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Status of phyto-parasitic nematodes in major fruits and vegetable crops of the tribal belt Kinnaur in Himachal Pradesh

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Abstract
The present investigations were carried out during the year 2015-16. Soil samples were collected from the rhizosphere of the commercial vegetable crops (pea, potato and cabbage) and fruit crops (apple, apricot and almond) of the tribal district Kinnaur in Himachal Pradesh. All the three developmental blocks of the district (Kalpa, Pooh and Nichar) were covered under the study. Four nematodes *viz*., lesion nematode (*Pratylenchus coffeae*), stunt nematode (*Tylenchorhynchus mashhoodi*), spiral nematodes (*Helicotylenchus dihystera*) and juveniles (J2) of root knot nematode (*Meloidogyne* sp.) were found prevalent in the rhizosphere of all the vegetable and fruit crops, with their considerable population build up. Among fruit crops, apple orchards were found harbouring highest population of all the nematodes, followed by apricot and almond, with lesion nematode as most predominant both in terms of its frequency of occurrence (100 %) and population density (299-384/ 200 cc soil). Among vegetable crops, pea was found most sensitive to nematode infestation and was having a maximum population build up of all the four nematodes (305,326, 252 and 244/ 200 cc soil, respectively). In all the three vegetables, maximum population density was recorded for stunt nematode (269-326/ 200 cc soil). All the localities of Kalpa block were found having highest nematode populations in both fruits and vegetable crops rhizosphere. Although, there was recorded positive impact of soil temperature and moisture on the buildup of different nematode population, both in fruit and vegetable crops, their impact did not remain considerable on the population of all the nematodes.

Keywords: Phyto-parasitic nematodes; fruit crops; vegetable crops; Kinnaur

1. Introduction
Fruits and vegetables are the natural food of man having a excellent sources of vitamins, minerals and enzymes. The Himachal Pradesh, popularly known as apple state of India, occupies a significant place in the horticultural wealth of the country by producing 738.7 thousand metric tons fruits with cultivated area of 107.7 thousand ha [15]. The state of Himachal Pradesh is the second highest producer of temperate fruits in the country. The scheduled areas, where the majority of the Scheduled Tribes are concentrated in the state of Himachal Pradesh occupy a vast expanse under Kinnaur and Lahaul & Spiti districts, covering over 43% of the total geographical area of the state. These tribal districts are located in the hinterlands amidst the Greater Himalayas, bordering Tibet and China [13]. The economy of these tribal people is mainly governed by the production of temperate fruits and vegetables. The area is known for quality production of these crops, in the national and international markets, owing to its highly congenial agro climatic conditions. Among the two major tribal districts of the state, Kinnaur occupies a major agrarian area (about 60 %) along with its higher population density (13 persons/ sq km.) in comparison to Lahaul & Spiti (2 persons/ sq km) [3]. The tribal district Kinnaur contributes an appreciable share in the horticultural economy of the state/country through its high quality apple (*Malus domestica*) production. Besides, the district is among pioneer producers of other temperate fruits (like apricot; *Prunus armeniaca* and almond; *Prunus communis*). The commercial vegetables cultivated in this province include cabbage (*Brassica oleracea*), pea (*Pisum sativum*) and potato (*Solanum tuberosum*). These vegetables are marketed in the off season (April- October) and contribute towards a major source of income for thousands of farmers in the tribal area with small land holdings (< one hectare). Among the agrarian crops, vegetable and fruit crops usually are most susceptible and worst affected by nematodes and overall average annual yield losses to the worlds major horticulture crops due to plant parasitic nematodes has been estimated around 13.5% [21].

In Himachal Pradesh these tiny organisms are known to cause 15-36% yield losses to vegetable and fruit crops [18, 2]. In the state as a whole, although plant parasitic nematodes do play an important role in limiting the production of many commercial horticultural crops, preliminary studies conducted in the tribal district (Kinnaur) have revealed the prevalence of many phytoparasitic nematodes of global importance in the rhizosphere of fruit crops. Among them, the species of *Pratylenchus* (lesion nematode), *Meloidogyne* (root knot nematode), *Xiphinema* (dagger nematode), *Paratylenchus* (pin nematode) and *Macroposthina* (ring nematode) were of major concern [2, 19]. As nematodes are not distributed uniformly in the rhizosphere [21], their community structure needs to be studied at different locations. Keeping in view the economic importance of phyto-parasitic nematodes and their community structure, present studies were undertaken to work out their status in the rhizosphere of commercial fruits and vegetable crops of the tribal district Kinnaur of HP.

2. Material and Methods

The study included survey, soil sampling, processing, population estimation, identification and observations on different abiotic parameters of the orchards/ fields, to work out their impact on the population buildup of nematodes.

2.1 Survey

A systematic survey of fruits and vegetables growing areas in the district Kinnaur was conducted. All the three development blocks of the district (Nichar, Kalpa and Pooh) were surveyed and from each block three localities were taken into consideration.

2.2 Soil sampling

In all, 270 soil samples were collected from the feeder-root zone of the plants. From each locality, five composite soil samples were collected for an individual crop and each sample was composed of three subsamples (each made of 150-200 cc soil). The sampling was done during peak growing season (June 2015-May 2016). The samples were collected manually with the help of khurpi/augur from the depth of 10-20 cm, covering 10-60 cm radius. These composite samples were put in polythene bags and tied with rubber band to check the loss of moisture. In the laboratory, the samples were kept at 5 ^{o}C in order to maintain their optimum moisture.

2.3 Processing

The samples were processed within 2-3 days of their collection to isolate the nematodes. From each composite sample, only 200 cc soil was processed after its thorough mixing. The processing was carried out by Cobb's seiving and decanting techniques [6]. Nematode suspensions were observed after 24 hours of processing under zoom-stereoscopic microscope to count their population densities and for identification of different plant parasitic nematode genera.

2.4 Population Estimation

Populations of different nematode genera were estimated by taking an average of three numbers of 2 ml nematode suspension counts × total volume of suspension. For root knot nematode (*Meloidogyne* species) only 2nd stage juvenile (J_2) populations were taken into consideration.

2.5 Identification

Nematodes genera were identified by observing the live specimens under zoom stereoscopic microscope with varying range of magnifications and as per key cited by Siddiqi [20]. Species identification was done on the basis of morphometrics and morphological characters as mentioned in the taxonomic keys [7, 1], after preparing their permanent mounts [17].

2.6 Abiotic parameters

Soil temperature, soil moisture, soil pH, altitude and plant age were recorded for the orchards and fields sampled.

2.6.1 Altitude

It was recorded with the help of an altimeter.

2.6.2 Soil temperature

Soil temperature (°C) was recorded after five minutes of insertion of soil thermometer up to 10 cm depth in the soil.

2.6.3 Soil pH

Weighed out 20 g of soil in a beaker, added 40 ml of distilled water (soil: water, 1:2) and stirred at least four times within a period of half an hour. This time is required for the soil and water to attain equilibrium. After half an hour again stirred the soil suspension and measure the pH in a pH meter.

2.6.4 Soil moisture

The collected soil sample (100 cc) was weighed immediately (W1). The soil sample was dried in an oven at 105 °C for 24-48 hours and weighed again (W2) and moisture content (MC) was calculated.

$$MC\ (\%) = \frac{\text{Weight of the moist soil} - \text{Weight of the dried soil}}{\text{Weight of the dried soil}} \times 100$$

W1 = Weight of moist soil (g)
W2 = Weight of dried soil (g)
MC% = Moisture content percentage

3. Results and Discussion

3.1 Nematode populations

3.1.1 Fruit crops

Result presented in (Table 1) revealed that four nematode species viz., *Pratylenchus coffeae* (lesion nematode), *Tylenchorhynchus mashhoodi* (stunt nematode), *Meloidogyne* sp. (root-knot nematode) and *Helicotylenchus dihystera* (spiral nematode) were found prevalent in the orchards of all the three fruit crops (apple, apricot and almond), with their 100 per cent frequency of occurrence. Besides, incidence of *Xiphinema* sp. was also recorded from some apple orchards (33.3 % frequency of occurrence). Average population buildup was highest for *P. coffeae* (329.00), followed by *Meloidogyne* sp. (299.00), *T. mashhoodi* (291.33) and *H. dihystera* (233.66), while it remained minimum for *Xiphinema* (6.00). Apple orchards were found harbouring maximum populations of all the four nematodes, with predominance of the lesion nematode (384), followed by stunt nematode (340), root knot nematode (322) and spiral nematode (247). Among apricot and almond, populations of *P. coffeae*, *T. mashhoodi* and *H. dihystera* were higher in the former rhizosphere (304, 276, and 220, respectively) while, *Meloidogyne* sp. (J_2) population was more in almond orchard (290). Apple orchards of the district supported highest total nematode population (1311), in comparison to apricot (1085)

and almond (1051). The lesion nematode (*P. coffeae*) showed highest population density in the rhizosphere of all the three fruit crops.

Predominance of lesion, stunt, spiral and root knot nematodes in apple almond and apricot orchards has also been reported from Kashmir [4]. Common occurrence of these nematodes in apple, apricot and almond rhizosphere was also recorded by various workers [10, 18, 12]. Present finding of *Xiphinema* association with apple and its absence on apricot and almond, has also been reported from Kashmir (4). In their study, they recorded prevalence of *Xiphinema* (*X. basiri*) on apple, while no incidence of the nematode was observed on almond and apricot.

Table 1: Plant parasitic nematodes associated with fruit crops in tribal district Kinnaur of H.P.

Crops	Nematode population (per 200 cc soil)					Total
	P. coffeae	***T. mashhoodi***	***Meloidogyne* sp.**	***H. dihystera***	***Xiphinema* sp.**	
Apple	384	340	322	247	18	1311
Apricot	304	276	285	220	0	1085
Almond	299	258	290	204	0	1051
Mean	329.00	291.33	299.00	223.66	6.00	1149
SD	50.16	43.04	19.81	21.66	NA	133.08
% frequency of occurrence	100.00	100.00	100.00	100.00	33.33	100.00
Range	299-384	258-340	285-322	204-247	0-18	1051-1311

3.1.2 Vegetable crops

The same four nematodes with 100 per cent frequency of occurrence were found prevalent in the fields of all the three commercial vegetable crops of the area (Table 2). Highest average population buildup was recorded for *T. mashhoodi* (292.66), followed by *P. coffeae* (240.00), *Meloidogyne* sp. (233.33) and *H. dihystera* (223.00). Maximum populations of all the nematodes were extracted from the rhizosphere of pea (305, 326, 244 and 252, respectively). Among potato and cabbage, the former crop harboured higher populations of *T. mashhoodi* and *Meloidogyne* sp. (283 and 241, respectively), while the populations of *P. coffeae* and *H. dihystera* were higher (218 and 219, respectively) in cabbage fields. With highest total nematode population of 1127, pea was found more prone to nematodes, followed by cabbage (921) and potato (919). In all the three vegetable crops, population buildup of the stunt nematode (*T. mashhoodi*) was highest.

Prevalence of these nematodes in the fields of pea, cabbage and potato have also been reported by various workers globally [9, 14, 7, 22].

Table 2. Plant parasitic nematodes associated with vegetable crops in tribal district Kinnaur of H.P.

Crops	Nematode population (per 200 cc soil)				Total
	P. coffeae	***T. mashhoodi***	***Meloidogyne* sp.**	***H. dihystera***	
Pea	305	326	244	252	1127
Potato	197	283	241	198	919
Cabbage	218	269	215	219	921
Mean	240.00	292.66	233.33	223.00	989.00
SD	56.78	29.68	15.96	32.07	121.74
% frequency of occurrence	100.00	100.00	100.00	100.00	100.00
Range	197-305	269-326	215-244	198-252	919-1127

3.2 Correlation between abiotic factors and nematode populations

Table 3: Range value of abiotic factors recorded from district Kinnaur in fruit and vegetable crops

Sr. No.	Block	Altitude (a.m.s.l)	pH	Moisture (%)	Age of tree/ crops Fruits (years)	Temperature Vegetables (months)	Block (ºc)
1.	Kalpa	2290-2960	5.2-5.8	15.0-20.2	20-32	4-6	23-26
2.	Pooh	2699-3662	5.1-6.1	6.0-10.0	19-25	5-6	17-20
3.	Nichar	2086-2100	5.3-6.0	18.2 -22.0	16-32	4-5	19-26

3.2.1 Fruit crops

From the results (Table 4) it was observed that among the four nematodes, only population of the stunt nematode (*T. mashhoodi*) was found significantly increased with increase in soil temperature and moisture (positive correlation) and decreased considerably with increase in soil pH (negative correlation). Other nematode populations were least affected with either of the parameters recorded.

Poor relationship between nematode population and soil moisture as recorded in the present study has also been recorded by Khan *et al.* [11] in apple orchards. Non significantly impact of soil pH on population density of most of the nematodes as recorded in the present study has been worked out and by Sen [16] in apple orchards of H.P.

Table 4: Correlation between nematode populations and abiotic factors in fruit crops

Nematode	Temperature	Moisture	Age of plants	pH	Altitude
P. coffeae	0.2236	-0.0585	-0.0207	-0.3434	0.3563
T. mashhoodi	0.6142*	0.4101*	0.2108	-0.4960*	-0.0750
Meloidogyne sp.	0.3788	0.3458	0.0974	-0.0601	-0.1425
H. dihystera	0.0250	0.0210	0.0027	0.0906	-0.2030

*Significant at 5% level

3.2.2 Vegetable crops

There was recorded significant positive impact of increased soil temperature and moisture on the population build up of *T. mashhoodi* and *Meliodogyne* sp (positive correlation). Juvenile population of the root-knot nematode was found considerably decreased with increase in altitude and plant age (negative correlation), while the lesion nematode population increased with the increase in altitude.

Positive correlation between lesion nematode population and altitude has also been reported from Himachal Pradesh [5] in French bean fields of H.P. Positive correlation between soil temperature and nematode population in the cabbage fields has been reported from Nigeria [23].

Table 5: Correlation between nematode populations and abiotic factors in vegetable crops

Nematode	Temperature	Moisture	Age of plants	pH	Altitude
P. coffeae	0.1179	-0.1417	0.1155	-0.2022	0.4091*
T. mashhoodi	0.5187*	0.5214*	-0.3790	-0.2097	-0.2735
Meloidogyne sp.	0.5881*	0.7573*	-0.4977*	-0.1369	-0.5475*
H. dihystera	0.1926	0.2366	-0.2105	-0.1626	-0.2596

*Significant at 5% level

4. Conclusion

From the results it can be concluded that all the commercial fruits and vegetable crops of the tribal district are harbouring heavy population densities of plant parasitic nematodes. In fruit crops, lesion nematode (*P. coffeae*) is most predominant with its highest population buildup in apple orchards. Orchards in the Kalpa block of the district are harbouring maximum populations of all the nematodes. In all the three vegetable crops, stunt nematodes are most predominant followed by and lesion nematode. In the pea fields, population buildup of all the nematodes are maximum in comparison to other two vegetables. Alarming population densities of these nematodes in vegetable fields are of special concern and requires constant attention to restrict their spread and multiplication.

5. References

1. Ahmad W. Plant parasitic nematodes of India. An Identification Mannual. Dept. of Zoology, Aligarh Muslim University, Aligarh, India.1996, 163-190.
2. Anonymous. Annual Progress Report of AICRP (Nematology) Solan Centre UHF, Nauni. 2000-2003.
3. Anonymous. Statistical Abstract of Himachal Pradesh. 2015-16.
4. Askary TH, Waliullah MIS and Mir MM. Distribution phytonematodes associated with stone and nut fruits in Kashmir valley, India. Journal of Applied Horticulture. 2014; 16(2):136-140.
5. Bhatia M. Status of Nematodes on French bean in Mid-Hill Region of Himachal Pradesh. M.Sc. Thesis Department of Entomology and Apiculture. Dr. Y. S. Parmar University of Horticulture and Forestery, Nauni, Solan. 1999; 70.
6. Cobb NA. Estimating the nema population of the soil. Agricultural Technology Circular Bureau Plant Industry, U.S. Department of Agriculture, 1918; 48.
7. De Man JG. Die einheimischen, frei in der reinen erde und im sussen wasser lebenden neniatoden monographic bearbeitet. Tijdschrift der Nederlandse Dieik Vereenig. 1980; 5: 1-104.
8. Esteves I, Maleita C, Abrantes. Root - Lesion and Root Knot Nematodes parasitizing potato. European Journal of Plant Pathology. 2015; 141:397-406.
9. Islam S, Khan A, Bilqees FM. Survey of stylet-bearing nematodes associated with apple (*Malus pumila* Mill.) in swat district, N W F P, Pakistan. Proceedings of Prasitology. 2006; 21:1-9.
10. Khan ML, Sharma NK. A description of *Pratylenchus manalensis* sp. associated with apple in India. Nematologia Mediterranea. 1991; 19:275-277.
11. Khan A, Shaukat SS, Islam S. Influence of soil temperature and moisture on seasonal variation of three plant-parasitic nematodes associated with apple in Swat, Pakistan. International Journal of Nematology. 1997; 7(1):26-29.
12. Mokbel AA, Ibrahim IA, EtSaedy MM, Hammad SE. Plant parasitic nematodes associated with some fruits trees and vegetable crops in Northern Egypt. Egypt Journal of Phytopathology. 2006; 34(2):43-51.
13. Parmar HS. Tribal Land and People of Himachal Pradesh. International Journal of Rural Studies. 2011; 18(1):2-12.
14. Roy K, Mukhopadhyay AK, Pramanik A. Occurrence, distribution and community analysis of plant parasitic nematodes associated with leguminous vegetable crops in West Bengal. Indian Journal of Nematology. 2007; 37:58-62.
15. Saxena M, Gandhi CP. Indian Horticulture Database. IG Printer Pvt. Ltd., New Delhi. 2014, 279.
16. Seinhorst JW. Killing nematodes for taxonomic studies with hot FA 4:1.Nematologica. 1966; 12:178.
17. Sen S. Status of plant parasitic nematodes in Apple orchards of Himachal Pradesh. MSc Thesis, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.), India. 2014, 41.
18. Sharma GC, Kashyap AS. Effect of different intercrop on the Nematode population and yield of apricot. Indian Journal of Horticulture. 2009; 66(3):420-421.
19. Sharma GC, Sen S. Status of plant parasitic nematodes in apple orchards of H.P. International Journal of Farm Science. 2015; 5(3):171-178.
20. Siddiqui MR. Tylenchida: Parasites of Plants and Insects, 2nd ed. CABI Publishing UK, Wallingford (GB), 2000, 833.
21. Singh S, Rai AB, Singh R, Singh AK. Population dynamics of phytonematodes in vegetable crops. Annual Plant Protection Science. 2011; 19:503-504.
22. Thakur NA, Devi G, Shylesha AN. Nematodes associated with vegetable crops in Ri-Bhoi District of Meghalaya. Indian Journal of Nematology. 2016; 35(2):217-218.
23. Umar, Chubado D. Survey of plant parasitic nematodes in the Benue valley of Adamawa State, Nigeria. Agriculture journal. 2008; 3(5):353-356.