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Effect of vegetation type and cultivation method on occurrence, diversity and dominance of spiders and other arthropods in Chia and Quinoa

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ABSTRACT

The experiment was carried out on chia and quinoa plants at Fayoum governorate during 2019/2020 season, to study the effect of conventional and organic cultivation on diversity and abundance of spiders and other arthropods. Spiders and other arthropods in the soil were collected using pitfall traps, while arthropods on plant leaves were surveyed using the direct count. Number of spiders collected from organic cultivation were (486 - 251 indv.) higher than those collected from conventional cultivation (423 - 213 indv.) for chia and quinoa respectively. The most abundant family was Lycosidae. *Pardosa* spp. was the most abundant species in two cultivations. The results revealed that chia cultivation included the highest number of dominant species in both cultivations. The total number of arthropods collected by pitfall traps was recorded (5985 - 2812 indv.) in conventional cultivation and (6703 - 2951indv.) in organic cultivation of chia and quinoa respectively. Arthropods on leaves were recorded (643 - 488indiv. in chia) and (256 - 238indv. in quinoa) for conventional and organic cultivation, respectively. The mite *Tetranychus urticae* Koch and *Phytoseiulus persimilis* Athias-Henriot were recorded on chia plants only, while *Liriomyza* spp. and *Tuta absoluta* (Meyrick) were recorded on quinoa plants only. *Tetranychus urtica* and *Bemisia tabaci* (Gennadius) were recorded as the highest dominant and abundant in chia, however, *Aphis* spp. and *Thrips tabaci* Lindeman were recorded in quinoa in both cultivations. A significant difference was found between chia and quinoa plants for the occurrence of arthropods, while an insignificant difference was found between conventional and organic cultivation.

Keywords: Soil and foliar arthropods, Biodiversity, Conventional cultivation, Organic farming.

INTRODUCTION

Chia, *Salvia hispanica* L. (Lamiaceae) is an annual herbaceous plant native to southern Mexico and Northern Guatemala (Ali *et al*., 2012 and Silva *et al*., 2016). It is a new introduced crop to the Egyptian cultivation system to enrich new of medicinal and aromatic crops (Salman *et al*., 2019). Quinoa (*Chenopodium quinoa* C.L. Willdenow (Willd.) (Amaranthaceae) is considered as a very important grain crop for the Andean region of Latin America (Shukla and Ohri, 2006). Quinoa has a high nutritive value because its grains contain high protein quality and quantity as well, all essential amino acids and trace elements and vitamins. Quinoa has the ability to adapt to different ecological environments and climates. Green leaves are eaten as vegetables (Rasmussen *et al*., 2003; El-Assiuty *et al*., 2014). The response of arthropod diversity and abundance to agricultural production practices has been documented, and varies widely (Adams *et al*., 2017).

Spiders constitute one of the major groups of generalist predators than other natural enemies due to their high abundance and predominantly insectivorous feeding habits. Documented comparisons of organic and conventional plantations have originally measured species richness of one or sundry taxonomic groups by sampling in different crop fields (Letourneau and Bothwell, 2008). Organic measure may add biodiversity to the soil structure and increase the abundance of prey and in turn, it leads to the dominance and abundance of spiders (Öberg, 2007). Several natural enemies associated with quinoa has been observed, including exotic and native species i.e. spiders. Also, natural enemies like Araneae showed featured patterns of abundance with regard to the quinoa and the time of the season (Yabar *et al.,* 2002).

The aim of this work to study effect of vegetation structure and cultivation system on incidence and diversity of spiders and other arthropods in chia and quinoa fields..

MATERIAL AND METHODS

1- Experimental design:

This study was conducted on chia and quinoa plants at Fayoum governorate during November 2019 to April 2020. Commercial chia (*Salvia hispanica* L., Lamiaceae) and quinoa (*Chenopodium quinoa* C.L. Willdenow (Willd.) (Amaranthaceae) seeds were used in this study. Each crop cultivated as organic and conventional cultivation in area of 2800 m^2 divided into 700 m^2 each. All agriculture treatments were conducted without any chemical pesticides. Spiders were collected using pitfall traps method as described by Southwood (1978) and Slingsby and Cook (1986). Twenty pitfall traps were placed every seven days. Samples were sorted in the laboratory; spiders and other arthropods were collected kept in glass vials containing 70% ethyl alcohol and some droplets of glycerin for further identification. Samples of 20 leaves from each plant were randomly picked up weekly, then kept in tightly closed paper bags and transferred to the laboratory where the observed of pests and predators were counted by the aid of stereo-microscope.

2-Identification of spiders:

Spiders were identified according to (El-Hennawy, 2017; Kaston, 1978; Levi, 2002; Ovtsharenko and Tacnasevitch, 2002; Proszynski, 2003; Huber, 2005; and Platnick, 2012). Juvenile spiders were mostly identified to family or to genus. Voucher specimens were preserved in 70% ethyl alcohol and deposited in the references collection of the Plant Protection Research Institute Museum (PPRIM), Agricultural Research Centre, Dokii, Giza governorate, Egypt.

3-Data analysis of spiders:

a. Spider community:

Spider fauna community was described using Shannon-Wiener "H", Simpson indices "S" and the species evenness. The Shannon-Wiener index "H" is one of the most common ecological indexes, providing an indication of community stability under the balance of nature. Higher number of "H" indicates higher number of species and relative abundance. However Simpson index "S" is more responsive to dominance of species. The two indices were calculated as described by Ludwig and Reynolds (1988):

$$\mathbf{H'} = -\Sigma\ (ni/n)\ \ln\ (ni/n) \text{ and } \mathbf{S} = \Sigma\ (ni/n)^2$$

Where n*i* 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.

b. Sørensen quotient of similarity:

Sørensen's quotient of similarity (Sørensen, 1948) was applied to determine the similarities of spider species composition among the communities.

QS = 2 C/A + B, Whereas A and B are the number of species in samples A and B, respectively, and C is the number of species shared by the two samples; QS is the quotient of similarity and ranges from 0-1.

c. Frequency and abundance values

The frequency values were classified into three classes according to Weis Fogh (1948) system; "Constant species" more than 50% of the samples, "accessory species" 25-50 % of the samples and "accidental species" less than 25%. The classification of dominance values were done according to (Weigmann, 1973) system in which the species were divided into five groups based on the values of dominance in the sample; Eudominant species (>30% individuals), dominant species (>10−30% individuals), subdominant (>5−10% individuals), recedent species (1−5% individuals) and subrecedent species (<1% individuals).

d. Guild composition

Spiders collected during this study were divided into seven guilds according to spiders' web-building and prey-catching behaviour as described in classification by (Uetz *et al.,* 1999).

4- Dominance and abundance of other arthropods collected using pitfall traps and leaves

Using the same above mentioned samples, dominance and abundance percentages of arthropod pests and predators inhabiting were determined by the formula (s) of Facylate (1971) as follows:

$$1\text{- } D = (t/T) \times 100$$

Where: D= Dominance percentage, t= Total number of each species during collecting period, T=Total number of all species collected during the collecting period.

$$2\text{- } A = (n/N) \times 100$$

Where: A= Abundance percentage, n= Total number of samples in which each species appeared, N= Total number of samples taken all over the season.

5- Statistical analysis:

All obtained data were statistically analyzed using the InfoStat computer software package (version, 2012). The differences among treatment means were compared by LSD as a post hoc test at ≤ 5% level of significance (Gomez and Gomez, 1984).

RESULTS

I- Spider assemblages:

Nine families and 21 species were collected from chia and quinoa fields Table (1). In chia about 423 & 486 indiv. in 21species were recorded, while in quinoa about 213 & 251 indiv. in 16 species were recorded for conventional and organic farming, respectively Table (2). The most abundant family was Lycosidae recorded 280 & 292indiv. in chia and 145 and 107 indiv. in quinoa, the most abundant species was *pardosa* spp. recorded 170 & 181indiv. in chia and 54 & 70 indiv. in quinoa for conventional and organic farming, respectively (Fig.1&2).

Table 1. Spiders collected from chia and quinoa in conventional and organic fields during 2019/2020 season.

Family	Species
Dictynidae O. P.-Cambridge, 1871	*Dictyna* sp.
Gnaphosidae Pocock, 1898	*Micaria dives* (Lucas, 1846) *Zelotes latus* (O.P.-Cambridge, 1872)
Linyphidae Blackwall, 1859	*Erigone* sp. Mermessus denticulatus *(Banks, 1898)* *Prinerigone vagans* (Savigny, 1825) Sengletus extricates *(O. Pickard-Cambridge, 1876)*
Lycosidae Sundevall, 1833	*Hogna ferox* (Lucas, 1838) *Pardosa injucunda* (O.P.-Cambridge, 1876) *Trochosa* sp. *Wadicosa fidelis* (O.P.-Cambridge, 1872)
Philodromidae Thorell, 1870	*Philodromus* sp. *Thanatus albini* (Audouin, 1825)
Salticidae Blackwall, 1841	*Ballus* sp. *Phlegra flavipes* Denis, 1947 *Thyene imperialis* (Rossi, 1846)
Theridiidae Sundevall, 1833	*Enoplognatha gemina* Bosmans & Van Keer, 1999 *Kochiura aulica* (C.L.Koch, 1838) *Steatoda erigoniformis* (O.P.-Cambridge, 1872)
Thomisidae Sundevall, 1833	*Thomissus spinifer* O.P.-Cambridge, 1872
Titanoecidae Lehtinen, 1967	*Nurscia albomaculata* (Lucas, 1846)

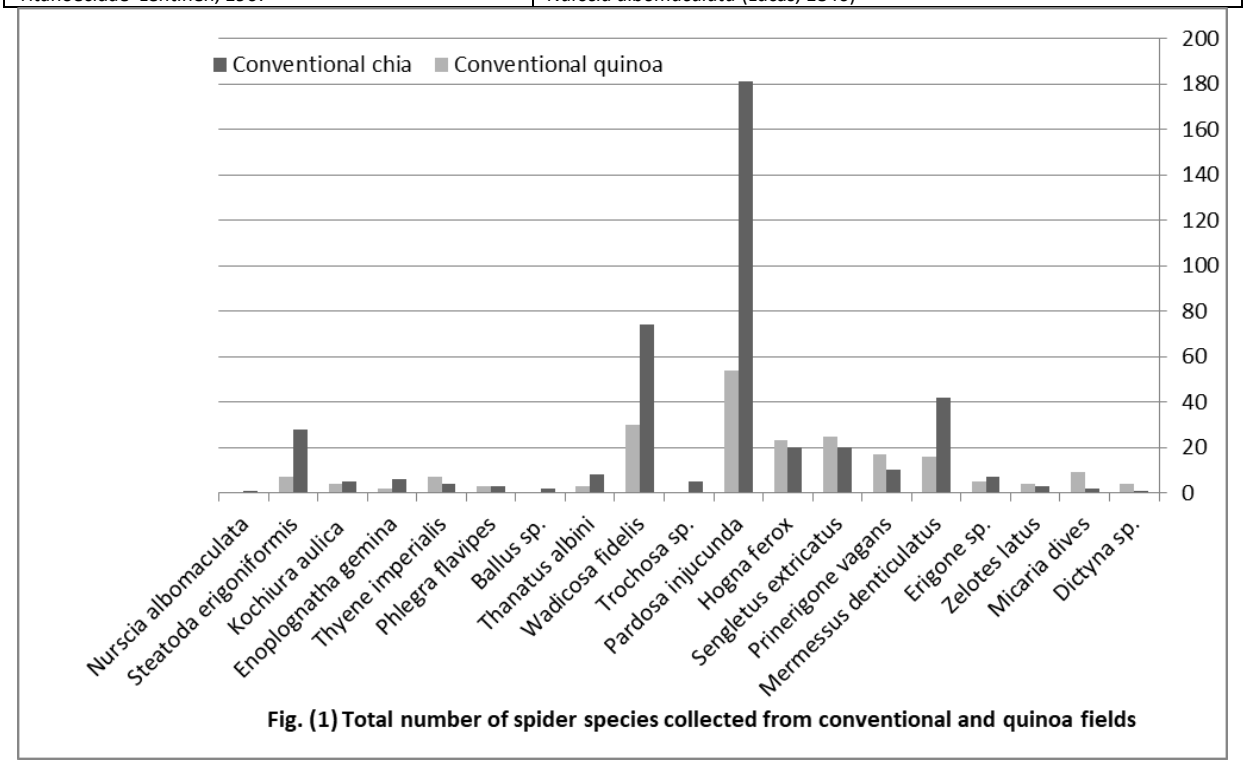

Fig. (1) Total number of spider species collected from conventional and quinoa fields

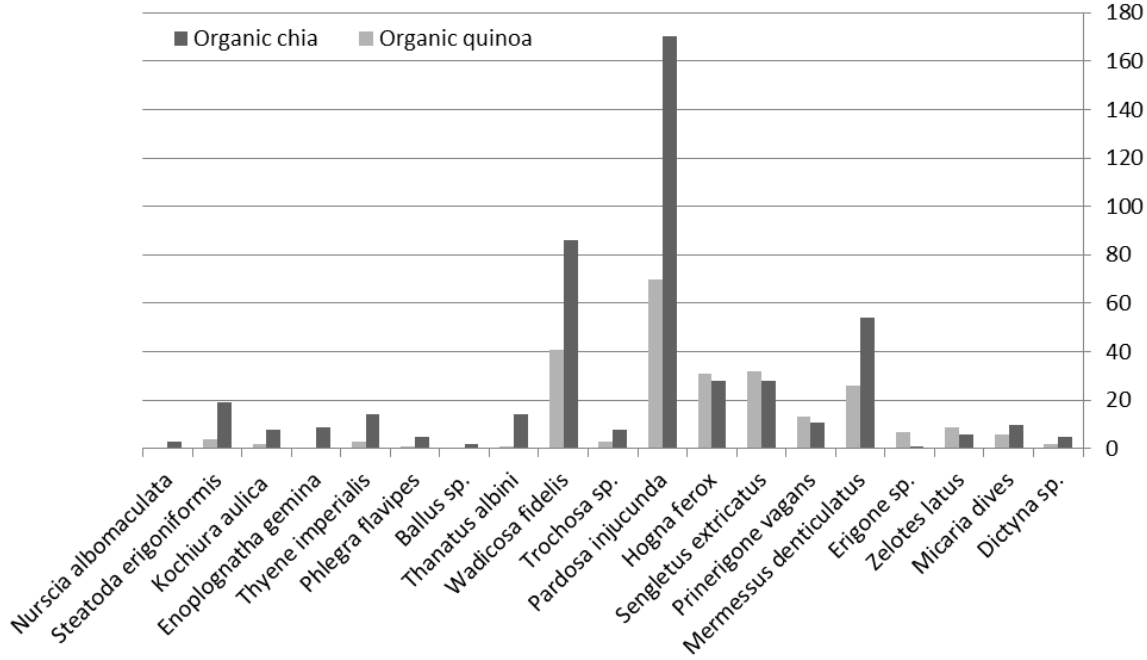

Fig. (2) Total number of spider species collected from organic and quinoa fields

Species restriction:

Spiders inhabiting soil of chia and quinoa:

A total of 909 and 464 spider individuals were collected in chia and quinoa in two cultivations. The species were respectively 21& 16 species. Juveniles comprised 7.09 and 11.73% in chia and 25.82& 25.1% in quinoa, while adults averaged 92.91 and 88.27% in chia and 74.18 and 74.9 % in quinoa, respectively. The sex ratio was 5.14♂: 1.00♀ and 4.88♂: 1.00♀ in chia and 8.29♂:1.00♀ and 7.55♂: 1.00♀ in quinoa, for conventional and organic cultivation respectively Table (2).

Table (2) Species richness of the collected spiders inhabiting chia and quinoa in conventional and organic fields during 2019/2020 season.

Families &taxa names	Conventional												Organic											
	Chia						Quinoa						Chia						Quinoa					
	♂	♀	*j*	Σ	Total	%	♂	♀	*j*	Σ	Total	%	♂	♀	*j*	Σ	Total	%	♂	♀	*j*	Σ	Total	%
Dictynidae																								
Dictyna sp.		1		1	1	**0.24**	1		3	4	4	**1.88**	3	0	2	5	5	**1.03**	2	0	0	2	2	**0.8**
Gnaphosidae																								
Micaria dives	2			2	5	**1.18**	6	2	1	9	13	**6.1**	6	1	3	10	16	**3.29**	4	0	2	6	15	**5.98**
Zelotes latus	2	1		3			2		2	4			3	0	3	6			7	1	1	9		
Linyphidae																								
Erigone sp.	5		2	7			4		1	5			1	0	0	1			2	0	5	7		
Mermessus denticulatus	29	11	2	42	79	**18.7**	13		3	16	63	**29.6**	34	15	5	54	94	**19.3**	17	2	7	26	78	**31.1**
Prinerigone vagans	7	2	1	10			14	1	2	17			5	1	5	11			9	0	4	13		
Sengletus extricatus	11	5	4	20			18	1	6	25			15	6	7	28			22	4	6	32		
Lycosidae																								
Hogna ferox	16	2	2	20			12	3	8	23			22	1	5	28			19	2	10	31		
Pardosa injucunda	154	21	6	181	280	**66.2**	38	5	11	54	107	**50.2**	143	19	8	170	292	**60.1**	48	7	15	70	145	**57.8**
Trochosa sp.	1	3	1	5						0			4	1	3	8			1	0	2	3		
Wadicosa fidelis	53	13	8	74			16	5	9	30			66	16	4	86			28	6	7	41		
Philodromidae																								
Philodromus sp.					8	**1.89**					3	**1.41**	3	1	1	5	19	**3.91**	0	0	0	0	1	**0.4**
Thanatus albini	8			8			2		1	3			11	1	2	14			1	0	0	1		
Salticidae																								
Ballus sp.	1	1		2	9	**2.13**				0	10	**4.69**	2	0	0	2	21	**4.32**	0	0	0	0	4	**1.59**
Phlegra flavipes	2	1		3			1		2	3			4	0	1	5			0	0	1	1		
Thyene imperialis	3		1	4			6		1	7			7	5	2	14			2	0	1	3		
Theridiidae																								
Enoplognatha gemina	4	1	1	6	39	**9.22**	1		1	2	13	**6.1**	7	0	2	9	36	**7.41**	0	0	0	0	6	**2.39**
Kochiura aulica	3	1	1	5			2		2	4			6	1	1	8			0	0	2	2		
Steatoda erigoniformis	26	1	1	28			5		2	7			11	5	3	19			4	0	0	4		
Thomisidae																								
Thomissus spinifer	1			1	1	**0.24**																		
Titanoecidae																								
Nurscia albomaculata	1			1	1	**0.24**							3	0	0	3	3	**0.62**	0	0	0	0	0	**0**
Total	**329**	**64**	**30**	**423**	**423**		**141**	**17**	**55**	**213**	**213**		**356**	**73**	**57**	**486**			**166**	**22**	**63**	**251**		
	423						**213**						**486**						**486**					

Frequency and abundance values:

As presented in Table (3) Lycosidae was considered "constant" (66.19 and 60.08%) in chia and (50.23 and 57.77%) in quinoa. Linyphiidae considered "accessory" (29.58 and 31.08%) only in quinoa, for conventional and organic cultivation respectively. Whilst all remaining families were "accidental" in chia and quinoa.

According to Weigmann classification of dominance, Table (3) showed that Lycosidae represented by four species: *Hogna ferox* (Lucas), *Pardosa* spp., *Trochosa* spp. and *Wadicosa fidelis* (O. Pickard-Cambridge) in chia and quinoa. In chia, *Pardosa* spp. considered "eudominant", *W. fidelis* was "dominant" and *H. ferax* and *Trochosa* spp. were "recedent". While in quinoa all the three species: *H. ferax, Pardosa* spp. and *W. fidelis* were considered "dominant".

In conventional cultivation, subdominant species recorded were *Mermessus denticulatus* (Banks) (Linyphiidae), *Steatoda erigoniformis* (O. Pickard-Cambridge) (Theridiidae) in chia, and *Prinerigone vagans* (Audouin) and *Sengletus extricates* (O. Pickard-Cambridge) (Linyphiidae) in quinoa. While in organic cultivation subdominant species were; *S. extricates*, *H. ferox* and *P. vagans*. However, all remaining species ranged between recedent and subrecedent in both cultivations.

Table (3) The dominance-frequency relationship of spider communities inhabiting chia and quinoa in conventional and organic fields.

Families &taxa names	Conventional										Organic									
	Chia					Quinoa					Chia					Quinoa				
	No.	sp.%	Dom.	F.%	Freq.	No.	sp.%	Dom.	F.%	Freq.	No.	sp.%	Dom.	F.%	Freq.	No.	sp.%	Dom.	F.%	Freq.
Dictynidae																				
Dictyna sp.	1	0.24	**Sr**	0.24	**A**	4	1.88	**R**	1.88	**A**	5	1.03	**R**	**1.03**	**A**	2	0.8	**Sr**	**0.8**	**A**
Gnaphosidae																				
Micaria dives	2	0.47	**Sr**	1.18	**A**	9	4.23	**R**	6.1	**A**	10	2.06	**R**	**3.29**	**A**	6	2.39	**R**	**5.98**	**A**
Zelotes latus	3	0.71	**Sr**			4	1.88	**Sr**			6	1.23	**R**			9	3.59	**R**		
Linyphidae																				
Erigone sp.	7	1.65	**Sr**			5	2.35	**Sr**			1	0.21	**Sr**			7	2.79	**R**		
Mermessus denticulatus	42	9.93	**sd**	18.68	**A**	16	7.51	**R**	29.58	**ac**	54	11.11	**D**	**19.3**	**A**	26	10.36	**D**	**31.1**	**AC**
Prinerigone vagans	10	2.36	**R**			17	7.98	**sd**			11	2.26	**R**			13	5.18	**Sd**		
Sengletus extricatus	20	4.73	**R**			25	11.74	**sd**			28	5.76	**Sd**			32	12.75	**D**		
Lycosidae																				
Hogna ferox	20	4.73	**R**			23	10.8	**D**			28	5.76	**Sd**			31	12.35	**D**		
Pardosa injucunda	181	42.79	**E**	66.19	**C**	54	25.35	**D**	50.23	**C**	170	34.98	**E**	**60.1**	**C**	70	27.89	**D**	**57.8**	**C**
Trochosa sp.	5	1.18	**R**			0	0				8	1.65	**R**			3	1.2	**R**		
Wadicosa fidelis	74	17.49	**D**			30	14.08	**D**			86	17.7	**D**			41	16.33	**D**		
Philodromidae																				
Philodromus sp.				1.89	**A**				1.41	**A**	5	1.03	**R**	**3.91**	**A**				**0.4**	**A**
Thanatus albini	8	1.89	**R**			3	1.41	**R**			14	2.88	**R**			1	0.4	**Sr**		
Salticidae																				
Ballus sp.	2	0.47	**Sr**	2.13	**A**	0	0		4.69	**A**	2	0.41	**Sr**	**4.32**	**A**				**1.59**	**A**
Phlegra flavipes	3	0.71	**Sr**			3	1.41	**R**			5	1.03	**R**			1	0.4	**Sr**		
Thyene imperialis	4	0.95	**Sr**			7	3.29	**R**			14	2.88	**R**			3	1.2	**R**		
Theridiidae																				
Enoplognatha gemina	6	1.42	**R**	9.22	**A**	2	0.94	**Sr**	6.1	**A**	9	1.85	**R**	**7.41**	**A**	0	0		**2.39**	**A**
Kochiura aulica	5	1.18	**R**			4	1.88	**R**			8	1.65	**R**			2	0.8	**Sr**		
Steatoda erigoniformis	28	6.62	**sd**			7	3.29	**R**			19	3.91	**R**			4	1.59	**R**		
Thomisidae				0.24	**A**															
Thomissus spinifer	1	0.24	**Sr**																	
Titanoecidae				0.24	**A**									**0.62**	**A**					
Nurscia albomaculata	1	0.24	**Sr**								3	0.62	**Sr**							
Total	**423**					**213**					**486**					**251**				

Spider guild composition (Functional groups):

The collected spider can be divided into five functional guilds (Table 4) based on their foraging behaviour in the field as described by (Uetz *et al*., 1999).

Hunting spiders:

- Stalkers: Salticidae.
- Ground runners: Lycosidae and Gnaphosidae.
- Ambushers: Philodromidae and Thomisidae.

Web building spiders (aerial web):

- Space weavers: Thridiidae, Titanocidae and Dictynidae.
- Wandering: Linyphidae.

Ground running was the highest species richness representing (67.38 and 63.37%) in chia and (56.34 and 65.02%) in quinoa of the total spiders, followed by wandering sheet with value (18.68 and 19.34%) in chia and (29.58 and 31.08%) in quinoa, for conventional and organic cultivations respectively.

Table 4. Guild classification of spider taxa inhabiting chia and quinoa in conventional and organic fields.

		Conventional										Organic									
	Families and foraging guild	Chia				Quinoa				Common species	Total species	Chia				Quinoa				Common species	Total species
		species richness	No of species	Unique species	%	species richness	No of species	Unique species	%			species richness	No of species	Unique species	%	species richness	No of species	Unique species	%		
Hunting Spider	1- Stalkers																				
	Salticidae	9	3	1	2.13	10	2	0	4.69	2	3	21	3	1	4.32	4	2	0	1.59	2	3
	2- Ground running																				
	Lycosidae	280	4	1	67.38	107	3	0	56.3	3	4	292	4	0	63.4	145	4	0	65	4	4
	Gnaphosidae	5	2	0		13	2	0		2	2	16	2	0		15	2	0		2	2
	3- Ambushers																				
	Philodromidae	8	1	0	2.13	3	1	0	1.41	1	1	19	2	1	3.91	1	1	0	0.4	1	2
	Thomissidae	1	1	1		0	0	0													
Web building	4- Space weavers																				
	Theridiidae	39	3	0	9.69	13	3	0	7.98	3	3	36	3	1	9.05	6	2	0	3.19	2	3
	Titanoecidae	1	1	1		0	0	0		0	1	3	1	1		0	0	0		0	1
	Dictynidae	1	1	0		4	1	0		1	1	5	1	0		2	1	0		1	1
	5- Wandering sheet				18.68				29.6						19.3				31.1		
	Liyphiidae	79	4	0		63	4	0		4	4	94	4	0		78	4	0		4	4
Total		423	20	4		213	16	0		16	19	486	21	4		251	16			16	21

Species diversity

Table (5) compared the biodiversity of collected spiders in different vegetation between chia and quinoa in both cultivations using Shannon-Wiener "H" and Simpson "S" indices of diversity. According to Shannon-Wiener "H" and Simpson indices indicated that chia cultivation included higher number of species diversity in both cultivations with higher value in organic one. Consequently, these values demonstrated that chia harbored more spider numbers, diverse and occurrence than in quinoa in both cultivations.

Table (5) Comparison of structure of collected spiders from chia and quinoa plants

	Conventional		Organic	
	chia	quinoa	chia	quinoa
Shannon-Wiener Index	1.97	2.35	2.21	2.16
Simpson Index	0.23	0.13	0.24	0.18

Similarity of species

Species richness of spiders collected from chia plants (423 and 486 indiv.) was greater than that collected from quinoa plants (213 and 251 indiv.) in conventional and organic cultivations respectively. Among 21 obtained genera about 21species were recorded in chia, while 16 species were recorded in quinoa. To allow a comparison between the habitats of the two cultivations, according to Sørensen′s quotient of similarity (QS) about 0.88 & 0.86 with percentage of similarity reached 88.89 & 86.50% for conventional and organic cultivations respectively.

II- Dominance and abundance of arthropod pests and predators collected by pitfall trap

Total number of arthropods captured from organic cultivation (6703 and 2951 indiv.) were higher than those collected from conventional cultivation (5985 and 2812 indiv.), in chia and quinoa, respectively Table (6). Arthropod pests and predators were represented by 28 species in conventional cultivation and 25 species in organic cultivation. The dominance and abundance indicated that collembola and spiders recorded the highest dominant and abundant in both chia and quinoa. Furthermore, these parameters were recorded in higher number in organic cultivation than the number recorded in conventional cultivation.

Table 6. Dominance and abundance (D and A) of arthropod collected from chia and quinoa in conventional and organic cultivation using pitfall traps during 2019/2020 season

Order	Family	Conventional						Organic					
		Chia	D%	A%	Quinoa	D%	A%	Chia	D%	A%	Quinoa	D%	A%
Coleoptera	Carabidae	122	2.04	93.33	77	2.73	93.33	147	2.19	86.7	91	3.08	80
	Scarabaeidae	8	0.13	26.67	0	0	0	14	0.21	33.33	5	0.17	20
	Staphylinidae	23	0.38	66.67	39	1.38	93.33	18	0.27	40	22	0.75	60
	Coccinellidae	2	0.03	6.67	10	0.35	40	7	0.1	26.7	3	0.1	13.33
Collembola	Collembola	3931	65.68	100	709	25.14	100	4792	71.49	100	1215	41.17	100
Diptera	Agromyzidae	7	0.12	20	5	0.18	13.33	13	0.19	33.33	21	0.71	60
	Cecidomyiidae	175	2.92	60	152	5.39	46.67	201	3	86.7	168	5.69	80
	Muscidae	344	5.75	100	378	13.4	100	322	4.8	93.33	296	10.03	80
	Syrphidae	3	0.05	13.33	0	0	0	9	0.13	33.33	4	0.14	26.7
Heteroptera	Anthocoridae	3	0.05	13.33	0	0	0	0	0	0	0	0	0
	Miridae	4	0.07	13.33	1	0.04	6.67	0	0	0	0	0	0
Homoptera	Aleyrodidae	89	1.49	93.33	3	0.11	13.33	34	0.51	66.7	11	0.37	26.7
	Aphididae	160	2.67	100	43	1.52	80	119	1.78	73.33	25	0.85	46.7
	Cicadellidae	47	0.79	80	17	0.6	53.33	18	0.27	53.33	6	0.2	33.33
Hymenoptera	Apidae	36	0.6	86.67	0	0	0	13	0.19	40	2	0.07	13.33
	Formicidae	370	6.18	100	1007	35.71	100	239	3.57	86.7	681	23.08	100
	Insect parasites	123	2.06	100	57	2.02	100	174	2.6	80	66	2.24	93.33
	Parasitoid wasps	17	0.28	53.33	0	0	0	12	0.18	53.33	3	0.1	20
Orthoptera	Acrididae	4	0.07	20	2	0.07	13.33	2	0.03	13.33	0	0	0
	Gryllidae	6	0.1	26.67	8	0.28	26.67	10	0.15	60	14	0.47	73.33
Thysanoptera	Thripidae	51	0.85	100	28	0.99	73.33	23	0.34	60	9	0.3	33.33
Neuroptera	Chrysopidae	1	0.02	6.67	1	0.04	6.67	0	0	0	0	0	0
Dermaptera	Labiduridae	11	0.18	53.33	4	0.14	13.33	16	0.24	86.7	12	0.41	53.33
Lepidoptera		0	0	0	19	0.67	66.67	4	0.06	20	8	0.27	60
Isopoda		9	0.15	33.33	6	0.21	40	9	0.13	46.7	11	0.37	53.33
Myriapoda		10	0.17	33.33	33	1.17	73.33	6	0.09	40	18	0.61	66.7
Spiders		423	7.07	100	213	7.55	100	486	7.25	100	251	8.51	100
Soil mites		6	0.1	13.33	0	0	0	15	0.22	46.7	9	0.3	26.7
Total		5985			2812			6703			2951		

III- Dominance and abundance of arthropod pests and predators on leaves:

Data in Table (7) revealed that a total of 643 and 488 indiv. in chia and 256 and 238indiv. in quinoa were counted from 15 observations in seedling to maturity for conventional and organic cultivations respectively. Obtained results indicated that phytophagus mite, *Tetranychus urtica* Koch and predatory mite, *Phytoseiulus persimilis* Athias-Henriot were recorded only on chia leaves, while leaf miners, *Liriomyza* spp. and *Tuta absoluta* (Meyrick) were recorded only on quinoa in both cultivations. *Tetranychus urtica* and *Bemisia tabaci* (Gennadius) recorded the highest dominant and abundant in chia, with higher number in conventional cultivation, however *Aphis* spp. and *Thrips tabaci* Lindeman in quinoa, also with higher number in conventional cultivation.

Table 7. Dominance and abundance (D% and A%) of arthropods collected from chia and quinoa leaves in conventional and organic cultivation during 2019-2020 season.

		Conventional						Organic					
families/Species		Chia			Quinoa			Chia			Quinoa		
		Total number	D %	A %	Total number	D %	A %	Total number	D %	A %	Total number	D %	A %
Tetranychidae *Tetranychus urticae*	*Tetranychus urticae* (Eggs)	312	48.52	100	0	0	0	243	49.8	73.33	0	0	0
	Tetranychus urticae Movable stages	74	11.51	100	0	0	0	52	10.7	86.7	0	0	0
Phytoseiidae	*Phytoseiulus persimilis*	11	1.71	40	0	0	0	6	1.23	20	0	0	0
Aleyrodidae	*Bemisia tabaci* (numphs)	190	29.55	100	48	18.75	66.67	136	27.87	86.7	63	26.47	60
Cicadellidae	*Empoasca* spp.	9	1.4	40	30	11.72	60	7	1.43	26.7	22	9.24	73.33
Aphididae	*Aphis* spp.	19	2.95	33.33	66	25.78	93.33	25	5.12	46.7	53	22.27	66.7
Thripidae	*Thrips tabaci*	28	4.35	66.67	45	17.58	93.33	19	3.9	80	34	14.29	80
Agromyzidae	*Liriomyza* sp.	0	0	0	42	16.41	86.67	0	0	0	29	12.18	33.33
Gelechiida	*Tuta absoluta*	0	0	0	25	9.77	73.33	0	0	0	37	15.55	46.7
Total		643			256			488			238		

IV- Data analysis:

Results of the statistical analysis Table (8) showed that significant difference was found between chia and quinoa plants for the population of the studied arthropods, while the difference between conventional and organic cultivation of both crops was insignificant for the occurrence of aforementioned arthropods.

Table 8. Difference between conventional and organic cultivation of chia and quinoa for occurrence of arthropods.

		conventional		Organic		
		Chia	Quinoa	Chia	Quinoa	LSD (5%)
soil fauna	spiders	28.20a	14.20a	32.40a	16.73b	6.92
	other arthropods	370.80a	173.27b	414.47a	180.00b	53.12
plant fauna	*T. urticae* (eggs)	20.80a	0.00b	16.20a	0.00b	6.64
	T. urticae (individuals)	4.93a	0.00c	3.47b	0.00c	1.30
	P. Persimilis	0.73a	0.00b	0.40a	0.00b	0.49
	B. Tabaci	12.67a	3.20c	9.07b	4.20c	3.59
	Empoasca. spp.	0.60bc	2.00a	0.47c	1.47ab	0.97
	Aphis spp.	1.27c	4.40a	1.67bc	3.53ab	2.06
	T. Tabaci	1.87b	3.00a	1.27b	2.27ab	1.12
	Liriomyza sp.	0.00b	2.80a	0.00b	1.93a	1.25
	T. absoluta	0.00b	1.67a	0.00b	2.47a	1.13

Means with a common letter are not significantly different ($p > 0.05$)

DISCUSSION

High number of spiders was recorded in organic cultivation than those recorded in conventional one. This result coincide with (Bengtsson *et al*., 2005; and Schmidt *et al*., 2005) who indicated that organic farming increases species richness and densities. Lycosidae was most abundant family, (Feber *et al.,* 1998; Tahir and Butt, 2009; and Rizk *et al*., 2015) were reported that Lycosidae was the most abundant family.

Lycosidae was considered "constant" (66.19 and 60.08%) in chia and (50.23 and 57.77%) in quinoa for conventional and organic cultivation respectively. These results agree with that of (Shuang-Lin and Bo-Ping, 2006) who indicated that Lycosidae was the dominant family and occupied more than 60% of individual's community. Also our results revealed that *Pardosa* spp. considered "eudominant", *W. fidelis* was "dominant". Similar result was obtained by (Rizk *et al*., 2015) who found that *W. fideles*, and *Pardosa* spp. ranged between "eudominant" and "dominant" according to Weigmann classification of dominance.

Obtained spider species in both cultivation were divided into five functional guilds; ground runners, wandering, ambushers, space weavers and stalkers. This is according to (Cardoso *et al.,* 2011) who suggested that eight guilds were discriminated: (1) sensing, (2) sheet, (3) space, and (4) orb web weavers; (5) specialists; (6) ambush, (7) ground, and (8) other hunters. Also these results agree with those of (Memah*et al.,* 2014) who mentioned that the seven spider guilds were orb-weavers, ground runners, space web builders, stalkers, wandering sheet weavers, foliage runners, and ambushers.

Collembola and spiders recorded the highest dominant and abundant values in both chia and quinoa, also these parameters were found in organic cultivation with higher number than the number recorded in conventional cultivation. These results coincide with (Fountain and Hopkin, 2004) who investigated that collembola are abundant and widespread in soil ecosystems and are important members of the decomposer community. (Moreover and Scialabba, 2007) showed that organic management increases the abundance and species richness of beneficial arthropods living above ground as compared to the inorganic and untreated plots, and some predators such as the spiders tend to exist in high. Furthermore, (Castro *et al*., 2015) investigated that agricultural practices profoundly affect the numbers and kinds of organisms by altering their densities and the ratios of the different groups.

Obtained results indicated that phytophagus mite, *Tetranychus urtica* Koch and predatory mite, *Phytoseiulus persimilis* Athias-Henriot were recorded only on chia leaves. Also, *Bemisia tabaci* (Gennadius) recorded the highest dominant and abundant value in chia. On the other hand *Tetranychus urtica* and *Bemisia tabaci* were recorded with higher number in conventional cultivation than recorded in organic one. However population of *Aphis* spp. and *Thrips tabaci* Lindeman on quinoa plants was higher than those on chia plants, also with higher number in conventional cultivation. (Abou El-Saad, 2015) showed that among the many sucking pests that were recorded *T. urticae* and *B. tabaci* were the highest dominance and abundance. (Yardım and Edwards, 2003) suggested that the application of either organic or synthetic fertilizers could increase pest populations on tomatoes. However, there were lower populations of aphids on tomatoes grown with organic fertilizer than on those grown with synthetic fertilizers.

CONCLUSION

Accordingly, we can conclude that plant type can have an impact on occurrence, population or diversity of different arthropods. On the other hand, farming system can also have an important role on the diversity and abundance of these arthropods.

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تأثير نوع النبات وطريقة الزراعة على تواجد وتنوع وانتشار العناكب ومفصليات الارجل االأخرى فى نباتات الشياوالكينوا

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الملخص العربى

أجريت التجربة على نباتات الشيا والكينوا بمحافظة الفيوم خلال موسم 2020/2019 لدراسة تأثير الزراعة التقليدية والعضوية على تنوع ووفرة العناكب ومفصليات الأرجل الأخرى. تم استخدام المصائد الأرضية لجمع العناكب ومفصليات الأرجل الأخرى في التربة ، بينما تم استخدام طريقة العد المباشر لحصر المفصليات على أوراق النباتات. سجلت العناكب عدد أعلى في الزراعة العضوية (486 و 251 فرد) عن الزراعة التقليدية (423 و 213 فرد) للشيا والكينوا على التوالي. وكانت أكثر العائلات وفرة هي Lycosidae وأكثر الأنواع وفرة *Pardosa* sp. في الشيا والكينوافي كلتا الزراعتين. أوضحت النتائج أن نباتات الشيا تضمنت أكبر عدد من الأنواع السائدة في كلتا الزراعتين. إجمالي عدد المفصليات التي تم جمعها بواسطة المصائد الأرضية (5985 و 2812فرد) في الزراعة التقليدية و (6703 و 2951 فرد) في الزراعة العضوية للشيا والكينوا على التوالي. سجلت مفصليات الأرجل على الأوراق (643 و 488 فردًا في الشيا) و (256 و 238 فردًا في الكينوا) للزراعة التقليدية والعضوية على التوالي. تم تسجيل *Tetranychus urticae* و*Phytoseiulus persimilis* على نباتات الشيا فقط ، بينما تم تسجيل *Liriomyza* sp. و *Tuta absoluta*على نباتات الكينوا فقط في كلتا الزراعتين. سجلت *T. urtica* و*Bemisia tabaci* أعلى نسبة سائدة ووفرة في الشيا، بينما Aphis spp. وThrips tabaci كانت الأكثر وفرة في الكينوا في كلتا الزراعتين.

الكلمات المفتاحية: مفصليات الأرجل، التنوع الحيوي، الزراعة التقليدية، الزراعة العضوية