

Original Research Article

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Roving Survey for Turmeric Root-Knot Nematode in Major Districts of Karnataka, India

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ABSTRACT

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Turmeric is one of the important spice crops grown in India. Root-knot nematode (*Meloidogyne* spp.) is a major problem, which causes galls/knots in the rhizomes and causes considerable yield losses. It also makes the way for the secondary infection by different pathogens like *Pythium*, *Fusarium* and *Ralstonia* in the soil. Yield losses due to nematode infestation are reported in turmeric-growing areas. A roving survey was conducted for incidence of root-knot nematode in turmeric during kharif season in 2016 at Belagavi, Bagalkot, Chamaraajanagar and Kalburgi districts of Karnataka. Survey conducted in 38 villages comprising 118 fields, the major symptoms recorded during survey are having large root galls, stunted growth, yellowing, marginal and tip drying of leaves and reduced tillering with galling and rotting of roots. The results revealed that highest root-knot index was recorded in Chamaraajanagara followed by belagavi, Bagalkot and Kalburgi districts. The lowest disease incidence was observed in Kalburgi.

Introduction

Turmeric (*Curcuma longa* L.) is one of the important spice crops grown in India since the times immemorial. It is an herbaceous perennial plant, native to tropical south-east Asia belonging to the family Zingiberaceae. It is regarded as a symbol of well-being and future and is widely used in ceremonies and religious functions. Medicinally, it acts as carminative, antiseptic and antiparasitic for many skin infections. It cures the sore throat,

common cold and used as an appetizer and helps in digestion. It is also used in the preparation of cosmetics, soaps, skin ointments and tooth pastes.

Turmeric is cultivated mainly in India, Pakistan, Jamaica, Sri Lanka, Indonesia, Bangladesh, Taiwan and China. India is the world's largest producer of turmeric and accounts for 80 per cent of the world production. It is grown in an area of 2.33 lakh hectares with a production of 11.90 lakh

metric tons and the productivity of 5.1 metric tons per hectare (Anon, 2015a). In India, turmeric is mainly grown in Tamil Nadu, Karnataka, Assam, Kerala, Maharashtra, Orissa and Andhra Pradesh. In Karnataka, it is grown in an area of 14.00 thousand hectares with an production of 65.00 thousand MT having productivity of 4.68 MT per hectare (Anon, 2015a). The major turmeric producing districts of the state are Charamrajnagar, Mysuru, Bagalkot, Belagavi, Bidar and Kalburgi (Anon., 2015b).

The root-knot nematode (*Meloidogyne* spp.) is a major problem, which causes galls or knots in the rhizomes and causes considerable yield loses. It also plays the way for the secondary infection by different pathogens like *Pythium*, *Fusarium* and *Ralstonia* in the soil (Udo and Ugwuoke, 2010).

A survey is necessary to assess the community structure of plant parasitic nematodes associated with turmeric crops. Many biotic and abiotic factors such as soil temperature, soil moisture, soil type, cultural practices, weed hosts and intercropping are known to influence nematode distribution. The survey on root-knot nematode will provide information on incidence, severity and distribution.

Materials and Methods

The roving survey was undertaken to know the occurrence of root-knot nematodes associated with turmeric crop in Chamarajanagara, Bagalkot, Belagavi and Kalburgi districts of Karnataka (Fig. 1) during 2016-2017. Samples comprising soil and root system were collected from rhizosphere of turmeric crop. The sampling was done in plants showing nematode symptoms *viz.*, yellowing, poor growth or stunted growth with reduced leaf size, chlorosis of foliage, wilting and root galls.

In each district, ten villages were selected and in each village, four soil and root samples were collected from different farmer's fields.

Collection of soil and root samples

Soil and root system samples from 3 to 5 spots were collected randomly with the aid of shovel from the root zone of standing turmeric crop. Later, a composite sample of 200 cc soil and root system were put in a polythene bag with proper labelling. Information pertaining to the crop, locality, soil condition *etc.*, was also collected along with the samples.

Estimation of nematode population in soil samples

Soil sample of 200 cc was washed thoroughly and processed using combined "Cobb's sieving and Baermann's funnel method" (Ayoub, 1977) as given below.

Two hundred cc of soil was taken in 1000 ml beaker and sufficient quantity of water was added to make soil solution.

This was stirred thoroughly and allowed to stand for heavier particles to settle down.

Then the soil solution was passed through a set of sieves of 100, 250, 325 and 400 mesh sizes, respectively.

Residue from 325 and 400 mesh sieves were collected and poured over a tissue paper spread on a wire gauge and placed on Baermann's funnel.

Level of water in the Baermann's funnel was maintained to keep the tissue paper wet and left undisturbed for 48 hr.

After incubation of 48 hr, the volume of suspension was made to 200 ml, out of which 10 ml was pipetted out and used for counting

of various plant parasitic nematodes present. Nematode population from this was finally estimated for 200 cc soil.

Estimation of nematode population in root samples

Nematode population in 10 g roots was estimated by Root incubation method (Ayoub, 1977) as explained below:

Procedure

Roots were gently washed to remove adhering soil particles.

Washed roots were cut into small bits of 2.5 cm and split longitudinally.

Then placed over tissue paper spread on a wire gauge and kept in a Petri plate filled with water.

Level of water was maintained in Petri plate and left undisturbed for 48 hours.

Later, the suspension in the Petri plate was collected and observed for nematodes using stereo-binocular microscope.

Counting the number of nematodes

The number of nematodes in an aqueous suspension was determined by using a counting dish. A five cm diameter glass Petri plate was used as a counting dish. Squares were made on the outer surface of the bottom of the dish to facilitate counting. A 10 ml volume of aqueous suspension from the beaker was taken and placed into the petriplate. Nematodes were counted in all squares under a stereo-binocular microscope. After counting, the suspension was transferred back to the mother container. Counting of each sample was repeated four times in same manner. The mean number of nematodes per

10 ml was determined by averaging the counts taken.

Results and Discussion

A roving survey was carried out to know the occurrence of root-knot nematode in major turmeric growing districts viz., Chamarajanagara, Bagalkot, Belagavi and Kalburgi during *Kharif* 2016 and the data obtained are depicted in Table 1. The soil and root samples were collected from different places and brought to the laboratory for analysis. The presence of root-knot nematodes was assessed.

In Chamarajanagara district, the number of galls per root system was ranged from 0-82. Maximum number of galls (82) was recorded in Shivapura (b) field followed by Shivapura (c) field (78). No galls were recorded in Kodehalli (c) and Belavadi (a) fields and minimum number of galls were recorded in Gundlupet (a) field (5).

The nematode population per 200 cc soil was ranged from 0-176. The maximum soil nematode population (176) was recorded in Shivapura (c) field followed by Shivapura (b) field (172) as against minimum population (15) in Belavadi (b) field.

On an average, the number of galls per root system was 26.26, gall index of 3.0 and soil nematode population of 73.30 recorded in Chamarajanagara district.

In Bagalkot district, the number of galls per root system was ranged from 4-32 with the maximum (32) in Jamakhandi (a) field followed by Sasalatti (b) field (25). The least number of galls was recorded in Mudhol (b) field (4).

Soil nematode population was ranged from 18-96. The maximum population (96) was

recorded in Bisnal (c) field followed by Bisnal (b) field (95) whereas the least of nematode population (18) was recorded in Mudhol (b) field.

On an average, the number of galls per root system (19.10) gall index (2.96) and soil nematode population per 200 cc of soil (57.30) was recorded in Bagalkot district. The results

of the survey in Belagavi district revealed that, the number of galls per root system was ranged from 0-54 with Kalloli (b) field was highest (54) followed by Kalloli (c) field (52).

The least number of galls per root system was recorded in Alagavadi (b) field (10) and zero galls were recorded in Raibagh (b), Devapura (b) and Alagavadi (e) fields.

Fig.1 Roving survey for root-knot nematode incidence in turmeric in major growing districts of Karnataka

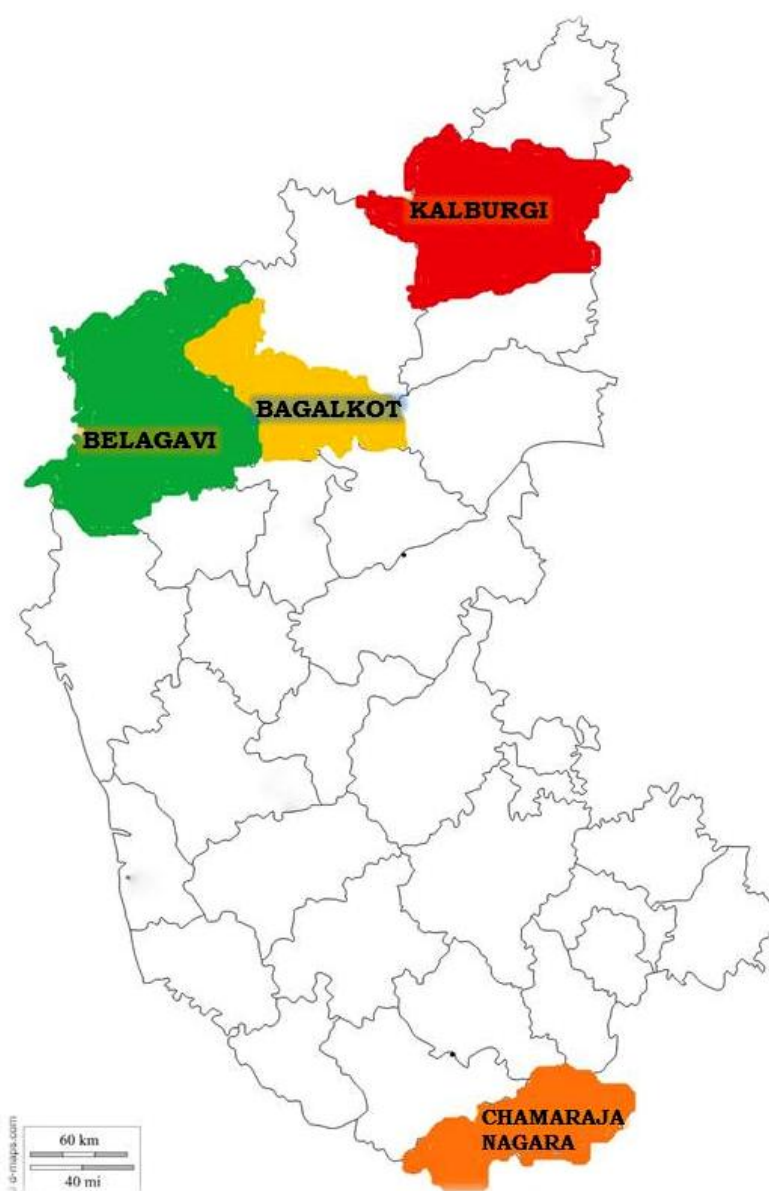


Table.1 Roving survey of root-knot nematode in major turmeric growing districts of Karnataka

District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
Chamarajanagara	Chamarajanagara	1	Chamarajanagara (a)	Salem	<i>Kharif</i>	132	Red sandy loam	22	3	86
		2	Chamarajanagara (b)	Salem	<i>Kharif</i>	145	Red sandy loam	26	3	120
		3	Chamarajanagara (c)	Salem	<i>Kharif</i>	145	Red sandy loam	32	4	86
		4	Chikkamole (a)	Local	<i>Kharif</i>	142	Light black	36	4	72
		5	Chikkamole (b)	Local	<i>Kharif</i>	145	Light black	28	3	68
		6	Chikkamole (c)	Local	<i>Kharif</i>	148	Light black	26	3	82
		7	Shivapura (a)	Salem	<i>Kharif</i>	138	Red sandy loam	36	4	160
		8	Shivapura (b)	Salem	<i>Kharif</i>	142	Red sandy loam	82	4	172
		9	Shivapura (c)	Salem	<i>Kharif</i>	138	Red sandy loam	78	4	176
		10	Devalapura (a)	Salem	<i>Kharif</i>	139	Red sandy loam	32	3	152
		11	Devalapura (b)	Salem	<i>Kharif</i>	145	Red sandy loam	42	4	87
		12	Devalapura (c)	Salem	<i>Kharif</i>	140	Red sandy loam	24	3	86
		13	Bailamudlu (a)	Salem	<i>Kharif</i>	148	Light black	18	3	46
		14	Bailamudlu (b)	Salem	<i>Kharif</i>	145	Light black	20	3	86
		15	Bailamudlu (c)	Salem	<i>Kharif</i>	142	Light black	21	3	56

Contd.....

District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
	Gundlupet	16	Annurkeri (a)	Local	<i>Kharif</i>	135	Red sandy loam	26	3	83
		17	Annurkeri (b)	Salem	<i>Kharif</i>	138	Red sandy loam	28	3	56
		18	Annurkeri (c)	Salem	<i>Kharif</i>	142	Red sandy loam	36	4	46
		19	Kodehalli (a)	Salem	<i>Kharif</i>	145	Light black	15	3	56
		20	Kodehalli (b)	Salem	<i>Kharif</i>	142	Light black	23	3	46
		21	Kodehalli (c)	Salem	<i>Kharif</i>	142	Light black	0	0	18
		22	Belavadi (a)	Local	<i>Kharif</i>	138	Red sandy loam	0	0	16
		23	Belavadi (b)	Local	<i>Kharif</i>	147	Red sandy loam	18	3	15
		24	Belavadi (c)	Local	<i>Kharif</i>	140	Red sandy loam	14	3	36
		25	Gundlupet (a)	Salem	<i>Kharif</i>	142	Light black	5	2	22
		26	Gundlupet (b)	Salem	<i>Kharif</i>	146	Light black	9	2	42
		27	Gundlupet (c)	Salem	<i>Kharif</i>	142	Light black	26	3	45
		28	Shivapura Karle (a)	Salem	<i>Kharif</i>	142	Red sandy loam	18	3	56
		29	Shivapura Karle (b)	Salem	<i>Kharif</i>	140	Red sandy loam	32	4	62
		30	Shivapura Karle (c)	Salem	<i>Kharif</i>	140	Red sandy loam	15	3	65
Total								788	90	2199
Average								26.26	3	73.30

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District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
Bagalkot	Mudhol	31	Bisnal (a)	Salem	<i>Kharif</i>	140	Medium black	19	3	78
		32	Bisnal (b)	Salem	<i>Kharif</i>	128	Medium black	21	3	95
		33	Bisnal (c)	Salem	<i>Kharif</i>	122	Medium black	22	3	96
		34	Mudhol (a)	Salem	<i>Kharif</i>	130	Medium black	18	3	65
		35	Mudhol (b)	Salem	<i>Kharif</i>	132	Medium black	4	2	18
		36	Mudhol (c)	Salem	<i>Kharif</i>	126	Medium black	16	3	65
		37	Halluru (a)	Cudappa	<i>Kharif</i>	137	Medium black	6	2	46
		38	Halluru (b)	Salem	<i>Kharif</i>	132	Medium black	17	3	42
		39	Halluru (c)	Salem	<i>Kharif</i>	130	Medium black	18	3	36
		40	Shirol (a)	Salem	<i>Kharif</i>	140	Medium black	12	3	42
		41	Shirol (b)	Salem	<i>Kharif</i>	142	Medium black	21	3	42
		42	Shirol (c)	Salem	<i>Kharif</i>	140	Medium black	16	3	28
		43	Jannuru (a)	Salem	<i>Kharif</i>	145	Medium black	21	3	44
		44	Jannuru (b)	Cudappa	<i>Kharif</i>	145	Medium black	22	3	42
		45	Jannuru (c)	Salem	<i>Kharif</i>	142	Medium black	24	3	42

Contd.....

District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
	Jamakhandi	46	Jamakhandi (a)	Salem	<i>Kharif</i>	130	Medium black	32	4	86
		47	Jamakhandi (b)	Salem	<i>Kharif</i>	140	Medium black	21	3	45
		48	Jamakhandi (c)	Salem	<i>Kharif</i>	132	Medium black	23	3	66
		49	Sasalatti (a)	Salem	<i>Kharif</i>	140	Medium black	24	3	80
		50	Sasalatti (b)	Salem	<i>Kharif</i>	135	Medium black	25	3	56
		51	Sasalatti (c)	Cudappa	<i>Kharif</i>	138	Medium black	20	3	48
		52	Golbavi (a)	Salem	<i>Kharif</i>	142	Red sandy loam	16	3	56
		53	Golbavi (b)	Salem	<i>Kharif</i>	144	Red sandy loam	18	3	60
		54	Golbavi (c)	Salem	<i>Kharif</i>	135	Red sandy loam	19	3	75
		55	Terdhal (a)	Salem	<i>Kharif</i>	140	Medium black	23	3	96
		56	Terdhal (b)	Salem	<i>Kharif</i>	135	Medium black	18	3	82
		57	Terdhal (c)	Salem	<i>Kharif</i>	138	Medium black	16	3	76
		58	Harogeri (a)	Cudappa	<i>Kharif</i>	142	Medium black	9	2	24
		59	Harogeri (b)	Salem	<i>Kharif</i>	139	Medium black	19	3	46
		60	Harogeri (c)	Salem	<i>Kharif</i>	142	Medium black	17	3	42
Total								573	89	1719
Average								19.10	2.96	57.30

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District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
Belagavi	Gokak	61	Arabhavi (a)	Salem	<i>Kharif</i>	142	Medium black	18	3	42
		62	Arabhavi (b)	Salem	<i>Kharif</i>	139	Medium black	16	3	68
		63	Arabhavi (c)	Salem	<i>Kharif</i>	140	Medium black	12	3	58
		64	Rajapura (a)	Salem	<i>Kharif</i>	142	Medium black	17	3	64
		65	Rajapura (b)	Salem	<i>Kharif</i>	140	Medium black	19	3	46
		66	Rajapura (c)	Salem	<i>Kharif</i>	136	Medium black	21	3	40
		67	Tukkanatti (a)	Salem	<i>Kharif</i>	128	Medium black	23	3	45
		68	Tukkanatti (b)	Salem	<i>Kharif</i>	130	Medium black	28	3	65
		69	Tukkanatti (c)	Salem	<i>Kharif</i>	132	Medium black	31	4	86
		70	Tukkanatti (d)	Salem	<i>Kharif</i>	135	Medium black	46	4	86
		71	Tukkanatti (e)	Salem	<i>Kharif</i>	138	Medium black	48	4	106
		72	Kalloli (a)	Salem	<i>Kharif</i>	136	Medium black	36	4	85
		73	Kalloli (b)	Salem	<i>Kharif</i>	140	Medium black	54	4	116
		74	Kalloli (c)	Salem	<i>Kharif</i>	135	Medium black	52	4	118
		75	Mudalagi (a)	Salem	<i>Kharif</i>	142	Medium black	13	3	56
76	Mudalagi (b)	Salem	<i>Kharif</i>	142	Medium black	15	3	62		
77	Mudalagi (c)	Salem	<i>Kharif</i>	140	Medium black	16	3	72		

Contd.....

District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
	Raibagh	78	Mugalkod (a)	Salem	<i>Kharif</i>	135	Medium black	16	3	36
		79	Mugalkod (b)	Salem	<i>Kharif</i>	140	Medium black	18	3	46
		80	Mugalkod (c)	Salem	<i>Kharif</i>	142	Medium black	11	3	28
		81	Raibagh (a)	Salem	<i>Kharif</i>	138	Medium black	15	3	18
		82	Raibagh (b)	Salem	<i>Kharif</i>	135	Medium black	0	0	12
		83	Raibagh (c)	Salem	<i>Kharif</i>	142	Medium black	16	3	26
		84	Devapura (a)	Salem	<i>Kharif</i>	140	Medium black	21	3	28
		85	Devapura (b)	Salem	<i>Kharif</i>	135	Medium black	0	0	0
		86	Devapura (c)	Salem	<i>Kharif</i>	132	Medium black	18	3	25
		87	Alagavadi (a)	Salem	<i>Kharif</i>	132	Medium black	16	3	40
		88	Alagavadi (b)	Salem	<i>Kharif</i>	138	Medium black	10	2	15
		89	Alagavadi (c)	Salem	<i>Kharif</i>	136	Red sandy loam	12	3	22
		90	Alagavadi (e)	Salem	<i>Kharif</i>	140	Red sandy loam	0	0	6
		91	Alagavadi (f)	Salem	<i>Kharif</i>	142	Red sandy loam	16	3	28
		92	Palabhavi (a)	Salem	<i>Kharif</i>	135	Medium black	18	3	36
93	Palabhavi (b)	Salem	<i>Kharif</i>	138	Medium black	21	3	46		
94	Palabhavi (c)	Salem	<i>Kharif</i>	140	Medium black	12	3	26		
Total								685	98	1653
Average								20.14	2.88	48.61

Contd.....

District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
Kalburgi	Chincholi	95	Ainalli (a)	Salem	<i>Kharif</i>	140	Medium black	9	2	18
		96	Ainalli (b)	Salem	<i>Kharif</i>	140	Medium black	6	2	16
		97	Ainalli (c)	Salem	<i>Kharif</i>	132	Medium black	0	0	16
		98	Kalluru (a)	Salem	<i>Kharif</i>	130	Medium black	0	0	12
		99	Kalluru (b)	Salem	<i>Kharif</i>	142	Medium black	0	0	16
		100	Kalluru (c)	Salem	<i>Kharif</i>	136	Medium black	0	0	10
		101	Chincholi (a)	Salem	<i>Kharif</i>	140	Medium black	0	0	8
		102	Chincholi (b)	Salem	<i>Kharif</i>	137	Medium black	0	0	5
		103	Chincholi (c)	Salem	<i>Kharif</i>	135	Medium black	0	0	9
		104	Degalamadi (a)	Salem	<i>Kharif</i>	140	Medium black	0	0	2
		105	Degalamadi (b)	Salem	<i>Kharif</i>	137	Medium black	0	0	0
		106	Degalamadi (c)	Salem	<i>Kharif</i>	142	Medium black	0	0	12
		107	Pinolli (a)	Salem	<i>Kharif</i>	140	Medium black	0	0	8
108	Pinolli (b)	Salem	<i>Kharif</i>	140	Medium black	0	0	6		
109	Pinolli (c)	Salem	<i>Kharif</i>	135	Medium black	0	0	6		

Contd.....

District	Taluk	Sample number	Village	Variety	Season	Days after planting	Soil type	No.of galls/root system	Gall index	Nematode population in soil
	Aland	110	Aland (a)	Salem	<i>Kharif</i>	140	Medium black	0	0	12
		111	Aland (b)	Salem	<i>Kharif</i>	142	Medium black	0	0	6
		112	Aland (c)	Salem	<i>Kharif</i>	137	Medium black	0	0	6
		113	Kadaganchi (a)	Salem	<i>Kharif</i>	142	Medium black	0	0	8
		114	Kadaganchi (b)	Salem	<i>Kharif</i>	145	Medium black	0	0	0
		115	Kadaganchi (c)	Salem	<i>Kharif</i>	142	Medium black	0	0	0
		116	Belamagi (a)	Salem	<i>Kharif</i>	135	Medium black	18	3	25
		117	Belamagi (b)	Cudappa	<i>Kharif</i>	140	Medium black	21	3	18
		118	Belamagi (c)	Salem	<i>Kharif</i>	142	Medium black	16	3	24
Total								70	13	243
Average								2.91	0.54	10.10
Grand total								2100	289	5914
Average								17.70	2.44	50.11

Incidence of root-knot nematode was recorded by using the gall index given by (Taylor and Sasser, 1978) which is as follows

Description	Grade
No galls or egg masses	0
1 to 2 galls or egg masses	1
3 to 10 galls or egg masses	2
11 to 30 galls or egg masses	3
31 to 100 galls or egg masses	4
More than 100 galls or egg masses	5

The highest soil nematode population was observed in Kalloli (c) field (118) followed by Kalloli (b) field (116), whereas least population (6) from Alagavadi (e) field and no population in Devapura (b) field.

In Belagavi district, on an average, the number of galls per root system was 20.14, gall index of 2.88 and soil nematode population of 48.61 was recorded.

In Kalburgi district the highest number of galls per root system was recorded in Belamagi (b) field (21) followed by Belamagi (a and c) fields (18 and 16) respectively. No galls were recorded in Ainalli (c), Kalluru (a, b and c), Chincholli (a, b and c), Degalmadi (a, b and c), Pinolli (a, b and c), Aland (a, b and c) and Kadaganchi (a, b and c) fields.

Maximum soil nematode population was recorded in Belamagi (a) field (25) followed by Belamagi (c) field (24) as against no population in Degalmadi (b), Kadaganchi (b and c). The minimum population was recorded in Degalmadi (a) field (2).

In Kalburgi district, on an average, the number of galls per root system was 2.91, gall index of 0.54 and nematode population of 10.10 was recorded.

On an average, among all the four districts surveyed, the maximum number of galls per root system (26.26), gall index (3.00) and soil

nematode population (76.63) was seen in Chamarajanagara district followed by Belagavi (20.14, 2.88, 48.61) and Bagalkot (19.10, 2.96, 57.30) as against minimum population in Kalburgi (2.91, 0.54, 10.10) respectively.

Present results are in conformity with the results of by Zarina and Shaheen (2014) who reported infestation of root-knot nematode in turmeric and black pepper. Yellowing, marginal and tip necrosis, reduced tillering in stunted growth, root galling and rotting are the principal symptoms of the infestation by *M. incognita* on turmeric (Mani *et al.*, 1987). Population density of *M. incognita* on turmeric increased with age of the crop and decreased crop resistance (Poornima and Sivagami, 1999). Takur and Sharma (2015) reported the plant parasitic nematodes associated with ginger in the mid hill region of Himachal Pradesh. The record of severe incidence of root-knot nematode, *M. incognita* was observed in crops such as pepper, cardamom, ginger, turmeric, clove, cinnamon and nutmeg (Sundararaiu *et al.*, 1979).

The present study revealed the prevalence of *Meloidogyne incognita* in most of the area surveyed and their recovery from turmeric field suggest that the nematode might have been introduced from one place to another place through soil, irrigation water, workers, infected plants and multiplied at faster rate as

Meloidogyne incognita is having wide host range, the survival and multiplication rate will be more.

The lowest incidence of root-knot nematode was observed in Kalburgi district may be due higher temperature which is responsible for soil solarization and crop rotation, dry weather conditions. The maximum incidence of root-knot neatode was recorded from ChamaraJanagara district may be due to mono cropping, suitable temperature, irrigation facilities and soil conditions.

References

- Anonymous, 2015a. District wise crop production statistics, <http://data.gov.in/catalog>
- Anonymous, 2015b. Indian horticulture database, www.nhb.gov.in.
- Ayoub, R. M., 1977. *Plant Pathology An Agricultural training Aid*. State California, Dept. Food and Agric. Sacramento, USA, p.156.
- Mani A, P. H., Naidu and Madhavachari, S., 1987. Occurrence and control of *Meloidogyne incognita* on turmeric in Andhra Pradesh, India. *Inter. Nematol.*

- Network Newslett.*, 2: 11-12.
- Poornima, K., Sivagami, V., 1999. Occurrence and seasonal population behavior of phytone-matodes in turmeric (*Curcuma longa* L.). *Pest Manage Hort. Ecosyst.* 5: 42-45.
- Sundararaju, P., Koshy, P. K. and Sosamma, V. K., 1979. Plant parasitic nematodes associated with spices. *Journal of Plantation Crops*, 7: 15-25.
- Taylor, A. L. and Sasser, N., 1978. Biology, Identification and control of Root- Knot Nematodes (*Meloidogyne* spp.) North Carolina State Univ., Graphics, p. 111.
- Thakur, N and Sharma, G. C., 2015. Status of plant parasitic nematodes in ginger fields of Himachal Pradesh, *Int. J. Sci. Env. Tech.*, 4(4): 976 – 979.
- Udo, I. A. and Ugwuoke, K. I., 2010. Pathogenicity of *Meloidogyne incognita* Race 1 on turmeric (*Curcuma longa* L.) as influenced by inoculum density and poultry manure amendment. *Plant Pathology J.*, 9: 162-168.
- Zarina, B. and Shaheen, N., 2014. Spice plants as new host record of *Meloidogyne incognita* in Pakistan. *Int. J. Biology and Biotechnol.*, 11(3): 449.

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