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EFFICACY OF CERTAIN ACARICIDES AGAINST *Tetranychus urticae* AND THEIR SIDE EFFECTS ON NATURAL ENEMIES, *Phytoseiulus persimilis* AND *Stethorus gilvifrons*

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ABSTRACT

The objective of this study was conducted to determine the efficacy of five acaricides; Abamectin, Emamectin benzoate, Acequinocyl, Chlorfenapyr and Hexythiazox against *Tetranychus urticae* and its natural enemies, *Phytoseiulus persimilis* and *Stethorus gilvifrons*. The tested acaricides were arranged in a descending order of speed of action against *T. urticae* as follows: Abamectin, Emamectin benzoate, Acequinocyl, Chlorfenapyr and Hexythiazox with $LT_{50;}$ 1.77, 2.85, 3.16, 3.94and 4.55 days, however, the corresponding speed action index were 100.00, 62.11, 56.01, 44.92 and 38.90%, respectively. Concerning *P. persimilis*, Abamectin was the slowest Speed of action compared with other tested acaricides (LT_{50}= 4.31 days) followed by Acequinocyl, Emamectin benzoate, Chlorfenapyr and Hexythiazox with LT_{50}; 2.90, 1.78, 1.38 and 1.03 days and the corresponding speed action index of 23.90, 35.52, 57.87, 74.64 and 100.00 %, respectively. Also, Abamectin recorded the lowest Speed of action against *S. gilvifrons* (LT_{50}= 4.16 days) followed by Acequinocyl, Emamectin benzoate, Hexythiazox and Chlorfenapyr with LT_{50}; 2.81, 2.61, 1.89 and 1.85 days and the corresponding speed action index of 44.47, 65.84, 70.88, 97.88 and 100.00 %, respectively. Reviewing the obtained results, it can be noticed that Abamectin was the quickest in its action against *T. urticae* and the slowest against *P. persimilis* and *S. gilvifrons* compared with other tested acaricides. The efficacy of the tested acaricides on the population density of *T. urticae* could be arranged according to the general mean of reduction percentage in a descending order as follows: Abamectin, Acequinocyl, Hexythiazox, Emamectin benzoate and Chlorfenapyr which recorded 83.29, 66.06, 56.40, 53.02 and 25.67% reduction, respectively.

INTRODUCTION

The approach to improve the pest management, especially in the direction of integrated biological and chemical methods is to include the impact of natural enemies and pesticides. Therefore, the knowledge of the effects of pesticides on beneficial species for particular crops is very important. Integrating biological control with chemicals in the spider mite management programs is particularly attractive because biological control of these pests has been implemented successfully on various horticultural crops (Helle and Sabelis, 1985). The two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae) is a polyphagous mite that feeds on parenchym cells of many agricultural crops (Tomczyk and Kropczynska1985). Two important groups of spider mite predators are predatory mites (Acarina: Phytoseiidae) and coccinellid beetles of the genus Stethorus (Coleoptera: Coccinellidae) (Roy *et al*., 2005). Predatory mites of the family Phytoseiidae are effective as biological control agents in agricultural systems (Hoy *et al.,* 1983). *Phytoseiulus persimilis* Athias-Henriot, is worldwide used in biological control programs in the world (Gerson *et al.,* 2003).The predatory ladybird beetle, *Stethorus gilvifrons* (Mulsant) is a predator preying on different life stages of two-spotted spider mites (Hajizadeh *et al*.1992; Afshari *et al*. 2001; Kheradpir *et al*. 2006). Numerous acaricides are used to control this pest, and consequently it has developed resistance to several acaricides. *T. urticae* outbreaks are induced by a number of factors, frequently by the use of pesticides non-selective towards its natural enemies (McMurtry *et al.,* 1970). In recent years, different strategies have been developed to manage the two-spotted spider mite, *T. urticae* Koch (Bostanian *et al.,* 2003). Since resistance to acaricides in *T. urticae* spread rapidly, biological control tactics are crucial to manage spider mite populations (Gerson and Weintraub 2007). However, it is important to study the predators as natural enemies when considering control of *T. urticae*. Thus, some trials in laboratory and field to assess the effects of five acaricides against *T. urticae* and its natural enemies, *P. persimilis* and *S. gilvifrons* were conducted.

MATERIALS AND METHODS

Rearing prey mite

The two spotted spider mite, *T. urticae* was reared on kidney bean *(Phaseolus vulgaris* L.) planted in a greenhouse (3-4 weeks after germination), and maintained at 25 - 28°C, 40 - 60% RH with a photoperiod of 16 L: 8 D (h) Each population was colonized before experiments in the laboratory.

Rearing predators

The phytoseiid predator *P. persimilis* was reared in plastic tray (25 x 25 cm) placed in a plastic box (40 x 60 x 7 cm) containing water to prevent mite escape. Fresh kidney bean leaves heavily infested with prey were added to the tray every 1 or 2 days and old leaves were removed once a week. The *P. persimilis* rearing was conducted under laboratory conditions of 23 ± 2°C, 50–70% R.H. and L16:D8 photoperiod. The acarophagous Ladybird, *S. gilvifrons (Mulsant)* was reared as a predator of spider mites under the same conditions.

Acaricides and application

The tested active ingredients, their trade names, formulations and applied concentrations are listed in Table 1. All of the concentrations are within the range of recommended rate for field use.

Table 1: Tested acaricides:

Active ingredient	Trade Name	% a.i. and formulation	Concentration ml / 100 L water
Hexythiazox	Delta care	10% EC	50
Emamectin benzoate	Gentraxiem	5% SL	30
Acequinocyl	Canemite	15% SC	100
Abamectin	Agremic gold	8.4 % SC	60
Chlorfenapyr	Payerseed	36% SC	35

Speed of action of tested acaricides:

The leaf disk assay was conducted using method described earlier by Pree *et al.,* (1989). The kidney bean leaf disks (2.5 cm diameter) cut from seedlings grown in a glass house with no chemical usage were dipped in concentration suggested for field applications according to APC 2010, Egypt of the various acaricides for 30 seconds. The discs were put on wet cotton wool in petri-dish and kept under constant conditions ((25 ± 2^oC, $65 \pm 5\%$ RH and 16:8 photoperiod). Ten female adults (one day old) of *T. urticae* were transferred on each disk with a fine brush. Control disks were dipped in tap water. Tests were repeated 5 times for each treatment. Mortality of mites treated with acaricides in all tests was assessed at different time intervals during 7 days after treatment. Data were corrected according to Abbott formula (1925). The half lethal time values (LT_{50}) were computed by Ldp Line program (Finny 1971). Also, the speed action index was measured by comparing the tested compound with the quickest speed of action compound. The same technique was occurred with the two predators *P. persimilis* and *S. gilvifrons.*

Effect of tested acaricides on population density:

Each evaluated chemical was mixed with distilled water to achieve a solution of the desired concentration. A100 ml volume of each solution was sprayed onto kidney bean to run-off using a 200 ml hand trigger sprayer with adjustable nozzle set to mist position. Untreated plants were sprayed with distilled water. Three plants were used for each pot. The kidney been were planted in November 2014 and grown in 3.81cm in diameter plastic pots under field conditions. Drip irrigation and nutrients were applied uniformly to all plants and no pesticides were used prior to the experimental applications. The plants remained outdoors under field conditions. Each acaricide was applied at the concentration suggested for field applications according to APC 2010, Egypt. Alive *T. urticae* was counted and recorded at pre-spraying and after 3, 6, 10, 14, 17, 24 and 30 days of application. Lower surface of the leaves was examined carefully using stereomicroscope. Five replicates were used for each treatment and the control. Percentage of reduction was estimated according to the equation of Henderson and Tilton (1955).

Statistical analysis

Data of population density were subjected for one way analysis of variance (ANOVA), and the means were separated using Duncan's multiple range Test CoHort Software 2004.

RESULTS

I -Speed of action:

Speed of action of tested acaricides against adult *T. urticae, P. persimilis* and *S. gilvifrons* at the recommended rates at different time intervals days are documented in Tables 2, 3 and 4. Data in table 2 show that the speed of action of Abamectin was very fast. Within 1.77days after treatment with Abamectin, approximately half of all *T. urticae* adults were killed and after 5 days all *T. urticae* adults were killed, whereas Hexythiazox recorded the lowest speed of action (LT_{50} = 4.55 days). The tested acaricides were arranged in a descending order of speed of action (from the highest to the lowest speed of action) as follows: Abamectin, Emamectin benzoate, Acequinocyl, Chlorfenapyr and Hexythiazox with $LT_{50;}$ 1.77, 2.85, 3.16, 3.94 and 4.55 days, however, corresponding speed action index were 100.00, 62.11, 56.01, 44.92 and 38.90%, respectively.

Concerning Speed of action against the predatory mite *P. persimilis*, Data in Table 3 indicate that Abamectin was the slowest speed of action compared with other tested acaricides (LT_{50}= 4.31 days) followed by Acequinocyl, Emamectin benzoate, Chlorfenapyr and Hexythiazox with LT_{50}; 2.90, 1.78, 1.38 and 1.03 days and the corresponding speed action index were 23.90, 35.52, 57.87, 74.64 and 100.00 %, respectively.

Similarly, Data in Table 4 show that Abamectin recorded the lowest Speed of action against the insect predator *S. gilvifrons* (LT_{50}= 4.16 days) followed by Acequinocyl, Emamectin benzoate, Hexythiazox and Chlorfenapyr with LT_{50}; 2.81, 2.61, 1.89 and 1.85 days and the corresponding speed action index were 44.47, 65.84, 70.88, 97.88 and 100.00 %, respectively.

II - Field efficacy of the tested acaricides against *T. urticae*:

As shown in Table (5), all tested acaricides significant reduced the population density of the two spotted spider mite, *T. urticae* compared with control. Concerning the initial effect (after one day of spraying), Abamectin and Acequinocyl were the most striking, which caused 57.97 and 57.88% reduction, respectively. While the lowest effect obtained with Hexythiazox which caused 37.38% reduction in population density compared with control. Abamectin reached the highest efficacy at tenth day (92.73% reduction),

DISCUSSION

Reviewing the obtained results, it can be noticed that the speed of action of Abamectin was the quickest against *T. urticae* and the slowest against *P. persimilis* and *S. gilvifrons* than the other tested acaricides.

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Several investigators have found that exposure to abamectin residues does not have a significant effect on *P. persimilis* survival (Oomen *et al*., 1991; Shipp *et al*., 2000; Zhang and Sanderson, 1990). Abamectin causes significant mortality and reduction in the mobility and fecundity of *T. urticae* (Zhang and Sanderson, 1990). Residual activity of Abamectin is likely to decrease more quickly in outdoor environments than indoor environments (Wright *et al*., 1984). Selective use of acaricides may create a favorable situation for release of *P. persimilis* by reducing *T. urticae* to manageable levels, providing that other environmental conditions are suitable. While treatment with acaricides that have long residual toxicity may be required to suppress high-density of spider mite population, their use may promote spider mite resistance. Acaricides that have short residual toxicities can be used in combination with predators to reduce large population of spider mites, but the timing of application and predator release is critical (Osborne and petitt, 1985). Exposure to abamectin, Gowan 1725, hexythiazox, horticultural oil, neem oil, pyridaben and spinosad residues at typical rates did not cause *P. persimilis* mortality 24 hours after application. However, abamectin residue did result in significant mortality to adult *T. urticae* 3, 7 and 14 days after application (Cote *et al*., 2002). Al-Zoubi and Çobanoğlu (2007) reported that the combination of hexythiazox with releasing of *P. persimilis* gave well control on spider mite, *T. urticae* when compared with chemical and predatory mite alone under greenhouse conditions. Nadimi *et al.,* (2008) cited that the total effect values of all concentrations of hexythiazox were below the lower threshold thus it could be considered a harmless acaricide to this predatory mite. In contrast, the total effect of all concentrations of fenpyroximate, and field, as well as, one half the field concentration of abamectin were found toxic to predatory mite and above upper threshold. Al-Zoubi (2010) found that, Hexythiazox was evaluated as harmless after 24 hours and moderately harmful after 72 hours to *P. persimilis.* For this reason, hexythiazox is suggested to be suitable in IPM program and ensure the preservation of predatory strains into local agroecosystem. Sanatgar *et al*., 2011 cited that the overall conclusion shows that this acaricide can be used against *T. urticae* without inducing the adverse effect on population growth parameters of its predator, *P. persimilis*. Irigaray *et al.,* (2007) found that, Abamectin was slightly persistent, while Acequinocyl was short lived to *P. persimilis*.

The efficacy of the tested acaricides in this study could be arranged according to the general mean of reduction percentages of the population density of *T. urticae* in a descending order as follows: Abamectin, Acequinocyl, Hexythiazox, Emamectin benzoate and Chlorfenapyr they were 83.29, 66.06, 56.40, 53.02 and 25.67% reduction, respectively.

Abd-Elhady and Heikal (2011) evaluate the selectivity of three acaricides sprayed at 1 and 1/2 field recommended rate on apple orchards on motiles of both two-spotted spider mite *T. urticae* and its predator *P. persimilis*. Results showed that, fenpyroximate and abamectin were found to be very toxic to the predatory mite at recommended field rate after 30 days and unfavorably selective (more toxic to *P. persimilis*). In conclusion, fenpyroximate and abamectin should be used carefully in Integrated Pest

Management programs. Salman (2007) cited that, as far the possible side effect of tested pesticides on different stages of the insect predator, *S. gilvifrons*. The result evoked that hexythiazox, fenpyroximate and chlorfenapyr were less toxic to all predator stages (egg, larvae and adult) under Laboratory condition. Also, revealed that the same compounds appear highly initial kill against the two-spotted spider mite *T. urticae* on watermelon, eggplant and squash under field conditions. The reduction percentages were more than 90%. However, moderate effects on the predator *S. gilvifrons* were observed. Mortality didn't exceed more than sixteen's percentage. Fortunately the predator were more tolerant comparing with mite. Kim and Yoo (2002) Adult female predators survived on a diet of spider mites treated with bifenazate, acequinocyl, chlorfenapyr, flufenoxuron and fenbutatin oxide, and their fecundity, prey consumption and the sex ratio of the progeny were not substantially affected so, its acaricides appeared to be the promising candidates for usein integrated mite management programs where *P. persimilis* is the major natural enemy. Moreover, they reported that feeding on *T. urticae* intoxicated with abamectin reduced 50% of the reproductive rate of female *P. persimilis.* Abd El-Mageed *et al.,* (2013) reported that chlorfenapyr, ethion and etoxazole are much less toxic to *P. persimilis* adult females than to *T. urticae* adult females, and the difference between the compounds may be due to their mode of actions.

In addition, the predators alone may not be able to maintain spider mite population below an economic injury level for an extended period of time (Kim *et al.,* 1997; Ibrahim and Yee 2000). In the presence of chemical applications, biological control of spider mites may be achieved by the selective use of the pesticides that are more toxic to pest species than to natural enemies (Spollen and Isman 1996). Thus, selective acaricides are needed to adjust the prey/predator ratio and to maintain adequate long-term control efficacy. In many cases, the combined use of chemical and biological control might provide the best approach for both managing pest populations and minimizing selection for resistance (Gentz *et al*., 2010). The Integrated Pest Management (IPM) which is based on selective toxicity of the phytophagous mites and harmless to predatory mite, became the most relevant strategy of plant protection (Leake, 2000; Linquist, 2000 and Klassen, 2000).

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فعالية بعض المبيدات الأكاروسية ضد *Tetranychus urticae* وآثارها الجانبية على الاعداء الطبيعية *Phytoseiulus persimilis* و *Stethorus gilvifrons*

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اجريت هذه الدراسة بهدف تقييم فعالية خمسة مبيدات أكاروسية وهى ابامكتين، ايماميكتين بنزوات، اسيكوينوسيل، كلورفينابير و هيكسيثيازوكس ضد العنكبوت الأحمر ذو البقعتين *Tetranychus urticae* و العدويين الطبيعيين *Phytoseiulus persimilis* و *Stethorus gilvifrons*. رتبت المبيدات الاكاروسية المختبرة تنازلياً وفقاً لسرعة تأثيرها ضد *T. urticae* كالاتى: ابامكتين، ايماميكتين بنزوات، اسيكوينوسيل، كلورفينابير و هيكسيثيازوكس وكانت قيم الوقت النصفى المميت LT_{50} تساوى ١.٧٧ ، ٢.٨٥ ، ٣.١٦ ، ٣.٩٤ و ٤.٥٥ يوم بدليل سمية ١٠٠.٠٠ ، ٦٢.١١ ، ٥٦.٠١ ، ٤٤.٩٢ و ٣٨.٩٠% على التوالى. سجل ابامكتين أقل سرعة تأثير مقارنة بالمبيدات المختبرة على *P. persimilis* (LT_{50} = ٤.٣١ يوم) يليه اسيكوينوسيل، ايماميكتين بنزوات، كلورفينابير و هيكسيثيازوكس بقيم LT_{50} ٢.٩٠ ، ١.٧٨ ، ١.٣٨ ، و ١.٠٣ يوم بدليل سمية ٢٣.٩٠ ،٣٥.٥٢ ، ٥٧.٨٧ ، ٧٤.٦٤ و ١٠٠.٠٠% على التوالى. أيضاً سجل ابامكتين أقل سرعة تأثير ضد *S. gilvifrons* (LT_{50} = ٤.١٦ يوم) يليه اسيكوينوسيل، ايماميكتين بنزوات، هيكسيثيازوكس و كلورفينابير بقيم LT_{50} ٢.٨١ ، ٢.٦١ ، ١.٨٩ و ١.٨٥ يوم بدليل سمية ٤٤.٤٧ ، ٦٥.٨٤ ، ٧٠.٨٨ ، ٩٧.٨٨ و ١٠٠.٠٠% على التوالى. من خلال النتائج يمكننا ان نلاحظ أن مبيد ابامكتين كان الأسرع تأثيراً ضد *T. urticae* و الأبطأ تأثيراً ضد كل من *P. persimilis* و *S. gilvifrons* مقارنة بالمبيدات الأكاروسية الاخرى المختبرة. وبدارسة فعالية المبيدات المختبرة فى خفض الكثافة العددية للعنكبوت الأحمر ذو البقعتين يمكن ترتيبها تنازلياً كالتالى: ابامكتين، اسيكوينوسيل، هيكسيثيازوكس، ايماميكتين بنزوات و كلورفينابير بنسب خفض ٨٣.٢٩ ، ٦٦.٠٦ ، ٥٦.٤٠ ، ٥٣.٠٢ و ٢٥.٦٧% على التوالى.

Table 2: Comparison of Speed of action of tested acaricides at the recommended rates against *Tetranychus urticae* at different time intervals (days)

Tested compounds	Mean number and percent of mortality at different time intervals (days)																Lt_{50} (days) Confidence limits at 95%	SAI
	1		2		3		4		5		6		7		8			
	N	% M	N	% M	N	% M	N	% M	N	% M	N	% M	N	% M	N	% M		
Hexythiazox	9.80	0.00	8.60	10.42	7.80	17.02	6.00	34.78	4.40	52.17	2.60	71.74	1.20	86.05	0.00	100.00	4.55 4.19 4.96	38.90
Emamectin benzoate	9.00	8.16	7.20	25.00	4.80	48.94	3.20	65.22	1.60	82.61	0.40	95.65	0.00	100.00	0.00	100.00	2.85 2.54 3.15	62.11
Acequinocyl	9.40	4.08	7.80	18.75	5.80	38.30	3.20	65.22	1.60	82.61	0.80	91.30	0.00	100.00	0.00	100.00	3.16 2.86 3.46	56.01
Abamectin	7.80	20.41	4.00	58.33	2.80	70.21	0.40	95.65	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	1.77 1.51 2.01	100.00
Chlorfenapyr	9.60	2.04	8.20	14.58	7.00	25.53	5.80	36.96	3.60	60.87	1.40	84.78	0.40	95.35	0.00	100.00	3.94 3.17 4.78	44.92
Control	9.80		9.60		9.40		9.20		9.20		9.20		8.60		8.60			

LT_{50}: calculated according to Ldp-Line program;
SAI: Speed action index = Lt_{50} of the quickest speed of action compound/Lt_{50} of the tested compound ×100

Table 3: Comparison of Speed of action of tested acaricides at the recommended rates against *Phytoseiulus persimilis* at different time intervals (days)

Tested compounds	Mean number and percent of mortality at different time intervals (days)												Lt_{50} (days) Confidence limits at 95%	SAI
	1		2		3		4		5		6			
	N	% M	N	% M	N	% M	N	% M	N	% M	N	% M		
Hexythiazox	2.33	53.33	1.67	64.29	0.33	92.86	0.33	92.31	0.00	100.00	0.00	100.00	1.03 - -	100.00
Emamectin benzoate	3.33	33.33	2.67	42.86	1.33	71.43	0.67	84.62	0.00	100.00	0.00	100.00	1.78 - -	57.87
Acequinocyl	4.33	13.33	3.67	21.43	2.67	42.86	1.33	69.23	0.67	84.62	0.00	100.00	2.90 2.25 3.78	35.52
Abamectin	5.00	0.00	4.67	0.00	3.67	21.43	3.33	23.08	1.00	76.92	0.00	100.00	4.31 - -	23.90
Chlorfenapyr	3.33	33.33	1.67	64.29	0.33	92.86	0.00	100.00	0.00	100.00	0.00	100.00	1.38 0.85 1.81	74.64
Control	5.00		4.67		4.67		4.33		4.33		4.00			

LT_{50}: calculated according to Ldp-Line program;
SAI: Speed action index = Lt_{50} of the quickest speed of action compound/Lt_{50} of the tested compound ×100

Table 4: Comparison of Speed of action of tested acaricides at the recommended rates against *Stethorus gilvifrons* at different time intervals (days)

Tested Compounds	Mean number and percent of mortality at different time intervals (days)														Lt_{50} (days) Confidence limits at 95%	SAI
	1		2		3		4		5		6		7			
	N	% M	N	% M	N	% M	N	% M	N	% M	N	% M	N	% M		
Hexythiazox	4.00	20.00	2.67	46.67	1.00	78.57	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	1.89 - -	97.88
Emamectin benzoate	4.00	20.00	3.33	33.33	2.33	50.00	1.67	64.29	0.67	84.62	0.00	100.00	0.00	100.00	2.61 1.84 3.59	70.88
Acequinocyl	4.33	13.33	3.67	26.67	2.67	42.86	1.33	71.43	0.67	84.62	0.00	100.00	0.00	100.00	2.81 2.15 3.64	65.84
Abamectin	5.00	0.00	4.33	13.33	3.67	21.43	3.33	28.57	1.67	61.54	0.33	92.31	0.00	100.00	4.16 3.54 4.99	44.47
Chlorfenapyr	3.67	26.67	2.67	46.67	1.33	71.43	0.67	85.71	0.00	100.00	0.00	100.00	0.00	100.00	1.85 1.17 2.48	100.00
Control	5.00		5.00		4.67		4.67		4.33		4.33		4.33			

LT_{50}: calculated according to Ldp-Line program;
SAI: Speed action index = Lt_{50} of the quickest speed of action compound/Lt_{50} of the tested compound ×100

Table 5: Efficacy of the tested acaricides against *Tetranychus urticae* on kidney bean *Phaseolus vulgaris* L. under field conditions.

Treatment	Before spraying	Mean number and (Reduction %) after spraying									General mean number (Reduction %)
		Initial effect after 1 day	Residual effect							Mean of residual effect	
			3 days	6 days	10 days	14 days	17 days	24 days	30 days		
Hexythiazox	42.00 b	34.80 bc (37.38)	26.20 b (54.91)	17.40 b (73.15)	16.80 b (74.15)	15.00 bc (70.72)	22.60 cd (70.70)	39.40 b (48.18)	59.00 b (22.01)	28.06 bc (59.12)	28.9 b (56.40)
Emamectin benzoate	30.60 b	22.60 cd (44.19)	14.80 c (65.04)	15.60 b (66.96)	16.80 b (64.52)	15.60 bc (58.21)	33.60 bc (42.20)	24.80 c (55.23)	39.80 c (27.81)	23.00 cd (54.28)	22.95 c (53.02)
Acequinocyl	36.60 b	20.40 d (57.88)	14.60 c (71.17)	12.00 b (78.75)	13.40 b (76.34)	18.00 bc (59.68)	23.60 cd (64.88)	25.60 c (61.36)	27.40 c (58.45)	19.23 d (67.23)	19.38 cd (66.06)
Abamectin	65.80 a	36.60 b (57.97)	12.80 c (85.94)	8.40 b (91.73)	7.40 b (92.73)	12.00 c (85.05)	14.60 d (87.92)	12.60 c (89.42)	29.00 c (75.54)	13.83 e (86.90)	16.68 d (83.29)
Chlorfenapyr	24.40 b	19.00 d (41.15)	17.20 bc (49.05)	11.20 b (70.25)	16.40 b (56.56)	26.00 b (12.65)	43.40 b (3.13)	47.00 b (-6.40)	53.20 b (-21.01)	30.63 b (23.46)	29.18 b (25.67)
Control	46.40 ab	61.40 a	64.20 a	71.60 a	71.80 a	56.60 a	85.20 a	84.00 a	83.60 a	73.86 a	72.30 a
LSD 0.05	22.22	13.14	10.32	9.36	11.34	10.31	17.17	13.56	13.03	5.10	4.71

Values followed by the same letter (s) in a column are not significantly different according to Duncan's test at level 0.05.