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Original Article

Efficacy of selected pesticides on Citrus Brown Mite, *Eutetranychus orientalis* (Acari: Tetranychidae) and the side effects on three predatory mites under citrus orchard conditions

Eficácia de pesticidas selecionados no ácaro marrom dos cítricos, *Eutetranychus orientalis* (Acari: Tetranychidae), e os efeitos colaterais em três ácaros predadores em condições de pomar de cítricos

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Abstract

The present study has been conducted to evaluate the effect of two sprays of seven pesticides at recommended dose on citrus brown mite, *Eutetranychus orientalis* and the side effects on their predatory mites, *Euseius scutalis*, *Amblyseius swirskii*, *Phytoseiulus persimilis* (Acari: Phytoseiidae) under field conditions at 2022 & 2023 seasons. The obtained results show that, all tested pesticides achieved high reduction % of *E. orientalis* ranged between (82.1-90.0%) and (81.6-87.1%) after the 1st and 2nd sprays of 2022 season, where it ranged between (84.9- 88.7%) and (79.7- 88.7%) after 1st and 2nd sprays of 2023 season. Abamectin recorded the highest reduction % against the citrus brown mite, whereas Congest pesticide recorded the lowest reduction % after the two sprays along 2022 & 2023 seasons. As for the side effects of tested pesticides on associated predatory mites, all pesticides were safely for *E. scutalis* numbers recording decrease % between (18.4-28.6%) and (16.2 -26.1%) after the 1st and 2nd spray at 2022 season , where it ranged between (15.3- 29.1%) and (19.6-32.0%) after the 1st and 2nd sprays of 2023 season. On contrary, imidacloprid was unsafely for *E. scutalis* numbers recording the highest mean decrease % after 1st and 2nd sprays during the two seasons. Also, all tested pesticides were safely for *A. swirskii* numbers, after the 1st and 2nd sprays of the two seasons recording decrease (from 10.9 to 28.1%) & (24.4 to 31.4%) for the 2022 season, and (19-38.9%) & (18.7-39.4%) at 2023 season. On contrary, imidacloprid was unsafely for *A. swirskii* numbers recorded the highest decrease % after 1st and 2nd sprays during the two seasons. As for, *Ph. Persimilis* numbers, all tested pesticides were safely, where it recorded low decrease % ranged between (17-33.8%) & (20.4-34.8%) after the 1st and 2nd sprays of 2022 season, and (24.3-39%) & (20.2-28.9%) after the 1st and 2nd sprays of 2023 season. On the other side, imidacloprid was unsafely for *Ph. persimilis* numbers recording the highest decrease % after the 1st and 2nd sprays during the two seasons. The present study proved that all tested pesticides were high effective against *E. orientalis* and appeared to be safely and selective for associated predatory mites except imidacloprid which was very harmful for all tested predatory mites, and it could be concluded that the tested pesticides, Fenpyroximate, Hexythiazox , Congest , Spirodiclofen, Abamectin, and Chlorfenapyr could be used in the Integrated Pest Management (IPM) programs for *E. orientalis* at citrus orchards.

Keywords: pesticides, efficacy, side effect, *Eutetranychus orientalis,* predatory mites.

Resumo

O presente estudo foi realizado para avaliar o efeito de duas pulverizações de sete pesticidas na dose recomendada sobre o ácaro marrom dos citros, *Eutetranychus orientalis*, e os efeitos colaterais sobre seus ácaros predadores, *Euseius scutalis*, *Amblyseius swirskii*, *Phytoseiulus persimilis* (Acari: Phytoseiidae) em campo, nas condições das temporadas de 2022 e 2023. Os resultados obtidos mostram que todos os pesticidas testados alcançaram alta redução (%) de *E. orientalis*, a qual variou entre (82,1-90,0%) e (81,6-87,1%) após a primeira e a segunda pulverizações da temporada de 2022. A redução variou entre (84,9-88,7%) e (79,7-88,7%) após a primeira e a segunda pulverizações da temporada 2023. A abamectina registrou a maior redução (%) contra o ácaro marrom dos citros, enquanto o pesticida Congest registrou a menor redução (%) após as duas pulverizações ao longo das temporadas de 2022 e 2023. Quanto aos efeitos colaterais dos pesticidas testados em ácaros predadores associados, todos os pesticidas

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foram seguros para números de *E. scutalis*, registrando diminuição (%) entre (18,4-28,6%) e (16,2-26,1%) após a primeira e a segunda pulverizações na temporada de 2022, a qual variou entre (15,3-29,1%) e (19,6-32,0%) após a primeira e a segunda pulverizações da safra 2023. Pelo contrário, o imidaclopride não foi seguro para os números de *E. scutalis*, registando a maior diminuição média (%) após a primeira e a segunda pulverizações durante as duas estações. Além disso, todos os pesticidas testados foram seguros para números de *A. swirskii*, após a primeira e a segunda pulverizações das duas temporadas, registrando diminuição (de 10,9 para 28,1%) e (de 24,4 para 31,4%) para a temporada de 2022, e (19-38,9%) e (18,7-39,4%), na temporada de 2023. Pelo contrário, o imidaclopride não era seguro para *A. swirskii* e os números registraram a maior diminuição (%) após a primeira e a segunda pulverizações durante as duas estações. Quanto aos números de *P. Persimilis*, todos os pesticidas testados foram seguros, em que se registrou baixa porcentagem de redução, variando entre (17-33,8%) e (20,4-34,8%) após a primeira e a segunda pulverizações da temporada de 2022, e (24,3-39%) & (20,2-28,9%) após a primeira e a segunda pulverizações da temporada de 2023. Por outro lado, o imidaclopride não foi seguro para os números de *P. persimilis*, registando a maior diminuição (%) após a primeira e a segunda pulverizações durante as duas épocas. O presente estudo provou que todos os pesticidas testados foram altamente eficazes contra *E. orientalis* e parecem ser seguros e seletivos para os ácaros predadores associados, exceto o imidaclopride, que foi muito prejudicial para todos os ácaros predadores testados. Pôde-se concluir que os pesticidas testados, Fenpiroximato, Hexitiazox, Congest, Espirodiclofeno, Abamectina e Clorfenapir, poderiam ser usados nos programas de Manejo Integrado de Pragas (MIP) para *E. orientalis* em pomares cítricos.

Palavras-chave: agrotóxicos, eficácia, efeito colateral, *Eutetranychus orientalis*, ácaros predadores.

1. Introduction

The citrus brown mite, *Eutetranychus orientalis* (Klein), is the most significant phytophagous species in fields. It is found in tropical regions and threatens a variety of economically important horticultural and ornamental plants (Kamali et al., 2004). The principle host of *E. orientalis* is *Citrus* spp.; despite its cause damage to more than 50 plant species (Márquez et al. (2006). Also, a broad-spectrum of ornamental, medicinal and agricultural plants suffers from *E. orientalis* as a serious pest Rasmy (1978). It mainly found in the upper leaf surfaces and also around the midribs. Discoloration of leaves and pale-yellow streaks along the midribs and veins are the main symptoms that appeared Ledesma et al. (2011). Luckey (1968) reported that these mites are very small and difficult to detect on or inside the plants and could be transported throughout the world. Phytoseiid mites are important natural enemies of several phytophagous mites and other pests on various crops (Bounfour and Mc Murtry, 1987; Mc Murtry and Croft, 1997). *Euseius scutalis* (Athias-Henriot) is considered one of the most pollen-feeding phytoseiid mite species and widely found in citrus crops. *Euseius scutalis* is a common phytoseiid mite in Middle East countries (Lebanon, Iran, Egypt, Jordan) and North Africa on a variety of host plants including *Citrus* spp Bounfour and McMurtry (1987). This mite does not cause economic damage on plant (Adar et al., 2012). In addition, it showed a large scale of tolerances for environmental conditions (temperature and humidity). Recently, Stathakis et al. (2021) reported that *E. scutalis* develop and reproduce feeding on both *T. urticae* and *E. orientalis*.

The predatory mite, *Amblyseius swirskii* feed on pests such as whiteflies, thrips, spider mites, and other pests of vegetables, fruits, and ornamental plants grown under protected structures (e.g., greenhouses, high tunnels) or in open fields (Nomikou et al., 2001; Calvo et al., 2015). *Amblyseius swirskii* is considered one of the most used predatory mites in the world for its ability to feed on the pollen of various plant species which make it a good predator for early-season establishment. The plant protection against harmful organisms cannot be achieved by increase application of pesticides. There are many disadvantages of pesticides application are: increase in pesticide production costs, a trouble in the ecological stability due to the mortality of numerous valuable organisms, the arising of pest's resistance to applied pesticides, and increase of the environmental pollution. Chemical control is remaining the most used method against pests in developing countries (Aktar et al., 2009).

From the previous view, there are need to determine the toxicity of pesticides for beneficial organisms, furthermore, to give suitable recommendations for integrated use, many studies are needed on the compatibility of chemical and biological control agents (Wright and Verkerk, 1995; Jansen, 2010). For that purpose, the aim of this study is to evaluate the effect of seven pesticides at recommended dose on citrus brown mite, *E. orientalis* and the side effects on the predatory mites, *E. scutalis*, *A. swirskii*, *Ph. persimilis* under orchard conditions along two successive seasons 2022 and 2023.

2. Materials and Methods

A field experiment was conducted on seedless orange, *Citrus sinensis* variety Navel along two successive seasons 2022 & 2023 to evaluate the efficacy of novel pesticides on citrus brown mite, *Eutetranychus orientalis* and the side effects on the predatory mites, *Euseius scutalis* , *Amblyseius swirskii* , *Phytoseiulus persimilis*.

The experiments were conducted in a completely randomized block design with seven treatments and three replications. Further details about the recommended dose rates, trade name, and mode of action are provided in Table 1.

2.1. Field assessment

The study was conducted during April &May months during 2022 and 2023 seasons under field condition. The field experiments were carried out at the a private farm of

Table 1. List of tested pesticides including group, mode of action and rate of use.

Common and trade name	Group	Mode of action	Rate of use
Fenpyroximate Ortus 5% SC	Pyrazole	It has a role as a mitochondrial NADH:ubiquinone reductase inhibitor	50 ml /100 L water
Hexythiazox Magnifico 5%EC	Thiazolidionone	Non-systemic acaricide with contact and stomach action. Good translaminar activity. Has ovicidal, larvicidal, and nymphicidal activity.	20 ml /100 L water
Abamectin2% +Imidacloprid 12% Congest 15% CS	-	-	40 ml /100 L water
Spirodiclofen Listomid 24% SC	Ketoenols or tetronic acids	Inhibition of lipid synthesis	30 ml /100 L water
Abamectin Spider gold 5% ME	Avermectin	Stimulate the release of gamma-aminobutyric acid (GABA) an inhibitory neurotransmitter. It inhibits FOF1-ATPase and adenine nucleotide translocator (ANT), preventing mitochondrial respiration.	20 ml /100 L water
Imidacloprid Admire 20% SC	Neonicotinoid	causes blockage of nicotinergic neuronal pathway by blocking nicotinic acetyl choline receptors, prevents it from transfer impulses between nerves, resulting pest paralysis and death.	125 ml/100 L water
Chlorfenapyr Vanti 24% SC	Pyrazole	disrupting the production of adenosine triphosphate	60 ml/100 L water

Shebin Elkom locality at Elmenoufia Governorate, Egypt on *Citrus sinensis* variety Navel orange trees (25 years old) which were naturally infested with *E. orientalis* on their leaves with the observation of the predatory mites: *E. scutalis, A. swirskii, Ph. persimilis* existence feeding on its prey. Twenty-five trees were chosen for this study, distributed on two feddan (three trees as three replicates for each pesticide in addition to other three trees served as control.

To calculate the number of mites that inhabite the leaves prior to spraying, researchers counted the total number of adults on each leaf with the use of a magnifying glass lens 10 x. Afterwards, seven pesticides with field recommended dose were sprayed on the respective trees, where, the first spray of each insecticide was applied immediately after the incidence of mite infestation was observed (1st April) and second spray was given after 30 days (1st May) of the first spray, using manually operated knapsack sprayer having duromist nozzle with slight runoff stage. The mite, *E. orientalis* and predatory mites: *E. scutalis, A. swirskii, P. persimilis* populations were recorded at three days, one week and two weeks after spraying, the total number of mites was calculated using a magnifying glass lens and by touching each mite with the aid of camel brush to observe its movement. Reduction or decrease over control was calculated for each insecticide and the data was subjected to statistical analysis.

3. Statistical analysis

The obtained data was statistically analyzed using analysis of variance (ANOVA) at 5% probability. The measurements were divided using Duncan's Multiple Range Test through CoStat software program (Version 6.400) 1989-2008 (COSTAT, 2022).The reduction percent was calculated by Henderson and Tilton (1955) equation:

Corrected % reduction = (1 - n in Co before treatment * n in T after treatment / n in Co after treatment * n in T before treatment).

Where, n = insect population Co = control T= treatment.

4. Results

1 - Effect of tested pesticides on *Eutetranychus orientalis* in a citrus orchard at 2022 and 2023 seasons:

The data in Tables 2 and 3 represented the effect of two sprays of tested pesticides on *Eutetranychus orientalis*, after 3, 7 and 14 days of spraying, in a citrus orchard at 2022 & 2023seasons.

After the 1st spray of 2022 season:

The obtained data in Table 2 revealed that there were significant differences between all tested pesticides and control in Final mean /leaf compared with control. Where, the imidacloprid treatment recorded the lowest Final mean /leaf1.6, followed by Abamectin which recorded 2.2. On the other side, the Congest 15% (Abamectin 2% +Imidacloprid 12%) treatment recorded the highest final mean numbers of *E. orientalis* /leaf 5.4. With respect to the grand reduction%, all tested pesticides achieved high reduction % , where, it ranged between (82.1 -90.0%). Abamectin, Imidacloprid and Fenpyroximate recorded the highest percent of *E. orientalis* reduction 90.0, 88.7 and 89.3%, respectively. On the other side, Congest 15% recorded the lowest reduction percent as 82.1%.

After the 2nd spray of 2022 season:

Data in Table 2 revealed that the final numbers of *E. orientalis* /leaf in all tested pesticides differed significantly than control. Imidacloprid recorded the lowest final numbers of mite /leaf 2.8, followed by Hexythiazox 3.0, Fenpyroximate 3.2 and Chlorfenapyr 4.0. As for grand reduction%, it was obvious that all tested pesticides achieved high reduction % of *E. orientalis* after three tested

Table 2. Effect of some pesticides on *Eutetranychus orientalis* at 2022 season in a citrus orchard.

Tested pesticides	Mean n of mites/ 10 leaf				Final mean /leaf ±SE	Reduction%			Grand R. %
	days after spraying					days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2022									
Fenpyroximate	187	22	24	30	3.0^{d} ±0.2	89.9	89.8	88.1	89.3 ^{a}
Hexythiazox	196	26	30	41	4.1^{c} ±0.2	88.6	87.8	84.5	86.3 ^{b}
Congest	187	32	41	54	5.4^{b} ±0.2	85.3	82.5	78.5	82.1 ^{d}
Spirodiclofen	189	31	40	40	4.0^{c} ±0.3	85.9	83.1	79.6	84.3 ^{c}
Abamectin	193	30	39	26	2.6^{d} ±0.2	86.6	83.9	81.1	90.0 ^{a}
Imidacloprid	192	23	42	16	1.6^{e} ±0.2	89.7	82.5	93.8	88.7 ^{a}
Chlorfenapyr	200	27	34	45	4.5^{c} ±0.2	88.4	86.4	83.3	86.0 ^{b}
Control	194	225	243	261	26.1^{a} ±0.4	-	-	-	-
LSD (0.05%)					0.83				1.4
2nd spray 2nd May, 2022									
Fenpyroximate	167	21	24	32	3.2^{c} ± 0.1	88.1	87.5	83.5	86.4 ^{a}
Hexythiazox	153	21	22	30	3.0^{c} ±0.3	87.0	87.5	83.1	85.9 ^{a}
Congest	151	22	25	52	5.2^{b} ±0.2	86.2	88.4	70.3	81.6 ^{d}
Spirodiclofen	179	21	27	52	5.2^{b} ± 0.1	88.9	86.9	74.9	83.6 ^{c}
Abamectin	169	18	26	35	3.5^{b} ±0.3	89.9	89.2	82.1	87.1 a
Imidacloprid	191	37	44	28	2.8^{c} ±0.2	81.7	83.9	87.3	84.3 ^{b}
Chlorfenapyr	172	23	26	40	4.0^{c} ±0.3	87.4	86.9	79.9	84.7 ^{b}
Control	241	255	277	279	27.9^{a} ±0.6	-	-	-	-
LSD (0.05%)					0.89				1.00

The different letters for each stage means significant difference at 5% level .

Table 3. Effect of some pesticides on *Eutetranychus orientalis* at 2023 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean / leaf ±SE	Reduction%			Grand R. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2023									
Fenpyroximate	162	18	21	29	2.9^{c}± 0.2	90.0	89.4	86.1	88.5 ^{a}
Hexythiazox	186	21	23	43	4.3^{bc}±0.2	89.8	89.9	82.1	87.3 ^{b}
Congest	182	24	28	49	4.9^{c}±0.2	88.1	87.5	79.1	84.9 ^{c}
Spirodiclofen	181	20	23	43	4.3^{bc}±0.2	90.0	89.6	81.6	87.1 ^{b}
Abamectin	174	19	28	30	3.0^{d}±0.2	92.7	86.9	86.6	88.7 ^{a}
Imidacloprid	192	25	29	28	2.8^{e}±0.2	88.2	87.7	88.7	88.2 ^{a}
Chlorfenapyr	171	22	25	35	3.5^{b}±0.3	88.4	88.1	84.1	86.7 ^{b}
Control	190	210	233	245	24.5^{a} ±0.5	-	-	-	-
LSD (0.05%)					0.88				0.8
2nd spray 2nd May, 2023									
Fenpyroximate	202	26	35	47	4.7^{c}±0.3	88.9	85.7	82.6	85.7 ^{b}
Hexythiazox	199	31	42	52	5.2^{bc}±0.1	86.5	82.6	84.3	84.4 ^{c}
Congest	198	39	50	61	6.1^{b}±0.4	83.0	79.2	77.0	79.7 ^{e}
Spirodiclofen	183	34	42	55	5.5^{bc}±0.3	83.9	81.1	77.6	80.9 ^{d}
Abamectin	190	23	25	32	3.2^{d}±0.1	89.5	89.2	87.4	88.7 ^{a}
Imidacloprid	190	40	45	22	2.2^{e}±0.1	81.8	80.5	91.4	84.6 ^{c}
Chlorfenapyr	190	27	32	45	4.5^{c} ±0.3	87.7	86.1	82.3	85.4 ^{b}
Control	200	231	243	268	26.8^{a}±0.6	-	-	-	-
LSD (0.05%)					0.87				0.68

The different letters for each stage means significant difference at 5% level .

periods, where Abamectin recorded the highest reduction as 87.1%, followed by Fenpyroximate 86.4% and Hexythiazox 85.9 5, whereas, Congest 15% recorded the lowest grand reduction as 81.6%.

After the 1st spray of 2023 season:

The data in Table 3 represented the effect of tested pesticides on *E. orientalis* in a citrus orchard at 2023 season by two sprays after 3, 7 and 14 days of pesticides application.

The obtained data in Table 3 revealed that there were significant differences between all tested pesticides and control in the final numbers of *E. orientalis* /leaf compared with control. Where, imidacloprid recorded the lowest *E. orientalis* numbers as 2.2 /leaf , followed by Imidacloprid 3.2 whereas, the Congest 15% recorded the highest final numbers /leaf as 6.1**.** With respect to the grand reduction of *E. orientalis*, all tested pesticides achieved high reduction %, where, Abamectin, Imidacloprid and Fenpyroximate recorded the highest reductions as 88.5, 88.7 and 88.2%, respectively. On the other side, Congest 15% recorded the lowest reduction percentage as 84.9%.

After 2nd spray of 2023 season:

The data in Table 3 show the effect of tested acaricides on *E. orientalis* numbers after 2nd spray at season 2023. The obtained data revealed that the final mean numbers/leaf in all tested pesticides significantly differed compared to control. Imidacloprid recorded the lowest final mean /leaf 2.2, followed by Abamectin 3.2, whereas, Congest 15% recorded the highest numbers 6.1/ leaf. As for grand reduction%, it was obvious that all tested pesticides achieved high mean reduction % of *E. orientalis* after three tested periods of observation, where Abamectin recorded the highest reduction as 88.7%, followed by Fenpyroximate and Chlorfenapyr which recorded grand reduction as 85.7 and 85.4%, respectively, whereas, Congest 15% recorded the lowest grand reduction as 79.7%.

Generally, the obtained results revealed that the final mean numbers of *E. orientalis* /leaf significantly differed in all treatments compared with control, in addition all tested pesticides recorded high mean reduction % after 1st and 2nd sprays along the two seasons. Moreover, Abamectin induced the highest reduction % after 1st and 2nd sprays at the two seasons. On the other side, Congest 15% recorded the lowest final mean numbers of *E. orientalis* /leaf and the lowest reduction % after 1st and 2nd sprays along the two seasons.

2 - Side effects of tested pesticides on predatory mite, *Euseius scutalis* along 2022 and 2023 seasons:

The data in Tables 4, 5 show the side effects of two sprays of tested pesticides on *Euseius scutalis* in a citrus orchard at 2022 and 2023 seasons, after 3, 7 and 14 days of spraying.

After the 1st spray of 2022 season:

The obtained data in Table 4 revealed that there were significant differences in the final mean numbers of *E. scutalis* /leaf after 1st spray between the tested pesticides and control. Imidacloprid recorded the lowest final mean numbers of *E. scutalis* /leaf as 0.2 compared with other tested compounds and control.

Table 4. Effect of some pesticides on *Euseius scutalis* at 2022 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean/leaf ±SE	Decrease %			Grand D. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2022									
Fenpyroximate	27	26	25	22	2.2^{b}±0.1	7.0	19.0	32.9	19.6 ^{e}
Hexythiazox	24	23	21	19	1.9^{b}±0.2	7.5	23.4	34.8	21.9 ^{d}
Congest	20	17	15	13	1.3^{b}±0.2	17.9	25.6	42.4	28.6 ^{b}
Spirodiclofen	19	18	17	17	1.7^{b}±0.2	8.5	21.7	26.3	18.8 ^{e}
Abamectin	18	17	16	16	1.6^{b}±0.2	8.8	36.1	26.8	23.9 ^{c}
Imidacloprid	12	6	4	2	0.2^{c}±0.06	51.7	70.8	86.3	69.6 ^{a}
Chlorfenapyr	19	18	16	17	1.7^{b}±0.1	8.5	26.3	20.4	18.4 ^{e}
Control	28	29	32	34	3.4^{a}±0.2	-	-	-	-
LSD (0.05%)					0.62				1.4
2nd spray 2nd May, 2022									
Fenpyroximate	22	21	23	25	2.5^{b}±0.2	18.7	14.1	15.7	16.2 ^{d}
Hexythiazox	21	20	20	21	2.1^{bc}±0.05	18.9	21.8	25.8	22.1 ^{c}
Congest	17	17	16	14	1.4^{d}±0.2	14.8	22.7	38.9	25.5 ^{b}
Spirodiclofen	20	19	18	19	1.9^{c}±0.2	19.1	26.1	29.5	21.6 ^{c}
Abamectin	21	19	18	21	2.1^{bc}±0.06	22.9	29.6	25.8	26.1 ^{b}
Imidacloprid	18	9	8	5	0.5^{e}±0.1	57.4	63.5	79.4	66.8 ^{a}
Chlorfenapyr	19	18	17	18	1.8^{b}±0.1	19.3	26.5	29.7	25.2 ^{b}
Control	23	27	28	31	3.1^{a}±0.1	-	-	-	-
LSD (0.05%)					0.34				1.6

The different letters for each stage means significant difference at 5% level.

As for the grand decrease % of *E. scutalis* after 1st spray, it was clearly obvious that all tested pesticides were safely for *E. scutalis*, where the grand mean decrease % were ranged between 18.4 -28.6% except imidacloprid which recorded the highest grand mean decrease as 69.6%. On contrary, Chlorfenapyr, Spirodiclofen and Fenpyroximate recorded the lowest decrease % as 18.4, 18.8 and 19.6%, respectively.

After 2nd spray of 2022 season:

The obtained data in Table 4 revealed that the final mean numbers of *Euseius scutalis* /leaf differed significantly between all tested pesticides and control after the 2nd spray. Imidacloprid recorded the lowest final mean numbers of *Euseius scutalis* /leaf as 0.5 compared with other tested compounds and control.

As for grand mean decrease % of *E. scutalis*, it was clearly obvious that all tested pesticides were safely for *E. scutalis*, where the grand mean decrease % ranged between 16.2 -26.1% except imidacloprid which recorded the highest grand mean decrease % as 66.8% after 2nd spray. On contrary Fenpyroximate recorded the lowest decrease 16.2%.

After the 1st spray of 2023 season:

The data in Table 5 show the side effects of tested pesticides on *E. scutalis* in a citrus orchard at 2023 season during two sprays after 3, 7 and 14 days of spraying.

The obtained data in Table 5 revealed that there were significant differences in final mean of *E. scutalis* /leaf between all tested pesticides and control after the 1st spray. Imidacloprid recorded the lowest final mean of *E. scutalis* numbers /leaf as 0.8 compared with other tested compounds and control.

As for grand decrease % of *E. scutalis* after the 1st spray, it was clearly obvious that all tested pesticides were safely for *E. scutalis*, where the grand mean decrease % ranged between15.3 - 29.1% except imidacloprid which recorded the highest grand decrease as 63.4%. On contrary, Fenpyroximate and Hexythiazox recorded the lowest decrease % as 15.3 and 19.0%, respectively.

After the 2nd spray of 2023 season:

The obtained data in Table 5 revealed that the final mean numbers of *E. scutalis* /leaf differed significantly between all tested pesticides and control after the 2nd spray. Imidacloprid recorded the lowest final mean numbers of *E. scutalis* /leaf as 0.5 compared with other compounds and control.

As for the grand mean decrease % of *E. scutalis*, it was clearly obvious that all tested pesticides were safely for *E. scutalis*, where the grand mean decrease % were ranged between 19.6 -32.0% except imidacloprid which recorded the highest grand decrease as 64.4% after the 2nd spray. On contrary, Chlorfenapyr recorded the lowest decrease as 19.6%.

It was obvious that grand mean decrease % of *E. scutalis* numbers were increased after the 2nd spray more than the 1st spray, but the tested pesticides remain safely for the predatory mite, *E. scutalis.*

3 - Side effects of tested pesticides on the predatory mite, *Amblyseius swirskii* along 2022 and 2023 seasons:

The data in Tables 6 and 7 show the side effects of two sprays of tested pesticides on *Amblyseius swirskii* in a citrus orchard after 3, 7 and 14 days of spraying at 2022 and 2023 seasons.

Table 5. Effect of some pesticides on ***Euseius scutalis*** at 2023 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean / leaf ±SE	Decrease %			Grand D. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2023									
Fenpyroximate	21	20	22	24	2.4^{b}±0.3	15.3	16.2	14.3	15.3 ^{d}
Hexythiazox	23	22	22	25	2.5^{b}±0.5	15.0	23.5	18.5	19.0 ^{c}
Congest	19	18	16	16	1.6^{c}±0.2	15.8	32.6	36.8	28.4 ^{b}
Spirodiclofen	22	21	19	18	1.8^{c}±0.2	15.2	30.9	38.6	28.2 ^{b}
Abamectin	18	17	16	14	1.4^{c}±0.2	16.1	28.9	41.7	28.9 ^{b}
Imidacloprid	21	10	9	8	0.8^{d}±0.2	57.7	65.7	66.7	63.4 ^{a}
Chlorfenapyr	20	19	18	15	1.5^{c}±0.2	15.6	28.0	43.8	29.1 ^{b}
Control	24	27	30	32	3.2^{a}±0.2	-	-	-	-
LSD (0.05%)					0.27				2.0
2nd spray 2nd May, 2023									
Fenpyroximate	29	28	26	21	2.1^{b}±0.1	9.5	20.9	39.7	23.4 ^{de}
Hexythiazox	22	21	18	17	1.7^{c}±0.2	10.5	27.8	35.6	24.6 ^{d}
Congest	21	20	16	12	1.2^{c}±0.2	10.7	32.8	52.4	32.0 ^{b}
Spirodiclofen	17	16	15	14	1.4^{c}±0.2	11.8	22.2	31.4	21.8 ^{e}
Abamectin	19	18	15	14	1.4^{c}±0.2	11.2	30.3	38.6	26.7 ^{c}
Imidacloprid	15	7	6	5	0.5^{d}±0.2	56.3	64.7	72.2	64.4 ^{a}
Chlorfenapyr	22	21	18	16	1.6^{c}±0.2	10.5	27.8	20.5	19.6 ^{f}
Control	30	32	34	36	3.6^{a}±0.3	-	-	-	-
LSD (0.05%)					0.37				2.9

The different letters for each stage means significant difference at 5% level.

Table 6. Effect of some pesticides on *Amblyseius swirskii* at 2022 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean / leaf ±SE	Decrease %			Grand D. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2022									
Fenpyroximate	18	17	16	14	1.4^{b}±0.2	0.3	15.6	29.6	15.2 ^{e}
Hexythiazox	16	15	15	14	1.4^{b}±0.2	1.0	10.9	20.8	10.9 ^{f}
Congest	20	18	14	12	1.2^{b}±0.1	5.0	33.5	45.7	28.1 ^{b}
Spirodiclofen	17	16	13	12	1.2^{b}±0.1	0.7	27.4	36.1	21.4 ^{c}
Abamectin	19	17	16	14	1.4^{b}±0.2	5.6	20.0	33.3	19.6 ^{d}
Imidacloprid	21	12	10	6	0.6^{c}±0.2	39.7	45.8	74.2	53.2 ^{a}
Chlorfenapyr	21	18	17	16	1.6^{b}±0.2	9.5	23.1	31.1	21.2 ^{c}
Control	19	18	20	21	2.1^{a}±0.2	-	-	-	-
LSD (0.05%)					0.31±				1.04
2nd spray 2nd May, 2022									
Fenpyroximate	16	15	14	13	1.3^{b}±0.2	14.1	23.0	36.2	24.4 ^{e}
Hexythiazox	18	17	15	14	1.4^{b}±0.2	13.4	26.7	38.9	26.3 ^{d}
Congest	16	15	12	11	1.1^{b}±0.1	14.1	34.0	46.0	31.4 ^{b}
Spirodiclofen	13	12	10	10	1.0^{b}±0.1	15.4	32.3	39.6	29.1 ^{c}
Abamectin	17	16	14	13	1.3^{b}±0.1	13.7	27.5	39.9	27.0 ^{d}
Imidacloprid	12	6	4	3	0.3^{c}±0.1	54.2	70.7	80.4	68.4 ^{a}
Chlorfenapyr	19	18	15	14	1.4^{b}±0.2	13.2	30.5	42.1	28.6 ^{c}
Control	22	24	25	28	2.8^{a}±0.3	-	-	-	-
LSD (0.05%)					0.35				1.6

The different letters for each stage means significant difference at 5% level.

Table 7. Effect of some pesticides on *Amblyseius swirskii* at 2023 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean / leaf ±SE	Decrease %			Grand D. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2023									
Fenpyroximate	14	12	11	11	1.1^{c}±0.1	19.1	21.4	29.7	32.4 ^{c}
Hexythiazox	15	14	13	12	1.2^{bc}±0.2	11.9	13.3	28.4	19.0 ^{e}
Congest	18	13	12	11	1.1^{c}±0.1	31.8	33.3	31.7	32.3 ^{c}
Spirodiclofen	20	18	17	16	1.6^{ab}±0.2	15.0	15.0	28.4	19.5 ^{e}
Abamectin	16	14	12	12	1.2^{bc}±0.2	17.4	25.0	32.9	25.1 ^{d}
Imidacloprid	18	10	9	7	0.7^{d}±0.2	47.5	50.0	65.2	54.2 ^{a}
Chlorfenapyr	20	16	15	14	1.4^{bc}±0.2	24.4	25.0	37.4	38.9 ^{b}
Control	17	18	17	19	1.9^{a}±0.2	-	-	-	-
LSD (0.05%)					0.31				1.54
2nd spray 2nd May, 2023									
Fenpyroximate	19	17	15	15	1.5^{bc}±0.2	14.4	27.6	33.2	25.1 ^{d}
Hexythiazox	16	15	14	14	1.4^{bc}±0.1	10.3	19.8	26.0	18.7 ^{f}
Congest	18	13	12	11	1.1^{c}±0.1	30.9	38.9	48.3	39.4 ^{b}
Spirodiclofen	17	14	14	13	1.3^{bc}±0.2	21.2	24.5	35.3	27.0 ^{c}
Abamectin	13	12	10	11	1.1^{c}±0.1	11.7	29.5	28.4	23.2 ^{e}
Imidacloprid	12	7	6	6	0.6^{d}±0.2	44.2	54.2	57.7	50.3 ^{a}
Chlorfenapyr	20	17	16	17	1.7^{b}±0.2	18.7	26.7	28.1	24.5 ^{d}
Control	22	23	24	26	2.6^{a}±0.3	-	-	-	-
LSD (0.05%)					0.31				1.2

The different letters for each stage means significant difference at 5% level.

After the 1st spray of 2022season:

The obtained data in Table 6 revealed that there were significant differences in final mean numbers of *A. swirskii* /leaf between the tested pesticides and control after the 1st spray. Imidacloprid recorded the lowest final mean numbers of *A. swirskii* /leaf as 0.6 compared with other tested compounds and control.

As for the grand mean numbers of *A. swirskii* decrease % after the 1st spray, it was clearly obvious that all tested pesticides were safely for *A. swirskii,* where the grand mean decrease % ranged between 24.4 -31.4% except imidacloprid which recorded the highest grand mean decrease as 63.4%. On the other side, Hexythiazox recorded the lowest grand mean decrease as 10.9%.

After the 2nd spray of 2022 season:

The obtained data in Table 6 revealed that the final mean numbers of *A. swirskii* /leaf differed significantly between all tested pesticides and control after the 2nd spray. Imidacloprid recorded the lowest final mean numbers of *A. swirskii* /leaf as 0.3 compared with other tested compounds and control.

As for grand mean decrease % of *A. swirskii*, it was clearly obvious that all tested pesticides were safely for *A. swirskii* numbers, where the grand mean decrease % were ranged between 19.6 -32.0% except imidacloprid which recorded the highest grand mean decrease as 68.4% after the 2nd spray. On contrary Fenpyroximate recorded the lowest decrease as 24.4%. It was obvious that grand mean decrease % of *A. swirskii* numbers were increased after the 2nd spray more than the 1st spray but the tested pesticides remain safely for *A. swirskii.*

After the 1st spray of 2023 season:

The obtained data in Table 7 revealed that there were significant differences in final mean numbers of *A. swirskii* /leaf between the tested pesticides and control after the 1st spray. Imidacloprid recorded the lowest final mean numbers of *A. swirskii* /leaf as 0.7 compared with other tested compounds and control.

As for the grand mean decrease % of *A. swirskii* after the 1st spray, it was clearly obvious that all tested pesticides were safely for *A. swirskii,* where the grand mean decrease % ranged between19 - 38.9% except imidacloprid which recorded the highest grand mean decrease as 54.2%. On the other side, Hexythiazox and Spirodiclofen recorded the lowest grand mean decrease as 19 and 19.5%.

After the 2nd spray of 2023 season:

As shown in Table 7 Imidacloprid recorded the lowest final mean numbers of *A. swirskii* /leaf as 0.6 compared with other tested compounds and control.

As for grand mean decrease % of *A. swirskii* numbers, it was clearly obvious that all tested pesticides were safely for *A. swirskii*, where the grand mean decrease % ranged between 18.7 - 39.4% except imidacloprid which recorded the highest grand mean decrease as 50.03% after the 2nd spray. On contrary Hexythiazox recorded the lowest decrease as 18.7%. It was obvious that grand mean decrease % of *A. swirskii* of some tested pesticides were increased after the 2nd spray more than after the 1st spray but they remain safely for predatory mite, *A. swirskii.*

4 - Side effects of tested pesticides on the predatory mite, *Phytoseiulus persimilis* along 2022 and 2023 seasons:

The data in Tables 8 and 9 show the side effect of two sprays of tested pesticides on *Phytoseiulus persimilis* in a citrus orchard at 2022 season , after 3, 7 and 14 days of spraying.

After the 1st spray of 2022season:

The obtained data in Table 8 revealed that there were significant differences in final mean numbers of *Ph. persimilis* /leaf between tested pesticides and control after the 1st spray. Imidacloprid recorded the lowest final mean numbers of *Ph. persimilis* /leaf as 0.7 compared with other tested compounds and control.

As for the grand mean decrease % of *Ph. persimilis* after the 1st spray, it was clearly obvious that all tested pesticides were safely for *Ph. persimilis,* where the grand mean decrease % were ranged between17-33.8% except imidacloprid which recorded the highest grand mean decrease as 51.8%. On the other side, Fenpyroximate and Abamectin recorded the lowest grand mean decrease as 17%.

After the 2nd spray of 2022 season:

As shown in Table 8 Imidacloprid recorded the lowest final mean numbers of *Ph. persimilis* /leaf as 0.8 compared with other tested compounds and control.

As for grand mean decrease % of *Ph. Persimilis* numbers, it was clearly obvious that all tested pesticides were safely for *Ph. persimilis*, where the grand mean decrease % were ranged between 20.4 - 34.8% except imidacloprid which recorded the highest grand mean decrease as 49.8% after the 2nd spray. On contrary Fenpyroximate recorded the lowest decrease as 20.4%. It was obvious that grand mean decrease %of *Ph. persimilis* of some tested pesticides were increased after the 2nd spray more than the 1st spray but they remain safely for *Ph. persimilis.*

After the 1st spray of 2023 season:

The obtained data in Table 9 revealed that there were significant differences in final mean numbers of *Ph. persimilis* /leaf between the tested pesticides and control after the 1st spray. Imidacloprid recorded the lowest final mean numbers of *Ph. persimilis* /leaf as 0.8 compared with other tested compounds and control.

As for the grand mean decrease % of *Ph. persimilis* after the 1st spray, it was clearly obvious that all tested pesticides were safely for *Ph. persimilis,* where the grand mean decrease % were ranged between 24.3 -39% except imidacloprid which recorded the highest grand mean decrease as 56.5%. On the other side, Fenpyroximate recorded the lowest grand mean decrease as 24.3%.

After the 2nd spray of 2023 season:

As shown in Table 9 Imidacloprid recorded the lowest final mean numbers of *Ph. persimilis* /leaf as 0.9 compared with other tested compounds and control Table 9.

Regarding to the grand mean decrease % of *Ph. persimilis* numbers (Table 9), it was clearly obvious that all tested pesticides were safely for *Ph. Persimilis* numbers, where the grand mean decrease % were ranged between20.2 - 28.9% except imidacloprid which recorded the highest grand mean decrease as 48.4% after the 2nd spray. On contrary Spirodiclofen recorded the lowest decrease as 20.2%. It was obvious that grand mean decrease % of *Ph. persimilis* of tested pesticides were decreased after the 2nd spray more than after the 1st spray but they remain safely for predatory mite, *Ph. persimilis.*

Table 8. Effect of some pesticides on *Phytoseiulus persimilis* at 2022 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean / leaf ±SE	Decrease %			Grand D. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2022									
Fenpyroximate	17	16	15	15	1.5^{b}±0.2	10.0	15.6	25.3	17.0 ^{f}
Hexythiazox	19	18	16	16	1.6^{b}±0.2	9.4	19.5	28.7	19.2 ^{e}
Congest	20	16	14	13	1.3^{b}±0.2	23.5	33.0	45.0	33.8 ^{b}
Spirodiclofen	16	15	13	12	1.2^{b}±0.2	10.3	22.3	36.5	23.0 ^{c}
Abamectin	20	19	18	17	1.7^{b}±0.2	9.1	13.9	28.1	17.0 ^{f}
Imidacloprid	16	10	8	7	0.7^{c}±0.2	40.2	52.2	63.0	51.8 ^{a}
Chlorfenapyr	19	18	16	15	1.5^{b}±0.2	9.4	19.5	33.2	20.7 ^{d}
Control	22	23	23	26	2.6^{a}±0.3	-	-	-	-
LSD (0.05%)					0.47				1.07
2nd spray 2nd May, 2022									
Fenpyroximate	19	18	16	15	1.5^{b}±0.2	9.1	22.3	29.8	20.4 ^{f}
Hexythiazox	17	15	14	14	1.4^{b}±0.2	15.3	24.0	26.8	22.0 ^{e}
Congest	18	14	12	12	1.2^{bc}±0.2	25.3	38.5	40.7	34.8 ^{b}
Spirodiclofen	20	18	16	15	1.5^{b}±0.2	13.6	26.2	33.3	24.4 ^{d}
Abamectin	17	15	12	13	1.3^{bc}± 0.2	15.3	34.8	32.0	27.4 ^{c}
Imidacloprid	16	10	8	8	0.8^{c} ±0.2	40.0	53.9	55.6	49.8 ^{a}
Chlorfenapyr	21	20	16	15	1.5^{b}±0.2	8.6	29.7	36.5	24.9 ^{d}
Control	24	25	26	27	2.7^{a}±0.2	-	-	-	-
LSD (0.05%)					0.43				1.2

The different letters for each stage means significant difference at 5% level.

Table 9. Effect of some pesticides on *Phytoseiulus persimilis* at 2023 season in a citrus orchard.

Tested pesticides	Mean n. of mites/ 10 leaf				Final mean / leaf ±SE	Decrease %			Grand D. %
	Days after spraying					Days after spraying			
	0	3	7	14		3	7	14	
1st spray 1st April , 2023									
Fenpyroximate	16	15	14	14	1.4^{b}±0.2	14.4	26.5	31.9	24.3 ^{e}
Hexythiazox	19	18	15	16	1.6^{b}±0.2	13.5	33.7	34.5	27.3 ^{cd}
Congest	19	15	14	12	1.2^{bc}±0.2	27.9	38.1	50.9	39.0 ^{b}
Spirodiclofen	17	16	15	13	1.3^{bc}±0.2	14.1	25.9	40.5	26.8 ^{d}
Abamectin	20	19	17	16	1.6^{b}±0.3	13.3	28.6	37.8	26.6 ^{d}
Imidacloprid	21	14	10	8	0.8^{c}±0.2	39.1	60.0	70.4	56.5 ^{a}
Chlorfenapyr	17	16	14	13	1.3^{bc}±0.2	14.1	30.8	40.5	28.5 ^{c}
Control	21	23	25	27	2.7^{a}±0.2	-	-	-	-
LSD (0.05%)					0.39				1.22
2nd spray 2nd May, 2023									
Fenpyroximate	18	16	14	13	1.3 ^{bc}±0.2	14.7	28.2	30.7	24.5 ^{c}
Hexythiazox	17	15	14	13	1.3^{bc}±0.2	15.3	24.0	26.6	22.0 ^{e}
Congest	20	16	15	14	1.4^{b}±0.2	23.2	30.8	32.8	28.9 ^{b}
Spirodiclofen	19	17	16	15	1.5^{b}±0.2	14.1	22.3	24.2	20.2 ^{f}
Abamectin	21	18	17	16	1.6^{b}±0.3	17.7	25.3	26.9	23.3 ^{d}
Imidacloprid	19	12	10	9	0.9^{c}±0.2	39.4	51.4	54.5	48.4 ^{a}
Chlorfenapyr	20	18	16	15	1.5^{b}±0.2	13.6	26.2	28.0	22.6 ^{de}
Control	24	25	26	25	2.5^{a}±0.2	-	-	-	-
LSD (0.05%)					0.33				1.02

The different letters for each stage means significant difference at 5% level.

Generally, all tested pesticides were effective for the safety of the tested predatory mites except imidacloprid which was effective against *Eutetranychus orientalis* and harmful on predatory mites. Although there are few studies recorded the effect of acaricides against *E. orientalis*.

5. Discussion

The obtained results are in agreement with Márquez et al. (2006) recorded that the mortality of *E. orientalis* were decreased to 100, 98.85, 85.05, 83.92 and 100%, and to 97.82, 85.92, 81.87, 100 and 100% after one week of exposure to Dicofol, Propargite, Hexitiazox, Etoxazol and Fenpyroximate on Valencia-late orange crops and Fine lemon, respectively. Debach and Rosen (1991) found that all components, in particular Abamectin and fenpyroximate, were effective against *E. orientalis*, without side effect on *E. scutalis* population under field conditions. Karmate and Chandele (1997) reported that abamectin was very effective in reducing the mite population in different crops Chandra Shekar et al., (2008) also reported that abamectin is the best insecticide for the management of mites in grapes. Mani et al., (2003), Anand Kumar (2002), Singh et al., (2004) and Roopa (2005) found that Abamectin, spirotetramat, Difenthiuron were superior over the old conventional acaricide sulphur. Alhewairini (2018) reported that the populations of *E. orientalis* reduced to 76.68 and 79.56% and to 78.52 and 80.12% after one-week exposure to the recommended dose of Abamectin and Bifenthrin under field and laboratory conditions, respectively. Kumari et al. (2019) reported that among the tested pesticides Abamectin @ 0.30 ml/l was effective in the management of Two species viz., *Tetranychus urticae,* and *Eutetranychus orientalis* in grapes with reduction percent 80.65% of mites compared with control after 10 days of second spray. Abdel Razik and Heikal (2019) found that Abamectin 1% +Thiamethoxam 9% was very toxic to *T. urticae* and safer for predacious mite, *Phytoseiulus persimilis*, Fenpyroximate was very toxic to *T. urticae* and safe for *P. persimilis* until 7 days of treatment under laboratory conditions. Al-amin et al. (2020) evaluated the effect of these seven acaricides against *E. orientalis* under field conditions and found that a total reduction % of were 88.26%, 90.40%, 87.99%, 88.91%, 88.78%, 88.41% and 87.82% and on *E. scutalis* were 23.69%, 19.61%, 14.33%, 12.7%, 15.52%, 16.51% and 15.33%, respectively. Abamactin 5% was significantly higher than other acaricides followed by Fenpyroximate 5% EC and Fenpyroximate 5% SC. Acaricides can be used against *E. orientalis* without affecting *E. scutalis*.

6. Conclusion

The tested seven pesticides (six acaricides and one insecticide) at recommended dose were highly effective against Citrus Brown Mite *Eutetranychus orientalis* and were safely on Predatory Mites, *Euseius scutalis*, *Amblyseius swirskii*, *Phytoseiulus persimilis* under field conditions after two sprays along two seasons 2022 and 2023 except imidacloprid which was harmful for all predatory mites. it could be concluded that the tested six acaricides, Fenpyroximate, Hexythiazox , Abamectin2% +Imidacloprid 12% , Spirodiclofen, Abamectin, and Chlorfenapyr could be used in the Integrated Pest Management (IPM) programs for *Eutetranychus orientalis* under citrus orchard conditions.

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