

Management of Pests Infesting Eggplant Using some Insecticides and Oils and their Relationship with Crop Yield under Greenhouse

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ABSTRACT

Experiments were conducted in the experimental Horticulture Research Station at Qaha, Qalubiya governorate under greenhouse conditions during two successive seasons (2016-2017 and 2017-2018). The study aims to evaluate insecticides, orange oil and mineral oil alone and in binary mixtures, their relationship with crop yield under greenhouse. *Bemisia tabaci* (Genn.) and *Tetranychus urticae* Koch the most important pest were found on eggplant, the mealy bug *Phenacoccus solenopsis* Tinsley its new insect pest of eggplant (*Solanum melano-genena* L.) these pests are attacking a wide spectrum of economic plants, causing great losses in their yield. Results showed that using Actara binary mixtures with mineral oil or orange oil binary mixtures with mineral oil have a highly significant effect on decreasing pests population infesting eggplant growth and yield. The insecticide binary mixtures with mineral oil have effect on pests population whereas decreased mean number of pests. The insecticide binary mixtures with mineral oil were the most efficiency method compared to control (without treatment).

Keywords: greenhouse, eggplant, insecticides, orange oil, mineral oil, binary mixtures, *Bemisia tabaci* (Genn.) and *Tetranychus urticae* Koch, *Phenacoccus solenopsis* Tinsley and crop yield.

INTRODUCTION

Eggplant (*Solanum melano-genena* L.) is an important vegetable crop grown in various tropical and temperate parts of the world (Kashyap *et al.*, 2003). It is a good source of vitamins and minerals (particularly iron making its total nutritional value comparable with tomato (Kalloo, 1993, Matsubara *et al.*, 2005). One hundred grams of fruit contains 0.7 mg iron, 13.0 mg sodium, 213.0 mg potassium (Nonnecke, 1989), 12.0 mg calcium 26.0 mg phosphorus, 5.0 mg ascorbic acid and 0.5 International Units of vitamin A and provides 25.0 calories (Tindall, 1978). Eggplant has been used in traditional medicines (Khan, 1979). For example, tissue extracts have been used for treatment of asthma, bronchitis, cholera and dysuria; fruits and leaves are beneficial in lowering blood cholesterol. Ninety percent of production comes from five countries; china produces 24.5 million tons followed by India 10.6 and Egypt come in the third by 1.2 million tons per year. About 1.7 million hectares are devoted to cultivate eggplant in the world (FAO, 2010).

Whitefly, *Bemisia tabaci* (Genn.), the most important insect pest of eggplant (Yadav and Kumawat, 2013) and the Cotton Mealybug, *Phenacoccus solenopsis*

Tinsley, (Abd El-Wareth, 2016). In addition to, the two spotted spider mite, *Tetranychus urticae* Koch, (Azouz, *et al.*, 2014) These pests are attacking a wide spectrum of economic plants, causing great losses in their yield. The problems of these pests are not only due to its direct damage to the infested plants but also to its capability to transmit viruses. The continuous and unwise uses of insecticides by farmers usually lead to adverse effects on naturally occurring biological control agents and the biotic environment as well. Also, eggplant can be infected by pests during the harvesting period. Therefore, the search for more safe insecticide alternatives is becoming so urgent. So, the aim of this work was to evaluate some insecticide, orange Oil with mineral oil for eggplant pest management and crop yield under greenhouse.

MATERIALS AND METHODS

Tested insecticides and control agents:

The evaluated insecticides, orange oil and mineral oil alone and in binary mixtures and control agents, common names and rates were introduced in the following Table (1):

Table 1. Insecticides, orange oil and mineral oil alone and in binary mixtures and control agents treatments, common names and field rates

Trade name	Common name	Rate / 100 liter water
KZ oil EC 95%	mineral oil	100cm ³
KZ oil EC 95% + (quartier of rate) Actara WG 25% in first spray	mineral oil + Thiamethoxam	100 cm ³ + 20gm
KZ oil EC 95% + (quartier of rate) Agri Flex SC 18.56% in second spray	mineral oil+ Abamectin Thiamethoxam	100 cm ³ + 120cm ³
KZ oil EC 95% + (quartier of rate) closer SC24% in the third spray	mineral oil + "Sulfoxaflor"	100 cm ³ + 50cm ³
Orange oil	Orange oil	30cm ³
KZ oil EC95%+ orangee oil	mineral oil+ Orange oil	100cm ³ +30cm ³
Actra	Thiamethoxam	20gm
Control	Without spray	

Ethyl acetate which was used as solvent of the orange oil at 0.5cm³/L.

Control plants which were sprayed with the tap water.

Field experiments:

Experiments were conducted in the experimental Horticulture Research Station at Qaha, Qalubiya governorate under greenhouse conditions during two successive seasons (2016-2017 and 2017-2018). Eggplant seedlings were transplanted at October 15, 2016 and October 15, 2017 in the greenhouse. The area of greenhouse was 9*40 m². Each treatment was replicated three times. Eggplant crop was

weighted during harvesting period. The insecticides were sprayed by A knapsack sprayer (10 liters) was used on three time at Nov., 14, Dec., 5, and Dec., 26, 2016, respectively. As the same date in the second season 2017. Control was sprayed only by water. The efficiency of the tested products was estimated by counting of the target alive pests (*Bemisia tabaci* (Genn.), *Phenacoccus solenopsis* Tinsley and *Tetranychus urticae* Koch) on the lower surface of ten eggplant leaves per each plot. Pretreatment counts were done just before application while post-treatment counts were made on days 1, 3, 5, 7, 9 and 14 days after treatment.

Counts were done in the early morning when flight activity is minimal according to Bulter *et al.* (1988). Reduction percentages were calculated according to Henderson and Tilton equation (1955). The treatments were compared with each other using one way ANOVA with LSD 0.05 (SAS Statistical Software, 1989).

RESULTS AND DISCUSSION

The efficiency of control agents on eggplant pests:- Whitefly *Bemisia tabaci* (Genn.)

First spray

Gradual reduction percentages of whitefly *B. tabaci* numbers as a result of insecticide, orange oil and mineral oil alone and in binary mixtures treatments were recorded in both seasons 2016- 2017 and 2017-2018 (Tables 2). Data indicated significant differences between the five compounds where F. value = 3.38 and L.S.D = 10.12%. These compounds could be divided three groups. The first group contained on mineral oil + (quarter of rate) Actara WG 25% and Actara WG 25% showing highly mortality 87.40% and 86.40%, respectively. The second group contained KZ oil EC 95%+ orange oil and KZ oil EC 95% showing moderate

effect 74.73% and 73.07%, respectively. The third group was orange oil showing low effect 69.77%.

Second spray

Data indicated significant differences between the five compounds where F. value = 4.33 and L.S.D = 11.35%. These compounds could be divided two groups. The first group contained on mineral oil + (quarter of rate) Agri Flex SC 18.56% and Actara WG 25% showing highly mortality 89.18% and 87.05%, respectively. The second group contained KZ oil EC 95%+ orange oil, KZ oil EC 95% and orange oil showing moderate effect 77.07% , 75.52% and 71.50%, respectively.

Third spray

Data assured that significant differences between The five compounds where F. value = 4.33 and L.S.D = 11.35%. These compounds could be divided two groups. The first group contained on mineral oil + (quarter of rate) closer SC 24%, Actara WG 25% and KZ oil EC 95%+ orange oil showing highly mortality 91.30%, 87. 05% and 85.73%, respectively. The second group contained, KZ oil EC 95% and orange oil showing moderate effect 79.60% and 78.85%, respectively.

Table 2. Mean reduction percentage of *B. tabaci* alive nymphs/ leaf on eggplant plants at Qaha, Qalubiyah Governorate during 2016&2017 and 2017&2018.

Treatments	No. Nymph Per Treatments	Initial Kill After 24 hours	Residual effect treatments					Average %	
			3 Days	5 Days	7 Days	10 Days	14 Days		
first spray	KZ oil EC95%	313	48.2	55	67.4	83.8	90.9	93.1	73.07b
	KZ oil EC95%+ (quarter of rate) Actara WG 25%	318	65.2	70.2	89	100	100	100	87.40a
	Orange oil	269	56.9	66.9	70.1	73	77.4	74.3	69.77c
	KZ oil EC95%+ orange oil	299	48.2	55	66	88.4	92.8	98	74.73b
	Actara	299	63.2	65.2	90	100	100	100	86.40a
	Control	290	--	--	--	--	--	--	--
F value	3.38*	L.S.D.	10.12						
Second spray	KZ oil EC95%	170	55.2	57.4	66.2	88.5	91.5	94.3	75.52b
	KZ oil EC95%+ (quarter of rate) Agri Flex SC 18.56%	145	67.2	77.7	90.2	100	100	100	89.18a
	Orange oil	178	50.6	65.4	72.4	77	80	83.6	71.50b
	KZ oil EC95%+ orange oil	149	53.2	60	67.4	93.8	94.9	93.1	77.07b
	Actara	150	61.3	69	92	100	100	100	87.05a
	Control	320	--	--	--	--	--	--	--
F value	4.33 *	L.S.D.	11.35						
third spray	KZ oil EC95%	100	60.2	66.4	70.3	89.5	92.2	94.5	78.85b
	KZ oil EC95%+ closer (quarter of rate) SC24%	99	68.4	81.2	98.2	100	100	100	91.30a
	Orange oil	107	53.1	67.5	76.4	91.2	94.4	95	79.60b
	KZ oil EC95%+ orange oil	98	60.2	73.3	88.3	94.4	98.2	100	85.73a
	Actara	103	63	68.9	90.4	100	100	100	87.05a
	Control	347	--	--	--	--	--	--	--
F value	5.67*	L.S.D.	10.62						

Means followed by the same letters are not significantly different according to the LSD0.05.

Mealybug *Phenacoccus solenopsis* Tinsley

First spray

Gradual reduction percentages of mealybug *P. solenopsis* numbers as a result of insecticide, orange oil and mineral oil alone and in binary mixtures treatments were recorded in both seasons 2016- 2017 and 2017-2018 (Tables 3). Data indicated significant differences between the five compounds where F. value = 7.38 and L.S.D = 14.30%. These compounds could be divided three groups. The first group contained on Actara WG 25% showing highly mortality 93.03%. The second group contained mineral oil + (quarter of rate) Actara WG 25%, KZ oil EC 95% and KZ

oil EC 95%+ orange oil showing moderate effect 85.92%, 74.5% and 74.9%, respectively. The third group was orange oil showing low effect 65.53%.

Second spray

Data indicated that significant differences between the five compounds where F. value = 5.16 and L.S.D = 12.37%. These compounds could be divided three groups. The first group contained on Actara WG 25% showing highly mortality 93.18%. The second group contained mineral oil + (quarter of rate) Agri Flex SC 18.56%, KZ oil EC 95% and KZ oil EC 95%+ orange oil showing moderate effect 88.83%, 78.12% and 78.03%,

respectively. The third group was orange oil showing low effect 69.03%. (Table 3)

Third spray

Data showed that significant differences between the five compounds where F. value = 4.19 and L.S.D = 10.38%. These compounds could be divided three groups. The first

group contained on Actara WG 25% showing highly mortality 93.40%. The second group contained mineral oil + (quarter of rate) closer SC 24%, KZ oil EC 95% and KZ oil EC 95%+ orange oil showing moderate effect 88.17%, 78.45% and 78.57%, respectively. The third group was orange oil showing low effect 69.47%.(Table 3)

Table 3. Mean reduction percentage of *P. solenopsis* alive nymphs/ leaf on eggplant plants at Qaha, Qalubiya Governorate during 2016&2017 and 2017&2018.

Treatments	No. nymph Per Treatments	Initial Kill After 24 hours	Residual effect treatments					Average %	
			3 Days	5 Days	7 Days	10 Days	14 Days		
First spray	KZ oil EC95%	59	40.2	52.4	63.2	91.2	100	100	74.50ab
	KZ oil EC95%+ (quarter of rate)	70	55	76	90	94.5	100	100	85.92ab
	Actara WG 25%	66	39	48.8	55.4	70	87.2	92.8	65.53b
	Orange oil	71	45.7	54.5	62.3	89.5	97.4	100	74.9ab
	KZ oil EC95%+ orange oil	69	77.6	86.2	94.4	100	100	100	93.03a
	Actara	70	--	--	--	--	--	--	--
	Control	70	--	--	--	--	--	--	--
F value	7.66*	L.S.D	14.30						
Second spray	KZ oil EC95%	29	44.8	59.4	69	95.5	100	100	78.12ab
	KZ oil EC95%+ (quarter of rate)	34	61	79	93	100	100	100	88.83ab
	Agri Flex SC 18.56%	38	42	50.4	62.2	73.2	90.6	95.8	69.03b
	Orange oil	33	49.8	63	69.8	89.6	96	100	78.03ab
	KZ oil EC95%+ orange oil	28	78	85.5	95.6	100	100	100	93.18a
	Actara	87	--	--	--	--	--	--	--
	Control	87	--	--	--	--	--	--	--
F value	5.16*	L.S.D	12.37						
third spray	KZ oil EC95%	15	47	60.5	68.8	94.4	100	100	78.45ab
	KZ oil EC95%+ closer (quarter of rate) SC24%	12	63	76	90	100	100	100	88.17ab
	Orange oil	17	41	52.8	59.8	74	92.2	97	69.47b
	KZ oil EC95%+ orange oil	16	49.8	65	68.4	90.2	98	100	78.57ab
	Actara	20	77	87.4	96	100	100	100	93.40a
	Control	69	--	--	--	--	--	--	--
	F value	4.19*	L.S.D	10.38					

Means followed by the same letters are not significantly different according to the LSD0.05.

Red mite *Tetranychus urticae* Koch,

First spray

Gradual reduction percentages of mealybug *P. solenopsis* numbers as a result of insecticide, orange oil and mineral oil alone and in binary mixtures treatments were recorded in both seasons 2016- 2017 and 2017-2018 (Tables 4). Data indicated significant differences between the five compounds where F. value = 7.24 and L.S.D = 11.69%. These compounds could be divided three groups. The first group contained on mineral oil + (quarter of rate) Actara WG 25% and Actara WG 25% showing highly mortality 90.98% and 85.88%, respectively. The second group contained KZ oil EC 95%+ orange oil showing moderate effect 82.20%. The third group contained KZ oil EC 95% and orange oil showing low effect 77.57% and 75.10%, respectively

Second spray

Data indicated that significant differences between the five compounds where F. value = 8.87 and L.S.D = 7.46%. These compounds could be divided three groups. The first group contained on mineral oil + (quarter of rate) Agri Flex SC 18.56%, showing highly mortality 91.90%. The second group contained Actara WG 25 showing moderate effect 85.93%. The third group contained KZ oil EC 95%+ orange, KZ oil EC 95% and oil orange oil showing low effect 82.0%, 81.45% and 76.97%, respectively. (Table 4)

Third spray

Data showed that significant differences between the five compounds where F. value = 5.79 and L.S.D = 11.14%. These compounds could be divided three

groups. The first group contained on mineral oil + (quarter of rate) closer SC 24%, and Actara WG 25% showing highly mortality 91.07% and 86.03%, respectively. The second group contained KZ oil EC 95%+ orange oil showing moderate effect 81.47%. The third group contained KZ oil EC 95% and orange oil showing low effect 79.63%and 77.10%. (Table 4)

The treatments-yield relationship:

The treatments effect of insecticide, orange and mineral oil alone and in binary mixtures treatments were recorded in both seasons 2016- 2017 and 2017-2018 on eggplant total yield was presented in Table (5) for the two successive seasons. Referring the effect using different treatments was high significantly between population and weight yield.

Data presented in Table (5) and Fig.(1), revealed that mineral oil + spray (Actara WG 25% , Agri Flex SC 18.56% and closer SC24%) and KZ oil EC 95%+ orange oil were the most potent treatment cause increasing weight of eggplant yield with low mean weekly number of the pests during the two seasons (213.3 and 216.0 individuals /120 leaves) with mean yield 399 and 376 kg, respectively), followed by Actara WG 25% and KZ oil EC 95% with moderate mean weekly number of the pests during the two seasons (218.7 and 224.0/ individuals with mean yield 355, 322 kg, respectively), followed by orange oil with high mean weekly number of the pests during the two seasons (227.7/ individuals with mean yield 265kg and control which record the highest mean number of pests in both seasons (305.0/ individuals with mean yield 200kg).

Table 4. Mean reduction percentage of *T. urticae* alive individuals/ leaf on eggplant plants at Qaha, Qalubiya Governorate during 2016&2017 and 2017&2018.

Treatments	No. Nymph Per Treatments	Initial Kill After 24 hours	Residual effect treatments					Average %	
			3 Days	5 Days	7 Days	10 Days	14 Days		
First spray	KZ oil EC95%	157	61.4	72.8	77.7	80.5	82.8	90.2	77.57b
	KZ oil EC95%+ (quarter of rate)	155	70	82.5	93.4	100	100	100	90.98a
	Actara WG 25%	173	49.2	64.2	74.8	81.2	88.4	92.8	75.10b
	Orange oil	165	66.4	71	83.2	85.4	91.8	95.4	82.20ab
	KZ oil EC95%+ orange oil	161	59.4	66.5	89.4	100	100	100	85.88a
	Actara	166	--	--	--	--	--	--	--
	Control	166	--	--	--	--	--	--	--
F value	7.24*	L.S.D	11.69						
Second spray	KZ oil EC95%	122	62.8	74.4	80.5	84.4	90.4	96.2	81.45ab
	KZ oil EC95%+ (quarter of rate)	123	72.2	84.8	94.4	100	100	100	91.90a
	Agri Flex SC 18.56%	111	48.8	63.8	77.8	85.4	90.2	95.8	76.97b
	Orange oil	109	64.2	69.4	82.8	86.8	92	96.8	82.00b
	KZ oil EC95%+ orange oil	123	58.8	68	88.8	100	100	100	85.93ab
	Actara	172	--	--	--	--	--	--	--
	Control	172	--	--	--	--	--	--	--
F value	8.87*	L.S.D	7.46						
Third spray	KZ oil EC95%	89	59.7	69.4	79.5	82.4	91.4	95.4	79.63b
	KZ oil EC95%+ (quarter of rate)	75	69.4	83.2	93.8	100	100	100	91.07a
	closer SC24%	99	46.8	64.2	76.8	86.8	92	96	77.10b
	Orange oil	89	63.8	70.2	81	85.8	91	97	81.47ab
	KZ oil EC95%+ orange oil	79	60.2	67	89	100	100	100	86.03a
	Actara	164	--	--	--	--	--	--	--
	Control	164	--	--	--	--	--	--	--
F value	5.79*	L.S.D	11.14						

Means followed by the same letters are not significantly different according to the LSD0.05

Table 5. Simple correlation and partial regression values of the three pests on weight yield of eggplant under effect of treatments and corresponding percentages of explained variance at Qaha, Qalubiya Governorate during 2016&2017 and 2017&2018 seasons.

Treatments	Whitefly meal bugs red mite			Mean	Total Yield (kg)	Correlation between insect pests and weight yield (r)	b value	F value	E.V %
	<i>Bemisia tabaci</i>	<i>Phenacoccus solenopsis</i>	<i>Tetranychus urticae</i>						
KZ oil EC95%	377	70	225	224.0	322	0.860*	0.800*	8.53*	74%
KZ oil EC 95% + (quarter of rate) Actara WG 25% in first spray									
KZ oil EC 95% + (quarter of rate) Agri Flex SC 18.56% in second spray	365	75	200	213.3	399	0.831*	3.11*	6.71*	70%
KZ oil EC 95% + (quarter of rate) closer SC24% in the third spray									
Orange oil	350	78	255	227.7	265	0.808*	1.125*	5.67*	61%
KZ oil EC95%+ orange oil	358	65	225	216.0	376	0.810*	0.276*	5.74*	66%
Actara	368	78	210	218.7	355	0.784*	0.257*	4.79*	65%
Control	498	92	325	305.0	200	0.389ins.	0.283ins	0.52ins	15%

r = simple correlation coefficient * = probity of correlation, b= the regression coefficient , * = probity of regression, E.V= Explained Variance

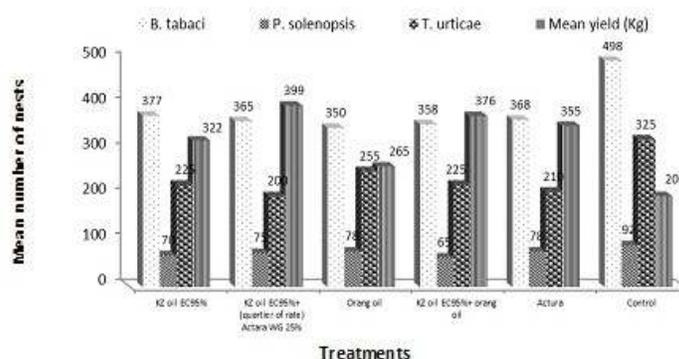


Fig. 1. mean number of pests infesting eggplant with different treatments and their relationship with crop yield under greenhouse.

The obtained results in Table (5) showed that the relationship between different treatments of management on population density of *B. tabaci*, *P. solenopsis* and *T. urticae* with increase of crop yield for eggplant were highly

significant effect of different treatments (KZ oil EC 95%, mineral oil + quartier of rate (Actara WG 25%, Agri Flex SC 18.56% and closer SC24%), orange oil, KZ oil EC 95%+ orange oil and Actara WG 25% whereas "r" values were 0.860 , 0.831, 0.808, 0.810 and 0.784, while "b" values were 0.80 Kg, 3.11 Kg , 1.125 kg, 0.276kg and 0.257 Kg with mean of both seasons, respectively.

These values of (E.V%) indicated that the different treatments were responsible percentage for 74%, 70%, 61%,66% and 65% in the average weight of yield in both seasons 2016 & 2017 and 2017&2018, respectively. Compared with control was responsible percentage for 15%.

These results were in line with those obtained by Horowitz *et al.*, 1998, Aslam *et al.*, 2004, Abdel-Rahman and Abou-Taleb. 2008, Yadav, and. Kumawat. 2013 and Hamdy and Barrania 2014.

CONCLUSION

Use insecticides binary mixtures with mineral oil or orange oil binary mixtures with mineral oil have a highly significant effect on eggplant growth and yield. The insecticide binary mixtures with mineral oil have effect on pests population whereas decreased mean number of pests. The insecticide binary mixtures with mineral oil were the most efficiency method compared to control (without treatment).

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إدارة الآفات التي تصيب الباذنجان باستخدام بعض المبيدات الحشرية والزيوت المعدنية وعلاقته بإنتاجية المحصول تحت الصوب

منى إبراهيم عمار و على كامل على رحومه

معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - الجيزة

تم إجراء التجربة بالصوب خلال موسمي الدراسة (2016 و 2017) ، (2017 و 2018) في موقع الزراعات المحمية بمحطة بحوث البساتين بقها ، محافظة القليوبية . تهدف الدراسة كيفية ادارة الآفات التي تصيب نباتات الباذنجان باستخدام بعض المبيدات الحشرية وزيت البرتقال وزيت المعدني بمفردها او مخلوط وعلاقته على انتاجية المحصول تحت الصوب وذلك لكل من الذبابة البيضاء *Bemisia tabaci* (Genn) ، العنكبوت الاحمر *Tetranychus urticae* Koch حيث تعتبر من اهم الآفات التي تصيب الباذنجان ، بق القطن الدقيقى *Phenacoccus solenopsis* Tinsley تعتبر افة جديدة على الباذنجان، وهذه الآفات من اخطر الآفات التي تسبب خسارة اقتصادية على المحصول الناتج. ولقد اظهرت النتائج انه توجد علاقة معنوية قوية بين استخدام معاملات على الاصابة بالآفات محل الدراسة فكانت لمعاملة الزيت المعدني مخلوط بالمبيد الحشرى اكتارا وايضا زيت المعدني مخلوط بزيت البرتقال حيث يعتبروا اكثر كفاءة على خفض تعداد خلال فترة الدراسة مقارنة بالكنترول(بدون رش)