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Original article

First record of phyto-parasitic nematodes associated with potato in Erbil and Duhok Provinces Kurdistan Region, Iraq

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Abstract

Potato is considered a crucial food crop globally; however, various biotic factors, including plant-parasitic nematodes, significantly restrict its productivity. This study aimed to identify nematodes associated with potato cultivation in Erbil and Duhok provinces of the Kurdistan Region of Iraq throughout the 2024 growing seasons. Notably, six phyto-parasitic nematodes were recorded for the first time, including: *Tylenchorhynchus* spp., *Ditylenchus destructor*, *Pratylenchus* spp., *Paratylenchus* spp., *Helicotylenchus* spp., and *Tylenchus* spp. The stunt nematode *Tylenchorhynchus* spp. was the most prevalent nematode in potato producing fields, with a higher population density (241.66 nematodes / 200 g of soil) and maximum percentage of absolute frequency (83.33%), relative frequency (17.41%) and absolute density (171.26%), followed by the pin nematode *Paratylenchus*, while the lowest percentage of population density (86.33 nematodes / 200 g of soil) was recorded by *Tylenchus* and minimum percentage of each, absolute frequency (8.33 %) and relative frequency (1.96%) was recorded by the spiral nematode *Helicotylenchus.* All nematode genera were extracted from infected potato roots and rhizosphere soil while the potato rot nematode *Ditylenchus destructor* was extracted from infected potato tubers and the surrounding soil. The results indicated that the prevalence and quantity of plant-parasitic nematodes in potato cultivation regions in Erbil and Duhok could potentially lead to significant output losses. Comprehensive surveys are necessary to accurately determine the distribution, frequency, and identification of plant-parasitic nematode species in these regions.

Keywords: distribution, morphometric, phyto-parasitic nematodes, potato

Introduction

Potato (*Solanum tuberosum* L.) is a crucial food crop globally, serving as a mainstay for over half of the global population (Grupa-Urbańska *et al*. 2025). It is commonly referred to as the king of vegetables and is highly vulnerable to phyto-nematodes. The Ministry of Agriculture and Water Resources reports substantial advancement in this area, as evidenced by a notable increase in potato production. Over a period of 14 years, potato production increased fiftyfold, growing from 12,000 to over 600,000 tones. It has also been identified as being infected by several plant parasitic nematodes (PPNs). The life cycle of PPNs is comprised of egg, juvenile, and adult stages. They belong to soil-borne pests that induce substantial alterations to agricultural crops globally.

Currently, there is insufficient information regarding the prevalence of PPNs associated with potato plants in the Kurdistan Region of Iraq. PPN injury significantly reduces tuber quality and leads to yield loss in potato in the field and during storage. The cyst nematode *Heterodera mothi* Khan & Husain,1965 was documented for the first time in Iraq by Husain *et al*. (1978). *Heterodera* spp. were identified in the roots of grapevine, almond, cherry, and date palm in Ninevah Province, Northern Iraq (Husain *et al.* 1978; Stephan *et al*. 1985). The roots of plant species are often infested by one or more plant-parasitic nematodes. The majority of these plant-parasitic nematodes are imperceptible to the unaided eye. Under optimal environmental conditions and with suitable hosts, nematode populations can proliferate, resulting in significant economic crop losses.

The symptoms produced by nematodes are not readily diagnosable in the field and may be mistaken for other illnesses, pests, nutritional deficiencies, or environmental variables. Diagnosing nematode damage typically requires testing soil or plant materials to accurately assess nematode populations in the field. Additionally, information on their dynamics and their potential impact on the cause of yield loss is essential for formulating an effective management strategy (Palomares-Rius *et al*. 2014). Globally, more than 10 of the most significant nematode genera associated with potato plants have been identified, namely *Meloidogyne*, *Pratylenchus*, *Heterodera*, *Ditylenchus*, *Globodera*, *Tylenchulus*, *Xiphinema*, *Radopholus*, *Helicotylenchus*, and *Rotylenchulus* (Sasser and Freckman 1987; Whitehead 1997; Dobosz *et al*. 2020). Furthermore, from the potato growing region the following nematode genera, including *Tylenchorhynchus*, *Paratylenchus* and *Tylenchus*, were recovered (Prasad 2008; Marais *et al*. 2023). Their effects are less than the other destructive parasitic nematodes on potato plants worldwide such as *Globodera* spp., *Melodogyne* spp. or even *D. destructor.* Several of these genera are recognized as economic pests affecting potato crops (Ames *et al*. 1996; Coyne *et al*. 2003).

Furthermore, data regarding nematode, behavior and possible yield losses which they may cause are essential for developing a suitable management approach. This study was conducted to identify plant parasitic nematodes associated with potato plants, their prevalence and occurrence in Erbil and Duhok provinces, as well as to evaluate the nematode community affecting potato plants in those areas.

Materials and Methods

Sample collection

Soil and root samples with potato tubers were randomly collected from designated sites in the main potato-producing regions of Khabat, Qushtapa and Ainkawa of Erbil Province, as well as in Bardarash, Akre, and Shekhan in Duhok Province (Fig.1). Potato plants on numerous fields exhibited symptoms including wilting, stunted growth, and yellowing leaves throughout the surveys. A minimum of 10 roots and soil sub-samples were collected from each field and placed in polyethylene bags for processing. A total of 120 soil and tuber samples were gathered from 12 locations in 6 districts of Erbil and Duhok provinces. Soil samples were obtained by utilizing an auger at a depth of 20 cm and within a 20 cm radius surrounding the rhizosphere of potato plants (Barker and Davis 1996). A random pattern of sampling technique was employed to gather soil and root samples from potato fields. The collected soil samples were combined in sealed bags and meticulously mixed into a composite sample, and subsequently sieved through a mesh sieve to remove any debris or stones.

Sample collection sites

The survey was conducted in Khabat at coordinates 36.188247’’N 43.594930’’E, 36.249306’’N, 43.646192’’E, Qushtapa at 36°02'21.3"N 43°58'46.5"E, 35.997831’’N, 44.075019’’E and Ainkawa at 36.298390’’N, 43.904774’’E, 36.341825’’N, 43.862982’’E in Erbil Province, as well as Shekhan at coordinates (36.681724’”N, 43.431287’’E), (36.706268’’N, 43.276772’’E) Akre at (36.699330’’N, 43.762421’’E), (36.637404’’N, 43.723268’’E) and Bardarash at (36.356727’’N, 43.746572’’E), (36.292982’’N, 43.635204’’E) in Duhok province, all of which are located within the Kurdistan Region – Iraq (Fig. 1).

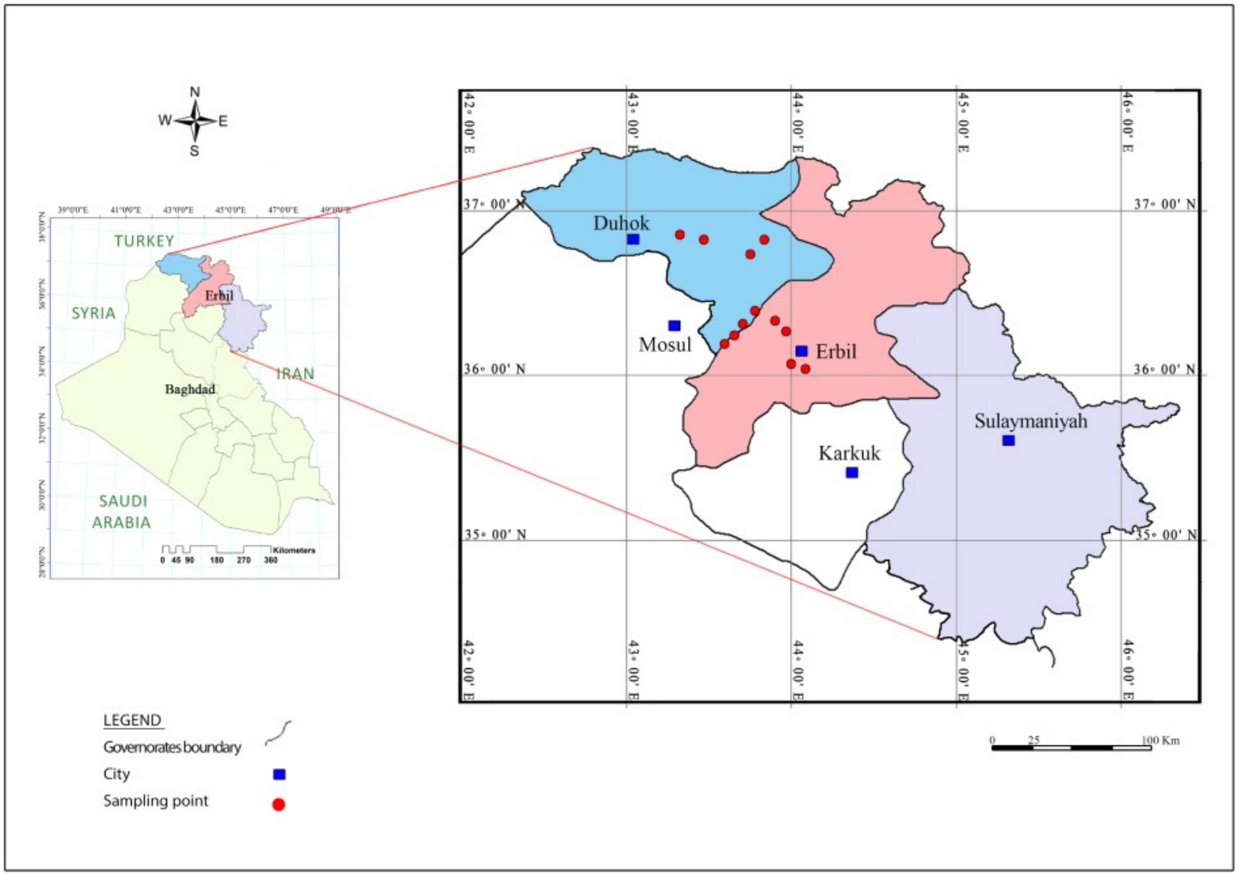

Fig. 1. Map of surveyed area

Nematode extraction from soil samples

Nematodes were extracted from soil by using the tray method as described by Coyne *et al.* (2007), where soil samples were placed on tissue paper on a sieve placed inside a tray (collecting dish). Distilled water was then carefully added directly to the tray below the sieve until the water level was slightly above the surface of the soil sample. All trays were covered to prevent evaporation. After 2 days, the sieves were removed from the collecting tray to discard the soil samples. The nematode suspension was poured into a separate beaker for each sample, and into a fine-mesh sieve if the nematode suspension was cloudy (muddy suspension). The nematodes were then rinsed from the sieve into the beaker using a washing bottle, where samples were examined for nematode identification over several days.

After collecting the nematodes using a special technique described by Seinhorst (1966), permanent slides of the nematode individuals were prepared and identified under a light microscope.

Nematode extraction from root samples

Extraction from the root tissues (10 g / sample) was performed using the root maceration method (Coyne *et al*. 2007), where root samples were cut into small pieces and a sub sample of 10 g was placed in a blender with a sufficient amount of a distilled water to cover the roots and blades. The blended suspension was poured into a beaker, which was then poured onto tissue paper to be extracted by the tray method.

Due to differences in sampling location, the distances between them and positions in potato fields, an analysis was conducted to determine the community structure of plant-parasitic nematodes. The formulas used by Norton (1978) were utilized in order to determine the population densities of the various nematode species that were present in the samples.

Absolute Frequency (AF)% = (No. of samples containing a genus or species / No. of samples collected) × 100

Relative Frequency (RF) % = (AF of a genus or species / Sum of frequencies of all nematode genera) × 100

Absolute Density (AD) % = (No. of individuals of a genus or species in a sample / weight of the sample) × 100

Nematodes were categorized by genus using morphological characteristics and identification keys. In general, nematodes can be identified by their overall appearance, including posture, growth, cuticle morphology, body size, and the anterior portion (mouth, head, skeleton, stylet, esophagus, median bulb, overlapping of esophagus, body wall, reproductive organs, tail form) (Southey 1986). Nematodes were identified by analyzing their morphological and anatomical traits under a microscope or through pictures. The identification of nematode genera was based on a key for agriculturally significant plant-parasitic nematodes (Mekete *et al*. 2012; Mai 2018).

Measurements

Four primary morphometric and morphological criteria were used for identification. The abbreviations and their definitions for the de Man's ratios and other indices used in tables are as follows: n = number of specimens on which measurements are based, L = overall body length, stylet length, body diameter at the base of the stylet, V = % distance of vulva from anterior = (distance from anterior end to vulva / total body length) ×100, a = body length / greatest body diameter, b = body length / distance from anterior to esophago-intestinal valve, b' = body length / distance from anterior to base of esophageal glands, c = body length / tail length and c' = tail length / tail diameter at anus or cloaca. The software ImageJ for Windows® (version 2.00) was used in interactive mode to determine the morphometric parameters of plant-parasitic nematodes associated with potato (n = 5). A digital camera was used to take the photomicrographs. Mean values (x) and standard deviation (SD) were calculated (Cornejo-Condori *et al*. 2021).

Results

During this survey 120 soil, root and tuber samples were collected from Erbil and Duhok provinces. Results revealed that plant parasitic nematode genera were detected in 90% of the samples. The genera of plant parasitic nematodes and their abundance in the study areas were determined. The average abundance per 200 g of soil was 341.66 in Grdmala village, Qushtapa distric, Erbil province as a minimum level, while in Bastam village, Khabat district, Erbil province the average was 642.98, which was its maximum level, both individual and in addition to samples of infected roots and tubers (Table 1). Some genera of free-living nematodes were also detected with an average of 253.66 – 407.33 nematodes / 200 g of soil.

Table 1. Distribution of plant parasitic nematodes associated with potato plants in 12 different localities of Erbil and Duhok Provinces / Kurdistan Region, Iraq (nematode population / 200 g soil)

Province	District	Village	Identified nematode genera or species							
			Tylenchorynchus	*Ditylenchus destructor*	*Paratylenchus*	*Pratylenchus*	*Helicotylenchus*	*Tylenchus*	Nematode population	Free living
Erbil	Khabat	Sfaya	200.66		151.66	113.66		122.66	588.64	271.66
		Bastam	100.33	202.66	128.33	97.33		114.33	642.98	253.66
	Qushtapa	Quchablbas	188	117.33		112.33		102.33	519.99	305.33
		Grdmala	200.33			141.33			341.66	354.66
	Ainkawa	Daraban	200.66		213.33		192.33		606.32	311.66
		Saydan	241.66	104.66	153.33			130.66	630.31	281.33
Duhok	Bardarash	Khandak		115.33	112.66			121.66	349.65	383.66
		Kawrasor	148.33	144.33	139.33			86.33	518.32	347.33
	Akre	Grasen		107.66	107.33	132.66		182.66	530.31	369.66
		Yakmala	103.33	189.33				103.22	395.88	374
	Shekhan	Bahadre	211.66		132.66				344.32	407.33
		Mahad	117.66	101.33	93.66			71.66	384.31	322.33
Total number			1712.62	1082.63	1232.29	597.31	192.33	1035.51	5852.69	3982.61

The most abundant and frequently encountered genus of plant-parasitic nematodes was the stunt nematode *Tylenchorynchus* spp., with an average of 241.66 nematodes / 200 g of soil, while the least abundant genus was the spiral nematode *Helicotylenchus* with an average of 192.33 nematodes / 200 g of soil (Table 1). Thus, the plant-parasitic nematode genera that were most abundant and commonly observed, along with their diagnostic features and morphometric measurements detailed in Table 2, were the stunt nematode *Tylenchorynchus* spp., root rot nematode *Ditylenchus destructor*, pin nematode *Paratylenchus* spp., root lesion nematode *Pratylenchus* spp., spiral nematode *Helicotylenchus* spp. and *Tylenchus* spp. In the infected roots one phyto-parasitic nematode species was identified as *Pratylenchus* spp., in addition to one nematode species in tubers which was *D. destructor* (Fig. 2).

Table 2. Morphometry of plant parasitic nematodes associated with potato roots and tubers All measurements are in µm and in the format: mean ± S.D. (range)

Characters	*Tylenchus* spp. m	*Tylenchus* spp. f	*Ditylenchus* spp.	*Tylenchorynchus* spp. m	*Tylenchorynchus* spp. f	*Paratylenchus* spp.	*Pratylenchus* spp.	*Helicotylenchus* spp.
L	609.9 ± 0.39 (609.5-610.4)	821.7 ± 0.99 (820.4-822.8)	825.18 ± 1.41 (823.2-826.7)	997.55 ± 4.3 (994.5-1000.6)	1156.42 ± 2.2 (1153.2-1158.9)	377.2 ± 1.02 (375.8-378.8)	445.42 ± 0.71 (444.7-446.5)	593.3 ± 1.67 (590.7-595.9)
greatest body diameter	19.2 ± 0.37 (19.1-19.7)	27.7 ± 0.83 (26.6-28.6)	33.2 ± 0.59 (32.5-33.9)	39.8 ± 1.2 (38.9-40.6)	42.2 ± 1.1 (40.8-43.8)	17.08 ± 1.08 (15.5-18.6)	20.16 ± 0.63 (19.3-20.9)	25.6 ± 0.68 (24.5-26.4)
distance from anterior to esophago-intestinal valve	109.3±0.33 (108.9-109.7)	73.6 ± 0.88 (72.4-74.5)	121.32 ± 0.69 (120.5-122.1)	116.3 ± 1 (115.6-117)	162.1 ± 1.2 (160.2-163.9)	85.38 ± 0.68 (84.1-86.1)	71.88 ± 0.61 (70.8-72.5)	117 ± 0.92 (115.2-118.2)
distance from anterior to base of esophageal glands	47.4±0.31 (47.1-47.8)	36.2 ± 0.7 (35.3-37.2)	58.26 ± 0.96 (56.9-58.7)	65.7 ± 0.6 (65.3-66.1)	106.2 ± 0.9 (105.1-107.8)	60.16 ± 0.67 (59.1-60.9)	43.1 ± 0.62	67.1 ± 0.99 (65.5-68.4)
tail length	32.1±0.22 (31.9-32.4)	76.1 ± 0.7 (75.2-76.9)	56.3 ± 1.06 (54.8-56.9)	53.8 ± 0.5 (53.4-54.1)	87.62 ± 1.0 (85.9-88.9)	19.66 ± 0.52 (19.5-20.4)	25 ± 0.74 (23.7-25.8)	16.3 ± 0.44 (15.7-16.9)
tail diameter at anus or cloaca	6.3±0.22 (6.1-6.6)	8.2 ± 0.54 (7.6-8.9)	19.2 ± 0.56 (18.5-19.9)	24.95 ± 0.5 (24.6-25.3)	33.1 ± 1.1 (31.5-34.8)	10 ± 0.33 (9.5-10.4)	13.3 ± 0.56 (12.6-14.1)	11.56 ± 0.7 (10.5-12.6)
Stylet	8.1±0.13 (7.9-8.2)	8.3 ± 0.34 (7.9-8.7)	11.2 ± 0.52 (10.6-11.9)	18.1 ± 0.4 (17.8-18.4)	29.16 ± 0.9 (27.9-30.6)	11.5 ± 0.68 (10.7-12.6)	11 ± 0.6 (10.1-11.8)	20.46 ± 0.37 (19.8-20.9)
body diameter at base of stylet	8.2±0.26 (7.9-8.5)	7.1 ± 0.54 (6.5-7.8)	11.4 ± 0.52 (10.8-11.9)	17.1 ± 0.8 (16.5-17.7)	24.6 ± 0.8 (23.7-25.9)	10.3 ± 0.48 (9.4-10.8)	11.62 ± 0.7 (10.6-12.7	11.72 ± 0.52 (10.8-12.4)
a	31.8±0.63 (30.9-32.4)	30.4 ± 1.2 (28.7-30.9)	24.9 ± 0.44 (24.3-25.3)	25.1 ± 0.6 (24.7-25.6)	27.4 ± 0.7 (26.5-28.3)	22.2 ± 1.35 (20.4-24.3)	22.12 ± 0.66 (21.4-23.0)	23.2 ± 0.56 (22.57-24.11)
b	5.6±0.02 (5.4-5.7)	11.2 ± 0.21 (11.0-11.4)	6.8 ± 0.03 (6.77-6.83)	8.6 ± 0.0 (8.6 -8.603)	7.1 ± 0.04 (7.07-7.2)	4.4 ± 0.03 (4.38-4.47)	6.19 ± 0.05 (6.16-6.28)	5.08 ± 0.03 (5.04-5.12)
b'	12.9±0.09 (12.8-12.9)	22.7 ± 0.51 (22.1-23.3)	14.2 ± 0.21 (13.9-14.5)	15.2 ± 0.1 (15.1-15.2)	10.9 ± 0.08 (10.8-10.9)	6.3 ± 0.06 (6.20-6.35)	10.3 ± 0.14 (10.19-10.56)	8.84 ± 0.11 (8.71-9.02)
c	19.0±0.13 (18.8-19.1)	10.8 ± 0.12 (10.7-10.9)	14.7 ± 0.25 (14.35-15.02)	18.6 ± 0.1 (18.5-18.6)	13.2 ± 0.13 (13.04-13.4)	19.2 ± 0.48 (18.6-20.0)	17.8 ± 0.5 (17.3-18.7)	36.45 ± 0.89 (35.26-37.62)
c'	5.1±0.14 (4.9-5.2)	9.3 ± 0.52 (8.6-9.9)	2.9 ± 0.05 (2.86-2.97)	2.1 ± 0.1 (2.1-2.17)	2.7 ± 0.07 (2.55-2.73)	1.97 ± 0.06 (1.89-2.1)	1.9 ± 0.04 (1.82-1.94)	1.13 ± 0.06 (1.34-1.5)
s	0.98±0.03 (0.95-1.03)	1.17 ± 0.11 (1.01-1.26)	1.0 ± 0.05 (0.9-1.0)	1.1 ± 0.0 (1.03-1.07)	1.2 ± 0.01 (1.17-1.2)	1.1 ± 0.05 (1.03-1.17)	0.95 ± 0.01 (0.92-0.96)	1.75 ± 0.05 (1.69-1.83)
V%		68.96 ± 0.48 (68.2-69.4)	82.7 ± 1.19 (81.1-84.2)		55.6 ± 0.86 (54.5-57)		72.62 ± 0.28 (72.1-72.8)	62.4 ± 0.42 (61.6-62.8)
Bursa of male	24.0 ±0.22 (23.7-24.2)			76.9 ± 0.8 (76.3-77.5)				

Several economically significant plant-parasitic nematodes were identified in the potato rhizosphere, including the potato root rot nematode, *D. destructor*, root-lesion nematode *Pratylenchus* spp. and the spiral nematode *Helicotylenchus* spp. The distribution of nematodes across the sampled area was not uniform. The population of stunt nematodes *Tylenchorynchus* is typically more abundant than that of the other plant parasitic nematode genera followed by pin nematodes *Paratylenchus,* and the root rot nematode *D. destructor* in the potato rhizosphere. The spiral nematode (*Helicotylenchus* spp.) population was lower than other nematode species in potato-growing regions. Additionally, the pin nematode *Paratylenchus* spp. was identified in numerous samples, however, no symptoms were observed. Furthermore, free-living nematodes were identified in all soil samples. Nematode species identified included *Dorylaimus*, *Rhabditis, Caenorhabditis*, and their population densities were found to be higher than those of plant-parasitic nematodes in all the potato fields surveyed. They influence the nitrogen cycle, soil integrity, and trophic networks. Numerous free-living nematodes decompose organic matter by consuming bacteria, fungi, algae, and other organisms.

The analysis of nematode communities is presented in Table 3, highlighting the identification of six genera of plant-parasitic nematodes. It appears that the most abundant of the nematode genera was *Tylenchorynchus* spp., with an absolute frequency and relative frequency of 83.33% and 17.41%, respectively, followed by *Paratylenchus* spp. for both characteristics (75% and 12.53%), respectively, with the same percentage of absolute frequency (75%) for *Tylenchus* spp. Meanwhile, the lowest percentage for both characteristics (8.33% and 1.96%, respectively) was recorded by *Helicotylenchus* spp. The results also showed that the highest absolute density (192.33%) was recorded for *Helicotylenchus* spp. in one location, followed by *Tylechorhynchus* spp. with a percentage of 171.26%, then *Paratylenchus* spp. at 136.92%, whilst the lowest absolute density (115.06%) was reported for *Tylenchus* spp. In general, free-living nematodes showed higher percentages in all traits than plant-parasitic nematodes.

Table 3. Analysis of the community structure of plant parasitic nematodes across six distinct localities in the Erbil and Duhok Provinces.

No.	Identified Nematodes	Absolute Frequency (%)	Relative Frequency (%)	Absolute Density (%)
1	*Tylenchorynchus* spp.	83.33	17.41	171.26
2	*Ditylenchus destructor*	66.66	11.01	135.33
3	*Paratylenchus* spp.	75	12.53	136.92
4	*Pratylenchus* spp.	41.66	6.07	119.46
5	*Helicotylenchus* spp.	8.33	1.96	192.33
6	*Tylenchus* spp.	75	10.53	115.06
7	Free living nematodes	100	40.49	331.88

Discussion

The primary objective of the current study was to explore the distribution of plant-parasitic nematodes in potato fields in Erbil and Duhok provinces, which are the most important potato producing provinces in the Kurdistan Region of Iraq. According to the findings, more than 40 % of the sampled potato fields were infested with nematodes, such as *Tylenchorhynchus*, *D. destructor*, *Paratylenchus*, *Pratylenchus*, *Helicotylenchus*, and *Tylenchus*. Furthermore, approximately 60% of the samples were co-infected with more than one of these nematodes. Only limited information is available regarding the potential damage that several of these species could cause to potatoes. On the other hand, *Ditylenchus*, and *Pratylenchus* species have the potential to cause damage to potatoes (Olabiyi 2007; Kepenekci *et al*. 2014).

Globally, the 10 most significant nematode genera associated with potatoes are *Meloidogyne*, *Pratylenchus*, *Heterodera*, *Ditylenchus*, *Globodera*, *Tylenchulus*, *Xiphinema*, *Radopholus*, *Helicotylenchus*, and *Rotylenchulus* (Sasser and Freckman 1987; Whitehead 1997). Several of these genera are recognized as economic pests affecting potato crops (Ames *et al*. 1996; Coyne *et al*. 2003). Sasser (1989) conducted a global survey identifying root-knot nematodes *Meloidogyne* species, root lesion nematodes *Pratylenchus* species, and cyst nematodes *Globodera* species as the three leading plant parasitic nematodes infecting potatoes worldwide. Furthermore, *Meloidogyne chitwoodi*, *Globodera* *rostochiensis*, *D. destructor*, *D. dipsaci* and *Pratylenchus* spp. have been identified as nematode pests affecting potato crops in Turkey (Evlice and Bayram 2012; Ulutas *et al*. 2012).

Ditylenchus destructor has been documented in several regions in Iran, with diverse climates, including Karaj, northern cities, Tehran, Semnan, Hamadan, Fars, West Azerbaijan, Ardebil, Isfahan, and Chahar Mahal and Bakhtiari (Naserzadeh *et al*. 2020; Niloufar *et al*. 2020). A survey of potato crops in the Kurdistan regions of Iran revealed the presence of plant-parasitic nematodes, including *Tylenchidae*, *Pratylenchus*, *Merlinius*, and *Ditylenchus* being the most prevalent species, found in 90%, 87.5%, 62.5%, and 50% of samples, respectively. In a similar study, *Pratylenchus* exhibited significant abundance in the fields, with densities ranging from 2 to 306 nematodes per 200 ml of soil (Ghaderi and Hamzezarghani 2021). These findings indicated the presence of primarily soil-dwelling pathogenic nematodes associated with potato plants as either ecto-parasites (*Paratylenchus* and *Tylenchus*), migratory semi-endoparasites (*Tylenchorhynchus* and *Helicotylenchus*) or migratory end-parasites (*Pratylenchus*). There is also *D. destructor* which infects internal tuber tissues in Erbil and Duhok Provinces, Kurdistan Region, Iraq.

Conclusions

This study presents the results of a survey carried out in six districts of the regions Erbil and Duhok Provinces, Kurdistan Region of Iraq. To our knowledge this is the first survey of potato fields in this region of Iraq. The findings indicated that PPNs associated with this crop exhibited remarkable diversity, as six genera of plant parasitic nematodes were identified for the first time in this particular region of Iraq. These genera are prevalent in this main region of potato cultivation, exhibiting a notable level of abundance. Nevertheless, the impact of these PPNs on potato growth and yield currently remains undetermined. Consequently, it is essential to investigate their bio-ecology and their pathogenicity to potatoes, specifically those PPNs that have been identified in this study. Furthermore, comprehensive investigations in the sampled regions are required to identify nematode species associated with potatoes and assess their significance.

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