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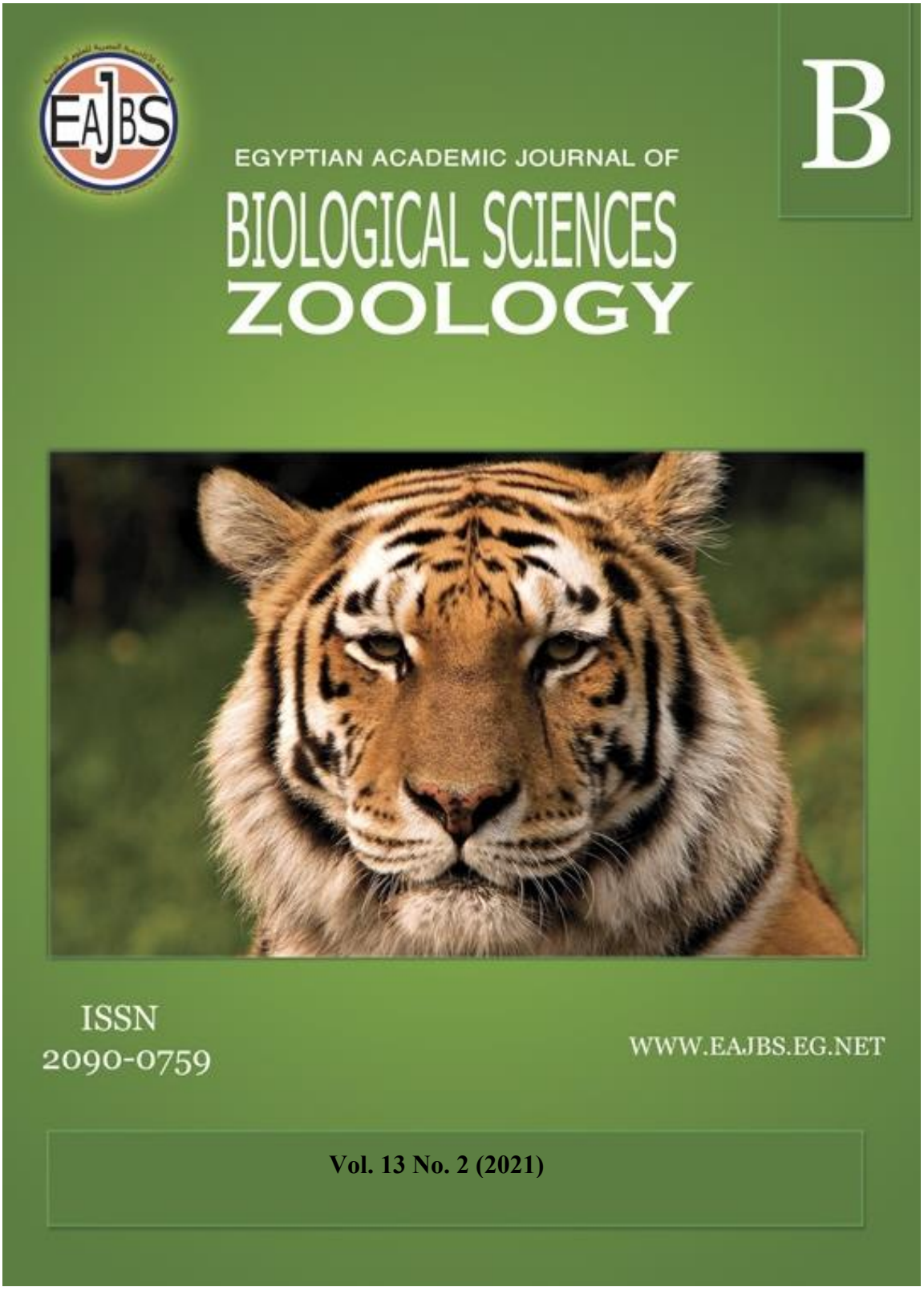

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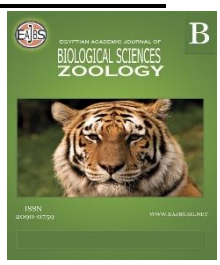

Population Dynamics of Mite Pests and Predacious Mites on Three Tomato Cultivars at Menoufia Governorate in Egypt

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ABSTRACT

A field experiment was conducted to investigate the population dynamics of phytophagous mites *Tetranychus urticae* Koch and *Aculus lycopersici* (Tryon) and their relation to prevailing weather variables on three Tomato cultivars 'Aliaa', 'Login' and 'Zena' in Shebeen El-Kom, Menoufia governorate, Egypt, during Summer and Nile seasons of 2021. The three tomato cultivars significantly differed in their susceptibility to *T. urticae* and *A. lycopersici* infestation. Login cultivar was the most highly significant susceptible to *T. urticae* and *A. lycopersici* infestation respectively 23.27 & 35.09, 24.50 and 28.88 individuals/ leaflet. In the summer season, *T. urticae* and *A. lycopersici* has one peak in mid-July of the three cultivars recorded 34.93, 44.23 and 30.83 individuals/ leaflet for *T. urticae* and 55.37, 58.23 and 35.40 for individuals/ leaflet for *A. lycopersici*. While in Nile season the two mite pests have one peak in mid-November on Aliaa and Zena and in late October on the Login cultivar. Population dynamics of *T. urticae* and *A. lycopersici* on the three Tomato cultivars during the summer season were affected significantly positive correlation by temperature, while it has a non-significantly negative correlation with relative humidity. Results showed that changes in the host plant's nutritional content had a greater impact on the dynamics of the mite population than did changes in the weather. Statistical analysis indicated that highly significant positive correlation between the three predators and the two phytophagous mites *T. urticae* and *A. lycopersici* population on three Tomato cultivars. In conclusion, these results of the current study contribute to developing an effective plan for the IPM of phytophagous mites on tomatoes.

INTRODUCTION

Lycopersicon esculentum Mill (Solanaceae) commonly known as the Tomato, is produced in controlled houses and open fields for processing and direct consumption. In Egypt, it is cultivated in 185211 feddan with the production of 3268740 tons (productivity 17.649 kg/feddan) (Ministry of Agriculture and Land Reclamation statistic, 2019). Various kinds of arthropods can find food, protection, and reproductive locations in every section of the Tomato plant. The two-spotted spider mite and the Tomato russet mite are two of the most common pest species that affect both protected and field-grown Tomatoes (Keifer, 1940; Lange and Bronson, 1981).

. The delicate tissues on the lower leaf surface are often where *T. urticae* feeds. It appears as white or yellowish stippling on the top leaf surface where the relevant spots are located Saito (1985).

The Tomato russet mite, *Aculus lycopersici* (Tryon) (= *Aculops lycopersicae* (Massee)) is the main pest of Tomato and infests most solanaceous plants potato, tobacco, eggplant, pepper, datura and black nightshade plants. The mite feeds on all green plant tissues, and both greenhouses and fields are where populations grow. The mites feed on the leaves, stems, and fruits, which results in severe leaf browning and curling as well as fruit rusting (Keifer, 1940). In frequent attacks, the females deposit eggs randomly on smooth fruits or in tiny cracks between the hairs on both leaf surfaces. The outer edge of infected plants has higher numbers. When an infestation is intense, the mites move across plants and take on the appearance of fine yellowish dust (Oldfield, 1996; Kim *et al.,* 2002; Vacante, 2016).

Different factors can influence mite distribution within plants, including leaf surface, food quality and quantity, leaf exploitation, predation, mite population, temperature, light, gravity, and humidity (Karban and English-Loeb, 1988). On Tomatoes and cucumbers, *T. urticae* population density and average leaf damage index are directly correlated (Hussey and Scopes, 1985). A positive correlation between the population of *T. urticae* on the upper leaves of Tomatoes and the mean leaf damage index (Nihoul *et al.*, 1991).

To reduce the need for further insecticides, it is essential to determine which Tomato hybrids are most resistant to infection with mite pests. Mite population numbers may be impacted by the morphological and chemical features of leaves, which often differ from one plant type to another. Many researchers studied the host plant's resistance to *T. urticae* infestation (Ibrahim *et al.,* 2008; Abdallah *et al.,* 2009; El-Saiedy *et al.,* 2011; Afifi *et al.,* 2013 and Ali *et al.*, 2015).

Many researchers study the injury and population of the tomato rust mite (Akira and Mohd, 2004; Van Houten *et al.*, 2013a,b and Farahat, 2020). Little information has been published on the population dynamics of mites associated with the tree tomato cultivars 'Aliaa', 'Login' and 'Zena' in Egypt.

The current study was carried out in Menoufia governorate to study the population dynamics of three Tomato cultivars in light of the significance of the spider mite, *T. urticae* and *A. lycopersici* and its predators, and plant growth developmental stages as plant age.

MATERIALS AND METHODS

The present study was carried out on three Tomato cultivars 'Aliaa', 'Login' and 'Zena' at Shebeen El-Kom, Menoufia governorate, Egypt, during the summer and Nile seasons of 2021. An area of about 525 m^2 was cultivated with the three Tomato cultivars 175m^2 for each cultivar. Seedlings were sowing on March 4th for summer and on July 7th for the Nile plantation. Planting of each cultivar was sown in three replicates. Normal Agricultural practices were followed except for keeping, the whole area free from any pesticide treatment.

Samples of 60 leaves from 20 plants were randomly collected biweekly for two hours from 10 am to 12 am after 45 days of the plantation from the three plant levels (upper, middle and lower parts). The number of adult stages of phytophagous and predacious mites found on leaf samples picked at random from the experimental was counted in the laboratory under a stereomicroscope. The maximum, and minimum

temperatures and relative humidity were obtained from the metrological weather of Menoufia throughout the investigation period.

Statistical Analysis:

Obtained data were analyzed using Procs Corr, and Reg in SAS (Anonymous 2003). Additionally, the SAS programme was used to conduct Duncan's multiple range tests to compare the differences between means. Simple correlations and partial regression were used to obtain the amount of variability in the pest activity which could be attributed to the percentages of explained variance (EV%) as the combined effect of the climatic factors Abou-Setta (2020). The effect of weather factors (i.e., maximum and minimum temperatures and RH%) were evaluated as simple correlations and partial regressions. Plant age which emulates plant growth stages was considered the third degree of the polynomial. The combined effect of weather factors and plant age was presented as $Y=a\pm b1\ Temp\_max\pm b2\ Temp\_min\pm b3\ RH\pm b4\ Age\pm b5\ Age^2\ \pm b6\ Age^3$.

RESULTS AND DISCUSSION

A-In the Summer Season 2021:

Population Dynamics of *Tetranychus urticae*:

The two-spotted spider mite *T. urticae* individuals were recorded on the lower leaf surface feeding on the tissues of Tomato. It appears as yellowish stippling on the upper leaf surface where the relevant spots are located. The three tomato cultivars significantly differed in their susceptibility to *T. urticae* infestation ($P > 0.05$). The login cultivar was the most highly significant susceptible to *T. urticae* infestation, it recorded 23.27 moving mite stages/ leaflet. The lowest infestation was observed on Aliaa and Zena cultivars which recorded 17.49 and 17.21 individuals/ leaflet Table (1). On the three Tomato Aliaa, Login and Zena cultivars, *T. urticae* has one peak in mid-July with mean numbers respectively 34.93, 44.23 and 30.83 individuals/ leaflet at maximum and minimum temperatures of 40.50 and 22.44°C, and 44.90% RH in the summer season. The spider mite was recorded in a few numbers in mid-April and gradually increased in number and reach its peak in mid-July, after that populations decrease in late July (Fig. 1).

Population dynamics of *T. urticae* on the three Tomato cultivars during the summer season were affected significantly by temperature, while it has a non-significantly negative correlation with relative humidity. The plant age revealed explained variance (EV) was 97.02, 96.29 and 96.82% for Aliaa, Login and Zena cultivars; while in combination with weather factors, shown EV over 99.0 % (**Table 2**).

Similar results were documented by (Ibrahim *et al.*, 2008 and Ali *et al.*, 2015) found that the population density of *T. urticae* is different in two seasons, this might be due to environmental conditions. The movable stages of *T. urticae* reached their peaks during September and October in two seasons. The Tomato cultivars were variably infested with *T. urticae* during early summer plantation. These results were in agreement with those obtained by (Ibrahim *et al.*, 2008; Abdallah *et al.*, 2009, El-Saiedy *et al.*, 2011, Afifi *et al.*, 2013and Ali *et al.*, 2015). Yassin *et al.*, 2014 reported significant differences between the population of *T. urticae* and *Tetranychus cucurbitacearum* (Sayed) on Meram, supper-gekal and Rawan Tomato varieties.

Population Dynamics of Tomato Rust Mite *Aculus lycopersici:*

The tomato russet mite, *A. lycopersici* is very minute in size; it can feed on the lower and upper leaves of a tomato favorite the lower surface, and favor the new leaves over than old one. Data in Table (1) indicated that the Login cultivar was the most highly significantly susceptible to *A. lycopersici* infestation than Aliaa and Zena cultivars.

Results illustrated in Figure (1) showed that the population of the Tomato rust mite was recorded with few numbers on leaves in mid-April, after that the population gradually increased to reach its peak in mid-July as 55.37, 58.23 and 35.40 individuals/ leaflet for Aliaa, Login and Zena cultivars, respectively at maximum and minimum temperatures of 40.50 and 22.44°C, and 44.90% RH in the summer season. After that, the population gradually decreased until the end of the season. Such a finding coincides with that obtained by Akira and Mohd (2004) found that about half the mite population infested leaflets and the other half petioles. Mite numbers were large on leaflets near the stem and most infested the upper surface of the leaves. Van Houten *et al.* (2013b) mentioned that Tomato plants have their leaves, petioles and stems covered with glandular trichomes that protect the plant against herbivores arthropods. The tomato russet mite, *A. lycopersici* is so minute that it can seek refuge and feed in between the glandular trichomes on tomato cultivars currently used in practice. Farahat (2020) indicated that the Tomato russet mite, *A. lycopersici* was active on the three tomato cultivars (Tomato-765, Safeera and Tomato 448) all over two seasons, with two peaks reached in October and November for two successive seasons.

Population dynamics of eriophyid mite *A. lycopersici* on the three Tomato cultivars during the summer season was affected significantly positive correlation by temperature, while it has a non-significantly negative correlation with relative humidity. The plant age revealed explained variance (EV) was 98.75, 96.83 and 98.91% for Aliaa, Login and Zena cultivars; while in combination with weather factors, shown EV over 99.0 % (Table 2).

The temperature was considered the most important factor affecting the eriophyid mites population Farahat (2020). The weather factors were less significantly affected by population dynamics considered pests than plant age these results agree with the finding by (Abou-Setta 2020).

Concerning the predators, two predator species were detected on Aliaa and Login Tomato cultivar *Amblyseius swirskii* Athias-Henriot and *Euseius scutalis* (Athias-Henriot), in addition, *Agistemus exsertus* Gonzalez on Zena cultivar. The results showed that *A. swirskii* and *E. scutalis* were found in late April, May, and June and reached their peak in July on both Tomato cultivars Aliaa and Login. While on Zena cultivar the three predators *A. swirskii*, *E. scutalis* and *A. exsertus* were found in mid-May, and Jun and reached a peak in late July during the summer season (Fig. 1). Statistical analysis indicated that highly significant positive correlation between the three predators and the two phytophagous mites *T. urticae* and *A. lycopersici* population on three Tomato cultivars.

Table 1. The general mean of *Tetranychus urticae* and *Aculus lycopersici* populations on three Tomato cultivars during two seasons.

Season	Pest	Aliaa	Login	Zena	LSD at 0.05
Summer	*T. urticae*	17.49 b	23.27 a	17.21 b	2.63
	A. lycopersici	29.00 b	35.09 a	17.69 c	4.69
Autumn	*T. urticae*	18.73 b	24.50 a	20.55 b	3.50
	A. lycopersici	24.62 ab	28.88 a	18.91 b	6.41

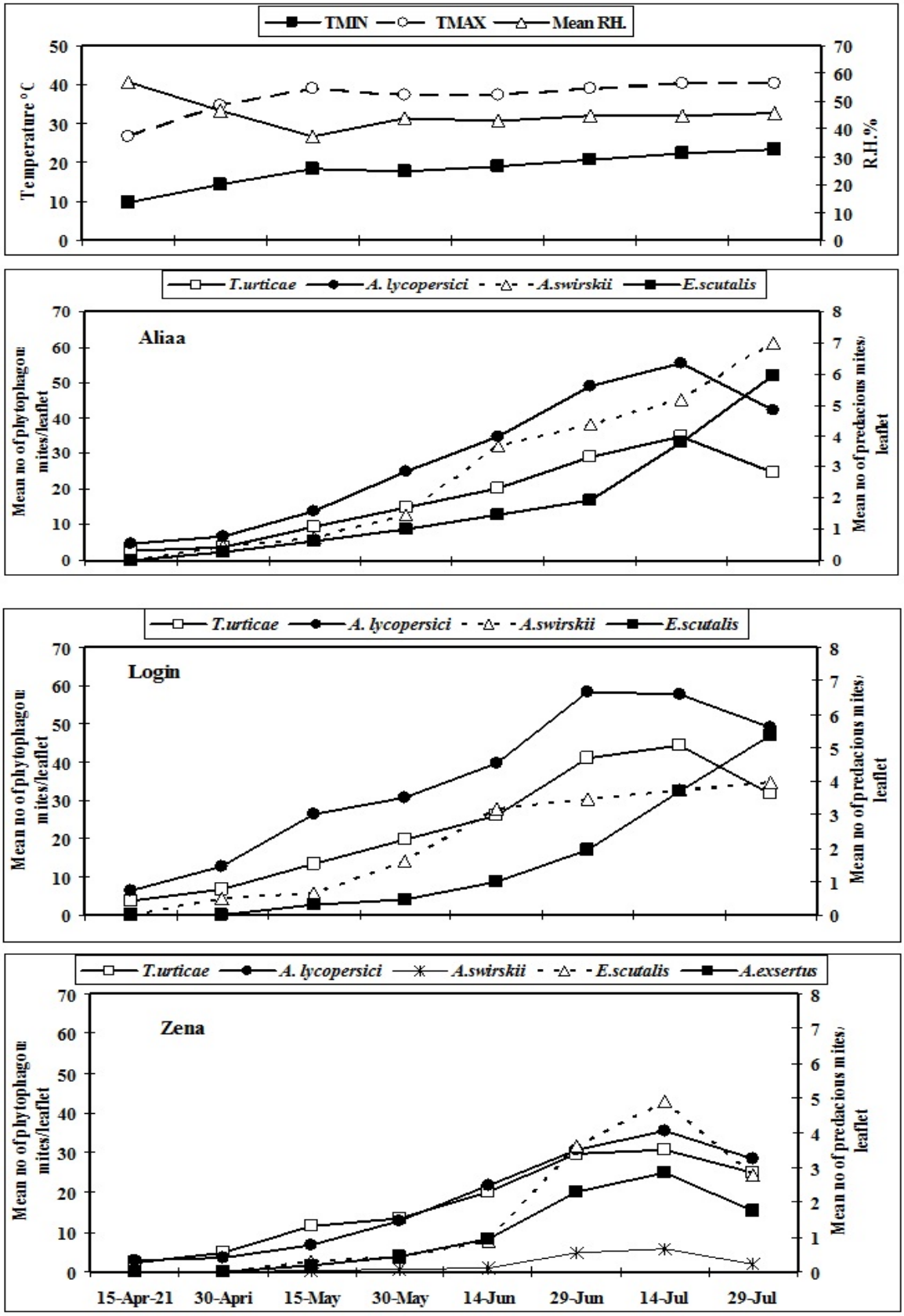

Fig. 1. Population dynamics of phytophagous and predacious mites on three Tomato cultivars during late summer season 2021.

Table 2. Simple correlation and multiple regression analysis of the effect of weather factors and plant age on *Tetranychus urticae* and *Aculus lycopersici* populations on Tomato cultivars during the summer season 2021.

Cultivar	pests	Factor	Level	Simple correlation		Multiple regression				
				R	P	b	P	F	P	EV %
Aliaa	*T. urticae*	Weather	Temp min	0.86	0.0052	3.40	0.2795	7.76	0.0383	85.34
			Temp max	0.73	0.0385	-0.58	0.8791			
			RH	-0.30	0.4676	0.70	0.5860			
		Plant age	Age-Age^3	-	-	-	-	43.37	0.0017	97.02
		Combined		-	-	-	-	277.7	0.0459	99.94
	A. lycopersici	Weather	Temp min	0.85	0.0055	6.13	0.2205	8.76	0.0312	86.79
			Temp max	0.72	0.0439	-1.62	0.7872			
			RH	-0.27	0.5026	1.07	0.5911			
		Plant age	Age-Age^3	-	-	-	-	105.4	0.0003	98.75
		Combined		-	-	-	-	2315.8	0.0159	99.99
Login	*T. urticae*	Weather	Temp min	0.86	0.0056	3.95	0.3456	6.72	0.0485	83.45
			Temp max	0.73	0.0366	-0.29	0.9552			
			RH	-0.31	0.4472	0.96	0.5834			
		Plant age	Age-Age^3	-	-	-	-	34.61	0.0025	96.29
		Combined		-	-	-	-	97.17	0.0775	99.83
	A. lycopersici	Weather	Temp min	0.91	0.0014	6.12	0.1995	10.27	0.0238	88.51
			Temp max	0.80	0.0163	-1.88	0.7416			
			RH	-0.41	0.3086	0.41	0.8239			
		Plant age	Age-Age^3	-	-	-	-	40.77	0.0019	96.83
		Combined		-	-	-	-	18.61	0.1756	99.11
Zena	*T. urticae*	Weather	Temp min	0.89	0.0023	3.63	0.1862	9.65	0.0265	87.86
			Temp max	0.77	0.0239	-1.29	0.6918			
			RH	-0.37	0.3659	0.26	0.8032			
		Plant age	Age-Age^3	-	-	-	-	40.57	0.0019	96.82
		Combined		-	-	-	-	56.43	0.1015	99.71
	A. lycopersici	Weather	Temp min	0.85	0.0071	4.53	0.1433	11.68	0.0190	89.75
			Temp max	0.68	0.0596	-1.51	0.6726			
			RH	-0.22	0.5989	0.79	0.5058			
		Plant age	Age-Age^3	-	-	-	-	120.6	0.0002	98.91
		Combined		-	-	-	-	318.9	0.0428	99.95

B-In Nile Season 2021:

Population Dynamics of *T. urticae*:

Data in Table (1) and Figure (2) showed that the three tomato cultivars significantly differed in their susceptibility to *T. urticae* infestation (P > 0.05). The login cultivar was the most highly significant susceptible to *T. urticae* infestation, it recorded 24.50 individuals/ leaflet. The lowest infestation was observed on Aliaa and Zena cultivars which recorded 18.73 and 20.55 individuals/ leaflet.

On the three Tomato Aliaa, Login and Zena cultivars, *T. urticae* has one peak in mid-November on Aliaa and Zena and in late October on Login cultivar recorded 39.02, 36.62 and 45.30 individuals/ leaflet at maximum and minimum temperatures of 31.06& 31.75 and 17.73& 18.18°C, and 61.51& 55.77% RH in Nile season. The spider mite was recorded in few numbers in mid-August and gradually increased in number and reached its peak in mid-November/ late October, after that populations decrease in late November (Figure 2). These results were in agreement with those obtained by (Ibrahim

et al., 2008; Abdallah *et al.*, 2009, El-Saiedy *et al.*, 2011, Afifi *et al.*, 2013and Ali *et al.*, 2015).

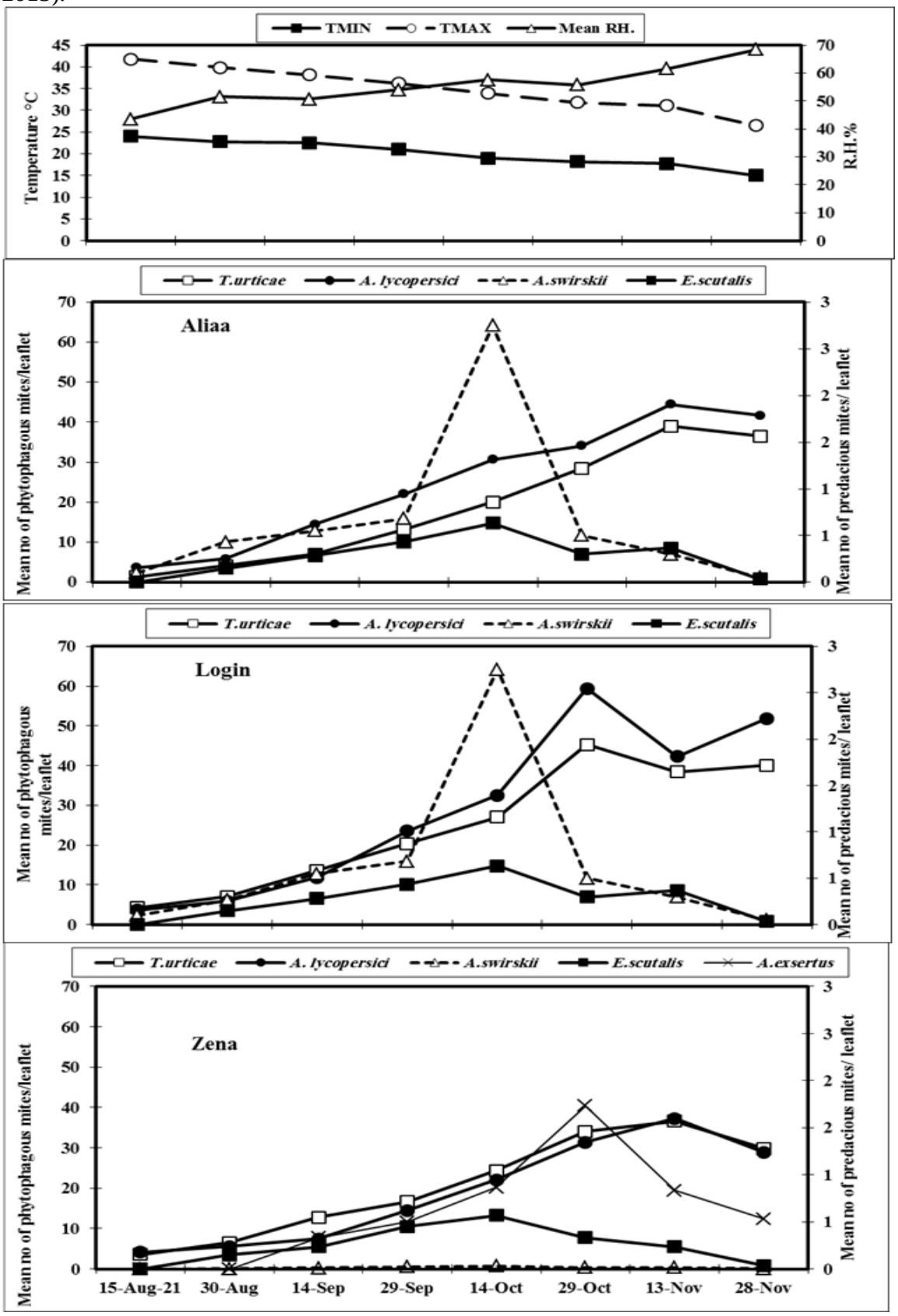

Fig. 2. Population dynamics of phytophagous and predacious mites on three Tomato cultivars during Nile season 2021.

Significant negative correlation values for maximum and minimum temperatures ranged from -0.89 to -0.96 with P-values between 0.0024 and 0.0005; whereas the significant positive correlation between *T. urticae* and relative humidity ranged from 0.80 to 0.88 with P-values between 0.0148 and 0.0077, during Nile season on three Tomato cultivars. The explained variance (EV%) was 93.01 on Aliaa cultivar and 93.60 on Login cultivar and 85.07 on Zeina cultivar. The plant age revealed explained variance (EV) was 99.95, 95.47 and 98.14% for Aliaa, Login and Zena cultivars, respectively; while in combination with weather factors, shown EV ranged from 98.56 to 100 % (Table 3).

Table 3. Simple correlation and multiple regression analysis of the effect of weather factors and plant age on *Tetranychus urticae* and *Aculus lycopersici* populations on Tomato cultivars during Nile season 2021..

Cultivar	pests	Factor	Level	Simple correlation		Multiple regression				
				R	P	b	P	F	P	EV %
Aliaa	*T. urticae*	Weather	Temp min	-0.96	0.0006	-1.62	0.8240	13.13	0.0307	93.01
			Temp max	-0.96	0.0005	-2.31	0.6031			
			RH	0.88	0.0077	-0.01	0.9862			
		Plant age	Age-Age^3	-	-	-	-	2013.8	0.0001	99.95
		Combined		-	-	-	-	0	0	100.0
	A. lycopersici	Weather	Temp min	-0.97	0.0002	-0.06	0.9902	31.55	0.0091	96.93
			Temp max	-0.98	0.0001	-3.35	0.3321			
			RH	0.91	0.0037	0.20	0.7843			
		Plant age	Age-Age^3	-	-	-	-	92.44	0.0019	98.93
		Combined		-	-	-	-	0	0	100.0
Login	*T. urticae*	Weather	Temp min	-0.92	0.0011	-2.21	0.7609	19.5	0.0075	93.60
			Temp max	-0.92	0.0009	-4.31	0.3463			
			RH	0.80	0.0148	-1.97	0.0993			
		Plant age	Age-Age^3	-	-	-	-	28.13	0.0038	95.47
		Combined		-	-	-	-	11.37	0.2232	98.56
	A. lycopersici	Weather	Temp min	-0.92	0.0012	-6.33	0.4596	27.77	0.0039	95.42
			Temp max	-0.92	0.0011	-4.48	0.3859			
			RH	0.79	0.0194	-3.16	0.00399			
		Plant age	Age-Age^3	-	-	-	-	13.79	0.0141	91.19
		Combined		-	-	-	-	7.68	0.2694	97.88
Zena	*T. urticae*	Weather	Temp min	-0.89	0.0024	-1.86	0.8332	7.59	0.0397	85.07
			Temp max	-0.90	0.0022	-2.68	0.6156			
			RH	0.80	0.0153	-1.12	0.3760			
		Plant age	Age-Age^3	-	-	-	-	69.92	0.0007	98.13
		Combined		-	-	-	-	62.2	0.0967	99.73
	A. lycopersici	Weather	Temp min	-0.89	0.0023	-5.55	0.5555	7.23	0.0430	84.43
			Temp max	-0.89	0.0027	-0.48	0.9295			
			RH	0.80	0.0154	-1.10	0.3998			
		Plant age	Age-Age^3	-	-	-	-	67.7	0.0007	98.07
		Combined		-	-	-	-	26.93	0.1464	99.38

Population Dynamics Of Tomato Rust Mite *A. lycopersici:*

Data in Table (1**)** showed that Login cultivar recorded a high number of *A. lycopersici* (28.88 individuals/ leaflet) than Aliaa and Zena cultivars (24.62 and 18.91 individuals/ leaflet), respectively.

Results illustrated in Figure (2) showed that the population of the Tomato rust mite was recorded with few numbers on leaves in mid-August, after that the population gradually increased to reach its peak in mid-November on Aliaa and Zena cultivars as 44.43 and 37.23 individuals/ leaflet, while for Login cultivar it has one peak in late

October 59.37 individuals/ leaflet. These results are in agreement with those conducted by Akira and Mohd, 2004; Van Houten *et al.*, 2013a and Farahat, 2020).

Statistical analysis in Table (3) showed that *A. lycopersici* on the three Tomato cultivars during Nile season was affected by a significantly negative correlation with temperature, while it has a significantly positive correlation with relative humidity. The explained variance (EV%) was 96.93 on Aliaa cultivar and 95.42 on Login cultivar and 84.43 on Zeina cultivar. The plant age revealed explained variance (EV) was 98.93, 91.19 and 98.07% for Aliaa, Login and Zena cultivars, respectively; while in combination with weather factors, shown EV ranged from 97.88 to 100 %.

Regarding the predators, the results showed that *A. swirskii* was recorded with few numbers in md-August, and reached its peak in mid-October as 2.75, 2.75 and 0.75 individuals/ leaflet on Aliaa, Login and Zena cultivars, respectively. Also, *E. scutalis* reaches its peak in mid-October at 0.63, 0.63 and 0.57 on Aliaa, Login and Zena cultivars, respectively. While predatory mite, *A. esxertus* reach its peak in late October was 1.73 individuals/ leaflet on Zena cultivar (Figure 2). Statistical analysis indicated that significant positive correlation between the three predators and the two phytophagous mites *T. urticae* and *A. lycopersici* population on three Tomato cultivars.

Conclusion

The results of the present study support the IPM programs and as there was a clear variation for Tomato cultivars and effects of weather factors in the two seasons on the two-spotted spider mite and Tomato rust mite and its predators during the study.

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ARABIC SUMMARY

ديناميكية التعداد للآفات والمفترسات الأكاروسية على ثلاثة أصناف من الطماطم بمحافظة المنوفية في مصر

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أجريت تجربة حقلية لدراسة ديناميكية التعداد للحلم النباتي *Tetranychus urticae* Koch وحلم صدأ الطماطم (Tryon) *Aculus lycopersici* وعلاقتهما بالعوامل الجوية علي ثلاثة أصناف من الطماطم (علياء، لوجين، زينا) بشبين الكوم في محافظة المنوفية ، مصر ، خلال الموسمي الصيفي والنيلي 2021. اختلفت أصناف الطماطم الثلاثة معنوياً في قابليتها للإصابة بـ العنكبوت الأحمر العادي و حلم صدأ الطماطم الدودي. كان صنف الطماطم لوجين هو الأكثر تأثراً بدرجة عالية للإصابة بـ العنكبوت الأحمر العادي و حلم صدأ الطماطم، حيث كانت 23.27 و 35.09 و 24.50 و 28.88 فرد / وريقة على التوالي. في فصل الصيف ، سجلت العنكبوت الأحمر العادي و حلم صدأ الطماطم الدودي ذروة واحدة في منتصف يوليو علي الأصناف الثلاثة التي سجلت 34.93 و 44.23 و 30.83 فرد / وريقة للعنكبوت الأحمر العادي و 55.37 و 58.23 و 35.40 فردا / وريقة لحلم صدأ الطماطم الدودي. بينما سجل أعلي تعداد في الموسم النيلي في منتصف نوفمبر على الصنف علياء وزينة وفي أواخر أكتوبر على الصنف لوجين. سجل ارتباط معنوي طردي بين كل من تعداد العنكبوت الأحمر العادي و حلم صدأ الطماطم الدودي على أصناف الطماطم الثلاثة خلال موسم الصيف بدرجات الحرارة ، بينما سجل ارتباط عكسي معنوي مع الرطوبة النسبية. أظهرت النتائج أن التغيرات في المحتوى الغذائي للنبات المضيف كان لها تأثير أكبر على ديناميكيات تعداد الحلم أكثر من التغيرات في الطقس. أشار التحليل الإحصائي إلى وجود علاقة ارتباط موجبة معنوية عالية بين المفترسات الثلاثة الحلم النباتي العنكبوت الأحمر العادي و حلم صدأ الطماطم الدودي علي الثلاثة أصناف من الطماطم. في الختام ، تساهم هذه نتائج الدراسة في وضع خطة فعالة للمكافحة المتكاملة للآكاروسات النباتية على الطماطم.