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Survey and Population Fluctuations of arthropods in winter potato plantation and effect of some compounds on predatory population and leaf chlorophyll content

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ABSTRACT

Field experiments were conducted during 2014/15 and 2015/16 seasons at Sakha, Kafr El-Sheikh governorate to survey arthropods associated with potato var. (Cara) and the population fluctuations of the main arthropod species in winter plantation. Also, efficiencies of certain compounds; Aveo & Indoprem (indoxacarb), Warnt (imidacloprid), Twistrid (acetamipirid), Kz oil, eucalyptus oil and garlic oil in reducing the population density of aphids (*Aphis gossypii,, Myzus persicae* and *Macrosiphum* sp.), *Bemisia tabaci* and *Empoasca* spp. were evaluated. In addition, their side effects on predators and chlorophyll content in potato leaves were evaluated. The investigation revealed the presence of 20 arthropod species were 15 families and 12 orders. Among the surveyed arthropods, 12 species were recorded as pests and eight species of beneficial arthropods on potato plants. Aphids constituted the greatest number followed by *B. tabaci* and *Empoasca* spp. *Nezara viridula* appeared in few numbers. Beneficial arthropods, *Scymnus* sp. constituted the greatest number but *P. alfierii* was recorded in few numbers. The highest population densities of *M. persicae* were recorded in December, and February. The highest population densities of *B. tabaci* were recorded in November, December and January, while leafhoppers were recorded in December and January. *Scymnus* sp. population was recorded in November, December, January and February. Peaks of *C. undecimpunctata* occurred in November and December, while spider populations were recorded in December and January in the two seasons. Twistrid was the most potent compounds in reducing the population density of *Aphis* spp., while garlic oil showed a low effect. Twistrid was the most potent compound in reducing *B. tabaci* eggs and adults also, Aveo had same effect in reducing *B. tabaci* immatures. Garlic oil showed a low effect in reducing *B. tabaci* immatures and adults while Warnt showed the lowest effect on whitefly eggs. All the tested compounds gave good effect in reducing *Emposaca* spp. Warnt was the most potent compound in reducing the population density of leafhoppers but eucalyptus oil showed a low effect. Warnt and Aveo induced a high effect on predators while garlic oil induced the lowest. All applications did not affect significantly on chlorophyll content.

INTRODUCTION

The potato, *Solanum taberosum* L. is an important solanaceous crop in many parts of the world. During the last twenty years, the potato cultivated area has steadily increased in Egypt, rendering potato the second most important vegetable crop after tomato (Abd El-Fattah *et al*., 2000).

Potato plants are attacked by several insect pests, such as aphids, whiteflies, leaf miners and potato tuber moth. Fortunately, these insect pests are associated with insect predators and spiders that regulate the populations of the abovementioned insects (El-Khawas and Shoeb, 2004, Golizadeh, *et al*., 2012 and Desoky, 2015).These insect pests affect directly or indirectly plant growth and subsequently, affect the yield (Mariy *et al*.1999).

The major damage was seen from hemipteran sucking pests, mainly aphids. Six aphid species are prevalent; damaging approximately 30 host plant species from 16 families (Kataria and Kumar, 2012). Green peach aphid was the most important and causes considerable damage to potato crop (Karimullah *et al*., 1995 and Saljoqi and van Emden, 2003). *Myzus persicae* is also considered to be a major pest of potatoes worldwide (Raman, 1988). Because aphids transmit diseases, these viruses can be as high as 90% depending on cultivar, infestation and environmental conditions (Raman, 1988).

Several natural enemies, especially predators attack pests on potato plants, where they play an important role in suppressing the pest populations. A wide range of chemicals have been marketing for controlling pests because of its effectiveness and speed controlling of sucking pests (El-Fakharany 2005). Also, petroleum oils were used, as they are cheaper and safer to human and environment. Mochiah *et al*., (2011) and Baldin *et al*. (2015) indicated into the effect of petroleum oil and plant oil against insect pests and predators.

The objective of this study was to survey arthropods associated with winter potato plantation, and monitor the population fluctuations of the main arthropod species. Also, efficiencies of certain compounds; Aveo & Indoprem (indoxacarb), Warnt (imidacloprid), Twistrid (acetamipirid), Kz oil, eucalyptus oil and garlic oil in reducing the population density of aphids, whitefly and leafhopper were investigated. The side effects of these compounds on predators and chlorophyll content in potato leaves were considered.

MATERIALS AND METHODS

The present study was undertaken during 2014/15 and 2015/16 seasons at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate.

1. Survey and population fluctuations of arthropods associated with winter potato plantation:

Potato tubers were sown on October 15th, in both seasons with cv. Cara. An area of about one feddan was divided into four equal plots (considered as four replicates). Inspection started 30 days after sowing, and continued weekly till the end of the crop season. Numbers of harmful arthropods were counted on 30 leaves taken from 10 plants/replicate (leaves picked up from lower, middle and upper levels). Beneficial arthropods were also counted on 10 plants/ replicate in the field. The same samples were moved to the laboratory to count the number of eggs and immatures of whitefly, and eggs, & mobile stages of *Tetranychus* sp. using binocular.

2-Toxicity of the tested compounds against sucking pests and their predators:

The efficiency of seven compounds and control against *Aphis* spp., *Empoasca* spp. (nymphs and adults), *Bemisia tabaci* (eggs, immatures and adults) and predators were evaluated in experimental area which was divided into 32 plots, each of 50 m^2. The treatments were arranged in a randomized complete block design with four replicates. The tested compounds were applied at recommended rates (Table, 2) using a knapsack motor sprayer. These compounds were sprayed on December 4th and 28th in 2014/15 and 2015/16 seasons, respectively at Sakha Agricultural Research Station, Kafr El-Sheikh governorate. The tested compounds and rate of applications were:

A. Insecticides:

1. Indoxacarb

- (Aveo 30% WG) at 50g/ feddan

-(Indoprem 30 % WG) at 15g/100 l water.

2. Imidacloprid

- (Warnt %) at 30g/100 l water.

3. Acetamipirid

-(Twistrid 40 % SP) at 20g/100 l water.

Mineral oil:- (Kz oil 95% EC) at 1000 ml/100 l water.

B. Plant oil:-Eucalyptus (*Eucalyptus camaldulensis*) oil at 1000 ml/100 l water

-Garlic (*Allium sativum*) oil at 1000 ml/100 l water.

Counts of sucking pests and predators were recorded before **spraying on 120 potato leaves and predators were also** counted on 40 potato plants. Counts were also recorded 2, 5, 7, 10 and 14 days after application. The considered predators were *Scymmus* sp., *Coccinella undecimpunctata* and spiders (spiderlings and adults). Percentage of population reductions were calculated according to Henderson and Telton (1955) equation.

4. Chlorophyll content of potato leaves

Chlorophyll content of potato leaves was measured in SPAD with a portable leaf chlorophyll meter (Minolta) (Marquard and Timpton, 1987) on the recently fully expanded leaf, ٢,٥,7,10 and 14 days after application (tested compounds).

RESULTS AND DISCUSSION

1. Survey and population fluctuations of arthropods associated with winter potato plantation:

Table (1) lists the arthropods found on winter potato plantation during 2014/15 and 2015/16 seasons. Data revealed the presence of 20 arthropod species, 15 families and 12 orders. Among the surveyed arthropods, 12 species were recorded as pests on potato plants.

Table (1): Population density of arthropod species occurring on potato winter plantation at Sakha, Kafr El-Sheikh Governorate.

Order/Family	Genus/species	Stage	Average No./30 leaves 2014/15	2015/16	Total	Occurrence%
Harmfull arthropods						
Hemiptera, Homiptera						
Aphididae	*Aphis gossypii* Glover *Myzus persicae* Sulzer *Macrosiphum* sp.	N,A	147.29	121.43	268.72	48.23
Aleyrodidae	*Bemisia tabaci* Genn.	N,A	81.50	73.71	155.21	27.86
Cicadellidae	*Empoasca* spp.	N,A	26.71	35.14	61.85	11.10
Lepidoptera						
Gelechiidae	*Phthorimaea operculella* (Zeller)	L	10.43	16.93	27.36	4.91
Gelechiidae	*Tuta absoluta* (Meyrick)	L	2.64	3.64	6.28	1.13
Noctuidae	(Semi looper worms)	L	0.79	0.50	1.29	0.23
Hemiptera Pentatomidae	*Nezara viridula* (L)	N,A	0.43	0.57	1.00	0.18
Diptera Agromyzidae	*Liriomyza* sp.	L	5.79	7.93	13.72	2.46
Thysanoptera						
Thripidae	*Thrips tabaci* Lind.	N,A	0.79	0.93	1.72	0.31
Acarina						
Tetranychidae	*Tetranychus* sp.	E,M	8.57	11.43	20.00	3.59
Total	-	-	284.94	272.21	557.15	100.0
Beneficial arthropods		Average No./10 plants				
Coleoptera						
Coccinellidae	*Scymnus* sp.	L,A	16.50	18.0	34.50	48.35
Coccinellidae	*Coccinella undecimpunctata* L.	L,A	8.57	9.71	18.28	25.62
Staphylinidae	*Paederus alfierii* (Koch)	A	0.29	0.21	0.50	0.70
Homiptera						
Anthocoridae	*Orius* sp.	N	0.43	0.29	0.72	1.01
Neuroptera						
Chrysopidae	*Chrysoperla carnea* Steph.	E,L,A	2.36	1.71	4.07	5.70
Diptera						
Syrphidae	Syrphidae	L,A	0.79	0.50	1.29	1.81
Prostigmata						
Anystidae	*Anystis* sp.	A	2.21	2.86	5.07	7.11
Araneae	Spiders	S,A	4.21	2.71	6.92	9.70
Total	-	-	35.36	35.99	71.35	100.0

E = Egg, L=larva, N= nymph, A=adult, M= mobile stage, S= Spiderling

These pests were *Myzus persicae* Sulzer, *Aphis gossypii* Glover, *Macrosiphum* sp., *Bemisia tabaci* Genn., *Empoasca* spp., *Phthorimaea operculella* (Zeller),*Tuta absoluta* (Meyrick), semi looper worms, *Nezara viridula* **(**L), *Liriomyza* sp., *Thrips tabaci* Lind. and *Tetranychus* sp. Eight species were beneficial arthropods; *Scymnus* sp., *Coccinella undecimpunctata* L., *Paederus alfierii* (koch), *Orius* sp., *Chrysoperla carnea*, Syrphidae, *Anystis* sp. and spiders. Aphids (*M. persicae, A. gossypii*, and *Macrosiphum* sp.) constituted the greatest number. Population density of aphids per 30 leaves was 268.72 individuals forming about 48.23% of the total harmful arthropods in 2014/15 and 2015/16 seasons. It was followed by *B. tabaci* recording 27.86% and *Empoasca* spp. recording 11.10% of the total collected harmful population. *N. viridula* was represented by few individuals (0.18%). As for beneficial arthropods, *Scymnus* sp. constituted the greatest number, with 34.50 individuals per 10 plants forming about 48.35% of the total beneficial arthropods in 2014/15 and 2015/16 seasons. The next common species on potato plant was *C. undecimpunctata* which represented about 25.62 %. Spiders occupied the third rank recording 9.70%, while *P. alfierii* was represented by few numbers recording 0.70 % out of total predators.

Abdalla *et al*. (1995) showed that thrips was less abundant than that of aphid on potato plants. Mariy *et al*. (1999) recorded *B. tabaci* attacking potato plants. Abd El-Fattah *et al*. (2000) found that *M. persicae* was the most dominant aphid species, while *A. gossypii* was much less abundant during the whole season. Ibrahim (2015) surveyed 24 arthropod species, belonging to 21 families and nine orders on potato.

2. Population fluctuations of some suking pests on potato plants:

Myzus persicae

Population densities of *M. persicae* on potato plants at Kafr El-Sheikh during 2014/15 and 2015/16 seasons are shown in Fig.(1). In 2014/15 season, the highest population densities of the pest were recorded on December 28th, January 11th and February 2nd. The highest population densities of *M. persicae* were recorded on December 14th& 28th and February 2nd in 2015/16.

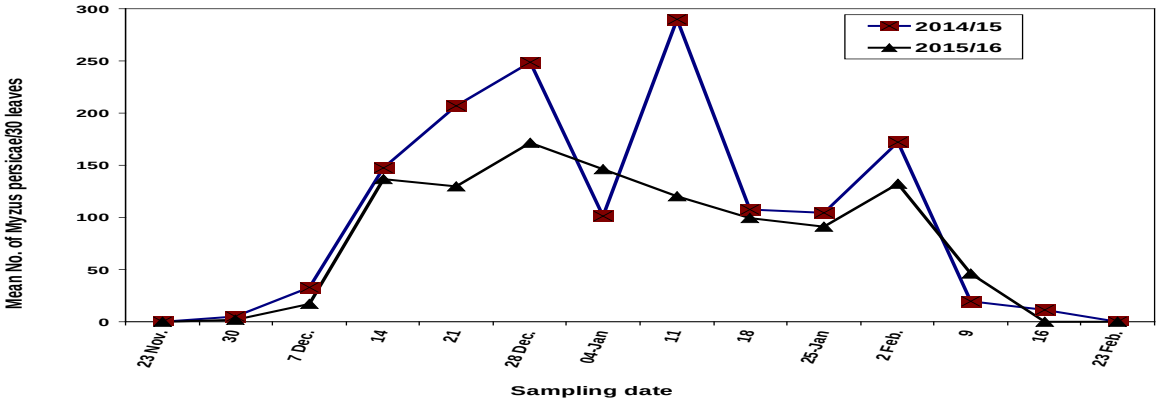

Fig. 1. Population fluctuations of *Myzus persicae* on potato plants.

El-Sheikh and El–Nagar (1994) reported that *M. persicae* occurred on potato plants throughout October/December, averaging of 1.31 aphids/3 leaflets. The peak number of this species was recorded in mid December during the winter plantation. Abd El-Fattah *et al*. (2000) reported that infestation of potato plants by *M. persicae* in winter plantation was much lower at the time of plant sprouting, then increased with the growing season from late October to the end of harvesting time. Pandey *et al*. (2007) detected the first appearance of *M. persicae* by the last week of November and first week of December, while the peak population was observed during the third week of January. Ibrahim (2015) recorded the first peak of *M. persicae* in potato fields on December 26th while, the second peak occurred on January 30th.

Bemisia tabaci

The highest population densities of *B. tabaci* were recorded on November 30th, December 28th and January 11th in both seasons (Fig. 2).

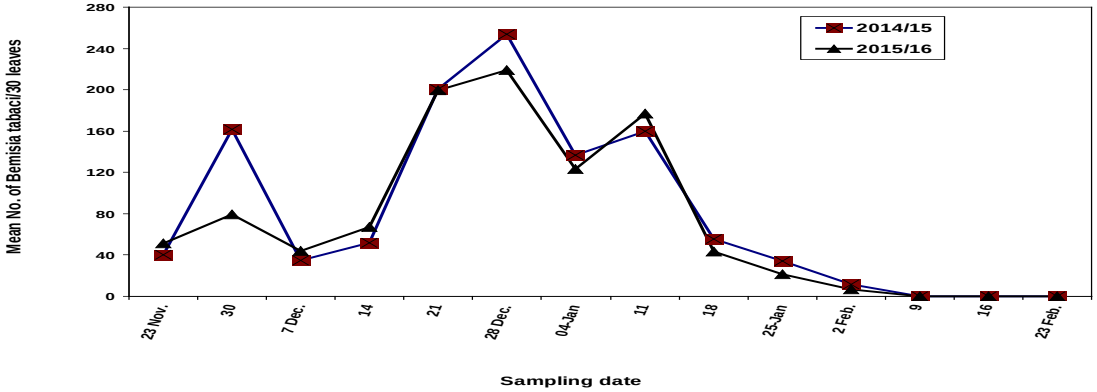

Fig. 2. Population fluctuations of *Bemisia tabaci* on potato plants.

***Empoasca* spp.**

The highest population densities of leafhoppers were recorded on December 21st, January 11th & 25th and February 9th in 2014/15 season. These were recorded on December 7th& 21st and January 4th&25th in 2015/16(Fig. 3).

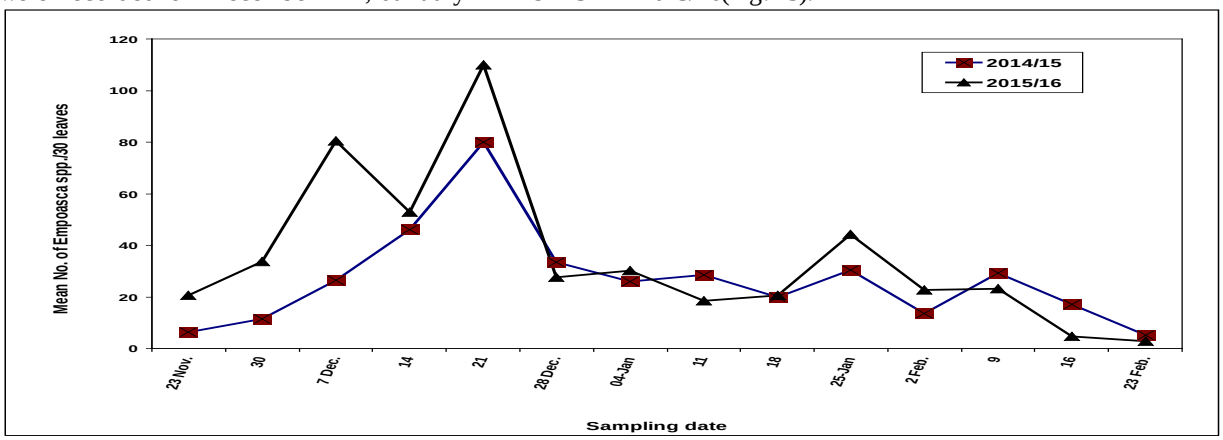

Fig. 3. Population fluctuations of *Empoasca* spp. on potato plants

3-Population fluctuations of predators

Population densities of the predators are presented in Fig. (4,5 and 6). The density population of *Scymnus* sp. (Fig.4) was recorded on November 30th, January18th and February 9th in the two seasons. Also, it was recorded on December 14th in 2014/15 and December 28th in 2015/16. Peaks of *Coccinella undecimpunctata* occurred on November30th, December 28th, January 25th and February 9th in 2014/15 (Fig. 5) and November 30th, December 21th and January 18th in 2015/16. The population density of spiders (Fig. 6) was recorded on December 21st, January4th and February 2nd&16th in 2014/15, while those in 2015/16 were recorded on December14th, January 11th and February 2nd (Fig.6).

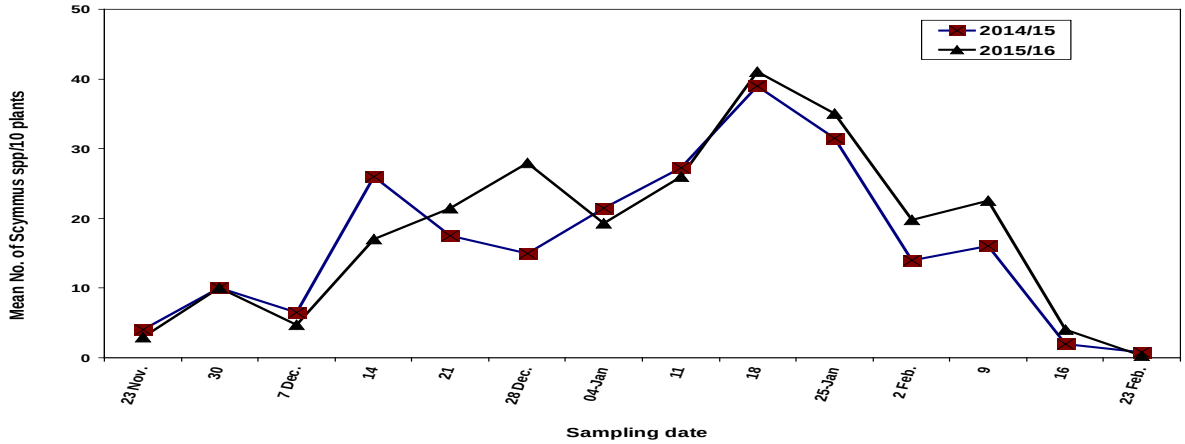

Fig. 4. Population fluctuations of *Scymnus* sp. on potato plants

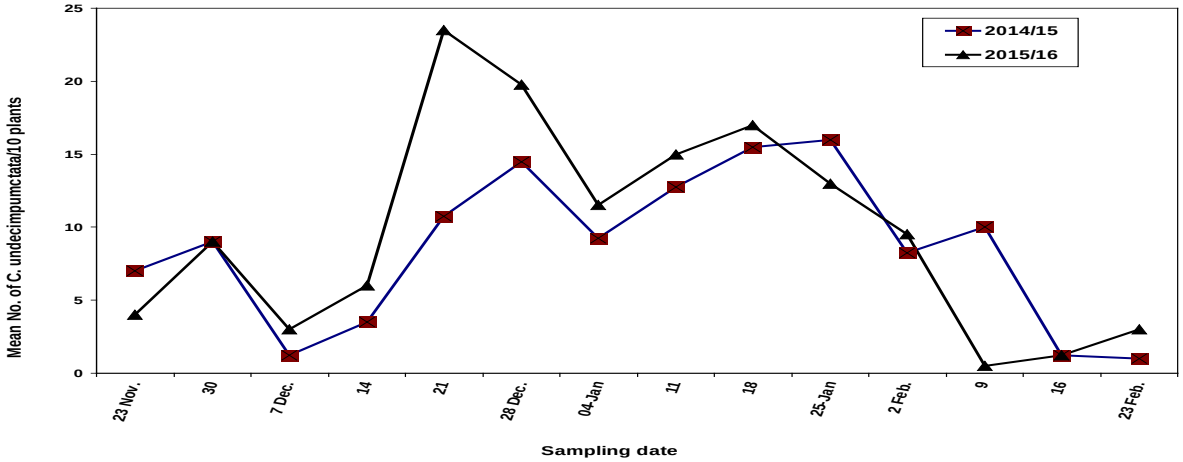

Fig. 5. Population fluctuations of *Coccinella undecimpunctata* on potato plants

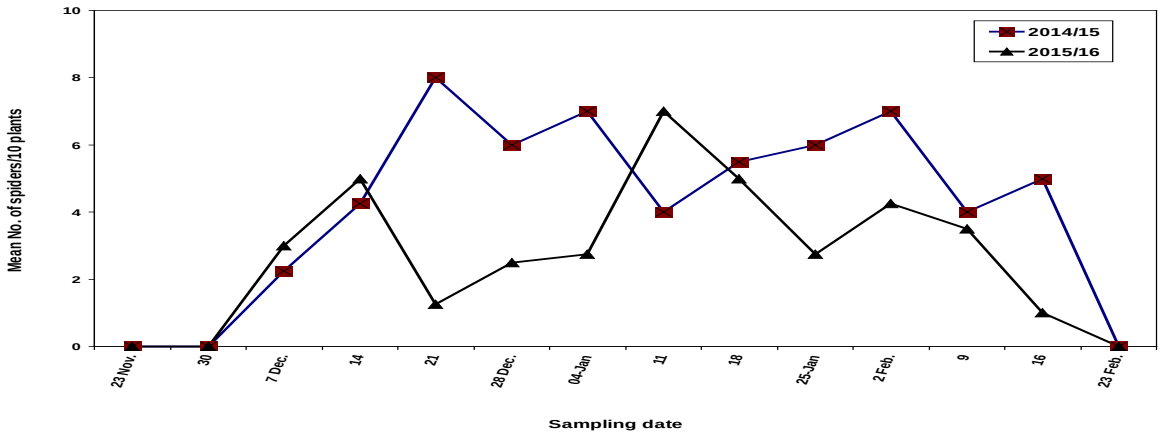

Fig. 6. Population fluctuations of spiders on potato plants

4. Efficiency of compounds on some sucking pests:

The effect of the tested compounds on *Aphis* spp. infesting potato plants are presented in Table (2). Twistrid, Warnt and Indoprem were the most potent compounds in reducing the population density of *Aphis* spp., with values of 91.35, 88.55 and 86.65% in 2014/15 and 93.30, 90.58 and 88.03% in 2015/16 season, respectively. It was followed by Kz-oil, with reductions of 85.04 and 86.05% in 2014/15and 2015/16 respectively,while garlic oil showed a low effect(Table 2).

Table 2. Potency of the tested compounds in reducing *Aphis* spp. populations on potato plants at Sakha, Kafr El-Sheikh Governorate

Compound	Rate/100 liter of water	Aver. No. pre-treat. /30 leaves	Initial effect %	% Reduction Residual effect after indicated days				Residual effect average	Grand average
				5	7	10	14		
2014/15									
Aveo	25 g	305.0	71.94	75.54	77.44	92.05	69.41	78.61	77.28
Indoprem	15 g	295.5	91.31	89.90	75.95	94.53	81.58	85.49	86.65
Warnt	30 g	350.0	94.87	78.69	90.39	86.15	92.67	86.98	88.55
Twistrid	20 g	401.5	89.34	85.69	92.55	94.97	94.67	91.85	91.35
Kz-oil	1L	315.0	84.79	73.95	90.27	91.02	85.19	85.11	85.04
Eucalyptus oil	1L	411.5	64.65	75.89	89.64	88.22	86.78	85.09	81.00
Garlic oil	1L	505.5	62.76	63.11	89.64	87.06	73.86	78.42	75.29
Untreated (No.)	-	299.5	350.0	401.5	400.5	370.75	385.25	-	-
2015/16									
Aveo	25 g	236.50	74.04	77.26	76.61	92.89	65.89	78.16	77.34
Indoprem	15 g	206.25	93.70	92.18	76.53	95.11	82.62	86.61	88.03
Warnt	30 g	165.00	96.42	80.44	93.71	87.78	94.57	89.13	90.58
Twistrid	20 g	385.00	90.42	87.43	96.41	96.51	95.34	93.92	93.30
Kz-oil	1L	489.50	86.25	72.25	90.82	93.48	87.18	86.0	86.05
Eucalyptus oil	1L	585.75	63.52	76.13	91.74	85.08	87.76	85.18	80.85
Garlic oil	1L	360.25	58.71	44.77	91.36	82.27	70.14	72.14	69.45
Untreated (No.)	-	242.00	563.75	123.75	192.50	396.0	74.25	-	-

The effect of the tested compounds on whitefly infesting potato plants are presented in Tables (3& 4). Twistrid, eucalyptus oil, Aveo and garlic oil were the most potent compounds in reducing *B. tabaci* eggs in the two seasons. They were followed by Indoprem and Kz-oil, while Warnt showed a low effect.

Aveo and Indoprem were the most potent compounds in reducing *B. tabaci* immatures in the two seasons, but garlic oil and Kz-oil showed low effects. The other compounds were of moderate effect (Table 3&4).

Twistrid, Warnt, Indoprem and Kz-oil were the most potent compounds in reducing *B. tabaci* adults in the two seasons. It was followed by eucalyptus oil, and Aveo. Garlic oil showed a low effect on the whitefly adult in the two seasons (Table 3&4).

The effects of the tested compounds on *Emposaca* spp. infesting potato plants are presented in Table (5). Warnt, Aveo, Indoprem and Twistrid were the most potent compounds in reducing the population density of leafhoppers in the two seasons. It was followed by Kz-oil and garlic oil, while eucalyptus oil showed a low effect.

Omar *et al.* (2001) found that the most potent insecticide in reducing *A. gossypii* numbers on squash was imidacloprid followed by malathion. El-Fakharany (2005) found that fenitrothion, sour oranage and blue gum oils reduced significantly *B. tabaci* populations. Hendawy and El-Fakharany (2012) found that Capl 2 oil and orange oil were the most potent compounds in reducing the population density of whitefly, followed by Kz oil and Actellic. Actellic and orange oil were the most potent compound in reducing the population density of *A. gossypii*, followed by Kz oil and Capl 2 oil. Gameel (2013) found that orange oil showed a moderate toxic effect on the population density of the whitefly. Gorri *et al.* (2015) found that chlorpyrifos and thiamethoxam were efficient against adults of *B. tabaci*.

5. Side toxic effects of the tested compounds on predators inhabiting potato plantations:

Warnt and Aveo induced a high effect on predators [*Scymnus* sp., *C. undecimpunctata* and spiders] in 2014/15 and 2015/16 at Sakha, Kafr El-Sheikh. The others compounds were of moderate effect on predators. Garlic oil induced the lowest effect (Table,6). El-Fakharany (2005) found that fenitrothion was the most harmful on *Scymnus* spp, *C. undecimpunctata*, and spiders, while Kz-oil, acidless orange and blue gum oils were the safest tested compounds on predators. Hendawy and El-Fakharany (2012) showed that the side effect of orange oil had slight effects, whereas kz oil and capl 2 caused moderate effects on *Scymnus* sp. and spiders. Gameel (2013) found that orange oil was of low toxic effect, whereas Azadirachtin showed a moderate toxic effect on the population density of the spiders but it was more toxic alternative pesticides against C. *undecimpunctata, and C. septempunctata*. Hendawy and El-Fakharany (2015) found that Biofly and Bio-Guard had slight effects, whereas Marshal and Agrothion were more toxic than Neomyl and Bermectine on spiders.

Table 3. Potency of the tested compounds in reducing *Bemisia tabaci* populations on potato plants in 2014/15 season at Sakha, Kafr El-Sheikh Governorate

Compound	Rate/100 liter of water	Ave. No. pre-treat. /30 leaves	Initial effect % (2 days)	% Reduction Residual effect after indicated days 5	7	10	14	Residual effect average	Grand average
Egg									
Aveo	25 g	141.0	37.77	96.66	97.90	85.19	89.63	92.35	81.43
Indoprem	15 g	78.5	55.29	56.51	65.09	76.06	99.19	74.21	70.43
Warnt	30 g	100.25	45.73	66.34	92.61	58.34	84.15	75.06	69.43
Twistrid	20 g	87.5	46.35	75.78	92.38	93.64	100.0	90.45	81.63
Kz oil	1L	101.25	49.73	92.25	74.40	80.75	52.93	75.08	70.01
Eucalyptus oil	1L	111.5	53.17	91.55	92.03	99.38	71.50	88.62	81.53
Garlic oil	1L	137.0	49.08	95.99	96.22	99.49	61.96	88.42	80.55
Untreated (No.)	-	98.5	112.25	125.5	133.0	141.5	155.0	-	-
Immature (nymphs and pupae)									
Aveo	25 g	81.5	75.09	89.75	91.57	84.09	59.71	81.28	80.04
Indoprem	15 g	99.75	60.18	84.93	96.17	87.81	79.65	87.14	81.75
Warnt	30 g	131.5	59.06	94.28	73.88	77.81	55.96	75.48	72.20
Twistrid	20 g	153.0	52.12	66.69	80.05	100.0	55.12	75.47	70.80
Kz-oil	1L	123.5	49.97	75.65	64.77	73.75	41.99	64.04	61.23
Eucalyptus oil	1L	111.25	54.38	89.49	83.54	89.07	38.28	75.10	70.95
Garlic oil	1L	115.0	75.44	95.64	81.42	40.81	40.29	64.54	66.72
Untreated (No.)	-	101.5	115.0	121.5	133.0	125.25	170.0	-	-
Adult									
Aveo	25 g	131.5	54.11	64.65	85.45	77.62	74.66	75.60	71.30
Indoprem	15 g	146.25	55.44	70.14	90.41	91.58	53.73	76.47	72.26
Warnt	30 g	153.5	69.07	79.81	73.82	90.19	79.29	80.78	78.44
Twistrid	20 g	112.75	67.17	85.63	93.78	94.23	89.54	90.80	86.07
Kz-oil	1L	162.5	76.23	85.26	93.72	92.84	92.11	90.98	88.03
Eucalyptus oil	1L	173.5	69.86	94.32	85.66	77.51	56.27	78.44	76.72
Garlic oil	1L	215.0	55.84	93.45	95.25	88.54	62.56	84.95	79.13
Untreated (No.)	-	121.5	151.0	172.5	190.5	177.5	237.0	-	-

Table 4. Potency of the tested compounds in reducing *Bemisia tabaci* populations on potato plants in 2015/16 season at Sakha, Kafr El-Sheikh Governorate

Compound	Rate/ 100 liter of water	Ave. No. pre-treat. /30 leaf	Initial effect % (2 days)	% Reduction Residual effect after indicated days 5	7	10	14	Residual effect average	Grand average
Egg									
Aveo	25 g	137.5	36.67	97.47	98.0	83.04	93.21	92.93	81.68
Indoprem	15 g	66.0	53.82	57.78	66.67	77.38	100.0	75.46	71.13
Warnt	30 g	90.75	44.82	67.37	93.94	58.87	83.55	75.93	69.71
Twistrid	20 g	88.00	45.27	76.25	93.75	95.76	100.0	91.44	82.21
Kz oil	1L	79.75	48.13	93.45	75.86	53.20	81.28	75.95	70.38
Eucalyptus oil	1L	68.75	52.50	92.40	92.0	72.86	100.0	89.32	81.95
Garlic oil	1L	79.75	48.13	97.82	96.55	62.56	100.0	89.23	81.01
Untreated (No.)	-	52.25	66.0	82.50	52.25	38.50	19.25	-	-
Immature (nymphs and pupae)									
Aveo	25 g	77.0	74.83	88.99	90.09	85.32	60.85	81.31	80.02
Indoprem	15 g	101.75	59.52	83.33	95.0	80.56	88.89	86.95	81.46
Warnt	30 g	104.5	58.27	95.94	70.79	56.73	78.36	75.46	72.02
Twistrid	20 g	123.75	51.06	65.74	79.44	56.60	100.0	75.45	70.57
Kz-oil	1L	132.0	48.61	74.31	63.39	42.19	74.31	63.55	60.56
Eucalyptus- oil	1L	115.5	53.85	88.99	82.38	38.82	90.21	75.10	70.85
Garlic- oil	1L	77.00	74.83	94.49	80.18	41.27	41.27	64.30	66.41
Untreated (No.)	-	101.75	115.50	66.00	110.0	99.0	74.25	-	-
Adult									
Aveo	25 g	145.75	52.45	65.13	86.22	78.14	75.41	76.23	71.47
Indoprem	15 g	112.75	53.17	71.32	91.09	92.94	54.08	77.36	72.52
Warnt	30 g	140.25	67.06	80.24	74.94	91.48	80.12	81.70	78.77
Twistrid	20 g	173.25	65.71	86.67	94.20	95.40	90.80	91.77	86.56
Kz-oil	1L	173.25	74.29	86.67	94.20	93.10	93.10	91.77	88.27
Eucalyptus oil	1L	112.75	67.80	95.90	86.64	78.81	57.61	79.74	77.35
Garlic oil	1L	154.00	53.93	94.00	96.74	89.66	63.79	86.05	79.62
Untreated (No.)	-	115.50	192.50	68.75	63.25	79.75	79.75	-	-

Table 5. Potency of the tested compounds in reducing *Emposaca* spp. populations on potato plants at Sakha, Kafr El-Sheikh Governorate

Compound	Rate/100 liter of water	Aver. No. pre- treat. /30 leaves	% Reduction						
			Initial effect	Residual effect after indicated days				Residual effect average	Grand average
			%	5	7	10	14		
2014/15									
Aveo	25 g	55.0	83.45	77.76	97.72	94.51	80.15	87.41	86.61
Indoprem	15 g	41.5	73.01	85.26	85.34	89.09	91.90	87.90	84.92
Warnt	30 g	36.75	90.48	83.36	87.34	85.63	87.43	85.94	86.85
Twistrid	20 g	60.25	83.73	85.79	95.25	68.69	83.97	83.43	83.49
Kz-oil	1L	35.5	72.39	70.71	92.94	87.25	88.17	84.77	82.29
Eucalyptus oil	1L	46.25	76.54	77.52	85.29	73.90	65.49	75.55	75.75
Garlic oil	1L	60.25	75.60	63.45	91.68	93.74	77.69	81.64	80.43
Untreated (No.)	-	31.5	45.0	51.5	44.0	41.75	37.5	-	-
2015/16									
Aveo	25 g	36.25	84.83	78.93	99.90	95.26	81.03	88.80	88.01
Indoprem	15 g	35.0	73.81	86.90	86.90	90.18	93.45	89.36	86.25
Warnt	30 g	40.0	91.98	84.72	88.54	87.11	88.54	87.23	88.18
Twistrid	20 g	57.5	84.86	86.71	96.01	67.12	84.06	83.48	83.75
Kz-oil	1L	45.0	73.52	69.44	94.91	88.54	89.81	85.68	83.24
Eucalyptus oil	1L	50.0	77.08	78.61	86.25	69.06	40.42	68.59	70.28
Garlic oil	1L	31.25	76.53	60.89	92.67	94.5	78.0	81.52	80.52
Untreated (No.)	-	27.5	75.0	22.5	15.0	20.0	15.0	-	-

Table 6. Effect of the tested compounds in reducing predator¤ populations on potato plants at Sakha, Kafr El-Sheikh Governorate.

Compound	Rate/ 100 liter of water	Aver. No. pre- treat. /10 plants	% Reduction						
			Initial effect	Residual effect after indicated days				Residual effect average	Grand average
			%	5	7	10	14		
2014/15									
Aveo	25 g	23.5	32.22	0.0	0.0	41.30	0.0	10.33	14.70
Indoprem	15 g	31.5	0.0	0.0	0.0	47.25	0.0	11.81	9.45
Warnt	30 g	25.0	31.19	0.0	21.0	41.06	0.0	15.52	18.65
Twistrid	20 g	40.25	0.0	0.0	20.41	22.11	0.0	10.63	8.50
Kz-oil	1L	22.75	1.99	0.0	22.57	33.86	0.0	14.11	11.68
Eucalyptus oil	1L	33.25	0.0	0.0	39.0	21.74	0.0	15.19	12.15
Garlic oil	1L	37.25	0.0	0.0	31.22	7.43	0.0	9.66	7.73
Untreated (No.)	-	19.75	31.0	41.5	37.0	31.5	27.25	-	-
2015/16									
Aveo	25 g	11.0	25.0	0.0	0.0	40.0	0.0	10.0	13.0
Indoprem	15 g	8.25	0.0	0.0	0.0	46.67	0.0	11.67	9.33
Warnt	30 g	11.0	25.0	0.0	20.0	40.0	0.0	15.0	17.0
Twistrid	20 g	11.0	0.0	0.0	20.0	20.0	0.0	10.0	8.0
Kz-oil	1L	13.75	0.0	0.0	20.0	36.0	0.0	14.0	11.2
Eucalyptus oil	1L	11.0	0.0	0.0	40.00	20.00	0.0	15.0	12.0
Garlic oil	1L	19.25	0.0	0.0	31.43	8.57	0.0	10.0	8.0
Untreated (No.)	-	11.0	11.0	8.25	13.75	13.75	16.5	-	-

¤ where predators : *Scymnus* sp.,*C. undecimpunctata* and spiders.

6. Effect of the tested compounds on chlorophyll content in potato leaves:

Results in Table (7) showed that chlorophyll content did not differ significantly due to compound applications. The chlorophyll content grand average increased by Aveo, Indoprem and Warnt treatments, while it was the least with eucalyptus oil treatment on leaves potato. The other tested compounds had moderate effects.

Table 7. Effect of the tested compounds on chlorophyll in potato leaves at Sakha, Kafr El-Sheikh Governorate

Compound	Rate/100 liter of water	Chlorophyll content (SPAD) unit effect after indicated days					
		2	5	7	10	14	Grand average
Aveo	25 g	44.0	44.07	43.6	44.0	44.97	44.71[a]
Indoprem	15 g	45.3	44.7	44.0	45.3	43.53	44.75[a]
Warnt	30 g	44.5	43.43	45.47	44.5	42.03	44.0 [a]
Twistrid	20 g	46.2	41.57	44.13	46.2	41.87	43.49 [a]
Kz-oil	1L	46.7	40.53	43.4	46.7	43.43	43.30 [a]
Eucalyptus oil	1L	39.7	43.13	43.57	39.7	41.8	42.16 [a]
Garlic oil	1L	40.8	43.33	45.03	40.8	42.5	43.04 [a]
Untreated	-	46.0	43.87	42.23	46.0	47.37	45.28 [a]

Mean followed by a common letter are not significantly different at the 5% level by DMRT (1955)

Reduction of the chlorophyll content in the current investigation which may be due to the inhibition of their biosynthesis or breakdown of pigments or their precursors as suggested for cowpea seedling under stress by insecticide dimethoate (Mishra *et al*., 2008). Seth *et al*. (2014) found that the increase in total chlorophyll content due to Neem extract treatment was significantly the same as synthetic pesticide (dimethoate) treated plant.

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حصر مفصليات الأرجل و كثافتها العددية فى زراعات البطاطس و كذلك تأثير بعض المركبات السامة عليها وعلى محتوي الكلورفيل فى الاوراق

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أجري البحث فى منطقة سخا بمزرعة محطة البحوث الزراعية بمحافظة كفرالشيخ موسمى ١٥/٢٠١٤ و١٦/٢٠١٥. بهدف حصر مفصليات الأرجل المتواجدة على زراعات البطاطس صنف (كارا) فى العروة الشتوية و كثافتها العددية ، و كذلك دراسة تأثير بعض المركبات السامة عليها وعلى محتوي الكلورفيل فى الأوراق ، أوضحت نتائج الحصر وجود ٢٠ نوعاً من مفصليات الأرجل تنتمى إلي ١٥ عائلة و التى تتبع ١٢ رتبة تم تسجيلها على نباتات البطاطس فى الحقل ، من بينها ١٢ نوعا من الآفات و ثمانية أنواع من المفترسات. كان أكثرها تعدادا المن ويليها الذبابة البيضاء ثم نطاطات الاوراق و أقلها البقة الخضراء.أما المفترسات كان الاسكمنس هو الأكثر تواجدا و أقلها الحشرة الرواغة. وقد سجل من الخوخ الأخضر أعلى تعداد له فى ديسمبر وفبراير فى كلا الموسمين كما ظهر له تعداد عالى فى يناير فى موسم ١٥/٢٠١٤ ، بينما ارتفع تعداد الذبابة البيضاء فى شهور نوفمبر و ديسمبر و يناير فى الموسمين. كما سجلت نطاطات الأوراق أعلى تعداد لها فى ديسمبرو يناير فى كلا الموسمين وبالإضافة إلى فبراير فى الموسم ١٥/٢٠١٤.فى حين كان الاسكمنس أعلى تعدادا فى نوفمبر و ديسمبر و يناير و فبراير فى الموسمين .بينما سجل أبوالعيد أعلى تعداد له فى نوفمبر و ديسمبرو يناير و فبراير فى الموسمين. كما سجلت العناكب أعلى تعداد لها فى ديسمبر و يناير و فبراير فى كلا الموسمين . كذلك تم دراسة تأثير رش بعض المركبات على الآفات الثاقبة الماصة فى زراعات البطاطس. حيث أظهرت النتائج أن كل المركبات المختبرة حقليا أدت إلى خفض تعدادها على نباتات البطاطس مع تفاوت نسب الخفض فى الإصابة،حيث كان تويست رايد أكثر المركبات سمية ضد المن. بينما كان زيت الثوم ذو سمية منخفضة على الآفة فى الموسمين.أما بالنسبة للذبابة البيضاء كان تويست رايد أكثر المركبات سمية ضد بيض الذبابة. بينما كان وارنت ذو سمية منخفضة على بيض هذه الآفة .فى حين كان افيو أكثر المركبات سمية على يرقات وعذراى هذه الآفة و أقلها زيت الثوم و كزد-أويل.وكان تويست رايد أكثر المركبات سمية على الحشرات الكاملة للذبابة و أقلها زيت الثوم .أما بالنسبة لنطاطات الأوراق كان وارنت أكثر المركبات سمية و أقلها زيت الكافور. عند دراسة الأثر الجانبى للمركبات المختبرة على المفترسات (الاسكمنس و ابوالعيد ١١ نقطة و العناكب المفترسة) كانت كل المركبات المختبرة ذات تأثير طفيف عليها ما عدا وارنت و افيو. لم تؤثر أى من المركبات المختبرة على محتوى الأوراق من الكلورفيل.

كلمات مفتاحية: مفصلية الارجل، الافات الثاقبة الماصة، زراعات البطاطس،المركبات، الكلورفيل.