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Survey and seasonal fluctuation of soil mites and spiders inhabiting cotton and broad bean plants grown in clay and sandy soils at Beni-Suef governorate

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ABSTRACT

Seasonal fluctuation and survey of some soil mites as well as spiders inhabiting cotton and broad bean plants at Beni-Suef governorate throughout the 2022–2023 seasons grown in clay and sandy soil. The investigation revealed 45 mite species in 32 genera and 22 families into four groups. The total number of the collected mite groups was 56, 187, 67, and 319 individuals in clay soil, and 29, 91, 20, and 124 individuals in sand soil for Astigmatina, Mesostigmata, Oribatida, and Prostigmata underneath cotton plants, while the number of mites was 26, 94, 37, and 234 individuals in clay soil, and 8, 28, 15, and 71 individuals for the same groups in sandy soil underneath broad bean plants, respectively. Soil mites inhabiting clay soil were more numerous than those inhabiting sandy soil. The prostigmatid and mesostigmatid mite species were most abundant in sandy and clay soil, followed by oribatid and astigmatid mites. For the spiders, five families presented by eight species in eight genera were recorded on cotton and broad bean plants grown in clay and sandy soil. The three most dominating families are Lycosidae, Salticidae, and Theridiidae.

Keywords: survey, Acari, spiders, *Gossypium barbadense*, *Vicia faba*.

INTRODUCTION

Cotton, *Gossypium* spp. (Malvaceae), is a major and widely grown agricultural and industrial crop globally. It is grown in over 100 countries on approximately 2.5% of arable land worldwide (Townsend and Liewellyn 2007). Fabacae plants have a significant impact on agro-ecosystems because they can establish symbiotic interactions with soil rhizobia that fix nitrogen from the atmosphere (Mortier et al. 2012). The broad bean (*Vicia faba* L., Fabacae) is the most nutritious and widely consumed food crop in Egypt. It contains a high percentage of proteins, carbohydrates, vitamins, and mineral salts, all of which are essential for human nutrition (Jensen et al. 2010).

The subclass Acari, the largest group of invertebrates, is extremely valuable economically. Over 60,000 species of mites have been reported from different parts of the world; they are found in all types of aquatic, arboreal, terrestrial, and parasitic environments, making up to 80% of all soil-dwelling arthropods (Minor and Norton 2004; Embarak and Abou El-Saad 2010). The majority of these species appears to be predators, feeding on small nematodes, mites, and small insects found on the soil's surface (Convey et al. 2000). Soil mites are abundant soil organisms that are sensitive to soil perturbations in agricultural practices and their number and diversity often get reduced affecting their ecosystem services (Minor and Cianciolo 2007). Several genera of soil mites are considered good bio-indicators of habitat and soil conditions (Behan-Pelletier 1999). Several studies have been conducted to study the distribution and abundance of soil mites at different locations in Egypt (Kandeel 1993; El-Moghazy 2006; El-Sharabasy 2010). The mesostigmatid mites play important role as predators of other soil microarthropods and both free-living and plant parasitic nematodes (Koehler 1999; Beaulieu and Walter 2007).

Prostigmata and Mesostigmata are the two most common groups of soil mites found in various soil habitats. They are plant parasitic nematodes and predators of other soil micro arthropods (Beaulieu and Walter 2007; Abdel-Rahman et al. 2015; El-

Nahas et al. 2022). Soil and litter habitats are recognized as important repositories for biodiversity. Detritus-feeding soil mites as oribatids, play a significant role in the breakdown of plant wastes and are considered to be a key factor in boosting soil fertility (Minor et al. 2004).

Furthermore, a survey of soil mites was investigated by several authors in Egypt (El-Sharabasy et al. 2008; El-Sharabasy 2010; Atwa et al. 2018; El-Nahas et al. 2022)

Spiders are major natural control agents worldwide, found in various sizes and hiding in many locations. They are predaceous and play a significant role in reducing pest populations. However, individual spider species, lack certain characteristics required for effective biological control. The importance of spider assemblages in pest management is largely unknown, and spiders have received little attention in research. Adult spiders are predators that play a crucial role in pest control. Overall, spiders are importanat natural pest control agents in agriculture (Khalil et al. 2016; Abu-Zaed 2019; Zaki and Aly 2019).

However, plants play an important role as the basis of the food web, therfore broad bean has proposed that plant litter quality and quantity. Thus, the objective of this study is to conduct a survey of soil mites and spiders as well inhabiting cotton grown in clay soil and broad bean grown in sandy soil at Beni-Suef governorate during two successive years (2022 and 2024).

MATERIALS AND METHODS

Mite sampling

During the 2022–2023 season, a survey was conducted of some soil mites and spiders inhabiting cotton and broad bean crops at Beni-Suef governorate, Egypt. Soil samples of about 500 g with three replicates at depth of 20 cm underneath broad bean as a winter crop throughout two successive seasons (2022–2023) and cotton as a summer crop during 2023 season. Mite samples were transported to the laboratory in polyethylene bags on the same collection day, for later examination. Samples were extracted with modified Berlease funnels (Lasebikan 1974) into a small jar containing 75% ethyl alcohol and 5% glycerol. Mites were inspected directly using a stereo-microscope (107, China). The mites were kept in Nesbitt's solution for 24 hrs before being mounted in Hoyer's medium on clean microscopic slides. The slides were kept on a hot plate at 50°C for ten days (Krantz and Walter 2009). Specimens were identified to their taxonomical ranks using several specific keys (Summers and Price 1970 for Cheyletidae; Hughes 1976 for Acaridae; Zaher 1986 for Mesostigmata and Prostigmata; Volgin 1989 for Cheyletidae; Krantz and Walter 2009 for Oribatidae; Abo-Shnaf and Moraes 2014 for Phytoseiidae).

Spider sampling

The samples were collected biweekly by hand from 9 to 11 a.m. during the summer and 10 to 12 p.m. in the winter, using a 10x lens. The spiders were separated, counted in glasses, and transported to the laboratory the same day for identification and counting. Specimens were identified using the descriptions of Kaston (1978) and the World Spider Catalog (2024).

Statistical analysis

SAS (2003) was used to analyze data based on the correlation coefficient between weather factors and mite and spider population. In addition, the statistical analysis of variance (ANOVA) procedure is used to compare the means of different groups and determine if they differ significantly. Differences between means were tested using SAS Statistical Software (2003).

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RESULTS AND DISCUSSION

Survey of soil mites

The present study surveyed different soil mites inhabiting cotton crop grown in clay soil and broad bean crop grown in sandy soil at Beni-Suef governorate during two successive seasons in 2022 and 2023. The results indicated of the presence of 45 mite species in 32 genera and 22 families from four mite groups (Table 1) The mite groups are cohort Astigmatina, which represented by two families, five genera, and six species. Order Mesostigmata was represented by 11 families, 15 genera, and 20 species. Suborder Oribatida was represented by three species and

three genera in three families, while suborder Prostigmata was represented by 16 species, nine genera, and six families.

1. Cohort Astigmatina

The two families of astigmatid mites are Acaridae and Pyroglyphidae. Mites from these families can cause direct damage by feeding on roots and fungi (Krantz and Walter 2009).

Family Acaridae Latreille

This family was represented by four species in four genera; *Caloglyphus berlesei* (Michael), *Rhizoglyphus robini* Claparédè, *Tyrolichus casei* (Oudemans), and *Tyrophagus putrescentiae* (Schrank). The latter species was found in large numbers in clay soil.

Family Pyroglyphidae Cunliffe

This family was represented by two species in one genera; *Dermatophagoides farina* Hughes and *D. pteronyssinus* (Trouessart). It was recorded in moderate numbers in sand soil.

2. Order Mesostigmata

Eleven families belonging to this order were recorded, namely: Ameroseiidae, Blattisociidae, Digamasellidae, Eviphididae, Laelapidae, Melicharidae, Ologamasidae, Pachylaelapidae, Parasitidae, Phytoseiidae, and Sejidae (Table 1).

Family Ameroseiidae Evans

This family was represented by only one species, *Ameroseius aegypticus* El-Badry, Nasr & Hafez, with moderate numbers inhabiting cotton fields in clay soil. El-Sayed et al. (2020) found similar findings when collecting from barley grain in Zagazig. Ameroseiid mites have been observed to feed on fungus (Zaher 1986).

Family Blattisociidae Garman

Two species in two genera: *Blattisocius keegani* Fox and *Lasioseius aegypticus* Afifi, were recorded with moderate numbers inhabiting cotton plants grown in clay soil, both of which feed on small arthropods.

Family Digamasilidae Evans

Only one species, *Dendrolaelaps* spp., was recorded with few numbers in clay and sand soils.

Family Eviphididae Berlese

Scamaphis equestris Berlese was recorded with a rare number in clay soil.

Family Laelapidae Berlese

Hypoaspisella orientalis (Hafez, El-Badry & Nasr) was found in large numbers in clay soil, whereas *Gaeolaelaps gergus* (Hafez, El-Badry & Nasr), *G. petrovae* (Shereef & Afifi), *Gaeolaelaps* spp., and *Ololaelaps bregetovae* Shereef & Soliman are members of this family and were found in moderate numbers. They are considered as free-living soil-borne predators (Fouly and Al-Rahiyani 2011).

Family Melicharidae Hirschmann

Only one species was collected in this family: *Proctolaelaps aegyptiacus* Nasr with moderate numbers in sand soil. According to similar findings by Fouly and Al-Rahiyani (2011), this species is free-living soil-borne predator.

Family Ologamasidae Ryke

Two species were recorded in this family with moderate numbers in clay soil and a rare numbers in sand soil, namely: *Gamasiphis denticus* Hafez & Nasr and *Gamasiphis parpulchellus* Nasr & Mersal. Ashoub et al. (2006) reported that these two species were found in debris and organic matter on eggplant and cucumber plants.

Family Pachylaelapidae Berlese

Two species, namely: *Pachylaelaps aegypticus* Hafez & Nasr in clay and sand soil, and *P. reticulatus* Hafez & Nasr in clay soil were collected represented this family. Zaki and Abo-Shnaf (2018) recorded the both species in organic and conventional chamomile and marigold.

Family Parasitidae Oudemans

This family was represented by three species, namely: *Gamasodes* spp. 1, *Gamasodes* spp. 2, and *Vulgarogamasus oudemansi* (Berlese). Parasitoid mites are predators that feed on nematodes and other microarthropod eggs (Zaher 1986).

Family Phytoseiidae Berlese

Only one species, *Neoseiulus barkeri* Hughes was recorded with a rare number in sand soil feeding on tetranychid mites and scale insects.

Family Sejidae Berlese

Sejus spp. was recorded in a few numbers in clay soil.

3.Suborder Oribatida

The current study revealed that there are mites with miscellaneous feeding habits in three families from Suborder Oribatida (Table 1), as follows:

Family Aphelacaridae Grandjean

Aphelacarus acarinus (Berlese) is the only species representing this family in the current survey.

Family Malaconothridae Berlese

This family was represented by a single species, *Malaconothrus robustus* Hammer, with a rare numbers in clay and sand soil.

Family Scheloribatidae Jacot

Only one species, *Scheloribates laevigatus* (Koch), was recorded, with a high numbers in clay soil and a rare numbers in sand soil. This data agrees with that obtained by Zaher (1986).

4.Suborder Prostigmata

The survey revealed 16 species belonging to 11 genera in six families (Table 1) as fallow:

Family Bdellidae Dugès

Spinibdella bifurcata Atyeo was found inhabiting cotton crops in a rare numbers, while *Cyta latirostris* (Hermann) was found inhabiting broad bean in a rear numbers. Both species feed on small arthropods in litter and soil (Abdel-Rahman et al. 2015).

Family Cheyletidae Leach

This family includes six species collected in the current work: *Acaropsella notchi* Goma & Hassan, *A. kulagini* (Rohdendorf), *Cheyletus badryi* Zaher & Hassan, *Ch. eruditus* (Shrank), *Ch. malaccensis* Oudemans, and *Eutogenes frater* Volgin. All members of this family are predators on mites and small insects (Zaher 1986; El-Nahas et al. 2022).

Family Cunaxidae Thor

This family is represented by two species in one genera, *Cunaxa nercruzanum* Baker & Hoffmann and *C. potchensis* Den Heyer, in clay soil.

Family Raphignathidae Kramer

Three mite species in one genus were recorded in this family: *Raphignathus bakeri* Zaher & Gomaa, *R. ehari* Zaher & Gomaa, and *R. niloticus* Rakha & Mohamed. These species are biological control agents for phytophous mites and scale insects, which are similar to those obtained by (Zaher 1986; El-Nahas et al. 2022).

Family Smarididae Kramer

Only one species belonging to this family, *Trichomaris jacoti* (Southcott), was collected in the current study with a rear numbers in clay soil.

Family Tydeidae Kramer

Two species in two genera belonging to this family were collected, namely, *Tydeus kochi* Oudemans and *Tydeus aegypticus* (Rasmy and El-Bagoury). Both species are considered as fungivorous (Zaher 1986; Abdel-Rahman et al. 2015).

The total number of collected mite groups was 85, 278, 87, and 443 individuals for Astigmatina, Mesostigmata, Oribatida, and Prostigmata in clay and sand soils cultivated with cotton plants, and 34, 122, 52, and 305 individuals for the same groups in clay and sandy soils cultivated with broad bean plants, respectively. Soil mites inhabiting clay soil were more numerous than that inhabiting sandy soil. The prostigmatid and mesostigmatid mite species have the most soil mites in sandy and clay soil, followed by oribatid and astigmatid Tables (2 and3). The most abundant mites were *Cunaxa nercruzanum* (Family Cunaxidae), which is inhabiting cotton plants grown in clay soil, and the cheyletid mites (*Cheyletus eruditus* and *C. malaccensis*), which are inhabiting broad bean plants grown in sandy soil. The obtained results are consistent with those reported by (Zaher 1986; Romeih 2002).

Table 1. Survey of soil mites inhabiting cotton and broad bean plants at Beni-Suef governorate during 2022–2023 season.

Family	Mite species	Abundance of mites in clay soil	Abundance of mites in sandy soil	Habitat
Cohort Astigmatina				
Acaridae Latreille	*Caloglyphus berlesei* (Michael)	+	-	Cotton
	Rhizoglyphus robini Claparédè	-	++	Broad bean
	Tyrolichus casei (Oudemans)	++	-	Cotton/ broad bean
	Tyrophagus putrescentiae (Schrank)	+++	+	Cotton/ broad bean
Pyroglyphidae Cunliffe	*Dermatophagoides farinae* Hughes	-	++	Broad bean
	D. pteronyssinus (Trouessart)	-	++	Broad bean
Order Mesostigmata				
Ameroseiidae Evans	*Ameroseius aegypticus* El-Badry, Nasr & Hafez	++	-	Cotton
Blattisociidae Garman	*Blattisocius keegani* Fox	++	-	Cotton
	Lasioseius aegypticus Afifi	++	-	Cotton
Digamasellidae Evans	*Dendrolaelaps* spp.	+	+	Cotton/ broad bean
Eviphididae Berlese	*Scamaphis equestris* Berlese	+	-	Cotton
Laelapidae Berlese	*Gaeolaelaps gergus* (Hafez, El-Badry & Nasr)	++	-	Cotton
	Gaeolaelaps petrovae (Shereef & Afifi)	++	-	Cotton
	Gaeolaelaps spp.	++	-	Cotton
	Hypoaspisella orientalis (Hafez, El-Badry & Nasr)	+++	-	Cotton
	Ololaelaps bregetovae Shereef & Soliman	++	+	Cotton/ broad bean
Melicharidae Hirschmann	*Proctolaelaps aegyptiacus* Nasr	-	++	Broad bean
Ologamasidae Ryke	*Gamasiphis denticus* Hafez & Nasr	++	+	Cotton/ broad bean
	Gamasiphis parpulchellus Nasr & Mersal	++	+	Cotton/ broad bean
Pachylaelapidae Berlese	*Pachylaelaps aegypticus* Hafez & Nasr	+	++	Cotton/ broad bean
	Pachylaelaps reticulatus Hafez & Nasr	++	-	Cotton
Parasitidae (Oudemans)	*Gamasodes* spp.1	+	-	Cotton
	Gamasodes spp.2	++	-	Cotton
	Vulgarogamasus oudemansi (Berlese)	++	+	Broad bean
Phytoseiidae Berlese	*Neoseiulus barkeri* Hughes	-	+	Broad bean
Sejidae Berlese	*Sejus* spp.	+	-	Cotton
	Suborder Oribatida			
Aphelacaridae Grandjean	*Aphelacarus acarinus* (Berlese)	++	+	Cotton/ broad bean
Malaconothridae Berlese	*Malaconothrus robustus* Hammer	+	+	Cotton/ broad bean
Scheloribatidae Jacot	*Scheloribates laevigatus* (Koch)	+++	+	Cotton/ broad bean

Table 1. *Continued.*

Suborder Prostigmata				
Bdellidae Dugès	*Spinibdella bifurcata* Atyeo	+	-	Cotton
	Cyta latirostris (Hermann)	-	+	Bean bean
Cheyletidae Leach	*Acaropsella kulagini* (Rohdendorf)	-	++	Bean bean
	A. notchi Goma & Hassan	+	-	Cotton
	Cheyletus badryi Zaher & Hassan	-	++	Bean bean
	Ch. eruditus (Shrank)	++	++	Cotton/ broad bean
	Ch. malaccensis Oudemans	++	+++	Cotton/ broad bean
	Eutogenes frater Volgin	++	+	Cotton/ broad bean
Cunaxidae Thor	*Cunaxa nercruzanum* Baker & Hoffmann	++	-	Cotton
	C. potchensis Den Heyer	+	-	Cotton
Raphignathidae Kramer	*Raphignathus bakeri* Zaher & Gomaa	-	+	Broad bean
	R. ehari Zaher & Gomaa	++	-	Cotton
	Raphignathus niloticus Rakha & Mohamed		++	Broad bean
Smaridídae Kramer	*Trichomaris jacoti* (Southcott)	+	-	Cotton
Tydeidae Kramer	*Tydeus kochi* Oudemans	++	-	Cotton
	T. aegypticus (Rasmy and El-Bagoury)	+	++	Cotton/ broad bean

(+) = rare (less than 3 individuals/500g of soil), (++) = moderate (3–9 individuals/500g of soil), (+++) = high (more than 9 individuals/500g of soil).

Seasonal fluctuation of soil mites

The current results indicated that cotton soil much higher numbers of mite species than broad bean soil. The average number of mites inhabiting cotton grown in clay and sand soil were 26.2 and 11.0/500 g of soil, respectively. While, the average number of mites inhabiting broad bean grown in clay and sand soil was 24.4 and 7.6/500 g, respectively Tables (2 &3).

Our findings showed that the number of prostigmatid mites in the clay soil underneath cotton and broad bean was the highest (53.2 and 58.5 individuals/500 g of soil), followed by Mesostigmata (31.2 and 23.5 individuals/500 g of soil), respectively, with significant differences between the Astigmatina and oribatida groups (Table 2 & 3).

Conversely, in July and Aug., the majority of soil mites inhabiting cotton plants were collected, with 31.3 and 34.8 individuals/500 g of clay soil, respectively, and in Aug. and Sep. with 13.5 and 12.8 individuals/500 g of sand soil, with significant differences between the two types of soil. In Jan. and Feb., the greatest numbers of mites inhabiting broad bean were 28.8 and 27.0 individuals/500 g of clay soil (Table 2 & 3). These results are agreed with those obtained by (Walia and Mathur 1994; Kalmosh and AbdelRahman 2023).

Statistical analysis of data on soil mites in cotton and broad bean plants in Beni-Suef governorate (Table 4) showed a highly significant positive correlation between the population of the four mite groups (Astigmata, Mesostigmata, Oribatida, and Prostigmata) and the max, min temperature and mean relative humidity in clay soil in cotton fields. However, a significant negative correlation was found with the Mesostigmata, Prostigmata, and Oribatida populations in clay and sand soils in faba bean crops with max and min temperatures. Moreover, mean soil relative humidity showed a non-significant negative correlation with Astigmata and Astigmata populations and sand soils in faba bean crops. These results agree with finding by Kalmosh and AbdelRahman (2023).

Table 2. Monthly total number of soil mites inhabiting cotton plants during 2023 season at Beni-Suef governorate.

Order	soil	Cotton								
		Apr.	May	June	July	Aug.	Sep.	Mean	Total	
Astigmata	Clay	4	6	9	11	14	12	**9.3**[a]	**56**	**85**
	Sand	3	4	4	5	6	7	**4.8**[b]	**29**	
Mesostigmata	Clay	17	28	30	38	41	33	**31.2**[a]	**187**	**278**
	Sand	12	16	17	14	18	14	**15.2**[b]	**91**	
Oribatida	Clay	5	6	10	15	16	15	**11.2**[a]	**67**	**87**
	Sand	3	4	3	2	4	4	**3.3**[b]	**20**	
Prostigmata	Clay	35	44	56	61	68	55	**53.2**[a]	**319**	**443**
	Sand	13	21	18	20	26	26	**20.7**[b]	**124**	
Mean	Clay	**15.3**[a]	**21.0**[a]	**26.3**[a]	**31.3**[a]	**34.8**[a]	**28.8**[a]	**26.2**[a]	**629**	**893**
	Sand	**7.8**[b]	**11.3**[b]	**10.5**[b]	**10.3**[b]	**13.5**[b]	**12.8**[b]	**11.0**[b]	**264**	

Means for each soil followed by different letters are significantly different at the 5% level.

Table 3. Monthly total number of soil mites inhabiting broad bean plants during 2022–2023 seasons at Beni-Suef governorate.

Order	soil	Broad bean						
		Nov.	Dec.	Jan.	Feb.	Mean	Total	
Astigmata	Clay	5	9	7	5	**6.5**[a]	**26**	**34**
	Sand	1	2	2	3	**2.0**[b]	**8**	
Mesostigmata	Clay	18	21	30	25	**23.5**[a]	**94**	**122**
	Sand	6	7	7	8	**7.0**[b]	**28**	
Oribatida	Clay	5	7	11	14	**9.3**[a]	**37**	**52**
	Sand	3	4	4	4	**3.8**[b]	**15**	
Prostigmata	Clay	40	63	67	64	**58.5**[a]	**234**	**305**
	Sand	13	18	20	20	**17.8**[b]	**71**	
Mean	Clay	**17.0**[a]	**25.0**[a]	**28.8**[a]	**27.0**[a]	**24.4**[a]	**391**	**513**
	Sand	**5.8**[b]	**7.8**[b]	**8.3**[b]	**8.8**[b]	**7.6**[b]	**122**	

Means for each soil followed by different letters are significantly different at the 5% level.

Table 4. Simple correlation between soil mite groups inhabiting cotton and broad bean plants and weather factors during 2022–2023 season at Beni-Suef governorate.

Soil	R-value	Cotton				Broad bean			
		Astigmatina	Mesostigmata	Oribatida	Prostigmata	Astigmatina	Mesostigmata	Oribatida	Prostigmata
Clay	**Temp max**	0.87	0.91	0.89	0.90	0.07	-0.76	-0.98	-0.82
	Temp min	0.95	0.97	0.96	0.96	-0.22	-0.78	-0.89	-0.89
	R.H.	0.94	0.94	0.93	0.92	0.98	-0.19	-0.34	0.32
Sand	**Temp max**	0.72	0.45	-0.14	0.68	-0.94	-0.94	-0.80	-0.92
	Temp min	0.77	0.46	-0.08	0.74	-0.92	-0.92	-0.94	-0.99
	R.H.	0.76	3.57	0.02	0.75	-0.009	-0.009	0.39	0.12

Survey of spiders

The current results revealed eight spider species belonging to eight genera and five families were recorded: *Brigittea innocens* **(**O. Pickard-Cambridge) (Dictynidae), *Zelotes tenuis* (Koch) (Ganphosidae), *Lycosa nilotica* Audouin, *Pardosa injucunda* (O. Pickard-Cambridge), *Trochosa urbana* O. Pickard-Cambridge (Lycosidae), *Euophrys* spp. (Salticidae), *Euryobis* spp. and *Steatoda erigoniformis* (O. Pickard-Cambridge) (Theridiidae) (Table 5). The most abundant species were noticed in clay soil, however some families, such as Salticidae, Theridiidae, and Ganphosidae, had a low density on cotton and broad bean plants grown in sandy soil. The beneficial role of the spider may be understood by the low population of pests when they existed; many authors reported that spider families are the most abundant predators found in Egyptian cotton and broad bean crops (Abu-Zaed 2019; Mohammed 2021; Mansour 2022). Zaki and Aly (2019) collected 1080 spiders from nine families, 22 genera, and 22 species in compost manure treatment, while 704 spiders from eight families, 20 genera, and 20 species were collected in zero compost.

Seasonal fluctuation of spiders

The cotton soil had significantly much higher average of spider numbers than broad bean soil. The average number of spiders found on cotton grown in clay and sand soil was 4.9 and 1.2 individuals/500 g, respectively, compared with 3.3 and 1.5 individuals/500 g of soil, respectively for broad bean grown in clay and sand soil (Table 6).

Our findings showed that the number of family Lycosidae was highest in the clay soil underneath cotton and broad bean plants (14.8 and 6.5 individuals/500 g of soil), while the number of family Dictynidae was lowest in the sand soil underneath cotton and broad bean plants, with significant differences (Table 5). Conversely, in Aug., the highest number of spiders underneath cotton plants was 7.4 individuals/500 g of soil recorded in clay soil and 4.8 individuals/500 g of sand soil underneath broad bean, with significant differences between the two types of soil. These results agree with the findings by Almada et al. (2012), who found that only four spider families constitute 95% of the spider community in cotton crops in Argentina. Also, family Lycosidae is the most common in the organic system (Zaki and Abo-Shnaf 2018; Zaki and Aly 2019).

Table 5. survey of spiders inhabiting cotton and broad bean plants at Beni-Suef governorate during 2022–2023 season.

Family	Species	Abundance of spiders in Clay soil	Abundance of spiders in sandy soil	Habitat
Dictynidae (O. Pickard-Cambridge)	*Brigittea innocens* (O. Pickard-Cambridge)	++	+	Cotton/ broad bean
Gnaphosidae Banks	*Zelotes tenuis* (Koch)	++	+	Cotton/ broad bean
Lycosidae Sundevall	*Lycosa nilotica* Audouin	+++	++	Cotton/ broad bean
	Pardosa injucunda (O. Pickard-Cambridge)	+++	-	Cotton/ broad bean
	Trochosa urbana O. Pickard-Cambridge	++	++	Cotton/ broad bean
Salticidae Blackwall	*Euophrys* spp.	+++	+	Cotton/ broad bean
Theridiidae Sundevall	*Euryopis* spp.	+	+	Cotton
	Steatoda erigoniformis (O. Pickard-Cambridge)	++	+	Cotton

(+) = rare (less than 3 individuals), (++) = moderate (3–9 individuals), (+++) = high (more than 9 individuals) per 500g of soil

Table 6. Monthly total numbers of spider inhabiting broad bean plants during 2022–2023 season, and cotton plants during 2023 season at Beni-Suef governorate.

Order	soil	Cotton							Broad bean				
		Apr.	May	June	July	Aug.	Sep.	Mean	Nov.	Dec.	Jan.	Feb.	Mean
Dictynidae	Clay	0	1	2	3	2	1	**1.5** [a]	1	2	2	0	**1.25** [a]
	Sand	0	1	1	0	0	1	**0.5** [b]	0	1	1	1	**0.75** [b]
Gnaphosidae	Clay	1	1	2	2	1	1	**1.3** [a]	1	3	2	1	**1.75** [a]
	Sand	0	0	1	0	1	0	**0.3** [b]	0	1	0	2	**0.75** [b]
Lycosidae	Clay	8	13	15	19	21	13	**14.8** [a]	4	7	10	5	**6.5** [a]
	Sand	2	4	3	4	4	5	**3.7** [b]	1	3	2	6	**3.0** [b]
Salticidae	Clay	2	3	5	6	8	1	**4.2** [a]	3	3	9	4	**4.75** [a]
	Sand	0	1	0	1	1	0	**0.5** [b]	2	2	2	3	**2.25** [b]
Theridiidae	Clay	1	2	2	4	5	1	**2.5** [a]	0	0	1	2	**2.25** [a]
	Sand	2	0	2	0	1	1	**1.0** [b]	0	1	1	0	**0.5** [b]
Mean	Clay	**2.4** [a]	**4.0** [a]	**5.2** [a]	**6.8** [a]	**7.4** [a]	**3.4** [a]	**4.9** [a]	**1.8** [a]	**3.0** [a]	**4.8** [a]	**2.4** [a]	**3.3** [a]
	Sand	**0.8** [b]	**1.2** [b]	**1.4** [b]	**1.0** [b]	**1.4** [b]	**1.4** [b]	**1.2** [b]	**0.6** [b]	**1.6** [b]	**1.2** [b]	**2.4** [b]	**1.5** [b]

A statistical analysis of data on spiders collected on cotton and broad bean plants at Beni-Suef governorate (Table 7) showed a significant positive correlation between the population of the five spider families and the maximum, minimum temperature, and mean relative humidity in clay soil underneath cotton plants. However, a non-significant correlation was found between the five families of spider numbers in sand soils underneath cotton plants and the maximum and minimum temperatures. Moreover, mean soil maximum and minimum temperatures, as well as relative humidity, showed a non-significant correlation with the five spider families in sand and clay soils underneath broad bean plants.

Table 7. Simple correlation between spider families on cotton and broad bean plants and weather factors during 2022–2023 season at Beni-Suef governorate.

Order	Soil	Cotton			Broad bean		
		Temp max	Temp min	R.H.	Temp max	Temp min	R.H.
Dictynidae	Clay	0.86	0.82	0.71	0.35	0.09	0.64
	Sand	0.08	-0.17	-0.36	-0.80	-0.94	0.60
Gnaphosidae	Clay	0.50	0.33	0.11	0.07	-0.22	0.93
	Sand	0.30	0.34	0.35	-0.65	-0.61	0.08
Lycosidae	Clay	0.81	0.90	0.90	-0.34	-0.51	0.28
	Sand	0.71	0.67	0.62	-0.82	-0.75	-0.06
Salticidae	Clay	0.50	0.63	0.69	-0.43	-0.45	-0.25
	Sand	0.31	0.43	0.53	-0.73	-0.56	-0.41
Theridiidae	Clay	0.56	0.73	0.82	-0.92	-0.76	-0.52
	Sand	-0.40	-0.10	-0.39	0.05	-0.33	0.70

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