EFFICACY OF SOME BIOPESITICIDES AGAINST *TETRANYCHUS URTICAE* INFESTING COWPEA PLANTS AND THEIR SIDE-EFFECTS ON CERTAIN PREDATORS

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(Manuscript received January 2002)

Abstract

The effects of abamectin, a natural product produced by the soil microorganisms *Streptomyces avermitilis*, azadirachtin, a natural product from neemplants, *Beauvaria bassiana*, an entomopathogenic fungus, thiocyclam hydrogen oxalate, a product from the marine annelid worm *Lumbrinereis spp.* and fenazaquin, a conventional acaricide were evaluated against *Tetranychus urticae* infesting cowpea, *vigna sinensis*, during 2000 and 2001 seasons. The side – effects of these materials on *T. urticae* associated predators, *Euseius scutalis* (a predatory mite) and *Chrysoperla carnea* (a predatory insect) were also evaluated.

The obtained data revealed that azadirachtin was the most potent compound introducing the population size of *T. urticae* after two seasons. The general mean reduction percentage was 80.71%, followed by *B. bassiana* and abamectin (77.59 and 76.35% respectively). However, thiocyclam and fenazaquin demonstrated low reduction percentages (55.96 and 52.26% respectively).

Fenazaquin and thiocyclam demonstrated unacceptable toxic effect on *E. scutalis*. The general mean reduction percentages were 72.11 and 63.14%, respectively. However, azadirachtin exhibited the lowest toxic effect (12.35%). The most harmful compound on the associated predator *C. carnea* was fenazaquin followed by thiocyclam, they reduced the predator populations by 54.84 and 44.59% respectively. The most secure compound was azadirachtin followed by *B. bassiana* and abamectin, reduction percentages were 18.95, 23.44 and 27.31%, respectivley.

In conclusion, azadirachtin, *B. bassiana* and abamectin can be applied effectively against *T. urticae* with minimal impact on the non-target organisms, i.e. the phytoseiid mite *E. scutalis* and the thysanopterous insect *C. carnea*. They may be classified as IPM-compatible acaricides in the integrated pest management programms against. *T. urticae* infesting snap bean.

Key Words : Biopesticides, predatory mite, predatory insect.

INTRODUCTION

Tetranychid mites are considered one of the major pests causing considerable damage to vegetable and horticulture crops. The two – spotted spider *Tetranychus urticae* Koch is the most economically important mite species of wide spread nature in Egypt.

Pesticides have brought several complications such as environmental pollution, phytotoxicity to susceptible crop plants and hazards to human and wild-life through persistent toxic residues. The wide spectrum poisons often induce undesirable side- effects on beneficial species and non-target organisms.

Consequently, alternatives to chemical control are being urgently sought. The choice of a suitable pesticide, when in need must be of the least hazard to the natural enemies (Burges and Hussey, 1971 and Delucchi, 1976).

Therefore, the present work aimed to evaluate the efficacy of some biopesticides, i.e. abamectin, azadirachtin, jojoba oil, *Beauvaria bassiana* and thiocyclam hydrogen oxalate compared with a conventional miticide fenzaquin against *T. urticae* and their side-effect on the predaceous mite *Euseius scutalis* (Athias-Henriot) (Acari: Phytoseiidae) and a predaceous insect *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) on snap bean plants during two successive seasons 2000 and 2001.

MATERIALS AND METHODS

Cowpea *Vigna sinensis* was planted in 15/3/2000 (1^{st} season) and 20/3/2001 (2^{nd} season), at Ismailia Governorate (100 km east of Cairo). The experimental area was divided into equal plots of $21m^2$ for four replicates, treated and untreated plots were arranged in a complete randomized block design, receiving routine agricultural practices. The tested materials were as follows:; (1) Abamectin (Vapcomic 1.8% EC at the rate of 40ml/100 liter water), a natural product prodcued by the soil microorganisms *Streptomyces avermitilis*. (2) Azadirachtin (Neemazal 5% EC at the rate of 300ml/100 liter water), a natural product from neem plants. (3) *Beauvaria bassiana* (Naturalis – L $2.3X10^7$ conidia/ml at the rate of 300ml/100 liter water), an entomopathogenic fungus. (4) Thiocyclam hydrogen oxalate (Evisect – S 50%-WP at the rate

of 250g/100 liter water), a product form the marine annelid worm *Lumbrinereis spp.* (5) Fenazaquin (Pride 20% EC at the rate of 60 ml/100 liter water), a conventional acaricide.

Four plots were sprayed with water only as control. Each material was applied once after 1.5 month from plantation on 1/5/2000 (1^{st} season) and 5/5/2001 (2^{nd} season) by using a knapsack sprayer (CP-3) equipped with one nozzle. Used materials were diluted with water at the rate of 200 liter/feddan ($4200m^2$). Samples of 10 leaves were picked randomly from each plot, before spray and then weekly following application. The leaves were transferred to the laboratory in paper bags and examined by using binocular microscope. The active individuals (moving stages) of both phytophagous, *T. urticae* koch and predaceous, *E. scutalis* were counted at two square inches; one from the upper and the other from the lower surface of each leave. The numbers of the insect predator *C. carnea* Stephens were directly counted in the field on 10 leaves randomly from each plot. The average number of mites and insects in treated and untreated leaves were counted and the percentages reduction were calculated by Henderson and Tilton (1955) equation. Data were analyzed by 1-way analysis of variance (ANOVA) and means were separated by Student-Newman Keuls test.

RESULTS AND DISCUSSION

Data shown in Tables 1 and 2 indicate that in general, all tested materials were significantly effective against *T. urticae* as compared with the untreated control. However, the used materials were more effective in controlling mites infesting snap bean plants in 2000. This may be attributed to the variations in the levels of infestation during the experimental periods, 59.75-63.25 individuals /10 leaves in 2000 and 70.50-72.50 individuals /10 leaves in 2001.

The field tests in 2000 showed that azadirachtin and fenazaquin were the most potent compounds in reducing the population size *of T. urticae* after one week from application, their reduction percentages were 89.28 and 89.12%, respectively. They were followed by thiocyclam and abamectin (86.92 and 86.32%, respectively). However, *B. bassiana* was the least effective (85.44%).

Table 1. Mean No. of *T. urticae* motile stages /10 cowpea leaves as affected by some biopesticides under field conditions during 2000 and 2001.

Treatment	Year	Before spraying	Periods after spraying					General mean
			1st week	2nd week	3rd week	4th week	Mean	
Abamectin	2000	59.75	10.25c	15.75c	20.00d	27.50d	18.37c	21.68c
	2001	70.50	15.00c	21.50c	29.00d	34.50d	25.00c	
Azadirachtin	2000	63.25	8.50d	12.00c	17.75e	23.75e	15.50c	18.50c
	2001	72.25	11.75e	17.00d	25.50e	31.75e	21.50c	
Beauvaria bassiana	2000	63.00	11.50b	15.25c	18.50e	25.00e	17.56c	20.96c
	2001	71.00	17.00b	20.75c	27.75d	32.00e	24.37c	
Thiocyclam	2000	61.00	10.00c	18.25b	59.00c	68.50c	38.93b	43.99b
	2001	72.50	13.50d	27.00b	70.25c	85.50c	49.06b	
Fenazaquin	2000	60.50	8.25d	15.00c	61.25b	81.00b	41.37b	45.87b
	2001	71.75	9.50f	18.25d	82.00b	91.75b	50.37b	
Untreated	2000	60.00	75.25a	81.50a	87.25a	95.50a	84.87a	90.37a
	2001	72.00	78.50a	89.00a	103.25a	112.75a	95.87a	
LSD at 0.05	2000	-	1.14	1.19	1.10	1.30	17.18	13.69
	2001	-	1.29	1.27	1.50	2.02	21.04	

Table 2. Reduction Percentage in *T. urticae* motile stages on cowpea leaves as affected by some biopesticides under field conditions during 2000 and 2001.

Treatment	year	Periods after spraying					General mean
		1st week	2nd week	3rd week	4th week	Mean	
Abamectin	2000	86.32	80.59	76.98	71.08	78.74	76.35
	2001	80.48	75.32	71.31	68.75	73.96	
Azadirachtin	2000	89.28	86.03	80.70	76.40	83.10	80.71
	2001	85.08	80.96	75.38	71.93	78.33	
Beauvaria bassiana	2000	85.44	82.17	79.8	75.06	80.61	77.59
	2001	78.03	76.35	72.74	71.21	74.58	
Thiocyclam	2000	86.92	77.97	33.48	29.44	59.45	55.96
	2001	82.92	69.87	32.43	24.69	52.47	
Fenazaquin	2000	89.12	81.74	25.46	15.88	53.05	52.26
	2001	87.85	79.42	20.3	18.34	51.47	

After two weeks, azadirachtin demonstrated the highest significant reduction in the numbers of *T. urticae* moving stages (86.03%), followed by *B. bassiana*, fenazaquin and abamectin (82.17, 81.74 and 80.59%, respectively). Thiocyclam was the least effective (77.97%). Azadirachtin still the most potent material after three weeks from application, it reduced the population size of *T. urticae* by 80.70%, *B. bassiana* and abamectin came next (79.80 and 76.98%, respectively), thiocyclam and fenazaquin were the least effective (33.48 and 25.46%, respectively). After four weeks, azadirachtin and *B. bassiana* showed the most significant reduction in the numbers of moving stages of *T. urticae* (76.40 and 75.06%, respectively), abamectin was next (71.08%) followed by thiocyclam (29.44%) and fenazaquin (15.88%). After the period of evaluation (one month) the used acaricides can be statistically arranged into two groups :- (1) azadirachtin, *B. bassiana* and abamectin were high effective in controlling *T. urticae*. The mean reduction percentages of mite populations were 83.10, 80.61 and 78.74%, respectively. (2) thiocyclam and fenazaquin were low effective (59.45 and 53.05%, respectively).

Tables 1-2 also present the results of field tests carried out in 2001. The data showed the same trend obtained in 2000, but in less effectiveness of the tested materials. They can be statistically classified into two groups: (1) azadirachtin, *B. bassiana* and abamectin provided high effective control of *T. urticae*. The mean reduction percentages after one month from application were 78.33, 74.58, 73.96%, respectively. (2) thiocyclam and fenazaquin showed lower reduction percentages (52.47 and 51.47%, respectively).

The integration of the data presented in Tables 1 and 2 show the general mean reduction percentage in *T. urticae* moving stage after two seasons of evaluation. It can be concluded that azadirachtin, *B. bassiana* and abamectin were successful in controlling this pest, they reduced the mite populations by 80.71, 77.59 and 76.35%, respectively, whereas thiocyclam and fenazaquin were less effective (55.96 and 52.26%, respectively).

The aforementioned results agree with the results obtained by Szwejda (1993). He reported that the two spider mites *T. urticae* and *T. cinnabarinus* were of economic importance in Poland. In his experiments with chemical control on both spider mite spe-

cies, the following compounds gave the best results: fenpyrad, acrinatrin, difenthiuon and abamectin. The mortality reached more than 98%. El-Adawy *et al.* (1995) tested eleven acaricides from different chemical groups and the entomopathogenic fungus; *B. bassiana* against *T. urticae* infesting cucumber under plastic house conditions. They found that chlorfenapyr, abamectin, fenpropathrin, azocyclotin, propargite (Acargite), propargite (comite), fenpyroximate and fenazaquin reduced the infestation by (71.25 – 80.38%), whereas hexythiazox, bromopropylate and ethion reduced it by (61.25-62.87%). *B. bassiana* resulted in 80.86% reduction in the mite population.

Sundaram and Sloane (1995) investigated pure azadirachtin – A (AZ-A) and 4 neem-based formulations, Margosan-O (RH), Azatin (MO), RH-9999 (PT) and Neem PTI-EC4 (AT) containing the insecticide isomer for their repellency, toxicity and oviposition deterrence against *T. urticae*. They found that the deterrent and biological effects decreased in the order AT>PT>MO>RH>AZ-A. Ryabchinskaja *et al.* (1996) found that the preparation of the avermectins group, phytoverm, was highly effective against *T. urticae*. The maximum reduction in its population was 93.1% 4 days after treatment when phytoverm was applied at 2 liter /ha. Kandybin and Smirnov (1996) mentioned that the sue of Actinine, a novel bioacaricide based on *Streptomyces* is effective and ecologically safe to tetranychid control.

It is evident, Tables 3 and 4 that all tested materials reduced the number of the phytoseiid predatory mite, *E. scutalis*, this reduction was not significant when azadirachtin, *B. bassiana* and abamectin were sprayed in 2000. The mean numbers of predator were 26.56, 24.63 and 22.81 individuals/10 leaves, respectively. In untreated plots the number was 29.87 individuals/10 leaves. However, all tested materials significantly reduced the predator numbers, Table 3.

The mean reduction percentages in *E. scutalis* moving stages on snap bean leaves after 4 weeks from the applications of azadirachtin, *B. bassiana*, abamectin , thiocyclam hydrogen oxalate and fenazaquin were 11.18, 13.85, 23.25, 66.09 and 79.37% in 2000 and 13.52, 18.40., 22.07, 60.20 and 64.86% in 2001, respectively. The general mean reduction percentages after two years were 12.35, 16.12, 22.66, 63.11 and 72.11, respectively, Table 4.

Table 3. Mean No. of *Euseius scutalis* motile stages /10 cowpea leaves as affected by some biopesticides under field conditions during 2000 and 2001.

Treatment	Year	Before spraying	Periods after spraying					General mean
			1st week	2nd week	3rd week	4th week	Mean	
Abamectin	2000	23.75	18.75d	20.75d	23.50d	28.25c	22.81a	24.81b
	2001	27.00	22.75b	24.00c	28.50b	32.00c	26.81d	
Azadirachtin	2000	24.00	23.00b	25.75b	28.00b	29.50b	26.56a	27.87b
	2001	26.50	24.00b	27.50b	30.75b	34.50b	29.18b	
Beauvaria bassiana	2000	22.75	21.00c	23.50c	25.75c	27.50c	24.43a	26.12b
	2001	26.75	23.00b	25.50c	29.75b	33.00c	27.81c	
Thiocyclam	2000	21.50	4.50e	7.25e	10.75e	14.75d	9.31b	11.56c
	2001	27.00	9.50c	11.00d	15.50c	19.25d	13.81e	
Fenazaquin	2000	21.25	2.75f	3.25f	6.75f	9.75e	5.62b	8.74c
	2001	26.25	7.75c	9.50d	13.25c	17.00e	11.87f	
Untreated	2000	24.00	26.50a	29.25a	31.00a	32.75a	29.87a	31.68a
	2001	27.00	29.00a	32.50a	35.00a	37.50a	33.50a	
LSD at 0.05	2000	-	1.68	2.11	1.02	0.77	5.35	3.06
	2001	-	3.05	1.71	2.46	1.48	0.86	

Table 4. Reduction Percentage in *Euseius scutalis* motile stages on cowpea leaves as affected by some biopesticides under field conditions during 2000 and 2001.

Treatment	year	Periods after spraying					General mean
		1st week	2nd week	3rd week	4th week	Mean	
Abamectin	2000	28.50	28.31	23.39	12.83	23.25	22.66
	2001	28.90	26.15	18.57	14.66	22.07	
Azadirachtin	2000	13.20	11.96	9.67	9.92	11.18	12.35
	2001	23.58	13.78	10.48	6.26	13.52	
Beauvaria bassiana	2000	16.40	15.24	12.37	11.41	13.85	16.12
	2001	27.45	20.80	14.20	11.17	18.40	
Thiocyclam	2000	81.04	72.33	61.29	49.72	66.09	63.14
	2001	70.31	66.15	55.71	48.66	60.20	
Fenazaquin	2000	88.27	87.45	75.40	66.37	79.37	72.11
	2001	75.08	69.93	61.06	53.37	64.86	

The side–effects of the tested acaricides against the predatory insect *Chrysoperla carnea* are presented in Tables 5 and 6. The obtained data reveal that all tested biopesticides significantly reduced the predatory insect except for azadirachtin in 2000 season. The mean numbers of *C. carnea* were 3.56, 4.25, 3.81, 2.93, 2.81 and 5.00 individuals/10 plant leaves in the 1st season, 3.81, 4.75, 4.18, 3.25, 2.87 and 5.68 individuals / 10 plant leaves in the 2nd season. The general mean numbers of *C. carnea* were 3.68, 4.50, 3.99, 5.52 and 5.34 individuals /10 plant leaves for abamectin, azadirachtin, *Beauvaria bassiana*, thiocyclam hydrogen oxalate, fenazaquin and control, respectively, Table 5.

The least toxic compound against *C. carnea* was azadirachtin, while the most toxic one was fenazaquin. The mean reduction percentages were 29.52, 21.06 24.45, 45.91 and 62.54% in the 1st season, 25.10 , 16.84, 22.43, 43.27 and 47.15% in the 2nd season and the general mean reduction percentages for the two successive seasons were 27.31, 18.95, 23.44, 44.59 and54.84% for abamectin, azadirachtin, *Beauvaria bassiana*, thiocyclam hydrogen oxalate and fenazaquin, respectively. Table 6.

In this respect, Tzeng and Kao (1996) revealed that the green lacewing *Mallada basalis* larvae are polyphagous predators which are mass-reared in the laboratory and used for the control of *T. urticae* on strawberry in Taiwan. They tested the toxicity of 23 pesticides commonly used to control pests on strawberry and other crops. Results revealed that 6 acaricides: hexythiazox, fenbutatin oxide, chinomethionat, fenpyroximate, fenothiocarb and abamectin were harmless (<50%) to the larvae of *M. basalis*. Badawy and El-Arnaouty (1999) found that organophosphorus iseciticides were more toxic than carbamates and biocides against third- instar larvae of *Chrysoperla carnea*. Percent moralities were low namely 7 and 40% for pirmicarb and carbosulfan, 4 and 7% for M-Pede (an organic insecticide based on potassium salts of fatty acids) and abamectin, 11 and 9% for Dipel (*Bacillus thuringiensis* var. Kurstaki) and Biofly (*Beauvaria bassiana*). They suggested that, pirimicarb, natural insecticides and biocides may be useful in integrated pest management programs. Markandeya and Divakar (1999) mentioned that azadirachtin is well known for its effect on pest species, but informations on its effects on bioagents is scanty. Therefore, they evaluated a commercial neem formulation (Margosom 1500 ppm) in the laboratory against two parasitoids; *Trichogramma chilonis* and *Bracon brevicornis* and two predators, the wolf spider *Lycosa pseudo-*

Table 5. Mean No. of *Chrysoperla carnea* larvae /10 snap bean leaves as affected by foliar spray with biopesticides under field conditions during 2000 and 2001.

Treatment	Year	Before spraying	Periods after spraying					General mean
			1st week	2nd week	3rd week	4th week	Mean	
Abamectin	2000	3.75	2.75b	3.00c	3.75b	4.75b	3.56c	3.68d
	2001	4.00	3.00d	3.50c	4.00c	4.75d	3.81d	
Azadirachtin	2000	4.00	3.25b	3.75b	4.50b	5.50a	4.25b	4.50b
	2001	4.50	4.00b	4.25b	5.00b	5.75b	4.75b	
Beauvaria bassiana	2000	3.75	3.00b	3.25c	4.00b	5.00b	3.81c	3.99c
	2001	4.25	3.50c	3.75c	4.25c	5.25c	4.18c	
Thiocyclam	2000	4.00	2.00b	2.50d	3.00c	4.25c	2.93d	3.09e
	2001	4.50	2.50e	3.00d	3.50d	4.00e	3.25e	
Fenazaquin	2000	4.25	1.00c	2.00e	2.50c	3.25d	2.18e	2.52f
	2001	4.25	2.00f	2.50e	3.25d	3.75e	2.87f	
Untreated	2000	3.75	4.25a	4.75a	5.25a	5.75a	5.00a	5.34a
	2001	4.50	5.00a	5.50a	6.00a	6.25a	5.68a	
LSD at 0.05	2000	-	0.92	0.32	0.71	0.33	0.27	0.16
	2001	-	0.31	0.32	0.31	0.33	0.22	

Table 6. Reduction Percentage in *Chrysoperla carnea* larvae on cowpea leaves as affected by some biopesticides under field conditions during 2000 and 2001.

Treatment	year	Periods after spraying					General mean
		1st week	2nd week	3rd week	4th week	Mean	
Abamectin	2000	35.29	36.84	28.57	17.39	29.52	27.31
	2001	32.50	28.40	25.00	14.50	25.10	
Azadirachtin	2000	28.30	25.98	19.64	10.32	21.06	18.95
	2001	20.00	22.72	16.66	8.00	16.84	
Beauvaria bassiana	2000	29.41	31.57	23.80	13.04	24.45	23.44
	2001	25.88	27.80	25.00	11.05	22.43	
Thiocyclam	2000	55.88	50.65	46.42	30.70	45.91	44.59
	2001	50.00	45.45	41.66	36.00	43.27	
Fenazaquin	2000	79.23	62.84	57.98	50.12	62.54	54.84
	2001	57.64	51.87	42.64	36.47	47.15	

innulata and the predatory beetle *Menochilus sexmaculatus.* They found that margo-
om was safe to all the four bioagents studied.

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تأثير بعض المبيدات الحيوية على العنكبوت الأحمر العادي الذي يصيب نباتات اللوبيا وآثارها الجانبية على بعض المفترسات

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تم تقييم مركبات أبامكتين وهو منتج طبيعي من الكائنات الدقيقة *Streptomyces avermitilis* في التربة ، أزاديراختين وهو منتج طبيعي من نباتات النيم، فطر (*Beauvaria bassiana*) وهو مبيد حيوي فطري ممرض للحشرات ، مركب *Thicocyclam hydrogen oxalate* وهو منتج طبيعي مستخرج من يرقات *Lumbrinereis spp.* البحرية ، والمبيد الأكاروسي التقليدي *Fenazaquin* ضد أكاروس *Tetranychus urticae* الذي يصيب اللوبيا *vigna sinesis* خلال موسمين ٢٠٠٠ و ٢٠٠١ .

تم تقييم الآثار الجانبية لهذه المركبات على كل من المفترس الأكاروسي *Euseius scutalis* والمفترس الحشري *Chrysoperla carnea*.

أظهرت النتائج أن أزاديراختين كان أكثر المركبات كفاءة في خفض تعداد مجتمع *T.urticae* بعد موسمين من التجريب. كانت النسبة المئوية للخفض ٨٠,٧١٪ ويأتي كل من *B.bassiana* وأبامكتين بعده في الترتيب بنسب خفض ٧٧,٥٩ و ٧٦,٣٥٪ على التوالي. أظهر كلاً من ثيوسيكلام وفينازاكوين نسب خفض أقل في أعداد الأكاروس (٥٥,٩٦ و ٥٢,٢٦٪ على التوالي).

عند دراسة الأثر الجانبي لهذه المركبات على المفترس *E. scutalis* كان التأثير السام لكلا المركبين فينازاكوين وثيوسيكلام سلبياً. وكانت نسب المتوسط العام للخفض في تعداد المفترس ٧٢,١١ ، ٦٣,١٤٪ على التوالي. أظهر مركب أزاديراختين أقل تأثير سام على المفترس.

كان أكثر المركبات ضرراً على المفترس الحشري *C.carnea* مركب فينازاكوين يليه ثيوسيكلام وكانت النسب المئوية للخفض في التعداد ٥٤,٨٤ و ٤٤,٥٩٪ على التوالي. أكثر المركبات أماناً كان أزاديراختين يليه فطر *B.bassiana* ثم أبامكتين حيث كانت النسب المئوية للخفض في تعداد المفترس *C.carnea* هى ١٨,٩٥، ٢٣,٤٤ ، ٢٧,٣١٪ على التوالي.