

Association of Plant Parasitic Nematodes with some Vegetables Crops of Khyber Pakhtun Khwa, Pakistan

Bilal Muhammad ^{1*}, Kubra Bibi ², Mian Sayed Khan ², Anitta Kiran ²

ABSTRACT

Plant parasitic nematodes (PPN) widely spread in nature which having varieties of hosts majorly every kind of crops and feed on their roots. Every crop in the world is damaging through at least one species of PPN. The main objective of the present study is to identify various species of nematodes which damage vegetables crops like potato (*Solanum tuberosum*), tomato (*Lycopersicon esculentum*), garlic (*Allium sativum*), onion (*Allium cepa*) and cucumber (*Cucumis sativa*). Some vegetables cultivated areas of Khyber Pakhtun Khwa (KPK) province were surveyed in the year of 2021 to identify various species of nematodes which damage vegetables crops. From these areas soil samples were collected the extraction of nematodes occurs through Cobb's wet-sieving and Baerman funnel techniques and identify of species through morphological keys. A total of 13 genera of plant parasitic nematodes were identified from 5 vegetables crops throughout the KPK province. The identified nematode genera include *Helicotylenchus*, *Tylenchus*, *Hoplotaimus*, *Longidorus*, *Meloidogyne*, *Tylenchorhynchus*, *Paratylenchus*, *Aphelenchus*, *Ditylenchus*, *Boleodorus*, *Filenchus*. The genera, *Belonolaimus* and *Xiphinema* were common in all the collected samples. The results indicated that vegetable cultivated areas of KPK are infested with many species of PPN which cause damage to crops.

Key words: Nematodes, cucumber, garlic, onion, potato, tomato, survey, identification.

INTRODUCTION

In Pakistan, agriculture is the largest sector which provides work to 45% population of the country and the 60% rural population of Pakistan directly or indirectly promised with agriculture sector. Horticulture and agriculture having vital role to enhance economy of country and also develop opportunities of employment and to establish new agriculture based industries which boost the economic growth in international market (Pandey *et al.*, 2018).

Many pathogenic organisms feed on vegetable crops and cause stunt growth, reduce the production and damage to crops (Pandey *et al.*, 2018). They are high threat to damage of crops, income of rural farmers and loss of food products as well these all occur mostly due to diseases and pests (Anupriya *et al.*, 2019).

Plant parasitic nematodes (PPN) are considered the major problem for crops worldwide, and due to this pathogen every year a value of about 100\$ billion of vegetables and fruits are destroying (Tariq-Khan *et al.*, 2017 and Kayani *et al.*, 2018).

PPN widely spread in nature which having varieties of hosts majorly every kind of crops and feed on their roots. Every crop in the world is damaging through at least one species of PPN. The quantity and quality of crop yield were reducing due to nematode diseases which further lead to financial consequences (Bernard *et al.*, 2017 and Basyony *et al.*, 2020).

The objective of the present study was to identify PPN associated with cucumber, garlic, onion, potato and tomato plants in KPK province, Pakistan and provide more extensive information on the distribution of the genera and species of PPN in Pakistan.

MATERIALS AND METHODS

Sample Collection:

Random soil samples were collected from the rhizosphere of 5 vegetables crops (cucumber, garlic, onion, potato and tomato) from 12 localities in KPK province were collected between March and July 2021. With the help of trowel/hoe, 2 samples were collected from each village at a depth of 25-30 cm along with rhizosphere of 500 g each and placed in polyethene bags and stored at 25-30 °C.

Sample Preparation:

Nematodes from a composite soil sample of 250 g were extracted by means of Cobb's wet sieving and Barmann funnel techniques (Ayoub, 1980).

Nematode Extraction and identification:

Extracted nematodes were treated with TEF (Triethylamine formaldehyde) solution and examined under the compound microscope for nematode identification.

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RESULTS AND DISCUSSION

RESULTS:

Thirteen genera of plant parasitic nematodes were identified from 5 vegetables crops throughout the KPK province. The nematode genera detected were *Helicotylenchus*, *Tylenchus*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Tylenchorhynchus*, *Paratylenchus*, *Aphelenchus*, *Ditylenchus*, *Boleodorus*, *Filenchus*. The genera, *Belonolaimus* and *Xiphenema* were found in all the collected samples.

Table (1) shows that the population of *Tylenchorhynchus vulgaris* is higher in Swabi, *Longidorus* spp. *Meloidogyne incognita*, *Tylenchus* spp. are respectively most abundant in Nowshera. *Meloidogyne incognita* is present dominant in

Charsadda, *Tylenchus* spp. more dominantly present in Mardan, *Tylenchorhynchus vulgaris* largely present in Haripur, *Hoplolaimus indicus* abundant in Peshawar, the population of *Hoplolaimus indicus* is more in Mansehra, and vegetable of Buner largely effect from *Longidorus* spp. While *Meloidogyne incognita* is most abundantly present among all localities.

Hoplolaimus galeatus is shown in Table (2) which is a dominant species among all recorded PPN on tomato in all localities. In Table (3) *Belonolaimus longicaudatus* is the most abundant species of PPN on garlic throughout all localities of KPK. *Aphelenchus avenae* is the most abundant species of PPN among all onion cultivated area of KPK (Table 4).

Table 1. Plant parasitic nematode (PPN) genera / g soil detected in potato plants grown in different localities of KPK province

Nematode species	Number of PPN/ g soil							
	Swabi	Nowshera	Charsadda	Mardan	Haripur	Peshawar	Mansehra	Buner
<i>Helicotylenchus pseudorobustus</i>	29	33	18	37	38	13	43	15
<i>Tylenchorhynchus vulgaris</i>	39	21	29	21	43	15	42	20
<i>Helicotylenchus dihysteva</i>	20	15	37	29	16	37	39	31
<i>Helicotylenchus</i> spp.	21	24	34	34	43	21	39	32
<i>Hoplolaimus indicus</i>	15	28	26	37	17	38	44	36
<i>Longidorus</i> spp.	24	36	25	18	37	34	35	40
<i>Meloidogyne incognita</i>	35	36	39	16	31	35	43	35
<i>Tylenchus</i> spp.	29	36	20	39	36	33	38	19
<i>Paratylenchus</i> spp.	37	41	23	25	38	36	39	21

Table 2. Plant parasitic nematode (PPN) genera / g soil detected in tomato plants grown in different localities of KPK province

Nematode species	Number of PPN/ g soil							
	Swabi	Nowshera	Charsadda	Mardan	Haripur	Peshawar	Mansehra	Buner
<i>Helicotylenchus</i> spp.	35	37	39	26	41	21	29	21
<i>Tylenchorhynchus vulgaris</i>	23	45	29	38	40	35	19	12
<i>Helicotylenchus dihysteva</i>	39	41	23	25	39	30	18	14
<i>Hoplolaimus galeatus</i>	39	38	40	31	40	33	21	21
<i>Hoplolaimus indicus</i>	40	39	29	39	37	31	26	19
<i>Tylenchus</i> spp.	39	29	30	16	36	35	34	17
<i>Belonolaimus longicaudatus</i>	36	30	19	34	24	40	29	15
<i>Belonolaimus</i> spp.	20	37	22	30	26	41	30	16
<i>Paratylenchus</i> spp.	41	35	34	37	22	29	24	15

Table 3. Plant parasitic nematode (PPN) genera / g soil detected in garlic plants grown in different localities of KPK province

Nematode species	Number of PPN/ g soil							
	Swabi	Nowshera	Charsadda	Mardan	Haripur	Peshawar	Manshehra	Buner
<i>Helicotylenchus</i> spp.	26	37	25	32	15	25	29	21
<i>Tylenchorhynchus vulgaris</i>	39	26	21	32	19	29	19	16
<i>Helicotylenchus dihysteva</i>	20	15	31	38	21	38	15	18
<i>Hoplolaimus galeatus</i>	22	19	23	40	23	35	18	20
<i>Hoplolaimus indicus</i>	26	29	21	41	39	36	21	21
<i>Tylenchus</i> spp.	31	39	20	29	29	29	25	19
<i>Belonolaimus longicaudatus</i>	38	29	19	32	37	38	23	25
<i>Belonolaimus</i> spp.	40	25	20	20	20	41	29	23
<i>Paratylenchus</i> spp.	34	20	29	23	31	39	30	21
<i>Aphelenchus</i> spp.	35	27	34	24	35	35	25	24

Table 4. Plant parasitic nematode (PPN) genera / g soil detected in onion plants grown in different localities of KPK province

Nematode species	Number of PPN/ g soil							
	Swabi	Nowshera	Charsadda	Mardan	Haripur	Peshawar	Manshehra	Buner
<i>Helicotylenchus</i> spp.	32	31	33	19	23	16	20	19
<i>Helicotylenchus dihysteva</i>	21	35	41	39	29	30	20	31
<i>Boleodorus thylactus</i>	39	20	37	25	19	25	25	34
<i>Filenchus pratensis</i>	30	33	21	40	20	15	24	29
<i>Paratylenchus thornei</i>	33	25	35	30	30	23	21	13
<i>Belonolaimus</i> spp.	28	35	26	30	39	15	23	21
<i>Paratylenchus neglectus</i>	37	30	28	32	41	23	19	29
<i>Aphelenchus avenae</i>	40	30	21	40	39	29	31	30

The collected samples from the cucumber cultivated area shown that *Meloidogyne incognita* cause more damage to cucumber crop than other species of PPN as shown in Table (5).

The *Meloidogyne* root-knot nematodes were mostly common in potato and cucumber. These nematodes were found in soil of vegetable crop roots and severely

caused root galling. The frequency of *Meloidogyne* was 25 to 43 in range per 150g of soil samples.

The ectoparasitic nematodes including the genera *Beleodorus*, *Belonolaimus*, *Hoplolaimus* and *Xiphinema americanum*, *Paratylenchus* is a migratory ectoparasitic nematode pest mostly found in many crops of vegetables feeding and caused destruction in crop plants.

Table 5. Plant parasitic nematode (PPN) genera / g soil detected in cucumber plants grown in different localities of KPK province

Nematode species	Number of PPN/ g soil							
	Swabi	Nowshera	Charsadda	Mardan	Haripur	Peshawar	Mansehra	Buner
<i>Helicotylenchus pseudorobustus</i>	20	39	24	21	31	21	31	25
<i>Tylenchorhynchus vulgaris</i>	25	41	33	27	35	25	34	37
<i>Helicotylenchus dihysteva</i>	21	20	35	17	39	28	23	31
<i>Hoplolaimus tobacum</i>	34	28	30	29	21	31	45	22
<i>Hoplolaimus indicus</i>	33	35	21	24	29	30	23	27
<i>Longidorus</i> spp.	39	15	32	34	25	15	29	29
<i>Meloidogyne incognita</i>	40	37	41	44	41	39	41	39
<i>Belonolaimus</i> spp.	39	30	37	32	37	25	39	40
<i>Paratylenchus</i> spp.	38	36	21	31	19	28	40	24
<i>Xiphinema americanum</i>	29	21	38	39	37	21	29	33

DISCUSSION

The present results confirm that the vegetable crops of KPK, Pakistan are highly targeted by various species of PPN. We also aim that from these results that approximately all types of root knot, ecto and endo parasitic nematodes were identified from the survived vegetable crop samples.

Weeds are also one of the main reservoirs of plant parasitic nematodes (Quénéhervé *et al.*, 2011). There are above 2,000 species of plant parasitized by *Meloidogyne* spp. (Jones *et al.*, 2013). Several studies indicated that *Meloidogyne* abundantly found in Argentina, Costa Rica, Hungary and United States (Kutywayo *et al.*, 2006) infection with *Meloidogyne incognita* mostly reduces the production of potatoes and reduce the marketability due to nematode galling (Montero *et al.*, 2007).

Tomato is the easy host for *M. incognita* which damage their roots, there are 720 juveniles/250 g of tomato rhizosphere (Adam *et al.*, 2013). The density of *M. incognita* in Ismailia governorate was 720 individuals/ 250 g similar study in Egypt showed that for tomato and density of *Tylenchorhynchus* was 160 nematodes/ 250 g for tomato (Abdel-Baset *et al.*, 2022).

Previous study by Anupriya *et al.* (2019) show that five genera of plant parasitic nematodes were identified in garlic soil samples in which *Pratylenchus* spp. had the most occurrence frequency followed by of 94.43%, *Tylenchorhynchus* spp. 74.96%, *Hoplolaimus* spp. 65.28%; *Helicotylenchus* spp. 79.15% and *Tylenchus* spp. occurrence of 54.13% in garlic (Anupriya *et al.*, 2019).

Also, Konate *et al.* (2019) reported that three genera of nematodes *Tylenchus*, *Tylenchorhynchus* and *Helicotylenchus* were recorded in onion which classified as a most damageable for this vegetables crops and most common all over the world which stunt the growth and production of onion and make it unmarketable.

Root knot nematodes attack cucumber and cause severe damage to it where 705-1460 nematode juveniles/100 g of soil were presented. In poly-houses, the growing cucumber and tomato were highly infested by *M. incognita* (Bhati and Baheti, 2020).

CONCLUSION

The results of this study showed that five vegetable crops of KPK province (cucumber, garlic, onion, potato, tomato) are infested with 13 genera of plant parasitic nematodes. The identified nematode genera included the genera, *Helicotylenchus*, *Tylenchus*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Tylenchorhynchus*, *Paratylenchus*, *Aphelenchus*, *Ditylenchus*, *Boleodorus*, and *Filenchus*. The genera, *Belonolaimus* and *Xiphinema* which found in all samples. The root- knot nematode, *Meloidogyne incognita* was mostly identified in all vegetables crops at every locality.

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Conflicts of Interest

No conflicts of interest

Funding Source

None

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الملخص العربي

تواجد الديدان الطفلة النباتية على بعض محاصيل الخضر في خيبر بختون خوا، باكستان

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التعرف على ١٣ جنساً من الديدان الخيطية الطفيلية النباتية في ٥ محاصيل خضروات في جميع أنحاء مقاطعة خيبر بختونخوا. تشمل أجناس الديدان الخيطية التي تم تحديدها بيلونوليمس (*Belonolaimus*)، زيفينما (*Xiphinema*)، هيليكوتيلينكوس (*Helicotylenchus*)، تيلينكوس (*Tylenchus*)، هولولايموس (*Hoplolaimus*)، لونجيدوروس (*Longidorus*)، ميلويدوجين (*Meloidogyne*)، تيلينكورينكوس (*Tylenchorhynchus*)، باراتيلينكوس (*Paratylenchus*)، أفيلينكوس (*Aphelenchus*)، ديتيلينكوس (*Ditylenchus*)، بوليدوروس (*Boleodorus*)، وفيلينكوس (*Filenchus*). وكان الجنسين بيلونوليمس (*Belonolaimus*)، وزيفينما (*Xiphinema*) أكثر الأجناس شيوعاً في جميع العينات. وقد أشارت النتائج إلى أن المناطق المزروعة بالخضروات في KPK موبوءة بالعديد من أنواع الديدان الخيطية الطفلة التي تسبب أضراراً للمحاصيل المختلفة.

تنتشر الديدان الخيطية الطفلة النباتية على نطاق واسع في الطبيعة وتتغذى على جذور العديد من العوائل النباتية والمحاصيل المختلفة، وتلحق الديدان الطفلة الضرر بكل محاصيل العالم من خلال نوع واحد على الأقل من الديدان الخيطية الطفلة. الهدف الرئيسي من هذه الدراسة هو التعرف على الأنواع المختلفة من الديدان الخيطية التي تصيب محاصيل الخضر مثل البطاطس (*Solanum tuberosum*)، الطماطم (*Lycopersicon esculentum*)، الثوم (*Allium sativum*)، البصل (*Allium cepa*) والخيار (*Cucumis sativus*). تم مسح المناطق المزروعة بالخضروات في خيبر بختون خوا (مقاطعة خيبر بختونخوا) في عام ٢٠٢١ لتحديد الأنواع المختلفة من الديدان الخيطية التي تصيب وتدمر محاصيل الخضروات. تم جمع عينات من التربة من هذه المناطق، وتم استخلاص الديدان الخيطية من خلال تقنية الغرايبيل وقمع بيرمان وتحديد الأنواع من خلال المفاتيح المورفولوجية. تم