Population Dynamics and Control of The Citrus Rust Mite, *Phyllocoptruta olievora* (Ashmead) Infesting Orange Trees in Egypt

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ABSTRACT: The population dynamics of the citrus rust mite are affected by many factors. The population fluctuation and control of the citrus rust mite *Phyllocoptruta olievora* by using different pesticides were investigated on Valencia orange trees in Wadi El-Natroun, Bohaira, Egypt during two seasons of 2015 and 2016. In the first season of 2015, the first appearance of the mite individuals on orange trees (summer crop) started, noticed and recorded in April, 11th and these individuals were vanished on October, 28th. The mite was found to have three peaks of activity; the 1st peak appeared in the second week of May. The 2nd peak was noticed by the end of June and the 3rd peak is shown in the 2nd week of September. During the season of 2016, the beginning of the presence of the mite individuals on the leaves was recorded on April, 30th. The end of the presence of the mite individuals was also observed on September, 27th. Also, it was noticed that the mite was found to have three activity peaks during the season of 2016 in the same experimental area. The 1st higher peak was shown in mid-June, the 2nd peak was seen in the first week of July, while the 3rd peak occurred during the last week of August. During these peaks periods of 2105 and 2016, the temperatures were appropriate for the mite activity and they were of 30° C range or more (30-34.5). Eight pesticides (hexythiazox, fenpyroximate, chlorfenapyr, abamectin, spirodiclofen, spirotetramat, petroleum oil and sulfur) were selected to control *P. olievora.* The calculation of the reduction percentage of 3 inspections after the 1st, 2nd and 3rd spray showed that abamectin was the most effective compound during both seasons of 2015 and 2016 giving percentage reduction means of the mite individuals of 90.0, 90.4 and 90.3% (2015) and 92.9, 95.2 and 96.3% as compared with the other tested compounds during 2106. Meanwhile, both sulfur and petroleum oil were the least effective evaluated pesticides, nevertheless, the general mean of mite individuals reduction (GRM) they caused was not less than 66.0 or 73.0% during the two seasons of study (2015 and 2016).

Keywords: Population dynamic, Citrus rust mite, *Phyllocoptruta olievora,* Chemical control, General reduction means (GRM)

INTRODUCTION

A number of plant pests may attack citrus trees such as the citrus rust mite *Phyllocoptruta oleivora* (Ashmead) (Acari: Eriophydae), red citrus mite Panonychus *citri* (Acari: Tetranychidae) (Puspitarini *et al.*, 2012; Bergh, 2000). Citrus rust mite adults are 0.13 to 0.17 mm long. The females are longer than the males. The life cycle from egg to adult can be as short as 7 to 10 days, so there are many generations during summer-autumn. (Beattie and Gellatley, 2003). Attack of the citrus rust mite could cause the fruit peel of citrus mottle (Yang *et al*., 1994), and may reduce the quality, appearance, even the price of the fruit. Therefore, the presence of mite on citrus plant needs to be monitored and controlled (Childers *et al*., 1996). Chemical control (application of

pesticides) provides a quick and sometimes effective solution to pest problems especially with the choice of safe systemic acaricides with little effect on the natural enemies, environment, fruits and human (Al-Azzazy *et al.,* 2013).

Many researchers studied the effect of pesticides against the citrus rust mite *Phyllocoptruta oleivora.* Smith *et al.* (1998) found that the miticide abamectin (combined with 0.2% petroleum oil) controlled the rust mites *Phyllocoptruta oleivora* (Ashmead). Also, Knapp *et al*. (2001) reported that petroleum spray oil (PSO) was effective against the citrus rust mite *Phyllocoptruta oleivora* (Ashmead) at higher dose (20 gallons/125 gallons of water/acre). Moreover, Kalaisekar *et al*. (2003) reported that wettable sulphur in field trial was effective for controlling citrus rust mite, *Phyllocoptruta oleivora* (Ashm.). In Southwestern Colombia, Rodríguez (2012) reported that abamectin is the most widely product used to control species like *P. latus* and *P. oleivora.* The present investigation was carried out to study the population dynamics of the citrus rust mite *P. olievora* on Valencia orange trees in Wadi El-Natroun, Egypt and its control by using eight different pesticides.

MATERIALS AND METHODS

1- Monitoring the population fluctuations of the citrus rust mite *Phyllocoptruta oleivora* in Wadi El-Natroun, Egypt

Experimental site

The experiments for estimating the population fluctuations of the citrus rust mite *P. olievora*, were carried out in a private orchard of orange trees in an area of about one feddan, in Wadi El-Natroun, El-Behaira, Egypt with 8-yr-old ' (Valencia orange variety) orange trees. Ten rows of trees ran from South to North (each row consisting of 14 trees) were examined. In order to study the population dynamic of eriophyid mite species through one year from beginning of January to late December, leaf samples were collected weekly, starting on 7 January until end of December of the same year.

Sampling and examination

Twenty orange leaves were taken randomly from trees and placed directly into plastic bags and transported to the laboratory. All mite stages (individuals) (eggs, immature stages and adults) were counted using stereoscopic binocular microscope and the mean numbers of mite individuals were calculated. Meanwhile, daily rates of temperature were taken from the central Meteorological Department, Ministry of Scientific Research during the sampling periods.

2- Evaluation of certain pesticides against the mite *P. oleivora*

Eight pesticides were selected to control *P. olievora.* The common names, trade names, formulation and the rate of application of the evaluated pesticides are shown in Table 1.

The spray of the chemical pesticdes during both two seasons of experiment was performed using a knapsack sprayer (CP3) (capacity of 20 litres), the rate of each tree is about 3 liters and 9 liters for each treatment. The spray solution was prepared as follows:

1-Spray tank was first filled till half by water, then the tested pesticide was added, 2- spray tank was then refilled to its final volume by water, and 3- the pH of the spray solution was then adjusted using citric acid at a rate of 50 g/100 liter water to bring the pH level to 6.2 - 6.5 by the aid a pH-meter (CARDY, Japan). The addition of citric acid to liquid spray was found to increase the efficacy of pesticides as compared with those pesticides alone in a water liquid spray. The infestation reduction percentages were calculated 5,10 and15 days post-each spray (Henderson and Tilton, 1955). The general reduction mean of 3 sprays (GRM) was also calculated.

Table (1). The tested pesticides, formulations and their rates of application

Pesticide		Formulation	Application rate
Common name	**Trade name**	**(%)**	**(ml /100) liter**
Abamectin	Tinam®	EC* 1.8	45
Fenpyroximate	Ortus®	EC 5	50
Chlorfénapyr	Challenger Super®	SC 36	75
Hexythiazox	Nissorun®	EC 5	50
Spirodiclofene	Envidor®	SC 24	30
Spirotetramate	Movento®	SC 24	100
Petroleum oil***	Saxol®	EC 80	1000
Sulfur	Acuadal®	WG 80	(250 g)**

*EC= Emulsifiable Concentrae, WG= Water dispersible Granules, SC= Soluble suspension Concentrate. **Solid material

*** Petroleum oils also termed horticultural, mineral, white or narrow range spray oils.

RESULTS AND DISCUSSION

1- Population dynamic of the citrus rust mite on orange trees (Valencia) during two seasons of study (2015 and 2016)

The season of 2015

The first appearance of the mite individuals on orange trees started, noticed and recorded in April, 11th and these individuals were vanished on October, 28th (Fig.1). This means that this period is the appropriate period for the activity of the agricultural mite individuals on summer crops, especially citrus

trees where it migrate to the new flushes of Valencia trees. The mite was found to have three activity peaks during that season in the experimental area. The 1st peak appeared in the second week of May (286 mite individuals/20 orange leaves). The 2nd peak was noticed by the end of June (286 mite individuals/20 leaves) and the 3rd peak is shown in the 2nd week of September (258 mite individuals/20 leaves). During these peaks periods the temperatures were appropriate for the mite activity and they were of 30°C range or more (Table 2).

The season of 2016

The beginning of the presence of the mite individuals on orange leaves was recorded on April, 30th. The end of the presence of the mite individuals was also observed on September, 27th. It was also noticed that the mite individuals were found to have three activity peaks.

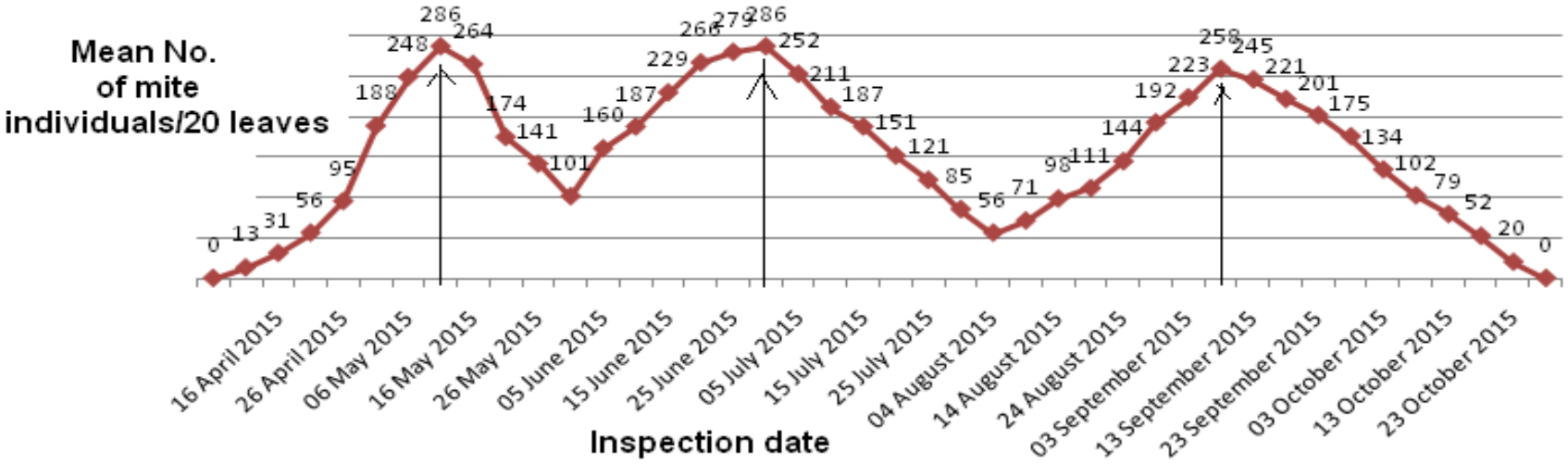

Figure (1). Population fluctuations of the citrus rust mite *Phyllocoptruta olievora* on orange trees (mean No. /20 leaves) during the season of 2015 (April- October)

Table (2). The recorded temperature (℃) during the period of examination in the season of 2015

Temperature	Temperature (℃) during the season of 2015						
	April	May	Jun	July	August	September	October
Max. *	27.6	32.8	34.2	34.2	34.4	32.3	29.8
Min.	12.2	17.7	19.6	20.9	20.9	19.4	16.2
Med.	19.9	25.2	26.9	27.5	27.6	25.8	23

*Max. = Maximum temperature, Min. = Minimum temperature and Med. = Median temperature.

The 1st higher peak was shown in mid-June (201 mite individuals/20 leaves), the 2nd peak was seen in the first week of July (271 mite individuals/20 leaves),, while the 3rd peak occurred during the last week of August (279 mite individuals/20 leaves) (Fig. 2). According to the recorded temperature during the course of study, it was clear that the mite individuals infesting orange trees depended on the maximum temperature especially those exceeded 30° C (Table 3).

1- Effect of certain pesticides against the mite *P. oleivora* on citrus trees during two seasons of study (2015 and 0216)

The season of 2015

The 1st spray

Numbers of individual mites/20 fixed leaves of 3 trees was determined and recorded after 5, 10, and 15 days post-treatment with different pesticides through three sprays during the season of 2015 were recorded. The mean No. of alive mite individual/20 fixed and labeled leaves before and after the application of the tested compounds and the reduction percentages of the alive mite individuals they caused after three applications (1st, 2nd and 3rd consequent sprays) of the assigned treatments on orange trees during the season of 2015 are shown in Table (4). Five days post-treatment, all the tested compounds showed their efficiency against the mite, nevertheless both hexythiazox and abamectin were the most effective tested compounds showing higher reductions of 79.7 and 79.5%, respectively. Meanwhile, sulfur and petroleum oil showed the lower reduction percentages of 62.9 and 62.3%, in respect as compared with the other tested compounds. The statistical analysis showed significant differences between the running treatments concerning their effect on the number of the mite individuals infesting the leaves. Ten days post-treatment, abamectin and hexythiazox were the most effective tested compounds showing a higher reduction of 94.2 and 92.3%, respectively; no significant differences between them. Although the activities of both sulfur and petroleum oil have been increased, they still the less active tested compounds showed the lower reduction percentages of 77.6 and 75.6%, in respect as compared with the other tested compounds.

Recording the number of mite individuals and the calculation of the infestation reduction percentages for different treatments 15 days post-treatment showed that all the tested compounds gave considerable effect against the citrus rust mite and that reduction were not less than 80%. The most active compound was abamectin showing the highest reduction of 96.3%, followed by spirotetramat and spirodiclofen which was active as hexythiazox (95.8, 95.2 and 94.8%, in respect) with no significant differences between them therefore the farmer can choose any one of these compounds and the cheaper will be the best to reduce the costs of control. Meanwhile the results showed that fenpyroximat, chlorfenapyr, sulfur and petroleum oil had the same activity against the citrus rust mite showing almost the same action for reducing the mite individuals.There were no significant differences between these treatments. The calculation of the reduction mean of 3 inspections after the 1st spray showed that abamection was the most effective compound giving 90.0% reduction of the mite individuals.

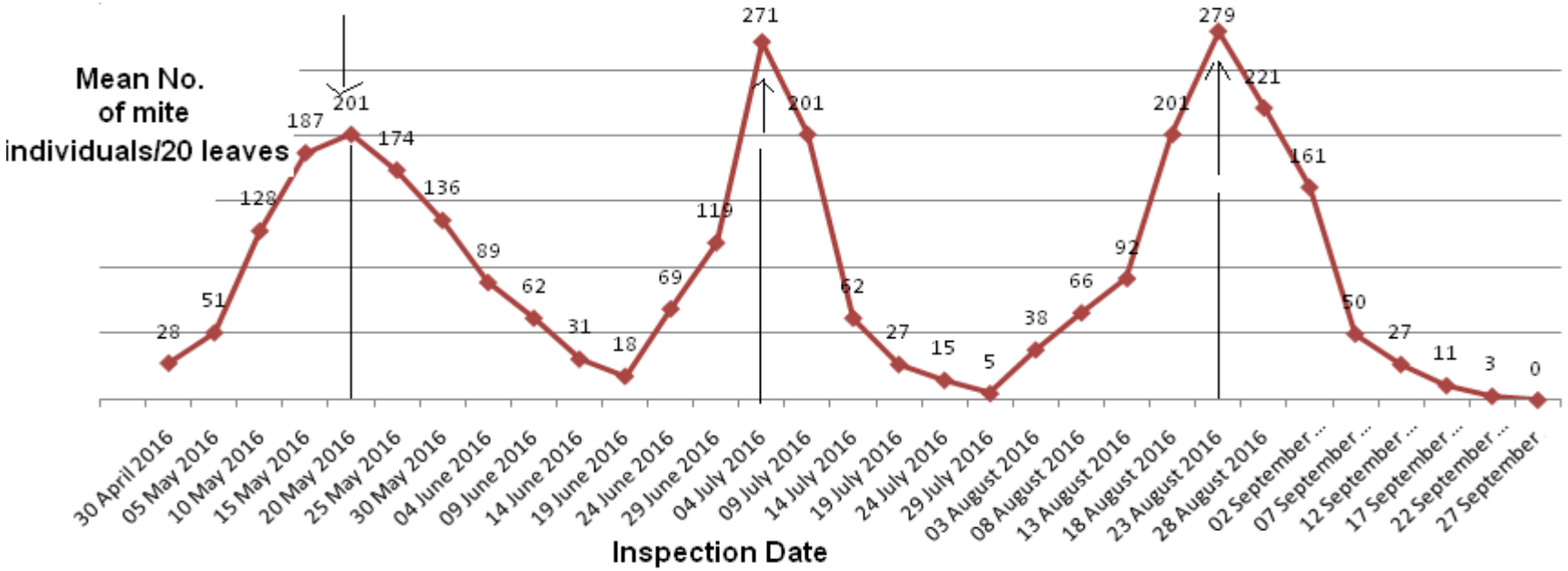

Figure (2). Population fluctuations of the citrus rust mite *Phyllocoptruta olievora* on orange trees (mean No. /20 leaves) during the season of 2016 (end of April- end of September)

Table (3). The recorded temperature (℃) during the period of examination in the season of 2016

Temperature	Temperature (° C) during the season of 2016						
	April	May	June	July	August	September	October
Max. *	27.6	33	34.2	34.3	34.5	32.4	29.8
Min.	12.3	17.8	19.6	21	20.9	19.6	16.2
Med.	19.9	25.4	26.9	27.6	27.7	26	23

*Max. = Maximum temperature, Min. = Minimum temperature and Med. = Median temperature.

Table (4). Efficiency of tested pesticides against the mite individuals infesting citrus trees (Valencia) (1st spray in the season of 2015)

Pesticide	Pre-treatment	1st spray (1-5-2015) # Mean No. of alive mite individuals/20 leaves (M) & (R%) at different intervals (days)						Reduction Mean
		5		10		15		
	M	M@	R%	M@	R%	M@	R%	(%)
Hexythiazox	179.0	48.0 c*	79.7	21.0 e	92.3	12.0 c	94.8	88.9
Fenpyroximate	176.0	56.0 c	75.9	35.0 cd	86.9	42.0 b	83.0	81.9
Chlorfenapyr	170.0	55.0 c	75.5	37.0 c	85.7	46.0 b	80.7	80.6
Abamectin	192.0	52.0 c	79.5	17.0 e	94.2	10.0 c	96.3	90.0
Spirodiclofen	180.0	56.0 c	72.6	27.0 cde	90.1	12.0 c	95.2	86.0
Spirotetramat	171.0	60.0 c	73.4	25.0 de	82.7	10.0 c	95.8	84.0
Petroleum oil	175.0	87.0 b	62.3	65.0 b	75.6	40.0 b	83.7	73.9
Sulfur	182.0	89.0 b	62.9	62.0 b	77.6	38.0 b	85.1	75.2
Untreated check	188.0	248.0 a		286.0 a		264.0 a		
LSD 0.05		12.83		10.25		14.02		

Date of spray (Day –Month- Year), M = Mean No. of the mite individuals before spray, M@ = Mean No. of the mite individuals/20 fixed leaves after spray and R% = Reduction percentage.

*Means followed by the same letter (s) in each column are not significantly different at $P < 0.05$ level.

The 2nd spray

Table (5) presented the mean numbers of the citrus rust mite individuals/20 leaves and the infestation reduction percentages of different evaluated treatments after the 2nd spray throughout the season of 2015. The all running treatments more or less had a considerable effect against the mite. Abamectin was the most effective tested compound showing the highest reduction of the mite calculated by 81.9%. On the other hand, sulfur and petroleum oil showed the lower reduction percentages of 55.5 and 52.3%, in respect as compared with the other tested compounds when they were evaluated 5 days post-treatment.

The calculation of the infestation reduction percentages 10 days post-treatment showed that abamectin was the most effective evaluated compound giving the highest reduction percentage of the mite as reached as high as 92.2% followed by hexythiazox, spirotetramat and spirodiclofen (91.7, 89.4 and 88.8%). Statistical analysis showed that there were no significant differences between these four pesticides. These four compounds can be classified in the 1st rank according to their effect on reducing the number of mite individuals infesting orange leaves. Petroleum oil was as active as sulfur against the rust mite showing more or less the same percentages of the mite reduction (67.9 and 70.5%) and the statistical analysis showed that there were no significant differences between them. The infestation reduction percentages of different evaluating treatments after 15 days post-treatment showed that abamectin and hexythiazox still are the most effective evaluated compounds against the rust mite giving the higher percentages of the mite reduction (97.0 and 95.7%, in respect). It could be said that all the evaluated compounds gave considerable effect since the percentages of infestation reduction were more than 80.0%. Sulfur and petroleum oil came in the last order of efficiency as they were compared with the other tested compounds; nevertheless, they recorded mite reduction percentages of 82.9 and 80.2%, in respect without significant differences between them.

The 3rd spray

The effect of the 3rd spray treatments on the number of the mite individuals/20 orange leaves is shown in Table (6). Over a period of 15 days of inspection post-treatment, it could be seen that all the evaluated compounds were effective against the mite. Five days after the application, abamectin recorded the highest percentage of reduction of 78.8. Hexythiazox, fenpyroximat, chlorfenapyr, spirodiclofen and spirotetramat were found to have the same effect against the rust mite. Sulfur and petroleum oil recorded the lower reduction percentages of 62.7 and 61.5, respectively without significant differences between them. Ten or 15 days-post treatment, the same trend as that detected after 5 days was gained showing that abamectin recorded the highest percentage of reduction of 92.2 and 97.2%, respectively.

Table (5). Efficiency of tested pesticides against the mite individuals infesting citrus trees (Valencia) (2nd spray in the season of 2015)

Pesticide	Pre-treatment	2nd spray (15-6-2015) # Mean No. of alive mite individuals/20 leaves (M) & reduction percentage (R%) at different intervals (days)						Reduction Mean
		5		10		15		
	M	M@	R%	M@	R%	M@	R%	(%)
Hexythiazox	169.0	45.0 de*	77.1	17.0 d	91.7	9.0 e	95.7	88.2
Fenpyroximate	180.0	52.0 de	75.1	71.0 bc	67.6	20.0 cd	91.1	77.9
Chlorfenapyr	158.0	69.0 c	62.4	78.0 b	59.5	22.0 c	88.8	70.2
Abamectin	190.0	40.0 e	81.9	18.0 d	92.2	7.0 e	97.0	90.4
Spirodiclofen	183.0	54.0 d	74.6	25.0 d	88.8	12.0 de	94.7	86.0
Spirotetramat	178.0	55.0 d	73.4	23.0 d	89.4	13.0 de	94.1	85.6
Petroleum oil	166.0	92.0 b	52.3	65.0 c	67.9	41.0 b	80.2	66.8
Sulfur	178.0	92.0 b	55.5	64.0 c	70.5	38.0 b	82.9	69.6
Untreated check	229.0	266.0 a		279.0 a		286.0 a		
LSD 0.05	16.48	12.22		10.34		8.27		

Date of spray (Day –Month- Year), M = Mean No. of the mite individuals before spray, M@ = Mean No. of the mite individuals/20 fixed leaves after spray and R% = Reduction percentage.

*Means followed by the same letter (s) in each column are not significantly different at $P < 0.05$ level.

Table (6). Efficiency of tested pesticides against the mite individuals infesting citrus trees (Valencia) (3rd spray in the season of 2015)

Pesticide	Pre-treatment	3rd spray (24-8-2015)# Mean No. of alive mite individuals/20 leaves (M) & reduction percentage (R%) at different intervals (days)						Reduction Mean	GRM$ (of 3 sprays)
		5		10		15			
	M	M@	R%	M@	R%	M@	R%	(%)	(%)
Hexythiazox	186.0	55.0 c*	77.8	23.0 c	92.0	10.0 de	97.0	88.9	88.7
Fenpyroximate	200.0	61.0 c	77.1	73.0 b	76.4	21.0 cd	94.1	82.5	80.8
Chlorfenapyr	180.0	56.0 c	76.7	78.0 b	72.0	26.0 c	91.9	80.2	77.0
Abamectin	212.0	60.0 c	78.8	22.0 c	93.3	5.0 e	98.7	90.3	90.2
Spirodiclofen	200.0	65.0 c	75.6	28.0 c	90.9	10.0 de	97.2	87.9	86.6
Spirotetramat	191.0	63.0 c	75.3	30.0 c	89.8	12.0 de	96.5	87.2	85.6
Petroleum oil	183.0	94.0 b	61.5	71.0 b	74.9	47.0 b	85.7	74.0	71.6
Sulfur	197.0	98.0 b	62.7	69.0 b	77.4	43.0 b	87.8	76.0	73.6
Untreated check	144.0	192.0 a		223.0 a		258.0 a			
LSD 0.05	22.67	16.91		12.25		10.5			

Date of spray (Day –Month- Year), M = Mean No. of the mite individuals before spray, M@ = Mean No. of the mite individuals/20 fixed leaves after spray, R% = Reduction percentage and GRM$= General Reduction Mean

*Means followed by the same letter in each column are not significantly different at $P < 0.05$ level.

Concerning the calculation of the general reduction mean (GRM) for 3 sequential applications of the tested compounds throughout the first season of 2015 which presented and shown in Table (6), it could be seen that abamectin was the most effective evaluated compound giving the highest general mean of reduction of the mite individual detected on the leaves of orange trees calculated by 90.2% as compared with the other tested compounds. The highest action of abamectin was followed by the application of hexythiazox, spirodiclofen and spirotetramat (88.7, 86.6 and 85.6%, in respect). Although both sulfur and petroleum oil showed their activity for reducing the individuals of the mite, they were the least effective compounds as compared with the other tested compounds and they came in the last rank without significant differences between them and their recorded GRM were 73.6% and 71.6%, in respect.

The season of 2016

The 1st spray

During the season of 2016, three sprays were also performed to assure the results of that season of 2015. The detected leaves were chosen from 4 branches located in the different four directions around each tree. Numbers of individual mites/20 fixed and labeled leaves of 3 trees (a replicate) was determined and recorded after 5, 10, and 15 days post-treatment with different pesticides through three sprays during the season of 2016. The effect of the tested pesticides (insecticides and acaricides) on orange trees infestations with the citrus rust mite *Phyllocoptruta oleivora* (Ashmead) was determined as a reduction percentage of the mite. Table (7) presented the mean number of the detected alive mite individuals/20 leaves and the infestation reduction percentages of different treatments after 5, 10 and 15 days post-treatment.

Five days post-treatment, all the tested compounds showed high efficiency against the mite, nevertheless both spirotetramat and fenpyroximat were the most effective tested compounds and have an equal effect showing the higher mite reductions of 85.4 and 84.3%. Meanwhile, fresh deposits of sulfur proved to be more effective than chlorfenapyr and petroleum oil. Herein, petroleum oil was the least effective tested compound as compared with the other evaluated compounds where it showed the lower reduction percentage of 68.2%. The statistical analysis showed significant differences between the running treatments concerning their effect on the number of the mite individuals infesting the leaves. All the tested compounds were found to be effective against the mite when the numbers of the alive mite individuals in the different treated blocks were inspected 10 days post-treatment. In this respect, abamectin was superior showing the highest reduction of the mite (94.1%), while sulfur showed the lowest one (72.7%). Abamectin showed a complete reduction (100%) when the effect of the application of different pesticides was evaluated 15 days post-treatment.

Table (7). Efficiency of tested pesticides against the mite individuals infesting citrus trees (Valencia) (1st spray in the season of 2016)

Pesticide	Pre-treatment	1st spray (10-5-2016)#						Reduction Mean
		Mean No. of alive mite individuals/20 leaves (M) & reduction percentage (R%) at different intervals (days)						
		5		10		15		
	M	M@	R%	M@	R%	M@	R%	(%)
Hexythiazox	135.0	36.0 de*	81.7	22.0 de	90.6	8.0 f	95.6	89.3
Fenpyroximate	196.0	42.0 d	85.3	55.0 bc	82.1	21.0 de	92.1	86.5
Chlorfenapyr	185.0	79.0 b	70.8	51.0 c	82.4	27.0 c	89.2	80.8
Abamectin	261.0	59.0 c	84.5	24.0 de	94.1	00.0 g	100.0	92.9
Spirodiclofen	113.0	33.0 d	80.0	14.0 e	92.1	5.0 f	96.7	89.6
Spirotetramat	178.0	38.0 d	85.4	31.0 d	88.9	18.0 e	92.6	89.0
Petroleum oil	168.0	88.0 b	68.2	64.0 b	75.7	47.0 b	79.4	74.4
Sulfur	105.0	37.0 d	75.9	45.0 c	72.7	23.0 cd	83.8	77.5
Untreated check	128.0	187.0 a		201.0 a		174.0 a		
LSD	32.19	12.61		9.99		4.45		

Date of spray (Day –Month- Year), M = Mean No. of the mite individuals before spray, M@ = Mean No. of the mite individuals/2fixed leaves after spray and R% = Reduction percentage.

*Means followed by the same letter in each column are not significantly different at $P < 0.05$ level.

Abamectin was followed by spirodiclofen (96.7%), hexythiazox (95.6%), spirotetramat (92.6%) and fenpyroximat (92.1%). Petroleum oil was the least effective compound as compared with the other tested compounds giving the lowest calculated reduction percentage of 79.4.The calculation of the mean reduction percentage of the all 3 sprays assured that abamectin was the most effective evaluated compound and could be considered as an effective acaricide that would be preferable in the integrated management programs.

The 2nd spray

Results presented in Table (8) show the effect of the 2nd spray of different evaluated pesticides against the citrus rust mite. Generally, all the evaluated compounds showed a considerable effect.
Abamectin was the most effective compound as evaluated 5, 10 and 15 days post-treatment showing a complete reduction (100%) 15 days post-treatment. The calculation of the mean reduction percentage of the all 3 applications of the 2nd spray assured again that abamectin was the most effective evaluated compound and could be a candidate effective acaricide that can be used within the integrated management programs of citrus pests in Egypt.

The 3rd spray

Table (9) shows the infestation reduction percentages of the citrus rust mite due to the application of different treatments (3rd spray) after 5, 10 and 15 days post-treatment. For each inspection interval, the statistical analysis indicated that there were significant differences between the all running treatments.

The calculated mean reduction percentage of the all three applications of the 3rd spray assured again that abamectin was the most effective evaluated compound. Petroleum oil was the least effective compound as compared with the other tested compounds. It could be said that both petroleum oil and sulfur have the same effect against the rust mite and either of them can be used depending on their price. The other tested compounds were moderately effective against the mite (spirodiclofen> hexythiazo > chlorfenapyr = spirotetramat = Fenpyroximat) based on their mean of reduction of three applications.

The calculation of the GRM for 3 sequential sprays of the tested compounds throughout the second season of 2016 is shown in Table (9). Abamectin was proved for the 2nd season to be the most effective evaluated compound against the citrus rust mite *Phyllocoptruta oleivora* (Ashmead) giving the highest reduction of the mite individual detected on the leaves of orange trees calculated by 98.8% as compared with the other tested compounds. The highest action (reduction of alive mite individuals) of abamectin was followed by the application of spirodiclofen, hexythiazox, and spirotetramat (90.9.7, 88.4 and 84.8, in respect).

Table (8). Efficiency of tested pesticides against the mite individuals infesting citrus trees (Valencia) (2nd spray in the season of 2016)

Pesticide	Pre-treatment	2nd spray (29-6-2016)# Mean No. of alive mite individuals/20 leaves (M) & reduction percentage (R%) at different intervals (days)						Reduction Mean
		5		10		15		
	M	M@	R%	M@	R%	M@	R%	(%)
Hexythiazox	140.0	45.0 bc*	85.9	22.0 de	90.7	12.0 d	83.5	86.7
Fenpyroximate	109.0	22.0 d	91.1	30.0 cd	83.7	15.0 cd	73.6	82.8
Chlorfenapyr	103.0	21.0 d	91.0	33.0 bc	81.0	14.0 cd	73.9	82.0
Abamectin	253.0	43.0 c	92.5	29.0 cd	93.2	0.0 f	100	95.2
Spirodiclofen	111.0	21.0 d	91.7	15.0 e	92.0	6.0 e	89.6	91.1
Spirotetramat	134.0	45.0 bc	85.2	31.0 c	86.3	15.0 cd	78.5	83.3
Petroleum oil	121.0	55.0 b	80.0	40.0 b	80.4	18.0 bc	71.4	77.3
Sulfur	116.0	45.0 bc	83.0	33.0 bc	83.1	22.0 b	63.6	76.6
Untreated check	119.0	271.0 a		201.0 a		62.0 a		
LSD 0.05	20.34	9.81		7.66		4.56		

Date of spray (Day –Month- Year), M = Mean No. of the mite individuals before spray, M@ = Mean No. of the mite individuals/20 fixed leaves after spray and R% = Reduction percentage.

*Means followed by the same letter in each column are not significantly different at $P < 0.05$ level.

Table (9). Efficiency of tested pesticides against the mite individuals infesting citrus trees (Valencia) (3rd spray in the season of 2016)

Pesticide	Pre-treatment	3rd spray (18-8-2016)# Mean No. of alive mite individuals/20 leaves (M) & reduction percentage (R%) at different intervals (days)						Reduction Mean	GRM$ (of 3sprays)
		5		10		15			
	M	M@	R%	M@	R%	M@	R%	(%)	(%)
Hexythiazox	152.0	30.0 d*	85.8	88.7	88.6	8.0 d	93.4	89.3	88.4
Fenpyroximate	151.0	50.0 c	78.5	80.8	83.1	17.0 c	85.9	82.5	83.9
Chlorfenapyr	200.0	60.0 c	78.4	77.0	80.4	20.0 c	87.5	82.1	81.6
Abamectin	281.0	28.0 d	92.8	90.2	96.1	0.0 e	100	96.3	94.8
Spirodiclofen	131.0	25.0 d	86.2	86.6	92.4	3.0 de	97.1	91.9	90.9
Spirotetramat	120.0	23.0 d	86.2	85.6	74.3	14.0 c	85.4	82.0	84.8
Petroleum oil	201.0	82.0 b	70.6	71.6	72.4	30.0 b	81.4	74.8	75.5
Sulfur	115.0	25.0 d	84.3	73.6	62.8	19.0 c	79.4	75.5	76.5
Untreated check	201.0	279.0 a				161.0 a			
LSD 0.05	25.92	15.7				5.63			

Date of spray (Day –Month- Year), M = Mean No. of the mite individuals before spray, M@ = Mean No. of the mite individuals/20 fixed leaves after spray, R% = Reduction percentage and GRM$= General Reduction Mean

*Means followed by the same letter in each column are not significantly different at $P < 0.05$ level.

Although both sulfur and petroleum oil showed their activity for reducing the individuals of the mite, they were the least effective compounds as compared with the other tested compounds showing GRM of 76.5 and 75.5%, in respect.

The present results are being supported by those published by French and Villarreal (1990) when they evaluated the efficacy of six different acaricides against *Phyllocoptruta oleivora*. They found that abamectin gave consistently good results. Petroleum derived spray oils such as Sun spray ultra-fine oil, have potential and can be used as tools in IPM to replace conventional pesticides. Jamieson and Stevens (2009) found that two applications of milbemectin, abamectin, fenpyroximate or propargite were effective against eggs and motile life stages of the red citrus mite *Panonychus citri*. Also, Stansly and Kostyk (2015) reported that treatments including abamectin (A21390F or Agri-Mek®) reduced the citrus rust mite (CRM) densities through 61 days after treatment. In addition, Al-Azzazy (2016) concluded that abamectin, was effective for controlling the citrus rust mite *P. olievora*a. Meanwhile, abamectin was the less harmful against the beneficial predatory mite, *Amblyseius swirskii* Athias-Henriot.

Therefore, it could be said that abamectin can play a big role for controlling the citrus rust mite conserving the beneficial non-targeted organism if it was used within an integrated pest management program for controlling citrus pests.

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الملخص العربي

حركية عشيرة ومكافحة أكاروس صدأ الموالح الذي يُصيب البرتقال في مصر

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قد تتأثر حركية عشيرة أكاروس صدأ الموالح بالعديد من العوامل. وقد تمت دراسة التذبذب العشائري ومكافحة أكاروس صدأ الموالح بإستخدام مبيدات مختلفة برشها علي اشجار البرتقال "ڤالينشيا" (محصول صيفي) المنزرعة في وادي النطرون– مصر خلال موسمي الدراسة (٢٠١٥ ، ٢٠١٦). في الموسم الأول (٢٠١٥) كان أول ظهور لأفراد الأكاروس في ١١ ابريل وأختفت هذه الأفراد في ٢٨ أكتوبر ، وأظهرت النتائج وجود ٣ فترات ذروة تتزايد فيها أعداد الأكاروس زيادة كبيرة ، وفترة الذروة الأولي تم تسجيلها في منتصف مايو وفترة الذرة الثانية سُجلت في نهاية شهر يونيو أما قمة تزايد الأكاروس الثالثة كانت في الأسبوع الثاني من شهر سبتمبر. وفي موسم ٢٠١٦ سُجل أول ظهور للأكاروس خلال هذا الموسم في ٣٠ ابريل وانتهي هذا التواجد في ٢٧ سبتمبر ، ولوحظ أيضاً أن هناك ٣ فترات ذروة تتزايد فيها أعداد الأكاروس زيادة كبيرة (حدوث قمة) وفترة الذروة الأولي تم تسجيلها في منتصف يونيو وفترة الذرة الثانية سُجلت في الأسبوع الأول من يوليو، أما قمة تزايد الأكاروس الثالثة كانت في الأسبوع الأخير من شهر أغسطس. وقد اعتمدت الإصابة وشدتها بالأكاروس علي درجة الحرارة وزيادتها عن ٣٠° مئوية في كلاً من موسمي الدراسة.

كما تم تقييم ثمانية مبيدات (هكسيثيازوكس ، فنبيروكسميت ، كلورفينابر، أبامكتين ، سبيرودايكلوفين ، سبيروتترامات ، زيت بترولي ، كبريت) في الحقل ضد أكاروس صدأ الموالح حيث طبقت هذه المبيدات بالجرعة الموصي بها من قبل وزارة الزراعة المصرية. وتم حساب متوسط الخفض في تعداد الآفة بعد ثلاثة فحصات بعد كل رشة (الرشة ألأولي ، الثانية ، الثالثة). في كل من موسمي الدراسة (٢٠١٥ ، ٢٠١٦) وأظهرت النتائج أن مركب أبامكتين كان أكثر المبيدات المختبرة كفاءة وأعطي أعلي متوسط خفض في الرشات الثلاثة قدر بـ ٩٠,٠ ، ٩٠,٤ ، ٩٠,٣% علي التوالي (٢٠١٥) وكان هذا المتوسط أيضاً ٩٢,٩ ، ٩٥,٢ ، ٩٦,٣% (٢٠١٦). في نفس الوقت أظهرت النتائج أن كل من الكبريت والزيت البترولي كانا أقل المركبات المختبرة كفاءة ومع هذا كان متوسط نسب خفض الأكاروس التي أحدثتها هذه المركبات لم تقل عن ٦٦,٠% (٢٠١٥) أو ٧٣,٠% (٢٠١٦).