Factors Affecting Abundance and Diversity of Some Soil Mites (Acari) in Different Soil Types in Ismailia Governorate, Egypt

Hamed, N. A.*, A. H. AbouGhalia, M. E. El-Naggar*, H. M. El-Sharabasy*****
* Plant protection insitute, Agriculture research center, Dokki, El-Giza, Egypt.
** Zoology Department, Faculty of Science, Suez Canal University, 41522 Ismailia, Egypt
*** Plant protection Department, Faculty of Agriculture, Suez Canal University, 41522 Ismailia, Egypt.

***Received:** 6/6/2011*

Abstract: Factors affecting the abundance and Diversity of soil mites in Ismailia Governorate were studied during twelve successive months from October 2008 to September 2009. It was carried out in four different localities cultivated with mango trees at three different depths. Results showed that there were 35609 individuals of soil Acari belong to four suborders were obtained; Oribatida, Actinedida, Gamasida, Acaridida. Oribatid mites obviously constituted the highest percentage of the total mite fauna, constituted about 40 % in the four soil types. The highest mean abundance of soil mite species were recorded in April (125.9 ± 22.7), while the lowest abundance was recorded in September (58.7 ± 4.0). The highest mean abundance recorded in litter was (112.8 ± 10.1) while, the abundance of soil mites recorded in the soil depth 0-10 cm was (79.9± 4.1) higher than their mean abundance in other soil depth 10-20 cm (54.6± 2.9).

***Keywords:** Soil mites, abundance, soil types, Seasonal variation, Ismailia.

INTRODUCTION

Soil mites (Acari) are the most abundant soil microarthropods (Badejo, 1990). They exist in all soil types with high species richness, abundance and diversity. Soil mites play a very important role in nutrient cycling by increasing the rate of litter break down and mixing breakdown products with organic matter in the soil (Usher, 1971). They are often used as significant indicators of soil quality and soil health. Population abundance of mites in soil varies in relation to various environmental factors like temperature, moisture, organic matter, nutrient availability, etc (Tousignant and Coderre 1992).

The complex physical and chemical nature of soil, with a porosity structure, immense surface area, and extremely variable apply of organic materials, food, water and chemicals mean that various animals, plants and microbial world can co-exist simultaneously are find appropriate niches for their development. This provides suitable habitats for a multitude of fauna and flora ranging from macro, micro- levels depending on climate, vegetation and physical & chemical characteristics of the given soil. The species numbers, composition and diversity of a given soil depend on many factors including aeration, temperature, acidity, moisture, nutrient contents and organic substrate.

There are studies on the distribution and abundance of soil mites in different habitats (Leetham and Milchunas 1985; Perdue and Crossley 1990; Banerjee *et al.*, 2009). In Egypt, several studies have been conducted to study the distribution and abundance of mites inhabiting different soil types at different locations (El-Kifl *et al.*, 1974; Zaher and Mohamed 1980; Hassan *et al.*, 1986; Zaki 1992; Kandeel 1993; El-Kady and Bahgat 2000; El-Sharabasy et al., 2008 and El-Sharabasy 2010). Therefore, the goal of the present study is investigate the distribution and abundance of soil mites affecting by some biotic and abiotic factors.

MATERIAL AND METHODS

Study area

The present work was conducted over a period of twelve successive months from October 2008 to September 2009. It was carried out in four different sites cultivated with mango trees in Ismailia Governorate. Site one: the Experimental Farm of Faculty of Agriculture, Suez Canal University (sandy loamy soil), Site two; Abou-Atwa village (sandy loamy soil), Site three: Ein-Ghosien village (sandy clay loamy soil) and Site four: Nefisha village (sandy clay loamy soil).

Soil sampling

Three random samples of litter layer and soil with two depths (0-10 cm and 10-20 cm) in each site were collected. Soil samples were collected by using a sampling soil core. Nine soil cores were taken in each plot in each site, and a total of thirty-six were collected monthly from all sites with a total of 432 soil samples. Each stratum weighed up to 500 g and put in a special naylon bag, labeled and transferred to the laboratory. Soil samples were put in Tullgren funnels for at least 24 hours to complete mite's extraction. The collected mites were examined by an ordinary binocular stereomicroscope and mounted in Hoyer's medium. Mites were identified according to Krantz (1978) and Zaher (1986).

Soil analysis

Determination of Electrical Conductivity (EC), pH, soluble anions and other cations and organic matter content (OM) in about 5g soil taken from each site were analyzed according to (Richard, 1954 and Jackson, 1958). Heavy metals (Cd, Cu, Pb and Ni) were analyzed by the total adsorbed metals (5 gm soil from each sample was digested with 25 ml DTPA), using Inductively Coupled Spectrometry Plasma (ICP), model 2- Jobin Yvonne.

Statistical analysis

The community structure of soil mites were analyzed using abundance as mean ±SE. One way ANOVA and Duncan's multiple tests were used to analyze the differences between abundance of mite groups and soil types. All statistical tests were performed by using the software packages SPSS 12.0.0 (USA).

RESULTS AND DISCUSSION

Soil analysis

Physical and chemical properties and heavy metal determination of the soil under investigation were showed in Table1. Data indicated that the soil pH values ranged between 7.2 and 7.7 while electric conductivity (EC) ranged between 0.82 and 1.23 dSm^{-1}. The mean values of organic matter (OM) percentage ranged between 1.93 and 2.4 %. Low organic matter content may be due to that no organic manures were receiving, and it has influence on soil properties and having significant effects on soil fertility. On the other hand, saturation percentage (SP) ranged between 10 % and 22 %.

With regard to heavy metals determination (Cd, Cu, Pb and Ni), data showed that heavy metals recorded in moderate concentrations in the soil (Table 1). While the maximum acceptable concentration of cadmium in soils is 5 m kg^{-1}, the cadmium content varied from 0.023 to 4.59 m kg^{-1}. The mean value for copper ranged between 0.19 and 11.24 m kg^{-1} within all investigated sites. Lead content not exceeds the maximum acceptable concentration in uncontaminated soil in Egypt (Aboulroos *et al.* 1996) in sites 1 and 3, the mean values ranged between 0.02 and 2.89 m kg^{-1}. In general, all heavy metals levels at all studied sites are relatively high in sites 2 and 4, and are also considerably higher than the other levels recorded in Egypt by Aboulroos *et al.* (1996).

Abundance and community structure:

During sampling in the four study sites, 35609 individuals of soil mites belong to four souborders were obtained; Oribatida, Actinedida, Gamasida, Acaridida. However, the Oribatid mites obviously constituted the highest percentage of the total mite fauna, constituted 40 % in the four soil types. Acaridid mites were much less in their number were constituted 9.5 % of the total soil mites. Both Actinedida and Gamasida composed a smaller fraction than oribatid mites (Table 3). EL-Kifl (1957) reported that the soil mites in a cultivated land in Giza made up a largest fraction of the total arthropods, especially in clay loams soils. Abou Korah *et al.*, (1985), found that Astigmata came the first followed by Cryptostigmata, while Mesostigmata and Prostigmata were the last two groups in okra field.

Soil mites abundance was significantly highest in site 3 ($P<0.05$). The highest percentage of oribatid mites were 41.4 % in the site 3 soil and it was (4643 ind. /500 g soil) in the site 1 , which representing 55.5 % of total soil mites but their lowest population was (1945 ind. /500 g soil) observed in site 4. There was a significant difference in mean abundance of oribatids among different types of soil ($P < 0.05$; $F=13.58$). Their mean total abundance of soil oribatid mites were significantly higher in site 3 (50.9 ± 5.1) compared to site 4 soil (18.0 ± 0.9) ($P< 0.05$) (Table 4).

Actinedid mites were constituted 30.2 % of the total soil mite and the mean population was significantly higher in site 3 (35.2 ± 4.9) in compared to site 4 (17.9 ± 1.5) ($P<0.05$). Gamasid mites were the lowest population (1025 individuals) in site 1. On the other hand, Acaridida constituted the lowest value among soil mite's groups, representing 8.8 % of the total soil mites. Their mean abundance was significantly higher in site 3 soil (14.6 ± 2.6) ($P<0.03$) than site 1 soil (1.9 ± 0.1). The low diversity of soil mites might be due to the chemical composition and physical analysis of the soil that can influence on the abundance and diversity of soil mites (El-Sharabasy et al., 2008).

Monthly variation:

Temperature and relative humidity were the most important factors regulating of microarthropod abundance and diversity (Noble *et al.* 1996). Results showed that abundance of soil mites varied significantly from month to month in different soil types (Table 2). In general, the highest mean abundance was recorded in April 2009 (125.9 ± 22.7) while, the lowest abundance was recorded in September 2009 (58.7 ± 4.0), ($P<.005$, $F=2.72$). In site 3, it constituted the largest fraction of soil mites was (263.8 ± 86.9) during February 2009 but decreased to the lowest value (39.4 ± 3.2) during June 2009. While in site 4 soil, the lowest mean of soil mites was (29.7 ± 1.6) during November 2008 then it increased to (71.9 ± 3.2) during July 2009. In site 1, the maximum mean abundance of them was 191.7 ± 43.0 during April but it decreased minimally to (39.4 ± 3.2) during August 2009. But, in site 2, their mean abundance was low during November 2008 (39.1 ± 2.4) and increased to (136.0 ± 53.0) during July 2009. There was significant effects of monthly variation on mean total abundance of soil mites in site 1, ($P<0.000$, $F= 6.13$). This agrees with the finding of El-Sharabasy (2010) who found that the highest population density was recorded in December – February in both litter and soil, while the lowest density was recorded in May – July in soil. El-Kifl *et al.*, (1974) found that oribatid mites tended to decrease during the summer months and to increase during spring and autumn. They found also that the maximal monthly of oribatids were noticed in September, while the minimal means were noticed in June.

Mahmoud (1999) found that the highest population density of soil mites was recorded during spring and autumn while the lowest one was occurred during summer and winter. Also, El-Kady and Bahgat (2000) found that the highest abundance of soil mites in North Sinai was recorded during winter months, while the lowest population was during summer months.

Soil depth:

From data obtained on the vertical distribution of soil mites (Table 3) , it could be noticed that in the four soil types, mites could found were more dominating in litter in sites 2, 3 and 4 (109.9 ± 14.5, 213.5 ± 31.2

Table (1): Soil properties and heavy metals analysis of the soil in the different studied sites.

Site	pH	SP%	EC	OM	Analysis of the soil extract							Size fraction			Texture	Heavy metal analysis			
					Anions			Cations											
					Hco_3^{-2}	Cl^-	So_4^{-2}	Ca^{+2}	Mg^{+2}	Na^+	K^+	Sand	Silt	Clay		Cd	Cu	Pb	Ni
1	7.20	18.00	0.82	1.93	6.00	1.60	0.61	4.40	2.20	0.59	1.02	81.00	1.00	18.00	SL	0.023	0.19	0.5	0.07
2	7.68	21.00	1.02	2.20	7.60	1.60	0.92	5.00	3.00	0.14	1.74	43.00	38.00	19.00	SL	2.91	2.62	1.76	1.52
3	7.79	22.00	1.23	2.40	5.60	1.40	5.34	7.00	4.00	0.34	1.00	68.50	7.50	26.00	SCL	0.2	0.25	0.02	0.72
4	7.53	10.00	1.01	2.10	7.00	1.20	1.90	6.20	2.90	1.00	1.20	66.00	7.50	24.00	SCL	4.59	11.24	2.89	1.89
Uncontaminated soil																0.014	1.86	1.17	1.56

EC = Electrical conductivity, SP = Saturation percent, OM= Organic matter, SL = Sandy loamy
SCL = Sandy clay loamy

Table (2): Monthly variations of mean abundance (M ±SE) of soil mite suborders in the four studied soil types from October 2008 to September 2009.

Sites	Soil mites	Months											
		Oct. 2008	Nov.	Dec.	Jan. 2009	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.
1	Oribatida	26.1 ±3.8	24.7 ±5.3	62.8 ±15.9	57.2 ±6.9	14.8 ±3.8	56.4 ±2.6	112.5 ±7.8	55.0 ±8.8	42.3 ±9.1	24.8±3.9	14.3±1.3	24.7 ±3.1
	Actinedida	11.3 ±1.7	28.0 ±8.0	13.3 ±2.1	19.2 ±2.7	62.4 ±6.9	24.0 ±4.9	54.4 ±3.8	14.5 ±7.9	13.5 ±5.6	11.3±2.0	14.2±2.1	15.7 ±2.5
	Gamasida	5.1 ±0.8	6.6 ±1.0	7.2 ±1.0	10.7 ±2.6	8.1 ±2.0	3.5 ±0.3	12.4 ±2.7	13.5 ±1.9	19.5 ±3.2	11.0±2.6	8.5 ±1.1	7.8 ±1.1
	Acaridida	1.7 ±0.5	0.9 ±0.3	1.3 ±0.5	0.6 ±0.3	2.1 ±0.5	2.9 ±0.6	4.0 ±1.2	0.9 ±0.4	1.5 ±0.6	2.2 ±0.4	1.5 ±0.5	3.3 ±0.6
2	Oribatida	15.9 ±3.1	13.8 ±1.5	15.8 ±1.7	20.7 ±2.8	25.5 ±2.8	32.1 ±2.1	14.9 ±1.9	26.2 ±3.4	19.5 ±3.1	101.9±44.3	49.1±6.6	14.0 ±2.0
	Actinedida	22.0 ±3.3	13.0 ±1.6	18.7 ±3.0	22.9 ±3.5	9.9 ±1.5	11.0 ±1.6	12.0 ±2.6	27.9 ±7.5	75.7 ±2.0	8.6 ±1.7	33.4 ±	10.0 ±1.8
	Gamasida	13.5 ±2.2	9.0 ±0.9	12.7 ±1.8	17.8 ±2.5	13.9 ±1.2	11.2 ±0.8	14.0 ±2.7	17.7 ±3.9	6.0 ±1.4	21.1 ±6.6	14.6 ±2.4	11.0 ±1.7
	Acaridida	5.0 ±1.2	3.9 ±0.7	11.5 ±2.9	9.0 ±1.9	12.5 ±3.0	20.6 ±4.5	7.7 ±3.9	5.9 ±1.4	3.3 ±1.0	4.2 ±0.9	2.7 ±0.7	6.0 ±1.6
3	Oribatida	63.3 ±15.6	101.7±24.3	16.7 ±4.7	12.2 ±1.5	105.0±35.6	67.0 ±13.7	56.8 ±15.1	24.9 ±3.1	15.2 ±4.3	58.8 ±13.6	34.2 ±3.8	55.4 ±6.9
	Actinedida	8.0 ±1.7	11.4 ±3.9	42.2 ±10.3	58.3 ±8.8	80.5 ±30.8	58.5 ±20.0	85.5 ±34.5	25.4 ±4.2	12.4 ±2.6	18.2 ±4.1	9.3 ±1.6	13.7 ±2.5
	Gamasida	23.5±5.3	43.9±12.9	8.5±1.3	14.0±4.3	41.0±7.0	18.0±3.0	20.3±9.3	14.2±3.2	7.5±1.8	42.8±11.8	16.3±2.9	14.5±1.8
	Acaridida	19.9±8.0	19.7±7.7	3.4±0.8	1.7±0.6	38.7±17.9	31.2±11.5	36.2±16.2	4.7±1.4	12.9±4.8	3.5±0.9	2.8±0.5	2.7±0.7
4	Oribatida	12.5±1.5	12.3 ±1.3	28.7±3.1	12.9±1.3	15.3±1.0	33.0±3.3	14.8±2.5	10.5±1.7	26.9±3.7	17.5±2.8	18.7±2.1	13.9±1.4
	Actinedida	12.4±2.3	10.2±1.1	12.9±1.8	14.5±2.0	11.9±1.5	14.3±1.4	37.±10.6	45.5±8.8	12.2±2.0	13.3±1.7	14.5±1.9	16.5±2.3
	Gamasida	7.3±1.2	5.0±1.0	12.3±2.1	9.4 ±1.9	11.5 ±2.8	16.0 ±2.5	11.1±1.9	12.1±1.6	15.4±1.6	32.0±6.2	23.1±4.6	22.1±0.6
	Acaridida	3.9 ±0.7	2.4 ±0.6	5.6 ±0.9	8.5 ±1.9	9.2 ±1.6	5.4 ±1.5	5.5 ±1.5	4.0±1.1	7.0 ±2.6	4.1 ±0.9	1.3±0.4	2.7 ±0.6

Table (3): Mean abundance (M ± SE) of soil mites in relation to soil depth in the four studied soil types.

Sites	Soil mites	Depth		
		Litter	0 -10 cm	10 -20cm
1	Oribatida	11.9 ± 1.2	63.7 ± 8.1	53.4 ± 6.9
	Actinedida	30.5 ± 6.3	25.0 ± 5.6	15.0 ± 3.3
	Gamasida	10.9 ± 1.1	11.1 ± 1.2	6.5 ± 0.8
	Acaridida	2.0 ± 0.4	2.1 ± 0.3	1.6 ± 0.2
	Total	55.3 6.8	101.9 12.5	76.5 9.2
2	Oribatida	44.2 ± 12.1	26.4 ± 2.8	16.9 ± 1.2
	Actinedida	28.9 ± 6.5	27.1 ± 4.7	12.1 ± 2.0
	Gamasida	16.2 ± 1.7	15.5 ± 1.4	8.7 ± 0.8
	Acaridida	7.0 ± 1.0	9.2 ± 1.4	6.7 ± 1.5
	Total	96.3 4.5	78.2 4.3	44.4 2.6
3	Oribatida	81.7 ± 13.0	42.9 ± 3.8	28.1 ± 3.3
	Actinedida	50.2 ± 11.3	37.8 ± 8.4	17.9 ± 3.0
	Gamasida	23.4 ± 3.7	25.7 ± 4.0	17.2 ± 2.8
	Acaridida	24.7 ± 6.0	16.5 ± 4.6	2.7 ± 0.4
	Total	180 3.2	122.9 8.3	65.9 4.6
4	Oribatida	13.4 ± 1.2	22.9 ± 1.8	17.7 ± 1.1
	Actinedida	22.7 ± 3.4	19.7 ± 2.7	11.5 ± 1.0
	Gamasida	16.4 ± 1.9	14.4 ± 1.2	13.6 ± 2.1
	Acaridida	5.0 ± 0.6	5.8 ± 0.7	3.9 ± 0.8
	Total	57.5	62.8	46.7

and 63.9 ± 3.1 , respectively) except in site 1, their mean abundance decreased to (64.0 ± 6.8), while the layer between (0 – 10 cm) below the soil surface contained a small proportion of mites. The third layer (10 -20 cm) below the soil surface contained the smaller magnitude of soil mites. Results showed that abundance of soil mites varied significantly from litter and other soil depths in different soil types. The highest mean abundance recorded in litter was (112.8 ± 10.1) while, the abundance of soil mites recorded in the soil depth (0-10 cm) was (79.9± 4.1) higher than their mean abundance in other soil depth (10-20 cm) (54.6± 2.9), ($P<0.05$, $F=19.91$). There were significant effects of soil depth on mean abundance of mites in three soil types. The highest population number of soil mites was found in the litter layer and soil surface (El-Kifl *et al.*, 1974, Jing *et al.*, 1999), where these layers contained higher proportion of nutritional materials in addition to proper soil particles as clay and silt.

In general, it is very hard to explain the seasonal fluctuations in soil mites. The distribution is affected by two factors which are classified into direct and indirect. The direct ones are the environmental factors (air, soil temperature, soil moisture and rainfall) and soil quality, while the indirect factors are those corresponding to choice of microhabitat, food and the relation between individuals (Zaki, 1992).

ACKNOWLEDGEMENTS

The authors are grateful to Dr Ahmed Ibrahim, Soil and Water Department, Faculty of Agriculture, Suez Canal University for soil analysis.

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العوامل المؤثرة علي تعداد وتنوع بعض أكاروسات التربة في أنواع مختلفة من التربة في محافظة الاسماعيلية، مصر

نيفين حامد*- أحمد أبو غالية**- محمود النجار*- حمدي الشرباصي***
* معهد بحوث وقاية النبات ، مركز البحوث الزراعية – دقي – جيزة
**قسم الحيوان – كلية العلوم - جامعة قناة السويس الاسماعيلية- مصر
*** قسم وقاية النبات – كلية الزراعة – جامعة قناة السويس- الاسماعيلية- مصر

تمت دراسة العوامل التي تؤثر علي توزيع وتنوع أكاروسات التربة في محافظة الاسماعيلية وذلك خلال عام كامل. تمت الدراسة في مناطق مختلفة منزرعة بأشجار المانجو وذلك علي أعماق مختلفة من التربة. أشارت النتائج إلي وجود ٣٥٦٠٩ فرد من الاكاروسات تتبع تحت رتبة امامية الثغر لالتنفسي ، متوسطة الثغر التنفسي ، عديمة الثغر التنفسي و خافية الثغر التنفسي. أوضحت النتائج أن تحت رتبة أوريباتيدا شكلت أعلي نسبة تعداد بين انواع اكاروسات التربة التي تم تسجسلها (٤٠ % من التعداد الكلي) . بالنسبة للاختلافات الشهرية فقد تم تسجيل أعلي تعداد خلال شهر أبريل (22.7 ± 125.9) بينما أقل تعداد فقد تم تسجيله خلال شهر سبتمبر (4.0 ± 58.7) . كما أظهرت النتائج أيضا أن المخلفات وسطح التربة كانت تحتوص علي أعلي تعداد من الاكاروسات (10.1 ± 112.8) بينما اقل تعداد تم تسجيله علي عمق من صفر – ٢٠سم (2.9 ±54.6).