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Effect of Some Control Programs and Weather Factors on Population Density of *Bemisia tabaci* Infesting Squash Plants (*Cucurbita pepo* L.)

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ABSTRACT

Squash is heavily infested by the white fly, *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) resulting in a huge loss in yield and quality directly by feeding on sap, causing physiological problems in plants, and transmitting viral diseases. This study was conducted during two successive seasons of 2023 and 2024 to evaluate biological and mix control programs compared with insecticides on squash crop under field conditions to control whitefly *B. tabaci*. The trials were carried out in Research Farm at El-Nubaria Research Station, El Behiera governorate, Egypt. Inspection was made once a week to determine the population density of whitefly. In the chemical treatment we used one of these pesticides (Buprofezin or Super alpha) after one month of transplanting, we applied first insecticide and other applications were done at fifteen days. In the mixed treatment, we used one of these pesticides (Buprofezin or Super alpha), *Beauvaria bassiana* and release the predator *Chrysoperla carnea* alternately every 15-day intervals until end of the season. In biological control, we carried out field trials to study the efficacy of *C. carnea* & *B. bassiana* in alternative ways at 15-day intervals. General mean of reduction of whitefly was revealed for Mix control (88.75% and 87 %) during season 2023 and season 2024, respectively. The estimated yield of squash crop post application of the treatments was significant by higher (4.848 & 4.572 ton/fed.) for chemical control, followed by Mix control (4.1064 & 4.020 ton/fed.) followed by biological control (2.925.6& 3.8748 ton/fed.) Compared to (2.6172 & 2.7468 ton /fed.) for the untreated check for season of 2023 & 2024, respectively. The effect of some weather factors such as mean temp. & mean R.H. were evaluated on population density of *Bemisia tabaci*, Although, a high benefit and greatest production were obtained with the use of chemical control, the author is under the impression of using the Mix control as it is desirable treatment for its environmental safety.

Keywords: Squash, *Bemisia tabaci*, biological control, *Chrysoperla carnea*, chemical control.

1. Introduction

Squash, (*Cucurbita pepo* L.) is one of the most Economically significant vegetable crops in the world (Ali, 2023). Because they were rich in carbohydrates, vitamins, minerals and amino acids, squash fruits had high nutritional benefits. Squash was grown on 22761 hectares (Refai & Hassan, 2019).

The white fly, *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae), the main insect pests of summer squash, include red pumpkin beetle, fruit fly, flea beetle, white fly, squash bug, melon aphid, and others, these pests are among the most damaging to agriculture worldwide, causing significant losses in crops (Oliveira *et al*., 2013; Lima *et al*., 2017). Farmers suffer significant losses in both quantity and quality. 600 host plant types are consumed by this polyphagous (De Barro 1995; Secker *et al.,* 1998). It is a significant pest of pepper, cotton, squash, tomato, cucumber and cabbage (Mc Auslane 2002). Chemical insecticides are the major method used to control these nuisance insects, but pesticide application is often not effective and hazardous to humans and environment. The excessive use has created problems with insecticide resistance and residue in addition to health risks (Elsanusi *et al*., 2020) mentioned that the spray with high volume was gave low percent reduction of pests and high contamination. Chemical pest control causes environmental damage, adverse effects on people, domestic animals, and natural

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enemies. Therefore, biological control is still a crucial part in managing insect pests. The previous few years, in integrated pest management, using as little insecticides as possible is the Ministry of agricultures goals. To preserve the natural balance, it is imported different predators, entomopathogenic fungi, *Beauvaria bassiana*, or microbial controls, which are eco-friendly and safe for life (El-Kareim *et al*., 2015).

Many studies have been conducted about the use of biological, chemical, or botanical pesticides in the crop (Mahato, 2017), but only a few have compared the effectiveness and profitability of both research approaches.

Insect distribution and abundance are significantly influenced by meteorological conditions (Nechols *et al*., 1999). While a lot of studies on population abundance of *B. tabaci* have been done on vegetable crops, little is known about the population of white fly on squash crops, particularly in Egypt.

Therefore, the objective of this work was to evaluate using biological and mix control to control whitefly *B. tabaci* compared with chemical control program during the fall season squash plantation under field conditions, also to determine the efficacy of different treatments on squash yield, and to investigate the impact of weather parameters (mean temp. &mean R.H.) on the infestation rates of white fly.

2. Material and Methods

2.1 Experiment site

The field experiments were carried out in the Research Farm at El-Nubaria Research Station, El Behiera governorate, Egypt, during the two consecutive seasons of 2023 and 2024, from September to December in both seasons. Squash hybrid cv. Aziad seeds were used in this experiment. The seeds were sown directly on 15, September 2023 and 8, September. 2024. The soil type was clay loam in the experimental site.

2.2 The Design of experiment

Each experiment was set up using a randomized complete block design (RCBD) with three replicates on a 175 m^2 area.

Ten leaves were taken randomly of squash beginning in early hours of the morning from the fourth week after transplanting and continuing every week until the seasons end. The leaves were collected in paper bags and brought to the laboratory for stereo microscope examination to identify and document the different white fly population.

2.3: Insecticides and predator used

The chemical insecticide used in this study were Buprofezin (20cm/20L), Alpha-cypermethrin (Super Alpha® 10%EC) (25cm/20L) and the bio-pesticide *Beauvaria bassiana* (Bio Power® WP) (60gm/20L), We used *Chrysoperla carnea* (200 larvae/kirate) as predator.

2.4: The experimental treatments were as follow Table (1)

There were four treatments selected including untreated check.

1. **Chemical control**: In the chemical treatment, using the back pack sprayer to apply the pesticides. Insecticides were used for the first time one month after transplanting and then 15-day intervals between applications were done.
2. **Mixed control:** In the mixed treatment, the first release with *C. carnea* was done by releasing about two hundreds of 2nd instar larvae randomly on 10th October, and followed by spraying chemical insecticide at 15 -day intervals until end of the season.
3. **Biological control**: In biological control, the effectiveness of *C. carnea* and *B. bassiana* in alternative ways was assessed by field trials conducted at 15 day intervals.
4. Untreated check

Table 1: The exact application plan during season 2023 and season 2024

Treatment	Season 2023			Season 2024		
	10/10/2023	**24/10/2023**	**10/11/2023**	**8/10/2024**	**23/10/2024**	**9/11/2024**
Chemical	Buprofezin	Buprofezin	Super Alpha	Buprofezin	Buprofezin	Super Alpha
Mix	*C. carnea*	Buprofezin	*B. bassiana*	*B. bassiana*	Buprofezin	*C. carnea*
Bio	*C. carnea*	*B. bassiana*	*B. bassiana*	*B. bassiana*	*C. carnea*	*B. bassiana*

2.5 Percentage reduction of whitefly

The percent reduction of whitefly population for every treatment was determined using the following formula (Henderson & Tilton, 1955) as follows:

Reduction % = $(1 - \frac{A \times C}{B \times D}) \times 100$

A - Population in a plot after treatment.
B - Population in a plot before treatment.
C - Population in check plot before treatment.
D - Population in check plot after treatment.

2.6. Average yield

Every two days, fruits were collected from the plants and weighed before being expressed in terms of feddan.

2.7. Weather data

Daily mean temp. & mean R. H. were acquired from Central Laboratory for agriculture Climate for both seasons under study. simple correlation and partial regression were used to statisticale analysis the mean number of *Bemisia tabaci* in order to assess the relationship between two meteorological parameters and population density of white fly.

2.8. Analysis of data

Statistical significance data was determined with one-way analysis of variance (ANOVA) as randomized complete blocks design (RCBD) and software Costat system, Version 6.311(Costat, 2006) was used to do basic correlation and compare the means of various treatments using the updated L.S.D test as outlined by Duncan, (1955).

3. Results and Discussion

3.1. Effect of Treatmets against the whitefly *B. tabaci* on the leaves of Squash plants.

Recently, the white fly has been established and spread rapidly throughout the infestation of leaves of growing plants in most of squash plantations in Egypt. Ultimately, a variety of pest management tactics will have to be employed to manage the *B. tabaci*, including mix, chemical and biological control. The efficiency of these treatments was evaluated on the leaves of infested plants. These leaves were checked before and after the application of the tested treatments.

3.1.1. Efficacy of treatments during fall season cultivation of season 2023 and season 2024 against the whitefly *B. tabaci*.

Results presented in Tables (2 & 3) show the percentages of reduction in whitefly *B. tabaci* nymph on squash leaves in 2023 and 2024. The general mean of reduction percentages of *B. tabaci* caused by chemical control, mix control and biological control were 77.5%, 88.75 %and 44.63% respectively in the season of 2023 and 60.75%, 87% and 44.88% at season 2024 respectively. It could be concluded that the superior efficient toxic effect of tested treatment was revealed for mix during season 2023 and season 2024 followed by the 2*nd* ranked chemical compared to that calculated general mean of reduction by biological. In mix treatment we used (super alpha, and Buprofezin), *B. bassiana* and we released the predator's aphid lion C. *carnea*. Similar findings were reported by Soomro *et al*. (2020), who evaluated the impact of chemical control and biological control on *B. tabaci* and discovered that the largest population decline was recorded in chemical control, followed by biological control (Basu, 2019) found that the number of *B. tabaci* nymphs and adults was reduced by foliar spraying a synthetic pyrethroid. (Bughdady *et al*., 2020) claimed that lambda-cyhalothrin provided the greatest decrease in whitefly

Table 2: Efficiency of tested treatments on the calculated reduction percentages of infested squash plants by whitefly nymph during season of 2023.

Treatment	No. of individuals pre treatment	No. of inspected insects individuals after treatments																General mean of reduction %
		17/10/2023		24/10/2023		1/11/2023		7/11/2023		14/11/2023		26/11/2023		4/12/2023		14/12/2023		
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Mix	392^{a}± 17.69	8.3^{ab}± 0.66	96	12^{a}± 2.65	93	16.33^{a}± 1.86	95	10^{b}± 1.2	98	62^{a}± 5.37	84	20^{a}± 1.73	96	35^{b}± 0.58	55	2.33^{b}± 1.45	93	88.75
Chemical	170^{b}± 7.97	7.67^{b}± 1.2	91	5.33^{bc}± 0.34	93	7^{b}± 1.53	95	17^{b}± 3.39	92	36.33^{b}± 6.07	79	8^{b}± 1.46	96	42^{a}± 3.76	-26	0^{b}± 0.00	100	77.5
Biological	48.3^{c}± 5.24	7^{b}± 0.58	70	3^{c}±0.34	87	12^{ab}± 2.73	70	16^{b}± 2.19	75	30^{b}± 8.38	38	4^{b}± 1.86	94	11.33^{c}± 0.33	-19	7^{a}± 1.77	-59	44.63
Untreated check	22^{c}± 2.09	11^{a}± 0.66		10.33^{ab}± 2.19		18^{a}± 2.52		29^{a}± 3.79		22^{b}± 3.47		28.33^{a} ±6.65		4.33^{d}± 0.88		2^{b}± 1.16		
L.S.D$_{0.05}$	32.92	2.66		5.65		7.21		9.22		19.81		11.62		6.39		4.17		

A: Mean number of insects ± S.E **B:** % Reduction
In each column, means followed by a common letter are significant different at 5% level by ANOVA Randomized Complete Blocks (F. test).

Table 3: Efficiency of tested treatments on the calculated reduction percentages of infested squash plants by whitefly nymph during season of 2024.

Treatment	No. of individuals pre treatment	No. of inspected insects individuals after treatments																General mean of reduction%
		16/10/2024		23/10/2024		1/11/2024		8/11/2024		15/11/2024		22/11/2024		29/11/2024		6/12/2024		
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Mix	34^{a}± 8.3	2^{b}± 0.34	99	6^{b}± 0.33	93	27^{a}± 1.77	92	2^{c}± 0.88	98	5^{a}± 1.2	93	4.6^{a}± 1.34	92	9^{a}± 1.00	62	5^{a}± 0.58	67	87
Chemical	6.33^{b}± 2.19	10^{a}± 2.73	63	11.33^{a}± 0.88	34	14^{b}± 5.9	77	0.33^{d}± 0.34	98	0.67^{b}± 3.47	95	1^{b}± 0.58	97	4^{bc}± 1.53	10	2.5^{b}± 1.73	12	60.75
Biological	7.33^{b}± 2.89	0^{b}± 0	100	4.33^{b}± 0.88	78	4^{c}± 2.03	94	5^{b}± 0.58	73	8.3^{a}± 0.88	46	5^{a}± 0.34	62	6.3^{ab}± 0.66	-23	5.66^{a}± 0	-71	44.88
Untreated check	3.33^{b}± 0.88	14.33^{a}± 1.67		9^{a}± 1.16		32^{a}± 1.53		8.33^{a}± 0.34		6.6^{a}± 1.77		6^{a}± 1.53		2.3^{c}± 1.2		1.67^{b}± 0		
L.S.D$_{0.05}$	14.01	5.24		2.82		10.28		1.54		3.80		3.48		3.73		2.11		

A: Mean number of insects± S.E **B:** % Reduction
In each column, means followed by a common letter are significant different at 5% level by ANOVA Randomized Complete Blocks (F. test).

populations and that it might be advised employing lambda-cyhalothrin in addition to thiamethoxam in integrated pest management to battle the tomato whitefly, *B. tabaci* (IPM).

Ali *et al.* (2005) *B. tabaci* and other homopteran pest are highly specific for Buprofezin. According to Bi *et al*. (2002), buprofezin greatly reduced the adult whitefly populations on strawberry in the field trial while being very effective against immature growth and development in greenhouse environments. white fly species were harmed by Isolates of the entomopathogenic fungus *B. bassiana*, which has mortality rates ranging from 3 to 85% (Quesada-Moraga *et al*., 2006).

Farías-Larios *et al.* (2000) evaluated the use of commercial *B. bassiana* formulations at various rates and came to the conclusion that *B.bassiana* and Endosulfan control nymphs and adults similarly. According to their percentages of infestation decrease, the evaluated pesticides' effectiveness against the white fly might be placed in the following order, according to Lasheen *et al*. (2020): Lambda cyhalothrin > *B. bassiana* > Thiamethoxam > Azadirachtin, respectively. According to Saleh *et al*. (2017) *C. carnea* is a significant predator of several white flies, aphids, and thrips. In semi-field circumstances on cantaloupe, (Younes *et al*., 2013) found that the white fly population decreased by 83.07% during the 2nd larval instar of *C. carnea*.

The first nymphal stage of *B. tabaci*, which was observed to be capable of limited movement and thus called a crawler, was observed to move a few centimeters in search of a feeding site, while the second instar nymphs were observed to be slightly larger than the first instar and immobile, (Ghelani *et al*., 2020) in our opinion. This is the reason why the mix treatment was more effective against *B. tabaci*. It provided an opportunity for the predator *C. carnea* to hunt and increase effectiveness of *B. bassiana* by contact the insects.

3.2. Effect of different treatments on the yield of squash plants season of 2023&2024

In Table (4) The estimated yield of squash crop post application of the treatments was significant by higher (4.848 & 4.572 ton/fed.) for chemical, followed by mix control (4.1064 & 4.020 ton/fed.) followed by bio control (2.9256 & 3.8748 ton/fed.) Compared to (2.6172 & 2.7468 ton/fed.) for the untreated control for season of 2023&2024 respectively (Parajuli, *et al.,* 2020) They discovered that chemical control was superior in terms of yield and the decrease of insect pests According to Mahato, (2017), the plots with the effective insecticides for controlling the main cucumber pests produced the maximum yield.

3.3. Population abundance of *B. tabaci* infesting squash plants.

In Figure (1) the population density of insects in the first season 2023 appeared in few numbers in the beginning of inspection period showing (11,10.33,18 individuals/10 leaves), after which the population increased till it peaked on November 7th (29, 22,28 individuals /10 leaves). following that the population started to decline in early December. During the second season of 2024The population density (Figure 2) varied from low abundance in mid-October to its maximum peak of (32 individuals /10 leaves) on November 1st, then population decreased gradually until end of season. Habashi *et al*. (2007) and Kamel *et al*. (2000) both agreed with these findings.

3.4. Impact of some meteorological parameters (Mean temperature and mean relative humidity) on the density of *B. tabaci* infestation in squash plants.

The data presented in (Table 5), demonstrated that the *B. tabaci* population densities were statistically analysed. The density of white flies were then compared to weather factors (temperature and relative humidity) using principal component analysis.

In the two seasons under study, 2023 and 2024 There were strong positive associations between population density of *B. tabaci* and weekly mean temperature as (r values = 0.39 and 0.48, respectively). For both seasons there was insignificant negative correlation between the weekly mean relative humidity and the mean number of white fly (r value = -0.01, -0.3 respectively). According to Abdel hamed *et al.* (2011) found that during the two seasons under study , the population of *B. tabaci, T. tabaci, L. trifolii* and *t. urticae* were significantly positively impacted by the weather factors (maximum, minimum, mean temperature) , whereas the population of these species were negatively impacted by the relative humidity .According to Amal *et al.* (2018) during summer growing seasons *B. tabaci* population density was positively impacted by temperature, however , during winter cropping seasons, the association between *B. tabaci* population and temperature was negligible.

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Table 4: Efficiency of Treatments on yield of squash season of 2023 and 2024.

Treatments	Yield (Ton/fed.) season of 2023	Yield (Ton/fed.) season of 2024
Mix	4.1064[b]	4.020[b]
Chemical	4.848[a]	4.572[a]
Biological	2.9256[c]	3.8748[c]
Untreated check	2.6172[d]	2.7468[d]
L.S.D$_{0.05}$	6.832	4.314

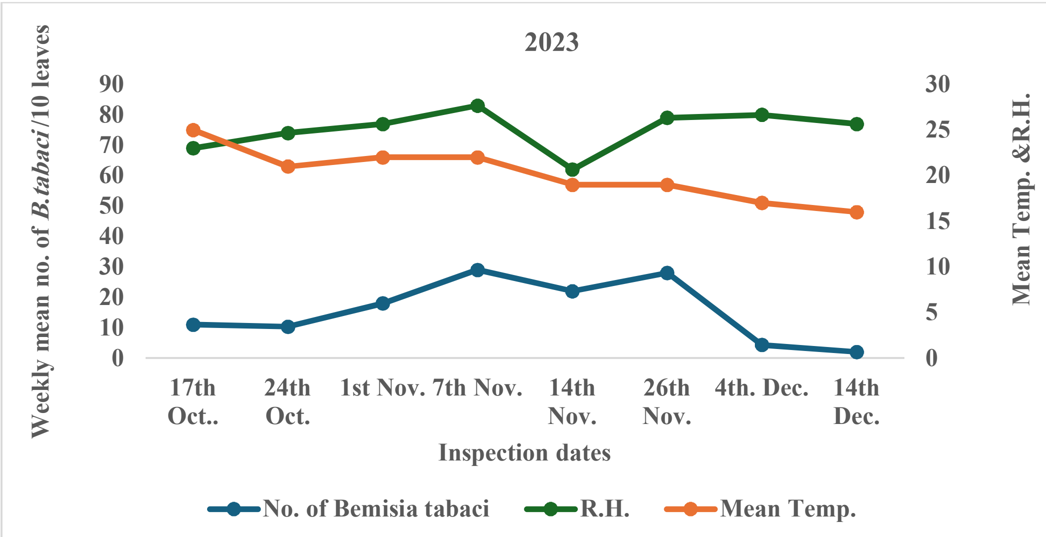

Fig. 1: Mean numbers of white fly, *Bemisia tabaci* on the leaves of squash plants under the prevailing weather factors during the elapsed period from Oct. 2023 –Dec. 2023 (Fall season).

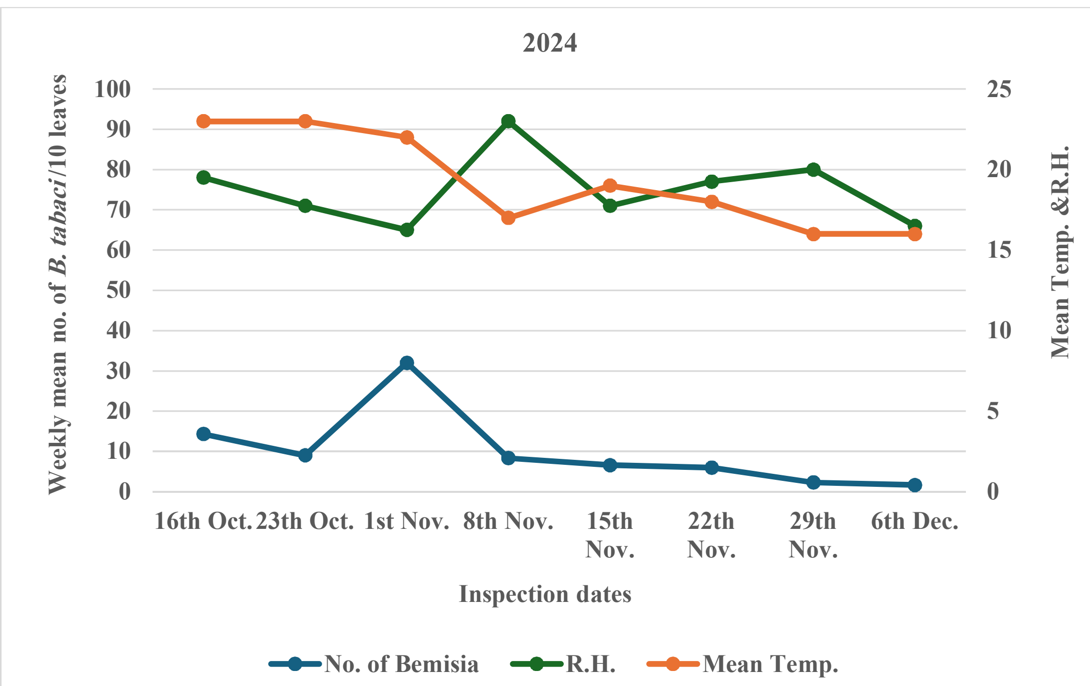

Fig. 2: Mean numbers of white fly, *Bemisia tabaci* on the leaves of squash plants under the prevailing weather factors during the elapsed period from Oct. 2024 –Dec.2024 (Fall season).

Table 5: The relationship between inspected white fly, *Bemisia tabaci* and prevailing hygro-thermic condition at El-Nobaria region, during the elapsed period from Oct. 2023 –Dec.2024 (Fall season).

Treatments	Season 2023		Season 2024	
	r Value		r Value	
	T ˚C	RH	T ˚C	RH
Mix	0.4676	-0.3822	0.4709	-0.2518
Chemical	0.4200	-0.3480	0.7784	-0.4454
Biological	0.3884	-0.5213	-0.3916	-0.0528
Untreated check	0.3941	-0.0108	0.4862	-0.3338

r = Correlation Coefficient factor

4. Conclusion

In the first, the mix control was very effective in decreasing the population of whitefly *B. tabaci*, the application of chemical control led to a greater benefit. The author is under the impression of using Mix control this method leads to less use of pesticides.

In the second, the white fly density on squash plants was significantly positive correlated with temperature and insignificantly negative correlated with relative humidity in both seasons.

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