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Population dynamics of some economically phytophagous mites in fig orchards in Egypt with their chemical control

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ABSTRACT

Fig trees are one of the most economically important fruit crops in Egypt. The current research aimed to study the population dynamics and chemical control of some phytophagous mites associated with fig orchards in Tanan village, Qalubia governorate, Egypt, from Mar. 2022 to Feb. 2024. The results showed the incidence of 12 mite species belonging to 12 genera in eight families. *Tetranychus urticae* Koch (Tetranychidae), *Aceria ficus* (Cotté) and *Neserella capreifoliae* Meyer & Ueckermann (Eriophyidae), as well as *Rhyncaphytoptus ficifoliae* Keifer (Diptilomiopidae) have become as important phytophagous mites on “Sultani” fig. The predatory mites, *Amblyseius swirskii* Athias-Henriot and *Phytoseius finitimus* Ribaga (Phytoseiidae), and *Agistemus exsertus* Gonzalez (Stigmaeidae) are the most commonly associated with phytophagous mites in fig trees. The phytophagous mites, *A. ficus*, *T. urticae*, *N. capreifoliae*, and *R. ficifoliae* have two annual peaks on fig leaves, with *A. ficus* in late June and mid-Oct., *T. urticae* in June and early Oct., and *N. capreifoliae* in mid-May and mid-Nov., while *R. ficifoliae* in mid-June and mid-Oct. The correlation coefficient between phytophagous mites and the weather factors showed a significant positive correlation with temperature but an insignificant correlation with relative humidity. Two sprays of the six acaricides, vertimec, solo, danisaraba, ceflo, magnifico, and envidor were used to control the previous phytophagous mites in fig orchards. All tested acaricides recorded a high mean reduction percentage after two sprays during the 2023 season. Spiromesifen and abamectin had the highest reduction percentage among all mite pests.

Keywords: Acaricide, Diptilomiopidae, ecology, *Ficus carica*, Phytoseiidae,Tetranychidae

INTRODUCTION

Ficus carica L. (Moraceae) is a deciduous fruit tree and the major species of the genus. *Ficus* is an important genetic resource that contributes greatly to the richness of the rainforest ecosystem. In tropical regions, it is also a good source of food for animals that eat fruit. Native to southwest Asia and the eastern Mediterranean, it is one among the first plants that people cultivated. Figs are a valuable fruit that may be purchased fresh or dried worldwide (Rønsted et al. 2007; Dueñas et al. 2008). Moreover, figs are one of the only five fruit plants mentioned in the Holy Quran. Furthermore, figs are high quality fruits with a sweet flavor and a high nutritional content. They are a great source of antioxidants and phenolic compounds (Mawa et al. 2013; Sheikh 2016).

Fig orchards are susceptible to a range of pests and diseases, the severity of which might differ according to the cultivar, location, weather or cultural practices. Pests can cause significant losses in fig trees; with phytophagous mites being a particular concern. Those mites cause serious damage that may have an impact on yield since they feed on the epidermal cells and sub-epidermal tissues such as mesodermal cells, leaves, and fruits (Beard et al. 2012). The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) is one of the most significant phytophagous mites in several cropping systems worldwide, affecting a wide range of crops, fruits, vegetables, and ornamentals— a total of 1586 plant species— (Migeon and Dorkeld 2024).

In Egyptian fig orchards, phytophagous mites, including *T. urticae*, fig bud mite, *Aceria ficus* (Cotté), and *Neserella capreifoliae* Meyer & Ueckermann (Eriophyidae), *Rhyncaphytoptus ficifoliae* Keifer (Diptilomiopidae) are harmful.

Eriophyoid bud and leaf mites are known to cause rusting or surface browning, bud blasting, the prevention of new growth, bud distortion, and leaf chlorosis. These mites feed by extracting the contents of plant cells, causing damage such as webbing, stippling, yellowing, leaf loss, and even plant death in the case of *T. urticae* (Elhalawany 2001, 2012; Elhalawany et al. 2019, 2022).

The phytophagous mites can be affected by different environmental conditions and biotic factors. Several researchers studied the mite population density on fig trees such as El-Halawany and Abdel-Samad (1990); El-Halawany et al. (1990a, b, c); Elhalawany (2001); Abo-Taka et al. (2014); Desoky et al. (2021); Elhalawany et al. (2022); and Mohamed et al. (2022).

With spider mites accounting over 80% of the market, acaricides are crucial for controlling phytophagous mites. They are most commonly used in vegetables and fruits (74%), but they are also used in major crops including cotton, corn, and soybean (Van Leeuwen et al. 2015). Because phytophagous mites are small, have a short life cycle, and with high fecundity, controlling them has proven to be challenging. Thus, they can be controlled by repeated treatments of acaricides, which quickly causes resistance (Van Leeuwen et al. 2010).

Consequently, the aim of this study is to investigate the population dynamics of some phytophagous mites associated with fig orchards. Additionally, evaluate the effect of six acaricides on *A. ficus*, *N. capreifoliae*, *R. ficifoliae*, and *T. urticae* in field at Qalubia governorate during 2023 season.

MATERIAL AND METHODS

Experimental site

The present study was conducted in fig orchard, about one feddan in Tanan village (30°15'5.63"N, 31°15'4.11"E), at Qalubia governorate, Egypt, from Mar. 2022 to Feb. 2024.

Incidence and population density

The area was cultivated by “Sultani” fig, as pesticide-free. Trees planted at spacing of 3 x 3 m, with ten years old, and 2 m high. Samples of 40 leaves and 12 buds were collected biweekly from 15 trees of “Sultani” fig. Leaf samples were taken, packed in paper bags, and brought to the laboratory for direct examination. The motile and adult stages of phytophagous and predatory mites were recorded using a stereo-microscope (Novex Holland) and cleared in Nesbitt solution for about one hr after that, mounted on microscope slides in Hoyer’s medium, which was used to set most mites on the slides (Jeppson et al. 1975). Samples of Eriophyoidea were mounted in Keifer's F-medium on microscope slides (Amrine and Manson 1996). Mounted slides were maintained at 45–60°C in an electric oven (BT5040) for one day. The mites were identified to species level using the aid of a phase contrast (Carl Zeiss, Germany) research microscope, with the help of Zaher (1986) for Prostigmata, Abo-Shnaf and Moraes (2014) for Phytoseiidae. The eriophyoid mites were identified by the senior author of this study using generic classification based on Amrine et al. (2003). Mite specimens are deposited in the mite reference collection of the Fruit Trees Acarology Research Department, Plant Protection Research Institute, Agricultural Research Centre, Egypt.

Chemical control

Six acaricides are used for controlling four phytophagous mites: *A. ficus*, *N. capreifoliae*, *R. ficifoliae*, and *T. urticae* in fig orchards, at Qalubia governorate, Egypt. The details about the recommended dose of application, molecular formula, trade name, and mode of action are provided in Table (1).

Experimental design

A field experiment on fig trees was conducted during the 2023–2024 season. To evaluate the efficacy of six acaricide treatments with four replications, a completely randomized block design was used. Each replicate contains five trees. The four phytophagous mites: *A. ficus*, *N. capreifoliae*, *R. ficifoliae* and *T. urticae* were found to be abundant on fig trees. Two sprays of six acaricides were carried out in the second season, the first was on May 1st week and the second on June 1st week, one month later when the mite population build up, using a motor sprayer with capacity of 20 L. Samples of 40 leaves were inspected shortly before treatment, as well as after three, seven, and two weeks. Samples were kept in coolers and transported to the laboratory for examination using a stereo-microscope (BS-3030B, China). The motile stages of four mentioned phytophagous mites were recorded.

Table 1. List of six tested acaricides, including their common and trade names, mode of action, and rate of application.

Trade name	Common name	Mode of action	Molecular Formula	Rate of use/ 100 liter of water
Ceflo 20% SC	Etoxazole	Chitin synthesis inhibitor	$C_{21}H_{23}F_2NO_2$	12.5 ml
Danisaraba 20% SC	Cyflumetofen	inhibit mitochondria complex II	$C_{24}H_{24}F_3NO_4$	40 ml
Envidor 24% SC	Spiromesifen	lipid biosynthesis inhibitor	$C_{21}H_{24}Cl_2O_4$	25ml
Magnifico 5%EC	Hexythiazox	Chitin synthesis inhibitor	$C_{17}H_{21}ClN_2O_2S$	40 ml
Solo 24% SC	Bifenazate	Mitochondrial complex III inhibitor	$C_{17}H_{20}N_2O_3$	40 ml
Vertimec 1.8% EC	Abamectin	Neurotoxin; disrupts nervous system	$C_{95}H_{142}O_{28}$	40 ml

SC= Suspension concentrate, EC = Emulsifiable concentrate

Statistical analysis

Simple correlation coefficients and partial regressions were used to determine the amount of variability in pest activity that could be attributed to the percentages of explained variance (EV%) as the combined effect of the climatic factors. This enabled the study of the impacts of weather factors and plant age. The dynamics of mites on perennials must be investigated in light of annual physiological growth changes in plants. As a result, the time from flowering to crop harvest (Mar. to Aug.) and post-harvest to leaf fall at the end of the year were covered separately (Abou-Setta 2020; Elhalawany et al. 2023). The effect of weather factors (e.g., maximum and minimum temperatures and RH%) were evaluated as simple correlations and partial regressions. Plant age was considered as multiple third-degrees of polynomial regressions. The model was represented as:

Y=a±b1 Temp_max±b2 Temp_min±b3 RH±b4.

Where a = constant and b1, b2 and b3 are the slopes of the first, second, and third parts of the response curve (Abou-Setta 2020). Obtained data were analyzed using Procs Corr, Reg, and ANOVA in SAS (SAS 2003).

A two-way ANOVA was used to compare the mean number of phytophagous mites and reduction percentage of mite motile stages. The LSD test was performed to compare means at the 0.05 level using SAS statistical software (SAS Institute 2003).

Reduction percentages of motile stages of phytophagous mites were calculated using the equation by Henderson and Tilton (1955) as follows:

$$\text{Reduction\% of population} = 1 - \left[\frac{A}{C}\ x\ \frac{B}{D}\right] x100$$

Where:

A = Number of mites in treatment after spray

B = Number of mites in control before spray

C = Number of mites in treatment before spray

D = Number of mites in control after spray

RESULTS AND DISCUSSION

1. Ecological studies

A. Incidence

The incidence of 12 mite species from 12 genera in eight families, with two groups (Prostigmata and Mesostigmata) was recorded (Table 1). Eight species of these are phytophagous mites, while three are predatory mites. During this study, *T. urticae*, *A. ficus*, *N. capreifoliae*, and *R. ficifoliae* are important phytophagous mites in "Sultani" fig. The predatory mites, *A. swirskii*, *P. finitimus*, and *A. exsertus* are the most commonly associated with phytophagous mites in fig trees. These results agree with those reported by Elhalawany (2001) who reported 33 mite species from 25 genera in 13 families including 13 and 11 species of phytophgous and predaceous mites, respectively on fig trees at Qalubia governorate. Abou El-Saad and Salem (2011) recorded four phytophagous mites in three families and five predatory mites in three families on fig orchards at Assuit governorate. Abo-Taka et al. (2014) collected *A. ficus*, *T. urticae* and *P. finitimus* in fig trees at Monufia governorate. Also, Desoky et al. (2021) and Mohamed et al. (2022) recorded 51 mite species including phytophagous, predaceous, and miscellaneous mites in "Sultani" and "Condria" figs at Sohag governorate.

Table 2. Incidence of phytophagous and predacious mites collected from leaves and buds in fig trees at Qalubia governorate

Mite group	Families	Species	Habitat	Abundance
Prostigmata	Diptilomiopidae keifer	*Diptilomiopus ficus* Attiah	Leaves	+
		Rhyncaphytoptus ficifoliae Keifer	Leaves	+++
	Eriophyidae Nalepa	*Aceria ficus* (Cotté)	Buds, leaves	+++
		Neserella capreifoliae Meyer & Ueckermann	Leaves	+++
		Tegonotus caricus Elhalwany, Mohammed & Ueckermann	Leaves	+
	Tarsonemidae Kramer	*Tarsonemus setifer* Ewing	Leaves	++
	Tenuipalpidae Berlese	*Cenopalpus pulcher* (Canestrini & Fanzago)	Leaves	+
	Tetranychidae Donnadieu	*Tetranycus urticae* Koch	Leaves, buds	+++
	Tydeidae Kramer	*Tydieus californicus* (Banks)	Leaves	+
	Stigmaeidae Oudemans	*Agistemus exsertus* Gonzalez	Leaves	++
Mesostigmata	Phytoseiidae Berlese	*Amblyseius swirskii* Athias-Henriot	Leaves	+++
		Phytoseius finitimus Ribaga	Leaves	+++

+ Low population (1–3/sample) ++ Moderate population (4–9/sample) ++ High population (> 9/sample)

Population density of phytophagous mites in "Sultani" fig during the 2022–2024 seasons.

Population density of *A. ficus*

Aceria ficus has two peaks in late June and in mid-Oct. during the two seasons on leaves of "Sultani" fig (Figure 1). *Aceria ficus* was first appeared in mid-April with moderate numbers and gradually increase until mid-Sept. The population reaches its highest in late June, with an average of respectively 1073 and 1086.6 individuals/leaf at maximum and minimum temperatures (33.7 & 23.5 and 33.2 & 23.1°C) and 52.0 & 50.1 RH% in the first and second seasons. The second peak recorded in mid-Oct. (257.6 and 240.5 individuals/leaf) at maximum and minimum temperatures (28.7 & 21.9 and 29.6 & 22.4°C) and 53.9 & 55.8 RH% in the first and second seasons, respectively. Populations decrease between late Oct. and late Dec. during the two seasons (Figure 1).

However, on buds, *A. ficus* was first recorded in mid-Nov., with few numbers and its population increased gradually until late Dec. The population reaches its highest in the second week of Jan., with an average of 69.6 and 72.9 individuals/bud at maximum and minimum temperatures (19.7 & 12.3 and 21.7 & 13.7°C) and 65.8 & 70.4 RH% in the first and second seasons, respectively. Generally, during the two seasons, *A. ficus* disappeared between early May and late Oct. (Figure 1).

Temperature had a highly significant effect on the population of *A. ficus* in "Sultani" fig in both seasons, but relative humidity did not. However, plant age had a significant effect on revealed EV, which ranged from 84.30 to 90.47%, while the combination of plant age and weather factors showed EV as 90.30 to 93.12% over the two seasons, respectively (Table 3).

This result agrees with those reported by El-Halawany et al. (1990a) who indicated that "Sultani" fig was more susceptible to *A. ficus* infestation than "Adsi" fig. According to El-Halawany et al. (1990c) and Elhalawany (2001), *A. ficus* was the main mite pest infesting figs, with two peaks in Oct. and June on young leaves, while on old leaves, it had one peak in May in "Adsi" fig and two peaks in June and Oct. in "Sultani" fig. That shows the temperature has a significant impact on the population of *A. ficus*. *Aceria ficus* was the most abundant in buds and leaves, with the highest population in buds in late June (Abou-Awad et al. 2000; Desoky et al. 2021). However, Abo-Taka et al. (2014) found a single peak in Sep. for this mite species.

Population density of *N. capreifoliae*

Neserella capreifoliae was recorded in high numbers on the lower leaf surface of "Sultani" fig throughout the two seasons. It appeared in large numbers on leaves in late Mar. and increased until June, then decreased from July to Sep. during both seasons. It has two peaks in mid-May and mid-Nov., with 207.5 and 233.3 individuals/leaf in the first season, while in the second season, it reached the peak in late June and late Nov., with 227.5 and 240.0 individuals/leaf, respectively (Figure 1). This finding is the first to report on *N. capreifoliae* population.

The results showed that weather factors had no significant effect on the population density of *N. capreifoliae* on “Sultani” fig during the 2022–2024 seasons; as the explained variance (EV%) ranged from 38.60 to 57.78%. The single effect of plant age was more significant, with explained variance ranging from 70.48 to 97.38% and P-value ranging from 0.2024 to 0.0001. The combined effect of weather factors and plant age was significantly higher than plant age alone, with values ranging from 72.43 to 98.62% (Table 4).

Population density of *R. ficifoliae*

Rhyncaphytoptus ficifoliae had two peaks in “Sultani” fig during mid-June (31.7 individuals/leaf) at maximum and minimum temperatures (35.0 and 24.0°C) and 45.2 RH% and mid-Oct. (21.7 individuals/leaf) at maximum and minimum temperatures (28.7 and 21.9°C) and 53.9 RH% in the first season (2022–2023). Similar results were obtained in the second season, as the largest population was recorded early in mid-June (32.4 individuals/leaf) and mid-Oct. (20 individuals/leaf) (Figure 1).

Data statistical analysis showed that the population of *R. ficifoliae* had a significantly positive correlation with maximum and minimum temperatures, but an insignificant negative correlation with relative humidity during the two seasons. The combination between temperature and relative humidity showed a significant indicated EV (72.64 to 85.80%) during the two seasons. Plant age revealed EV, ranged from 77.87 to 93.72%, and when combined with weather factors, revealed EV ranged from 83.43 to 95.09% during the two seasons (Table 5).

This result parallels with what obtained by Mohamed et al. (2022) who found two peaks for *R. ficifoliae*, in the mid-June and late-Nov., where positively correlated with temperature and negatively correlated with relative humidity. However, Abou-Awad et al. (2000) recorded three peaks for *R. ficifoliae* in early June, early July and early Nov., respectively where negative correlation between population and both temperature and relative humidity was reported. Change in the nutritional value of the host plant had effective impact on mite population than weather factors (Desoky et al. 2021), this might explain the given outcomes.

Population density of *T. urticae*

Population of *T. urticae* was found in moderate numbers on leaves in early Apr., then gradually increased until mid-June during the two seasons in “Sultani” fig. *Tetranychus urticae* has two peaks, the first in late June and the second in early Oct. During the two seasons, the mean number was 35.6 & 53.5 and 22.6 & 40.5 individuals/leaf, respectively. The second peak occurred in mid-Oct. (257.6 and 240.5 individuals/leaf) at maximum and minimum temperatures (28.7 & 21.9 and 29.6 & 22.4°C) and 53.9 & 55.8 RH% in the first and second seasons, respectively (Figure 1).

Statistical data analysis from (Table 6) indicated that the population of *T. urticae* was considerably affected by temperature in both seasons but not by relative humidity. However, plant age had a significant influence on revealed EV, which ranged from 64.3.5 to 93.337%, and the combination of plant age and weather factors showed EV as 90.30 to 93.12% over the two seasons, respectively.

El-Halawany et al. (1990a) mentioned that “Sultani” fig was more susceptible to *T. urticae* infestation than “Adsi” fig. According to El-Halawany and Abdel-Samad (1990), *T. urticae* had one peak in June on young leaves and in July on old leaves which is conistent with our findings. Abou-Awad et al. (2000) reported that *T. urticae* population exhibited a gradual increase from late Apr. and reached its peak in June. However, Elhalawany (2001) and Mohamed et al. (2022) recorded two peaks for *T. urticae* in June and Oct.-Nov. on young and old leaves in “Sultani” fig where population density was positively correlated with temperature, but negatively correlated with relative humidity. That explained what reported by Elhalawany et al. (2023), who found that the combined effects of weather and plant age had a greater impact on population of phytophagous mites than weather factors alone.

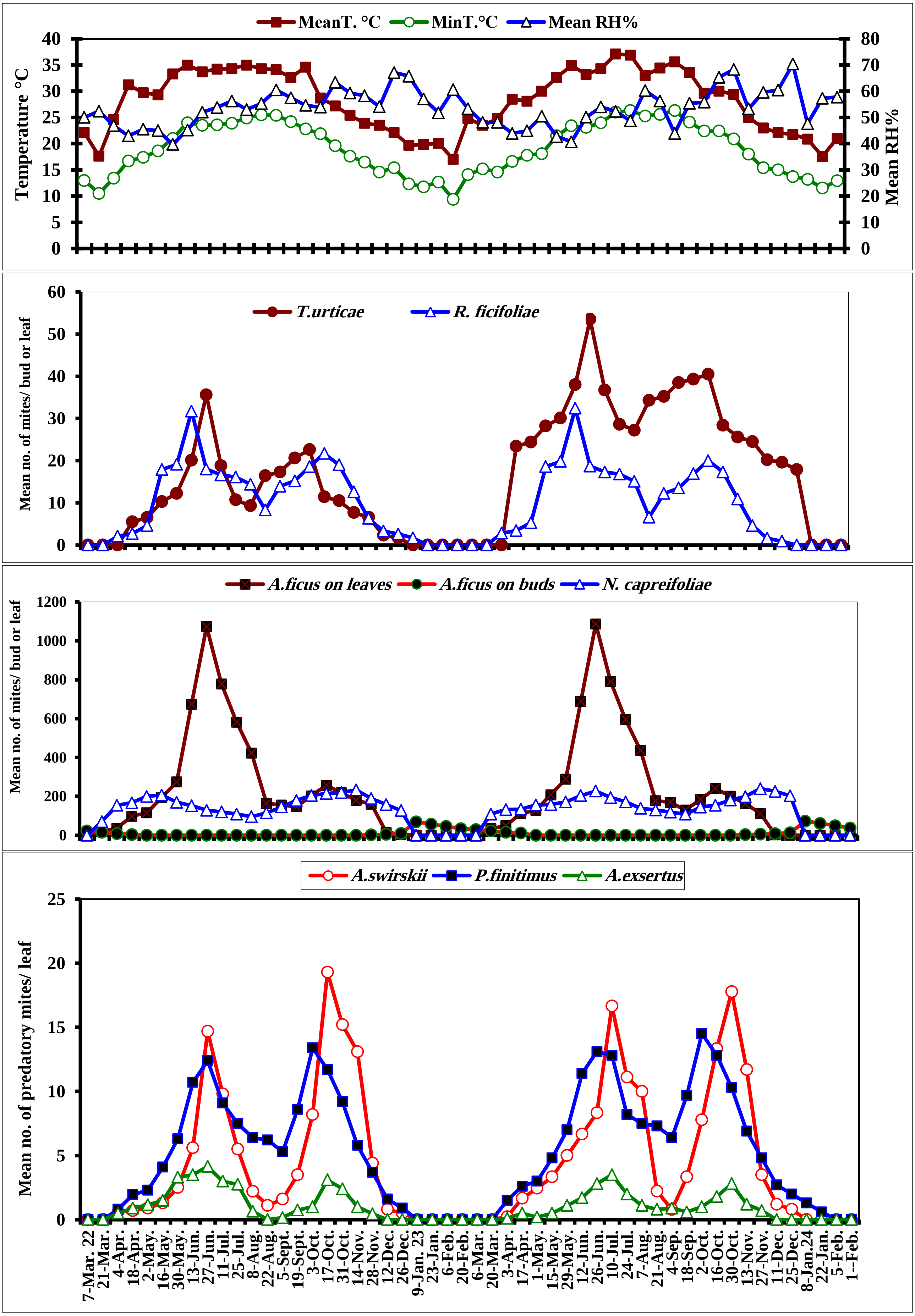

Figure 1. Population fluctuation of phytophagous and predacious mites in "Sultani" fig in Tanan village, Qalubia governorate during the 2022–2024 seasons.

Table 3. Simple correlation coefficient and multiple regression values for the effect of weather factors and plant age on *Aceria ficus* population in "Sultani" fig in Tanan village, Qalubia governorate during the 2022–2024 seasons.

Season	Factor	Level	Simple correlation		Multiple regression				
			R	P	b	P	F	P	EV %
Mar. 22 to Aug. 22	Weather	Temp max	0.68	0.0092	25.77	0.7419	3.40	0.0668	53.16
		Temp min	0.72	0.0053	23.85	0.7687			
		RH	0.31	0.2948	0.83	0.6717			
	Plant age	Age-Age^3	–	–	–	–	16.11	0.0006	84.30
	Combined		–	–	–	–	10.79	0.0054	91.52
Sep. 22 to Feb.23	Weather	Temp max	0.76	0.0021	–11.65	0.5102	6.18	0.0144	67.31
		Temp min	0.80	0.0008	28.19	0.1698			
		RH	–0.17	0.5596	–2.46	0.5879			
	Plant age	Age-Age^3	–	–	–	–	28.47	0.0001	90.47
	Combined		–	–	–	–	11.99	0.0040	90.30
Mar.23 to Aug. 23	Weather	Temp max	0.72	0.0050	43.01	0.5829	3.38	0.0679	52.97
		Temp min	0.69	0.0079	11.34	0.8893			
		RH	0.01	0.9533	–4.54	0.8088			
	Plant age	Age-Age^3	–	–	–	–	16.03	0.0006	84.24
	Combined		–	–	–	–	8.32	0.0078	90.31
Sep. 23 to Feb.24	Weather	Temp max	0.84	0.0003	–33.43	0.0630	19.50	0.0003	86.67
		Temp min	0.87	0.0001	53.7	0.0144			
		RH	–0.03	0.9148	2.07	0.2316			
	Plant age	Age-Age^3	–	–	–	–	23.84	0.0001	88.82
	Combined		–	–	–	–	13.53	0.0029	93.12

Table 4. Simple correlation coefficient and multiple regression values for the effect of weather factors and plant age on *Neserella capreifoliae* population in "Sultani" fig in Tanan village, Qalubia governorate during the 2022–2024 seasons.

Season	Factor	Level	Simple correlation		Multiple regression				
			R	P	b	P	F	P	EV %
Mar. 22 to Aug. 22	Weather	Temp max	0.36	0.2204	15.06	0.2352	4.11	0.0431	57.78
		Temp min	0.24	0.6267	–10.30	0.4232			
		RH	–0.58	0.0338	–4.72	0.2144			
	Plant age	Age-Age^3	–	–	–	–	111.6	0.0001	97.38
	Combined		–	–	–	–	71.67	0.0001	98.62
Sep. 22 to Feb.23	Weather	Temp max	0.72	0.0053	–5.12	0.7860	3.94	0.0477	56.76
		Temp min	0.75	0.0031	19.28	0.3685			
		RH	–0.09	0.7586	–0.29	0.9601			
	Plant age	Age-Age^3	–	–	–	–	39.99	0.0001	93.02
	Combined		–	–	–	–	13.58	0.0029	93.14
Mar.23 to Aug. 23	Weather	Temp max	0.62	0.0212	–1.76	0.8889	3.47	0.0641	53.63
		Temp min	0.59	0.0323	10.40	0.4397			
		RH	–0.26	0.3740	–4.85	0.1360			
	Plant age	Age-Age^3	–	–	–	–	18.88	0.0003	86.25
	Combined		–	–	–	–	15.89	0.0019	94.08
Sep. 23 to Feb.24	Weather	Temp max	0.40	0.1676	–46.0	0.1993	1.89	0.2024	38.60
		Temp min	0.45	0.1182	60.3	0.1419			
		RH	0.11	0.7076	2.68	0.4390			
	Plant age	Age-Age^3	–	–	–	–	7.16	0.0093	70.48
	Combined		–	–	–	–	2.63	0.1325	72.43

Table 5. Simple correlation coefficient and multiple regression values for the effect of weather factors and plant age on *Rhyncaphytoptus ficifoliae* population in "Sultani" fig in Tanan village, Qalubia governorate during the 2022–2024 seasons.

Season	Factor	Level	Simple correlation		Multiple regression				
			R	P	b	P	F	P	EV %
Mar. 22 to Aug. 22	Weather	Temp max	0.74	0.0036	–2.0	0.2348	0.76	0.0049	74.49
		Temp min	0.74	0.0027	3.81	0.0444			
		RH	–0.09	0.7505	–1.18	0.0332			
	Plant age	Age-Age^3	–	–	–	–	10.55	0.0026	77.87
	Combined		–	–	–	–	12.09	0.0040	92.36
Sep. 22 to Feb.23	Weather	Temp max	0.85	0.0001	–0.35	0.7685	10.24	0.029	77.34
		Temp min	0.87	0.0001	1.76	0.2019			
		RH	–0.14	0.6274	–0.07	0.7994			
	Plant age	Age-Age^3	–	–	–	–	44.78	0.0001	93.72
	Combined		–	–	–	–	19.38	0.0011	95.09
Mar.23 to Aug. 23	Weather	Temp max	0.76	0.0023	2.54	0.1559	7.97	0.0067	72.64
		Temp min	0.66	0.0140	–0.92	0.6076			
		RH	–0.29	0.3329	–0.52	0.2077			
	Plant age	Age-Age^3	–	–	–	–	11.96	0.0017	79.94
	Combined		–	–	–	–	5.03	0.0349	83.43
Sep. 23 to Feb.24	Weather	Temp max	0.87	0.0001	–1.99	0.1722	18.13	0.0004	85.80
		Temp min	0.90	0.0001	3.59	0.0419			
		RH	–0.08	0.7834	0.11	0.4069			
	Plant age	Age-Age^3	–	–	–	–	36.59	0.0001	92.42
	Combined		–	–	–	–	15.65	0.0002	93.99

Table 6. Simple correlation coefficient and multiple regression values for the effect of weather factors and plant age on *Tetranychus urticae* population in "Sultani" fig in Tanan village, Qalubia governorate during the 2022–2024 seasons.

Season	Factor	Level	Simple correlation		Multiple regression				
			R	P	b	P	F	P	EV %
Mar. 22 to Aug. 22	Weather	Temp max	0.71	0.0056	–0.69	0.7497	4.11	0.0431	57.80
		Temp min	0.75	0.0030	2.35	0.3119			
		RH	0.18	0.5395	–0.32	0.6253			
	Plant age	Age-Age^3	–	–	–	–	5.42	0.0210	64.35
	Combined		–	–	–	–	3.97	0.0587	79.89
Sep. 22 to Feb.23	Weather	Temp max	0.97	0.0001	1.83	0.0091	54.2	0.0001	94.76
		Temp min	0.93	0.0001	–0.53	0.4102			
		RH	–0.20	0.5085	0.03	0.8132			
	Plant age	Age-Age^3	–	–	–	–	37.97	0.0001	92.68
	Combined		–	–	–	–	43.56	0.0001	97.76
Mar.23 to Aug. 23	Weather	Temp max	0.79	0.0012	2.02	0.5383	5.20	0.0234	63.42
		Temp min	0.76	0.0022	0.81	0.8116			
		RH	0.01	0.9521	–0.27	0.7514			
	Plant age	Age-Age^3	–	–	–	–	13.48	0.0011	81.79
	Combined		–	–	–	–	4.93	0.0366	83.15
Sep. 23 to Feb.24	Weather	Temp max	0.89	0.0001	–2.03	0.4459	18.36	0.0004	85.95
		Temp min	0.91	0.0001	4.82	0.1713			
		RH	–0.01	0.8919	0.27	0.3005			
	Plant age	Age-Age^3	–	–	–	–	41.96	0.0001	93.33
	Combined		–	–	–	–	18.22	0.0013	94.80

Population density of the predatory mites

The predatory mites, *A. swirskii*, *P. finitimus*, and *A. exsertus* are most common on the leaves of "Sultani" fig. *Amblyseius swirskii* and *A. exsertus* have two peaks in late June and late Oct. (14.7 & 4.2 and 19.3 & 3.1 individuals/leaf) in the first season. While in the second season, it has two peaks on the 2nd week of July and late Oct. (16.7 & 3.5 and 17.8 & 2.8 individuals/leaf), respectively (Figure 1). *Phytoseius finitimus* population had two peaks during the two seasons in mid-June and early Oct., with respectively, 12.4 & 13.1 and 13.4 & 14.5 individuals/ leaf in the first and second seasons.

Predatory mites appear to play an important role in combating eriophyid mites Elhalawany et al. (2023). According to Abou-Awad et al. (2000), there is a positive relationship between the predatory mites, *Pronematus ubiquitus* (McGregor), *A. swirskii*, and *A. exsertus* and the incidence of the eriophyoid mites.

El-Halawany et al. (1990 c) mentioned that *P. finitimus* found on both young and old leaves of "Sultani" and "Adsi" figs in May, then increased in number from May to Aug.; with one peak in June on young leaves and in July on old leaves (El-Halawany and Abdel-Samad 1990). Meanwhile, Elhalawany (2001) reported two peaks for *P. finitimus* in June and Oct.-Nov. on young leaves, where positively correlated with the density of both *A. ficus* and *T. urticae,* on young and old leaves of "Sultani" fig which is coincided with our results. Also, Desoky et al. (2021) found two peaks for *A. exsertus* in late June and Nov. on fig which agrees our finding.

Statistical analysis in (Table 7) indicated a significant positive relationship between the incidence of the three phytophagous mites: *A. ficus*, *T. urticae,* and *R. ficifoliae* as well as both predatory mites: *P. finitimus* and *A. exsertus*, during the two seasons. While there was an insignificant positive relationship between those phytophagous mites and the predator *A. swirskii*. Moreover, there was an insignificant positive relationship between the three predatory mites: *A. swirskii, P. finitimus* and *A. exsertus* and the eriophyid mite *N. capreifoliae* during the two seasons. This finding suggested that the predatory mites would occur in nature and can manage phytophagous mite populations.

Table 7. Simple correlation coefficient between phytophagous and predacious mites population in "Sultani" fig in Tanan village, Qalubia governorate during tha 2022–2024 seasons.

Mite pests	2022–2023			2023–2024		
	A. swirskii	*P. finitimus*	*A. exsertus*	*A. swirskii*	*P. finitimus*	*A. exsertus*
A. ficus	0.56	0.72*	0.83**	0.61	0.71*	0.83**
T. urticae	0.55	0.88**	0.67*	0.58	0.88**	0.72*
N. capreifoliae	0.52	0.57	0.42	0.51	0.57	0.52
R. ficifoliae	0.64	0.89**	0.80**	0.68*	0.85**	0.75**

*significant, ** highly significant

Chemical control

Efficacy of acaricides on *A. ficus*

The results showed significant differences between all tested acaricides and the control after three days. The spiromesifen had the highest reduction percentage (92.45%), followed by cyflumetofen, etoxazole, and hexythiazox. While, after 7 and 14 days of application, there was an insignificant difference between the six acaricides, whereas the reduction percentage ranged between 92.19 and 93.19% after 14 days. However**,** after the 2nd spray in the 2023 season, a significant difference between all tested acaricides and the control were obtained after 3, 7, and 14 days, without significant differences between the six acaricides (Table 8). The reduction percentage ranged from 87.14 to 89.46% after three days, 96.47 to 97.55% after seven days, and 93.94 to 95.01% after 14 days. Generally, the results revealed that all tested acaricides recorded a high mean reduction percentage after 1st and 2nd sprays during the 2023 season.

Efficacy of acaricides on *N. capreifoliae*

The results indicated significant differences between all tested acaricides and the control after 3 and 14 days, but no significant differences between the six acaricides found. However, after seven days of application, there was a significant difference between the six acaricides. Abamectin had the highest reduction percentage (94.62%) after 14 days, followed by spiromesifen (94.05%). After the 2nd spray, there were significant differences between all tested acaricides and the control after 3, 7, and 14 days, with the six acaricides showing the most variation. The highest reduction percentage was 88.14, 82.75, and 81.76% for abamectin, while the lowest was 75.91, 68.62, and 65.69% for hexythiazox after 3, 7, and 14 days, respectively (Table 9). Overall, the results showed that all tested acaricides had a high mean reduction percentage after the 1st and 2nd sprays. Furthermore, abamectin caused the highest reduction percentage after the 1st and 2nd sprays during the 2023 season.

Efficacy of acaricides on *R. ficifoliae*

The present study found that all tested acaricides were sufficient to control *R. ficifoliae* (Table 10). There were significant differences between acaricides efficiency. After 3 days of the 1st spray, the highest reduction percentage was 95.66% for spiromesifen and 94.25% for abamectin. While, after 7 and 14 days, the highest reduction percentage was respectively 93.42 and 95.64% for abamectin and 93.16 and 94.92% for spiromesifen. After the 2nd spray, the findings indicated significant differences between all tested acaricides and the control after three days, without significant differences between the six acaricides. Whereas, after seven days, the highest reduction percentage was 95.30 for spiromesifen, followed by 84.68 for etoxazole. While after 14 days, the highest reduction percentage was 100% for spiromesifen, followed by 76.21% for abamectin.

Efficacy of acaricides on *T. urticae*

There were significant differences between acaricides efficiency. The highest reduction percentage of *T. urticae* was 97.95, 98.06, and 97.06% for abamectin after 3, 7, and 14 days, respectively. While, the lowest was 91.33, 91.88, and 88.35% for etoxazole. A similar trend of results was observed after the 2nd spray, with significant differences between all tested acaricides and the control. Spiromesifen and abamectin had the highest reduction percentage (100 & 96.02, 96.56 & 96.56, and 96.73 & 96.89%) after 3, 7, and 14 days, respectively. However, etoxazole showed the lowest reduction percentage (90.50, 88.18, and 87.09%) (Table 11). A statistical analysis of data using LSD test at the P = 0.05 level revealed highly significant differences between the two most efficient acaricides and the other acaricides.

Such finding coincided with that obtained by Abou-Awad et al. (2000), who showed that one summer application of abamectin in early June, when the mite population begins to increase, was adequate to control phytophagous mites' population for the full year. Sayed et al. (2006) found that the vertimec is more effective than actellic and biofly against *T. urticae*. Elhalawany and El-Sayed (2013) showed that ortus, menova, agromic, and baroq were effective for suppressing the guava rust mite, *Tegolophus guavae* (Boczek), with reduction percentages of 91.47, 92.22, 93.94, and 96.47%, respectively; other compounds also achieved similar reduction percentages; In addition to the highest reduction percentage of the tenuipalpid mite, *Brevipalpus phoenicis* (Ceijskes) was recorded for ortus 5% (90%) on leaves and fruits of guava.

Abou El-Ela (2014) revealed significant reductions in *T. urticae* population during two seasons, with reduction percentage of 81.55, 80.62, 75.94, 65.35, and 54.57%, respectively for challenger, ortus, vertimec, delmite, and bioca. Also, Elhalawany et al. (2017) evaluated the effects of various acaricides, insecticides, mineral oil, sulfur, and water on *Oligonychus afrasiaticus* (McGrgor) in date palm "Barhi" and "Bartmoda", where challenger super and vertimec were the most effective in reducing date palm mite populations; while abroch, ortus super, tafaban, and envidor showed reductions ranging from 85.07 to 87.74%. Abdel-Razik and Heikal (2019) demonstrated that abamectin 1% + Thiamethoxam 9% was extremely toxic to *T. urticae* but safer for the predatory mite, *Phytoseiulus persimilis* Athias-Henriot after seven days of treatment in laboratory. Fenpyroximate was likewise highly toxic to *T. urticae* but safe for *P. persimilis*. Rajashekharappa et al. (2023) found that spiromesifen 22.9% SC was the most effective in reducing population of *T. urticae* (87.21% reduction). According to Al-Dhafar et al. (2024), abamectin had the highest reduction of *Eutetranychus orientalis* (Klein), while congest had the lowest, all tested pesticides were safely for the associated predator, *E. scutalis*, with decline rates ranging from 16.2 to 28.6%.

Table 8. Mean number and reduction percentage of *Aceria ficus* after two applications of some acaricides on fig leaves at Qalubia governorate in field during the 2023 season.

Acaricides	Pre-count	Mean number and reduction percentage of mites/leaf after												
		First application						Pre-count	Second application					
		3 days		7 days		14 days			3 days		7 days		14 days	
		No.	R.%	No.	R.%	No.	R.%		No.	R.%	No.	R.%	No.	R.%
Etoxazole	92.3	10.8	91.12 ab	8.3	93.91 a	11.8	92.63 a	46.0	5.0	89.46 a	9.5	97.15 a	14.8	93.94 a
Cyflumetofen	95.3	10.5	91.58 ab	8.8	93.76 a	12.3	92.56 a	49.0	6.0	87.98 a	9.3	97.29 a	15.0	94.17 a
Spiromesifen	98.3	9.8	92.45 a	8.3	94.29 a	12.5	92.60 a	52.0	5.5	89.38 a	9.8	97.32 a	14.0	94.89 a
Hexythiazox	93.0	11.0	91.01 ab	9.3	93.24 a	12.5	92.20 a	46.8	6.3	87.14 a	11.0	96.47 a	14.0	94.17 a
Bifenazate	101.8	12.8	90.44 b	9.0	93.97 a	12.0	93.19 a	55.5	6.3	89.37 a	10.0	97.55 a	14.5	95.01 a
Abamectin	90.5	11.0	90.77 b	9.3	93.08 a	12.3	92.19 a	44.3	5.5	87.88 a	7.8	97.54 a	12.8	94.54 a
Control	95.0	125.0	-	140.0	-	165.0	-	420.0	440.0	-	325.0	-	240.0	-
LSD at 0.05			1.54		1.24		1.45			5.33		1.94		196

No. = Mean number of mite, R%= reduction percentage, different letters in same column denote significant difference (P < 0.05).

Table 9. Mean number and reduction percentage of *Neserella capreifoliae* after two applications of some acaricides on fig leaves at Qalubia governorate in field during the 2023 season.

Acaricides	Pre-count	Mean number and reduction percentage of mites/leaf after												
		First application						Pre-count	Second application					
		3 days		7 days		14 days			3 days		7 days		14 days	
		No.	R.%	No.	R.%	No.	R.%		No.	R.%	No.	R.%	No.	R.%
Etoxazole	152.8	10.5	93.50 a	14.5	91.40 b	18.8	90.43 a	70.8	12.8	81.87 ab	13.3	78.97 ab	12.3	78.36 ab
Cyflumetofen	151.8	10.0	93.79 a	15.3	90.81 b	17.5	91.01 a	55.3	9.0	84.66 a	14.8	70.89 cd	12.8	72.13 bc
Spiromesifen	143.3	7.3	95.34 a	9.5	94.05 a	16.0	91.42 a	47.0	6.5	86.74 a	8.0	81.09 ab	10.8	71.29 bc
Hexythiazox	141.8	9.3	93.94 a	14.0	91.07 b	15.5	91.56 a	53.0	13.3	75.91 b	15.0	68.62 d	15.0	65.69 c
Bifenazate	159.5	8.3	95.21 a	13.8	92.16 b	16.3	91.87 a	64.0	13.0	80.66 ab	13.8	76.34 bc	14.8	72.16 bc
Abamectin	150.3	8.5	94.77 a	9.0	94.62 a	14.8	92.40 a	45.3	5.5	88.14 a	7.3	82.75 a	6.8	81.76 a
Control	162.0	175.0	-	180.0	-	210.0	-	185.0	197.0	-	170.0	-	155.0	-
LSD at 0.05			3.08		145		2.69			7.65		5.53		9.49

No. = Mean number of mite, R%= reduction percentage, different letters in same column denote significant difference (P < 0.05).

Table 10. Mean number and reduction percentage of *Rhyncaphytoptus ficifoliae* after two applications of some acaricides on fig leaves at Qalubia governorate in field during the 2023 season.

Acaricides	Pre-count	Mean number and reduction percentage of mites/leaf after												
		First application						Pre-count	Second application					
		3 days		7 days		14 days			3 days		7 days		14 days	
		No.	R.%	No.	R.%	No.	R.%		No.	R.%	No.	R.%	No.	R.%
Etoxazole	9.0	3.0	77.12 b	2.3	85.30 ab	3.3	84.56 c	6.5	0.8	90.47 a	1.0	84.68 ab	1.0	74.12 b
Cyflumetofen	8.8	2.5	79.17 b	2.0	86.32 ab	2.5	87.36 bc	6.0	0.8	89.62 a	1.3	75.93 b	1.3	67.95 b
Spiromesifen	8.8	0.5	95.66 a	1.0	93.16 a	1.0	94.92 ab	4.5	0.3	93.54 a	0.3	95.30 a	0.0	100.00 a
Hexythiazox	9.5	3.0	77.82 b	2.5	84.63 b	4.0	82.69 c	7.0	1.0	86.60 a	1.5	78.99 ab	1.5	65.78 b
Bifenazate	8.8	3.0	75.05 b	2.8	81.13 b	3.5	83.92 c	5.8	0.8	89.02 a	1.8	71.37 b	1.5	58.43 b
Abamectin	9.3	0.8	94.25 a	1.0	93.42 a	1.0	95.64 a	3.5	0.3	95.16 a	0.8	80.43 ab	0.5	76.21 b
Control	10.0	14.0	-	17.0	-	25.0	-	31.0	40.0	-	33.0	-	19.0	-
LSD at 0.05			11.25		8.47		7.95			15.74		19.33		22.91

No. = Mean number of mite, R%= reduction percentage, different letters in same column denote significant difference ($P < 0.05$).

Table 11. Mean number and reduction percentage of *Tetranychus urticae* after two applications of some acaricides on fig leaves at Qalubia governorate in field during the 2023 season.

Acaricides	Pre-count	Mean number and reduction percentage of mites/leaf after												
		First application						Pre-count	Second application					
		3 days		7 days		14 days			3 days		7 days		14 days	
		No.	R.%	No.	R.%	No.	R.%		No.	R.%	No.	R.%	No.	R.%
Etoxazole	21.0	2.0	91.33 c	2.0	91.88 b	3.0	88.35 c	11.0	1.3	90.50 c	1.8	88.18 b	2.0	87.09 b
Cyflumetofen	21.8	1.8	92.67 bc	1.0	96.08 a	3.0	88.65 c	11.5	0.8	94.48 bc	1.8	88.35 b	2.0	87.55 b
Spiromesifen	21.5	1.0	95.71 ab	1.0	96.03 a	1.5	94.21 ab	11.0	0.0	100.00 a	0.5	96.56 a	0.5	96.73 a
Hexythiazox	23.0	2.0	91.98 bc	2.0	92.58 b	2.3	91.99 bc	11.0	1.3	90.50 c	2.0	86.31 b	1.5	90.23 b
Bifenazate	22.5	2.0	91.78 c	2.0	92.29 b	2.3	91.64 bc	11.5	1.0	92.74 bc	1.5	90.20 ab	1.5	90.80 ab
Abamectin	21.5	0.5	97.95 a	0.5	98.06 a	0.8	97.06 a	10.8	0.5	96.02 ab	0.5	96.56 a	0.5	96.89 a
Control	23.0	25.0	-	27.0	-	28.0	-	30.0	36.0	-	40.0	-	42.0	-
LSD at 0.05			3.19		3.18		3.68			4.85		7.78		6.13

No. = Mean number of mite, R%= reduction percentage, different letters in same column denote significant difference ($P < 0.05$).

CONCLUSION

The study looked at the population dynamics and the chemical control of phytophagous mites in fig orchards in Tanan village, Egypt. Where 12 mite species from 12 genera in eight families were found, including *T. urticae*, *A. ficus, N. capreifoliae,* and *R. ficifoliae*, which are common in "Sultani" fig. The predatory mites, *A. swirskii*, *P. finitimus*, and *A. exsertus* were the most frequently associated with those phytophagous mites. The correlation coefficient showed a significant positive correlation with temperature but not with relative humidity. We further conclude that vertimec, solo, danisaraba, ceflo, magnifico, and envidor are effective and can be used successfully in controlling these phytophagous mites in fig orchards. Therefore, the study suggests such acaricides be used in integrated pest management programs.

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