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Distribution of phytonematodes associated with stone and nut fruits in Kashmir valley, India

Tarique Hassan Askary[1]*, Mohammad Islam Shah Waliullah[1] and Mohammad Maqbool Mir[2]

*[1]Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus, Shalimar, Srinagar-190025, Jammu and Kashmir, India. [2]Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus, Shalimar, Srinagar-190025, Jammu and Kashmir, India. *E-mail: tariq_askary@rediffmail.com*

Abstract

Soil samples were collected from the rhizosphere of stone fruits *viz.*, peach, plum, apricot, cherry and nut fruits *viz.*, almond and walnut from three year old nurseries at five different localities of Kashmir valley and processed to assess the population density of phytonematodes at each locality. Ten species/ genera of plant parasitic nematodes *viz.*, *Pratylenchus penetrans*, *Paratylenchus juglansi*, *Meloidogyne hapla*, *Tylenchorhynchus* spp., *Criconema* spp., *Rotylenchus* spp., *Xiphinema basiri*, *Longidorus* spp., *Hoplolaimus* spp. and *Helicotylenchus indicus* were recorded. The most common nematode species which was frequently found in the rhizosphere of the surveyed fruit crops were *Pratylenchus penetrans* and *Helicotylenchus indicus*. *Meloidogyne hapla* was also common in all the fruit crops except peach and walnut. *Paratylenchus juglansi* was reported from the rhizosphere of walnut only. Absolute frequency of *P. penetrans* and *Tylenchorhynchus* spp. in almond and *H. indicus* in walnut was 100% in three different localities. Absolute density and prominence value of *H. indicus* was highest *i.e.* 665 in walnut followed by 623 of *P. penetrans* in cherry and 618 of *Tylenchorhynchus* spp. in almond at separate localities of the survey. Presence of varying densities and types of plant parasitic nematodes associated with stone and nut fruits reveal that plant parasitic nematodes form an important component in temperate fruit ecosystem which needs to be investigated for assessing the role of relative virulence of a particular species, host specificity and tolerance level in host.

Key words: Phytonematodes, distribution, stone fruits, nut fruits, soil, rhizosphere, peach, plum, apricot, walnut, cherry, almond

Introduction

The state of Jammu and Kashmir is blessed with the production of a large varieties of temperate fruit crops and among them stone and nut fruits are considered a major commercial venture throughout the Kashmir valley because of higher remuneration per unit area as well as the realization that fruit consumption is essential for human health and nutrition (Askary *et al.*, 2011) as they are very rich in proteins, fats and minerals and are a concentrated source of energy. Plant parasitic nematodes pose a continuous threat to fruit crop production as they cause serious damage to many fruit and horticultural trees (Askary and Haidar, 2010). The overall average annual yield loss of the world's major horticultural crops due to damage caused by plant parasitic nematodes has been estimated as 13.54% (Reddy, 2011).

Large numbers of studies have been made on plant parasitic nematodes associated with temperate fruits (Khan and Sharma, 1992; Waliullah and Kaul, 1997; Sharma and Kashyap, 2009), however, only a few studies have dealt with community structure of plant parasitic nematodes associated with stone and nut fruits. Kashmir valley is considered one of the major temperate fruit growing regions of India and a preliminary work has been done only regarding association of plant parasitic nematodes in early stages of plant growth (Askary *et al.*, 2012), but practically no work has been done so far on community analysis of plant parasitic nematodes associated with stone and nut fruit plants at nursery stage. Hence, the present study was undertaken to assess distribution, abundance and frequency of plant parasitic nematodes in three year old nurseries at five different localities, in stone and nut fruit ecosystems of Kashmir valley.

Materials and methods

A random survey of plant parasitic nematodes associated with stone fruits *viz.*, peach (*Prunus persica*), plum (*Prunus domestica*), apricot (*Prunus armeniaca*), cherry (*Prunus avium*) and nut fruits *viz.*, almond (*Prunus amygdalus*), walnut (*Juglans regia*) was made during June-July, 2012 from three years old nurseries at five different localities *viz.*, Sumbal, Shuhama, Wanihama, Gasoo and Arabal in Ganderbal and Srinagar districts of Kashmir valley. A total 360 soil samples were collected *i.e.* 60 soil samples for each fruit crop wherein 12 soil samples were from each locality for one fruit crop. The soil samples were drawn from the rhizosphere of peach, plum, apricot, cherry, almond and walnut plants at a depth of 10-15 cm. 250 mL soil of each sample was processed for nematode extraction by Cobb's sieving and decanting method (1918) followed by Baermann's funnel method (1917). The nematodes thus collected were fixed in hot TAF (Triethelene Amine Formaline) and stored for analysis. Genera and species of plant parasitic nematodes were identified. The population density of plant parasitic nematodes was assessed for each locality with the help of Syracuse counting dish. Data on key nematodes population were analyzed to work out absolute

frequency (AF), relative frequency (RF), absolute density (AD), relative density (RD) and prominence value (PV) by the method adopted by Norton (1978).

$$AF\ (\%) = \frac{\text{Number of samples containing species}}{\text{Number of samples collected}} \times 100$$

$$RF\ (\%) = \frac{\text{Freqency of all species}}{\text{Sum of freqency of all species}} \times 100$$

$$AD = \frac{\text{Number of individuals in a sample}}{\text{Total number of samples collected}}$$

$$RD\ (\%) = \frac{\text{Number of individuals of a species in a sample}}{\text{Total number of all individuals in a sample}} \times 100$$

$$PV\ (\%) = \frac{\sqrt{\text{Absolute frequency x Absolute density}}}{\text{Number of samples collected}} \times 100$$

Results and discussion

The results showed that in 360 soil samples collected from the rhizosphere of peach, plum, apricot, cherry, almond and walnut, ten species/ genera of plant parasitic nematodes *viz.*, lesion nematode (*Pratylenchus penetrans*), pin nematode (*Paratylenchus juglansi*), root-knot nematode (*Meloidogyne hapla*), stunt nematode (*Tylenchorhynchus* spp.), spine nematode (*Criconema* spp.), dagger nematode (*Xiphinema basiri*), needle nematode (*Longidorus* spp.), lance nematode (*Hoplolaimus* spp.), spiral nematode (*Helicotylenchus indicus*) and *Rotylenchus* spp. were recorded. *Pratylechus penetrans*, *Paratylenchus* spp., *Tylenchorhynchus* spp., *Xiphinema basiri, Hoplolaimus* spp. and *Helicotylenchus indicus* were the key nematodes of peach (Table 1) whereas for plum it was *Pratylechus penetrans*, *Paratylenchus* spp., *Meloidogyne hapla*, *Xiphinema basiri, Longidorus* spp. and *Helicotylenchus indicus* (Table 2). *P. penetrans* and *H. indicus* were most common and abundant in rhizosphere of all the fruit crops in the study whereas *M. hapla* was common in all except peach. *Rotylenchus* spp. was observed in apricot (Table 3) and cherry (Table 4) whereas, *Criconema* spp. was encountered in apricot only. At Sumbal locality, the absolute frequency of *P. penetrans* was 100% in almond and it was present in all the 12 samples, whereas at Gasoo the absolute frequency of *Tylenchorhynchus* spp. was 100% (Table 5). Similarly, *H. indicus* was present in all the 12 samples of walnut at Sumbal and its absolute frequency was 100% (Table 6). Absolute density and Prominence value of *H. indicus* was highest (665) in walnut at Sumbal (Table 6) and it was followed by *P. penetrans* (623) in cherry at Wanihama (Table 4) and *Tylenchorhynchus* spp. (618) in almond at Sumbal (Table 5). Presence of these plant parasitic nematodes on peach, plum, apricot and cherry confirms the findings of earlier workers (Waliullah and Kaul, 1997; Askary *et al.*, 2012). In case of nut fruits, *P. penetrans*, *P. juglansi*, *Tylenchorhynchus* spp., and *H. indicus* were common in both almond and walnut (Table 5 & 6). However, besides these, root-knot nematode, *M. hapla* and *Criconema* spp. was frequently encountered in the rhizosphere soil of almond plants from all the locations (Table 5) but they were absent in case of walnut. Similarly, *Xiphinema* spp. and *Longidorus* spp. were found in the rhizosphere of walnut plants (Table 6) but not in almond. These reports are in confirmation with the work done by other researchers (Khan and Siddiqi, 1964; Khan and Sharma, 1992; Lorrain, 2000; Askary *et al.*, 2012). Presence of *P. juglansi* in the rhizosphere of walnut has also been reported earlier by Kaul and Waliullah (1989). Because of high population of these plant parasitic nematodes encountered around the rhizosphere of fruit crops in nurseries it is assumed that the plant parasitic nematodes may be a contributing factor in declining health of these plants.

Due to lack of information, diversity among the species of

Table 1. Distribution of plant parasitic nematodes infesting peach in different locations of Kashmir valley

Species	Parameter	Location				
		Sumbal	Shuhama	Wanihama	Gasoo	Shalimar
Pratylenchus penetrans	N	8	11	7	9	10
	AF	66.7	91.7	58.3	75.0	83.3
	RF	17.8	24.4	15.5	20.0	22.2
	AD	534.0	332.0	566.0	315.0	375.0
	RD	25.1	15.6	26.7	14.8	17.7
	PV	433.8	316.7	431.0	272.7	341.6
Paratylenchus spp.	N	10	10	9	8	7
	AF	83.3	83.3	75.0	66.7	58.3
	RF	22.7	22.7	20.4	18.2	15.9
	AD	37.0	90.0	74.0	62.0	90.0
	RD	10.5	25.5	20.9	17.5	25.5
	PV	33.7	82.0	64.0	50.6	68.7
Tylenchorhynchus spp.	N	11	9	8	8	11
	AF	91.7	75.0	66.7	66.7	91.7
	RF	23.4	19.1	17.0	17.0	23.4
	AD	460.0	145.0	110.0	160.0	145.0
	RD	45.0	14.2	10.8	15.7	14.2
	PV	440.4	125.5	89.8	130.6	138.8
Xiphinema basiri	N	10	11	8	11	9
	AF	83.3	91.7	66.7	91.7	75.0
	RF	20.3	22.4	16.3	22.4	18.3
	AD	246.0	260.0	193.0	256.0	250.0
	RD	20.4	21.5	16.0	21.2	20.7
	PV	224.5	248.9	157.6	245.1	216.5
Hoplolaimus spp.	N	8	7	7	9	10
	AF	66.7	58.3	58.3	75.0	83.3
	RF	19.5	17.0	17.0	21.9	24.3
	AD	460.0	222.0	160.0	205.0	210.0
	RD	36.6	17.6	12.7	16.3	16.7
	PV	375.6	169.5	122.1	177.5	191.6
Helicotylenchus indicus	N	10	9	9	11	11
	AF	83.3	75.0	75.0	91.7	91.7
	RF	20.0	18.0	18.0	22.0	22.0
	AD	540.0	286.0	238.0	294.0	314.0
	RD	32.3	17.1	14.2	17.5	18.7
	PV	492.8	247.6	206.1	281.5	300.0

N- Species Frequency; AF- Absolute frequency; RF- Relative frequency; AD- Absolute density; RD- Relative density; PV- Prominence value

Table 2. Distribution of plant parasitic nematodes infesting plum in different locations of Kashmir valley.

Species	Parameter	Location				
		Sumbal	Shuhama	Wanihama	Gasoo	Shalimar
Pratylenchus penetrans	N	11	9	8	10	10
	AF	91.7	75.0	66.7	83.3	83.3
	RF	22.9	18.7	16.6	20.8	20.8
	AD	438.0	327.0	250.0	445.0	372.0
	RD	23.9	17.8	13.6	24.3	20.3
	PV	419.4	283.2	204.1	406.1	339.5
Paratylenchus spp.	N	9	8	8	5	6
	AF	75.0	66.7	66.7	41.6	50.0
	RF	25.0	22.2	22.2	13.8	16.7
	AD	212.0	195.0	190.0	150.0	175.0
	RD	23.0	21.1	20.6	16.2	18.9
	PV	183.6	159.2	155.1	96.7	123.7
Meloidogyne hapla	N	8	11	11	9	10
	AF	66.7	91.7	91.7	75.0	83.3
	RF	16.3	22.4	22.4	18.3	20.4
	AD	64.0	131.0	155.0	122.0	138.0
	RD	10.5	21.4	25.4	20.0	22.6
	PV	52.2	125.4	148.4	105.6	125.9
Xiphinema basiri	N	7	6	9	9	6
	AF	58.3	50.0	75.0	75.0	50.0
	RF	18.9	16.2	24.3	24.3	16.2
	AD	26.0	93.0	122.0	115.0	118.0
	RD	5.5	19.6	25.7	24.2	24.9
	PV	19.8	65.7	105.6	99.6	83.4
Longidorus spp.	N	8	10	10	9	11
	AF	66.7	83.3	83.3	75.0	91.7
	RF	16.6	20.8	20.8	18.7	22.9
	AD	35.0	88.0	56.0	78.0	97.0
	RD	9.9	24.8	15.8	22.0	27.4
	PV	28.5	80.3	51.1	67.5	92.9
Helicotylenchus indicus	N	10	9	7	9	7
	AF	83.3	75.0	58.3	75.0	58.3
	RF	23.8	21.4	16.7	21.4	16.7
	AD	512.0	449.0	327.0	517.0	403.0
	RD	23.2	20.3	14.8	23.4	18.2
	PV	467.2	388.8	249.6	447.0	307.7

N- Species Frequency; AF- Absolute frequency; RF- Relative frequency; AD- Absolute density; RD- Relative density; PV- Prominence value

Table 3. Distribution of plant parasitic nematodes infesting apricot in different locations of Kashmir valley.

Species	Parameter	Location				
		Sumbal	Shuhama	Wanihama	Gasoo	Shalimar
Pratylenchus penetrans	N	8	11	9	9	7
	AF	66.7	91.7	75.0	75.0	58.3
	RF	18.2	25.0	20.4	20.4	15.9
	AD	348.0	294.0	285.0	236.0	187.0
	RD	25.8	21.8	21.2	17.5	13.8
	PV	284.2	281.5	246.8	204.4	142.8
Meloidogyne hapla	N	3	5	9	2	2
	AF	25.0	41.7	75.0	16.7	16.7
	RF	14.3	23.8	42.8	9.5	9.5
	AD	20.0	37.0	65.0	20.0	35.0
	RD	11.3	20.9	36.7	11.3	19.8
	PV	10.0	23.9	56.3	8.2	14.3
Tylenchorhynchus spp.	N	7	11	8	10	9
	AF	58.3	91.7	66.7	83.3	75.0
	RF	15.5	24.4	17.8	22.2	20.0
	AD	237.0	238.0	216.0	215.0	150.0
	RD	22.4	22.5	20.4	20.3	14.2
	PV	180.9	227.9	176.4	196.2	129.9
Criconema spp.	N	5	5	8	6	8
	AF	41.7	41.7	66.7	50.0	66.7
	RF	15.6	15.6	25.0	18.7	25.0
	AD	35.0	73.0	200.0	95.0	104.0
	RD	6.9	14.4	39.4	18.7	20.5
	PV	22.6	47.1	163.3	67.2	155.9
Rotylenchus spp.	N	1	4	3	3	4
	AF	8.4	33.4	25.0	25.0	33.4
	RF	6.7	26.7	19.9	19.9	26.7
	AD	20.0	32.0	54.0	51.0	30.0
	RD	10.7	17.1	28.9	27.3	16.0
	PV	18.3	18.5	27.0	25.5	17.3
Helicotylenchus indicus	N	4	4	7	7	6
	AF	33.4	33.4	58.3	58.3	50.0
	RF	14.3	14.3	25.0	25.0	21.4
	AD	65.2	59.0	109.0	70.0	85.0
	RD	13.8	5.7	29.0	18.7	22.7
	PV	30.0	34.1	83.2	53.4	60.1

N- Species Frequency; AF- Absolute frequency; RF- Relative frequency; AD- Absolute density; RD- Relative density; PV- Prominence value

phytonematodes could not be compared, however, it may be assumed that diversity varies considerably with habitat, area and the number of individuals (Sivakumar *et al.*, 2002). The present community analysis revealed that *P. penetrans* and *H. indicus* were the most frequent and dominant species associated with the rhizosphere of stone (peach, plum, apricot, cherry) and nut (walnut, almond) fruits. Association of *P. penetrans* and *H. indicus* infesting peach, plum, apricot, cherry, walnut and almond has also been reported recently from Shalimar area of Kashmir valley (Askary *et al.*, 2012).

The present study on nematode community structure associated with stone and nut fruits indicate that plant parasitic nematodes

Table 4. Distribution of plant parasitic nematodes infesting cherry in different locations of Kashmir valley

Species	Parameter	Location				
		Sumbal	Shuhama	Wanihama	Gasoo	Shalimar
	N	7	11	12	9	9
	AF	58.3	91.7	100.0	75.0	75.0
	RF	14.6	22.9	25.0	18.7	18.7
Pratylenchus penetrans	AD	53.0	415.0	623.0	384.0	490.0
	RD	2.7	21.1	31.7	19.5	24.9
	PV	40.4	397.4	623.0	332.5	424.3
Meloidogyne hapla	N	7	9	10	9	6
	AF	58.3	75.0	83.3	75.0	50.0
	RF	17.0	21.9	24.4	21.9	14.6
	AD	44.0	83.0	110.0	90.0	65.0
	RD	11.2	21.2	28.0	22.9	16.6
	PV	33.6	71.8	100.4	77.9	45.9
Tylenchorhynchus spp.	N	8	8	10	7	9
	AF	66.7	66.7	83.3	58.3	75.0
	RF	19.0	19.0	23.8	16.5	21.4
	AD	176.0	198.0	405.0	227.0	315.0
	RD	13.3	15.0	30.6	17.2	23.8
	PV	143.7	161.7	369.6	173.3	272.8
Xiphinema basiri	N	9	9	11	7	7
	AF	75.0	75.0	91.7	58.3	58.3
	RF	20.9	20.9	25.6	16.3	16.3
	AD	255.0	144.0	150.0	120.0	168.0
	RD	30.4	17.2	17.9	14.3	20.1
	PV	220.8	124.7	143.6	91.6	128.3
Rotylenchus spp.	N	7	9	9	6	7
	AF	58.3	75.0	75.0	50.0	58.3
	RF	18.4	23.7	23.7	15.8	18.4
	AD	49.0	72.0	127.0	70.0	48.0
	RD	13.4	19.7	34.7	19.1	13.1
	PV	37.4	62.3	110.0	49.5	36.6
Helicotylenchus indicus	N	7	9	10	7	9
	AF	58.3	75.0	83.3	58.3	75.0
	RF	16.7	21.4	23.8	16.7	21.4
	AD	350.0	275.0	525.0	330.0	412.0
	RD	18.5	14.5	27.7	17.4	21.8
	PV	267.2	238.1	479.1	251.9	356.8

N- Species Frequency; AF- Absolute frequency; RF- Relative frequency; AD- Absolute density; RD- Relative density; PV- Prominence value

Table 5. Distribution of plant parasitic nematodes infesting almond in different locations of Kashmir valley

Species	Parameter	Location				
		Sumbal	Shuhama	Wanihama	Gasoo	Shalimar
	N	12	9	10	6	10
	AF	100.0	75.0	83.3	50.0	83.3
	RF	25.5	19.1	21.3	12.7	21.3
Pratylenchus penetrans	AD	361.0	325.0	322.0	215.0	260.0
	RD	24.3	21.9	21.7	14.5	17.5
	PV	361.0	281.4	293.8	152.0	237.3
Meloidogyne hapla	N	8	10	11	9	9
	AF	66.7	83.3	91.7	75.0	75.0
	RF	17.0	21.2	23.4	19.1	19.1
	AD	29.0	20.0	54.0	13.0	28.0
	RD	20.1	13.9	37.5	9.0	19.5
	PV	23.7	18.2	51.7	11.2	24.2
Tylenchorhynchus spp.	N	9	10	10	12	8
	AF	75.0	83,3	83.3	100.0	66.7
	RF	18.3	20.4	20.4	24.5	16.3
	AD	618.0	459.0	444.0	520.0	309.0
	RD	26.3	19.5	18.9	22.1	13.1
	PV	535.2	418.9	405.2	520.0	252.3
Paratylenchus spp.	N	6	6	9	7	11
	AF	50.0	50.0	75.0	58.3	91.7
	RF	15.4	15.4	23.1	17.9	28.2
	AD	15.0	23.0	90.0	38.0	42.0
	RD	7.2	11.0	43.2	18.2	20.2
	PV	10.6	16.2	77.9	29.0	40.2
Criconema spp.	N	7	10	11	8	9
	AF	58.3	88.3	91.7	66.7	75.0
	RF	15.5	22.2	24.4	17.8	20.0
	AD	28.0	45.0	123.0	56.0	70.0
	RD	87.0	14.0	38.2	17.4	21.7
	PV	21.4	41.1	117.8	45.7	60.6
Helicotylenchus indicus	N	8	8	6	11	10
	AF	66.7	66.7	50.0	91.7	83.3
	RF	18.6	18.6	13.9	25.6	23.2
	AD	230.0	240.0	215.0	180.0	175.0
	RD	22.1	23.1	20.7	17.3	16.8
	PV	187.8	196.0	152.0	172.3	159.7

N- Species Frequency; AF- Absolute frequency; RF- Relative frequency; AD- Absolute density; RD- Relative density; PV- Prominence value

form an important component of soil ecosystem. However, the nematode population of different sexes and stages, relative virulence of a particular species/ pathotype, its host specificity and tolerance level in host, needs to be investigated for assessing the role of these ecological parameters in the management of plant parasitic nematodes.

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Table 6. Distribution of plant parasitic nematodes infesting walnut in different locations of Kashmir valley

Species	Parameter	Location				
		Sumbal	Shuhama	Wanihama	Gasoo	Shalimar
	N	7	11	4	11	9
	AF	58.3	91.7	33.4	91.7	75.0
Pratylenchus	RF	16.4	26.2	9.5	26.1	21.4
penetrans	AD	127.0	89.0	88.0	60.0	75.0
	RD	28.9	20.3	20.0	13.7	17.1
	PV	97.0	85.2	50.8	57.4	64.9
Paratylenchus spp.	N	9	2	7	3	3
	AF	75.0	16.7	58.3	25.0	25.0
	RF	37.5	8.3	29.1	12.5	12.5
	AD	132.0	12.0	47.0	18.0	19.0
	RD	57.9	5.2	20.6	7.9	8.4
	PV	114.0	4.9	35.9	9.0	9.5
Tylenchorhynchus	N	11	7	10	8	10
spp.	AF	91.7	58.3	83.3	66.7	83.3
	RF	28.3	18.0	25.7	20.6	25.7
	AD	417.0	254.0	300.0	310.0	265.0
	RD	27.0	16.4	19.4	20.0	17.1
	PV	399.3	193.9	273.8	253.2	241.8
Xiphinema spp.	N	6	8	6	7	7
	AF	50.0	66.7	50.0	58.3	58.3
	RF	17.6	23.5	17.6	20.6	20.6
	AD	366.0	210.0	216.0	237.0	210.0
	RD	29.5	16.9	17.4	19.1	16.9
	PV	258.8	171.5	152.7	180.9	160.3
Longidorus spp.	N	9	6	6	9	4
	AF	75.0	50.0	50.0	75.0	33.4
	RF	26.4	17.6	17.6	26.4	11.8
	AD	490.0	113.0	118.0	140.0	90.0
	RD	51.5	11.9	12.4	14.7	9.4
	PV	424.3	79.9	83.4	121.2	52.0
Helicotylenchus	N	12	7	10	10	8
indicus	AF	100.0	58.3	83.3	83.3	66.7
	RF	25.5	14.9	21.3	21.3	17.0
	AD	665.0	397.0	328.0	378.0	296.0
	RD	32.2	19.2	15.9	18.3	14.3
	PV	665.0	303.1	299.3	345.0	241.3

N- Species Frequency; AF- Absolute frequency; RF- Relative frequency; AD- Absolute density; RD- Relative density; PV- Prominence value

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