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Seasonal dynamics and environmental influences of phytophagous mites infesting tomato and pepper crops

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Abstract

The population dynamics of phytophagous mites infesting tomato and pepper plants in Qena Governorate, Egypt, were investigated over two consecutive seasons (2021/2022 and 2022/2023). Survey study identified nine species from five genera across four families; Tetranychidae, Tenuipalpidae, Eriophyidae, and Tarsonemidae in four localities; Qena, Qus, El Marashda, and Nag Hmady. The study recorded the first appearance of two-spotted spider mites on tomatoes in the 2nd week of December 2021, with peak infestations occurring in the 1st week of March 2022. In the following winter season, mites first appeared in October 2022, reaching peak densities in March 2023. On pepper plants, mites were first observed in January 2022, peaking in February 2022, while in the 2022/2023 season, the first appearance was in October 2022 with peak densities in March 2023. During the summer seasons, no mite infestations were recorded in 2022. However, in 2023, mites appeared in July, with peak densities in October 2023. The statistical analysis revealed a significant positive correlation between mite population density and relative humidity in the summer of 2023, with no significant correlation with temperature. These findings are consistent with previous research, which indicates a positive correlation between mite populations, temperature, and relative humidity. This study contributes valuable insights into the seasonal behavior and environmental factors influencing phytophagous mite populations, aiding in the development of effective pest management strategies for vegetable crops in Egypt.

Keywords: survey, population dynamics, Tetranychidae, vegetable crops.

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1. Introduction

Vegetable crops are a significant agricultural product often impacted by various pests, particularly phytophagous mites. Among these, the Two-spotted spider mite, *Tetranychus urticae* Koch, stands out as a major pest affecting vegetable crops and ornamental plants globally (Boudreaux, 1956; 1963; Huffaker *et al*., 1970). As the population of *T. urticae* grows, especially during dry periods, it spreads across all parts of the plant, covering it with webbing. Moderate infestations can significantly reduce crop yields, while severe infestations may lead to plant death (Jeppson *et al*., 1975). This pest causes substantial economic losses in crops such as eggplant, tomato, roses, soybeans, pepper, and strawberries (So, 1991) **.**The Tetranychidae family, which includes *T. urticae*, has been documented feeding on around 1,200 plant species across 70 genera (Bolland *et al*., 1998). Similarly, the Eriophyidae family, comprising gall and rust mites, is entirely phytophagous. Their feeding often triggers plant responses that result in gall formation (Smith, 1984). Factors such as weather conditions and the type of host plant play a crucial role in influencing the population dynamics of these pests (Nyoike and Liburd, 2013). Given these challenges, this study was conducted to document the diversity of phytophagous and predacious mite species, as well as their seasonal activity patterns, in Qena Governorate, Egypt. The aim is to develop effective Integrated Pest Management (IPM) strategies to mitigate their impact.

2. Materials and methods

2.1 Survey of Phytophagous mites

A survey of mites inhabiting field crops of tomato (*Lycopersicon esculentum*) and pepper (*Capsicum annum*) was conducted across four localities in Qena Governorate, Egypt (Qus, Qena, El Marashda, and Nag Hammady). The survey spanned two consecutive years (2021/2022 and 2022/2023). Random plant samples were collected from these crops and individually placed in lightly sealed polyethylene bags. Each bag was labelled with essential details, including habitat, locality, and collection date, before being transported to the laboratory for analysis. In the laboratory, the samples were examined directly under a binocular microscope. Mites were identified and classified using the taxonomic keys for sub-families and genera provided by Chant and McMurtry (1994). This process allowed for the accurate identification and documentation of the mite species present on the surveyed crops.

2.2 Population dynamics of mites

The population dynamics of mites inhabiting tomatoes and pepper were recorded from September 2021 to October 2023 in Qena Governorate, Egypt. The experiments involved collecting samples of 25 leaves from each crop, replicated four times, every two weeks. These samples were promptly examined in the laboratory using a stereomicroscope. Number per 25 leaves were recorded.

Daily recording of the mean temperature (°C) and relative humidity (R.H. %) for Qena Governorate were obtained from the Meteorological station in Cairo Governorate, Egypt.

2.3 Statistical analysis

The correlation between average temperature and relative humidity was analyzed, and the significance of the relationship was assessed using regression analysis, following the methodology outlined by Steel et al. (1960). This approach allowed for the evaluation of how these climatic factors influence mite populations and their seasonal dynamics.

3. Results and Discussion

3.1 Incidence

The results presented in Table (1) indicate that the phytophagous mites identified comprised 9 species, categorized into 5 genera and 4 families: Tetranychidae, Tenuipalpidae, Eriophyidae, and Tarsonemidae. These findings align with previous studies conducted by Zaher (1986), El-Duweini *et al*. (2003), Fiaboe *et al*. (2007), Al-Atawi (2011), Rai (2011), and Binisha and Bhaskar (2013). These researchers also reported that Tetranychidae mites were the most predominant and significant group among phytophagous mites, followed by Eriophyidae and Tenuipalpidae mites. This consistency across studies highlights the widespread importance of Tetranychidae as a major pest group in agricultural systems.

3.2 Population dynamic of T. urticae mite during two winter seasons 2021/2022 and 2022/2023 on tomato crop at Qena governorate

Data in Table (2) indicated that the first appearance of *T. urticae* mites was recorded in the second week of December during the winter season of 2021/2022. Infestations gradually increased, reaching their peak in the first week of March in Qena and Qus localities, with average numbers of 167 and 103 mites per 25 leaves, respectively. In contrast, peaks were observed in the fourth week of February in El Marashda and Nag Hmady, with averages of 58 and 20 mites per 25 leaves, respectively. The total average number of *T. urticae* mites across all localities peaked in the third week of February recording 76 individuals per 25 leaves. In 2022/2023 season, the first appear of *T. urticae* mites were in the second week of October and peaking in the second week of December in El Marashda. In Qus, the recorded peak was observed in third week of March, while in Qena and Nag Hmady, the peak occurred in the third week of February. The peak averages were 338, 250, 210, and 187 mites per 25 leaves for El Marashda, Qus, Qena, and Nag Hmady, respectively. The total average number of *T. urticae* mites across all localities peaked in the fourth week of December at 138 mites per 25 leaves. Statistical analysis revealed that

during the 2021/2022 season, there was no significant correlation between the population density of *T. urticae* mites and either temperature or relative humidity. However, in the 2022/2023 season, a significant positive correlation was observed between the population density of *T. urticae* and temperature, indicating that higher temperatures were associated with increased mite populations. Conversely, a significant negative correlation was found between population density and relative humidity, suggesting that lower humidity levels were linked to higher mite densities. These findings highlight the influence of climatic factors on the population dynamics of *T. urticae* and their variability across different growing seasons.

Table (1): Phytophagous mites infesting tomato and pepper at Qena governorate, Egypt.

Family	Mite species	Host Plant	Locality
Tetranychidae, Dinadieu	*Tetranychus urticae* Koch	Tomato** & Pepper*	Qus, Qena, El Marashda & Nag Hmady
	T. ludenensis Attiah	Tomato*	Qus & Qena
	T. cucurbitacearum Sayed	Tomato** & Pepper*	Qus, Qena, El Marashda & Nag Hmady
	T. musus Zaher, Gomaa & El-Enany	Tomato*	El Marashda
	T. neocalidonicus Andre	Tomato*	Qus, Qena, El Marashda
	Eotetranychus zaheri Zaher, Gomaa, El-Enany	Tomato**	Qus, Qena, El Marashda & Nag Hmady
Tenuipalpidae, Berlese	*Brevipalpus californicus* Banks	Tomato*	Qus & Qena
Tarsonemidae, Kramer	*Tarsonemus meyerus* Soliman and Kandeel	Tomato**	Qus & Qena
Eriophyidae, Nalepa	*Aculops lycopersici* (Massee)	Tomato***	Qus & Qena

*** High incidence, ** Moderate incidence, * Low incidence.

Table (2): Population dynamic of *T. urticae* mites infesting tomatoes during two winter seasons 2021/2022 and 2022/2023 in Qena governorate, Egypt.

Months	Mean No. of moving stages /25 Leaves													
	2021/2022							2022/2023						
	Locality				Mean of mites	Mean of Temp. C°	Mean of RH	Locality				Mean of mites	Mean of Temp. C°	Mean of RH.
	Qus	Qena	El Marashda	Nag Hmady				Qus	Qena	El Marashda	Nag Hmady			
September	0	0	0	0	0	30.3	29.1	0	0	0	0	0	31.9	23.4
October	0	0	0	0	0	25.4	33.3	103	38	0	0	35.25	27.1	28.7
November	0	0	0	0	0	22.3	39.9	152	183	0	15	87.5	21.4	40.4
December	6	17	32	0	13.75	16.7	41.6	19	70	338	124	137.75	18.5	47
January	27	30	29	21	26.75	16.3	39.2	18	0	337	0	88.75	14.8	40.2
February	98	128	58	20	76	18.3	34.5	83	210	0	187	120	17.6	34.4
March	103	167	5	9	71	22.3	28.1	250	186	0	0	109	22.7	25.7
Correlation														
Temp.	0.307-	0.270-	0.736-	0.589-	0.414-			0.015	0.293-	0.620-	0.466-	0.839*		
R.H.	0.420-	0.457-	0.356	0.036	0.321-			0.302-	0.050	0.731	0.422	0.669		

* Correlation is significant at the 0.05 level, Temp. = Temperature, R.H.= Relative humidity.

3.3 Population dynamic of T. urticae mites during two summer seasons 2022 and 2023 in tomato crop at Qena governorate

The first appearance of *T. urticae* mites was recorded in the second week of June during the summer seasons of 2022 and 2023. Infestation levels gradually increased, reaching their peak in third week of September across all localities

(Qena, Qus, El Marashda, and Nag Hmady). In 2022, the average numbers of phytophagous mites were 269, 130, 107, and 79 individuals per 25 leaves, respectively. While in 2023, the average numbers were 200, 191, 147, and 75 individuals per 25 leaves at El Marashda, Qus, Nag Hmady, and Qena localities, respectively .The total average number of *T. urticae* mites across all localities peaked in third week of September, with 146.25 individuals per 25 leaves in 2022 and 153.25 individuals per 25 leaves in 2023 .Statistical analysis indicated a significant positive correlation between the population dynamics of *T. urticae* mites and relative humidity in the Qena locality during the 2022 season. Additionally, a significant positive correlation was observed between the average population density of *T. urticae* and relative humidity across all localities for the same season. However, no significant correlation was found between *T. urticae* population density and temperature during the 2022 season. In season 2023, a significant correlation was detected between *T. urticae* population density and relative humidity in both Qena and Nag Hammady localities. However, similar to the previous season, no significant correlation was observed between population density and temperature (Table 3). These results underscore the role of relative humidity in influencing *T. urticae* population dynamics, while temperature appeared to have a less pronounced effect during the studied periods.

Table (3): Population dynamic of *T. urticae* infesting tomatoes during two summer seasons 2022 and 2023 in Qena governorate, Egypt.

Months	Mean No. of moving stages /25 Leaves													
	2022							2023						
	Locality				Mean of mites	Mean of Temp. ºC	Mean of RH.	Locality				Mean of mites	Mean of Temp. ºC	Mean of RH.
	Qus	Qena	El Marashda	Nag Hmady				Qus	Qena	El Marashda	Nag Hmady			
June	40	44	40	8	30.66	33.3	16.2	34	0	29	42	26.25	32.7	16.6
July	50	108	91	92	85.25	34.1	18.8	113	33	65	117	82	33.6	19.7
August	73	167	67	67	93.5	34.2	21.2	43	31	26	113	53.25	36.9	20
September	130	269	107	79	146.25	31.9	23.4	191	75	200	147	153.25	33.6	22
Correlation														
Temp.	0.765-	0.604-	0.425-	0.041	0.620-			0.290	0.111	0.291-	0.339	0.121		
R.H	0.926	0.986*	0.785	0.675	0.968*			0.808	0.967*	0.7462	0.988*	0.892		

* Correlation is significant at the 0.05 level, Temp. = Temperature, R.H.= Relative humidity.

3.4 Population dynamic of T. urticae mites during two winter seasons 2021/2022 and 2022/2023 on pepper at Qena governorate

The initial infestation of pepper plants by *Tetranychus urticae* mites during the 2021/2022 winter season began in the second week of January. The infestation peaked in the first week of February at the El Marashda locality, with an average of 32 individuals per 25 leaves. Across all surveyed localities, the highest

infestation level was observed in the third week of February, averaging 13.5 individuals per 25 leaves. In 2022/2023 season, the first occurrence of *T. urticae* mites was recorded in the second week of October at the Nag Hammady locality, with the population reaching its peak in the second week of March at the same location. Notably, no infestations were recorded in the other localities within Qena Governorate during this period. Statistical analysis revealed that the population density of *T. urticae* mites showed no significant correlation with either temperature or relative humidity during both the 2021/2022 and 2022/2023 seasons (Table 4). This suggests that other factors, beyond temperature and humidity, may have played a more critical role in influencing the population dynamics of *T. urticae* during these periods.

Table (4): Population dynamic of *T. urticae* mites infesting pepper during two winter seasons 2021/2022 and 2022/2023 in Qena governorate, Egypt.

Months	Mean No. of moving stages /25 Leaves													
	2021/2022							2022/2023						
	Locality				Mean of mites	Mean of Temp. °C	Mean of RH.	Locality				Mean of mites	Mean of Temp. °C	Mean of RH.
	Qus	Qena	El Marashda	Nag Hmady				Qus	Qena	El Marashda	Nag Hmady			
September	0	0	0	0	0	30.3	29.1	0	0	0	0	0	31.9	23.4
October	0	0	0	0	0	25.4	33.3	0	0	0	34	8.5	27.1	28.7
November	0	0	0	0	0	22.3	39.9	0	0	0	43	10.75	21.4	40.4
December	0	0	0	0	0	16.7	41.6	0	0	0	31	7.75	18.5	47
January	0	0	0	6	1.5	16.3	39.2	0	0	0	25	6.25	14.8	40.2
February	0	0	32	22	13.5	18.3	34.5	0	0	0	18	4.5	17.6	34.4
March	0	0	10	31	10.25	22.3	28.1	0	0	0	62	15.5	22.7	25.7
Correlation														
Temp.	0.326		0.276	0.221-	0.263-			0.571			0.753-	0.750		
R.H	0.149-		0.231-	0.502-	0.405			0.548-			0.089	0.070		

* Correlation is significant at the 0.05 level, Temp. = Temperature, R.H.= Relative humidity.

3.5 Population dynamic of T. urticae mites during two summer seasons 2022 and 2023 in on pepper at Qena governorate

During the summer season of 2022, no *T. urticae* mites were recorded in any location at Qena governorate. However, in the summer season of 2023, the first appearance of phytophagous mites was noted in second week of July in Qena and Nag Hmady localities. The infestation peaked in second week of October in Qus, Qena, and Nag Hmady localities, with 33, 22, and 18 individuals per 25 leaves, respectively. The overall average number of *T. urticae* mites across all surveyed localities peaked in the second week of October, with an average of 18.25 individuals per 25 leaves (Table 5). Statistical analysis further revealed a significant positive correlation between the population density of *T. urticae* mites and relative humidity during the 2023 season. However, no significant correlation was found between mite population density and temperature, indicating that relative humidity played a more influential role in shaping mite dynamics during this period.

Table (5): Population dynamic of *T. urticae* mites infesting pepper during two summer seasons 2022 and 2023 in Qena Governorate, Egypt.

Months	Mean No. of moving stages /25 Leaves													
	2022							2023						
	Locality				Mean of mites	Mean of Temp. °C.	Mean of R.H.	Locality				Mean of mites	Mean of Temp. °C.	Mean of R.H.
	Qus	Qena	El waqf	Nag Hmady				Qus	Qena	El waqf	Nag Hmady			
June	0	0	0	0	0	33.3	16.2	0	0	0	0	0	32.7	16.6
July	0	0	0	0	0	34.1	18.8	0	15	0	6	3	33.6	19.7
August	0	0	0	0	0	34.2	21.2	28	0	0	10	9.5	36.9	20
September	0	0	0	0	0	31.9	23.4	14	0	0	0	3.5	33.6	22
Correlation														
Temp.								0.144-	0.718-		0.400-	0.451-		
R.H								0.738	0.756		0.818-	0.909*		

* Correlation is significant at the 0.05 level, Temp. = Temperature, R.H.= Relative humidity.

The findings of this study align with previous research by Siddiqui *et al*. (2006), who reported a significant positive correlation between *Tetranychus urticae* populations and both temperature and relative humidity. Similarly, Hoque *et al*. (2010) observed that mite numbers increased proportionally with rising temperatures. Gotoh *et al*. (2000) highlighted that while vegetable crops were susceptible to phytophagous mite infestations year-round, the severity of infestations was particularly high during the summer months (June to July) and post-monsoon periods (September to October). In contrast, mite activity was relatively low during the rainy season and negligible in winter (December to February). These mites were commonly found on a variety of vegetable crops, including okra, eggplant, tomato, chili, French bean, cowpea, pumpkin, bottle gourd, and cucumber **.**Additionally, Skoracka and Kuczyński (2003) reported that the population densities of eriophyoid mites peaked during summer and autumn but declined significantly in winter. They attributed these population dynamics to temporary and unpredictable environmental factors. These collective findings underscore the influence of seasonal and climatic conditions on the population dynamics of phytophagous mites, with temperature and relative humidity playing key roles in shaping their abundance and activity patterns**.**

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