Biodiversity and occurrence of soil mites associated with some field crops at Ismailia Governorate, Egypt

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Abstract: The purpose of this study was to shed light on the occurrence and dispersion of soil mites associated with clover, wheat, broad bean, and onion during winter of 2022 at the Agricultural Research Station, Ismailia Governorate. Within the four main categories of soil mites namely, Mesostigmata, Prostigmata, Cryptostigmata, and Astigmata, 36 mite species were identified belonging to 20 families and 34 genera. A total of 1976 soil mite individuals were gathered from all habitats that were studied. The most prevalent group of mites was Mesostigmata, but two species of Prostigmatid mites had the lowest individual numbers (288 individuals). Twelve species dominated the Mesostigmata, which made up 38.5% of all the mites. In contrast to broad bean, which had the fewest soil mite individuals, clover plantation soils showed higher mite abundance, richness, and variety. Following harvest, the diversity index values in the crop fields under examination were decreased, most likely as a result of agricultural machinery disturbing the soil. The various crops differed significantly from one another. At the farm under investigation, the onion field had a Shannon-Wiener's diversity index of 3.2, whereas the wheat field had an index of 1.4.

Key words: *Biodiversity, soil mites, field crops, Ismailia Governorate.*

INTRODUCTION

Understanding the structure and dynamics of soil mite populations requires an understanding of distribution, a crucial ecological topic. The impact of soil mites on nutrient mineralization and organic matter breakdown (Clements and Cook, 1997).

Numerous soil mites typically have a close interaction with the environment. The environmental elements influencing the soil are reflected in the composition of the soil mite community (Gulvik 2007). Agro-ecosystems benefit greatly from the biodiversity of soil mites, and there is proof that soil biodiversity increases resistance to environmental stress (Brussaard *et al.,* 2007; Culman *et al.,* 2010; DuPont *et al.,* 2010).

Seventy percent of all soil fauna are soil mites and certain soil mites that are particularly significant as agricultural plant pests have been thought to (Bardgett 1996; Yeates *et al.,* 1997 and Clements and Cook, 1997). There is likely some vegetation, which affects the soil's characteristics and the number of resources that are available there. It also has a significant effect on soil mites. Because of their sensitivity to certain agricultural methods, soil mites frequently decline, which impacts the ecological services they provide (Minor and Cianciolo 2007).

The goal of the current study was to identify the species composition of soil mites at Ismailia Governorate and how cultivated crops may affect the assemblages of soil mites.

MATERIALS AND METHODS

Site description: A variety of field crops were chosen for soil samples in the agricultural plots where the survey was conducted. The broad bean (*Vicia faba* L.) was planted in the first plot. In the winter of 2022, the second plot was an onion (*Allium cepa* L.), the third was wheat (*Triticum aestivum* L.), and the fourth was a study plot of clover plantations (*Trifolium alexandrinum* L.) at Agricultural Research Station, Ismailia, Egypt. It is one of some environmentally distinct agricultural areas, located in Kilo 4.5 of the ring road of Ismailia Governorate located between latitude 30º 35 º 30 º N, longitude 32 º 14 º 50 º and elevation 3 meters from the sea level.

Samples collection: Soil samples were taken every two weeks. We gathered about 500 g of clover, broad bean, onion, and wheat. Samples were taken from the topsoil layer; between 0 and 20 cm. According to Krantz and Walter (2009), mites were collected from soil samples using a modified Tullgren funnel, stored in 70% ethanol alcohol, and then mounted on Hoyer's medium. Soil mite specimens were identified by examining them with phase contrast (Olympus, BHA) microscopes. Identification was done in accordance with Zaher (1986) and Krantz (1979). The specimens were held in the mite collections of the Plant Protection Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

Species diversity: The diversity index was used to measure the composition of the soil mite community. The Simpson index "S" and the Shannon-Wiener index "H" were calculated. They were computed according to Magurran (2003) methodology. The number of individuals of each species for each plant in the plots was used to calculate the abundance. One-way analysis of variance (ANOVA) was performed on the data.

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RESULTS AND DISCUSSION

Mite abundance: The numerical abundance of soil mites was assessed under some field crops (Wheat, Broad bean, Onion, and Clover) during the winter season 2022 at the Agricultural Research Station at Ismailia Governorate, Egypt. The total number of soil mites was 1976 individuals under all field crops. The highest population numbers were 690 individuals under clover plantations while the lowest population numbers recorded under broad bean was 220 individuals, (Table 1). Data in Table (2) showed that the soil of onion plantation comprised a high species number of mites (25 species), in contrast to broad beans and wheat crops which comprised a low number of species (19 and 20 species, respectively). On the other hand, number of species in clover soil was 22 species. Soil mites were formed by eudominant group of mites 18 families: 6 families of suborder Prostigmata, 9 families of suborder Mesostigmata, one family of suborder Astigmata, and 3 families of suborder Cryptostigmata. In Ismailia Governorate, Hussian *et al.* (2018) discovered similar findings when they identified 60 soil mite species from 27 genera and 21 families belonging to four suborders Astigmata, Prostigmata, Mesostigmata, and Cryptostigmata beneath mango trees. Obtained results reveled to the abundances of mites varied among different field crops (Table 1). Prostigmata recorded 30.1% of the total mites, Cryptostigmata 17%, Astigmata 14.5% and Mesostigmata 38.5%. Mesostigmata were the most abundant for the cultivated crops, but the less abundant group of mites were for Astigmata. Mesostigmatid mites were more significantly ($p < 0.001$) higher in clover plantation than in the other crops. Mostly, major groups of soil mites occurred at their lowest abundance in soils of broad bean plantations especially, Prostigmata, Mesostigmata, and Astigmata. Wheat plots had low abundances of Prostigamta, Astigmata and Mesostigmata, respectively.Mesostigmatid mites were harbored by 759 individuals from soils of all plant types. Mesostigmata included 12 species and 8 families. It was represented by families; Ascidae, Macrochelidae, Uropodidae, Parasitidae, Ologamasidae, Uropodidae, Ameroseiidae and Laelapidae. Among their species, *Lasioseius aegypticus* Afifi (Blattisociidae) was the most abundant mesostigmatid species accounted for (150 individuals.). Mesostigmatid mites recorded their highest population numbers below the onion crops while their lowest populations were noted below broad bean. The high populations were recorded for *L. aegypticus* followed by *Macrocheles muscadomesticae* (Scopoli) for 112 individuals then *Parasitis sp* 90 individuals. Most mesostigmatid species occurred with their high numbers below onion plantations except for three species were absent, *Proctolaelaps orientalis* Naser, *Uroobovells* (Fuscuropoda) sp., while the mite species *Digamasellus presepum* Berlese, while *Digamasellus presepum* Berlese recorded their lowest population abundance in clover soil and wasn't collected from the soils of other sampled crops. The soil grown with various field crops had the highest numbers of soil predaceous mites, which may help control nematode and insect pests. Prostigamtids comprised 30.11 % of the total soil mites (El-Banhawy *et al*., 2006). A total of 595 specimens were found in soils of different field crops. Onion was recorded the highest population numbers for prostigmatid soil mites (220 individuals). Prostigmatid mites were dominated by *Pronematus rykei* (Baker) (106 individuals). These results contrasted with Abdel-Rahman *et al*., (2015) who found *Eupodes aegyptiacus* was the most dominant soil mite associated with Onion and Wheat at Qalubia Governorate. Its abundance was followed by *Cheyletus eruditus* (Shrank (75 individuals) below Clover plantations, then *Cheyletus malaccensis* Oudemans (64 individuals). On the other hand, *Leeuwenhoekia* was the least abundant associated only with wheat crops. (Table 1). Prostigmatids were represented by many species (18 species). Cryptostigmatid mites were represented by 4 species belonging to three families. *Oppia sticta* Popp was abundant soil mite species and its highest population recorded under clover plantations. The observation that oribatid mites predominate in soils with a high amount of organic matter was corroborated by Urhan *et al.* (2008) and other researchers. Several variables, including soil temperature, moisture content, rainfall, and, frequently, food quality and individual relationships, influence oribatid mite density (Zaki, 1992). Zaher and Mohamed (1980) and El-Kifl *et al.* (1974) noted them. Maraun and Scheu (2000) discovered that the diversity and identity of plants in the soil system did not affect cryptostigmatids. According to (Maraun *et al.* 2003), plant heterogeneity and richness quality led to the emergence of soil mites. Additionally, Clapperton *et al.* (2002) discovered a favorable correlation between soil mites and plant productivity, and consequently, the number of soil resources. Astigmata represented by two mite species; *Tyrophagus putrescentiae* (Schrank) and *Rhizoglyphus robini* Claparede which were collected from the selected field crops. Soils of clover crops aggregated the highest numbers of astigmatid mites where *T. putrescentiae* recorded its highest peak with it (181 individuals) while *R. robini* was absent from the soil of Onion crop. Wheat aggregated high density of astigmatid mites followed to clover plantations and expressed by 83 individuals. Romeih (2002) and Zaher (1986) all have findings that are comparable to ours. In terms of soil fauna, they discovered that actinedid mites were the most prevalent type. As per El-Banhawy (2002), and El-Banhawy *et al.* (2006), the quantity and existence of predacious mites are associated with soil types, organic matter levels, and growing plants. The biodiversity of the collected mites was compared using the Shannon-Wiener "H" and

Simpson "S" Indices of Diversity in Table (2). Among the field crops studied, mite richness varied, with the greatest documented mites found in clover cultivation. The soil used for clover cultivation has the greatest value (4.05), according to the Shannon-Wiener "H" Index, Table (2).

This suggested that the variety index of clover plants was higher. For every crop group, the values of other cultivations revealed a different species diversity index. This is consistent with Jiang *et al.* (2015). Because plant species affect the quality of resources that are returned to the soil, these findings suggested that they may be useful against soil mites (Walter and Proctor 2004). According to Andrén and Lagerlöf (1983), high organic matter content attracts some oribatid mites and encourages the growth of bacteria and fungi. Oribatid mites directly consume organic particles from the soil (Scheu and Falca 2000). By changing the type and amount of plant litter inputs on soil physical and chemical properties, the application of soil management techniques affects soil fauna populations. Cultivating the soil lowers the total density of soil mites (Hulsmann and Wolters, 1998) because the plant residue cover of uncultivated soils offers a readily available food source, and soil temperature moderates and decreases soil surface moisture (Koukoura *et al*., 2003 and Hussian *et al*., 2018). Because typical cropping practices destroy upper layers, expose them to desiccation, and interfere with their access to food sources, mite numbers can be decreased (Fox *et al.,* 1999).

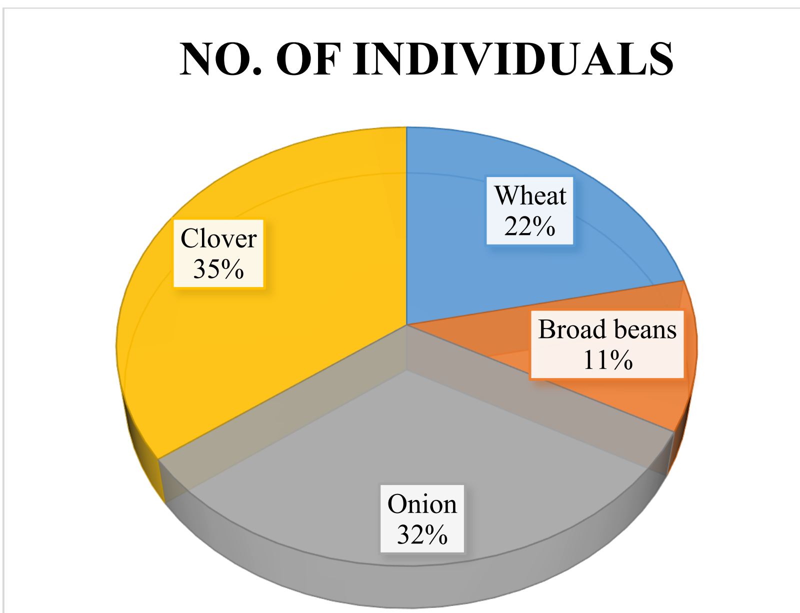

Fig. (1): Occurrence percentage (%) of soil mite species associated with some field crops at Ismailia Governorate during season 2022.

Table (1): Number of soil mites associated with some field crops at Ismailia Governorate during season 2022.

Family	Mite taxa	Wheat	Broad beans	Onion	Clover	Total
Oribatulidae	*Scheloribates zaheri*	15	27	22	66	130
	Zygoribatula sayedi	0	12	9	33	54
Oppiidae	*Oppia sticta*	10	21	29	70	130
Galumnidae	*Galumna sp.*	0	6	2	12	20
Eupodidae	*Eupodes aegyptiacus*	15	5	23	0	43
	Eupodes niloticus	0	17	10	0	27
Raphignathidae	*Raphignathus bakeri*	0	0	29	10	39
Cheyletidae	*Acaroppsellina sp.*	2	0	10	0	12
	Cheletonella caucasica	13	0	0	0	13
	Henicheyletia congensis	0	0	13	0	13
	Cheyletus eruditus	0	0	25	50	75
	Cheyletus malaccensis	25	2	15	22	64
	Ker bakeri	0	11	0	0	11
	Ker summersi	25	7	0	0	32
	Eutogenes africanus	0	12	0	0	12
Tydeidae	*Orthotydeus kochi*	0	17	0	0	17
	Pronematus rykei	27	0	33	46	106
Cunaxidae	*Cunaxa setirostris*	0	0	32	6	38
	Cunaxa capreolus	17	0	16	22	55
	Coleoscerius baptos	0	0	14	0	14
	Cunaxa nercruzanum	0	14	0	0	14
Trombidiidae	*Leeuwenhoekia sp.*	10	0	0	0	10
Acaridae	*Tyrophagus putrescentiae*	51	14	44	72	181
	Rhizoglyphus robini	32	20	0	55	107
Ameroseiidae	*Kleemania wahabi*	9	0	13	21	43
Ascidae	*Gamasellodes bicolor*	18	6	30	11	65
	Proctolaelaps orientalis	22	0	0	0	22
	Proctolaelaps. aegyptiacus	11	0	20	26	57
	Lasioseius aegypticus	35	5	51	59	150
Blattisociidae	*Blattisoeius keegani*	0	0	24	11	35
Macrochelidae	*Macrocheles muscadomesticae*	32	12	41	27	112
Uropodaidae	*Uroobovells (Fuscuropoda) sp.*	0	0	0	23	23
Ologamasidae	*Gamasiphis pulchellus*	18	0	28	33	79
	Digamasellus presepum	0	0	0	10	10
Parasitidae	*Pasasitis sp..*	0	2	83	5	90
laelapidae	*Androlaelaps casalis*	41	10	22	0	73
Total		428	220	638	690	1976

Table (2): Number of species, species diversity and evenness (EH) of soil mite community for some field crops at Ismailia Governorate.

	Habitats			
	Wheat	**Broad beans**	**Onion**	**Clover**
Number of species	20	19	25	22
Species diversity	1.65	2.21	1.63	2.39
Evenness (EH)	0.231	0.352	0.232	0.399

CONCLUSION

Thirty-six species of soil mites belonging to 34 genera and 20 families have been recorded, belonging to four suborders of soil mites: Mesostigmata, Prostigmata, Cryptostigmata, and Astigmata. 1976 soil mite individuals were collected from all sampled families. The suborder Mesostigmata was the most abundant mite group, while the lowest numbers of spiracles were recorded (288 individuals). Mites with moderate respiratory gap constitute 38.5% of the total mites identified

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التنوع الحيوي والتواجد لأكاروسات التربة المصاحبة لبعض المحاصيل الحقلية بمحافظة الإسماعيلية، مصر

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تهدف هذه الدراسة لتسليط الضوء على تواجد وإنتشار أكاروسات التربة في الأراضي المنزرعة بمحصول القمح والفول والبصل والبرسيم خلال شتاء 2022 بمحطة البحوث الزراعية بمحافظة الإسماعيلية. تم تسجيل ستة وثلاثون نوعًا من أكاروسات التربة تنتمي إلي 34 جنساً و 20 عائلة تتبع أربعة تحت رتبة من أكاروسات التربة هي Mesostigmata وProstigmata وCryptostigmata وAstigmata. تم جمع 1976 فرداً من أكاروسات التربة من جميع العوائل التي تم أخذ العينات منها. كانت تحت رتبة Mesostigmata هي مجموعة الحلم الأكثر وفرة، في حين تم تسجيل أقل الأعداد من الاكاروسات عديمة الثغر التنفسي (288 فردًا). تشكل الاكاروسات ذات الثغر التنفسي المتوسط 38.5% من إجمالي الاكاروسات التي تم تعريفها. لوحظ وفرة وتنوع أكاروسات في التربة المنزرعة بالبرسيم مقارنة بمحصول الفول الذي يحتوي على أقل عدد من أفراد الأكاروسات. في حقول المحاصيل التي تم فحصها، كانت قيم مؤشر التنوع أقل بعد الحصاد، ربما بسبب اضطراب التربة بواسطة الآلات الزراعية. وكان هناك اختلاف كبير بين المحاصيل المختلفة. حيث بلغ مؤشر التنوع (3.2) في حقل البصل و (1.4) في حقل القمح.