Comparative Field Evaluation of Certain Acaricides Against *Tetranychus urticae* on Strawberry

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ABSTRACT: The present investigation was carried out in a private strawberry farm at Kom Hamada district, Behaira governorate. The investigation was carried out during two succeseive seasons 2015 and 2016. The biological performance of cartin acaricides was studied against *Tetranychus urticae* the pattern of acaricides on 2014/2015 includen: Fenpyroximate, Ethoxazole, Bifenazate and Abamectin while the pattern in the second season include: Fenpyroximate, Ethoxazole, Bifenazate, Abamectin, Milbemectin and Hexythiazox the strawberry plants received six consequent sprays in the first season of 2014/2015 while received five sprays in the second season 2015 on both season, the sprays were carried out on 15 days intervals. The biological performance against *Tetranychus urticae* could be arranged after 24hrs from treatments. The results showed that the order of reduction of acaricides against TSSM, were Milbemectin ≥ Abamectin > Bifenazate > Fenpyroximate > Hexythiazox> Ethoxazole after 24 hrs; Abamectin ≥ Milbemectin > Bifenazate ≥ Fenpyroximate > Ethoxazole> Hexythiazox after 48 hrs; and Milbemectin > Abamectin > Bifenazate > Fenpyroximate > Hexythiazox > Ethoxazole after 72 hrs.Therefore, the results concluded that for controlling of TSSM on strawberry plants, it could be applied milbemectin or abamectin in outbreak for fasting effects on it.

Key words: The two-spotted spider mite, *Tetranychus urticae* Koch, Milbemectin, Abamectin, Bifenazate, Fenpyroximate, Hexythiazox, Ethoxazole on strawberry plants.

INTRODUCTION

The two-spotted spider mite (TSSM), *Tetranychus urticae* (Koch) is widely distributed and a common pest for many plant species in greenhouses, nurseries and field crops. A population of TSSM could be increased rapidly especially during hot and dry periods. TSSM (*T. urticae* Koch) infests many crops including tomatoes, beans, peppers, egg plants and ornamental plants (Cagle, 1949). More than 130 species of spider mites known, TSSM is the major pest species on agricultural crops worldwide (Wu *et al.,* 1990; Ho, 2000 and Takafuji *et al.,* 2000). Since TSSM is a major pest for important vegetable crops including strawberry (Naher *et al.*, 2006).

Most of the difficulties in controlling this pest are initial detection and economically damaging levels that are closely associated with insecticide applications (Wilson, 1991; Iftner and Hall, 1984). One explanation for this is that acaricides reduce the natural enemies of TSSM, causing a reduction in predation pressure, which may allow mite number to be increased. Acaricide applications are necessary to suppress the TSSM population, but selective use of acaricides that are compatible with natural enemies may preserve predator population of TSSM and enhance control (Trumble and Morse, 1993).

Many new acaricides are now available in the market but they have a high cost associated with their use and application restrictions listed on the label to prevent the development of resistance. Treatment with acaricides that have long residual toxicity may be required to suppress high-density spider mite populations. However, use of acaricides with long residual periods may promote resistance in spider mite populations. Low-density populations may be suppressed with acaricides that have short residual toxicity. Diverse natural enemies have an important role in the ecology of the TSSM (Brandenburg and Kennedy, 1987).

In recently many efforts have been made to avoid the damage caused by this pest using some conventional acaricides but the extensive applications of such pesticides usually induce resistance to these chemicals.

The present investigation aimed to evaluate the biological performance of six selected insecticides namely, Fenpyroximate, Ethoxazole, Bifenazate, Abamectin, Milbemectin and Hexythiazox against TSSM on strawberry plants under the field conditions. The tested acaricides are belonging to different chemical groups, varied in their mode of actions and specialized upon the developmental stages of the spider mite.

MATERIALS AND METHODS

Chemicals used

Six acaricides referring to different chemical groups were used against TSSM, on strawberry plants under the field conditions in this study. These acaricides have five modes of action according to the classification of the Insecticide Resistance Action Committee (IRAC). The tested acairicides were applied separately during the course of the present investigation. The application rates of the used acaricides during two strawberry winter seasons of 2014/15 and 2015/16 are shown in Table (1).

Table (1). Dosage rates of the used acaricides during the two strawberry winter seasons of 2014/15 and 2015/16

Common name	Trade name	IRAC group	Application rate
Fenpyroximate	Ortus super® 5%EC	21A	50ml/100L
Abamectin	Vertimec® 1.8EC	6	40ml/100L
Bifenazate	Acramite® 48%SC	20D	35ml/100L
Ethoxazole	Baroque® 10%SC	10B	25ml/100L
Milbemectin	Milbecknok®1%EC	6	50ml/100L
Hexythiazox	Maccomite®10%WP	10A	20g/100L

EC= Emulsifiable Concentration, WP= Wettable Powder and SC= Soluble Concentration

Experimental design and field treatments

The present investigation was carried out in a private strawberry farm at Kom Hamada district, Behaira governorate during the two successive seasons of 2014/15 and 2015/16. The seeds were sown on the 15th (mid) September in both seasons. The selected farm is divided into several longitudinal blocks separated by buffer paths of 50cm to prevent insecticides drift. All plants received the same agricultural practices throughout the course of this study.

Four acaricides were tested in the first season (Fenpyroximate, Ethoxazole, Bifenazate and Abamectin) and the treated plants have been divided into 5 small plots (4 treatments plus untreated check). In the 2nd season, six acaricides (Fenpyroximate, Ethoxazole, Bifenazate, Abamectin, Milbemectin and Hexythiazox) that represented in 7 small plots were evaluated. The tested acaricides were applied at the recommended doses of the Egyptian Ministry of Agriculture. In both seasons during March and April plants were sprayed using a Knap sack sprayer (20 L), at the rate of 400 liters / fed. Each pesticide was applied by six sequential sprays in 2014/15 and five sprays in 2015/16 with 15 day interval.

Sampling technique for the *T. urticae* inspection

Ten leaves from each replicate (30 leaves per treatment) were taken randomly from three parts (lower – middle – upper) for inspecting the infestation by the mature acari-pest. The infested leaves during the period of study (March and April) were recorded in each treatment plus check. The mean number of the mature acari / 30 leaves and the infestation reduction percentage were calculated weekly after 24, 48 and 72 hours post spraying.

Calculation of the infestation reduction

Pre- and post-treatment application samples after 24, 48 and 72 hours were taken. The percent reduction was calculated according to Henderson and Tilton (1955) equation as follows:

$$\text{Reduction \%} = 1 - \left[\frac{A}{B} \times \frac{C}{D} \right] \times 100$$

Where:
A: % infested leaves in treatment after spraying.
B: % infested leaves in treatment before spraying.
C: % infested leaves in the check before spraying.
D: % infested leaves in the check after spraying.

Statistical analysis

Data were subjected to the analysis of variance ANOVA using ″F″ Test following the randomized complete block design (RCBD), with three replications for each treatment. The least significant differences (L.S.D) at the 0.05 ≤ level were determined according to computer program (COSTAT software, 1988) and

Duncan's Multiple Range Testes modified by Steel and Torrie (1981) to compare the average numbers of the inspected insect at different intervals.

RESULTS AND DISCUSSION

The biological performance of certain acaricides against the two-spotted spider mite

A. After 24 hours of acaricides spray.

The listed results in Tables (1 and 2) showed the general present reduction for the two-spotted mite, *T. urticae* after spraying 6 sequential sprays for each tested acaricide with 15 days interval. The mean number of the mature acari/30 leaves after 24 hrs resulted from each single acaricide spray during the two successive seasons of 2014/15 and 2015/2016.

In the first season of 2014/2015, the statistical analysis showed varied significant reductions than the untreated check. Abamectin, significantly, showed the first rank in decreasing the infestation of the matured acari with value 13.03 mature/30 leaves. Fenpyroximate, Bifenazate and Ethoxazole came in the 2nd order giving general means of 14.45, 14.80 and 14.97 mature/30 leaves, successively, without in-between significant differences. The untreated check recorded 21.32 mature / 30 leaves (Table, 1). Regarding the general mean of reduction percent during the first season of 2014/15, there were no significant variations among Abamectin, Bifenazate, Fenpyroximate and Ethoxazole. The highest (38.88) general mean of reduction percentage was corresponded to abamectin, followed by (32.22) for bifenazate, (30.58) for fenpyroximate. Unlikely, ethoxazole proved to be the least effective one, with the value of 29.78%

On season of 2015/16 the data in Table (2) showed that Milbemectin and Abamectin placed the first rank in decreasing the mature stage of acari with values 9.35 and 9.45 mature / 30 leaves without significant variations. Bifenazate, Fenpyroximate and hexythiazox came in the 2nd order giving general mean of 11.26, 12.12 and 12.17 mature / 30 leaves, successively, without significant differences. Again, ethoxazole was the least effective acaricide recording 13.49 mature / 30 leaves compared with untreated check that recorded 22.14 mature / 30 leaves. In general, Milbemectin and Abamectin topped all the tested treatments, as they recorded the highest general reductions of 57.76% and 57.31%, successively, followed by 49.14%, 45.25% and 45.03% for Bifenazate, Fenpyroximate and Hexythiazox, respectively. The least effective one was Ethoxazole with a reduction 39.06%, (Table, 2).

Table (2). Efficacy of the tested acaricides against the two-spotted spider mite, *T. urticae* after 24 hrs during the first season of 2014/15

Treatments	Mean number of mature acari / 30 leaves after 24 hrs							% Infestation reduction
	1st	2nd	3rd	4th	5th	6th	General mean	
Fenpyroximate	12.00	13.80	12.30	21.60	16.30	12.80	14.80	30.58
Ethoxazole	11.00	14.20	12.70	21.80	16.50	13.60	14.97	29.78
Bifenazate	9.80	13.70	12.20	21.30	16.40	13.30	14.45	32.22
Abamectin	8.70	13.40	11.10	19.90	14.40	10.70	13.03	38.88
Untreated check	19.63	20.50	16.90	27.00	25.50	18.40	21.32	0.00
LSD $_{0.05}$	1.224	2.519	1.625	2.957	1.851	1.682	0.747	-

Table (3). Efficacy of the tested acaricides against the two-spotted mite, *T. urticae* after 24 hrs during the second season of 2015/16

Treatments	Mean number of mature acari / 30 leaves after 24 hrs						% Infestation reduction
	1st	2nd	3rd	4th	5th	General mean	
Fenpyroximate	12.10	12.26	12.43	10.63	13.20	12.12	45.25
Ethoxazole	14.10	13.56	13.86	12.26	13.70	13.49	39.06
Bifenazate	11.90	10.36	11.90	9.96	12.20	11.26	49.14
Abamectin	10.03	8.70	9.86	8.03	10.66	9.45	57.31
Milbemectin	9.20	9.76	9.33	7.33	11.13	9.35	57.76
Hexythiazox	12.56	12.30	11.86	11.63	12.50	12.17	45.03
Untreated check	19.43	23.63	26.30	22.56	18.80	22.14	0.00
LSD $_{0.05}$	2.24	2.47	1.82	3.39	1.98	1.01	-

B. After 48 hours of acaricides sprays.

The results in Tables (3 and 4) exhibit the efficacy of the used treatments demonstrate the reduction percentages of the spider mite population on strawberry plants. Mostly, the evaluated treatments found to be effective on the two-spotted spider mite, *Tetranychus urticae*. It is worth to mention that, there were significant differences among the treatments throughout six sprays.

In the first season of 2014/15, data presented in Table, (3), showed that Abamectin achieved the first rank in decreasing the mature of acari with values 8.40 mature / 30 leaves followed by Bifenazate and Fenpyroximate that came in the 2nd order giving 9.78 and 9.40 mature / 30 leaves, successively, without significant difference Ethoxazole was the least effective acaricide with a significant differences than abamectin recording 10.27 mature acari/30 leaves, meanwhile, the untreated check recorded 21.23 mature / 30 leaves. During the first season of 2014/15 and after the 6th applications by the suggested treatments, the highest general mean of reduction percentage was achieved by Abamectin (60.43), followed by Bifenazate (53.93), Fenpyroximate (53.65) and Ethoxazole (51.62) without significant differences, subsequently (Table, 3).

In the 2nd season of 2015/16, data presented in Table, (4) showed that Milbemectin and Abamectin placed the first rank in decreasing the mature of acari with values 5.98 and 6.43 mature / 30 leaves with significant variations than others. Fenpyroximate, Bifenazate and Hexythiazox came in the 2nd order that giving general mean of 7.64, 7.77 and 8.73 mature / 30 leaves, successively, without in-between significant differences, However, Ethoxazole gave the least effective treatment recording 9.47 mature / 30 leaves. The untreated check recorded a high accounted mean number of 21.78 mature / 30 leaves. In general, in the 2nd season of 2015/16, Milbemectin and Abamectin headed all treatments, as recorded the highest general means of reduction percentages (72.54 and 70.47), followed by both Fenpyroximate (64.92%) and Bifenazate (64.32%). Significantly, the least effective treatments were corresponded to either Hexythiazox or Ethoxazole with reduction percentages of 59.91 and 56.51, successively (Table, 4)

Table (4). Efficacy of the tested acaricides against the two-spotted spider mite, *T. urticae* after 48 hrs during the first season of 2014/15

Treatments	Mean number of mature acari / 30 leaves after 48 hrs							Reduction of infestation %
	1st	2nd	3rd	4th	5th	6th	General mean	
Fenpyroximate	6.40	7.50	8.00	15.70	12.03	9.40	9.84	53.65
Ethoxazole	6.60	7.60	7.60	17.00	12.30	10.50	10.27	51.62
Bifenazate	6.30	7.10	7.60	16.30	12.20	9.20	9.78	53.93
Abamectin	6.00	6.10	7.10	14.40	10.10	6.70	8.40	60.43
Untreated check	20.60	19.50	17.10	27.60	25.06	17.50	21.23	0.00
LSD $_{0.05}$	2.13	1.34	1.12	2.51	1.16	1.02	0.57	-

Table (5). Efficacy of the tested acaricides against the two-spotted spider mite, *T. urticae* after 48 hrs during the second season of 2015/16

Treatments	Mean number of mature acari/30 leaves after 48 hrs						Reduction of infestation %
	1st	2nd	3rd	4th	5th	General mean	
Fenpyroximate	9.46	6.40	7.03	6.63	8.70	7.64	64.92
Ethoxazole	12.73	7.73	8.86	8.46	9.60	9.47	56.51
Bifenazate	10.40	6.50	7.63	7.00	7.36	7.77	64.32
Abamectin	8.50	5.00	6.26	6.10	6.30	6.43	70.47
Milbemectin	8.10	4.83	5.60	5.80	5.60	5.98	72.54
Hexythiazox	11.66	7.40	8.06	7.26	9.30	8.73	59.91
Untreated check	22.86	20.93	23.66	22.46	19.00	21.78	0.00
LSD $_{0.05}$	3.80	1.35	2.11	1.69	1.75	0.96	-

C. After 72 hours of acaricides sprays.

In the first season of 2014/15, the statistical analysis showed that Abamectin occupied the first rank in decreasing mature acari with value of 5.02 mature / 30 leaves. Without in-between significant differences, Fenpyroximate, Bifenazate and Ethoxazole came in the 2nd order giving general mean of 6.75, 690 and 7.54 mature / 30 leaves, successively, versus 21.03 mature / 30 leaves in the untreated check (Table, 5). Generally, Abamectin induced the highest general mean of reduction percentage with 76.12. Fenpyroximate and bifenazate came in the 2nd order giving general mean of reduction percentages of 67.90 and 67.18, in sequence, but the least effective treatment was ethoxazole that gave 64.14 a reduction percentage, (Table, 5).

During the 2nd season of 2015/16, the inspected mature of acari were significantly decreased by Milbemectin and Abamectin (3.15 and 3.23 mature / 30 leaves) followed by Bifenazate, Fenpyroximate and Hexythiazox (4.45, 4.94 and 5.68 mature / 30 leaves, successively), meanwhile, Ethoxazole was the least effective one recording 6.29 mature / 30 leaves; versus 21.46 mature / 30 leaves in untreated check (Table, 6). In this context, the highest general means of reduction percentages resulted from milbemectin 85.32, Abamectin 84.94 followed by Bifenazate 79.26 and Fenpyroximate 76.98. Meanwhile, Hexythiazox gave 73.53%, but Ethoxazole 70.68%, were the least effective treatments in reducing the infestation.

From another view, all the tested treatments were more effective on the adults of *T. urticae* especially the treatments of Abamectin and Milbemectin. Results showed that the order of reduction of acaricides against TSSM, were Milbemectin ≥ Abamectin > Bifenazate > Fenpyroximate > Ethoxazole after 24hrs; Abamectin ≥ Milbemectin > Bifenazate ≥ Fenpyroximate > Ethoxazole> Hexythiazox after 48 hrs; and Milbemectin > Abamectin > Bifenazate > Fenpyroximate > Fenpyroximate > Hexythiazox > ethoxazole after 72 hrs.

Table (6). Efficacy of the tested acaricides against the two-spotted spider mite, *T. urticae* after 72 hrs during the first season of 2014/15

Treatments	Mean number of mature acari / 30 leaves after 72 hrs							% Infestation reduction
	1st	2nd	3rd	4th	5th	6th	General mean	
Fenpyroximate	4.60	4.80	4.90	12.00	9.00	5.20	6.75	67.90
Ethoxazole	4.50	4.90	5.60	14.30	10.06	5.90	7.54	64.14
Bifenazate	4.80	3.90	4.90	13.30	9.10	5.40	6.90	67.18
Abamectin	4.03	3.40	4.10	9.40	6.50	2.70	5.02	76.12
Untreated check	19.70	19.40	17.70	27.80	24.60	17.00	21.03	0.00
LSD 0.05	2.6441	1.0700	0.9701	3.3246	1.3282	1.1616	0.64584	-

Table (7). Efficacy of the tested acaricides against the two-spotted spider mite, *T. urticae* after 72 hrs during the second season of 2015/16.

Treatments	Mean number of mature acari / 30 leaves after 72 hrs						%
	1st	2nd	3rd	4th	5th	General mean	Infestation reduction
Fenpyroximate	6.76	4.20	4.70	4.83	4.23	4.94	76.98
Ethoxazole	7.40	6.06	6.66	5.93	5.43	6.29	70.68
Bifenazate	6.20	4.23	4.80	3.40	3.66	4.45	79.26
Abamectin	4.50	3.06	3.73	2.66	2.23	3.23	84.94
Milbemectin	4.36	3.06	3.30	3.00	2.03	3.15	85.32
Hexythiazox	8.23	5.13	5.03	5.20	4.83	5.68	73.53
Untreated check	22.20	20.60	25.46	22.46	16.6	21.46	0.0
LSD $_{0.05}$	2.08	1.97	1.71	3.66	1.00	0.94	-

Gengotti *et al.* (2009) showed that Milbemectin gave a good control in reducing the infestation against the red spider mites in strawberries. From India Kumari *et al.* (2012) evaluated Bifenazate (Acramite 50WP) against tea red spider mites at different application rates (100, 125, 175, 200 and 250 g/ha) compared with the propargite 57 EC (1 l/ha) throughout two seasons. In first season, a single spray of Bifenazate 250 g/ha provided 63% control up to 35 days post treatment. In the 2nd season, the treatments of Acramite with 250 and 200 g/ha provided 91-93% control up to 35 days. Treatments 175 and 125 g/ha provided 84-86% control similar to propargite 1 l/ha. Acramite 200 or 125 g/ha with a follow up spray after 14 days is recommended for the control of tea mites.

Mwandila *et al.* (2013) compared the efficacy of Syringa (*Melia azedarach* L.) extracts with the synthetic acaricides: Abamectin, chlorfenapyr and protenofos on eggs, nymphs and adult red spider mites, *Tetranychus* spp. on tomatoes. Result revealed that the efficacy of seed extracts and commercial synthetic acaricides increased with exposure time. Concentration of 50% and above seed extracts was as effective against red spider mite (RSM) adults, eggs and nymphs as the synthetic acaricides. Latheef and Hoffmann (2014) found that bifenazate was 10 times more toxic than dicofol, as well as abamectin was more toxic than spiromesifen against the red spider mites, *T. urticae* in *Phasolus vulgaris*. The order of toxicity for acaricides against adult two spotted spider mite was abamectin > bifenazate > dicofol > propargite = spiromesifen. Liu *et al.* (2016) assessed bifenazate (Acramite_) and the predatory mite *Neoseiulus californicus* McGregor against *T. urticae* in greenhouse and field-grown strawberries. Also, Lu *et al.* (2017) compared 8 acaricides for adults of *T. urticae* and 5 acaricides for larvae of *T. urticae* and found the highest effective one was Abamectin on both adults and larvae.

CONCLUSION

For controlling of two spotted spider mite (TSSM), *Tetranychus urticae* on strawberry plants, it could be applied milbemectin or abamectin in outbreak for fasting effects on it.

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الملخص العربي

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أجرى البحث الحالي في مزرعة فراولة خاصة بمنطقة كوم حمادة بمحافظة البحيرة أثناء الموسمين المتتاليين ٢٠١٤/٢٠١٥ و ٢٠١٥/٢٠١٦ بهدف تقييم بعض المبيدات الأكاروسية التى تنتمى إلى مجموعات كيميائية مختلفة ضد العنكبوت الأحمر ذو البقعتين على نباتات الفراولة تحت الظروف الحقلية . تضمنت المعاملات ٤ مبيدات أكاروسية فى الموسم الأول ٢٠١٤/٢٠١٥ هى فنبيروكسيمات ، إيتوكسازول ، بيفينازيت و الأبامكتين بالإضافة إلى الكنترول الغير معامل. علاوةً على ذلك فى الموسم الثانى ٢٠١٥/٢٠١٦ تضمنت المعاملات ٦ مبيدات أكاروسية هى فنبيروكسيمات ، إيتوكسازول ، بيفينازيت ، الأبامكتين ، ملبيمكتين و هكسياثيازوكسى بالإضافة إلى الكنترول الغير معامل. تم تطبيق ٦ رشات متتالية لكل معاملة مختارة في الموسم الأول ٢٠١٤/٢٠١٥ و ٥ رشات متتالية في الموسم الثانى ٢٠١٥/٢٠١٦ بفارق ١٥ يوما بين كل رشة وأخرى خلال كلا الموسمين. أوضحت المعاملات إنخفاض واضح في متوسط عدد الافراد فى الطور البالغ لكل ٣٠ ورقة بعد ٢٤ ساعة من الرش طوال الموسم. أوضحت النتائج أنه يمكن ترتيب المبيدات الأكاروسية ضد ضد العنكبوت الأحمر ذو البقعتين على نباتات الفراولة حسب نسبة الخفض كالتالى: ملبيمكتين ≤ الأبامكتين > بيفينازيت > فنبيروكسيمات > هكسياثيازوكسى > إيتوكسازول بعد ٢٤ ساعة من الرش ، الأبامكتين ≤ ملبيمكتين > بيفينازيت > فنبيروكسيمات > إيتوكسازول > هكسياثيازوكسى بعد ٤٨ ساعة من الرش أما بعد ٧٢ ساعة من الرش فكانت ملبيمكتين > الأبامكتين ≤ بيفينازيت > فنبيروكسيمات > هكسياثيازوكسى > إيتوكسازول .

من هذه النتائج يمكن التوصية بتطبيق المبيد ملبيمكتين أوالأبامكتين فى حالة حدوث تفشى وانتشار للعنكبوت outbreak لسرعة تأثيرهم بعد فترة وجيزة.