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Efficacy and Residual Effect of Abamectin and Chlorpyrifos-Methyl against the Second Larval Instar of the Cotton Leafworm, *Spodoptera littoralis* (BOISD.) Under Field and Semi-Field Condition

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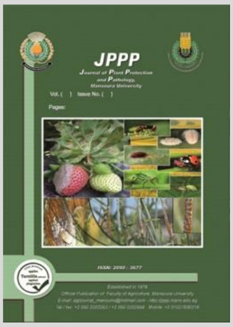

ABSTRACT

The initial mortality and residual effect of abamectin and chlorpyrifos-methyl against the second instar larvae of the leafworm, *Spodoptera littoralis* (Boisduval) and beneficial arthropods were evaluated on tomato crop during 2019 and 2020 growing seasons under field and semi field conditions.The obtained data were revealed that Chlorpyrifos-methyl gave 100% initial mortality one to five days in 2019 and one to three days in 2020 growing season after application when the recommended rate was used in both seasons.Also, abamectin expressed 100 and 96% initial mortality during the first 24 hr after application in 2019 and 2020 growing seasons, respectively.When the recommended rate was applied,abamectin and chlorpyrifos-methyl were completely lost their toxic residues after 7.55 and 18.39 in 2019 and7.64 and 16.77 days during 2020 growing season of field application, respectively.On the other hand, abamectin had negatively effection on the population of predators at the first day after application then the population was turned back to its normal abundance after 48hr, particularly with half of the recommended rate as well as the field rate of application in both seasons. However, chlorpyrifos-methyl was showed negative impact on the predators, which resulted 100% reduction of predators' population within 96 hr post application, and then the percentage reduction continuously increased till day 13 then it decreased starting from day 14.Therefore, it could be recommended that using abamectin for controling Lepidopterous pests on vegetables to minimize the pre-harvest interval, which makes these crops edible for human use shortly after treatment and also to preserve beneficial predators.

Keywords: Residual effect, Abamectin, Chlorpyrifos-methyl, *Spodoptera littoralis*, Field condition, Semi-field condition.

INTRODUCTION

The cotton leafworm, *Spodoptera littoralis* is serious pest attacks cotton plants during the growing season and causes severe damage to cotton and other crops such as tomato, soybean, sugar beet, and corn. One of the most economically important crops that attacked by *S. littoralis* is tomato. It is widely grown vegetables in the world (Dorais *et al.*, 2008). It constitutes a basic component of human diet in many countries around the world (Dorais *et al.*, 2008). Egypt considers the fifth largest tomato producer in the world with production of seven million tons each year (FAO, 2011).

The insecticidal effect of various pesticides was evaluated against cotton leafworm, *Spodoptera littoralis* (PPDB). Chlorpyrifos-methyl and abamectin have been chosen in this study because of their efficacy against wide range of plant pests. Chlorpyrifos-methyl is a well known pesticide belongs to the organophosphate group. It uses as insecticide and acaricide to control soil and foliage pests in grain, cotton, fruit, nuts and vegetables (Kang *et al.*, 2004). The active ingredient of chlorpyrifos-methyl has been classified as highly and slightly hazardous pesticides, respectively (WHO, 2010).

In addition, abamectin representing a novel family of natural products derived from the mycelia of a soil organism, *Streptomyces avermitilis* (Campelwl *et al.*, 1983). Putter *et al.*, (1981) described the structural formula of abamectin and reported that this isolate, although slow acting as a toxin at low dosages, adversely affected the reproduction of some insects. Abamectin has demonstrated activity against a range of insect pests, especially lepidopteran insects (Reed *et al.*, 1985; Beach and Todd, 1985; Christiep and Wrightd, 1990). It is important to know the efficacy of pesticides against the harmful pests, beneficial predators, and the pre-harvest intervals (PHI) before filed application. The degradation and residual behaviors of insecticides after their application may be affected by many factors such as plant species, insecticide chemical structure, and type of formulation, volatilization, application method, climate, and photo degradation (Garau *et al.*, 2002).

Therefore, the present study aimed to investigate the efficacy of abamectin and chlorpyrifos-methyl against 2nd instar larvae of leafworm, *S. littoralis* (Boisduval), and their persistence residues on tomato crop under field conditions. Also, determination of pre-harvest interval (PHI) for the tested pesticides.

MATERIALS AND METHODS

Expermintal design of field evaluation for abamectin and chlorpyrifos-methyl against cotton leafworm

Abamectin (commercially, named EVERKEN®, EC,1.8%) and chlorpyrifos-methyl (commercially, named RELDAN®, EC, 50%) were evaluated for its initial toxicity as well as the persistence of toxic residues using target pest (cotton leafworm) and non-target beneficial arthropods

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(predator populations) as indicators for the bioresiduality on tomato plants in two successive summer seasons of 2019 and 2020. Four pesticides rates for each compound were tested including 50. 100, 150, and 200% of the recommended field rate which referred to as 0.5X, 1X, 1.5X and 2.0X, respectively. Control treatment was received water instead of pesticides. The experiment was conducted on about 0.25 feddan was divided to 25 plots of 42 square meters each. Five plots were used for each treatment as replications and the replicates of each treatment were distributed in completely randomized block design.

Expermintal design of semi field evaluation for Abamectin and chlorpyrifos-methyl against second instar larvae of the cotton leafworm:

The pesticides were applied on tomato plants at previously described rates. Treated tomato leaves were collected daily after pesticides treatments, transferred to the laboratory and placed in 1/2kilogram glass jars, each provided with ten second instar larvae (five jars for each treatment). Treated leaves were enough for feeding larvae for two successive days. The efficacy of pesticides against 2nd instar larvae of cotton leafworm was evaluated daily on collected tomato leaves as mortality %. The evaluation was continued till day 8 for abamectin and 15 day for chlorpyrifos-methyl. The evaluation was ended on day 8 because the toxic residues of abamectin, even when it was used at the duplicated rate were ineffective against the 2nd instar larvae of cotton leafworm. The means of each treatment was compared between the 8 and 15 time intervals for abamectin and chlorpyrifos-methyl, respectively,

Effect of abamectin and chlorpyrifos-methyl against the predator populations:

Negative impact of abamectin and chlorpyrifos-methyl at different rates on predator populations was evaluated as predator population which was counted on 25 plants, randomly chosen from each plot. These counts were conducted just before starting the field treatment and repeated at daily intervals up to 8 days after abamectin field application and 15 days after chlorpyrifos-methyl field application. Reduction percentage of predator population was calculated according to the formula of Henderson and Tilton (1955).

% Reduction = (1- {n in Co before treatment * n in T after treatment / n in Co after treatment * n in T before treatment}) * 100

Where:

n = Insect population, C= Control, T= Treatment

Statistical analysis

Data was analyzed using analysis of variance followed Duncan Multiple Comparison test at 5% level of probability. For each time interval, control, abamectin and chlorpyrifos-methyl at different rates were statistically compared based on the least significant difference at 5% level of probability.

RESULTS AND DISCUSSION

A: Efficacy of abamectin and chlorpyrifos-methyl on the cotton leafworm

The obtained data revealed that abamectin significantly persists shorter than chlorpyrifos-methyl under field conditions in 2019 and 2020 growing seasons (Table 1 and 2). Mortality percentages of cotton leafworm larvae in control treatment ranged from 0.0 to 8.0% and from 0.0 to 10% in 2019 and 2020 seasons, respectively. Toxic residues of abamectin and chlorpyrifos-methyl on tomato foliages slightly increased as concentration increased. It is obvious that the (50% and 100%) recommended rate of abamectin gave (96% and 100%) and (94% and 96%) initial mortality (day 0) in 2019 and 2020 growing seasons, respectively. Moreover, it showed 100% initial mortality at (150% and 200%) recommended rates. after treatment in both seasons.

Table 1. Mortality percentages of cotton leafworm 2ndinstar larvae exposed to the residues of abamectin and chlorpyrifos-methyl on Tomato plants at daily intervals after application in 2019 Tomato growing season.

Rate of application		Mortality percentages (Mean ± SE) at daily intervals after spraying abamectin and chlorpyrifos-methyl at different rates during 2019 tomato growing season																LSR 0.05
		Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day10	Day11	Day12	Day13	Day14	Day15	
0.0X	chlorpyrifos-methyl	2.0 ± 1.57	2.0 ± 1.57	4.0 ± 3.35	4.0 ± 3.35	6.0 ± 4.37	6.0 ± 4.37	8.0 ±5.41	8.0± 5.41	6.0 ±4.37	6.0 ±4.37	2.0 ± 1.57	4.0 ± 3.35	2.0 ± 1.57	0.0	0.0	0.0	NS
	Abamectin	2.0 ± 1.57	4.0 ± 3.35	6.0 ± 4.37	8.0 ± 5.41	4.0 ± 3.35	2.0 ± 1.57	0.0	0.0	0.0	-	-	-	-	-	-	-	NS
0.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	96.0 ± 5.47	92.0 ± 8.37	86.0 ± 7.69	80.0 ±10.59	76.0 ± 8.54	68.0 ± 5.47	52.0 ± 4.37	32.0 ± 4.37	6.0 ± 4.37	4.0 ± 2.69	0.0	14.35
	Abamectin	96.0 ± 5.74	82.0 ± 8.37	58.0 ±14.83	26.0 ±18.17	6.0 ± 5.48	2.0 ± 4.48	2.0 ± 4.48	0.0	0.0	-	-	-	-	-	-	-	12.35
1.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	96.0 ± 9.26	92.0 ± 8.37	86.0 ± 7.37	80.0 ± 5.45	72.0 ± 4.26	60.0 ± 7.07	38.0 ± 6.26	6.0 ± 5.41	4.0 ± 1.57	0.0	17.37
	Abamectin	100.0 ± 0.0	88.0 ± 8.37	68.0 ± 7.47	32.0 ±13.03	12.0 ± 8.35	6.0 ± 5.45	4.0 ± 3.26	0.0	0.0	-	-	-	-	-	-	-	14.37
1.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	98.0 ± 5.47	96.0 ± 9.26	92.0 ± 8.37	86.0 ± 6.47	76.0 ± 6.17	64.0 ± 5.47	44.0 ± 7.07	12.0 ± 3.35	6.0 ± 2.41	0.0	18.61
	Abamectin	100.0 ± 0.0	100.0 ± 0.0	92.0 ±11.40	76.0 ± 7.07	52.0 ± 6.52	28.0 3.74	14.0 ± 2.45	4.0 ± 2.45	0.0	-	-	-	-	-	-	-	17.61
2.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	96.0 ± 9.26	90.0 ± 6.26	84.0 ± 7.37	66.0 ± 5.26	46.0 ± 4.23	14.0 ±11.45	8.0 ± 3.86	0.0	19.24
	Abamectin	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	84.0 ±10.00	68.0 ± 7.07	36.0 ± 8.37	18.0 ± 5.48	10.0 ± 4.54	0.0	-	-	-	-	-	-	-	17.24
LSD 0.05	chlorpyrifos-methyl	8.50	7.21	12.80	13.88	11.88	14.62	3.54	3.16	4.56	3.12	4.17	2.18	3.58	2.65	NS	NS	—
LSD 0.05	Abamectin	7.50	6.21	13.80	12.88	13.88	15.62	4.54	2.16	NS	-	-	-	-	-	-	-	—

For each row, Comparison based on Duncan Multiple Comparison test with the least significant range at 5% level of probability. Comparison within each column between different rates of abamectin and chlorpyrifos-methyl applications is based on LSD 0.05.

Table 2. Mortality percentages of cotton leafworm 2nd instar larvae exposed to the residues of abamectin and chlorpyrifos-methyl on tomato plants at daily intervals after application in 2020 Tomato growing season.

Rate of application		Mortality percentages (Mean ± SE) at daily intervals after spraying abamectin and chlorpyrifos-methyl different rates during 2020 tomato growing season																LSR 0.05
		Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	
0.0X	chlorpyrifos-methyl	2.0 ± 1.57	2.0 ± 1.57	4.0 ± 3.35	4.0 ± 3.35	6.0 ± 4.37	6.0 ± 4.37	8.0 ±5.41	8.0 ±5.41	10.0 ± 7.07	10.0 ±4.37.07	6.0 ± 4.37	8.0 ± 5.41	8.0 ± 5.41	0.0	0.0	0.0	NS
	Abamectin	2.0 ± 1.57	2.0 ± 1.57	4.0 ± 3.35	2.0 ± 1.57	4.0 ± 2.45	2.0 ± 1.57	0.0	0.0	0.0	-	-	-	-	-	-	-	NS
0.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	96.0 ± 0.0	92.0 ±12.40	86.0 ± 7.47	78.0 ± 7.37	76.0 ± 7.94	72.0 ± 6.69	68.0 ± 9.59	52.0 ± 5.54	36.0 ± 5.47	16.0 ± 3.37	4.0 ± 3.35	0.0	0.0	15.35
	Abamectin	94.0 ± 5.48	78.0 ± 8.37	56.0 ±18.17	20.0 ±10.05	10.0 5.37	8.0 ± 1.45	4.0 ± 0.67	0.0	0.0	-	-	-	-	-	-	-	10.58
1.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	96.0 ±13.07	92.0 ±12.40	84.0 ±11.26	82.0 ±11.37	80.0 ±10.45	76.0 ± 9.26	56.0 ± 8.07	44.0 ± 6.26	22.0 ± 5.41	6.0 ± 4.37	0.0	0.0	16.37
	Abamectin	96.0 ± 5.78	80.0 ± 7.07	60.0 ±14.14	24.0 ± 5.48	14.0 ± 5.09	12.0 ± 4.47	8.0 ±1.6	0.0	0.0	-	-	-	-	-	-	-	9.16
1.5X	chlorpyrifos-methyl	100.0 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	94.0 ±12.45	88.0 ±11.45	86.0 ± 7.47	84.0 ± 8.47	80.0 ±10.45	60.0 ± 7.37	48.0 ± 6.47	26.0 ± 5.07	10.0 ± 3.45	0.0	0.0	18.61
	Abamectin	100.0 ± 0.0	100.0 ± 0.0	90.0 ±11.40	72.0 ± 7.07	56.0 ± 6.52	34.0 3.74	20.0 ± 2.45	6.0 ± 2.45	0.0	-	-	-	-	-	-	-	15.33
2.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	98.0 ±13.37	94.0 ±12.45	90.0 ±11.26	88.0 ±11.45	84.0 ±11.26	66.0 ± 8.37	52.0 ± 7.26	30.0 ± 6.26	14.0 ± 5.54	0.0	0.0	9.16
	Abamectin	100.0 ± 0.0	100.0 ± 0.0	94.0 ± 7.07	82.0 ±13.42	66.0 ± 8.37	42.0 ± 6.45	24.0 5.09	10.0 3.09	0.0	-	-	-	-	-	-	-	16.45
LSD 0.05	chlorpyrifos-methyl	8.54	7.65	12.86	13.34	12.68	14.43	5.34	2.45	4.68	3.76	3.76	2.67	2.34	1.54	NS	NS	—
LSD 0.05	Abamectin	8.54	5.81	15.53	16.81	15.71	8.36	4.25	1.35	NS	-	-	-	-	-	-	-	—

For each row, Comparison based on Duncan Multiple Comparison test with least significant range at 5% level of probability. Comparison within each column between different rates of abamectin and chlorpyrifos-methyl applications is based on LSD 0.05.

Corbitt *et al.*, 1989 reported that the initial toxicity of abamectin on Chinese cabbage was more toxic within the first Three days and gradually decreased against second-instar larvae of *Spodoptera littoralis*. Also, the susceptibility of *Spodoptera littoralis* second larval instar has been confirmed in various studies (Paul *et al.*, 1990 and Abdel-Latif and Abdu-Allah 2013).

However, chlorpyrifos-methyl gave 100% initial mortality at all of recommended rates in both seasons. Data was showed that in day 1 the recommended rate of 50% and 100% of abamectin gave (82% and 88%) and (78% and 80%) initial mortality, in 2019 and 2020 seasons, respectively. Also, it expressed 100% initial mortality at (150% and 200%) recommended rates within the first 24hr, then the mortality percentage start to decline until reached 0 in day 8 in all of the recommended rates in both seasons. Moreover, chlorpyrifos-methyl gave 100% initial mortality at all off recommended rates during day 1, 2. 3, and 4 in both seasons then it started to decreased gradually until reached 0 in day 15. Similar results were reported by Ahmed and Hassanein (2005) and Barrania *et al.*, (2012)

Data of the two seasons 2019 and 2020 confirmed that abamectin persists shorter under field conditions with T_{50} values were 3.22, 3.62, 5.13 and 5.49 compared with chlorpyrifos-methyl that showed 10.31, 10.80, 11.23 and 11.64 day at 50%, 100%, 150% and 200% of the recommended rate, respectively (Table 3).

Table 3. Summary of the biological residues of abamectin and chlorpyrifos-methyl at four different rates when cotton leafworm 2nd instar larvae were used as a bio-indicator for its residual performance under Minia weather conditions

Rate of application and linear equation		Bio-residue profiles based on percentages of mortality of second instar larvae					
		2019 season		2020 season		Average of the two seasons	
		T_{50}	T_0	T_{50}	T_0	T_{50}	T_0
0.5X	chlorpyrifos-methyl	10.95	17.84	10.11	16.12	10.31	16.97
	Abamectin	3.72	7.44	3.24	7.41	3.22	7.32
Linear equation	chlorpyrifos-methyl	y = -7.2598x + 129.52		y = -7.7771x + 125.34		y = -7.5093x + 127.42	
	Abamectin	y = -13.474x + 100.25		y = -12.012x + 88.988		y = -12.177x + 89.229	
1.0X	chlorpyrifos-methyl	11.37	18.39	10.25	16.77	10.80	17.57
	Abamectin	3.93	7.55	3.78	7.64	3.62	7.51
Linear equation	chlorpyrifos-methyl	y = -7.1219x + 130.99		y = -7.6696x + 128.62		y = -7.3874x + 129.79	
	Abamectin	y = -13.796x + 104.19		y = -12.939x + 98.861		y = -12.861x + 96.558	
1.5X	chlorpyrifos-methyl	11.89	19.23	10.81	17.69	11.23	18.22
	Abamectin	5.07	8.44	5.18	8.67	5.13	8.56
Linear equation	chlorpyrifos-methyl	y = -6.8111x + 130.95		y = -7.2583x + 128.46		y = -7.1618x + 130.46	
	Abamectin	y = -14.839x + 125.3		y = -14.332x + 124.31		y = -14.585x + 124.79	
2.0X	chlorpyrifos-methyl	12.28	19.83	11.04	17.84	11.64	18.79
	Abamectin	5.47	8.87	5.51	9.04	5.49	8.95
Linear equation	chlorpyrifos-methyl	y = -6.623x + 131.31		y = -7.3565x + 131.21		y = -6.9815x + 131.25	
	Abamectin	y = -14.699x + 130.38		y = -14.172x + 128.06		y = -14.434x + 129.21	

In another studies by Ramadan *et al.*, (2016), the values of half-life of abamectin was estimated to be 4.1 days and pre-harvest interval (PHI) was 7 days. Also, Abdelfatah *et al.*, (2020) reported that half-life of abamectin was 3.91 days and (PHI) was 10 days after the application on tomato fruits. While, Shalaby *et al.*, (2012) found that the pre-havest intervals (PHI= safety period) for tomato fruits were 15 days for treated plants by profenofos and cyfluthrin after spraying, while this period was more than fifteen days in the case of plants treated by chlorpyriphos-methyl.

It could be concluded that abamectin is appropriate for controlling leafworm and other Lepidoptera pests in short season vegetables which reduces the pre-harvest interval compared to chlorpyrifos-methyl. The same recommendation was reported by Abdelfatah *et al.*, (2020) who recommended that the use of tomato fruits treated with abamectin was safe for consumption after these intervals.

B: Negative impact of abamectin and chlorpyrifos-methyl on predatory population:

Based on the reduction percentages of predator populations either between different rates of abamectin at each time interval or between the residues of each rate at different time intervals, the trend of harmful effects was different from the comparisons based on the mean number of predators. It is more accurate to depend on percent reduction in predator population because in this criterion the pre spray and post spray counts for each of control and chemical treatments will be taken in consideration. Data in Tables (4 α 5) showed that the abamectin had greatest reduction in predator population when applied at all rates on day 1 ranged from 43.92 to 58.61 in 2019 and from 48.85 to 57.96% in 2020 growing season. However, on day 2 the reduction percentage ranged from 21.67 to 29.32 in 2019 and from 20.82 to 26.29% in 2020 growing season. In general, the lowest reduction was recorded on day 8 in both seasons 2019 and 2020 (Tables 4 and 5).

Table 4. Reduction percentages in predator populations when sprayed abamectin and chlorpyrifos-methyl at different rates of field application in 2019 Tomato growing season.

Rate of application		Percentages of reduction (Mean ± SE)															
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	LSR 0.05
0.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	94.0 ± 15.4	68.39 ±14.24	61.48 ±14.07	53.53 ±13.41	45.44 ±12.41	35.57 ±12.07	28.98 ±11.07	21.21 ± 9.37	18.21 ± 8.41	6.79 ± 3.11	5.31 ± 2.54	1.74 ± 0.11	14.35
	Abamectin	43.92 ± 1.76	21.67 ± 0.74	12.91 ± 2.43	8.30 ± 2.15	7.05 ± 1.14	6.90 ± 1.07	1.74 ± 1.62	0.83 ± 0.16	-	-	-	-	-	-	-	10.53
1.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	96.0 ±13.40	93.71 ±13.26	86.0 ±12.38	85.87 ±11.47	79.63 ±10.66	78.81 ± 9.17	58.42 ± 8.54	48.46 ± 7.32	28.08 ± 7.65	21.25 ± 5.25	13.32 ± 5.37	15.25
	Abamectin	54.03 ± 1.92	25.16 ± 2.34	16.69 ± 1.86	11.18 ± 1.42	11.01 ± 1.79	10.84 ± 0.74	5.83 ± 0.82	4.98 ± 0.65	-	-	-	-	-	-	-	9.62
1.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	97.85 ±15.25	95.49 ±14.12	89.76 ±13.45	88.0 ± 13.8	86.87 ±12.24	82.65 ± 12.3	80.85 ± 10.3	66.12 ± 9.47	48.83 ± 9.07	29.49 ± 8.35	15.15 ± 7.38	17.52
	Abamectin	57.47 ± 2.02	28.78 ± 1.76	19.54 ± 2.77	17.35 ± 0.79	15.03 ± 0.95	13.79 ± 1.14	9.93 ± 1.07	6.07 ± 0.08	-	-	-	-	-	-	-	12.35
2.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	98.91 ±13.43	96.58 ±13.83	90.80 ±12.73	89.04 ±12.38	87.83 ±11.74	84.66 ± 9.53	81.7240 ± 8.38	73.05 ± 8.92	50.39 ± 7.35	30.76 ± 6.25	15.28 ± 5.82	15.74
	Abamectin	58.61 ± 2.35	29.32 ± 1.31	22.09 ± 0.91	20.02 ± 1.17	18.68 ± 0.71	18.43 ± 1.15	15.70 ± 1.09	11.75 ± 0.11	-	-	-	-	-	-	-	14.36
LSD 0.05	chlorpyrifos-methyl	NS	NS	NS	7.68	12.43	11.34	8.45	6.03	9.32	8.76	7.48	9.58	8.24	6.72	4.88	—
LSD 0.05	Abamectin	6.94	5.65	3.12	4.43	6.45	5.61	4.34	2.59	-	-	-	-	-	-	-	—

For each row, Comparison based on Duncan Multiple Comparison test with least significant range at 5% level of probability. For each column, the value under each column, represent the least significant difference for the means represented in each column.

Table 5. Reduction percentages in predator populations when sprayed abamectin and chlorpyrifos-methyl at different rates of field application in 2020 Tomato growing season.

Rate of application		Percentages of reduction (Mean ± SE)															
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	LSR 0.05
0.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	92.46 ± 12.3	89.23 ± 13.84	81.10 ±11.07	73.08 ±11.56	67.35 ±10.42	64.46 ± 11.52	38.40 ± 9.36	36.06 ± 9.54	14.56 ± 8.88	3.51 ± 1.25	0.05 ± 0.54	16.35
	Abamectin	48.85 ± 2.48	20.82 ± 1.73	15.34 ± 1.43	10.56 ± 1.14	11.19 ± 1.52	7.94 ± 0.86	2.81 ± 1.45	2.24 ± 0.65	-	-	-	-	-	-	-	11.86
1.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	95.84 ± 12.25	94.80 ±12.85	89.25 ± 13.85	88.55 ±12.54	86.32 ±10.32	83.35 ± 9.58	62.78 ± 9.12	47.47 ± 8.32	21.76 ± 6.74	17.97 ± 4.65	12.48 ± 3.14	14.32
	Abamectin	52.18 ± 2.45	22.86 ± 2.45	17.46 ± 1.22	12.76 ± 2.20	12.25 ± 1.14	11.64 ± 1.76	6.61 ± 0.47	3.86 ± 0.05	-	-	-	-	-	-	-	13.74
1.5X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	97.01 ± 15.65	95.88 ± 15.54	91.03 ± 12.57	87.91 ±11.35	85.05 ±12.43	72.51 ±11.35	64.49 ± 10.35	50.06 ± 9.35	27.91 ± 8.31	19.47 ± 7.43	15.34
	Abamectin	56.71 ± 2.45	25.81 ± 2.11	20.00 ± 2.20	17.04 ± 1.86	15.36 ± 1.79	13.68 ± 1.23	9.26 ± 1.78	6.51 ± 1.56	-	-	-	-	-	-	-	12.36
2.0X	chlorpyrifos-methyl	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	99.95 ± 15.43	97.04 ±14.38	92.95 ±13.31	88.80 ± 11.67	86.90 ±10.53	80.45 ± 8.13	66.11 ± 9.34	51.62 ± 8.39	29.31 ± 7.65	19.70 ± 5.25	15.54
	Abamectin	57.96 ± 2.20	26.29 ± 1.45	21.51 ± 2.75	18.60 ± 1.20	17.32 ± 1.75	16.13 ± 1.12	12.28 ± 1.76	9.44 ± 0.59	-	-	-	-	-	-	-	10.76
LSD 0.05	chlorpyrifos-methyl	NS	NS	NS	NS	7.77	7.52	6.47	6.34	7.89	6.45	5.53	4.58	5.45	7.34	3.52	—
LSD 0.05	Abamectin	8.34	4.52	4.65	6.32	5.63	4.96	6.94	NS	-	-	-	-	-	-	-	—

For each row, Comparison based on Duncan Multiple Comparison test with least significant range at 5% level of probability. For each column, the value under each column, represent the least significant difference for the means represented in each column.

Low mortality on predators population was reported when sprayed abamectin on different crops against various pests (Kim and Yoo, 2002; Michael and Parrella, 2005 and Nadimi *et al.* 2011).

The greatest reduction in predator population after treatment with chlorpyrifos-methyl was on day 1, 2, 3 and 4 at all recommended rates except 0.5X, while the lowest reduction was recorded on day 15 in all tested rates. In contrary, chlorpyrifos-methyl was highly toxic against predators population which recorded 100% mortality of *Aphytis melinus*, *Coccophagus Lycimnia* and *Leptomastix dactylopii* (Suma *et al.*, 2009).

In general, data suggested that abamectin has negatively affect predator population within the first 24 hr. after application and the negative effect was negligible after one week, suggesting release natural enemies one week after the field application of abamectin. While, chlorpyrifos-methyl negatively affect predator population on the day 1 to 4 after application and the negative effect was negligible after 2 weeks, suggesting releasing natural enemies two week after the field application of chlorpyrifos-methyl.

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تقييم الفاعلية والأثر المتبقي لكلا من الأبامكتين والكلوربيريفوس-ميثيل ضد يرقات العمر الثاني لدودة ورق القطن تحت الظروف الحقلية ونصف الحقلية

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تم تقييم التأثيرات السمية الفورية والمتبقية لكلا من الأبامكتين والكلوربيريفوس-ميثيل ضد يرقات العمر الثاني لدودة ورق القطن و المفترسات النافعة علي محصول الطماطم خلال موسمي 2019 و 2020 تحت الظروف الحقلية ونصف الحقلية. أوضحت النتائج المتحصل عليها عندما استخدم المعدل الحقلي الموصي به وجد أن الكلوربيريفوس-ميثيل أعطي 100% موت فوري إبتداءا من اليوم الأول حتي اليوم الخامس فس موسم 2019 ومن اليوم الاول حتي اليوم الثالث في موسم 2020 بعد المعاملة. أيضا الأبامكتين أعطي 100% موت فوري خلال 24 ساعة الأولي في موسم 2019 و96% في موسم 2020 بعد التطبيق. كما وجد أن كلا من الأبامكتين و الكلوربيريفوس-ميثيل فقدوا سميتهم وأثرهم المتبقي بعد 7.55 و 18.39 يوم في موسم 2019 و 7.64 و 16.77 يوم في موسم 2020 من التطبيق الحقلي,علي التوالي و عندما استخدم المعدل الحقلي الموصي به. علي الجانب الآخر وجد أن الأبامكتين أثر سلبيا علي الأعداء الحيوية في اليوم الأول بعد التطبيق ولكن لوحظ أن تعداد الأعداء الحيوية بدأ في الإزدياد تدريجيا بشكل طبيعي بعد 48 ساعة من المعاملة بالمعدل النصف حقلي. بينما, لوحظ أن الكلوربيريفوس-ميثيل أثر سلبيا علي الأعداء الحيوية حيث أعطي 100% خفض في التعداد خلال 96 ساعة الأولي بعد المعاملة ثم استمر تعداد الأعداء الحيوية منخفض حتي اليوم 13 وعاد في التزايد ثانية ابتداء من اليوم 14 ,ولذلك, يوصي باستخدام الأبامكتين لمكافحة حشرات حرشفية الأجنحة وخاصة علي محاصيل الخضر لما له من أثر متبقي منخفض يجعل هذه المحاصيل متاحة للإستهلاك الآدمي بعد أسبوع من المعاملة وأيضا لعدم تأثيره السلبي علي المفترسات النافعة.