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Occurrence and seasonal abundance of mite species, thrips, and spiders associated with garlic crop at Qalubia and Beni-Suef governorates, Egypt

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ABSTRACT

This work deals with the occurrence and seasonal abundance of mite species, thrips and spiders associated with garlic crop at Qalubia and Beni-Suef governorates, Egypt during the 2023–2024 season**.** Eight mite species belonging to eight genera and seven families from four mite groups as well as one insect, *Thrips tabaci* Lindeman (Thripidae), were collected. *Tyrophagus putrescentiae* (Schrank) and *Rhizoglyphus robini* Claparédè (Acaridae) was the most common mite species found in all inspected materials at both locations, followed by the eriophyid bulb mite *Aceria tulipae* (Keifer) (Eriophyidae). *Tyrophagus putrescentiae* has one peak at the end of Feb. at Beni-Suef governorate; however, at Qalubia governorate, it has two peaks during mid-Dec. and mid-Feb. The bulb mite, *R. robini* has two peaks in mid-Nov. and late Jan. at Beni-Suef governorate; while at Qalubia governorate, it has one peck in mid-Jan. *Aceria tulipae* reached its peak (194.0 individuals/ cm^2) late in Jan. at Beni-Suef governorate; while at Qalubia governorate, it has two peaks (193.6 and 355.5 individuals/ cm^2) in late Dec. and late Feb. 2024, respectively. For the spiders, 12 species in 12 genera and six families were found on garlic plants at the two governorates. Families Philodromidae, Salticidae, and Theridiidae are the most dominant over the two governorates.

Keywords: *Allium sativum*, ecology, phytophagous mites, predatory mites, thrips, true spiders.

INTRODUCTION

Garlic (*Allium sativum* L.; Amarylidaceae), is a valuable bulbous plant that originated in Central Asia. Egypt ranks the third in garlic area, with 64,000 hectares and 205.000 tons produced annually (FAOSTAT 2024). Garlic can be used in plant protection as a botanical compound to control several insect pests (Boyd and Alverson 2000). Garlic contains about 33 sulfur compounds, 17 amino acids, fiber, water, copper, iron, zinc, selenium, magnesium, calcium, potassium, and vitamins A, C, and B1 (Josling 2005). Garlic is attacked by several insect and mite pests in the field and during storage, resulting in significant yield loss (Lawande et al. 2009).

Pests and diseases play a key role in garlic production, with losses ranging from 10–50%. This loss can be exceeding 100%, depending on the crop species and pest density. The number of studies on garlic plants is quite small. The majority of them are related to the mite species associated with onion and bulbous ornamental plants (Chen and Lo 1989; Díaz et al. 2000).

In many areas, the eriophyid bulb mite, *A. tulipae* is considered a garlic pest. Affected garlic cloves had one or more brownish sunken areas, indicating tissue loss (Courtin et al. 2000). The mite completes its life cycle by feeding on the cloves of stored garlic bulbs, causing them to dry out and lose quality (Manson 1970; Keifer et al. 1982; Gope et al. 2022).

The bulb mite, *R. robini* and *T. putrescentia* are the most dangerous pests of ornamental plants grown in greenhouses and open fields including tulips, lilies, and hyacinths, as well as stored bulbs. The mites cause both immediate and indirect damage by feeding on plants and transport phytopathogenic bacteria and fungi, such as *Fusarium oxysporum* Schlecht., to other plants (Díaz et al. 2000; Zhang and Fan 2005).

Garlic thrips, *T. tabaci*, harm plants by piercing surface tissues, causing tissue death and silver-grey leaf patches. They reduce plant

vigour and may cause leaves to wilt. Thrips has infested numerous crops, including onions, leeks, and cucumbers, and can cause fruit damage. Thrips can be found on a wide range of plants, both outside and inside greenhouses (Sabra and Abdel-Wareth 2012; Saljoqi et al. 2021). Thrips is active during the entire garlic growing season, from Nov. to Apr. (Hussein et al. 2015).

Spiders are widespread natural control agents that can be found in a range of hiding places worldwide. Because of their predatory behavior, they significantly reduce insect populations. Nevertheless, several spider species lack critical features required for effective biological control. Spider research has not been well focused, and it is unknown how significant spider assemblages are for pest control, however, adult spiders play a vital role in pest management. Overall, spiders are important natural pest control agents in agriculture (Khalil et al. 2016; Abu-Zaed 2019; Zaki and Aly 2019).

Previous studies on garlic mites and other pests were reported by Sabra and Abdel-Wareth (2012); Hussein et al. (2015); Cilbircioğlu and Çobanoğlu (2019); Díaz et al. (2000); and Gope et al. (2022).

Thus, the current work aims to investigate the occurrence and seasonal abundance of garlic-associated mite species, thrips, and spiders at Qalubia and Beni-Suef governorates, Egypt.

MATERIALS AND METHODS

Mite sampling

The current study was conducted on 'Balady' garlic crop (525 m^2), in Qaha district, Qalubia governorate, from 10 Oct. 2023 to 15 Apr. 2024 and in Alwasta district, Beni-Suef governorate, from 01 Sept. 2023 to 30 Mar. 2024. The area was divided into three replicates, each with 20 rows x 6 m long, 50 cm wide, and 10 cm between cloves. Cloves were planted along both sides of the rows. The experimental area was received regular agricultural procedures, and no pesticides were applied during the trial. After one month of planting, 20 plant samples were collected and transported to the laboratory to determine the presence of mites and insects, and calculate their average number per plant.

For eriophyid mites, the number of movable stages per one cm^2 leaf area was counted. Soil samples weighing approximately 250 g were collected at a depth of 20 cm underneath the garlic plants throughout the 2023–2024 season. The soil samples were extracted using modified Berlease funnels into a small jar containing 75% ethyl alcohol and 5% glycerol. The collected plant samples were inspected directly under a stereo-microscope (MBS-10, Russian). The mites were kept in Nesbitt's solution for 24 hrs before being mounted in Hoyer's medium on clean microscopic slides.

Eriophyid mites were cleared and mounted on microscopic slides using Keifer's F-medium (Amrine and Manson 1996). The slides were kept on a hot plate at 50°C for ten days (Krantz and Walter 2009). The mite specimens were identified using a research microscope (XSZ-107 BN, China) to species level with the help of Hughes 1976 for Acaridae, Zaher 1986 for Mesostigmata, Volgin 1989 for for Cheyletidae, Zhang and Fan 2005 for Acaridae, and Krantz and Walter 2009 for Oribatida .

Spider sampling

The samples were collected biweekly by hand between 10 and 12 pm, using a 10x lens. The spiders were separated, counted in glasses, and transported to the laboratory on the same day for identification and counting. Specimens were identified using descriptions from the World Spider Catalogue (2024).

The percentage of frequency of occurrence for both spiders was also calculated using the following equations according to Norton, 1978:

Frequency occurrence % (F.O.) =

$$\frac{No.\,of\ sample\ containing\ \ a\ species\ X\ 100}{Total\ No.\,of\ Sample}$$

Throughout the experiment, maximum and minimum temperature, as well as relative humidity, was obtained using the online database underground® (The Weather Company, GA, USA). The peaks of the most common pests and spiders were determined in relation to weather and plant phenology.

Statistical analysis

The correlation coefficient between climatic conditions and the number of mites and spider families was analyzed using SAS (2003).

RESULTS AND DISCUSSION

Occurrence of mites and thrips on garlic crop

The current study recorded several mite species inhabiting garlic crop at Beni-Suef and Qalubia governorates over the 2023–2024 season. The findings revealed the presence of eight mite species in eight genera and seven families, representing four mite groups, as well as one insect, *T. tabaci* . The mites are placed into the cohort Astigmatina, which has one family, two genera, and two species. The suborder Prostigmata had three species, three genera, and three families. The order Mesostigmata comprised two species, two genera, and two families, while one species representing the suborder Oribatida (Table 1).

The family Acaridae was represented by two species: *T. putrescentiae* and *R. robini* , which was abundant on cloves and roots. *Cheletomorpha lepidopterorum* (Shaw), a predatory species from the family Cheyletidae was also collected. Family Eupodidae represented by only one species, *Benoinyssus momeni* (Abou-Awad). The eriophyid bulb mite, *A. tulipae*, was found in large number on upper leaf surfaces in both governorates. Family Melicharidae Hirschmann was represented by only one species: *Proctolaelaps pygmaeus* (Müller), which was recorded with few number. One species from family Laelapidae: *Hypoaspis aculeifer* (Canestrini) was found in few number. Only one species: *Scheloribates laevigatus* (Koch) was recorded from family Scheloribatidae in the current study, with moderate number.

Only one insect species from family Thripidae, *T. tabaci*, was found in large number on garlic leaves. This evidence supports previous findings by Hughes (1976); Zaher (1986); Volgin (1989); Díaz *et al*. (2000); Zhang and Fan (2005); Krantz and Walter (2009); Hussein et al. (2015); and Gope et al. (2022).

The frequency of occurrence (F.O.%) of mite species and thrips

The percentage frequency of occurrence of the collected mites and insect were respectively 91.6, 100, 83.3, 83.3, 91.6, 100, 83.0, 90, and 100% for *T. putrescentiae*, *R. robini*, *C. lepidopterorum*, *B. momeni*, *A. tulipae*, *P. pygmaeus*, *H. aculeifer*, *S. laevigatus*, and *T. tabaci* at Beni-Suef governorate. Those numbers at Qalubia governorate were respectively 100, 100, 90.9, 100, 90.9, 100, 45.4, 100, and 100% (Figure 1). The obtained results are comparable with those reported by El-Sayed and Ghallab (2007), who reported that *T. putrescentiae* and *R. robini* are the most abundant fungivore mites found in grains and stored products. Mostafa (2011) recorded 12 mite species associated with stored onion bulbs, including *T. putrescentiae* (25%) and *C. lepidopterorum* (15%).

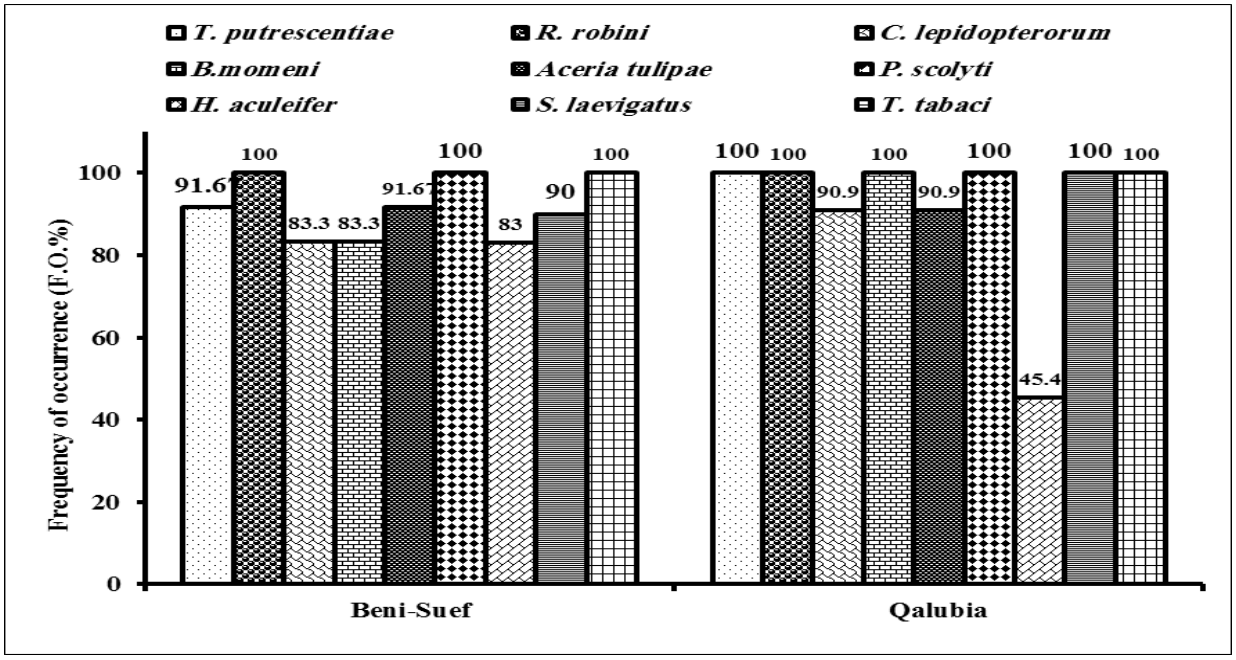

Figure 1. Frequency of occurrence (F.O.%) of mite species and thrips associated with garlic crop at Beni-Suef and Qalubia governorates during the 2023–2024 season.

Table 1. Occurrence of mites and thrips associated with garlic crop at Beni-Suef and Qalubia governorates during the 2023–2024 season.

Families	Species	Qalubia						Beni-Suef					
		Nov.	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**
Cohort Astigmatina													
Acaridae Latreille	*Tyrophagus putrescentiae* (Schrank)	++	++	++	++	++	+	+	+	++	++	++	++
	Rhizoglyphus robini Claparédè	+	++	++	++	++	+	+	++	++	+++	+	++
Suborder Prostigmata													
Cheyletidae Leach	*Cheletomorpha lepidopterorum* (Shaw)	+	+++	++	+++	++	+	+	-	++	+	++	++
Eupodidae Koch	*Benoinyssus momeni* (Abou-Awad)	++	++	+++	+++	++	++	-	++	++	+	+	+
Eriophyidae Nalepa	*Aceria tulipae* (Keifer)	++	++	+++	+++	+++	++	+	+++	+++	+++	+++	+++
Order Mesostigmata													
Melicharidae Hirschmann	*Proctolaelaps pygmaeus* (Müller)	++	++	++	++	++	+	+	+	++	+	+	+++
Laelapidae Berlese	*Hypoaspis aculeifer* (Canestrini)	-	++	++	++	-	-	-	+	++	++	++	+
Suborder Oribatida													
Scheloribatidae Jacot	*Scheloribates laevigatus* (Koch)	++	++	+++	+++	++	+	+	++	++	+	++	+++
Order Thysanoptera													
Thripidae Stephens	*Thrips tabaci* Lindeman	+	++	++	++	++	+	+	+	++	+++	++	+++

(+) = rare (less than 3 individuals), (++) = moderate (3–9 individuals), (+++) = high (more than 9 individuals) per plant.

Seasonal abundance of mite species and thrips associated with garlic crop at Beni-Suef and Qalubia governorates during the 2023–2024 season.

The most abundant mite species on garlic were *T. putrescentiae*, *R. robini*, *A. tulipae*, as well as the garlic thrips, *T. tabaci* at Beni-Suef and Qalubia governorates. The population of those pests began early in the season at the seedling stage, one month after plantation, with relatively low number, then increased (Figures 2 and 3). The population abundance of *T. putrescentiae* increased from 4 individuals/clove in late Oct. 2023 to 10 individuals/clove at the end of Feb. 2024 at Beni-Suef governorate, with maximum and minimum temperature of 20.93 and 13.20°C and 70.94% RH, respectively. While at Qalubia governorate, *T. putrescentiae* has two peaks: 11 individuals/clove in mid-Dec. at maximum and minimum temperature of 22.93 and 15.81°C and 60.22% RH, and10 individuals/clove in mid-Feb. 2024 at maximum and minimum temperature of 19.68 and 11.73°C and 55.95% RH (Figure 2).

The astigmatid bulb mite, *R. robini*, was found on garlic cloves in small numbers early in the season, but gradually increased to a peak of 11 individuals/clove in mid-Nov. 2023, then fluctuated to reach the second peak of 14 individuals/clove on 28 Jan. 2024 at Beni-Suef governorate. While, *R. robini* had one peak in mid-Jan. 2024 with 9 individuals/clove at Qalubia governorate (Figures 2 and 3).

The eriophyid bulb mite, *A. tulipae*, feeds young garlic leaves and founds in layers of garlic bulb. Because they feed on the curled green part and leaves of garlic plants, they harm and the leaves dry. This eriophyid mite was recorded in large number on garlic leaves in both governorates. The population of *A. tulipae* was observed on upper leaves in late Oct. 2023 with 80 individuals/cm^2 and gradually increased, reaching its peak of 194 individuals/cm^2 on 28 Jan. 2024, with maximum and minimum temperature of 20.27 and 13.07°C and 61.85% RH at Beni-Suef governorate. Meanwhile, at Qalubia governorate, it had two peaks (193.6 and 355.5 individuals/cm^2) in late Dec. and late Feb. 2024, respectively (Figures 2 and 3).

Thrips tabaci was constantly present during the garlic cropping season. The population of *T. tabaci* began to increase in mid-Oct. 2023 and continued until the last week of Mar. 2024. The population increased from 57.7 individuals/plant in mid-Oct. to 62.5 individuals/plant in mid-Nov. 2023. The first peak of 78.6 thrips/plant was reported in the last week of Nov., while the second peak occurring in mid-Jan. 2024 at 76.6 thrips/plant. The population of *T. tabaci* decreased to 14 thrips/plant at the end of Mar. 2023 at Beni-Suef governorate. However, at Qalubia governorate, thrips reached one peak of population (87.5 individuals/plant) in mid-Dec., following which the population gradually decreased till end of the season (Figures 2 and 3).

Relationship between mite and thrips population, abiotic factors, and spiders

The statistical analysis of the data in Table (2) indicated that both maximum and minimum temperature had a significant negative effect on the population of *T. putrescentiae*, although relative humidity had no significant positive influence on the mite population in the two governorates. None of the abiotic factors had a significant effect on *R. robini* population at Beni-Suef governorate; however, temperature had a significant negative effect on the mite population at Qalubia governorate (Table 2). Both maximum and minimum temperature showed negative effect on population of the eriophyid mite, *A. tulipae*, although relative humidity had no significant positive or negative effect on the mite population in either governorates. Thrips population in the two governorates is not significantly affected by abiotic factors such as temperature and relative humidity (Table 2).

Furthermore, a non-significant positive correlation was found between the overall population of spiders and both *T. putrescentiae* and *A. tulipae* in both governorates. The results indicate that there is a highly significant positive correlation between spiders and *R. robini* population at Qalubia governorate, while there is a non-significant negative correlation between the population of both taxa at Beni-Suef. On the other hand, there is a highly negative correlation between thrips and spiders population at Beni-Suef governorate, while there is a non-significant positive correlation between them at Qalubia governorate (Table 2).

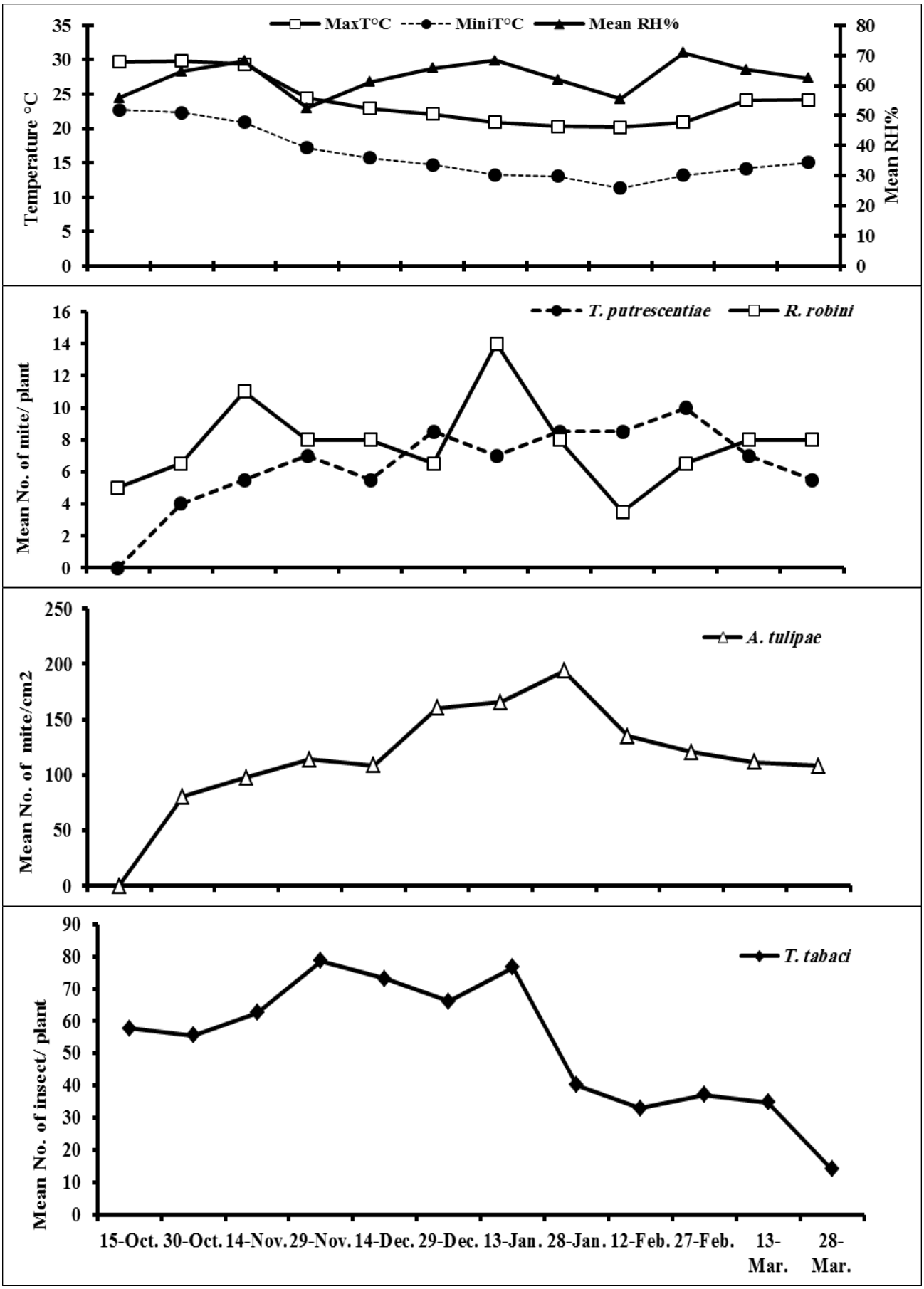

Figure 2. Temperature, relative humidity, and seasonal abundance of mite species and thrips associated with garlic crop at Beni-Suef governorate during the 2023–2024 season.

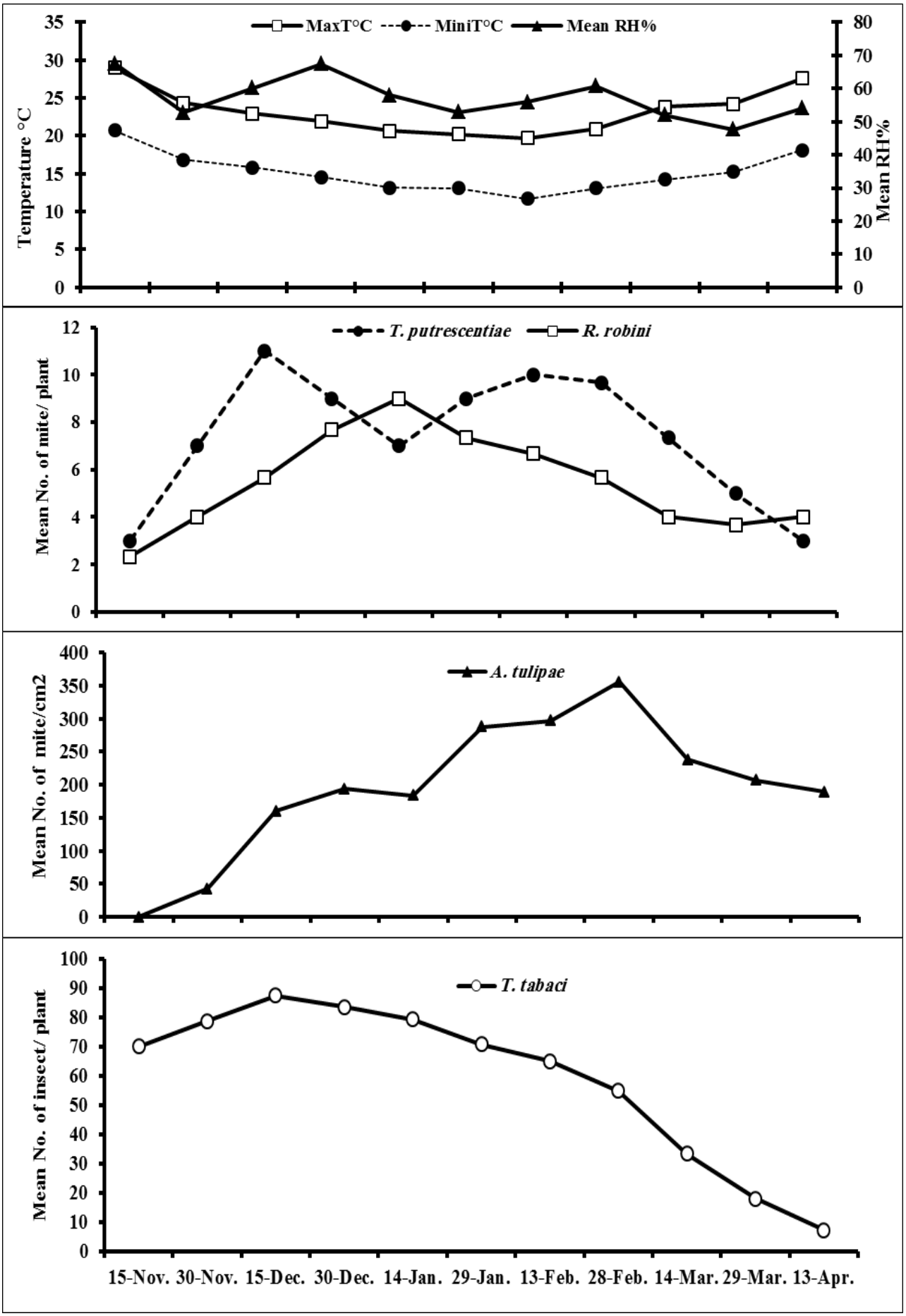

Figure 3. Temperature, relative humidity, and seasonal abundance of mite species and thrips associated with garlic crop at Qalubia governorate during the 2023–2024 season.

Table 2. Simple correlation between mite species and thrips inhabiting garlic plants and weather factors at Beni-Suef and Qalubia governorates during the 2023–2024 season.

Species	Beni-Suef				Qalubia			
	MaxT.	MiniT.	Mean RH%	Spiders	MaxT.	MiniT.	Mean RH%	Spiders
Tyrophagus putrescentiae	-0.81**	-0.83**	0.32	0.52	-0.83**	-0.74*	0.10	0.57
Rhizoglyphus robini	-0.03	0.03	0.48	-0.11	-0.83**	-0.74*	0.15	0.86**
Aceria tulipae	-0.80**	-0.78**	0.29	0.35	-0.71*	-0.82**	-0.26	0.32
Thrips tabaci	0.18	0.33	-0.08	-0.75**	-0.40	-0.15	0.57	0.57

According to Sabra and Abdel-Wareth (2012), the population of *T. tabaci* on garlic crop at Fayoum governorate was ranged between 4 and 605 insects/10 plants. The current results are consistent with their findings. Satyagopal et al. (2014) reported several pests on garlic including thrips, *T. tabaci*, *R. robini*, and *A. tulipae*, and *Tetranychus urticae* Koch [mentioned as *T. cinnabarinus* (Boisduval)], which have a significant impact on the country and considerably yield loss. According to *Hussein et al.* (2015), *T. tabaci* is active from Nov. until the end of Apr., which is the whole growing season for garlic crop.

Debnatha and Karmakar (2013), mentioned that *A. tulipae* infests the midrib of leaves, causing a 32% yield loss in India; the number of mites reaches its peak in mid-Feb. 90 days after planting.

Occurrence of spiders on garlic crop

A survey of spider families associated with garlic crop was cultivated at Qalubia and Beni-Suef governorates during the 2023–2024 season. The current result recorded 12 spider species belonging to six families as follows: *Zelotes tenuis* (Ganphosidae), *Lycosa nilotica*, *Pardosa injucunda*, and *Trachosa urbana* (Lycosidae), *Thanatus albini* (Philodromidae), *Ballus piger*, *Euophrys* spp., and *Thyene imperialis* (Salticidae), *Euryobis* spp., *Kochiura aulica*, and *Theridion melanostictum* (Theridiidae) (Table 3).

The spider families: Dictynidae, Gnaphosidae, and Lycosidae were found to be the most abundant species associated with garlic crop at Beni-Suef governorate; nevertheless, Philodromidae, Salticidae, and Theridiidae families had a high density in garlic crop in the two governorates. Spiders are important natural pest control agents in agriculture crops because they reduce pest population density; several authors have observed that spiders family Theridiidae are the most abundant predators recorded in Egyptian *Gossypium* spp. and *Vicia faba* L. crops (Abu-Zaed 2019; Mohammed 2021; Mansour 2022).

Seasonal abundance of spider families associated with garlic crop at Beni-Suef and Qalubia governorates during the 2023–2024 season

Our findings indicated that the number of family Lycosidae in garlic crop was the highest (119 and 98 individuals/20 plants), followed by family Theridiidae (99 and 81 individuals/20 plants) at Beni-Suef and Qalubia governorates, respectively. While, family Dictynidae was found to have the fewest number in garlic crop (Figure 4). However, the highest number of spiders was recorded in Feb. and Mar. at Beni-Suef governorate, and in Jan. at Qalubia governorate. These findings are consistent with those of Khalil et al. 2016; Abu-Zaed 2019; Mohammed 2021; and Mansour 2022.

A statistical analysis of data on spiders in garlic plants at Beni-Suef and Qalubia governorates (Table 4) showed a non-significant negative correlation between the populations of the three spider families: Gnaphosidae, Philodromidae, and Theridiidae and the maximum and minimum temperature, as well as a non-significant positive correlation with relative humidity in the two governorates in garlic crop. However, Dictynidae and Salticidae families at Beni-Suef governorate had a significant negative correlation with both maximum and minimum temperature. However, maximum and minimum temperature as well as relative humidity, showed no significant correlation with population of both Dictynidae and Salticidae families at Qalubia governorate.

Table 3. Occurrence of spiders associated with garlic crop at Qalubia and Beni-Suef governorates during the 2023–2024.

Spider family	Spider taxa	Qalubia						Beni-Suef					
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Dictynidae O. Pickard-Cambridge	*Brigittea innocens* (O. Pickard-Cambridge)	+	+	+	+	-	-	-	-	++	++	+++	++
Gnaphosidae Banks	*Zelotes tenuis* (Koch)	+	+	+	++	+	+	+	-	++	+++	++	+++
Lycosidae Sundevall	*Lycosa nilotica* Audouin	++	++	++	+++	+	+	+++	++	+++	++	+++	+++
	Pardosa injucunda (O. Pickard-Cambridge)	++	++	++	++	++	+	++	++	+	++	++	++
	Trochosa urbana O. Pickard-Cambridge	+	+	++	++	+	-	++	+	+	+	+	+
Philodromidae Thorell	*Thanatus albini* (Audouin)	++	+	++	++	+	+	++	++	++	+++	+++	+++
Salticidae Blackwall	*Ballus piger* O. Pickard-Cambridge	++	++	++	++	+	+	++	++	++	+++	+++	+++
	Euophrys spp.	++	++	++	+	++	+	-	-	++	++	++	++
	Thyene imperialis (Rossi)	++	++	+	++	+	+	-	-	+	+	+	+
Theridiidae Sundevall	*Euryobis* spp.	+	++	++	++	++	+	-	-	+	++	++	++
	Kochiura aulica (Koch)	++	++	++	++	++	+	-	-	+	+++	+++	+++
	Theridion melanostictum O. Pickard-Cambridge	+	++	++	++	++	+	-	-	++	++	++	+++

(+) = rare (less than 3 individuals), (++) = moderate (3–9 individuals), (+++) = high (more than 9 individuals) per plant

Table 4. Simple correlation between spider families inhabiting garlic plants and weather factors at Beni-Suef and Qalubia governorates during the 2023–2024 season.

Species	Qalubia			Beni-Suef		
	MaxT.	MiniT.	Mean RH.%	MaxT.	MiniT.	Mean RH%
Dictynidae	-0.02	0.17	0.29	-0.72*	-0.77**	0.12
Gnaphosidae	-0.02	-0.17	-0.61	-0.49	-0.57	0.28
Lycosidae	-0.84**	-0.80**	-0.07	0.14	0.14	-0.06
Philodromidae	-0.53	-0.50	-0.40	-0.42	-0.58	0.11
Salticidae	0.06	0.20	0.55	-0.73*	-0.83**	0.33
Theridiidae	-0.39	-0.41	-0.18	-0.59	-0.72*	0.31

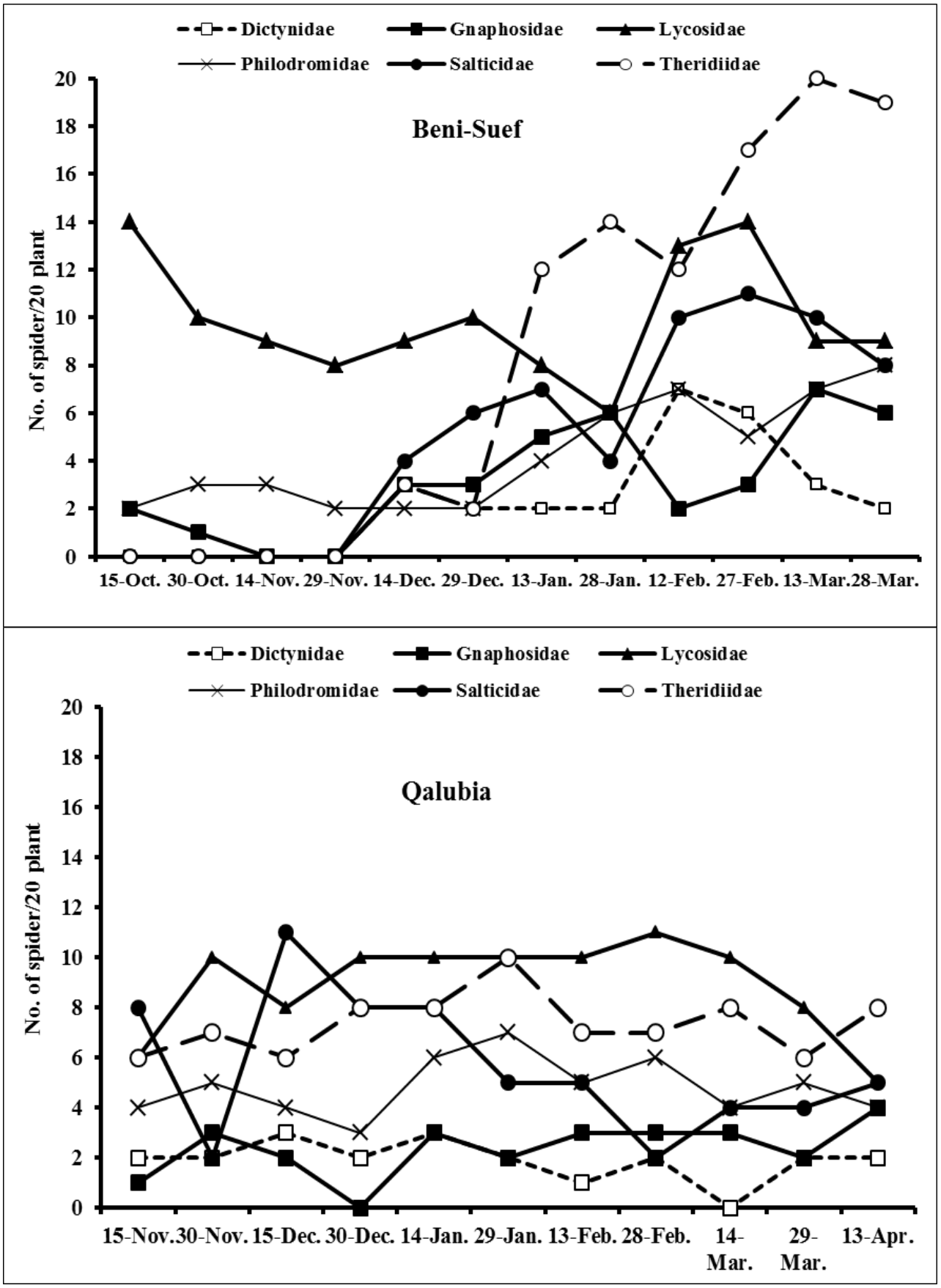

Figure 4. Seasonal abundance of spider families associated with garlic crop at Beni-Suef and Qalubia governorates during the 2023–2024 season.

CONCLUSION

The study reported garlic-associated mite species, thrips, and spiders at Qalubia and Beni-Suef governorates during 2023–2024 season. Eight mite species and one insect were found. The most frequent mite species was *T. putrescentiae*, *R. robini*, and *A. tulipae*. *Tyrophagus putrescentiae* reached its peak in Feb., whilst *R. robini* and *A. tulipae* reached their peak in late Dec. and Feb. 2024, respectively. Spiders are effective natural pest control agents in agriculture, reducing pest population. Spider families: Dictynidae, Gnaphosidae, and Lycosidae are common in garlic crop at Beni-Suef governorate. However, Philodromidae, Salticidae, and Theridiidae families are abundant in garlic crop at both governorates.

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