Occurrence of Soil Mites in Relation to Soil Analysis at Sharkia Governorate

H. M. G. El-Kawas*; Hala M. Mead* and H. M. El-Sharabasy**

*Plant Protection Research Institute, A.R.C., Dokki, Giza, Egypt, (hmg731@yahoo.com)

** Plant Protection Dept., Faculty of Agric., Suez Canal Univ., Ismalia, Egypt

ABSTRACT

This investigation was carried out to throw light on the occurrence and distribution of mites inhabiting soil planted with onion and garlic plants during the season 2009-2010 at Sharkia Governorate. Twenty three species belonging to four suborders were collected. Actinedida was represented by six families, Gamasida (5 families), Oribatida (3 families) and Acaridida (one family). Results cleared that Actinedida and Oribatida were the most dominant in onion and garlic soils, contributing by 35.16 and 41.38 % of total mites, respectively. Furthermore, December seemed to be the most numerical compared with other tested months. Data also, demonstrated that soil mites diversity was positively related to both organic matter and N^+.

Key Words: Soil mites, Occurrence, Diversity, Onion, Garlic, Soil analysis.

INTRODUCTION

Onion, *Allium cepa* L. and garlic, *Allium sativum* L. are main crops in Egypt for local consumption and exportation.

Soil is an important component for monitoring sustainability of land use in relation to the conservation of natural resources, biodiversity of ecosystems and biosphere processes.

Mites are one of the most abundant members of soil arthropods (95 %) of all individuals (Behan *et al.*, 1978 and Seastedt, 1984). Their importance for soil fertility is well established (Crossley, 1977 and Heneghan *et al.*, 1998). Also, mites affect soil decomposition by feeding on microbes and debris, as predators, omnivores, and plant feeders (Kethley, 1990 and Walter & Proctor, 1999). Soil mites are often used as significant indicators of soil quality and soil health (Valerie, 1999 and Ruf *et al.*, 2003). Population abundance of mites in soil vary according to various environmental factors (Sanyal & Bhaduri, 1982 and Tousignant & Coderre, 1992).

Thus, the objective of this study aimed to throw lights on soil mites inhabiting soils of the two crops; onion and garlic at Sharkia Governorate. Monthly fluctuations of soil mites were also investigated. Moreover, the relationship between the abundance of soil mites and some physical and chemical properties of soil planted with onion and garlic plants were investigated.

MATERIALS AND METHODS

Sampling:

The present study was carried out on onion, *A. cepa* and garlic, *A. sativum* fields at Zagazig district, Sharkia Governorate during 2009- 2010 season. Soil samples were weekly taken (December 2009 to March 2010) from the top soil layer (0-20 cm.) using a steel core for sampling (5 cm diameter). Soil mites were extracted using Tullgren funnels. Identification was carried out according to Krantz (1979) and Zaher (1986).

Data analysis:

The community structure of soil mites was analyzed using abundance and dominance percentages. Species diversity was expressed by the Shannon-Wienner Index (H') and the evenness (J') was calculated by Pielous (J') according to Pielou (1984):

$$H' = - \sum_{i=1}^{s} (p_i \ln p_i)$$

J' = H' / ln s

S, the first species;

P, the proportion of first species.

Soil analysis:

Organic matter content, pH and soluble cations (N^+, P^+, K^+ and Ca^{++}) in about 5 gm soil taken from the study area were analyzed according to Richard (1954) and Page *et al.*, (1982).

RESULTS AND DISCUSSION

The total identified individuals of soil mites represented by four suborders; Gamasida, Actinedida, Acaridida, and Oribatida extracted from soil samples cultivated by onion and garlic plants were presented in Table (1).

Gamasida: A total number of 32 and 38 mite individuals were recorded in soil samples for onion and garlic, respectively. However, family Laelapidae was represented by the highest number of species (3 species) in garlic soil, rhodacarid mites were the most abundant number recorded 20 individuals representing 52.63%. While, Ascidae was the most numerous family representing the highest number of

Table (1): Abundance and dominant of soil mite suborders inhabiting onion and garlic soils during 2009-2010 season at Sharkia Governorate

Suborders	Abundance		Dominance %	
	Onion	Garlic	Onion	Garlic
Gamasida	32	38	25.00	32.76
Actinedida	45	26	35.16	22.41
Acaridida	13	4	10.16	3.45
Oribatida	38	48	29.69	41.38
Total individuals	128	116		

mites (14 individuals) inhabiting onion soil recording 43.75 % dominance; Uropodidae was the least dominant one in the soil of both crops that recorded zero and 2.63 %, respectively (Table 2).

Actinedida recorded the largest number of families (six families). Pygmephoridae recorded the highest dominance percentages of mite individuals in the two tested crops, onion and garlic compared to other families (93.33 and 65.38 %), respectively, by the presence of *Pygmephorus zeai* Yousef & Kandeel. On the other hand, Tarsonemidae and Siteroptidae were the least dominant families in onion soil, whereas, Eupodidae was the least one in garlic soil, recording zero individual (Table 2).

Acaridida was the least recorded suborder which represented by only one family (Acaridae) having two species. *Rhizoglyphus robini* Claparede was 12 and 3 individuals, and 92.31 and 75.00%, dominance in soil cultivated by onion and garlic, respectively, while the second species, *Tyrophagous putrescentia* (Schrank) was 7.69 and 25.00% dominance (Table 2).

Oribatida was represented by three families. Oribatullidae was the most dominate family recording 42.11 and 47.92 % in onion and garlic soils, respectively. *Zygoribatula tritici* El-Badry & Nasr was the most dominant species in soil of both crops recording 34.21 and 41.67%, respectively. In the contrary, *Oppia bayoumii* Shereef & Zaher and *Oppiella egyptiaca* El-Badry & Nasr were the least recorded species in onion and garlic plants (Table 2).

Generally, suborders Actinedida and Oribatida were the most dominant recording 35.16 and 41.38 % of the total mites extracted from soil cultivated by onion and garlic, respectively. The least category was obtained by Acaridida which recorded 10.16 and 3.45 % of the total mites, respectively. *P. zeai* was the most abundant species extracted from onion soil (42 individuals), while *R. roseus*; *Z. tritici* and *Phthiracarus* sp. were the most abundant species that recorded the same value (20 individuals) in garlic soil (Table 2).

Data in Tables (3 & 4) revealed that the number of soil mites inhabiting garlic soil was more than that recorded in onion soil represented by 19 and 16 species, respectively. The diversity of soil mites expressed by Shannon index (H'), while richness by Evenness (J'), in soil grown with garlic recording 2.38 and 0.809, respectively, were higher than those obtained with onion soil, 2.23 and 0.802, respectively. In despite of the number of soil mite suborders observed at onion and garlic soil gave the same value (four suborders), the total mite individuals recorded in onion soil (128 individuals) was more than in garlic soil (116 individuals) resulting the increase in diversity and Evenness (1.34 and 0.964, respectively), in the case of onion than in garlic soil (1.2 and 0.863, respectively), (Table 4).

As a general trend, both diversity and Evenness were positively correlated with number of mite species.

Monthly density of mites inhabiting with soil of onion and garlic plants:

Results in Figures (A & B) show the distribution of four major mite suborders inhabiting soils of onion and garlic plants from December 2009 till March 2010. Monthly density of different mite groups in onion soil varied irregularly (Fig. A). The highest populations were recorded in December and January for Actinedida (19 individuals/500 gm soil) and Acaridida (5 ind./500 gm soil), respectively, while it was minimum in March (1 and zero ind./500 gm soil respectively).

On the other hand, Oribatida and Gamasida were more abundant during March (18 ind. / 500 gm soil) and February (16 ind. / 500 gm soil), respectively. Whereas, the lowest numbers were observed in January (3 ind./500gm soil) and February (2 ind./500 gm soil), respectively.

The maximum numbers of Oribatida, Actinedida and Gamasida that extracted from garlic soil were observed in December recorded 19, 18, and 13 individuals / 500 gm soil, respectively, followed by gradual decrease in population till reaching its minimum in March (3, 4 and zero ind./500 gm soil, respectively). While Acaridida recorded (2, zero, 1 and 1 ind./500 gm soil) on December, January, February and March, respectively (Fig. B).

Soil analysis:

Properties of soils cultivated by onion and garlic plants were shown in Table (5). Organic matter % was lower in onion soil recorded 0.62%, where it was 0.65% in garlic soil. In contrary, values of pH recorded 7.53 and 7.34 for onion and garlic, respectively.

As the values of cations Ca^{++} and K^{+} were increased in onion soil than in garlic soil which recorded 99.30 & 72.00 µg/gm soil and 20.93 & 61.00 µg/gm soil, respectively. Meanwhile, N^{+} and

Table (2): Abundance and dominance of soil mite species associated with onion and garlic plants during 2009-2010 season

Sub. order	Species	Abundance		Dominance (%)	
		Onion	Garlic	Onion	Garlic
Gamasida	Parasitidae Oudemans				
	Parasitis sp.	0	5	0	13.16
	Rhodacaridae Oudemans				
	Rhodacarus roseus Oudemans	13	20	40.63	52.63
	Ascidae Voigts & Oudemans				
	Gamasellodes sp.	4	0	12.5	0
	Protogamasellus denticus Nasr	10	5	31.25	13.16
	Laelapidae Berlese				
	Androlaelaps sp.	4	4	12.5	10.53
	Hypoaspis baloghi Shreef & Afifi	1	2	3.13	5.26
	H. arabicus Hafez, El-Badry & Nasr	0	1	0	2.63
	Uropodidae Berlese				
	Urodiaspis aegypticus Ahmed	0	1	0	2.63
Actinedida	Eupodidae Koch				
	Eupodes Koch	1	0	2.22	0
	Cunaxidae Thor				
	Cunaxa capreolus (Bereles)	1	0	2.22	0
	Pseudocunaxa simplex (Ewing)	0	2	0	7.69
	Stigmaeidae Oudemans				
	Agistemus exsertus Gonzalez	1	3	2.22	11.54
	Siteroptidae Mahunka				
	Siteroptes sp.	0	1	0	3.85
	Pygmephoridae Cross				
	Pygmephorus zeai Yousef & Kandeel	42	17	93.33	65.38
	Tarsonemidae Kramer				
	Stenotarsonemus sayedi Zaher & Kandeel	0	3	0	11.54
Acaridida	Acaridae Leach				
	Rhizoglyphus robini Claparede	12	3	92.31	75.00
	Tyrophagous putrescentiae (Schrank)	1	1	7.69	25.00
Oribatida	Oppiidae Grandjean				
	Oppia bayoumii Shereef & Zaher	0	4	0	8.33
	O. sticta Popp	5	1	13.16	2.08
	Oppiella egyptiaca El-Badry & Nasr	9	0	23.68	0
	Oribatulidae Thor				
	Zygoribatula tritici El-Badry & Nasr	13	20	34.21	41.67
	Scheloribates zaheri Yousef & Nasr	3	3	7.89	6.25
	Phthiracaridae Perty				
	Phthiracarus sp.	8	20	21.05	41.67

Table (3): Number of species (S), species diversity (Shannon index, H') and evenness (J') of soil mite communities under different habitats

	Habitats	
	Onion	Garlic
Number of species (S)	16	19
Shannon index (H')	2.23	2.38
Evenness (J')	0.802	0.809

Table (4): Number of suborders, species diversity (Shannon index H') and Evenness (J') of soil mites under different habitats

	Habitats	
	Onion	Garlic
Number of mite suborders	4	4
Shannon index (H')	1.34	1.20
Evenness (J')	0.964	0.863

Table (5): Soil properties of both onion and garlic plants at Zagazig district, Sharkia Governorate

Characteristic	Soil	
	Onion	Garlic
Organic matter, %	0.62	0.65
pH	7.53	7.34
Ca^{++} (µg/gm soil)	99.30	20.93
N^{+} (µg/gm soil)	82.60	90.60
P^{+} (µg/gm soil)	1.06	1.55
K^{+} (µEq × 10^{3}/gm soil)	72.00	61.00

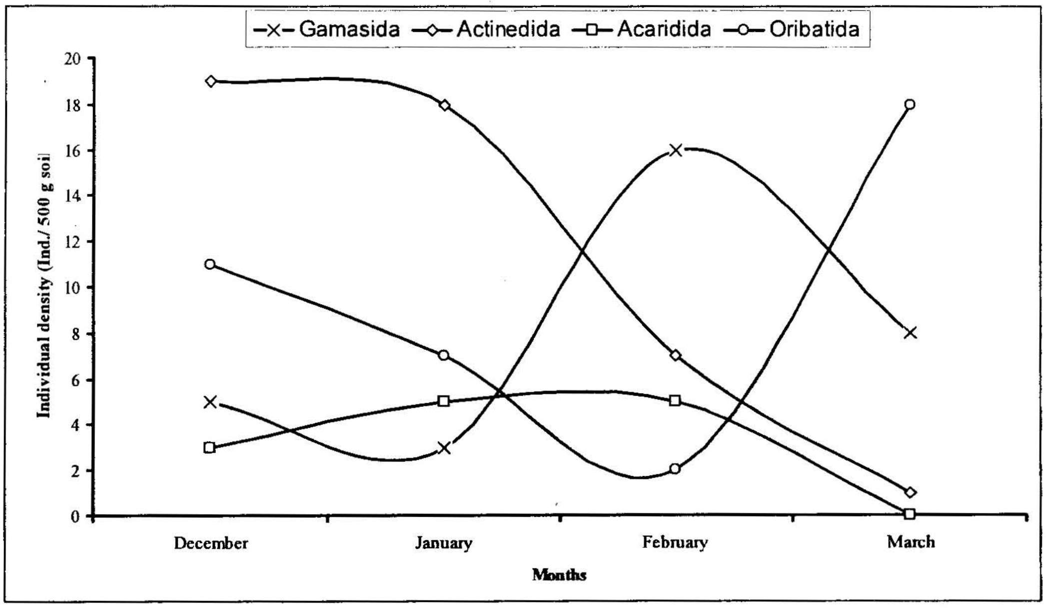

Fig. (A): Monthly density of soil mites inhabiting onion plants during December 2009 - March 2010.

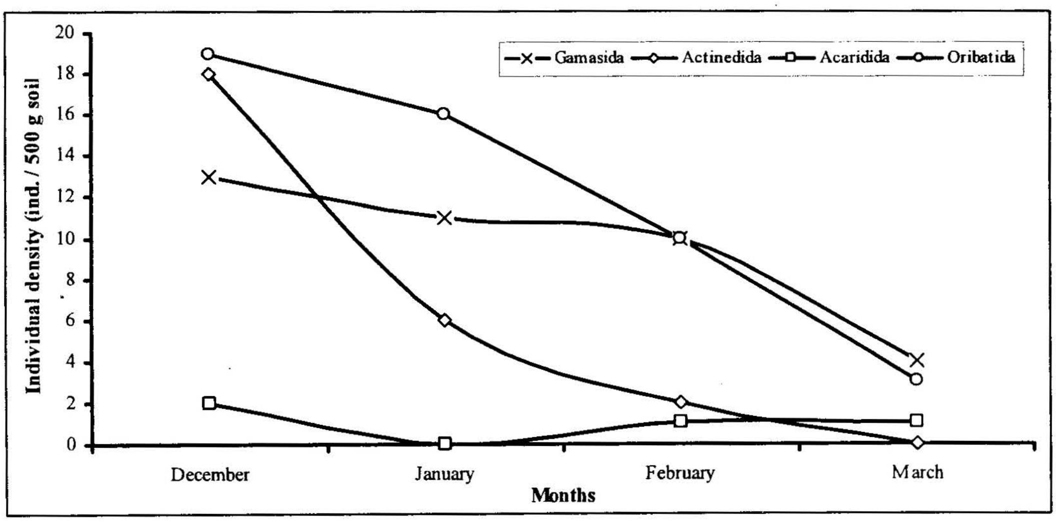

Fig. (B): Monthly density of soil mites inhabiting garlic plants during December 2009 - March 2010.

P^+ recorded 82.60 & 90.60 μg/gm soil and 1.06 & 1.55 μg/gm soil for onion and garlic, respectively.

Twenty three species belonging to 15 families and four suborders were identified in soil grown with onion and garlic. Similar results was obtained by Abd El-Halim (1998) who recorded 18 mite species belonging to 14 families and four suborders associated with three onion varieties. He added that Actinedida was the richest one. Also, El-Sharabasy *et al.*, (2008) collected soil mite species from different orchards being, Actinedida and Oribatida were the most dominant in onion and garlic soils, respectively. Among mite suborders occurred in soils, Krantz (1979) found that Oribatida was the most abundant. The difference in soil mite species and individual numbers may be based on host plant. Stork and Eggleton criteria (1992) used soil mites as indicators of soil quality.

The number of mite species inhibiting in garlic soil were more than in onion soil causing the increase of diversity and Evenness in garlic soil.

The low diversity of soil mites in soil grown with onion than with garlic may be explained by decrease its contents of organic matter and N^+. There is a clear match between mite diversity and organic matter because it's direct effects as food or support of food for mites. Qin *et al.*, (2004) reported that, the higher the organic matter and total N^+ in soil, the greater the species of Gamasida and the highest in their population. Ducarme and Lebrun (2004) and Barbercheck *et al.*, (2009) reached the same conclusion regarding the group diversity of soil mites.

In onion soil Actinedida, Acaridida, Gamasida and Oribatida recorded the highest mite populations in December, January, February and March, respectively, whereas reached their maximum populations in December in garlic soil. These results are in harmony with that of Perdue and Crossley (1990). Furthermore, Kandil *et al.*, (1997) concluded that all soil mite species extracted from some onion varieties reached their maximum in February and March.

Leetham & Milchunas (1985) and Zaki (1992) found that distribution of soil mites affected by two factors which are classified into direct and indirect. The direct ones are the environmental factors and soil quality, while the indirect factors are those corresponding to choice of microhabitate, food, root biomass and the relation between individuals.

In general, organic matter, N^+ and P^+ were higher in garlic soil than onion soil. Reversely, pH, Ca^{++} and K^+ were more in onion soil than garlic soil. It is probably that, the occurrence and distribution of soil mites were attributed to the different properties of the two tested soils.

The onion soil has higher pH than it is obtained from garlic soil. The regression of the diversity of soil animals and soil environment showed that the size of soil fauna was decreasing with increasing soil pH (Bo *et al.*, 2007). Also, Qin *et al.*, (2004) found that, the species of Gamasida tend to live in slightly acid habitats.

Acaridid mites in onion soil constituted the higher abundant population in comparison to garlic soil, that may be due to increase its contents with potassium (K^+). Potassium sulfate plus urea significantly increased Acari population density in fodder beet soil compared to those treated with urea only (Rady *et al.*, 1997).

In the same direction, Sjursen *et al.*, (2005) reported that Actinedida and Acaridida increased in soil with increasing fertilization by N.P.K.

Elevation the amount of Ca^{++} that presented in soil grown with onion more than in garlic soil probably gave another elucidation for decreasing oribatid and gamasid mites inhabited with onion soil than in garlic. Seniczak *et al.*, (1999), studied the effect of Ca^{++} deposition produced a cement and lime factory in Poland on soil mites in young Scots pine forest. In the treated plots, the oribatid and gamasid mites number was lower than in the control.

As a general trend, application of soil management practices impacted soil fauna population by altering the quality and quantity of plant litter inputs and by influencing the soil microhabitat in terms soil physical and chemical qualities (Bardgent & Cook, 1998).

So, among all soil animal groups, soil mites are the best bio-indicator in terms of soil quality and soil health because of its relatively short life span, the ease of collecting them in the field and its sensitivity to land use changes.

ACKNOWLEDGMENT

The authors thank Dr. Wahid M. H. Desuky, Chief Researcher (Emeritus), Plant Protection Research Institute, A.R.C., Egypt for his helpful comments and encouragement during this work.

REFERENCES

Abd El-Halim, S. M. 1998. Mites associated with onion at Fayoum Governorate. Ann. Agric. Sci. Moshtohor, 36(4): 2671-2675.

Barbercheck, M.E.; Neher, D.A.; Anas, O.; El-Allaf, S.M. and Weicht, T.R. 2009. Response of soil invertebrates to disturbance across three resource regions in North California. Springer, Dordrecht, Netherlands. Environmental Monitoring and Assessment, 152(1/4): 283-298.

Bardgent, R.D. and Cook, R. 1998. Functional aspects of soil animal diversity in agricultural grasslands. Appl. Soil Ecol., 10: 263-276.

Behan, V.M.; Hill, S.B. and Kevan, D.K.M. 1978. Effects of urea, as fertilizer on Acarina and other arthropods in Quebec black spruce (*Picea mariana* Mill.) humus. Pedobiologia, 18: 249-263.

Bo, S.; JianHua, Ma; Jian, Li and Qin, Y.X. 2007. Soil animals and their response to soil population in Kaifeng City. Acat Pedologica Sinica, 44(3): 529-535.

Crossley, D.A.Jr. 1977. The roles of terrestrial saprophagous arthropods in forest soils: current status of concepts. In Proceedings in life sciences: The role of arthropods in forest ecosystems, (W. J. Mattson ed.) Springer-Verlag, New York: 49-56.

Ducarme, X. and Leburn, P. 2004. Spatial microdistribution of mites and organic matter in soils and caves. Biol. Fertil. Soils, 39: 457- 466.

El-Sharabasy, H.M.; Hassan, M.F. and Mohamed, A.I. 2008. Occurrence of soil mites at El-Maghara region, Sinai Peninsula. Acarines, 2: 31-35.

Heneghan, L.; Coleman, D.C.; Zoub, X.; Crossley, D.A. Jr. and Hainese, B. L. 1998. Soil microarthropod community structure and litter decomposition dynamics. A study of tropical and temperate sites. Applied Soil Ecology, 9: 33-38.

Kandil, M.M.; Rady, G.H.; Ahmed, S.S. and Halawa, S.M. 1997. Population density of soil mites associated with some field crops in Qalubia Governorate. Ann. Agric. Sci., Moshtohor, 35(4): 2545-2555.

Kethley, J. 1990. Acarina: Prostigmata (Actinedida). Pages 667-778 in D.L. Dindal, editor. Soil biology guide. Johan Wiley and Sons, New York, USA.

Krantz, G.w. 1979. A manual of Acarology. 2 nd. ed. Oregon state Univ., Book Stores, Corvallis, Oregon, USA, 509pp.

Leetham, J.W. and Milchunas, D.G. 1985. The composition and distribution of soil microarthropods in the shortgrass steppe in relation to soil water, root biomass, and grazzing by cattle. Pedobiologia, 28: 311-325.

Page, A.L.; Miller, R.H. and Keeny, D.R. 1982. Methods of soil analysis, Part 2, Am. Soc. Agronomy, Inc. Mad. Wisconisn, USA.

Perdue, J.C. and Crossley Jr., D.A. 1990. Vertical distribution of soil mites (Acari) in convention and no-tillage agricultural systems. Biol. Fertil. Soils, 9: 135-138.

Pielou, E.C. 1984. The interpretation of ecology data. A primer on classification and ordination. John Wiley & Sons. Singapore. 263 pp.

Qin, Yin Xiu; Li Ming, Ma and Weihua, Dong. 2004. Ecological distribution of soil Gamasida in forests in Xiaoxing anling. Science Press, Beijing, China, Acta Pedologica Sinica, 41(5): 767-773.

Rady, G.H.; Kandil, M.M.; Ahmed, S.S. and Halawa, S.M. 1997. Effect of soil fertilization on population density of soil Acari concomitanted with certain field crops. Ann. Agric. Sci., Moshtohor, 35(4): 2557-2570.

Richard, L.A. (1954): Diagnosis and improvement of saline and alkali soils. USAD, Hand book, 60.

Ruf, A.; Beck, L. and Dreher, P.A. 2003. A biological classification concept for the assessment of soil quality: "Biological soil classification scheme" (BBSK). Agriculture, Ecosystems and Environment, 98: 263-271.

Sanyal, A.K. and Bhaduri, A.K. 1982. Seasonal changes in the density of soil oribatid mites in relation to temperature and water content of soil at Sagar Island, 24-Parganas, West Bengal. Proc. Symp. Ecol. Anim. Popul. Zool. Surv. India, 3: 119-126.

Seastedt, T.R. 1984. Microarthropods of burned and unburned tallgrass prairie. J. Kansas Entomological Society, 57: 468-476.

Seniczak, S.; Dabrowski,J.; Klimek, A. and Kaczmarek,S. 1999. Effect of alkaline deposition on mites (Acari) associated with young Scots pine forests in Poland. Water, Air and soil pollution, 109(1/4): 407-428.

Sjursen, H.; Michelsen, A. and Jonasson, S. 2005. Effect of long-term soil warming and fertilization on micro-arthropod abundances in three sub-article ecosystem. Elsevier, Amsterdam, Netherlands, Applied Soil Ecology, 30(3): 148-161.

Stork, N.E. and Eggleton, P. 1992. Invertebrates as determination and indicators of soil quality. A. J. Alternative Agric., 7: 38-47.

Tousignant, S. and Coderre, D. 1992. Niche partitioning by soil mites in a recent hardwood plantation in Southern Quebec, Canada. Pedobiologia, 36: 287-294.

Valerie, M.B. 1999. Oribatid mite biodiversity in agroecosystem: role for bioindication. Agriculture, Ecosystems and Environment, 74: 411- 423.

Walter, D.E. and Proctor, H.C. 1999. Mites: ecology, evolution and behaviour. New South Wales Press, Sydney, Australia.

Zaher, M.A. 1986. Survey and ecological studies on phytophagous, predaceous and soil mites in Egypt. II: Predaceous & nonphytophagous mites. PL. 485 programme, U.S.A. Project No. EG-ARS-30. Grant No. FG-EG-138.

Zaki, A.M. 1992. Population dynamics of soil mites associated with some stone fruit tress in Menoufia, Egypt. Acta Phytopathologica et Entomologica Hungarica, 27(1-4): 679-685.