Egypt. J. Plant Prot. Res. Inst. (2021), 4 (1): 42 –56

وزارة الزراعة واستصلاح الأراضي
Ministry of Agriculture and Land Reclamation
مركز البحوث الزراعية
Agricultural Research Center

Egyptian Journal of Plant Protection Research Institute

www.ejppri.eg.net

Population species diversity of soil fauna is influenced by agricultural practices

Marguerite, A. Rizk[1]; Amira , S. Soliman[2]; Sahar, Hussein Hekal[2] and Amna, A.A. Fazaa[3]

[1] *Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.*

[2]*Department of Natural Resources, Faculty of African Postgraduate Studies, Cairo University, Egypt.*

[3]*Kashif Organization, El-Khartum, Elfaki Aiwad Allah, bulding No. five, Sudan.*

ARTICLE INFO

Article History

Received: 11 / 1 /2021

Accepted: 19 / 3 /2021

Keywords

Diversity, functional group, crop cover, tillage, fertilizer, Shannon-Wiener and Simpson indices and soil fauna.

Abstract:

The study was carried out in different soil occupation systems: Tomato and maize, comparing with fallow using pitfall traps installed per treatment. The captured surface soil fauna was listed according to the Ascending Hierarchic classification (AHC) (Roux,1985). Fauna were classified into the five main functional group, herbivores, detrivores , carnivores , parasitoids and pollen grain transmitters. The community composition in the period of this study was determined using the Shannon-Wiener and Simpson indices of diversity, slight difference in the species diversities among the two cover of cultivation was observed comparing with fallow. The highest abundance was found under maize growing conditions (533 individuals), the number decreased to (357) under tomato and the lowest abundance values were found in fallow (213 individuals). The different systems of soil occupation showed different abundance and diversity, demonstrating how soil occupation interferes with the dynamics of the invertebrate soil fauna.

Introduction

Soil fauna are very sensitive to agricultural practices, with their numbers and diversity becoming severely reduced in intensively cultivated soils. Consequently, natural systems usually contain richer communities than managed ones. No-tillage environment can have a positive, negative or neutral effect on pest-, crop-, and biological control interaction.

Population species diversity of soil fauna is influenced by agricultural practices (Wallwork, 1976). The practices that adversely affect fauna population include mechanized land clearing and ploughing (Bigler *et al*., 1995a and 1995b). On the other hand, soil- and crop-management techniques that favor and enhance the activity of soil fauna include mulch farming (Maia *et al*., 1991), no-tillage (Rizk and Mikhail, 1999), cover crops, agroforestry and other ecologically compatible farming systems (Lee, 1995). On the other hand, population densities of soil animals and their functional (Trophic) groups are responsible to a great extent for N mineralization in such agro-ecosystem (Persson, 1989). Most of this mineralization is affected by bacterivores, fungivores and herbivores, that feed on N-poor food, have little influence on N mineralization.

The aim of the present study is to investigate the effect of no-tillage and conventional tillage practices and the type of cover crops as well seasonal variations, on the activity density of soil fauna taxa in El-Marazeeq village, Giza Governorate.

Materials and methods

1. **Study area :**

The experiment was conducted at village of El- Marazeeq - Giza Governorate during the period between September 2014 and October 2015 . The study area consists of 1/3 feddan (1 feddan = 4200 m^2). The area was cultivated with tomato and rotation with cultivated maize and between two cultivated leave the land fallow. The aim of this study was to investigate the effect of crop type, crop rotation, the effect of tillage for preparing for cultivated crop and different fertilizing used in different crap type on the activity density of arthropods and the most characteristic taxa in both plantations.

To cultivated tomato used as the normal cultivation treatment. Also, normal agricultural practices were followed in the same plot to cultivated maize, including the addition of N-chemical fertilizer (Table 1).

2. Method of sampling soil mesofauna:

Different cultivated systems were compared using pitfall traps method as described by Southwood (1978) , Slingsby and Cook (1986) and Southwood and Henderson (2000), pitfall traps are cups sunk into the ground flush with the soil surface which collect organisms that fall into them. In this method the number of individuals trapped is primarily dependent on their locomotion activity and these are therefore called activity-density rather than population- density (Kromp, 1990) and Mikhail, 1993). The activity-density cannot be related to the abundance per unit area (Kromp,1990) but, is taken as number per trap, (Mikhail,1993).

This experiment continued for 13 months, ten pitfall traps were distributed in each plot of the mentioned field, cultivated with different cover crop and when its fallow; samples were taken at every two weeks intervals from each cultivation and fallow, samples were taken by setting the traps for 24 hours .The contents of the pitfall traps were then transferred to the laboratory where the captured arthropods identified and counted for each treatment.

3.Treatment of data:

The captured surface soil fauna was listed according to the Ascending Hierarchic Classification (AHC) (Roux,1985).

4. Functional groups:

The breakdown of trophy group based on feeding strategies and method of locomotion in the soil **(Wallwork, 1976);** as soil arthropods eat their food and mix up the soil.

5. The abundance:

The frequency values of the most abundant species were classified into three classes according to the system adopted by Weis Fogh (1984);" Constant species "were considered as those found in more than 50 % of the sample, "accessory species" were those found in 25-50 % of samples and "accidental species" were those found less than 25% of the samples. On the other hand, the classification of dominance values were done according to Weigmann (1973) system and El-Shahawy and El-Basheer (1992) in which the species were divided into five groups based on the values of dominance in the samples; eudominant species (>30% individuals), dominant species (>10-30% individuals), subdominant species (5-10% individuals), resident species (1-5%

individuals) and sub-resident species (1% individuals).

6. Species diversity:

The biodiversity of soil fauna collected were estimated by using equilibrium. Diversity of collected arthropods was determined for samples pooled over one different patterns of cover cultivation crop. It was measured by diversity indices that reflect the number of species (richness) in the samples.

Two common indices were computed, the Shannon-Wiener (1963) (Shannon and Wiener index "H" and the Simpson (1949) index "S". They were calculated as described by Ludwig and Reynolds (1988).

$H' = -\sum (n_i / n) \ln (n_i / n)$ and $S = \sum (n_i/n)^2$

Where "*ni*" is the number of individuals belonging to the i^{th} of "S" taxa in the sample and "n" is the total number of individuals in the sample ; "H" is more sensitive to changes in rare taxa , while "S" is more responsive to changes in the most dominant species (Ludwig and Reynolds, 1988).

Results and discussion

1. Arthropods collected by pitfall traps from tomato, maize and fallow during 2014 / 2015:

As shown in Table (2) arthropods captured by pitfall – trap method belonging to 12 orders , 8 of them are insect orders (Coleoptera , Collembola , Dermaptera , Diptera , Hemiptera , Hymenoptera , Lepidoptera and Orthoptera and other for groups : Isopoda, soil mites , Acari and Snails. The total population of all surveyed arthropods reached 1103 individuals some of these arthropods considered parameters which determine the differentiation between both covering crops, the most important parameter is collembola , which among the most abundant soil – dwelling arthropods. In present study, arthropods collected by pitfall traps from maize was more than in tomato and fallow. The increasing N rat causing increased the fauna population (Sharshir, 1998) as in the Maize crop which received N-chemical fertilizer. The maize cultivation was characterized by the abundance of collembolan, a detrivores soil fauna which were greatest in soils treated with mineral fertilizer plus mulch (Sisti *et al*., 2004).

In the present study, the number of collembolan obtained in maize was higher (138 individuals) than in tomato (73 individuals), this number decreased to (51 individuals) at fallow. Collembolan was accounted for 23.75% and considered as accidental species according to system adapted by Weis Fogh (1984) and it was dominant species (10-30% individual)as shown the classification of dominance values which was done by (Weigmann, 1973). Abd El-Karim *et al.* (2016) indicated that the most important parameter is collembola which among the most abundant of all soil – dwelling arthropods and represent the greater fraction of biomass of invertebrates in the considered soil (as soil macro fauna) and play a vital role in soil solvation and hence they can be as indicators for soil fertility. Also, Ghallab *et al*. (2007), agree that, Collembola abundance serve as good indicators of soil health. It has been shown that collembolans prefer high soil moisture (Rodgers, 1997) . This suggests that the greater abundance of collembolans was a result of the greater quality and quantity of litter in the vegetation plots. Collembola play a significant role in various soil processes such as decomposition, soil formation and nutrient cycling (Behan-Pelletier, 2003).

Also, in the present study, Table (2) showed that, spiders were found with highest number at maize (105 individuals) decreased to (36 individuals) at tomato but more found at fallow (65 individuals). True spider was accounted for 18.68% and considered as accidental species according to system adapted by Weis Fogh (1984) and it was dominant species (10-30% individual)as shown the classification of dominance values which was done by (Weigmann, 1973). Spiders were more in the maize plots than tomato plots. This result indicated that vegetation type may be influenced spider abundance. This result indicated that vegetation type may be influenced spider abundance. Tahir and Butt (2009) indicated that, the spider densities vary with phonology of crops. Also, (Liu *et al.*, 2003) indicated that, the density of the spiders in the fields increase with the increase in plant size and complexity, then smaller plant host fewer spider than tall ones. Also, Bardwell and Averill (1997) and Malony *et al*. (2003) showed spiders preyed upon collembolan and small dipterous larvae located in the ground.

Diptera was represented by four families; Muscidae , Fannidae (ditrevares) , Syrphidae (carnivores) and Bombylidae *Lucilla* sp. (parazitec). Muscidae was the highest number (25 individuals) at tomato cultivation decreased to (9 individuals) in maize cultivation. Also, Fannidae was the highest number (10 individuals) at tomato. Hymenoptera was represented by Apidae (pollinators), its highest at tomato (5 individuals), decreased to (2 individuals) at maize. Also, Formicidae , these insects were found in tomato and maize more than in fallow. But, the beneficial Farmicidae represented by, (*Componontus maculatus*, *Monomarium* sp. and *Pheidale* sp.). The largest number of Hymenoptera was obtained in the tomato cultivation (112 individuals) decreased to (102 individuals) in maize cultivation and the lowest number (21 individuals) in fallow. *Monomarium* sp. was a accounted for 21.31% and considered as accidental species according to system adapted by Weis Fogh (1984)and it was dominant species (10-30% individual)as shown the classification of dominance values which was done by (Weigmann, 1973).

Also, Hemiptera represented by two herbivorous families, Aphididae and Cicadellidae. *Aphis* sp. recorded at the highest number (5 individuals) in the tomato cultivation but Cicadellidae recorded the highest number (18 individuals) in the maize cultivation. Carabidae and Staphilinidae were found in tomato cultivation with more numbers than the numbers recorded in maize cultivation and fallow. But mite found at tomato and decreased in maize cultivation. The activity- density of soil mites revealed differences between tomato, maize and fallow. The highest number found in tomato cultivation (6 individuals) decreased to(2,1 individuals) in fallow and maize, respectively. Soil mites accounted for (0.82%) of the total captured fauna and considered as accidental and there for they were subrecedent (>1% individuals) population. The number of Oribatid mites was correlated with the concentration of nitrate nitrogen regardless of the soil types. This fact may indicate that the determination of the number of oribatid mites is a useful, indicator of the amount of nitrogen mineralized from organic matter, Enami *et al*. (1999). For other arthropods namely isopoda was found at maize cultivation more than tomato and fallow. *Anthicus* sp., *Tropinata squalida* , Staphilinidae, *Labidura confuse*, *Labidura riparia*, Diptera,(Faniidae, Muscidae), Lepidoptera, Orthoptera, *Gryllus domesticus*, were accounted (1.90,1.27,1.18,”4.35,1.63”,2.45”1.36, 3.72”,1.18,1.18,1.18), respectively and considered as accidental species and they were accidental according to Weis Fogh (1984) abundance(>25%) and it was Recedent (R) (1-5%)dominant value (Weigmann, 1973).

Tables (1 and 2) showed that, the fallow plot had low numbers of soil fauna (64 individuals) in September 2014, and they become higher (180 individuals) in October 2014 when organic manure was added to cultivated tomato. Also, increasing N rate in Jun 2015 to cultivated maize, causing to increased population from (44individuals) in Jun to (134 individuals) in July , (Sisti *et al*. (2004) approved this result, that plot which received N –chemical fertilizer increasing the fauna. Soil organisms are not uniformly distributed throughout the soil habitat.

They tend to be patchy in distribution and concentrated in areas that provide space (between soil particles), moisture and resources such as food (Ettema and Wardle, 2002). Collection of soil fauna from the two crops cover cultivation as well as the fallow , of the present study , gives an idea about the perturbation of community structure of soil fauna under such different treatments. The most pronounced differences were those associated with the total number of individuals as well as the variation between the fallow treatment on one hand, and each of the cultivation treatments, (Tomato , maize). Microclimate modification, food resource availability, and land management practices (e.g., tillage, organic resource use, crop rotation, and application of agrochemicals such as pesticides, herbicides, and inorganic fertilizers) are known to either positively or negatively influence the diversity and abundance of soil fauna communities (Nhamo, 2007 and Gianessi, 2010).

The activity and diversity of soil organisms are directly affected by the reduction of soil organic matter content, and indirectly by the reduction in plant diversity and productivity. Also, Table (2) show that, Formicidae, collembola, sbiders and Diptera are the most dominant taxa in the catches of the pitfall traps. Collembolans were the dominant category using the pitfall trap method. This study has shown that collembolans were one of the more abundant orders found in cultivation (Maize and tomato). There were more twice as many collembolans found in the vegetation than in the fallow.

2. Monthly Variation in numbers of individuals and taxa :

Most of the micro arthropod groups showed higher abundance on early sampling dates (Octoper,180 individual) and on later sampling dates (July, August and September)(134,149 and 147 individual) respectively in both growing crops. A similar observation in micro arthropod abundance fluctuations has been noted in studies conducted in warm season crops (Schrader and Lingnau, 1997).

The main results of this study population density of Acarina, Collempola , ants were affected with temperature. Rizk *et al* . (2000) indicated that the variations in numbers of the collembolan closely follow the elevation of temperature from December to April which are the hottest months. Vats and Narula (1993), and Rizk (2002) found that population density of Acarina was positively correlated with temperature.

Van der Putten (2010) the main abiotic factors are climate, including temperature and moisture, soil texture and soil structure, salinity and pH. Overall, climate influences the physiology of soil organisms, such that their activity and growth increases at higher temperatures and soil moistures. As climate conditions differ across the globe and also, in the same places, between seasons, the climatic conditions to which soil organisms are exposed vary strongly. Soil organisms vary in their optimal temperature and moisture ranges, and this variation is life-stage specific, e.g. larvae may prefer other optima than adults.

3. Functional group:

Ghabbour (1991) pointed out that soil fauna can be divided into trophic groups in different ecosystems. These trophic groups are herbivores (harmful potential agricultural pests), carnivores (Beneficial, natural enemies of herbivores) and detritivores (Essential to soil fertility and are well representable under all crops) (Hussein and Mikhail 1998). Rizk *et al*. (2000) show that soil fauna breakdown into the three mains functional (Trophic) group carnivores, herbivores and Detritivores, under different treatment. Table (3) and Figure (1) show the results of the breakdown of the surface soil fauna in the different cultivation and follow into the main functional groups : Herbivores , detrivores , predators" Carnivores" , parasites and pollen grain transmitters.

3.1. Detrivores group:

The collembolans, ants and dipteran were the main groups of arthropods found in the soils numbers of these groups were higher when maize cultivation than tomato cultivation but the lowest number on fallow . Generally, the detrivores are the most abundant group or recorded 57.12 %of the total pitfall trap catches.

3.2. Carnivores or predators group:

Recorded 30.55 % and represented by true spiders , robben fles *Syrphus corollae* (Diptera : Syrphidae) , *Ciccendela aulica* and *Ciccendela melanocholica* (Coleoptera: Ciccendelidae) , *Anthicus* sp. (Coleoptera : Anthicidae) and beetles (Coleoptera: Carabidae). The true spiders are the more abundant than other predators. This group was found in high population in the plot when cultivated with maize (186 individuals) decreased to (64 individuals) when plot cultivated with tomato increased to (87 individuals) when plots was followed.

3.3. Herbivores group:

Represented by aphid , leaf hoppers , grass hoppers , Lepidoptera , Acrididae and Gryllidae accounted for 9.16 % . Maize received the highest population of herbivores (43 individuals) decreased to (33 individuals) when tomato was cultivated.

3.4. Parasitoids group:

Recorded by 1.09 % found in high population in the maize cultivation (9 individuals) and the (2 individuals) at fallow but decreased to (1 individuals) when tomato was cultivated.

3.5. The pollen grain transmitters:

Recorded by 2.09 % and represented by bee, Apidae (*Apis mellifera*) Hymenoptera , collected in tomato cultivation (15 individuals) decreased to (5 individuals) in maize cultivation. Scherer–Lozenzen (2005) indicated that the diversity of functional groups in general had more pronounced effects than the numbers of species, emphasizing the importance of functional traits of species. This study indicated that the activity – density of predator (true spiders and collembola were greatly higher in maize cultivation could be a result of the highest numbers of hobivares and detrivares groups , this deduction is supported with Malony *et al* . (2003) and Rizk *et al*. (2009) who showed that spiders preyed upon collembola and small dipterous larvae located in the ground. Also, we found that the abundance of herbivores on maize more than in tomato and fallow.

In this study found that Detritivores were abundant in cultivation more than fallow plot due to the surplus amount of water used and subsequent increase in soil humidity as well as the higher availability of organic matter (Rizk, 2002 and Rizk, *et al*. 2006) approved this result. The tomato plots recorded the highest of Detritivores due to the highest available of organic matter and the increase of soil humidity in tomato plots, consequently, population of ants and collembolan increased twice.

Also, our results reveal that the pollen grain transmitters recorded the highest numbers when tomato cultivated because it is more flowering than maize. The use of different flowering plants can produce diverse effects on agro ecosystem management: for example, the nutritional value of pollen and nectar can be largely different, strongly affecting food supplied to beneficial parasitoids (Lu *et al.*, 2014). In natural ecosystems, spiders constitute the main invertebrate predatory group hence play an important ecological function in pest control. Araneae being mostly polyphagous predators, can significantly affect the population dynamics of many phytophagous and saprophagous invertebrates (Ekschmitt *et al*., 1997 and Ziesche and Roth, 2008).

Table (1): Crops cultivated and agricultural practices in the study area during the study period between September 2014 and October 2015.

Months	Crop Type	Agricultural Practices
September 2014	Fallow	Ploughing + organic manure at the recommended rates + irrigation
October	Tomato	The field which will receive the seedling must be humid and holes must be made in order to deposit the seedling. Tomato plants were transplanted at both sides of the terraces in hills of 40 cm.
November	Tomato	Fertilization sulfur + super phosphate before transplantation and second, 60 days + irrigation
December	Tomato	Third after 100 days + irrigation + sulfur + super phosphate
January 2015	Tomato	Added different fertilization sulfur and Potassium + irrigation
February	Tomato	Crop collection + sulfur super
March	Fallow	Crop collection
April	Fallow	Maize were sown in rows over the terraces in ridges 15 cm apart N-chemical fertilizer
May	Maize	Ploughing + Irrigation
June	Maize	Super + Nitrogen 33
July	Maize	Nitrogen 33 + Potassium (2200) + Nitrate (700)
August	Maize	120 days collected
September	Maize	After crop collection + the collected Hoeing
October	Fallow	Follow

Table (2): Diversity between soil/litter and fuana at maize, tomato cultivation and fallow

Taxa	F	M	T	Total	Frequency and Dominance %
Isopoda	1	5	0	6	0.54 (A, Sr)
Soil Mites	2	1	6	9	0.82 (A, Sr)
Snails	0	0	1	1	0.09 (A, Sr)
Spider	65	105	36	206	18.68 (A, D)
Coleoptera	0	7	0	7	0.63 (A, Sr)
Anthicidae					
***Anthicus* sp.**	2	13	6	21	1.90 (A, R)
Carabidae	1	1	2	4	0.36 (A, Sr)
Ciccendelidae	0	3	0	3	0.27 (A, Sr)
Ciccendela aulica	0	7	0	7	0.63 (A, Sr)
Ciccendela melanocholica	0	2	0	2	0.18 (A, Sr)
Elateridae	0	3	O	3	0.27 (A, Sr)
Scarabaeidae	1	0	0	1	0.09 (A, Sr)
***Aphodius* sp.**	3	2	0	5	0.45 (A, Sr)
Tropinata squalida	3	0	11	14	1.27 (A, R)
Staphilinidae	3	3	7	13	1.18 (A, R)
Paedrus alffierii	0	1	0	1	0.09 (A, Sr)
***Atheta* sp.**	0	1	0	1	0.09 (A, Sr)
Collembola	51	138	73	262	23.75 (A, D)
Dermaptera	2	0	1	3	0.27 (A, Sr)
Labiduridae					
Labidura confuse	13	26	9	48	4.35 (A, R)
Labidura riparia	1	17	0	18	1.63 (A, R)
Diptera	7	9	11	27	2.45 (A, R)
***Lucilia* sp.**	0	7	0	7	0.63 (A, Sr)
Faniidae	2	3	10	15	1.36 (A, R)
Muscidae	7	9	25	41	3.72 (A, R)
Musca domestica	1	6	6	13	1.18 (A, R)
Syrphidae					
Syrphus corollae	0	0	3	3	0.27 (A, Sr)
Embioptera	0	0	1	1	0.09 (A, Sr)
Geotomus intrusus	0	1	0	1	0.09 (A, Sr)
Lygaeidae	0	1	1	2	0.18 (A, Sr)
Hemiptera					
***Aphis* sp.**	2	1	5	8	0.73 (A, Sr)
Cicadellidae	2	18	3	23	2.09 (A, A)
Hymenoptera	1	2	5	8	0.73 (A, Sr)
Apidae	1	2	5	8	0.73 (A, Sr)
Apis mellifera	1	1	5	7	0.63 (A, Sr)
Braconidae	2	2	1	5	0.45 (A, Sr)
Formicidae	1	4	0	5	0.45 (A, Sr)
Camponotus maculatus	1	4	0	5	0.45 (A, Sr)
***Monomorium* sp.**	21	102	112	235	21.31 (A, D)
***Pheidole* sp.**	0	6	7	13	1.18 (A, R)
Lepidoptera	1	0	1	2	1.18 (A, R)
Orthoptera	0	2	0	2	1.18 (A, R)
Acrididae	2	5	1	8	0.73 (A, Sr)
***Aiolopus* sp.**	7	3	1	11	1.00 (A, R)
Gryllidae	1	2	1	4	0.36 (A, Sr)
Gryllus domesticus	5	7	1	13	1.18 (A, R)
Gryllus bimaculatus	0	1	0	1	0.09 (A, Sr)
	213	533	357	1103	

Frequency (abundance), by Weis Fog , Dominance, by Weigmann, > 50 % = Constant (C) > 30 % = Eudominant (E) 1 - 5 % Recedent (R), 25 - 50 % = Accessory (ac) 10 - 30 % = Dominant (D) > 1 % = Subrecedent (Sr), > 25 % = Accidental (A) 5 - 10 % = Subdominant (sd)

Table (3): Breakdown of surface soil fauna into trophic group in different cover cultivation from September 2014 to October 2015 .

Functional Group	Fallow	Maize	Tomato	Total	Dominance%
Detrivores	96	290	244	630	57.12
Herbivores	25	43	33	101	9.16
Parasitoids	2	9	1	12	1.09
Predators	87	186	64	327	30.55
Poll. Gr.Trans.	3	5	15	23	2.09
Total	213	533	357	1103	

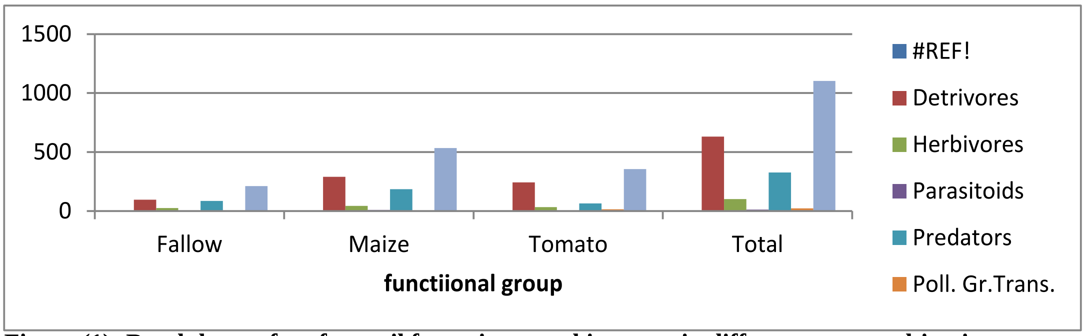


Figure (1): Breakdown of surface soil fauna into trophic group in different cover cultivation from September 2014 to October 2015.

4. Species composition , species richness and species abundance :

The collected arthropods were summarized by orders in Table (4) and show their abundance, frequency (richness) and dominance. As shown in Table (4) and Figures (2 and 3) members of Hymenoptera involved the greatest numbers of soil fauna. This order Hymenoptera accounted for 25.93 % of the total captured arthropods. The largest numbers of Hymenoptera was obtained in the tomato cultivation (135 individuals) decreased to (123 individuals) in maize cultivation. In general ant populations are the highest members of this order, they are responsive to change environmental conditions of soil. This result approved by Ghallab *et al.* (2007), she found that the highest number of ants in the tomato cultivation. Adopted by Weis Fogh (1984) and it was dominant species(>30% individuals). Presence of ants could be due to the soil type which is based on the nutrients and a wide variety of decaying organic materials,(Wallwork, 1976). The Hymenoptera considered as accessory species according to system.

The beneficial collembola represented by 23.75 % of the total cached soil fauna. Table (4) show that collembolan was considered as Dominant species (>30% individual) as shown the classification of dominance values which was done by (Weigmann, 1973). This result is in good accordance with Fountain and Hopken (2004), who showed that collembolan (springtails) are abundant and widespread in soil ecosystems and are important members of the composer community. Rizk *et al* . (2009) indicated that their abundance serves as good indicators of soil health. Number of collembolan was increased in maize cultivated as planted in hot month's this result approved by (Rizk *et al*., 2000).The variation in numbers of the collembolan closely fallow the elevation of temperature from December to April which there was hottest month's. Also, Table (4) show the frequency of true spiders constitute high degree in abundance in the maize cultivation (105 individuals) while tomato received the lowest numbers (36 individuals).

Spider was considered as dominant species (18.68 %). The order Diptera followed in the abundance, accounted for 9.97 % of the total captured arthropod. Diptera was considered as accidental species (>25%) and it was subdominant (5– 10 %). The highest number found tomato cultivation (57 individual) decreased to (36 individual) in the maize cultivation. Order Hemiptera was considered as Resident species (1 – 5 % Resident) , the abundance of their individuals accounted to 2.81 % of the total arthropods . It includes the major piercing sucking pests causing economic damage to the plant host, they represented by two species belonging to two families, they are *Aphis gossypii* (Aphidae) and *Agallia aegyptiaca* (Cicadellidae). Members of Acarina , Lepidoptera snail and isopoda are the lowest frequent taxa among the soil fauna recorded and they were accounted for (0.82 , 0.18 , 0.09 and 0.54%) respectively , and considered as accidental species and therefore they were subresident (>1% individuals).

Table (4): Species composition, species richness and species abundance.

Order	Fallow	Maize	Tomato	Total	Frequency and Dominance %
Isopoda	1	5	0	**6**	**0.54 (a/ Sr)**
Acarina	2	1	6	**9**	**0.82 (a/ Sr)**
Snails	0	0	1	**1**	**0.09 (a/ Sr)**
Araneae	65	105	36	**206**	**18.68 (a/D)**
Collembola	51	138	73	**262**	**23.75 (a/D)**
Coleoptera	13	43	26	**82**	**7.43 (a/ sd)**
Dermaptera	16	43	10	**69**	**6.26 (a/ sd)**
Diptera	17	36	57	**110**	**9.97 (a/ sd)**
Hemiptera	4	19	8	**31**	**2.81 (a/ R)**
Hymenoptera	28	123	135	**286**	**25.93 (A/ D)**
Lepidoptera	1	0	1	**2**	**0.18 (a/ sr)**
Orthoptera	15	20	4	**39**	**3.54 (a/ R)**
Total	**213**	**533**	**357**	**1103**	

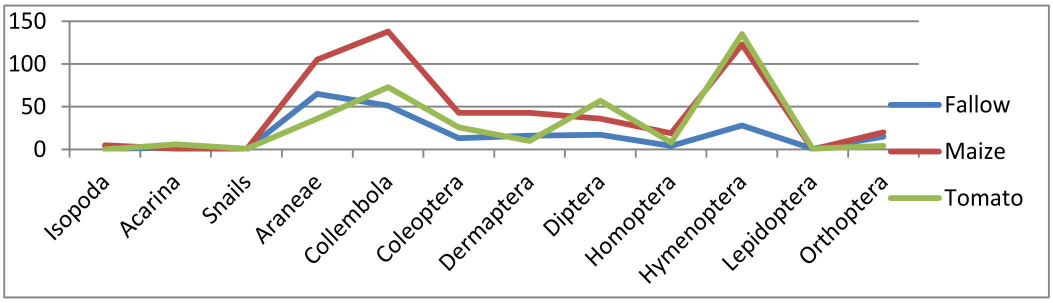


Figure (2): Species composition, species richness and species abundance.

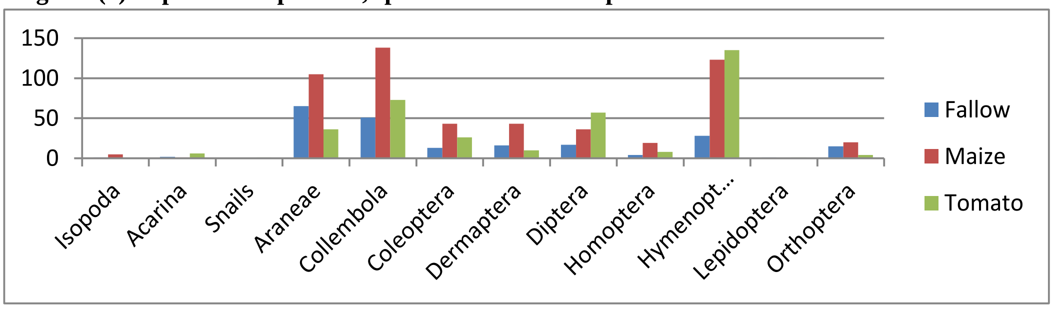


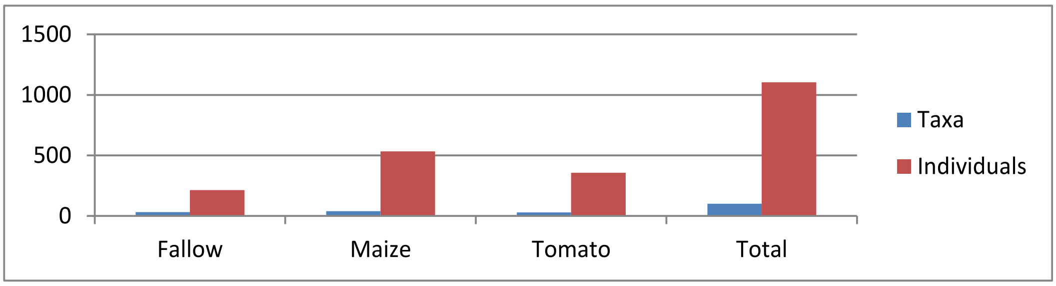
Figure (3): Species composition, species richness and species abundance.

5. Variation in each of numbers of species and/or higher taxa and number of individuals and each of Simpson (S) and Shannon Weiner (H) indices of diversity under different crop and fallow :

Also, Table (5) and Figure (4) showed, each of Simpson and Shannon – Weiner indices of diversity in different caver crop (Tomato and maize) comparing with fallow. The diversity is minimum in two cultivation and being (0.01 Simpson index), while Shannon – winter has 0.19 in maize, increased to 0.21 in tomato. But these two indices are higher in fallow, Simpson index has value 0.02, while Shannon – Weiner has 0.28. Cover plants strongly affected the soil invertebrate assemblages. The biodiversity of the soil arthropods in the different cultivation, by using Shannon and Wiener (1963) "H" and Simpson (1949) "S" Indices of diversity. From this study we can be concluded the species diversity was nearly similar to some extent in different vegetation types. Similar results have been .reported by (Al-Assiuty *et al*., 1993 and Rizk *et al*. 2009). Different plant species used as cover plants seem to have different effects on beneficial fauna. Crop rotations are fundamental to sustainable cropping systems. As well a designed crop creates diversity and improves soil condition also generate biodiversity of soil form and soil fatality, (Rizk *et al*., 2006). Also, Sommaggio *et al*. (2018) indicated that, cover plants strongly affected the soil invertebrate assemblages. We speculate that higher soil fauna taxonomic richness in the medium and long-term trials could be due to long-term build-up of soil organic matter as food for the soil fauna groups.

Table (5): Species diversity of fauna collected from fallow, maize and tomato by using Shannon-Weiner and simpson indices during 2014-2015.

Season	Fallow	Maize	Tomato	Total
Taxa	31	40	30	101
Individuals	213	533	357	1103
Shannon	0.28	0.19	0.21	0.22
Simpson	0.02	0.01	0.01	0.01



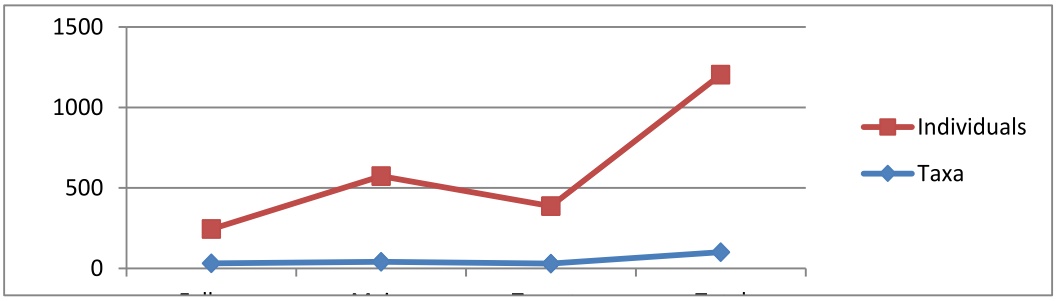


Figure (4): Species diversity of fauna collected from fallow, maize and tomato.

Our results indicated that each of the two different cropping plantations could affect the population of the mesofauna. Finally, we think that the soil organisms of rotary cultivated plots are greater with maize than vegetable crops (Tomato) . We can say that , the rotary cultivation plots had more soil animals than the fallow. Continued long term studies on the effect of tillage on soil dwelling micro arthropods, are needed to fully understand the dynamics of these populations relative to disturbance. Increased awareness of how tillage affects the soil community may aid in the development of sustainable agricultural. Finally, it can be recommended that both cultivation (tomato and maize) or crop rotation and conventional farming system are necessary to know the incidence, abundance and diversity of pests and how to monitor them, as well as to identify beneficial arthropod, especially spiders, to effectively manage pests in these two plants covering crops. More researches should be carried out to understand the impact of differ and type of fertilization and tillage or no tillage on the surface soil fauna. Entomologist should play on important role in such efforts in the future.

References

Abd El-Karim ,H. S. ; Rahil, A. A. and Rizk, M. A. (2016): The difference between organic and conventional cultivation on biodiversity activity of spider (Araneae) in Chamomile and Chrysanthemum in Fayoum governorate , Egypt. Egypt. Acad. J. Biolog. Sci., 9(4):83-95.

Al-Assiuty, A.I.M. ; Bayoumi, B.M. ; Khalil, M.A. and Van Straalen, N.M . (1993): The influence of vegetational type on seasonal abundance and species composition of soil fauna at different localities in Egypt. Pediologia, 37 : 210 - 222 .

Bardwell, C. J. and Averill, A. (1997): Spiders and their preys in Massachusetts cranberry bogs J. Arachnol., 25: 31-41.

Behan-Pelletier, V. M. (2003): Acari and collembola biodiversity in Canadian agricultural soils. Canadian Journal of Soil Science, 83: 279-288.

Bigler, F.; Waldburger, M. and Frei, G. (1995 a): Some diseases and pests of maize. Agrarforschung, 2 (9): 380-382.

Bigler, F.; Waldburger, M. and Frei, G. (1995 b): Important insects and spiders as natural enemies in maize. Agrarforschung, 2 (9): 383-386.

Ekschmitt, K.; Wolters, V. and Weber, M. (1997): "Spiders, carabids and Staphylinids: the ecological potential of predatory microarthropods," in Fauna in Soil Ecosystems: Recycling Processes, Nutrient Fluxes and Agricultural Production, ed G. Benckiser (Newyork, NY: Mercel Dekker), 307–362.

El-Shahawy. A.A. and El-Basheer, Z.M. (1992): Seasonal abundance of soil collembola in the reclaimed soil at Sharkkiya Governorate Egypt. Bull. Soc. Egypt. , 70:243-253.

Enami, Y. ; Shiraishi, H. and Nakamura,Y. (1999): Use of Soil Animals as Bioindicators of Various Kinds of Soil Management in Northern Japan. JARQ, 33: 85-89.

Ettema, C. H. and Wardle, D. A. (2002): Spatial soil ecology. Trends in Ecology & Evolution, 17: 177-183.

Fountain, M.T. and Hopkin, S.P. (2004): Biodiversity of

Collembola in Urban soils and the use of *Folsomia condida* to assess soil quality. Ecotoxicology, 13: 555 - 572.

Ghabbour, S.I. (1991): Towards a zoo sociology of soil fauna Rev. Boil Sol., 28:77–90.

Ghallab , M. M.; Habashi, N. H.; Manssour ,E. S. and Rizk, M. A. (2007): Impact of effective microorganisms, micro-nutrients and their mixtures on the arthropods inhabiting soil in cucumber cultivation. proc. Proc.2 inter. Conf. Ent. Soc. Egypt., 11:137-154.

Gianessi, L. P. (2010): Pesticide use and biodiversity conservation on farms. Crop Life Foundation Washington, dc. For full report. www.croplifefoundation.org.

Hussein, A.M. and Mikhail, W.Z.A. (1998): Evaluation of agricultural pests in tuber crop plantations in Menofiya Governorate. Menofiya J. Agric. Res., 23 (3): 639-649.

Kromp, B. (1990): Carabid beetles (Coleoptera Carabidae) as bio-indicators in biological and conventional farming in Austrian potato field. Biol. Fert. Soils, 9 : 182 -187 .

Lee, H.C. (1995): Sustainable farming practices in central Queensland, Australia. In:C. Carrol; M. Halpin and H.F. Cook (eds.) Soi management in Austainable agriculture. Proceedings Third International Conference on sustainable Agriculture, Wye College, University of London, 31 August to 4 September 1993:31-36.

Liu, W. X.; Hou, M. L.; Wan, F. H. and Wang, F. L (2003): Temporal and spatial niche dynamics of spiders and their control effects on cotton bollworms in transgenic Bt cotton field. Entomol. Know., 40: 160-163.

Lu, Z. X. ; Zhu, P. Y. ; Gurr, G. M. ; Zheng, X. S. ; Read, D.M. ; Heong, K. L. ; Yang, Y. J. and Xu, H. X. (2014): Mechanisms for flowering plants to benefit arthropod natural enemies of insect pests: prospects for enhanced use in agriculture. Insect Sci., 21:1–12.

Ludwig, J.A. and Reynolds, J.F. (1988): Statistical Ecology : A primer on methods and computing – New-York, pp. 337.

Maia, A.I.; Serralheiro, F. ; Franco, J. and Mareira, I. (1991): Influence on soil mesofauna of the systems of soil management in vineyards. pp. 223-226. In Proceedings of the 1991 meeting of the Spanish Weed Science Society.

Malony, D. ; Drummond, F.A. and Alford, R. (2003): Spider predation in agroecosystem , can spiders effectively control pest population . Technical Bulletin 190 Marine Agriculture& Forest Experiment Station ,The Univ. of Marine , Depart. of Biol. Sci., pp 32.

Mikhail, W.Z.A. (1993): Effect of soil structure on soil fauna in a desert wadi in southern Egypt. J. Arid. Environ., 24:321-331.

Nhamo, N. (2007): The contribution of different fauna communities to improved soil health: A case of Zimbabwean soils under conservation agriculture. Publisher: Center for Development Rsearch. ISBN: pp.978.

Persson, T. (1989): Role of soil animals in C and N mineralization. Plant and Soil, 115: 241-245.

Rizk, M. A. ; Ghallab, M. M.and Habashi, N. H. (2009): Abundance and activity- density of soil fauna in different vegetables, monoculture and intercropping systems. Egypt.J.Agric.Res., 87(2):211-226.

Rizk, M.A. (2002). Effect of soil solarization for soil sterilization on population densities of soil fauna at Fayoum Governorate, Egypt. ICESA(2002) Hebei,Conference center Shijiazhuang,Hebei,China,September 15-19, 327-332.

Rizk, M.A. and Mikhail, W.Z.A. (1999): Impact of no tillage agriculture on soil fauna diversity. Zoology in the Middle East, 18:113-120.

Rizk, M.A.; Ghabbour, S. I. and Mikhail, W. Z. (2000): Effect of irrigation Regimes in Mixed tomato cultivations on population activity densities of the Collembolan *Friesea claviseta* in Fayoum Region, Egypt. Paper presented at.: Xth international colloquium on Apterygota (X.ICA) Ceske Budejovice 21-24 Augast

Rizk, M.A.; Mikhail, W. Z. and Ghallab, M. M. (2006): The benefits of medicinal and aromatic plants rotations before tomatoes crops on biodiversity of soil fauna. Proc 3 Egypt &Syr. Conf. Agric.& Food, El Mania: Nov. 6-9, 3(2): 179-188.

Rodgers, D. (1997): Soil collembolan (Insecta: Collembola) assemblage structure in relation to understorey plant species and soil moisture on a eucalypt woodland site. Memoirs of the Museum of Victoria, 56(2): 287-293.

Roux, M. (1985): Algorithmes de Classification. Masson, Paris : pp.151.

Scherer- Lorenzen, M. (2005): Biodiversity and Ecosystem Functioning : Basic Principkes, in biodiversity: Eolss Publishers , Oxford, UK, (http://www.eolss.net).

Schrader, S. and Lingnau, M. (1997): Influence of soil tillage and soil compaction on micro arthropods in agricultural land. Pedobiologia, 41: 202-209.

Shannon, C.E. and Wiener, W. (1963): The Mathematical Theory of communication. University of Illinois Press, Urbana.

Sharshir, F. A. (1998): Effect of three conventional tillage systems and fertilizer applications on soil Acarina and Collembola populations inhabiting faba bean (*Vicia faba* L.) cultivation in Kafer El-Sheikh, Ann. Agricultural Sci., Cairo, Special Issue, **3**: 957-971.

Simpson, E.M. (1949): Measurement of diversity . Nature, 163:688.

Sisti, C.P.J.; Santos, H.P.; Kohhann, R.; Alves, B.J.R.; Urquiaga, S. and Boddey, R.M. (2004): Change in carbon and nitrogen stocks in soil under 13 years of conventional or zero tillage in Southern Brazil. Soil Till. Res., 76: 39–58.

Slingsby, D. and Cook, C. (1986): Practical Ecology, Mc Millan, London : pp. 213.

Sommaggio, D. ; Peretti, E. and Burgio, G. (2018): The effect of cover plants management on soil invertebrate fauna in vineyard in Northern Italy. Bio Control ,63:795–806.

Southwood, T.R.E. (1978): Ecological Methods with particular reference to the study of insect population. Chapman and Hall, London: pp. 524.

Southwood, T.R.E. and Henderson, P.A. (2000): Ecological Methods Blackwell ,Science Ltd., Oxford,pp. 574.

Tahir, H. M. and Butt, A. (2009): Effects of different management practices and field margins on the abundance of ground spiders in rice ecosystems. Pakistan J. Zool., 41(2): 85-93.

Van der Putten, W. H. (2010): Soil biodiversity: functions, threats and tools for policy makers. Final report, European Commission DG ENV, February 2010.

Vats, L. K. and Narula, A. (1993): Soil arthropods of cropland and forest stand. Annals of Entomology, 8(2) :39-42.

Wallwork, J. A. (1976): The distribution and diversity of soil fauna. Academic Press, London: pp. 355.

Weigmann , G . (1973): Zur Okologie der collemolen and Oribatiden in Gerenzhereich Land- Meer (Collembola, Insects Oribatei, Acari). *Z.* iwss.Zool.

Weis Fogh, T. (1984) . Ecological Investigation on mites and collembolan in the soil . Nat. Jutlant , 1 : 135 – 270 .

Ziesche, T. M., and Roth, M. (2008): Influence of environmental parameters on small-scale distribution of soil-dwelling spiders in forests: what makes the difference, tree species or microhabitat? For. Ecol. Manag., 255: 738–752.