

## Community analysis of major plant parasitic nematodes associated with rice in Himachal Pradesh

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### ABSTRACT

Qualitative and quantitative analysis for plant parasitic nematodes associated with rice was made in 107 localities of seven districts of Himachal Pradesh, India. Study revealed the presence of six nematodes i.e. *Meloidogyne graminicola*, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Pratylenchus* spp., *Hirschmanniella* spp. and *Criconeematids* in the rhizosphere of rice plants. *M. graminicola* was found to be most prevalent nematode species followed by *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Hirschmanniella* spp., *Pratylenchus* spp. and *Criconeematids* with prominence value of 159.7, 133.0, 123.8, 25.9, 11.6 and 7.3, respectively. The mean *M. graminicola* population in the roots was recorded ranging from 35.7 to 70.5 J<sub>2</sub> and that of *Hirschmanniella* spp. from 5.5 to 10.5 individuals in 5g root. *Aphelenchoides besseyi* was found to be distributed in all the seven districts with mean population ranging from 45 to 60 individuals in 50 grains. Avoidable loss due to *M. graminicola* was estimated to be 8.3 percent.

**Key words:** rice, parasitic nematodes, survey, Himachal Pradesh, yield loss

Rice is grown in 10 out of 12 districts of Himachal Pradesh (HP) in an area of 69210 ha with total production of 123490 tonnes (Anonymous, 2009). Amongst various factors affecting the yield of rice, plant parasitic nematodes are reported to play an important role (Cho *et al.*, 1994; Padgham *et al.*, 2004; Jain, *et al.*, 2007; Thakur *et al.*, 1987). A number of plant parasitic nematodes are reported to be associated with rice throughout the world including India (Pedramfar *et al.*, 2001; Baqri and Ahmad, 2000; Sharma *et al.*, 2001; Coyne *et al.*, 1999). Limited work has been conducted on plant parasitic nematodes of H.P. The present study was undertaken to analyze the plant parasitic nematode community of rice in H.P and to estimate the avoidable losses due to root knot nematode, *Meloidogyne graminicola*.

### MATERIALS AND METHODS

Random survey was carried out in seven districts, namely, Kangra, Mandi, Hamirpur, Kullu, Una, Chamba and Sirmour of HP to record the diversity and density of plant parasitic nematodes in the rhizosphere of rice

crop and also to know the distribution status of white tip nematode in the paddy seeds. A total of 281 soil and root samples were collected during the crop season (July-August), 2006-08. Soil samples were taken from the rhizosphere of plants with help of a hand hoe. A composite sample (about 500cc) was drawn from 4-6 plants of each locality prepared by drawing about 100cc of soil from the rhizosphere of each plant. This composite sample so collected was put in polyethylene bag, labelled, tied with rubber band and brought to the laboratory for processing. The samples were processed within 48 hrs after bringing to laboratory to determine the nematode fauna and their respective counts. Each composite sample was thoroughly mixed and 200cc of the soil was processed using Cobb's decanting and sieving method followed by modified Baermann's funnel technique (Townshend, 1963). The nematodes recovered were killed and preserved in hot TAF (formalin 7 ml, triethanolamine 2 ml and distilled water 91 ml) fixative. Plant parasitic nematodes were identified by preparing temporary and permanent mounts.

For the estimation of nematode population in roots, these were washed in running tap water to remove the adhering soil. These roots were chopped in small pieces of about 0.5 cm and stained in 0.1 percent acid fuchsin solution. The population of *Meloidogyne graminicola* and *Hirschmanniella* spp. was calculated in 5 g root from each locality. For each nematode, average, range, absolute frequency, absolute density, relative frequency, relative density and prominence value (PV) was computed (Norton, 1978). For the presence of white tip nematode, paddy seeds were collected from different localities. From each of these localities, about 50 g paddy seeds were collected from 2-3 stores of the farmers. These sub samples were mixed thoroughly to form a composite sample. From each composite sample, 50 seeds were drawn randomly and each seed was given 2-3 longitudinal/cross cuts with the help of a blade to separate hull from the kernel. Entire mass of these seeds was soaked for overnight in water and suspension was directly examined for presence of nematodes under stereo microscope.

The avoidable loss due to *M. graminicola* was assessed for two years (2007 and 2008) at Rice and Wheat Research Station, Malan, HP in a field having high incidence of *M. graminicola*. Variety HPR-1156 was direct sown in 12 m<sup>2</sup> plots, prepared as per paired plot technique. The control plots were left untreated and in treated plots were carbofuran (Furadan 3G) was applied @ 140 g plot<sup>-1</sup>. Observations on root galls in 10 plants plot<sup>-1</sup>, final nematode population in soil (200 cc) and roots (5g) and yield of grains were taken. The 't' value and percent avoidable loss was calculated.

## RESULTS AND DISCUSSION:

Six plant parasitic nematodes were found to be associated with rice crop in HP including *M. graminicola*, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Pratylenchus* spp., *Hirschmanniella* spp. and criconematids (Table 1). Out of seven districts, four were found to be infested with *M. graminicola* with population ranging from 18 to 4800 J<sub>2</sub> in 200 cc soil. Average population of this nematode was maximum in Kangra 568.9 in 200 cc soil) with maximum prominence value (PV) (220.4).

*Helicotylenchus* spp. was found to be associated with rice in all the districts under survey with maximum population (individuals in 200 cc soil) in Mandi (471.4). PV for this nematode was calculated to be highest in Sirmour district (488.4) followed by Una (475.1). The four other nematodes i.e. *Tylenchorhynchus* spp., *Pratylenchus* spp., *Hirschmanniella* spp. and criconematids were recorded to be with considerably low populations in different districts. The *Tylenchorhynchus* spp. was recorded in four districts i.e. Kangra, Mandi, Kullu and Chamba with PV 59.1, 68.2, 586.8 and 285.9, respectively. The PV for *Hirschmanniella* spp. was calculated to be 16.7, 41.6, 74.5, 39.4, and 212.9 in Kangra, Mandi, Hamirpur, Chamba and Sirmour. *Pratylenchus* spp. was recorded in Kangra, Chamba and Una with PV of 11.4, 129.0 and 120.6, respectively. Criconematids could be recorded in Kangra and Mandi with very low PV of 9.4 and 5.4.

Average population of *M. graminicola* in roots varied from 35.7 in Una to 70.5 individuals in Kangra (Table 2). Forty eight percent of the root samples were found to have population of this nematode species. *Hirschmanniella* spp. population was found to be very low compared to *M. graminicola* and mean population was recorded ranging from 5.5 to 10.5 individuals in 5 g of the roots.

The plant parasitic nematodes incidence varied from 50 percent in Chamba to 100 percent in Una. The 84.3 percent soil samples of rice in H.P. were found infested with one or other nematode species (Table 3). Highest average population (per 200 cc soil sample) was recorded in case of *Tylenchorhynchus* spp. (421.3) followed by *M. graminicola* (362.8 J<sub>2</sub>), *Helicotylenchus* spp. (255.4), *Hirschmanniella* spp. (99.5), *Pratylenchus* spp. (98.9) and Criconematids (42.7) (Table 4). However, absolute frequency was computed to be maximum for *Helicotylenchus* spp (70.1) followed by *M. graminicola* (50.2), *Tylenchorhynchus* spp. (22.4), *Hirschmanniella* spp. (17.4), Criconematids (7.5) and *Pratylenchus* spp. (3.6). The absolute frequency and relative frequency were found to be maximum for *Helicotylenchus* followed by *M. graminicola*, *Tylenchorhynchus*,

**Table 1. Average, range, frequency, density and prominence value of major nematodes associated with rice in Himachal Pradesh**

District	Nematode	Average (range)	Absolute frequency	Absolute density	Relative frequency	Relative density	Prominence value
Kangra	<i>M. graminicola</i>	568.9 (68-4800)	77.8	284.5	32.6	38.6	220.4
	<i>Helicotylenchus</i> spp.	313.6 (38-1235)	77.8	156.8	32.6	21.3	121.6
	<i>Tylenchorhynchus</i> spp.	233.4 (76-748)	33.3	116.7	14.0	15.8	59.1
	<i>Hirschmanniella</i> spp.	78.4 (20-156)	23.5	39.2	9.9	5.3	16.7
	Criconematids	42.1 (15-84)	24.7	21.1	10.4	2.9	9.4
	<i>Pratylenchus</i> spp.	238.0 (238)	1.2	119.0	0.5	16.1	11.4
Mandi	<i>M. graminicola</i>	316.1 (116-888)	54.3	158.1	36.7	26.0	157.5
	<i>Helicotylenchus</i> spp.	471.4 (25-1620)	54.3	235.7	36.7	38.8	235.1
	<i>Tylenchorhynchus</i> spp.	226.9 (75-500)	19.6	113.5	13.3	18.7	68.2
	<i>Hirschmanniella</i> spp.	146.6 (114-165)	17.4	73.3	11.8	12.1	41.6
	Criconematids	54.0 (54)	2.2	27.0	1.5	4.4	5.4
Hamirpur	<i>M. graminicola</i>	156.5 (23-296)	92.0	78.3	44.6	31.0	207.0
	<i>Helicotylenchus</i> spp.	245.7 (80-572)	86.0	122.9	41.7	48.7	314.5
	<i>Hirschmanniella</i> spp.	102.1 (69-120)	28.0	51.1	13.6	20.2	74.5
Kullu	<i>Helicotylenchus</i> spp.	59.4 (24-132)	66.7	29.7	60.4	6.8	52.8
	<i>Tylenchorhynchus</i> spp.	818.7 (156-2400)	43.8	409.4	39.6	93.2	586.8
Una	<i>M. graminicola</i>	31.3 (18-48)	22.3	15.7	18.2	12.4	52.9
	<i>Helicotylenchus</i> spp.	151.7 (36-468)	76.7	75.9	62.7	60.0	475.1
	<i>Pratylenchus</i> spp.	69.9 (45-152)	23.3	35.0	19.1	27.6	120.6
Chamba	<i>Helicotylenchus</i> spp.	60.0 (60)	6.3	30.0	7.2	15.6	41.9
	<i>Tylenchorhynchus</i> spp.	167.7 (81-297)	37.5	83.9	42.8	43.7	285.9
	<i>Hirschmanniella</i> spp.	25.3 (22-31)	31.3	12.7	35.7	6.6	39.4
	<i>Pratylenchus</i> spp.	131.0 (98-164)	12.5	65.5	14.3	34.1	129.0
Sirmour	<i>Helicotylenchus</i> spp.	275.0 (100-450)	100.0	137.5	76.9	55.7	488.4
	<i>Hirschmanniella</i> spp.	218.3 (148-245)	30.0	109.2	23.1	44.3	212.9

**Table 2. Population and incidence of *Meloidogyne graminicola* and *Hirschmanniella* spp. in rice in Himachal Pradesh.**

District	No. of samples analyzed	<i>Meloidogyne graminicola</i>			<i>Hirschmanniella</i> spp.		
		No. of samples +ve for nematodes	Percent incidence	Average population/5g roots (range)	No. of samples +ve for nematodes	Percent incidence	Average population/5g roots (range)
Kangra	81	61	75.3	70.5 (8-1120)	18	22.2	10.0 (2-22)
Mandi	46	24	52.2	48.4 (6-785)	7	15.2	7.0 (1-19)
Hamirpur	50	45	90.0	65.6 (10-915)	3	6.0	8.5 (2-14)
Kullu	48	-	-	-	-	-	-
Una	30	5	16.7	35.7 (5-409)	-	-	-
Chamba	16	-	-	-	5	31.3	5.5 (3-9)
Sirmour	10	-	-	-	4	40.0	10.5 (4-24)
Average	-	-	48.0			-	13.2

*Hirschmanniella*, *Criconeematids* and *Pratylenchus*. On the other hand side, absolute density and relative density were maximum for *Tylenchorhynchus* followed by *M. graminicola*, *Helicotylenchus*, *Hirschmanniella*, *Pratylenchus* and *Criconeematids*. PV was calculated to be 159.7, 133.0, 123.8, 25.9, 11.6 and 7.3 for *M. graminicola*, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Hirschmanniella* spp., *Pratylenchus* spp. and *Criconeematids*, respectively.

From the perusal of the literature, it appears that community analysis of plant parasitic nematodes

**Table 3. District-wise Incidence of plant parasitic nematodes in rice in Himachal Pradesh.**

Districts	No. of samples analyzed	No. of samples +ve for nematodes	Percent incidence
Kangra	81	66	81.5
Mandi	46	35	76.1
Hamirpur	50	46	92.0
Kullu	48	43	89.6
Una	30	30	100.0
Chamba	16	8	50.0
Sirmour	10	9	90.0
Average	-	-	84.3

**Table 4. Populations, frequency, density and prominence value of major nematodes associated with rice in Himachal Pradesh.**

Nematode	Average (range)	Absolute frequency	Absolute density	Relative frequency	Relative density	Prominence value
<i>M. graminicola</i>	362.8 (18-4800)	50.2	181.4	29.3	29.5	159.7
<i>Helicotylenchus</i> spp.	255.4 (24-1620)	70.1	127.7	40.9	20.8	133.0
<i>Tylenchorhynchus</i> spp.	421.3 (75-2400)	22.4	210.7	13.1	34.2	123.8
<i>Hirschmanniella</i> spp.	99.5 (20-245)	17.4	49.8	10.2	8.1	25.9
<i>Criconeematids</i>	42.7 (15-84)	7.5	21.4	4.4	3.5	7.3
<i>Pratylenchus</i> spp.	98.9 (45-238)	3.6	49.5	2.1	8.0	11.6

**Table 5. Population and incidence of *Aphelenchoides besseyi* in Himachal Pradesh.**

District	No. of samples analyzed	No. of samples +ve for nematodes	Percent incidence	Population in 50 grains
Kangra	42	17	40.5	60.0 (10-345)
Mandi	36	11	30.6	57.0 (8-201)
Hamirpur	42	8	19.0	48.0 (12-180)
Kullu	28	4	14.3	59.5 (15-218)
Una	26	9	34.6	52.5 (4-195)
Chamba	22	8	36.4	60.8 (18-150)
Sirmour	18	4	22.2	45.0 (14-225)
Average	-	-	28.5	55.0 (4-345)

species. The average population of the nematode species ranged from 45 to 60 individuals in 50 seeds. The occurrence of this nematode species is earlier reported from a number of states of India including H.P. (Chandel and Chandel, 1996; Savitri *et al.*, 1998; Das and Khan, 2007; Kamalwanshi *et al.*, 2003; Prasad *et al.*, 2007).

Number of galls in the root as well as soil population and yield varied significantly in treated and untreated plots. The average root galls plant<sup>-1</sup>, root population (per 5g), soil population (J<sub>2</sub> in 200 cc soil) and yield (t ha<sup>-1</sup>) were recorded to be 65, 600.3, 1953 and 2.64 in untreated plots compared to 17.2, 41, 429.3 and 2.86 in treated plots (Table 6). Avoidable losses to the tune of 8.3 percent were calculated. The information on quantification of exact losses due to *M. graminicola* in rice is scanty though its economic impact in the crop has been highlighted. McGowan (1989) reported the losses due to *M. graminicola* ranging from 17 to 30

**Table 6. Number of gall, yield and population of *Meloidogyne graminicola* in protected and un protected plots of rice crop.**

Parameter	Unprotected	Protected	Percent increase/ decrease in treated over untreated	t <sub>cal</sub> value
Root galls plant <sup>-1</sup>	65.0	17.2	-73.5	2.8
Root population/5g root	600.3	41.0	-93.2	22.1
Soil population/200cc soil	1953.0	429.3	-78.0	20.0
Yield (t/ha)	2.64	2.86	+8.3	10.2

t<sub>0.05</sub> table value (n-1=8) = 2.306

associated with the rice rhizosphere by computing their relative prominences have not been published so far. However, there are records from India and abroad revealing the association of a number of plant parasitic nematodes in the rice rhizosphere including those also reported in the present studies (Pedramfar *et al.*, 2001; Baqri and Ahmad, 2000; Sharma *et al.*, 2001; Ravichandra *et al.*, 2003; Kumar *et al.*, 2002; Singh *et al.*, 2005; Dabur and Jain, 2005).

*A. besseyi* was found to be distributed in all the districts of HP. The incidence was found to range from 14.3 percent (Table 5) in Kullu to 40.5 percent in Kangra district. The 28.5 percent paddy seeds were found to harbour different stages of this nematode

percent. Jain *et al.* (2007) estimated the losses of 4779 million rupees due to *M. graminicola* in India. Dabur and Jain (2005) reported *M. graminicola*, a threat under rice-wheat cropping system.

## REFERENCES

- Anonymous 2009. Statistical outlines of Himachal Pradesh, Economics and Statistical Department, Himachal Pradesh. pp. 68-70
- Baqri QH and Ahmad N 2000. Qualitative and quantitative studies of plant and soil inhabiting nematodes associated with rice crop in Sikkim, India. Records of the Zoological Survey of India 98:137-148

- Chandel YS and Chandel RS 1996. Distribution of white nematode, *Aphelenchoides besseyi* Christie and loss assessment in paddy in Himachal Pradesh (India). *Journal of Soil Biology and Ecology* 16: 60-63
- Cho HJ, Mew TW, Ahn JW, Yoon MS and Lee JR 1994. Assessment of yield loss by rice-root nematode *Hirschmanniella oryzae*, in IRRI rice fields. *Journal of Agricultural Science* 36: 63-67
- Coyne DL, Plowright RA, Twumasi J and Hunt DJ 1999. Prevalence of plant parasitic nematodes associated with rice in Ghana with a discussion of their importance. *Nematology* 1: 399-405
- Dabur KR and Jain RK 2005. Rice root nematode *Meloidogyne graminicola* - a threat to rice-wheat cropping system. *Indian Journal of Nematology* 35: 81-82
- Das TK and Khan MR 2007. Occurrence and distribution of white tip nematode, *Aphelenchoides besseyi* in West Bengal, India. *Indian Journal of Nematology* 37: 94-97
- Jain RK, Mathur KN and Singh RV 2007. Estimation of losses due to plant parasitic nematodes on different crops in India. *Indian Journal of Nematology* 37: 219-221
- Kamalwanshi RS, Khan A and Kumar S 2003. Occurrence of white tip disease of rice in Uttar Pradesh. *Indian Journal of Nematology* 33: 177
- Kumar V, Singh RV, Gaur HS and Singh J 2002. Biodiversity of plant parasitic nematodes associated with rice-based cropping system in around Palampur, Himachal Pradesh. In proceedings of national symposium on biodiversity and management of nematodes in cropping systems for sustainable agriculture, Jaipur India. 11-13 Nov. 2002. pp. 27-28
- McGowan JB 1989. The rice root-knot nematode *Meloidogyne graminicola* Golden & Birchfield. *Nematology Circular* No. 166
- Norton DC 1978. Ecology of plant parasitic nematodes. A Willey Interscience publication. John Wiley and Sons. New York, 268pp.
- Padgham JL, Duxbury JA, Mazid AM, Abawi GS and Hossain M 2004. Yield loss caused by *Meloidogyne graminicola* on lowland rainfed rice in Bangladesh. *Journal of Nematology* 36: 42-48
- Pedramfar H, Pourjam E and Kheiri A 2001. Plant parasitic nematodes associated with rice in Guilan Province, Iran. *Iranian Journal of Plant Pathology* 37: 285-301
- Prakash A, Rao J, Singh ON, Tyagi, JP Singh S and Rath PC 2007. Rice: the queen of cereals. AZRA, Publ. pp-215
- Prasad JS, Sharma OP, Katti G, Pasalu IC, Singh A and Sankar M 2007. Association of white-tip nematode with chaffiness of rice in Haryana. *Indian Journal of Plant Protection* 35: 153-154
- Ravichandra NG, Krishnappa K and Reddy BMR 2003. Occurrence and distribution of phytoparasitic nematodes associated with rice in Mandya District, Karnataka. *Indian Journal of Nematology* 33: 178
- Savitri H, Tayaba W, Sattar MA and Reddy BM 1998. Prevalence of white tip nematode (*Aphelenchoides besseyi* Christie) in rice samples of Andhra Pradesh. *Journal of Research* 26: 74-76
- Sharma SB, Pande S, Saha M, Kaushal KK, Lal M, Singh M, Singh K, Pokharel R and Upreti RP 2001. Plant parasitic nematodes associated with rice and wheat based cropping systems in Nepal. *International Journal of Nematology* 11 35-38
- Thakar NA, Patel BK, Patel HR and Patel CC 1987. Occurrence of white tip disease of rice in Gujarat. *Gujarat Agricultural University Research Journal* 13: 65
- Townshend JL 1963. A modification and evaluation of the apparatus for Oostenbrink direct filter extraction method. *Nematologica* 14: 106-110