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Incidence and Importance of Plant-parasitic Nematodes on Pigeonpea and Groundnut in Karnataka State in Southern India

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Abstract. Samples were collected from 68 pigeonpea and 93 groundnut fields in five districts of Karnataka State, India. *Heterodera cajani* was found in all the locations in pigeonpea fields, with nematode densities greater ($p = 0.05$) in Belgaum and Gulbarga districts than in others. *Rotylenchulus reniformis* was present in 75% of the samples and nematode densities were greater ($p = 0.05$) in Dharwad and Bijapur than in other districts. Average population densities of eggs and juveniles of *H. cajani* was 62% higher on Vertisols than on Alfisols whereas average population density of *R. reniformis* was 43% greater on Alfisols than on Vertisols. Other nematodes present were: *Aphelenchoides* spp., *Ditylenchus* spp., *Helicotylenchus retusus*, *Helicotylenchus* sp., *Hoplolaimus seinhorsti*, *Hoplolaimus* sp., *Meloidogyne* sp., *Pratylenchus coffeae*, *P. zeae*, *Tylenchorhynchus vulgaris* and *Tylenchorhynchus* sp. *Pratylenchus* spp. were predominant and highest density of 1.9 *Pratylenchus* per cm^3 of soil was observed at Chikodi in Belgaum district. Lesions on groundnut pods were not serious in any region and *Meloidogyne* spp. were not important on these crops.

Keywords: Alfisol, cropping system, groundnut, *Heterodera cajani*, pigeonpea, *Pratylenchus* spp., *Rotylenchulus reniformis*, Vertisol.

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) Millsp.) and groundnut (*Arachis hypogaea* L.) are important grain legumes in Karnataka State of Southern India. Groundnut is planted in about 400 000 ha and pigeonpea in nearly 300 000 ha. These crops are normally sown in June in the rainy season. There is a lack of data on the distribution of plant-parasitic nematodes associated with these crops, particularly in the major production regions in South Asia. We report here the distribution of plant-parasitic nematodes of pigeonpea and groundnut in Karnataka, in relation to soil types and cropping systems. This is the first report of extensive surveys of nematodes of these crops in South Asia. It is hoped that the information furnished in this paper will be useful in developing geographical information systems on the biotic constraints of these two crops in the region.

MATERIALS AND METHODS

Belgaum, Bijapur, Dharwad and Raichur districts in Karnataka State account for 73% of groundnut cultivation during the rainy season. Gulbarga along with these districts account for 72% of the pigeonpea production area in Karnataka. These areas were, therefore, selected for extensive surveys in September, 1990. Samples were collected depending on the area under these crops from different regions, referred to as taluks, in each district. Individual fields were the basic units of the survey and were selected arbitrarily so as to represent the major areas within each taluk. Composite soil samples were collected with the help of a 25-cm long soil sampler from each field down to a depth of 20 cm. Each sample contained 10–20 soil cores; root samples were collected along with the soil. Roots and groundnut pegs and pods were examined on the spot for lesions and root-knots.

The major soils were Alfisol (red soil) and Vertisol (black-cotton soil). H 208 (a Spanish bunch), local (spreading type groundnut cultivars), and PT 221 (Medium-duration pigeonpea cultivar) were widely cultivated in all districts. H 208 was in flowering and podding stages while the spreading types were in pre-flowering and flowering stages. Pigeonpea was in pre-flowering stage at all locations.

The nematode populations were extracted from 250 cm^3 soil samples by suspending them in water, passing them through nested sieves (850-, 180- and 38-µm-pore), and placing the residue from the 38-µm-pore sieve on a modified Baermann funnel. Cysts were collected on a 180-µm-pore sieve. Roots were gently rubbed on a 180-µm-pore sieve to remove white

and brown cysts adhering to them. Randomly picked cysts were cut and eggs and juveniles were counted.

The nematode population densities were counted using a stereoscopic binocular microscope and log-transformed nematode data were analysed using the analysis of variance technique. Means were compared by Duncan's new multiple range tests by SAS computer program to study the differences in nematode communities and their densities in different regions in different soils, and under four cropping systems. Based on the frequency of occurrence of a nematode species and its density per 250 cm^3 soil, prominence value of the species in a district was calculated (Tables 1 and 2). The nematode densities in each taluk were ranked on a 1 (low) to 5 (severe) scale to assess the infestation levels in the taluks and districts.

RESULTS

Plant-parasitic nematodes in pigeonpea fields

The plant-parasitic nematodes occurring in 68 pigeonpea fields were: *Heterodera cajani, Helicotylenchus retusus, Helicotylenchus* sp., *Hoplolaimus indicus, H. seinhorsti, Meloidogyne* sp., *Pratylenchus coffeae, P. delattrei, P. zeae, Rotylenchulus reniformis, Tylenchorhynchus vulgaris* and *Tylenchorhynchus* sp. Cysts of *H. cajani* were present in 91.2% of pigeonpea fields. Populations of this nematode were observed in soil and/or root samples from all the 68 fields (Table 1, Fig. 1). Incidence of the root-knot disease caused by *Meloidogyne* species was not noticed; however, second-stage juveniles (*M. incognita* ?) in low numbers were observed in soil samples.

H. cajani and *R. reniformis* were the two prominent nematode species in the field. *H. cajani* cyst densities in soil and root samples were greater ($p = 0.05$) in Belgaum and Gulbarga districts than in Dharwad, Bijapur and Raichur districts (Table 1). Gulbarga taluk in Gulbarga district and Sankeshwar taluk in Belgaum district had more than 20 cysts of *H. cajani* per 250 cm^3 soil (Table 3). A range of 2.0–7.5 eggs and juveniles per cm^3 soil was recorded in these regions. In 33.3% taluks in these districts, the average infestation level was more than 10 cysts per 250 cm^3 soil. Sankeshwar region had 31 cysts per g of pigeonpea root. Jevargi and Chittapur regions had more than 20 cysts per g root while more than 10 cysts per g root were found in Saudatti (Belgaum district), Ron (Dharwad district) and Gulbarga (Gulbarga district). Egg and second-stage juvenile numbers of *H. cajani* in Dharwad, Bijapur and Raichur districts were lower than the average egg and second-stage juvenile density (395 per 250 cm^3 soil) in the five districts.

Populations of *R. reniformis* were present in 75% of soil samples. Nematode densities were greater ($p = 0.05$) in Dharwad and Bijapur districts than in Raichur, Belgaum and Gulbarga districts. *R. reniformis* population densities were between 2.1 and 5 nematodes per cm^3 soil in Ron and Hubli taluks in Dharwad; Jamkhandi, Bagewadi and Indi taluks in Bijapur and Chikodi taluks in Belgaum. Sankeshwar, Chikodi, Ron and Hukkeri taluks had an average density of more than 10 cysts of *H. cajani* and 250 R. reniformis per 250 cm^3 soil. Pigeonpea was in pre-flowering stage at most of the locations. Population densities of *H. cajani* and *R. reniformis* did not differ with the crop growth stages.

Plant-parasitic nematodes in groundnut fields

In addition to the nematode species associated with pigeonpea, populations of *Aphelenchoides* spp. and *Ditylenchus* spp. were found in the soil samples from groundnut fields. *Pratylenchus* spp. (*P. coffeae, P. delattrei* and *P. zeae*) were the most prominent (Table 2, Fig. 1). Highest average density of 1.9 *Pratylenchus* spp. per cm^3 of soil was observed in Chikodi taluk. The nematode density was more than one *Pratylenchus* individual per cm^3 soil in Ron and Indi taluks (Table 3). However, no correlated and appreciable pod and root lesion diseases of groundnut were observed in these regions. *Helicotylenchus* spp. were observed in 48% of the samples. Population densities of other species of plant-parasitic nematodes were below 0.5 individuals per cm^3 soil. The root-knot disease was not observed during this survey, but second-stage juveniles of *Meloidogyne* were observed in the rhizospheres. Whereas the groundnut crop was in pre-flowering, flowering and flowering and podding stages at different locations, no significance difference correlated with growth stages of the crop was found in the population densities of various nematode species.

Cropping systems and population densities of plant-parasitic nematodes

Sole groundnut, sole pigeonpea, groundnut + pigeonpea (4:1), groundnut + cereals (maize, sorghum or pearl millet), pigeonpea + cereals, groundnut + pulses (green gram, or horse gram, or cowpea, or black gram), and pigeonpea + pulses were the cropping patterns in different regions. The number of *H. cajani* cysts on pigeonpea roots was 15 times lower ($p = 0.05$) in pigeonpea + other pulses than in sole pigeonpea (Table 4). Average population densities of *Helicotylenchus* spp. were nearly 10 times lower ($p = 0.05$) in cereals + pigeonpea, and pulses + pigeonpea intercropped than in sole pigeonpea fields. Densities of other nematode species did not differ ($p = 0.05$) between sole and intercropped fields. Population densities of *Pratylenchus* spp. in groundnut were lower ($p = 0.05$) in groundnut + cereal system than in other cropping systems.

Table 1. Distribution of plant-parasitic nematode species in pigeonpea growing areas in Karnataka.

District	No. of Taluks	No. of fields surveyed	*H cajani* cysts & juveniles			*H cajani* cyst/g root			*H cajani* eggs and juveniles			*R. reniformis*			*Helichotylenchus* spp.			*Hoplolaumus* spp.			*Pratylenchus* spp.			*Tylencho-rhynchus* spp.		
			F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV
Dharwad	9	6	83.3	8.5^{bc}	7 8	66.7	5 3^{b}	4.3	100.0	153.0^{a}	153.0	100.0	408.0^{a}	408.0	16.7	4.2^{b}	1.7	33.3	5 0^{c}	2.9	8.5	20.8^{a}	14.9	0.0	0.0a	0.0
Bijapur	8	11	100.0	10.9^{ab}	10.6	81.8	3.2^{b}	2.8	94.1	128.8^{a}	125 0	100.0	547 7^{a}	547 7	54 5	41.8^{a}	30.9	63.6	15 1^{abc}	12.3	45 4	15 9^{a}	10.7	9 1	9 2^{a}	0.7
Raichur	3	16	81.2	3.8^{c}	3.5	6.2	0.1^{c}	0.0	25 0	45 1^{a}	22.5	75 0	85 0^{bc}	73 6	87 5	64 1^{a}	59 9	87 5	22.8^{ab}	21.3	50.0	30.3^{a}	21.4	18.8	5 3^{a}	2.3
Belgaum	5	10	100.0	19 4^{a}	19 4	60.0	11.2^{ab}	8.7	100.0	506.3^{a}	506.3	80.0	427 0^{ab}	381.9	10.0	1.0^{b}	0.3	80.0	59 5^{a}	53.2	80.0	43.0^{a}	38.5	0.0	0.0^{a}	0.0
Gulbarga	5	25	92.0	18.2^{a}	17 4	88.0	14.3^{a}	13 4	80.0	750.7^{a}	671.4	56.0	56.6^{c}	42.4	72.0	24 0^{a}	20.4	32.0	31.6^{bc}	17 9	56.0	29 4^{a}	22.0	16.0	4.0^{a}	1.6
Total	30	68	91.2	12.9	12.3	61.8	7 9	6.2	73.5	395.4	339 0	75 0	228.2	197 6	58.8	31.2	23 9	57 3	28.7	21.7	55 9	28.7	21.4	11.8	3.1	1.1

F = percentage of infested fields (frequency of occurrence of a nematode species); AD = average nematode density per 250 ml soil sample, PV = prominence value (= AD/F/100). Average nematode densities with same letter in a column do not differ ($p = 0.05$). Data were log-transformed for analysis. Untransformed data given in table.

Table 2. Distribution of plant-parasitic nematode species in groundnut growing areas in Karnataka.

District	No. of Taluks	No. of fields surveyed	*Pratylenchus* spp.			*Helicotylenchus* spp.			*Tylenchorhynchus* spp.			*Hoplolaumus* spp.			*R reniformis*			*Aphelenchoides* spp.			*Heterodera* eggs and juveniles		
			F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV	F	AD	PV
Dharwad	9	29	79 3	134.7^{ab}	119 2	34.5	13.7^{b}	18.6	37 9	17 7^{d}	9 0	24 1	5 1^{a}	2.5	44 8	44 7^{ab}	29 9	3 4	1.0	0.2	34 0	18.8^{a}	11
Bijapur	8	24	54.2	124.6^{b}	91.6	45 8	45 0^{b}	30.5	37 5	15 8^{a}	9 7	8.3	4 6^{ab}	1.3	54 1	152.7^{a}	112.4	0.0	0.0	0.0	25 0	16.7^{a}	8.3
Raichur	3	22	22.7	24.8^{c}	11.8	40.1	21.8^{b}	13.9	40.9	30.0^{a}	19 1	9 1	3 4^{ab}	1.3	9 1	4 8^{c}	1.4	9 1	5.0	1.0	13.6	2.9^{a}	1.1
Belgaum	5	183	82.3	187 9^{a}	170.6	48.0	67 3^{a}	46.6	5 9	1.8^{b}	0.4	0.0	0.0^{b}	0.0	23 5	60.6^{bc}	29 3	5 9	1.5	0.3	29 4	19 5^{a}	10.
Total	25	93	60.0	115.6	87 3	48.0	39 4	27 2	33.0	16.2	9 3	12.0	3 6	1.3	35 0	66.2	39 1	4.0	1.8	0.4	26.0	14.6	7 4

F = percentage of infested fields (frequency of occurrence of a nematode species); AD = average nematode density per 250 ml soil sample, PV = prominence value (= AD/F/100). Average nematode densities with same letter in a column do not differ ($p = 0.05$). Data were log-transformed for analysis. Untransformed data given in table.

Table 3. Population densities (per 250 ml soil) of plant-parasitic nematodes in different taluks in five major pigeonpea- and groundnut-growing districts in Karnataka, India.

Crop	Range of nematode population density / 250ml soil	Dharwad	Bijapur	Raichur	Belgaum	Gulbarga
Pigeonpea	*H cajani* cysts					
	1-5 (low)	Savanur Hubli	Bagalkot	Manvi Raichur Devdurg	Belgaum	Shahpur
	6-10 (moderate)		Bagewadi Indi Badami		Saudatti	Jevargi
	11-20 (high)	Ron	Jamkhandi Sindagi Bijapur		Chikodi Hukkeri	Sedam
	21-40 (very high)					Gulbarga
	> 40 (severe)				Sankeshwar	
	R reniformus					
	1-50 (low)	Kundagol Sawanur	Badami	Manvi	Saudatti Belgaum	Jevargi Sedam Shahpur
	51-250 (moderate)			Devdurg Raichur	Sankeshwar	Gulbarga Chittapur
	251-500 (high)		Bagalkot Bijapur Sindagi		Hukkeri	
	501-1000 (very high)	Ron Hubli	Bagewadi Indi			
	> 1000 (severe)		Jamkhandi		Chikodi	
Groundnut	*Pratylenchus* spp.					
	1-50 (low)	Haveri Kundagol Dharwad	Teradal Jamkhandi Badami	Devdurg Raichur	Saudatti	
	51-250 (moderate)	Savanur Laxmeshwar Navalgund Hubli Shiggaon	Bijapur Bagewadi Bagalkot Sindagi	Manvi	Sankeshwar Hukkeri Belgaum	
	251-500 (high)	Ron	Indi		Chikodi	

Table 4. Population densities (per 250 ml soil) of plant-parasitic nematodes in different cropping systems in Karnataka, India, in 1990.

Cropping systems	*H. cajani* eggs and juveniles	*R. reniformis*	*H. cajani* cysts/g root	*Helicotylenchus retusus*	*Hoplolaimus* sp.
Pigeonpea only	579.6 (4.08)[a]	154.4 (2.96)[a]	10.4 (1.60)[a]	39.4 (2.58)[a]	26.8 (1.70)[a]
Groundnut + pigeonpea	142.6 (3.53)[a]	416.3 (4.63)[a]	3.4 (0.75)[ab]	34.2 (2.22)[ab]	15.5 (1.87)[a]
Sorghum or pearl millet + pigeonpea	258.7 (3.22)[a]	183.0 (3.25)[a]	9.8 (1.21)[ab]	4.0 (0.58)[c]	67.0 (2.75)[a]
Pigeonpea + other pulses	242.0 (5.19)[a]	73.3 (3.11)[a]	0.7 (0.37)[b]	3.33 (0.80)[bc]	6.7 (1.60)[a]

Means with same letter in each column do not differ significantly ($p = 0.05$).
Figures in parentheses are log-transformed values.

Table 5. Population densities (per 250 ml soil) of plant-parasitic nematodes associated with pigeonpea in two soil types.

Soil type	*H. cajani* eggs and juveniles	*R. reniformis* cysts/g root	*H. cajani*	*Helicotylenchus* sp.	*Hoplolaimus* sp.
Alfisols	183.2 (3.14)[a]	324.8 (4.67)[a]	3.3 (0.84)[a]	45.5 (2.25)[a]	33.3 (2.43)[a]
Vertisols	490.2 (4.16)[b]	185.1 (2.94)[b]	10.0 (1.43)[b]	24.8 (2.05)[a]	26.6 (1.66)[a]

Means with same letter in each column do not differ significantly ($p = 0.05$).

Plant-parasitic nematode densities on Alfisols and Vertisols

Average population densities of eggs and juveniles of *H. cajani* and number of cysts per g pigeonpea root were 62% and 67% higher ($p = 0.05$) on Vertisols than on Alfisols (Table 5). Average *R. reniformis* population density was 43% greater ($p = 0.05$) on Alfisols than on Vertisols. Population densities of species of *Hoplolaimus*, *Helicotylenchus*, *Pratylenchus* and *Tylenchorhynchus* did not differ significantly in the two soil types.

DISCUSSION

Heterodera cajani and *Rotylenchulus reniformis* were the two most prominent nematodes associated with pigeonpea. Other species of plant-parasitic nematodes were present in relatively low numbers and were not important. The widespread distribution of *H. cajani* in Gulbarga district is of particular significance because it has nearly 50% of the total pigeonpea growing area in Karnataka State.

Pigeonpea crop had many patches of sick-looking stunted plants showing reduced root systems and white females of *H. cajani* on the roots. Poor growth of pigeonpea in the heavily infested fields and the damage thresholds as established in the literature, indicate that *H. cajani* and *R. reniformis* considerably reduce the biomass and yield of pigeonpea in Belgaum and Gulbarga regions (Saxena & Reddy, 1987; Sharma & Nene, 1988).

Meloidogyne spp. were not important on these two crops. Ishwara Bhat and Krishnappa (1989) also did not find *Meloidogyne* spp. on groundnut in 10 districts of Karnataka. The lesion nematodes, *Pratylenchus* spp., may be suspected as

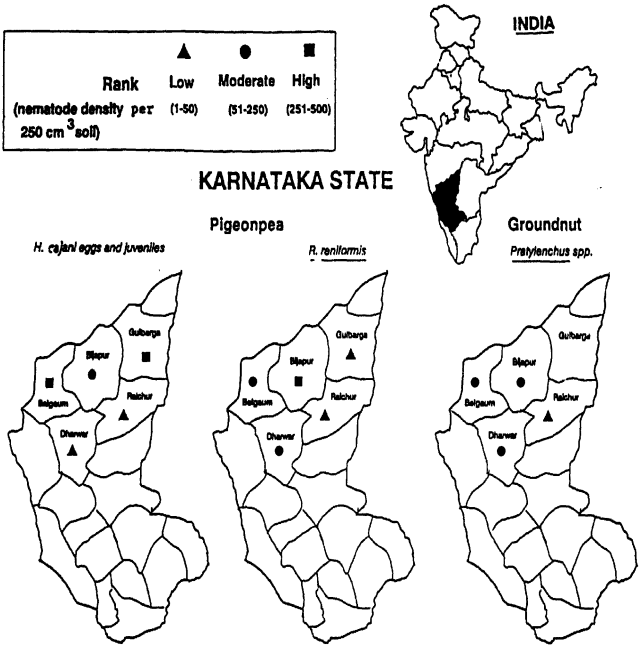

Fig. 1. Plant-parasitic nematode species in pigeonpea and groundnut growing areas in Karnataka.

potentially important on groundnut since they can damage the susceptible groundnut cultivars (Sharma & McDonald, 1990).

This survey confirms the preference of *H. cajani* for Vertisols, and of *R. reniformis* for Alfisols (Sharma & Nene, unpublished). The finding of reduced *H. cajani* infection on pigeonpea roots in a pigeonpea + pulse intercrop is interesting and requires further investigation because the intercropped pulses are also good hosts of *H. cajani*. *H. cajani* may have more preference for cowpea, mung bean and black gram than for pigeonpea. The survey provides important background information to plan multilocational yield loss estimation studies and administer nematode management strategies. Similar surveys in other major pigeonpea- and groundnut-growing regions will help identify the major nematode problems of these crops in South Asia.

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