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SIDE EFFECTS OF SOME PESTICIDES APPLIED ON *THRIPS TABACI* L. AND *TETRANYCHUS URTICAE* (KOCH) ON SOME BIOCHEMICAL CONTENTS AND ENZYME ACTIVITIES OF CUCUMBER LEAF

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ABSTRACT: *Thrips tabaci* L. and *Tetranychus urticae* (Koch) are pests that can cause direct and indirect damage to cucumber plants. *T. tabaci* and *T. urticae* population densities were recorded in cucumber highest peaks in April and May in 2022 and 2023 seasons in greenhouse at Sakha. The effectiveness of nine pesticides in controlling infestations of *T. urticae* and *T. tabaci* on cucumber plants was investigated. A significant reduction in *T. urticae* eggs following of jojoba oil compared to the other compounds tested but abamectin+ bifenthrin was the most in reducing *T. urticae* mobile stage in cucumber plants, while thiamethoxam + abamectin was the least in this pest eggs and mobile stage control. Almost, reduction was found highly significant differences among treatments of *T. urticae* eggs ($p \leq 0.01$). All treatments proved to be the most potent on *T. Tabaci* reduction, with highly significant differences ($p \leq 0.01$). The application of different compounds resulted in significant differences in chlorophyll content. Non -enzymatic components significantly decreased in cucumber plants due to some compounds in comparison with the control. The increase of carbohydrates, fats and total phenols% were observed in leaves with abamectin + bifenthrin treatment. Also, the effect of jojoba oil on increasing the protein content and total lipid in the leaves. Jojoba oil treatment increased the of enzymatic activity (catalase, peroxidase and polyphenol oxidase) specially at 10 days after application to an extent of 29.91, 19.68 and 21% respectively.

Keywords: Spider mite, thrips, *Cucumis sativus* L., pesticides, non-enzymatic, antioxidant enzymes

INTRODUCTION

Cucumber, *Cucumis sativus* L. is one of the most important cucurbitaceous vegetable crops in Egypt, as it cultivated under different environmental conditions, open fields and greenhouses for local consumption and exportation (Hanafy *et al*., 2014). Cucumber plants are usually infested by onion thrips, *Thrips tabaci* L. and the two spotted spider mite, *Tetranychus urticae* Koch (Ghallab *et al.* 2011 and Shalaby *et al.* 2013).

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) and *Thrips tabaci*, L. (Thysanoptera: Thripidae) are a major economic pest attacking several kinds of vegetables especially cucumber. *T. urticae* is considering serious economic pest, they have ability to produce webs on the host plants that coating them with a shiny dust which reduces the plant photosynthetic abilities. It is a major pest of vegetables (Abdallah *et al.*, 2019 and Abdallah *et al.*, 2020). Also, *T. tabaci*, L. is a polyphagous that causes a serious damage on vegetables and ornamental plants all over the world (Murai, 2000). Nymphs and adults feed on green leaf tissue, causing direct damage by destroying epidermal cells (Koschier *et al.*, 2002). The major greenhouse pests are *T. tabaci* and *Tetranychus* sp. in cucumber (Yasarakinci and Hincal, 1997).

Controlling *T. urticae* and *T. tabbaci* depends in most cases on uses of synthetic pesticides (Shaalan 2016). The intensive use of acaricides in the last few years has become unaccepted in the modern criteria of integrated pest management programs, leading to an increasing interest for alternative pesticides (Subba and

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Ghosh 2016, El-Fakharany, 2017, 2021 and Nasr *et al.,* 2020).

The agricultural pesticides interact with the plant system and affect the physiological and biochemical activities of the plants (Kaur *et al.*, 2011 and Ashrafi and Pandit, 2016). Various studies have revealed that the quantitative formation of different bimolecular and activity of some enzymes of the crop plants are affected by application of pesticides (Kaur *et al.*, 2011, Ashrafi and Pandit, 2016 Homayoonzadeh *et al.*, 2020)). It was observed that foliar application imidacloprid resulted in reducing the total phenols, and increasing the total protein content and enzymes (catalase, peroxidase and polyphenol oxidase) activity (Chauhan *et al.*, 2013; Ashrafi and Pandit, 2016 and Homayoonzadeh *et al.*, 2020).

Hence it is important to study the influence of pesticides on the population fluctuation of onion thrips and two spotted spider mites on cucumber crop in the greenhouse. In addition, the effects of the tested pesticides after application on a cucumber greenhouse on chlorophyll, some biochemical components and enzyme changes parameters are investigated in cucumber leaf. These studies would give an idea about the suitable pesticide applications for controlling the two selected pests which in turn may be useful in developing better pest management strategies.

MATERIAL AND METHODS

1. Population density of *Tetranychus urticae* and *Thrips tabaci* in cucumber

Cucumber seedlings (*Cucumis sativus* L.) were transplanted in two seasons; 2022 and 2023 on March with cultivar Prince. The area was four greenhouses was divided into four equal plots. The design employed for this experiment was a complete randomized block design. The cucumber plants were weekly examined 15 days after transplanting till the end of May. In order to estimate the population dynamic of two-spotted spider mite and onion thrips on the cucumber, number of plants (according to availability) at weekly visits, for region. The leaves taken from each plant were put in paper bag, then placed in a cool box then transported to the laboratory to count the numbers of mobile stages under binocular microscope, while onion thrips (larvae and adults) were counted and recorded in greenhouse.

2. Tested pesticides used

The present investigation aimed to assess the impact of nine commercially available pesticide formulations on greenhouse. Table 1 summarize the generic and chemical details of the pesticides under study. The concentrations utilized in the experiment were determined according to the recommendations set by the Egyptian Ministry of Agriculture for controlling the sucking pest insects in both greenhouse and field environments.

3. Chemical control in the greenhouse

During the cucumber growing seasons of 2022 and 2023, trials were conducted at the Sakha Agricultural Research Station greenhouse located in the Kafr El-Sheikh Governorate. Cucumber plants (*Cucumis sativus* L var, Prince) were planted throughout five greenhouses in the two seasons, which was divided into two compounds for one greenhouse. The seedlings were transplanted to the greenhouses in 15 March. The area was divided into 40 plots (nine pesticides plus control with four replicates), under a randomized complete design, where the selected pesticides were applied in this area in the last week of April 2022 and 2023 during the cucumber season. All agricultural practices were carried out throughout the entire season without any pesticide treatments before control is applied. A Knapsack sprayer was used to apply the tested pesticides.

T. urticae (eggs and mobile stage) and *T. tabaci* (larvae and adults) counts were recorded before spraying, on 40 cucumber leaves (spider mite) (using binocular microscope) and onion thrips were counted on ten leaves/replicate in the greenhouse for each treatment. Counts were also taken to assess the infestation levels of pests two, five, seven and ten days after the application. To determine the percentage of infestation reductions, equation of Fleming and Ratnataran (1985) was used.

Table (1): **Specific information regarding the compounds tested.**

Name		Company	(Chemical classes)	Application (rate/100L)
Common	Trade (R)			
Jojoba oil	Top healthy 60% EC	Top Chemical Factory for the manufacture of pesticides and specialized Chemicals	Plant oils	400 ml
Abamectin	Espinosa 1.8% EC	Jiangsu Fengyuan Bioengineering Co., Ltd China	Avermectin	40 ml
Abamectin 1.3% + bifenthrin 8.8%	Quick 10.1% EC	Starchem Industrial Chemicals Egpyt	Avermectin+ pyrethroid	75 ml
Fenpyroximate 10% + etoxazole 10%	Turbo 20% SE	Starchem Industrial Chemicals Egpyt	Pyrazole + phenetole	25 ml
Chlorfenapyr	Challenger 24%	Debbie Johnlong Agrochemical Co. Ltd China	Arylpyrrole	60 ml
Imidacloprid	Keribs 35% SC	National Agricultural Chemicals Co. Egpyt	Neonicotinoid	75 ml
Imidacloprid 12% + abamectin 2%	Congest-Extra 14% SC	Starchem Industrial Chemicals Egpyt	Neonicotinoid +avermectin	50 ml
Thiamethoxam	Coragector 25% WG	Bionoblestar Agrochemical Co, Ltd China	Neonicotinoid	40 g
Thiamethoxam 15.24% + abamectin 3.32%	Regular-zol 18.56% SC	Mirs Agricultural Development Co.	Neonicotinoid + avermectin	60 ml

4. Determination of enzyme activity and biochemical components of cucumber leaf after spraying compounds to spider mite and thrips in the greenhouse

4.1. The chlorophyll content of cucumber leaf

The samples were taken of treated leaves with trial chemical control in 2023 season the chlorophyll content of cucumber leaves was assessed using a portable leaf chlorophyll meter (Minolta) in SPAD units. This measurement method was based on the technique described by Marquard and Timpton in 1987. The chlorophyll content was determined on the recently fully expanded leaf of the cucumber plant two, five, seven and ten days after application.

4.2. Determination of malondialdehyde content (MDA)

Ten days after treatment fresh cucumber leaves (newly matured) were randomly collected from each replicate from each greenhouse. Samples (1 gm) of fresh cucumber leaf were mixed with 1 ml of 0.67% thiobarbituric (TBA) and 1 ml of 10% trichloroacetic acid (TCA) and heated in a boiling water bath for 15 min. MDA was measured spectophotometrically by absorbance at (535 nm) and expressed as n mol of MDA per gram fresh leaf samples (Madhava Rao and Sresty, 2000)

4.3. Total carbohydrates, protein content and antioxidant enzymes assays

The freshly collected cucumber leaves (1 gm) were homogenized in liquid N2 with 0.05 M. EDTA and 1 PVP at 4 °C, the extracts were centrifuged at 4 °C 5000 xg (Lowry *et al.*, 1951). The resulting supernatant was used for determination of nonenzymatic components (total carbohydrates and protein content) and antioxidant enzymes (catalase, peroxidase and polyphenol oxidase). Catalase activity was measured according to Aebi (1984), the methods of Polle *et al.* (1994) was used for determination of peroxidase activity. Polyphenol oxidase activity was determined as described by Sharma *et al.* (2012), protein content was measured according to A.O.A.C. (1990), and total carbohydrates was determined by phenol-sulphuric acid method described by Dubois *et al.*

(1956) and calculated as percentage. The determination of protein content, enzyme activity and total carbohydrate levels was carried out in the laboratory of the Pesticides Chemistry and Toxicology Department, situated in the Faculty of Agriculture at Damanhur University.

5. For statistical analysis

An Analysis of Variance (ANOVA) was conducted to determine significant differences between the means of the treatments. To further analyze the significant differences, Duncan's Multiple Range Test (Duncan, 1955) was utilized. The statistical analysis was performed using the SPSS statistical software package, version 16.0 (SPSS Inc., Chicago, IL, USA, 2016).

RESULTS AND DISCUSSION

Population density of *Tetranychus urticae* and *Thrips tabaci*

Population densities of two-spotted spider mite mobile stages and onion thrips larvae and adults on cucumber plants in the greenhouse of Sakha Agricultural Research Station were recorded for the 2022 and 2023 seasons. The data is illustrated in Figure 1 and 2.

In both the 2022 and 2023 seasons, the appearance of *T. urticae* was observed in the third week of March in Prince cultivar cucumber plants. Subsequently, their population densities gradually increased over time. The highest peak in spider mite population density was reached during the second week of April and the first and third weeks of May (Figure 1).

The population of *T.urtiace* was distributed during the months of the growing Nile seasons and the population of pest recorded two peaks during July and August (Shaalan, 2016). Abo-Elmaged *et al.* (2020) Egypt, recorded the highest peak of *T. urticae* population the middle of May on cucumber, while Bamel *et al.* (2021) who showed that *T. urticae* population recorded peak on third week of May. Bouchelta and Allam (2023) showed that, infestation peaks occurred in March and declined later in October.

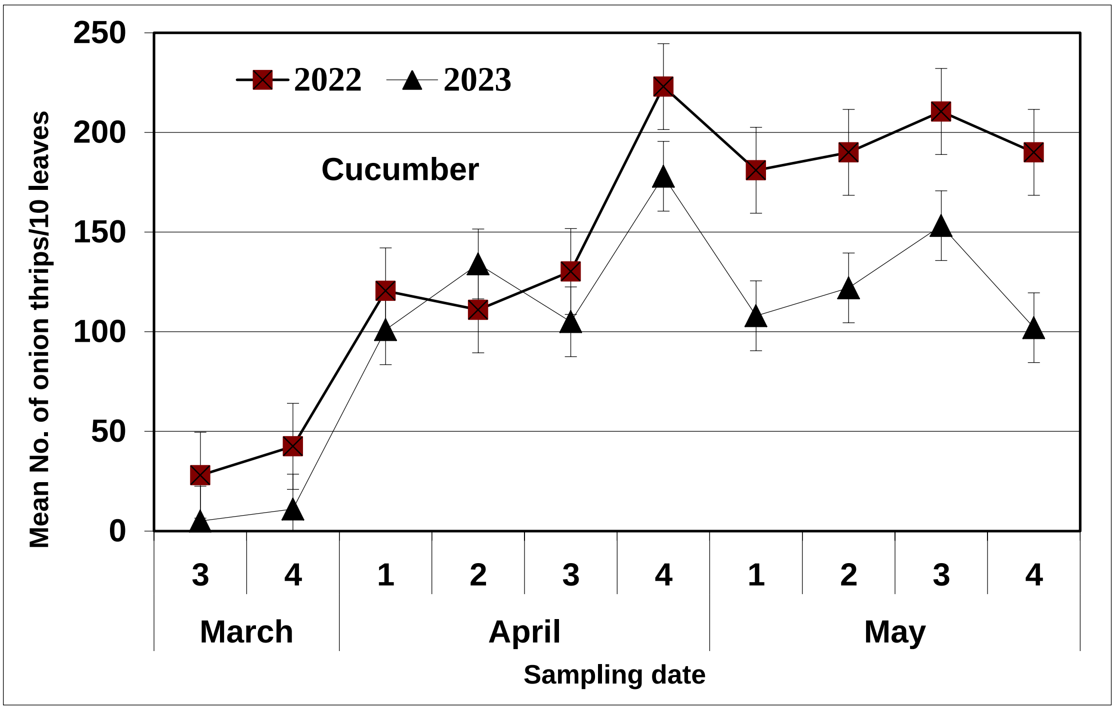

Figure (1): Population densities of *Tetranychus urticae* mobile stages on cucumber plants at Sakha Agricultural Research Station greenhouse

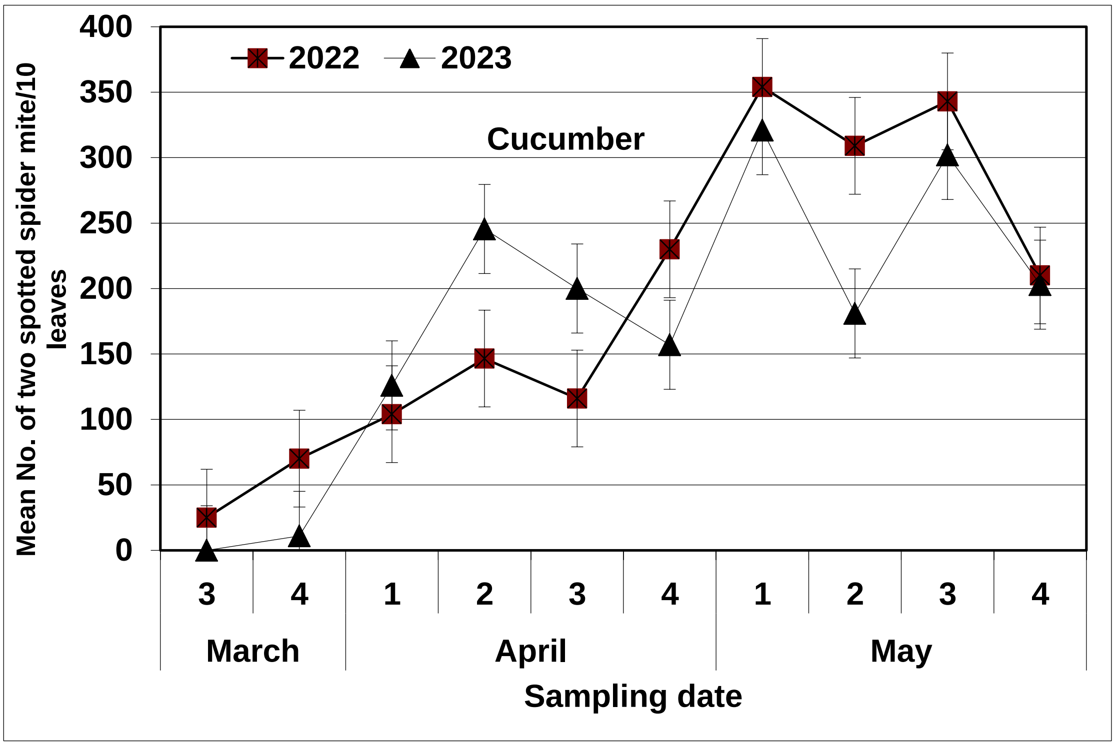

Figure (2): Population densities of *Thrips tabaci* on cucumber plants at Sakha Agricultural Research Station greenhouse

For both seasons, the presence of *T. tabaci* was initially observed at low densities in the third week of March. Subsequently, their population densities gradually increased over time. The highest peaks of thrips infestations were recorded during different weeks in the two seasons. In the 2022 season, the highest peak population of thrips on cucumber plants occurred in the first and fourth weeks of April and the third week of May, while those in 2023 season were recorded in the second and fourth weeks of April and third of May (Fig. 2).

Our results are in conformation with the findings of Ullah *et al.* (2010) who showed that the activity of onion thrips was first recorded on 3rd February and reached to its peak in the last week of April. Later, the population declined to towards the end of May as the crop started to mature**.** Additionally, Shaalan (2016) found that the population dynamics *T. tabaci* was recorded two peaks in July and August on cucumber. Medshikar *et al.* (2023) found that highest population of *T. tabaci* was in the last week of March on cucumber during summer 2022 in India.

Efficiency of the tested pesticides on *Tetranychus urticae* and *Thrips tabaci*

Under greenhouse conditions, the efficacy of nine selected pesticides from different chemical groups was evaluated to assess their effectiveness against *T. urticae* and *T. tabaci* infesting cucumber plants at Sakha, Kafr El-Sheikh in 2022 and 2023. This evaluation was conducted using data presented in Tables 2, 3, and 4. Randomly selecting and sampling infested plants allows researchers to obtain representative data on pest populations and evaluate the effectiveness of various control methods. The formula by Fleming and Ratnakaran (1985) to calculate the percentage change in the population of spider mite and thrips. This formula was employed by comparing the mean population of spider mites before and after the application of sprays in both treated and control plots.

Tetranychus urticae

The results in Table (2) indicated that jojoba oil was the most effective pesticide in reducing *T. urticae* eggs in cucumber crop as initial effect with (98.84, 97.37%) in 2022 and 2023 respectively. While the residual effect and grand average residual effect and grand average effects were (97.50, 95.80, 98.17 and 96.59%) in 2022 and 2023 respectively. Thiamethoxam + abamectin exhibited the lowest efficacy in controlling the pest eggs (Table, 2). Highly significant differences among the treatments in terms of reducing *T. urticae* eggs ($p\leq0.01$) (Table 2).

Table (2): The potency of various tested compounds in reducing *Tetranychus urticae* egg populations on cucumber plants was assessed at Sakha Agricultural Research Station greenhouse, located in Kafr El-Sheikh Governorate

Pesticide	**(Used*) conc., [mg a.i.l^{-1}]**	**Ave. (No.) pre- treat. /10**	**%Reduction**		
			Initial effect %	**Residual effect**	**Grand Average**
2022					
Jojoba oil	2395	682	98.84±0.58a	97.50±1.15a	98.17±0.58a
Abamectin	7	775	93.82±1.73bc	95.08±2.31a	94.45±2.31ab
Abamectin + bifenthrin	76	371	91.93±1.73bc	93.29±1.73ab	92.61±1.15abc
Fenpyroximate + etoxazole	50	535	91.57±2.31bc	82.66±1.73d	87.12±2.31d
Chlorfenapyr	144	485	93.31±1.73bc	96.02±1.15a	94.67±1.73ab
Imidacloprid	262	123.5	92.51±1.73bc	85.1±2.31cd	88.81±1.73cd
Imidacloprid + abamectin	70	200	88.73±1.73cd	89.0±1.73bc	88.87±2.31cd
Thiamethoxam	100	327	95.77±1.73ab	84.57±2.31cd	90.17±1.73bcd
Thiamethoxam + abamectin	111	199.75	85.26±1.73d	66.35±2.31e	75.81±1.15e
F	-	-	5.84	25.58	13.16
p-value	-	-	**	**	**
2023					
Jojoba oil	2395	720	97.37±1.15a	95.80±1.15a	96.59±1.15a
Abamectin	7	805	92.87±1.15ab	93.76±1.73a	93.32±1.73ab
Abamectin + bifenthrin	76	401	90.98±1.73bc	91.57±1.15ab	91.28±1.73bcd
Fenpyroximate + etoxazole	50	800	90.17±1.15bc	81.38±2.31d	85.78±1.73e
Chlorfenapyr	144	502	91.31±2.31bc	94.25±1.73a	92.78±1.73abc
Imidacloprid	262	200	91.93±1.15b	83.91±1.73cd	87.92±1.15cde
Imidacloprid + abamectin	70	300	86.89±1.15c	87.5±1.15bc	87.20±1.73de
Thiamethoxam	100	341	93.27±1.73ab	83.37±1.73cd	88.32±1.73bcd
Thiamethoxam + abamectin	111	200.5	81.39±1.45d	66.81±2.31e	74.10±1.73f
F	-	-	9.26	27.76	15.76
p-value	-	-	**	**	**

In the column, means followed by the same letter are not significantly different at the 5% level by DMRT (Duncan's Multiple Range Test 1955

** Highly significant ($p\leq 0.01$); * significant ($p\leq 0.05$)

Data in Table (3) revealed that abamectin+ bifenthrin pesticide was the highly effective pesticide on initial effect and grand average reduction of *T. urticae* mobile stage with (95.80 and 95.26% in 2022) and (93.99 and 93.24% in 2023) respectively, while thiamethoxam +

abamectin pesticide was the least effect pesticide at residual effect and grand average in this pest mobile stages control. Almost, highly significance differences were between all applied pesticides ($p \leq 0.01$) (Table 3).

Table (3): The potency of various tested compounds in reducing *Tetranychus urticae* mobile stages populations on cucumber plants was assessed at Sakha Agricultural Research Station greenhouse, located in Kafr El-Sheikh

Pesticide	**(Used*) conc., [mg a.i.l^{-1}]**	**Ave. (No.) pre- treat. /10 leaves**	**%Reduction**		
			Initial effect %	**Residual effect**	**Grand Average**
2022					
Jojoba oil	2395	144.25	90.71±2.31abc	96.50±1.73ab	93.61±1.73a
Abamectin	7	208	80.94±0.58d	92.27±1.15ab	86.61±2.31c
Abamectin + bifenthrin	76	186	95.80±2.31a	94.71±2.31ab	95.26±1.15a
Fenpyroximate + etoxazole	50	196	88.04±1.73bcd	96.96±1.73a	92.5±2.31ab
Chlorfenapyr	144	101.25	93.25±2.89ab	90.12±1.73b	91.69±2.31ab
Imidacloprid	262	58.25	84.67±2.31cd	73.31±1.73d	78.99±1.73cd
Imidacloprid + abamectin	70	93	86.79±2.31bcd	90.97±2.31ab	88.88±2.31ab
Thiamethoxam	100	103	89.16±2.31abc	82.33±1.15c	85.75±2.31c
Thiamethoxam + abamectin	111	96	83.72±2.31cd	61.76±3.44e	72.74±2.89d
F	-	-	4.58	34.76	12.26
p-value	-	-	**	**	**
2023					
Jojoba oil	2395	300	89.04±2.89abc	95.35±2.31a	92.20±2.31a
Abamectin	7	208	79.46±2.31d	90.68±1.15a	85.07±2.31ab
Abamectin + bifenthrin	76	186	93.99±1.73a	92.49±2.89a	93.24±2.31a
Fenpyroximate + etoxazole	50	201.5	86.95±3.46abcd	94.39±2.31a	90.67±1.15a
Chlorfenapyr	144	305	91.38±0.58ab	88.66±4.04a	90.02±3.46a
Imidacloprid	262	147.25	83.48±1.73bcd	71.41±0.58c	77.45±2.89bc
Imidacloprid + abamectin	70	193	85.35±2.89abcd	88.96±2.31a	87.16±4.04a
Thiamethoxam	100	203	88.99±4.04abc	79.88±3.18b	84.44±2.31ab
Thiamethoxam + abamectin	111	157	81.16±2.31cd	60.61±2.89d	70.89±3.46c
F	-	-	3.29	20.63	6.84
p-value	-	-	*	**	**

In the column, means followed by the same letter are not significantly different at the 5% level by DMRT (Duncan's Multiple Range Test 1955

** Highly significant ($p \leq 0.01$); * significant ($p \leq 0.05$)

Chlorfenapyr, spiromesifen, fenpyroximate, abamectin and bifenazate showed 97.13–99.88% reduction of the two spotted spider mite over untreated control except the azadirachtin which showed 89.81% reduction (Reddy *et al.*, 2014). Our results are in conformation with the findings of Shaalan (2016) who showed clearly that fenpyroximate, ethoxazole, thiamethoxam, imidacloprid and chlorfenapyr significantly decreased the population density of *T. urticae.* El-Fakharany (2017 and 2021) found that abamectin, Kz oil, Capl2, azadirachtin oil and orange oil caused high reduction in infestation of *T. urticae* eggs and mobile stages. Ali (2018) found that Pine oil, Castor oil, imidacloprid, fenpyroximate and abamectin were highly effective in controlling *T. urticae***.** Hassan and Hamad-Ameen (2019) found that chlorphenapyr was the best abamectin, and asequinocyl against *T. urticae*. Osman (2019) found that abamectin was the most effective compound while fenpyroximate and cypermethrin caused a moderate effective, but Wormseed caused the least effective compound to mobile stages of *T. urticae.* Nag *et al.* (2020) found that propargite and spiromesifen was more than 80% reduction of *T. urticae*. Azadirachtin exhibited a higher level of mortality as compared to homemade neem fruit aqueous extract. Abamectin, abamectin + bifenthrin and chlorfenapyr demonstrated significant mortality of *T. urticae* when compared to the control for a duration up to 21 days. On the other hand, spinosad, deltamethrin, imidacloprid, and thiamethoxam showed significant mortality of *T. urticae* for a period of up to 14 days. Among the tested compounds, abamectin and chlorfenapyr stood out for their higher residual efficacy against the pest. This means that even after the initial application, these compounds continued to display effectiveness in controlling *T. urticae* for a more extended period compared to other compounds. Based on the findings, it is suggested that abamectin and chlorfenapyr can be recommended for the management of mites due to their higher toxicity and extended residual efficacy (Rabbi *et al.*, 2021). The highest mortality percentage in *T. urticae* populations was 98.4 % after 24h of spraying with abamectin (Senbill *et al.*, 2023).

Thrips tabaci

Regarding to the Initial effect, residual effect and grand average effect of pesticides used on *T. Tabaci* Table (4) showed that the fastest effective pesticides were fenpyroximate + etoxazole (95.83, 93.36 and 94.60% reduction in 2022) and (93.99, 91.69 and 92.84% reduction in 2023), respectively, followed by abamectin, imidacloprid + abamectin and jojoba oil without significant differences, while thiamethoxam was the least in this pest control. (Table, 4). Based on the average reduction in *T. Tabaci* population on cucumber plants 10 days after spraying, all tested pesticides were highly effective.

These results are consistent with those found by Ullah *et al.* (2010) who endosulfan, imidacloprid, spinosad, thiamethoxam and acetamiprid were significantly effective against the onion thrips compared to control. Acetamiprid along with spiromesifen were found to be effective against chilli thrips (Varghese and Mathew, 2013). Additionally, Shaalan (2016) found that fenpyroximate, ethoxazole, thiamethoxam, imidacloprid and chlorfenapyr significantly decreased the population density of *T. tabaci.* Chlorfenapyr though proved to be superior in performance for management of thrips. Subba and Ghosh (2016) showed that acetamiprid was most effective against *T. tabaci*. However, neem+spilanthes gave satisfactory result.

The effect of tested pesticides on chlorophyll content in cucumber leaves

chlorophyll molecules also play a crucial role in capturing carbon dioxide (CO_2) from the atmosphere during photosynthesis as a photoreceptor, which acts as a transitional factor in the transformation of absorbed solar energy and synthesis of organic substances in plants. The results presented in Table (5) revealed significant differences in chlorophyll content due to pesticide applications. The chlorophyll content in cucumber leaves was evaluated after 2, 5, 7 and 10 days of treatment with various compounds. The results indicated that the fenpyroximate + etoxazole treatment led to a significant increase in chlorophyll content. On the other hand, thiamethoxam treatment and control resulted in the lowest chlorophyll content in 2022 and 2023 respectively. The remaining tested compounds showed moderate effects on chlorophyll content in cucumber leaves. Mishra *et al.* (2008) showed that the chlorophyll content reduction which may be due to the inhibition of their breakdown of pigments or biosynthesis or their precursors as suggested for cowpea seedling under stress by compound dimethoate. These results are consistent with those found by Seth *et al.* (2014) found that neem extract treatment due to the increase in chlorophyll content plant but no significant difference found between the neem extract and dimethoate treated plant. Additionally, El-Fakharany (2016) found that the application of different compounds resulted in significant differences in chlorophyll content. It was increased significantly by primiphos-methyl treatment. Grand average of chlorophyll content increased significantly by primiphos-methyl and acetamipirid application, while it was the lowest with imidacloprid application on leaf.

Table (4): The potency of various tested compounds in reducing *Thrips tabaci* populations on cucumber plants was assessed at Sakha Agricultural Research Station greenhouse, located in Kafr El-Sheikh

Pesticide	**(Used*) conc., [mg a.i.l^{-1}]**	**Ave. (No.) pre- treat. /10 leaves**	**%Reduction**		
			Initial effect %	**Residual effect**	**Grand average**
2022					
Jojoba oil	2395	105	93.65±2.31ab	88.26±4.04a	90.96±1.73ab
Abamectin	7	150	94.44±1.73ab	92.22±2.31a	93.33±2.31a
Abamectin + bifenthrin	76	100	91.67±1.73abc	89.08±1.15a	90.38±2.89ab
Fenpyroximate + etoxazole	50	200	95.83±2.31a	93.36±2.31a	94.60±2.31a
Chlorfenapyr	144	50	83.33±1.73d	79.67±1.73b	81.5±2.89c
Imidacloprid	262	48.75	82.91±2.89d	79.69±2.89b	81.3±3.46c
Imidacloprid + abamectin	70	200	94.17±2.31ab	93.25±2.89a	93.71±2.89a
Thiamethoxam	100	51	84.31±2.89cd	77.1±1.15b	80.71±1.73c
Thiamethoxam + abamectin	111	50	86.67±3.46bcd	79.82±3.46b	83.25±1.73bc
F	-	-	4.70	6.55	5.58
p-value	-	-	**	**	**
2023					
Jojoba oil	2395	98	91.32±2.89ab	87.66±2.89ab	89.49±2.31ab
Abamectin	7	141	93.18±2.89ab	91.49±2.89a	92.34±2.89a
Abamectin + bifenthrin	76	91	89.43±3.46abc	88.19±1.73ab	88.81±1.73abc
Fenpyroximate + etoxazole	50	166	93.99±2.31a	91.69±2.89a	92.84±2.31a
Chlorfenapyr	144	70.5	81.64±1.73c	81.85±2.31b	81.75±2.31c
Imidacloprid	262	61	84.84±2.31bc	80.42±1.73b	82.63±1.15bc
Imidacloprid + abamectin	70	137	91.90±2.31ab	92.01±2.31a	91.96±2.31a
Thiamethoxam	100	88.25	84.91±2.89bc	82.21±1.73b	83.56±2.31bc
Thiamethoxam + abamectin	111	59.5	85.08±2.89bc	85.38±2.89ab	85.23±2.89abc
F	-	-	2.75	3.48	3.65
p-value	-	-	*	**	**

In the column, means followed by the same letter are not significantly different at the 5% level by DMRT (Duncan's Multiple Range Test 1955

** Highly significant (p≤ 0.01); * significant (p≤ 0.05)

Table (5): Effect of tested pesticides on chlorophyll content in cucumber leaves

Compound	(Used*) conc. [mg a.i.l^{-1}]	The effect of indicated days on chlorophyll content, measured in SPAD			
		2	5	7	10
2022					
Jojoba oil	2395	52.5±1.44bc	53.5±0.87de	56.0±0.58bc	58.0±1.79ab
Abamectin	7	54.0±1.74b	58.7±2.19bcd	57.9±1.67abc	58.0±1.73ab
Abamectin+bifenthrin	76	56.8±2.31ab	52.3±10.98e	59.3±0.40ab	59.3±1.56ab
Fenpropathrin+etoxazole	50	60.9±2.37a	65.1±2.37a	62.5±0.87a	61.7±1.61a
Cblcknapyr	144	47.3±0.98cd	63.7±1.61ab	58.9±1.73abc	47.8±1.10c
Imidacloprid	262	54.4±2.08b	56.1±1.67de	56.2±2.77abc	59.5±1.50ab
Imidacloprid+ abamectin	70	48.0±2.02cd	61.7±2.25abc	47.1±2.82d	57.3±0.98ab
Thiamecthioxam	100	42.6±0.81d	46.8±1.27f	52.8±0.69c	47.8±2.25c
Thiamecthioxam + abamectin	111	51.0±1.73bc	53.3±1.56de	59.2±2.19ab	56.2±1.62ab
Untreated	-	51.1±2.25bc	57.9±1.73cde	56.9±2.89abc	54.3±2.14b
F	-	7.87	10.83	4.92	8.07
p-value	-	**	**	**	**
2023					
Jojoba oil	2395	46.5±1.44f	58.9±2.94b	62.3±0.98ab	39.6±1.50d
Abamectin	7	52.2±1.04de	57.7±2.48b	54.4±2.08de	57.2±2.77ab
Abamectin+bifenthrin	76	61.2±1.33abc	50.0±1.33d	60.4±3.23abcd	60.3±1.56a
Fenpropathrin+etoxazole	50	65.3±1.56a	67.2±1.04a	64.8±1.84a	61.9±3.46a
Cblcknapyr	144	56.3±2.71cd	55.9±1.21bc	61.1±2.25abcd	49.1±2.25c
Imidacloprid	262	63.8±1.27ab	59.6±1.56b	61.5±2.60abc	50.4±0.92c
Imidacloprid+ abamectin	70	55.5±1.50cd	60.1±3.41b	60.8±1.73abcd	53.7±1.33bc
Thiamecthioxam	100	59.5±2.02bc	50.4±0.23cd	57.8±1.15bcde	51.1±0.52bc
Thiamecthioxam + abamectin	111	60.0±2.37abc	58.7±0.46b	55.0±2.60cde	48.1±1.96c
Untreated	-	48.5±1.56ef	46.3±1.56d	52.9±0.64e	50.5±2.02c
F	-	12.89	10.31	3.56	10.46
p-value	-	**	**	**	**

In the column, means followed by the same letter are not significantly different at the 5% level by DMRT (Duncan's Multiple Range Test 1955

(. ** Highly significant ($p\leq 0.01$); * significant ($p\leq 0.05$))

Biochemical and enzyme activity changes in cucumber plants after pesticides application

Some non-enzymatic components and antioxidant enzymes as parameters related to the performance of biochemical changes were detected in cucumber leaves after applications pesticide for spraying spider mite and thrips.

Effect of tested pesticides on non-enzymatic components

Non -enzymatic components (carbohydrates, protein content, fats, total lipid and total phenols) significantly decreased in cucumber plants after 10 days due to some compounds in comparison with control. The findings in Table (6) indicate that the increase of carbohydrates, fats and total phenols were observed in leaves with abamectin + bifenthrin. Also, the effect of jojoba oil on increasing the protein content and total lipid% in the leaves. Analysis and ANOVA indicates the statistical highly significance and the change in non-enzymatic components in leaves were the tested compounds treatment dependent.

The results were obtained by Chauhan *et al.* (2013) showed that the imidacloprid treatment decreased the reducing total phenols but increased the total protein content. Seth *et al.* (2014) reported that significant increase of carbohydrate and protein content with neem extract treatment whereas decrease with dimethoate. Moreover, total soluble carbohydrates, proline, total protein and total phenolic content were observed a significant elevation in response with Imidacloprid and dichlorvos used to control whiteflies were sprayed on cucumber plants compared to the control (Homayoonzadeh *et al.*, 2020).

Table (6): The effect of tested pesticides on non-enzymatic components in cucumber leaves after 10 days of treatment

Treatment	Non-enzymatic components				
	Carbohydrates	Protein	Fats	Total lipid%	Total phenols%
Jojoba oil	44.46±1.73bc	6.21±0.46a	0.89±0.06cd	0.63±0.02a	1.73±0.02abc
Abamectin	48.96±2.31ab	5.78±0.58ab	0.82±0.01de	0.59±0.06ab	1.67±.017bc
Abamectin + bifenthrin	52.11±1.15a	5.02±0.57ab	1.05±0.03a	0.45±0.02bcd	2.07±0.04a
Fenpyroximate + etoxazole	44.12±1.73bc	5.78±0.46ab	0.96±0.02abc	0.41±0.01def	1.93±0.02ab
Chlorfenapyr	47.43±2.31ab	5.70±0.46ab	0.94±0.02bc	0.52±0.01bc	1.85±0.01ab
Imidacloprid	37.79±1.73d	5.27±0.46ab	0.76±0.03ef	0.54±0.02abc	1.47±0.23c
Imidacloprid + abamectin	41.62±1.17cd	4.91±0.57ab	0.70±0.06ef	0.50±0.06bcd	1.42±0.10c
Thiamethoxam	44.29±1.62bc	4.91±0.58ab	0.90±0.06cd	0.38±0.01ef	1.76±0.12abc
Thiamethoxam + abamectin	37.50±0.87d	4.26±0.91b	0.82±0.01de	0.35±0.03f	1.64±0.04bc
Control	51.22±1.73a	6.15±0.52a	1.01±0.06ab	0.56±0.02ab	2.00±0.12ab
F	8.98	1.61	9.66	9.41	3.51
p-value	**	**	**	**	**

In the column, means followed by the same letter are not significantly different at the 5% level by DMRT (Duncan's Multiple Range Test 1955)

** Highly significant ($p \leq 0.01$); * significant ($p \leq 0.05$)

Effect of tested pesticides on antioxidant enzymes

Environmental stresses in plants lead to higher levels of ROS in cells. Thus, cells respond to stress with changing enzymes. Plants which express higher levels of SOD, CAT and GPx could relatively resist against these stresses. These promising results of transgenic plants indicate that it could be possible to gain tolerant plants which could resist against higher levels of ROS production (oxidative stress) (Varjovi *et al.*, 2015). Catalase (CAT), peroxidase (POD) and polyphenol oxidase (PPO) were considered as antioxidant enzymes, as changes of their activity after treatments of the pesticides to plant tissues are produced by accumulation of reactive oxygen species ROS in plant tissues. Superoxidase (SOD) constitutes the first line of defense on ROS (Alscher *et al.*, 2002) by catalyzing the dismutation of superoxide radical to H_2O_2 and O_2, after that CAT and POD the two enzymes participate in the detoxification of H_2O_2 by converting it to H_2O and O_2 (Parween *et al.*, 2012).

Table (7) showed that jojoba oil treatment increased the of enzymatic activity (catalase, peroxidase and polyphenol oxidase) specially at 10 days after application to an extent of 29.91, 19.68 and 21% respectively. The thiamethoxam, fenpyroximate+ etoxazole and chlorfenapyr applications on cucumber plants decreased the activities of catalase, peroxidase and polyphenol oxidase. Almost, peroxidase significantly varied among treatments ($p \leq 0.05$). Analysis and ANOVA indicates the statistical highly significance and the change in peroxidase activity in leaves were the tested compounds treatment dependent.

Table (7): The effect of tested pesticides on antioxidant enzymes activity in cucumber leaves after 10 days treatment

Treatment	**Antioxidant enzymes**		
	Catalase (nmol H2O2 mg protein^{-1}min^{-1}) (CAT)	**Peroxidase (nmol ascorbate oxidized mg protein^{-1} min^{-1})**	**Polyphenol oxidase (nmol ascorbate oxidized protein^{-1} min^{-1})**
Jojoba oil	6.08±0.53a (+29.91) *	9.79±0.58a (+19.68)	10.89±1.15a(+21)
Abamectin	5.51±0.57ab (+17.74)	8.39±0.40ab (+2.57)	10.14±1.07ab (+12.67)
Abamectin + bifenthrin	5.18±0.51abc (+10.68)	9.62±0.57a (+17.60)	10.58±0.58a (+17.56)
Fenpyroximate+ etoxazole	4.47±0.46bc (-4.49)	7.13±0.5bc (-12.84)	8.98±0.58ab (-0.22)
Chlorfenapyr	4.40±0.23bc (-5.98)	7.11±0.51bc (-13.08)	8.62±0.57ab (-4.22)
Imidacloprid	5.17±0.48abc (+10.47)	9.43±0.33a (+15.28)	10.61±0.58a (+17.89)
Imidacloprid+ abamectin	5.31±0.58abc (+13.46)	8.73±0.44ab (+6.72)	10.08±1.11ab (+18.67)
Thiamethoxam	3.80±0.17c (-18.80)	6.05±0.55c (-26.04)	7.64±0.44b (-15.11)
Thiamethoxam + abamectin	5.74±0.46ab (+22.65)	8.32±0.39ab (+1.71)	9.02±0.57ab (+0.22)
Control	4.68±0.46abc	8.18±0.58ab	9.00±1.15ab
F	2.21	6.08	1.62
p-value	ns	**	Ns

In the column, means followed by the same letter are not significantly different at the 5% level by DMRT (Duncan's Multiple Range Test 1955))

(** Highly significant ($p \leq 0.01$); * significant ($p \leq 0.05$))

*percent increase (+) / decrease (–)

The results were obtained by Chauhan *et al.* (2013), Mishra *et al.* (2015) and Ashrafi and Pandit (2016) who showed that the imidacloprid and profenophos treatments increased enzyme (catalase, peroxidase and polyphenol oxidase) activity. Homayoonzadeh *et al.* (2020) studied imidacloprid and dichlorvos sprayed to control cucumber whiteflies on cucumber seedlings. They found imidacloprid and dichlorvos significantly increased on superoxide dismutase, catalase, ascorbate peroxidase, guaiacol peroxide, and phenylalanine ammonia-lyase activity, while it leads to a significant decrease on polyphenol oxidase change.

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التأثيرات الجانبية لبعض المبيدات المطبقة في مكافحة *Thrips tabaci* L. و*Tetranychus urticae* (Koch) على بعض المحتويات البيوكيماوية والنشاط الإنزيمي لأوراق الخيار

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الملخص العربى

تربس البصل *Thrips tabaci* L. والعنكبوت الاحمر ذو البقعتين *Tetranychus urticae* (Koch) كلاهما من الآفات التي تسبب أضرارًا مباشرة وغير مباشرة لنباتات الخيار. تم دراسة الكثافة العددية للأطوار المتحركة لعنكبوت الاحمر وتربس البصل (اليرقات والحشرات الكاملة) على نباتات الخيار تحت ظروف الصوب بمحطة البحوث الزراعية بسخا كفر الشيخ في موسمي ٢٠٢٢ و٢٠٢٣. تم تسجيل أعلى كثافة عددية لحشرة تربس البصل والعنكبوت الأحمر على صنف خيار (البرنس) في شهري إبريل ومايو.

تم تقييم فاعلية تسعة مركبات من مجموعات كيميائية مختلفة تحت ظروف الصوب في محطة البحوث الزراعية بسخا محافظة كفر الشيخ خلال موسمي النمو ٢٠٢٢ و٢٠٢٣. وكان الهدف هو تقييم فعاليتها في مكافحة الإصابة بـ *T. urticae* و*T. tabaci* على نباتات الخيار. لوحظ انخفاض معنوي في عدد بيض *T. urticae* مع معاملة زيت الجوجوبا مقارنة بالمركبات الأخرى التي تم اختبارها، وكان الأبامكتين + البيفينثرين الأكثر خفضا تعداد الاطوار المتحركة لعنكبوت الاحمر في نباتات الخيار، في حين كان الثيامثوكسام + الأبامكتين الأقل تأثيرا في مكافحة بيض والاطوار المتحركة للآفة. وجد أن الانخفاض في تعداد بيض العنكبوت الأحمر ذات فروق معنوية عالية بين المعاملات ($p \geq 0.01$). كما أن جميع المعاملات أدت إلى انخفاض عالي في تعداد التربس مع وجود اختلافات معنوية عالية ($p \geq 0.01$).

أدى تطبيق المركبات المختبرة إلى وجود اختلافات معنوية في محتوى الكلوروفيل. حيث تم زياده بشكل ملحوظ مع معاملة الفينبيروكسيميت + الإيتوكسازول. كما نلاحظ انخفاض المكونات غير الانزيمية (الكربوهيدرات، محتوى البروتين، الدهون، الدهون الكلية، الفينولات الكلية) انخفاضا معنويا في اوراق نباتات الخيار بعد ١٠ أيام مع المعاملات مقارنة بالكنترول. ولوحظت زيادة في نسبة محتوى الكربوهيدرات والدهون والفينول الكلي في الأوراق مع المعاملة بالأبامكتين + البيفنثرين. وأيضا لوحظ تأثير زيت الجو جوبا على زيادة محتوى البروتين والدهون الكلية في الأوراق. كما أظهرت المعاملات فروق عالية المعنوية في المكونات غير الأنزيمية فى الأوراق معتمدة على نوع المعاملة.

تمت دراسة أنشطة الإنزيمات المضادة للأكسدة (catalase, peroxidase and polyphenol oxidase) الكاتالاز والبيروكسيداز وبولي فينول أكسيداز في ورق الخيار بعد ١٠ أيام من تطبيق المركبات المختبرة. لوحظت زيادة في نشاط الكاتالاز والبيروكسيداز وبولي فينول أكسيداز بنسبة ٢٩,٩١% و١٩,٦٨% و٢١% على التوالي بعد ١٠ أيام من التطبيق باستخدام زيت الجوجوبا. الجدير بالذكر أن نشاط الإنزيم في هذه المعاملة ظل أعلى من الكنترول وباقي المعاملات. كما أدى تطبيق الثياميثوكسام والفينبيروكسيمات + الإيتوكسازول والكلورفينابير إلى انخفاض في نشاط الكاتالاز والبيروكسيداز وبولي فينول أكسيداز في أوراق نباتات الخيار. تباين البيروكسيداز بشكل ملحوظ بين المعاملات ($p \leq 0.05$). وكانت التغيرات في نشاط البيروكسيداز في الأوراق عالية المعنوية معتمدة على المعاملات المختبرة.