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Nematode constraints to pigeonpea and chickpea in Vidarbha region of Maharashtra in India

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Abstract. Plant parasitic nematodes associated with pigeonpea and chickpea in Akola, Amravati, Buldhana, Yavatmal and Wardha districts in Vidarbha region of Maharashtra, India were observed and recorded. Based on population densities and extent of occurrence, cyst (*Heterodera cajani*) and reniform (*Rotylenchulus reniformis*) nematodes were important on pigeonpea, and *Pratylenchus* spp. and *R. reniformis* on chickpea. The root-knot nematodes were not important on these crops in Vidarbha. *H. cajani* was virtually absent in locations where sesamum, rice, cotton or vegetables were cultivated in the rainy season and chickpea in the post-rainy season. The vegetable-chickpea cropping system greatly favoured build up of the lesion (*Pratylenchus* spp.) and reniform nematodes.

Keywords. Chickpea, cropping system, *Heterodera cajani*, India, nematode survey, pigeonpea, population density, *Pratylenchus* spp., *Rotylenchulus reniformis*, Vidarbha region.

INTRODUCTION

Vidarbha is a semi-arid region of Maharashtra State in India. Cotton and sorghum are the major rainy season crops cultivated in Vidarbha. The rainfall in the region is highly variable and average ranges from 600 to 800 mm. The soils in Vidarbha are medium black; parts of Buldhana, Wardha and Yavatmal districts have coarse shallow black soils (Anonymous, 1995). These soils have high levels of potash, low to medium levels of nitrogen and low levels of phophorus. Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important component of cropping systems and it is grown as an intercrop with sorghum and cotton. Chickpea (*Cicer arietinum* L.) is a post rainy season crop and its cultivation in Buldhana and Wardha districts is extensive. The two crops are important sources of proteins in the diets of people in Vidarbha. However, the gap between potential and average yields of these crops in the region is very high. Many factors are presumably responsible for the low yields, and biotic constraints are one of the most important contributory factors.

The information on nematode parasites of pigeonpea and chickpea in Vidarbha is scanty. The objectives of this study were: to characterize the associated nematode community, identify potential nematode constraints to pigeonpea and chickpea, and to determine the distribution patterns of plant parasitic nematodes in different cropping systems in the region.

MATERIALS AND METHODS

Pigeonpea and chickpea growing regions in five districts (Akola, Amravati, Buldhana, Wardha and Yavatmal) in Vidarbha region of Maharashtra in India were examined in December, 1995, for the presence of plant parasitic nematodes. Soil and root samples were collected from the feeder root zone with the help of a 30-cm long augur and a steel shovel. Number of soil cores per sample varied from one location to another, depending on the area of infestation. However, a minimum of 25 soil cores were collected from each hectare samples. For a given cropping system in a village, composite samples of soil and roots were collected from continuous fields from patchy areas of suspected nematode infestation.

Roots were washed free of soil and examined visually in the field after staining with trypan blue, for on-the-spot identification and assessment of root-knot and reniform nematode infections (Sharma and Ashokkumar, 1991; Sharma and Mohiuddin, 1993). Additional information of soil type, irrigation, and cropping history were collected. Each soil sample was thoroughly mixed and 100 cm^3 soil was processed by wet sieving and decantation and the residue on 80 mesh sieve (180 µm pore size) was observed for cysts under a stereomicroscope. Roots collected on 20 mesh sieve (850 µm pore size) were gently macerated on the 80 mesh sieve to collect females and cysts attached to the roots. The residue on

the 400 mesh sieve (38 µm pore size) was placed on a modified Baermann funnel (Schindler, 1961). After 48 hours, nematodes in the water suspension were examined under a stereoscopic microscope as well as a high resolution microscope for identification. For species identification, the specimens were fixed in 4% formalin and mounted in hot lactophenol before observing them under the microscope. Average density of nematodes in each location, frequency distribution, and prominence values were calculated. In the greenhouse, bioassay tests were conducted by inoculating populations of important nematode species on pigeonpea and chickpea and checking the roots after eight weeks for nematode reproduction.

RESULTS AND DISCUSSION

Nematode Community. Examination of the nematode community in root and soil samples revealed widespread presence of cyst, reniform, lesion, spiral, lance and stunt nematodes (Tables 1 & 2). Detailed study of these nematodes showed that the most commonly occurring species were *Heterodera cajani*, *Rotylenchulus reniformis*, *Pratylenchus coffeae*, *Helicotylenchus retusus*, *H. mucronatus* and *Hoplolaimus indicus*. Association of these nematodes with pigeonpea and chickpea has been reported (Nene *et al.*, 1996).

The reniform nematode (*Rotylenchulus reniformis*) population from Buldhana district was different from the typical *R. reniformis* populations observed at other locations and it appeared closer to the description of *Rotylenchulus parvus*. However, further taxonomic study is needed to confirm the identity of this population. *Rotylenchus*, *Ditylenchus*, *Telotylenchus*, and *Tylenchus* were other tylenchid nematodes found in the soil samples. High levels of *Trichodorus* sp. were observed on pigeonpea and of *Telotylenchus* sp. on chickpea from Akola (location: Khamked) and Buldhana (location: Pet) districts. *Helicotylenchus retusus* was ubiquitous in Akola, Buldhana and Wardha districts while *H. mucronatus* was common in Yavatmal district. Moderate populations of *Rotylenchus* were noticed on chickpea in localised pockets in Amravati (Damura) and Buldhana (Khandula) districts. A stunt nematode population on chickpea in Yavatmal (Umari) was identified as *Tylenchorhynchus clavicaudatus*.

Important Nematodes. The population density of pigeonpea cyst nematode (*Heterodera cajani*) was high (>500 eggs and juveniles per 100 cm^3 soil) in most of the pigeonpea areas surveyed particularly in Amravati district (Table 1). The average population density of *H. cajani* was 3356 eggs and juveniles per 100 cm^3 soil in Legaon village in this district. The population densities of the reniform nematode were generally low to moderate; only Damura region in Amravati district had a high population density of 620 vermiform stages per 100 cm^3 soil; this region had low incidence of *H. cajani*. The root lesion nematodes (*Pratylenchus* spp.) were generally present in low numbers.

The lesion nematodes and the reniform nematode (*R. reniformis*) were the most prominent nematode populations associated with chickpea in Akola, Wardha, and Yavatmal districts while *H. cajani* was the most predominant nematode in Amravati and Buldhana districts. The population densities of *H. cajani* in Karankhed region (Buldhana district) and Dharyapur and Jallu regions (Amravati district) were above 500 eggs and juveniles per 100 cm^3 soil. It is interesting that Karankhed is not a pigeonpea growing region and high numbers of *H. cajani* indicate that this species has some other hosts that have not yet been recorded. Bioassay tests in the greenhouse revealed that commonly grown pigeopea cultivars were not good hosts and it does not seem reasonable to believe that the associated high population of *H. cajani* was due to its reproduction on chickpea. There is a need to check the most common weeds in these areas for their reaction to *H. cajani*. *Hoplolaimus* populations were generally below threshold level wherever recorded. High densities of spiral and stunt nematodes were noticed in Buldhana while lesion nematode had its highest average density in Wardha district. Khamked and Akot (Akola district), Damura (Amravati district), Khandula (Buldhana district) and Husnapur (Wardha district) regions were identified as areas with widespread infestation of the lesion nematodes.

Nematode community and population density analysis and bioassay tests in the greenhouse indicated that the cyst nematode is an important problem on pigeonpea in Amravati, and reniform nematode on chickpea in Wardha. Populations of lesion, spiral, lance and stunt nematodes were found in greater numbers mainly in those areas where *H. cajani* and *R. reniformis* were either absent or present in low numbers.

Cropping System Effect. Average nematode densities were compared in six important cropping systems (Table 3). *Heterodera cajani* population was non-existent in sesamum-chickpea, rice or cotton-chickpea, and vegetables-chickpea cropping systems. Presence of pigeonpea or safflower in the cropping system appeared to greatly favour build up of *H. cajani* population. The highest density of 865 eggs and juveniles of *H. cajani* per 100 cm^3 soil was in pigeonpea-chickpea or safflower system. The bioassay tests in the greenhouse did not reveal any reproduction of the nematode on safflower. The reniform nematode population generally occurred along with the cyst nematode except in vegetables-chickpea system, where *H. cajani* was absent. This cropping system was favorable for the lesion nematodes and highest density (150 juveniles and adults per 100 cm^3 soil) was found on vegetables-chickpea system followed by fallow/greengram-chickpea/safflower systems.

The survey results indicated that *H. cajani*, *R. reniformis* and *Pratylenchus* spp. were important nematode problems on chickpea and pigeonpea in Vidarbha region of Maharashtra. This scenario is typical of that reported from other pigeonpea growing States of Gujarat, Karnataka (Patel *et al.*, 1996; Sharma *et al.*, 1992a, 1992b) and Uttar Pradesh (Sharma *et al.*,

Table 1. Distribution of plant parasitic nematodes on pigeonpea and chickpea in Vidarbha region of Maharashtra.

Crop	Nematode	Density/100 cm^3	Akola	Amravati	Buldhana	Wardha	Yavatmal
Pigeonpea	*H. cajani*	Low	Uguva	Damura	_	_	_
		Moderate	Divtara	_	_	_	Mohada
		High	Khamked	Legaon, Shivani-rasulpur	_	_	_
	R. reniformis	Low	Khamked	Masurpur	_	_	Erad
		Moderate	Divtara	Shivani-rasulpur	_	_	_
		High	_	Damura	_	_	_
	Pratylenchus spp	Low	Uguva	Shivani-rasulpur	_	_	_
		Moderate	_	_	_	_	_
		High	_	_	_	_	_
Chickpea	*H. cajani*	Low	_	_	Kolharb, Kandula	_	_
		Moderate	Balapur	Legaon	Mathina, Tapperkhed-muslwan, Chikli	Husnapur, Ratnapur, Sirpur	Bhari
		High	_	Dharyapur, Jallu	Karankhed	_	Loni
	R. reniformis	Low	_	_	Khandula, Pet, Khamgaon	_	_
		Moderate	Khamked, Shiroda	Damura, Javara, Lakhad	Kolharb	Dedi, Issapur, Ratnapur, Selsura	Erad, Parave, Sonvadona
		High	Divtara	_	Kharankhed	Sirpur	_
	Pratylenchus spp	Low	Shiroda	–	Kolharb	_	Parave
		Moderate	Khamked, Akot	Damura	Khandula	Husnapur	_
		High	_	_	_	_	_

Low = 1-100 nematodes, Moderate = 101-500 nematodes, High = >500 nematodes

Table 2. Frequency of occurrence, average density (per 100 cm^3 of soil) and distribution of important nematode species on chickpea and pigeonpea in Vidarbha region of Maharashtra.

	H. cajani cysts			*H. cajani* eggs and juveniles			*R. reniformis*			*Pratylenchus* spp.			*Helicotylenchus* spp.			*Hoplolaimus* spp.			*Tylenchorhynchus* spp		
	F	AV.D	PV	F	AV.D	PV	F	AV.D	PV	F	AV.D	PV	F	AV.D	PV	F	AV.D	PV	F	AV.D	PV
Chickpea																					
Akola (7)*	11	456	151	0	0	0	44	285	190	44	99	190	33	69	40	44	14	9	66	28	23
Amravati (6)	57	589	445	28	12	6	42	219	143	14	145	143	14	3	1	28	11	5	0	0	0
Buldhana (8)	44	380	252	33	13	7	66	172	140	22	142	140	55	243	181	33	11	66	11	200	66
Wardha (6)	50	152	107	37	35	21	75	320	277	12	240	277	25	73	36	12	15	5	0	0	0
Yavatmal (8)	30	228	124	20	117	52	50	206	146	10	75	146	30	155	85	30	48	26	30	118	
Pigeonpea																					
Akola (4)	50	418	295	50	10	7	50	113.5	80.25	39	95.6	59	385.6	216.6	134.4	38.5	15.2	9.4	61.5	29	22.7
Amravati (4)	75	1469	1272	50	58.5	83	75	304.7	263.9	18	96.5	41	9	3	0.9	27.3	12.3	6.4	0	0	0
Yavatmal (2)	50	304	215	0	0	0	50	54	38.2	0	0	0	0	0	0	50	12	8.5	50	85	60

F = Frequency of occurrence, AV. D = Average density, PV = Prominence value
* Number of villages surveyed.

Table 3. Plant parasitic nematode densities (per 100 cm^3 of soil) in various cropping systems in Vidarbha region of Maharashtra.

Cropping System	*Heterodera cajani*	*Rotylenchulus reniformis*	*Pratylenchus* spp.	*Helicotylenchus* spp.	*Hoplolaimus* spp.	*Tylenchorhynchus* spp.	Other tylenchids
Pigeonpea/ Soybean/ Cotton/ – Chickpea	145	273	123	69	8	29	101
Pigeonpea/Sorghum – Chickpea/ Safflower/ Sorghum/ Cotton/ Sunflower	865	213	72	434	19	64	202
Fallow or Greengram – Chickpea/ Safflower	448	205	143	117	42	48	87
Sesamum – Chickpea	0	0	85	85	0	45	433
Rice/Cotton/ Mustard – Chickpea	0	0	0	0	0	250	53
Vegetables – Chickpea	0	259	150	0	0	35	60

1996). The root-knot nematode species that are important constraints to chickpea production were not important in Vidarbha region (Ali, 1995; Sharma and McDonald, 1990). However, the lesion nematode populations on chickpea deserves attention as these can cause serious damage to chickpea (Ali, 1995). The reniform nematode populations cause damage to pigeonpea (Sharma *et al.*, 1993) and have the ability to survive without host plants under drought conditions. These nematodes may affect the severity of other soil-borne diseases and retard the efficiency of Rhizobium nodules on chickpea and pigeonpea (Reddy *et al.*, 1993). It is apparent from this study that a cropping system approach could be useful in managing the populations of highly damaging nematode species below threshold levels. Singh *et al.* (1994) also found that pigeonpea-based cropping systems greatly influence the populations density of *H. cajani* and productivity of newer production system technologies can be enhanced by the inclusion of a nematode management component.

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