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Diagnosis of Nematode Populations Found in Chard, Barley and Onion Grown in North of Iraq and South of Turkey

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ABSTRACT: The soil samples of three different crops namely Chards, Barely and Onion in south part of Iraq and north part of Turkey during 2014-2015 were examined and the abundance, distribution and genera of nematodes were diagnosed based on their community compositions and trophic groups. Nematodes from 230 collected soil samples from both countries extracted by Baermann systems, identified, and quantified by microscopic observations. Total number of genera belonging four trophic groups of nematodes were 19, 11, 7, and 8 for free living, plant parasite, omnivorous and predaceous nematodes, respectively. In Iraq, the highest numbers nematodes were found in free living genus of *Cephalobus* with 600, 1044 and 693 individual for Chard, Barley and Onion, respectively. Overall, in Turkey, the highest numbers of free living nematodes were also found in genus *Cephalobus* with 446, 492 and 541 individual for Chard, Barley and Onion, respectively. In study, the greater free living nematode densities in all three crops from both counties were *Cephalobus* followed by *Chiloplacus*, *Rhabditis*, *Monhystera*, *Eucephalobus*, *Acrobeles* and *Wilsonema*. On the other hand, the highest densities of plant parasitic nematodes were observed in *Tylenchus*, *Pratylenchus*, *Aphelenchus*, *Filenchus*, *Ditylenchus*, *Aphelnchoides*, *Heterodera*, *Meloidogyne* and *Helicotylenchus*. Current study indicated that the number of nematodes genus occurred in both countries differed, because of possibly different soil and environmental conditions for nematodes.
Key words: Biodiversity, nematodes, trophic groups, density

Türkiye'nin Doğusu ile Irak'ın Kuzeyinde Yetiştirilen Zeytin, Asma ve Karışık Meyve Alanlarındaki Nematod Yoğunluklarının Tanımlanması

ÖZET: Türkiye'nin doğusu ile Irak'ın kuzeyinde yetişen pazı, arpa ve soğan alanlarından, 2014-15 yıllarında, alınan toprak örneklerinde görülen nematodların trofik yapı ve cinslerine göre yoğunlukları, dağılımları ve biyoçeşitlilikleri araştırılmıştır. Her iki ülkeden alınan toplam 230 toprak örneğinde nematodlar Baermann sistemi yardımı ile elde edilmiş ve ışık mikroskobunda teşhisleri yapılmıştır. Çalışmada, dört trofik gruba ait nematodların cins sayıları bitki paraziti nematodlar için 11, serbest yaşayanlar için 19, predatörler için 8 ve omnivor nematodlar için ise 7 adet olmuştur. Çalışmanın Irak bölgesinde, en yüksek serbest yaşayan nematod sayısı *Cephalobus* cinsinde bulunmuş olup sırası ile pazı, arpa ve soğan için 600, 1044 ve 693 ve Türkiye için ise bu sayılar sırası ile 446, 492 ve 541 olmuştur. Çalışmanın tamamına bakıldığında her iki ülkede de *Cephalobus*'dan sonra sırası ile *Chiloplacus*, *Rhabditis*, *Monhystera*, *Eucephalobus*, *Acrobeles* ve *Wilsonema* cinsleri takip etmiştir. Diğer taraftan, çalışmada en yüksek bitki paraziti nematod sayıları sırası ile *Tylenchus*, *Pratylenchus*, *Aphelenchus*, *Filenchus*, *Ditylenchus*, *Aphelnchoides*, *Heterodera*, *Meloidogyne* ve *Helicotylenchus* olmuştur. Mevcut çalışmada her iki ülkede mevcut faklı toprak ve çevresel faktörlerden kaynaklı nematod cins ve sayılarında farklılıklar gözlenmiştir.
Anahtar sözcükler: Biyoçeşitlilik, nematodlar, trofik grouplar, yoğunluklar

INTRODUCTION

The Phylum Nematoda is extremely varied in terms of species richness and one of the most plentiful metazoan groups on earth. Nematodes cover nearly 90% of all multicellular organisms. Soil nematodes are considered a good indicators of soil quality and play an important role in essential soil processes (Neher, 2001). Nematodes are abundant in soils and contain a high level of trophic variety (Bongers and Bongers, 1998; Yeates et al., 2009) and they could provide significant nitrogen and biomass mineralization to the plants. The sequences of crop turnover in the soil including various crop varieties can also effect nematode presence, community structure and diversity (Rahman et al., 2007). Feeding strategies in the nematodes are varied which cover all main trophic consumer levels and are associated in the degrading of dead organic material, nutrient cycling and microbial activities (Bardgett et al., 1999).

From an environmental viewpoint, nematodes are part of nearly all ecosystems in their roles as herbivores, bacterivores, fungivores, omnivores, predators, plants and animal parasites, and as consumers of organic matter. They are crucial in the flow of cycling and energy of nutrients (Abebe et al., 2011). Nematodes are also important controllers of remains degradation (Ruess and Ferris, 2004). Because nematodes sustain a various life history strategies and gain different food sources, they are considered as a part of trophic levels in the food webs (Hsieha, et al., 2016). Nematodes play a

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remarkably role as bio-pointers of soil health (Wilson and Kakouli-Duarte, 2009). However, some of parasitic nematodes are very important economically across to world, due to their negative effect on cultivated crops, on some animals and people (Blaxter et al., 1998).

The aims of the study were; a) to compare biodiversity of nematodes occurring in fields of Chard, Barley and Onion growing areas of Iraq and in Turkey. b) to determine the population and effect of nematode genera occurring in different crops of both countries.

MATERIAL and METHODS

Study Area

This research was conducted to determine the nematodes populations and their biodiversity in agricultural soils of two countries, Turkey and Iraq. Samples were taken from the agricultural field cultivated with different crops during 2014 and 2015. Soil samples were collected from Chard, Barley and Onions fields in two city of Iraq namely Erbil and Kirkuk and 5 cities of Turkey including Kahramanmaraş, Gaziantep, Osmaniye, Adana and Şanlıurfa. Location of each sample taken were recorded by Global Positioning System (GPS) (Figure 1, 2).

Field Survey

In this study, a total of 230 samples were collected from Chard, Barley and Onions grown soils located in both countries of Iraq and Turkey. The soil samples were taken randomly from top 5 to 25 cm in depth with representing the entire sampled field. Samples were taken based on 6 sub-samples (cores) by a zigzag pattern. Approximately 500 cm^3 of soil volume for each samples were placed into a polyethylene bag to prevent sun light and high temperature exposure. The taken samples were labeled with information needed and transported to the lab in an ice chest for further evaluations. The abundance of nematodes were determined based on 100 cm^3 sub soil samples for each location of each crop.

Figure 1. A view of soil sampling areas of both south of Turkey and north of Iraq.

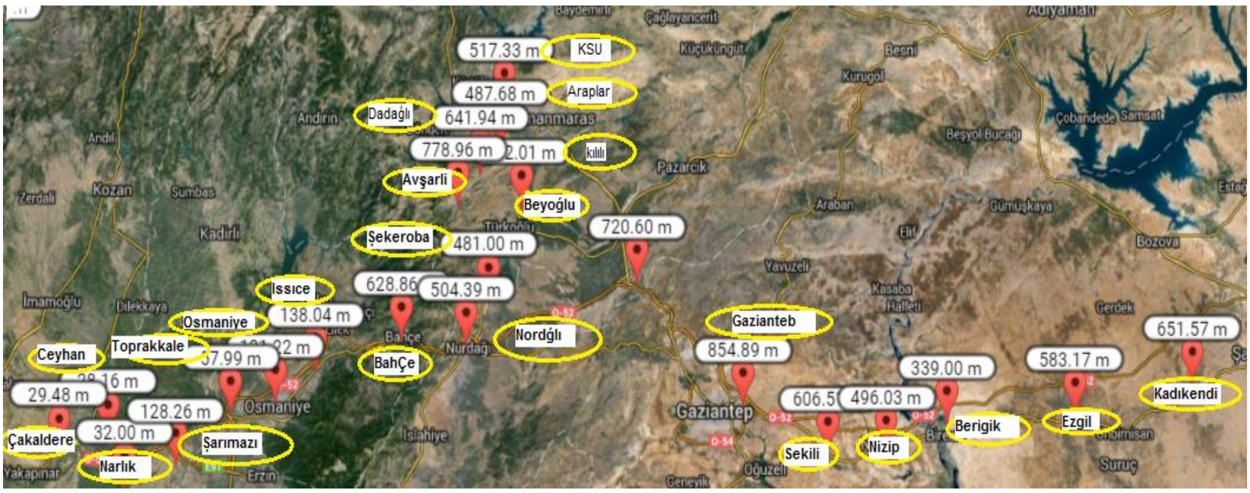

Figure 2. A view of soil sampling areas of south of Turkey.

Extraction producers of nematodes

Modified Baermann Funnel procedure was used for 10 days to extract occurring nematodes as outlined by Barker and Campbell, (1981). Extraction process of nematodes was finalized by sieving the nematode containing suspension with a 500 mesh-opening sieve (Spaull and Braithwaite, 1979). Extracted nematodes were identified to genus level and comparative abundance was assessed in each sample by a light microscope. Some of nematodes found in the sample were fixed for imaging and kept for further studies (Kimenju et al., 2004).

Morphological identification

Nematodes identification is primarily based on morphological characters and morphometric measurements. Several morphological characteristics used in the identification of the species such as overall size, shape, presence and shape of the stylet, stylet knobs, stage of development, juvenile vs adult. Some morphological traits are not visible thus collected nematodes were identified to the genus level via an inverted compound microscope, Lx400 Labomed (40 to 60X) (Bridge and Starr, 2007). The nematodes were assigned bacteriovores, fungivores, plant parasites and omnivores or predators (Yeates et al., 1993).

RESULTS and DISCUSSION

Nematode populations and biodiversity for two different countries, Iraq and Turkey, varied. Overall, 37 nematodes genus were identified in both countries.

In Iraq, samples taken from the soils of Chard, Barley and Onion, sixteen genera of nematodes were identified with the number of nematodes 2082, 3804 and 1793, respectively. In Turkey, 18 genera were identified with the number of nematodes 2366, 2398 and 2885 for Chard, Barley and Onion, respectively (Table 1).

In Iraq, 8 genera of nematodes were identified with the number of nematodes of 1260, 3202 and 764 for Chard, Barley and Onion, respectively. In Turkey, however, the number of nematode genera were found to be 10 and the total number of nematodes counted as 1085, 1388 and 1455 for Chard, Barley and Onion, respectively (Table 2). In Iraq, the number of nematode genera identified were 5 and the number of nematodes were 227, 557, and 155 for Chard, Barley and Onion, respectively. In Turkey, however, the number of nematode genera were 7 and the number of nematodes for Chard, Barley and Onion 435, 491 and 573, respectively (Table 3). The highest and the lowest number of predacious nematodes through all crops from both countries were 632 and 225 in Onion of Iraq and Onion of Turkey, respectively (Table 4).

Accumulative total of 36 genera were observed from soil samples of both countries from all three crops. Total of 16 free living nematode genera were identified from soil samples of all crops Chard, Barley and Onion in Iraq. Of which, *Cephalobus* spp. *Eucephalobus* spp. *Monhystera* spp. *Chiloplacus* spp. *Rhabditis* spp. *Acrobeles* spp. *Wilsonema* spp. *Amphidelus* spp. *Acrolobus* spp. *Cervidelus* spp. Geomonhystera spp. *Panagrolaimus* spp. *Prismatolaimus* spp.), were bacterivorous, *Aphelenchus* app. *Aphelenchoides* spp. *Tylenchus* spp. and *Ditylenchus* spp. were fungivorous nematodes. The latter five genus were also consider as plant parasites except *Dorillum* spp. (Table 5).

Eight plant parasitic nematodes genera specifics from soil samples collected from Chard, Barley field were *Ditylenchus* spp. *Meloidogyne* spp. *Pratylenchus* spp. *Heterodera* spp. *Tylenchus* spp. *Aphelenchus* spp. *Aphelenchoides* spp. and *Helicotylenchus* spp. (Table 6). Seven genera of omnivorous nematodes and predacious nematodes from all crops Chard, Barley and Onion soil samples were existed including *Labronema* spp. *Ecumenicus* spp. *Eudorylaimus* spp. (also considered predacious nematode), *Aprocelaimus* spp. and Dorylaimus spp. *Mesodorylaimu*s spp. *Enchodelus* spp. (Table7). Overall eighteen genera of free living nematodes including *Cephalobus* spp. *Eucephalobus* spp. *Monhystera* spp. *Chiloplacus* spp. *Rhabditis* spp. *Acrobeles* spp. *Wilsonema* spp. *Amphidelus* spp. *Acrolobus* spp. *Cervidelus* spp. *Panagrolaimus* spp. *Geomonhystera* spp. and *Prismatolaimus* spp. as bacterivorous, *Aphelenchus* spp. *Aphelencoides* spp. *Tylenchus* spp. *Ditylenchus* spp. *Dorillum* spp. as fungivorous were detected in Chard and Barley. (Table 5). Total of 10 genera of plant parasitic nematodes namely *Aphelenchus* spp. *Aphelenchoides* spp. Pratylenchus spp. *Heterodera* spp. *Tylenchu*s spp. *Helicotylenchus* spp. *Meloidogyne* spp. *Psilenchus* spp. *Filenchus* spp. and *Ditylenchus* spp. were detected in Chard and Onion of Turkey. *Psilenchus* spp. was not observed in Barley in both countries (Table 6)

Seven omnivorous and predacious genera identified from Chard, Barley and Onion including *Labronema* spp., *Eudorylaimus* spp., *Aporcelaimus* spp. *Ecumenicus* spp. *Enchodelus* spp. (also considers as predacious nematode), *Mesodorylaimus* spp. and *Dorylaimus* spp. were found.in both countries (Tables 7)

In this study nematodes communities were monitored and quantified in the soil samples taken from Chard, Barley and Onion growing agriculture areas of two countries. Nematode community structure categorized based on taxonomic family and trophic groups (i.e. bacterivores, fungivores, plant-parasite, omnivores and predators). Sampling approaches, the spatial investigation and nematode distributions in the field were similar to that reported by Neher et al., (2005), Zhang et al., (2012). Using Cobb's sieving and decanting technique the samples taken from soils of all fields and then followed by modified Baermann technique (Young-Mathews et al., 2010). Studies on nematode community structure in cultivated soils showed that nematodes are one of the most abundant components of the micro fauna of agricultural soils (Boag and Yeates, 1998).

Nematode community structure and diversity (Bulluck et al., 2002) are affected by the soil amendments, this also true for soil texture (Hunt, 1993), soil temperature (Boag et al., 1991) and broad vegetation types (grasses versus woody plants) (Boag and Orton Williams, 1976). However, they stay constant with the cultivation. Water level also effects on the activity and population of nematodes in soil reported by Steinberger and Sarig, (1993) Thus there are studies showed that rainfall is the main impact on the nematode and its species population densities. This might be the case with our study, where the differences in rainfall or soil moisture content might have caused the differences between the countries nematode community structure and densities.

During 2014-1015, the soil samples taken from the fields of Chard, Barley and Onion in both countries showed similarity in number of genera of the free living nematodes. However, there were differences in the number of each genera presented in the soil samples of the fields in both countries. Seven genera of predacious nematodes were identified at both countries with nearly same abundance within all three crop fields Chard, Barley and Onion respectively. (Table 7). There were some differences in the genera number of Omnivorous nematodes between both countries. The soil samples from all three fields of Chard, Barley and Onion Iraq contained only 5 genera. However, all three crops of Iraq did not have any nematodes belonging the genera *Mesodorylaimus* spp. and *Enchodelus* spp.

Table 1. Total numeral of free living nematodes (frugivorous and bacterivorous) and belonging genus bring in 100 cm^3 soil sample taken from Chard, Barley and Onion of Turkey and Iraq in 2014-2015.

Crops	North of Iraq		South of Turkey	
	Number of nematodes	Number of genera	Number of nematodes	Number of genera
Chard	2082	16	2366	18
Barley	3804	16	2398	18
Onion	1793	16	2885	18

Table 2. Total numeral of plant parasitic nematodes and belonging genus bring in 100 cm^3 soil sample taken from Chard, Barley and Onion of Turkey and Iraq in 2014-2015.

Crops	North of Iraq		South of Turkey	
	Number of nematodes	Number of genera	Number of nematodes	Number of genera
Chard	1260	8	1085	10
Barley	3202	8	1388	9
Onion	764	9	1455	10

Table 3. Total numeral of omnivorous nematodes and belonging genus found in 100 cm^3 soil sample taken from Chard, Barley and Onion of Iraq and Turkey in 2014-2015.

Crops	North of Iraq		South of Turkey	
	Number of nematodes	Number of genera	Number of nematodes	Number of genera
Chard	227	5	435	7
Barley	557	5	491	7
Onion	155	5	573	7

Table 4. Total numeral of predacious nematodes and belonging genus found in 100 cm^3 soil sample taken from Chard, Barley and Onion of Iraq and Turkey in 2014-2015.

Crops	North of Iraq		South of Turkey	
	Number of nematodes	Number of genera	Number o f nematodes	Number of genera
Chard	289	7	373	7
Barley	610	7	530	6
Onion	225	6	632	6

 Araştırma Makalesi/Research Article
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Table 5. The mean number of Bacterivorous and Fungivorous nematodes found in chard, barley and onion in Iraq and Turkey in 2014-2015.

Crops			Barley	Chard	Onion		Barley	Chard	Onion
	Cephalobus		15.78b	23.72a	22.3a		12.61a	13.51a	12.88a
	Eucephalobus		0.78b	2.11ab	4.16a		2.51b	4.48a	2.57b
	Monhystera		2.76a	2.90a	2.41a		6.00b	8.21a	8.19a
	Chiloplacus		5.84a	5.20a	4.06b		11.02ab	10.18b	12.64a
	Rhabditis		6.6a	5.45a	3.09b		6.17b	8.48a	6.00b
Bacterivorous	*Acrobeles*		0.68b	2.77a	0.51b		1.51b	2.24a	2.80a
	Wilsonema		1.60a	1.0ab	0.51b		0.50a	0.57a	0.71a
	Amphidelus		1.23a	0.54ab	0.38b		0.10a	0.18a	0.28a
	Acrolobus	North of Iraq	0.34b	0.36b	1.03a	South of Turkey	0.35a	0.48a	0.66a
	Cervidelus		0.13a	0.27a	0.35a		0.07a	0.12a	0.00a
	Panagrolaimus		0.34b	0.68a	0.29b		0.07a	0.36a	0.14a
	Geomonhystera		0.00	0.00	0.00		0.66ab	1.03a	0.42b
	Prismatolaimus		0.00	0.00	0.00		0.61a	0.54a	0.19b
	Aphelenchus		7.28b	14.0a	5.29b		6.30a	7.50a	7.04a
Fungivorous	*Aphelencoides*		4.68b	0.79c	7.32a		1.66a	0.66b	1.61a
	Tylenchus		5.13b	21.0a	4.38b		5.66b	8.70a	8.21a
	Ditylenchus		1.07b	4.56a	1.32b		5.10a	3.36b	3.40b
	Dorillum		0.52b	1.00a	0.32b		0.41a	0.90a	0.83a

Data are an average of nematode numbers per sample. Data transformed with log10(x+1) but actual numbers are presented. Means within a row in the same country followed by the same letter are not different according to Duncan's multiple-range test ($P \leq 0.05$).

Table 6. The mean number of plant parasitic nematodes found in chard, barley and onion in Iraq and Turkey in 2014-2015.

		North of Iraq			South of Turkey		
	Crops	Barley	Chard	Onion	Barley	Chard	Onion
Plant Parasitic Nematodes	*Aphelenchus*	12.97a	8.32ab	5.90b	6.41a	6.88a	7.58a
	Aphelenchoides	0.86b	2.9ab	7.00a	1.74a	0.76b	1.88a
	Pratylenchus	20.34a	7.92b	3.51c	8.53a	6.14b	6.39b
	Paratylenchus	1.54a	1.42a	0.87a	1.56ab	2.29a	0.86b
	Tylenchus	21.0a	6.35b	4.30b	6.79a	9.47a	8.46a
	Helicotylenchus	1.09a	1.80a	0.83a	1.23a	0.61a	1.04a
	Meloidogyne	10.70a	0.92b	0.7b	0.64a	0.20a	0.41a
	Psilenchus	0.00a	0.00a	0.10a	0.00a	1.11a	0.62a
	Filenchus	0.00	0.00	0.00	4.17a	2.08b	2.51b
	Ditylenchus	4.20a	1.82b	1.10b	4.48a	2.32b	4.04a

Data are an average of nematode numbers per sample. Data transformed with log10(x+1) but actual numbers are presented. Means within a row in the same country followed by the same letter are not different according to Duncan's multiple-range test ($P \leq 0.05$).

Table 7. The mean number of predacious nematodes found in chard, barley and onion in Iraq and Turkey in 2014-2015.

		North of Iraq			South of Turkey		
	Crops	Barley	Chard	Onion	Barley	Chard	Onion
Predacious Nematodes	*Labronema*	5.29a	2.75b	2.80b	2.30b	5.09a	5.23a
	Eudorylaimus	2.79a	1.60b	1.51b	2.84a	2.18a	2.46a
	Senura	0.25b	0.15b	0.70a	0.17a	0.36a	0.09a
	Mononchus	3.68a	1.90b	1.29b	0.92b	2.57ab	5.93a
	Discolaimus	1.02a	0.60b	0.54b	0.35b	0.24b	0.79a
	Aprocelaimus	0.47a	0.07b	0.00b	0.30a	0.54a	0.18a
	Anatonchus	0.34a	0.15a	0.45a	0.00b	0.30a	0.00b

Data are an average of nematode numbers per sample. Data transformed with log10(x+1) but actual numbers are presented.
Means within a row in the same country followed by the same letter are not different according to Duncan's multiple-range test ($P \leq 0.05$).

CONCLUSION

In current study, 37 genera belonging to different nematodes trophic groups from Chard, Barley and Onions field's soils of different parts of two countries were diagnosed. From the soil samples taken at both countries, four trophic groups belonging free living, plant parasite, omnivorous and predaceous were identified. Total of nineteen genera from free-livings, 10 genera from plant parasites, 5 genera from omnivorous and 7 genera from predaceous.

We can conclude that the number and genera of nematodes from the Turkey province was higher than Iraq, this may be due to differences in moisture, climate, the tillage or crop rotation. The individual number of free-living nematodes were higher than all other three nematodes, and we noticed that individual numbers of plant parasite nematodes from Barely crops were higher in both countries than other crops. In general highest individual numbers containing genera was *Cephalobus* followed by *Aphelechus*, *Rhabditis*, *Tylencus*, *Pratylencus*, *Monhystera*, *Chiloplacus*, *Eucephalobus*, *Meloidogyn*, *Heterodera*, *Aphelencoided*, *Ditylencus*, *Helycotylencus*, *Labronema*, *Monhestera*, *Eudorilymus*, respectively. The lowest number of diagnosed nematodes were *Psilenchus*, *Cervidelus*, *Prismatolaimus*, *Amphidelus*, *Wilsonema*, *Geomonhystera*, *Anatonchus*, *Aporcelaimus*, *Senura*, *Discolimus*, and *Ecuminicus*.

In current study, within the three different crops fields of two countries, the genera and species of nematodes showed that there were differences of obtained data. Because of difference in the geographic and climatic region of both countries, the nematode biodiversity in some degree is inevitable. More detailed studies covering more areas of related crops are needed.

Therefore, it is not surprising that nematode communities varied among regions. Thus, the region and ecosystem type can be used for the interpretation of nematode index values (Ruess, 2003).

We suggest that there should be farmers' awareness about the plant parasite nematodes and their expected damages to the farms. In addition, they should be inform about the managing nematodes. More comprehensive studies with wider crop varieties needed to be conducted to learn more of nematode density and biodiversity.

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