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Impact of Eco-Friendly Methods in Controlling the Population Density of Pests that Infesting Cucumber Crop

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ABSTRACT

Experiments were conducted in Qaha, Qalubiya governorate under field conditions during two successive seasons (2020-2021 and 2021-2022). This work aims to study the impact of eco-friendly methods in controlling the population density of pests that infest cucumber crops. Data showed a significant difference between the general weekly mean number of the pests *(Bemisia tabaci* (Genn.), *Thrips tabaci* (Lind.), *Aphis gossypii* glover, and *Tetranychus urticae* Koch) investigations, whereas the F values were 31.85 and 23.48 individuals for two successive seasons, respectively. The results showed, in general, that the number of pests was greater in the second season compared to the first season, and it was found that the whitefly *B. tabaci* was the most prevalent pest on the cucumber crop during the two seasons studied. According to the results, the use of the recommended pesticide, N-P-K 20-20-20, N-P-19-19-19, was followed by the use of amino acids, then humic delta, which was the most affected compound and had the lowest yield compared to the other compounds.

Keywords: field, cucumber, *T. tabaci*, *Bemisia tabaci* (Genn.) *Aphid gosspyii, Thrips tabaci* and *Tetranychus urticae* Koch, potassium silicate, humic delta, amino aceta, N-P-K, pesticide, modern methods, fertilization and crop yield.

1. Introduction

Cucumber, *Cucumis sativus* L. is one of the most important vegetables crops, as it widely cultivating all over the world. In Egypt, cucumber farms are advancing at a relatively fast rate, especially in the new reclaimed areas at the open field for the local consumption or for export to foreign markets (Pardosi *et al*. (2004)). However, cucumber plants in Egypt are subjected to infestation by many pests Sap-sucking insect pests: whitefly; *Bemisia tabaci* (Genn); cotton aphid; *Aphis gossypii* (Glov); onion thrips; *Thrips tabaci* (Lind) and the two spotted spider mite *Tetranychus urticae* Koch are the most economically important pests on many vegetable crops such as cucumber (*Cucumis sativus* L.) in different parts of the world (Saad 2002, Mohamed 2004, Abdallah *et al*., 2014 and Marabi *et al* 2017). The excess use of nitrogen fertilizers in agriculture can lead to nitrate accumulation in plants and ground water pollution, nitrate accumulation in edible plants is a problem when eaten, part of ingested nitrate may be converted to nitrite causing methaemoglobinaemia or oven to carcinogenic nitrosamines (Alexander, 1977). Accordingly, active researches must be conducted to find ways of reducing nitrate accumulation in vegetable crops. Humic acid had significant effect on vegetative growth and yield of potato plants (Awad and El-Ghamry 2007). Using Humic and organically materials wastes improved of soil characteristics that increased the yields of some field crops in several studies (Ahmad, 2005 and Ulukan, 2008). The role of potassium in mitigating crop damage due to insects is complex. Potassium plays an important physiological role including build-up of resistance to insect pests. Adequate amounts of K have been reported to decrease the incidence of insect damage considerably. Plants well supplied with nitrogen and insufficient potassium have soft tissue with little resistance to sucking and chewing pests. Potassium is involved in almost all metabolic processes of plants. Also, it plays an important role

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in photosynthesis and production of carbohydrates, restoring nitrate and assist in consuming ammonium ions in manufacturing amino acids and protein synthesis. Also, it is effective in balancing nutrients, increasing tubers and increasing the absorption of nitrogen and phosphorus in plants (Khan et al., 1994). For many years, chemical insecticides have been used in a large and unwise scale for controlling agricultural pests. The increasing resistance of pests against chemical pesticides, pollution of the ecosystem and other deleterious side effects on non-target organisms have initiated and favored the use of other agents to be incorporated into integrated control programs. Improvement of soil conditions and establishing equilibrium among plant nutrients are also important for soil productivity and plant production. Because it is an urgent request to produce vegetables and fruits free from insecticides and to produce safe products to avoid human health problems, Therefore, the present work was carried out as an Impact of Eco-Friendly Methods in Controlling the Population Density of Pests that Infest Cucumber Crops.

2. Material and Methods

2.1. Experimental under field conditions:-

This experiment was conducted in the Experimental Farm of Plant Protection Research Institute, Agriculture Research Center (ARC), Qaha, Qalyubia governorate during the winter plantation seasons (2020 and 2021) to study the impact of eco-friendly methods in controlling the population density of pests *(Bemaisi tabaci*, *Thrips tabaci*, *Aphis gosspyii* and *Tetranychus urticae*) that infesting cucumber crop. A complete randomized block design with three replicates was used in both seasons, each plot (replicate) about 700 m^2. Sowing took place on Sep. 15^{th} seeds of cucumber cultivar “hayel” Two plants per hill. After three weeks for open field cucumber cultivation, taken fifteen randomly leaves chosen from different levels of plants and picked up from each treatment then kept in tightly closed paper bags and transferred to the laboratory at the same day for examination and identify with the aid of a stereomicroscope. The sampling was taken 7 days intervals continued until 12 weeks for all treatments and evaluate total yield during fruit-set a long season.

2.2. The experiment included six treatments:

Treatments were applied with rate of application with water as a foliage spray after two months of sowing cucumber in 9^{th} of November. Samples of 15 leaves were collected at random in the early morning from each treatment. The leaves were sampled directly before spray and 1(Checked twice in first week), 2, 3 and 4 weeks after foliar spray. The inspected leaves were transmitted to the laboratory where a binocular microscope was used to count the pests. The reduction percentages were calculated using the equation of Henderson and Tilton (1955): Reduction %= 100 * (1 - (Ta * Cb)/(Tb * Ca), where: Ta= number of mite after spray; Tb= number of mite before spray; Ca = the number of mite in the control after spray; Cb = number of mite in the control before spray.

Treatments and application rate**:**

Treatments	**Rate of Application**
Humic delta 10%	10gm./1L
Potassium silicate	10gm./1L
N-P-K (19-19-19)	10gm./1L
N-P-K (20-20-20)	10gm./1L
Decomposed organic fertilizer	10gm./1L
Chlorfenapyr (challenger 24%SC)	$2cm^3$/1litter
Control	Without any fertilizer

Control plants which were sprayed with the tap water.

Analysis of variance (ANOVA) was performed on infesting pests and yield variables (SAS, 1999) and appropriate error terms for the F tests of interactions were calculated separately. Comparisons of means were performed using the Duncan’s multiple range test (= 0.05).

3. Results and Discussion

Use of fertilizing compounds such as potassium silicate, humic acid, and amino acids has been shown to encourage plant growth in terms of increasing plant height and enhancing nutrient uptake. These sounds depend on the concentration and source of the substance and on the types of plants. Potassium is involved in almost all metabolic processes of plants. Also, it plays an important role in photosynthesis and production of carbohydrates, restoring nitrate and assist in consuming ammonium ions in manufacturing amino acids and protein synthesis. Also, it is effective in balancing nutrients, increasing tubers and increasing the absorption of nitrogen and phosphorus in plants. and Humic substances have the ability to hold seven times their volume in water, a greater water holding capacity than clay soils. Water stored within the topsoil enables plant roots to quickly access the available nutrients required for plant growth and yield.

3.1. Effect of different treatments on cucumber crop

Results showed the relation shape between differences between six treatments (Humic delta 10%, potassium silicate , N-P-K 19-19-19, N-P-K20-20-20, amino acids and Chlorfenapyr (challenger 24%SC)) and reduction percentage of individuals of *B. tabaci*, *T. tabaci* , *A. gossypii* and *T.urticae* infesting cucumber plants a combination of them after two months of sowing cucumber under field condition during two seasons 2020and 2021.

3.1.1. *Bemisia tabaci*

The data demonstrated in (Table, 1), in first week showed that significant differences between the six compounds where F. value = 67.10 *** L.S.D.$_{05}$ = 4.54%. These compounds could be divided to six groups. The first and second groups contained on Chlorfenapyr (challenger 24%SC) and potassium silicate, showing highly mortality 51 and 35% individuals / 30 leaves, respectively. The moderate group contained, amino acids and N-P-K20-20-20 whereas, 29 and 27% individuals / 30 leaves, respectively. The lowest affect for N-P-K 19-19-19 and Humic delta 10% whereas, 23 and 22% individuals / 30 leaves, respectively (for first week).

Table 1: Mean reduction percentage of *B. tabaci* individuals infesting cucumber crop after treating six treatments under field condition during two seasons 2020 and 2021.

Treatments	No. larvae Per Treatments	Initial kill	Reduction % after application			Residual toxicity
		After 1 week	2 weeks	3 weeks	4 weeks	
Humic delta 10%	294	22 E	45	76	71	75 F
Potassium silicate	312	35 B	62	96	92	90 B
N-P-K (19-19-19)	307	23 DE	54	89	76	82 E
N-P-K (20-20-20)	302	29 CD	57	81	81	88 C
Amino acids	299	27 C	49	88	78	84 D
Chlorfenapyr (challenger 24% SC)	289	51 A	82	100	100	97A
Control	303	--	--	--	--	

F value for first Week (Initial Kill) = 67.10*** and L.S.D.$_{05}$= 4.54
F value residual toxicity = 394.33*** and L.S.D.$_{05}$= 1.15

In data from residual toxicity indicated that the high significant differences between the six compounds where F. value = 394.33 *** L.S.D.$_{05}$ = 1.15%. These compounds could be divided to six groups. The first and second groups contained on Chlorfenapyr (challenger 24%SC) and potassium silicate, showing highly mortality 97 and 90% individuals / 15 leaves, respectively. The moderate group contained, N-P-K20-20-20, amino acids and N-P-K 19-19-19 whereas, 88, 84 and 82% individuals / 15 leaves, respectively. The lowest affect for Humic delta 10% whereas, 75 % individuals / 15 leaves, respectively (Table 1).

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3.1.2. Thrips tabaci

Data showed in first week high significant differences between the six compounds where F. value = 443.59 *** L.S.D.$_{05}$ = 1.58%. These compounds could be divided to five groups. The first group contained on Chlorfenapyr (challenger 24%SC), showing highly mortality 45 % individuals / 30 leaves, respectively. The moderate group contained, N-P-K 19-19-19, N-P-K20-20-20 and potassium silicate whereas, 27, 26 and 23% individuals / 30 leaves, respectively. The lowest affect for amino acids and Humic delta 10% whereas, 19 and 16% individuals / 30 leaves, respectively.

In data from residual toxicity indicated that the high significant differences between the six compounds where F. value = 424.87 *** L.S.D.$_{05}$ = 0.94%. These compounds could be divided to six groups. The first group contained on Chlorfenapyr (challenger 24%SC) showing highly mortality 95 % individuals / 15 leaves, respectively. The moderate group contained, potassium silicate and N-P-K20-20-20 whereas, 89 and 89% individuals / 15 leaves, respectively. The third and fourth groups contained, N-P-K 19-19-19 and amino acids whereas, 82 and 81% individuals / 15 leaves, respectively. The lowest affect for Humic delta 10% whereas, 79 % individuals / 15 leaves, respectively (Table 2).

Table 2: Mean reduction percentage of *T. tabaci* individuals infesting cucumber crop after treating six treatments under field condition during two seasons 2020 and 2021.

Treatments	No. larvae Per Treatments	Initial kill	Reduction % after application			Residual toxicity
		After 1 week	2 weeks	3 weeks	4 weeks	
Humic delta 10%	127	16 E	39	79	74	79 E
Potassium silicate	122	23 C	54	94	89	89 B
N-P-K (19-19-19)	119	27 B	44	88	79	82 C
N-P-K (20-20-20)	143	26 B	49	90	82	89 B
Amino acids	120	19 D	51	76	72	81 D
Chlorfenapyr (challenger 24%SC)	117	45 A	79	100	100	95 A
Control	113	--	--	--	--	

F value for first Week (Initial Kill)= 443.59*** and L.S.D. $_{05}$= 1.58
F value residual toxicity = 424.87*** and L.S.D. $_{05}$= 0.94

3.1.3. Aphis gosspyii

Data indicated that in first week the highest effect significant differences between the six compounds where F. value = 814.34 *** L.S.D.$_{05}$ = 1.40%. These compounds could be divided to six groups. The first and second groups contained on Chlorfenapyr (challenger 24%SC) and potassium silicate, showing highly mortality 59 and 51 % individuals / 30 leaves, respectively. The moderate group contained, N-P-K20-20-20 and N-P-K 19-19-19 whereas, 46 and 44% individuals / 30 leaves, respectively. The lowest affect for amino acids and Humic delta 10% whereas, 31 and 26% individuals / 30 leaves, respectively.

In data from residual toxicity indicated that the high significant differences between the six compounds where F. value = 354.11 *** L.S.D.$_{05}$ = 0.99%. These compounds could be divided to five groups. The first and second groups contained on potassium silicate, N-P-K20-20-20 and Chlorfenapyr (challenger 24% SC) showing highly mortality 92, 90 and 89 % individuals / 15 leaves, respectively. The moderate group contained, N-P-K 19-19-19 and amino acids whereas, 82 and 81% individuals / 15 leaves, respectively. The lowest affect for Humic delta 10% whereas, 77 % individuals / 15 leaves, respectively (Table 3).

Table 3: Reduction percentage of *A. gosspyii* individuals infesting cucumber crop after treating six treatments under field condition during two seasons 2020 and 2021.

Treatments	No. larvae Per Treatments	Initial kill	Reduction % after application			Residual toxicity
		After 1 week	2 weeks	3 weeks	4 weeks	
Humic delta 10%	137	26 F	44	82	74	77 E
Potassium silicate	119	51 B	78	100	100	92 A
N-P-K (19-19-19)	139	44 D	69	97	77	82 C
N-P-K (20-20-20)	121	46 C	71	100	85	90 B
Amino acids	133	31 E	75	89	72	81 D
Chlorfenapyr (challenger 24% SC)	112	59 A	83	100	100	89.6 B
Control	114					

F value first Week (Initial Kill= 814.34*** and L.S.D. $_{05}$= 1.40
F value residual toxicity = 354.11*** and L.S.D. $_{05}$= 0.99

3.1.4. Tetranychus urticae

Data showed in first week high significant differences between the six compounds where F. value = 198.09 *** L.S.D.$_{05}$ = 0.99%. These compounds could be divided to six groups. The first group contained on Chlorfenapyr (challenger 24%SC), showing highly mortality 45 % individuals / 30 leaves, respectively. The moderate group contained, potassium silicate, N-P-K20-20-20 and N-P-K 19-19-19 whereas, 31, 29 and 26% individuals / 30 leaves, respectively., The lowest affect for Humic delta 10% and amino acids whereas, 20 and 17% individuals / 30 leaves, respectively.

In data from residual toxicity indicated that the high significant differences between the six compounds where F. value = 380.09 *** L.S.D.$_{05}$ = 1.31%. These compounds could be divided to six groups. The first group contained on Chlorfenapyr (challenger 24%SC) showing highly mortality 97 % individuals / 15 leaves, respectively. The moderate group contained, potassium silicate and N-P-K20-20-20 whereas, 89 and 80% individuals / 15 leaves, respectively. The third and fourth groups contained, Humic delta 10% and amino acids whereas, 79 and 78% individuals / 15 leaves, respectively. The lowest affect for N-P-K 19-19-19 whereas, 76 % individuals / 15 leaves, respectively (Table 4)

Table 4: Reduction percentage of *T. urticae* individuals infesting cucumber crop after treating six treatments under field condition during two seasons 2020 and 2021.

Treatments	No. larvae Per Treatments	Initial kill	Reduction % after application			Residual toxicity
		After 1 week	2 weeks	3 weeks	4 weeks	
Humic delta 10%	187	20 E	34	75	71	79 E
Potassium silicate	169	31 B	55	95	90	89 B
N-P-K (19-19-19)	166	26 D	40	83	79	76 F
N-P-K (20-20-20)	180	29 C	52	87	82	80C
Amino acids	172	17 F	49	80	70	78 D
Chlorfenapyr (challenger 24%SC)	169	45 A	82	100	100	97 A
Control	177	--	--	--	--	

F value first Week (Initial kill) = 198.00*** and L.S.D. $_{05}$= 0.94
F value residual toxicity = 380.09*** and L.S.D. $_{05}$= 1.31

3.2. General mean of reduction percentage:

The data in table 5 showed that there were significant differences between the six treatments (Humic delta 10%, potassium silicate , N-P-K 19-19-19, N-P-K 20-20-20, amino acids and Chlorfenapyr (challenger 24%SC) and reduction percentage of individuals of *B .tabaci*, *T.tabaci* , *A. gossypii* and *T.urticae* infesting cucumber plants a combination of them after two months of sowing cucumber under field condition during season 2020 and 2021From the data demonstrated in (Table, 6), it was found that the highest reduction percentage of *B. tabaci*, *T. tabaci*, *A. gosspyii* and *T. urticae* for

Chlorfenapyr (challenger 24%SC) with mean number (94.75, 93.5, 93.0 and 94.75) , respectively after four weeks of application. Followed by potassium silicate, (85.00, 81.5, 92.50 and 82.25%), respectively. the moderate affect followed by N-P-K 20-20-20, N-P-K 19-19-19 and amino acids with mean numbers (76.75, 77.5, 86.50 and 75.25%), (75.25, 73.25, 81.25 and 69.5%) and (74.75, 70.0, 79.25, and 69.2%5), respectively. The lowest general means reduction percentage of tested pests population for Humic delta 10% with mean number (66.75, 67.75, 69.25 and 64.75%), respectively.

Table 5: General mean reduction percentage of individuals of pests infesting cucumber plants after treating different treatments under field condition during 2020 and 2021 seasons.

Treatments	Means Reduction percentage of pests /15 leaves after 4 weeks			
	***B. tabaci* (Nymph)**	***T. tabaci* (Nymph)**	***A. gosspyii* (Nymph)**	***T. urticae* (Movable stage)**
Humic delta 10%	66.75 D	67.75 F	69.25 F	64.75E
potassium silicate	85.00 B	81.5 B	92.50 B	82.25 B
N-P-K (19-19-19)	75.25 C	73.25 D	81.25 D	69.5D
N-P-K (20-20-20)	76.75 C	77.5 C	86.50 C	75.25 C
Amino acids	74.75 C	70 E	79.25 E	69.25D
Chlorfenapyr (challenger 24% SC)	94.75 A	93.5 A	93.30 A	94.75 A
F value	314.02***	815.86***	928.34***	216.04***
L.S.D $_{0.05}$	1.69	1.08	0.51	0.97

Different letters in same column denote significant difference ($P < 0.0001$).

3.3. Impact of different treatments on total yield of cucumber crop:

The impact of different treatments of management (Humic delta 10%, potassium silicate , N-P-K 19-19-19, N-P-K20-20-20, amino acids and Chlorfenapyr (challenger 24%SC) on cucumber total yield was presented in Table (6) for two successive seasons. Referring the effect using different systems of management was high significantly between pest population and weight yield (F value = 4.25* and L.S.D= 114.8).

Data in Table (6) revealed that potassium silicate was the most potent treatment cause increasing weight of cucumber yield with low mean weekly number of the pests during the two seasons (106.75) with mean yield (220 kg.), followed by amino acids, N-P-K 19-19-19, Chlorfenapyr (challenger 24%SC), N-P-K 20-20-20 (138.5, 184.5, 193.5 and 217.75), respectively with mean yield (197, 198, 178 and 188kg.). Humic delta 10%, which record the highest mean number of pests in both seasons (333.5) with low mean yield 198 kg. Compared with us pesticide Chlorfenapyr (challenger 24%SC) indicated that low mean yield (178Kg) with mean weekly number of the pests during the two seasons (193. 5).

Table 6: Effect of different treatments management of pests infesting cucumber plants and total yield in field condition at Qaha, Qalubiya Governorate during 2020 and 2021seasons.

Treatments	***B. tabaci* (Nymph)**	***T. tabaci* (Nymph)**	***A. gosspyii* (Nymph)**	***T. urticae* (Movable stage)**	**Means**	**Total Yield (kg)**
Humic delta 10%	799	182	221	132	**333.5 A**	198 B
Potassium silicate	302	45	33	47	106.75 B	**220 A**
N-P-K 19-19-19	458	71	123	86	184.5 B	198 B
N-P-K 20-20-20	509	123	141	98	217.75 B	188 C
Amino acids	286	103	77	87	138.25 B	197 B
Chlorfenapyr (challenger 24%SC)	423	122	156	73	193.5 B	178 D

F value between weekly mean pests= 4.25* L.S.D= 114.8
F value between yield crop = 514.42*** L.S.D= 1.92

4. Discussion

Cucumber plants in Egypt are subjected to infestation by many pests Sap-sucking insect pests whitefly; *Bemisia tabaci* (Genn); and cotton aphid; *Aphis gossypii* (Glov); onion thrips; *Thrips tabaci* (Lind) and two spotted spider mite *Tetranychus urticae* Koch are economically important pests on many economic plants such as cucumber (*Cucumis sativus* L.) in different parts of the world. Observations are compatible with those AL-Antary *et al.* (2012) who reported that Chlorfenapyr induced very effective against T. urticae J. Plant Prot. and Path., Mansoura Univ., Vol.7(2), February, 2016 153 population on cucumber. However, Hassan *et al.,* (2007) stated that Vertemic (Abamectin) and Ortus (Fenpyroximate) was the best in reducing *T. urticae* population on cucumber. Additionally, Tuzel *et al.,* (2005) studied the yield net return of cucumber whereas compared between the conventional and organic agriculture. However, Pitan and Filani (2013) stated that cucumber yield was significantly higher by 50% in plots sprayed at post flowering over the control against main pests of cucumber in Nigeria. Also, Hussain *et al.,* (1997) studied the economical of insecticidal applications for control *T. tabaci* on garlic plants. They showed that the net yield return increased in the four insecticide treatments when compared with untreated plants. El–Dewy and El – Zahi (2018) showed that humic acid was the most effective nutritive acid against *Aphid gossypii* with a 42.21% mean of reduction. With respect to the binary mixtures of pesticides with boric acid, humic acid and fulvic acid, slight and insignificant decreases were found in the activity of the mixtures comparing to the insecticides applied alone. El-Sayed *et al*., (2021) showed that the reduction percentage of *Tetranychus urticae* was 84.15, 83.44 and 81.38% for Chlorfenapyr+ Fulvic acid; Chlorfenapyr+ Humic + Fulvic acid and Chlorfenapyr, respectively.

5. Conclusion

Use of fertilizing compounds such as potassium silicate has been shown to encourage plant growth in terms of increasing plant height and enhancing nutrient uptake. Potassium is involved in almost all the metabolic processes of plants. It also plays an important role in photosynthesis and the production of carbohydrates, restoring nitrate and assisting in consuming ammonium ions in manufacturing amino acids and protein synthesis. It is also effective in balancing nutrients, increasing tubers and increasing the absorption of nitrogen and phosphorus in plants. The potassium silicate was the most potent treatment, causing an increasing weight of cucumber yield with a low mean weekly number of the pests during the two seasons.

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