإختيارية وقد كان من أكثر المواد تأثيرا على إستهلاك بيض الأكاروس بواسطة المفترس (أمبليسيس جوسيباى) وكذلك إنتاج بيض المفترس. مركب بيريدابن كان من أكثر المركبات تأثيرا على فقس بيض الضحية. ينخفض تأثير مركب (بروموبروبايلات) كمبيد بيض (الفقس) مع زيادة عمر البيض. لم يظهر مركب (بيوفلاى) أى إتجاه محدد فيما يخص التأثير كمبيد بيض على أطوار البيض المختلفة للأكاروس الضحية.