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Survey of Plant-Parasitic Nematodes Associated with Cotton in Nuh and Palwal Districts of Haryana

Vinod Kumar^{1*}, Prakash Banakar², Anil Kumar³ and Priyanka Duggal⁴

Dept. of Nematology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (125 004), India

Corresponding Author

Vinod Kumar

e-mail: vinodnagal09@gmail.com

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Abstract

An extensive survey was conducted to assess the frequency and abundance of plant-parasitic nematodes associated with cotton (*Gossypium hirsutum* L.) in Haryana (Nuh and Palwal districts) during 2018-20. Based on incidence, population density and associated damage on affected crops, root-knot nematode (*Meloidogyne incognita*) was considered to be the most important parasite of the crops under local condition. During 2018-19, a total of 11 soil and root samples of cotton were collected from Nuh and Palwal districts. Out of these, eight were found infested with *M. incognita* with 72.0% frequency of occurrence. The results revealed that out of 7 samples (Nuh), five were found infested with *M. incognita* with 71.4% frequency of occurrence. In Palwal district, this nematode had 75.0% frequency of occurrence with density range of 60-300 j₂ 200⁻¹ cc soil. During 2019-20, a total of 27 soil and root samples of cotton were collected from Nuh and Palwal districts. Out of these, 14 were found infested with *M. incognita* with 51.8% frequency of occurrence. The results revealed that out of 21 samples (Nuh), 12 were found infested with *M. incognita* with 57.1% frequency of occurrence and density range of 95-690 j₂ 200⁻¹ cc soil. In Palwal district, this nematode had 33.3% frequency of occurrence (2 out of 6 samples) with density range of 135-435 j₂ 200⁻¹ cc soil. Other plant parasitic nematodes which were found associated with the cotton belonged to *Rotylenchulus reniformis*, *Hoplolaimus* sp., *Helicotylenchus* sp. and *Tylenchorhynchus* sp.

Keywords: *Meloidogyne incognita*, plant-parasitic nematodes, survey

1. Introduction

Cotton (*Gossypium hirsutum* L.), popularly known as 'White Gold', is an important cash crop of India. The production and productivity in India is of great concern owing to the demand for cotton all over the world. India produces around 377 lakh bales of cotton from an area of 1225.35 lakh ha with productivity of 524 kg ha⁻¹. However, the production potential of the crop has not been fully exploited due to numerous biotic and abiotic factors. One of the prime challenges to attain high cotton production is damage caused by plant-parasitic nematodes. Globally, the most damaging nematodes of cotton are *Meloidogyne incognita* races 3 and 4 and *Rotylenchulus reniformis*. *M. incognita* and *R. reniformis* occur in tropical, subtropical and warm temperate soils throughout most of the world, generally within 35° of the equator (Robinson et al., 2001; Taylor and Sasser, 1978). One or both species are present in most cotton-producing regions and are considered to be serious problems in cotton production wherever they occur. The root-knot nematode, *M. incognita*, is widespread and a major pathogen in cotton production areas worldwide (Starr et al., 2005), causing direct damage and increasing the

incidence and severity of the root diseases. In the United States, *M. incognita* is found on cotton in all cotton-producing states and *R. reniformis* occurs only in states east of New Mexico (Heald and Robinson, 1990; Koenning et al., 2004; Lawrence and McLean, 1996; Robinson, 2007).

Besides inflicting direct losses in crop yields, plant-parasitic nematodes also play an important role in disease complexes involving other pathogens. The expression of damage in crop plants due to plant parasitic nematodes often goes unnoticed for want of diagnostic symptoms. Based on this comprehensive survey on a global scale, the annual economic crop yield losses due to plant parasitic nematodes in major crops have been estimated to be USD 173 billion (Elling, 2013). As such, the annual cotton yield loss due to damage by plant parasitic nematodes on a worldwide basis is estimated to be 10.7% (Sasser and Freckman, 1987). In Georgia in 2012, *M. incognita* caused an estimated 10.0% reduction in yield resulting in a loss of 75,000,000 kg of lint (Blasingame and Patel, 2013). In India, the annual cotton yield loss due to damage by root-knot nematodes is estimated to be 20.5% (Kumar et al., 2020). Not much information is available on the distribution of



plant parasitic nematodes around the rhizosphere of cotton in Nuh and Palwal districts of Haryana. Hence, in the present study an attempt has been made to assess the frequency and abundance of plant-parasitic nematodes associated with cotton in Haryana (Nuh and Palwal districts).

2. Materials and Methods

Surveys were conducted in the major cotton growing villages of districts of Nuh and Palwal districts of Haryana during 2018-20. The samples were collected from individual fields from villages within tehsils (administrative subunit of a district) of each of the two districts. Soil and root samples of plants exhibiting nematode symptoms were collected and analyzed for plant parasitic nematodes. Composite samples of soil and root were collected randomly from rhizosphere of disease infected cotton crops. When the samples were being collected, the farmers and villagers were interviewed to collect data on previous crop history, cropping pattern, fertilizer, irrigation and pesticide inputs. Soil samples were collected in polythene bags, labeled, handled and refrigerated at 7-10 °C before processing. Data on nematode population densities were analyzed to assess the average density of each nematode species, and frequency of occurrence in each district.

2.1. Extraction of nematodes from soil samples

Cobb's decanting and sieving combined with Modified Baermann's funnel technique (Schindler, 1961) was used for the extraction of nematodes from soil samples collected during survey. Killing and fixing of nematodes was done by adding boiling fixative (8% formalin) to nematode suspension. The nematode suspension further processed by glycerol ethanol method for identification of nematodes. Nematode population as estimated by using a stereoscope microscope and the range was determined. The species of root-knot nematode was identified by its perennial pattern.

3. Results and Discussion

Survey of Nuh and Palwal districts was conducted for the presence of plant-parasitic nematodes during 2018-20. Soil samples were collected from different locations along with roots. The samples were analyzed as per the standard protocol. During 2018-19, a total of 11 soil and root samples of cotton were collected from Nuh and Palwal districts. Out of 11 of samples, eight were found infected with root-knot nematode with 72.0% frequency of occurrence (Table 1). Other plant parasitic nematodes which were found associated with cotton belonged to *Hoplolaimus* sp. (63.6%), *Helicotylenchus* sp. (9.0%), *Tylenchorhynchus* sp. (9.0%) and *R. reniformis* (90.9%). A total of seven soil and root samples were collected from Nuh district (Table 2). Similarly, four samples were collected from Palwal district. The results revealed that out of seven samples (Nuh), five were found infested with root-knot nematode with 71.4% frequency of occurrence. In Palwal district, this nematode had 75.0% frequency of occurrence with density range of 60-300 j₂ 200⁻¹ cc soil (Table 3).

Table 1: Nematode associated with cotton in Nuh and Palwal districts of Haryana (2018-20)

Year	Nematode	Frequency of occurrence (%)
2018-19	<i>Meloidogyne incognita</i>	72.0
	<i>Hoplolaimus</i> sp.	63.6
	<i>Helicotylenchus</i> sp.	9.0
	<i>Tylenchorhynchus</i> sp.	9.0
	<i>Rotylenchulus reniformis</i>	90.9
2019-20	<i>Meloidogyne incognita</i>	51.8
	<i>Hoplolaimus</i> sp.	40.7
	<i>Helicotylenchus</i> sp.	25.9
	<i>Rotylenchulus reniformis</i>	40.7
	<i>Pratylenchus</i> sp.	62.9

Table 2: Distribution of root-knot nematode (*M. incognita*) in Haryana associated with cotton crop (2018-19)

S r. No.	GPS Informa- tion		Sample Information			Root-knot nematode 200 ⁻¹ cc soil
	Lat.	Long.	Village	Block	Dis- trict	
1	28.181	76.958	Charodu	Taoru	Nuh	1080
2	28.163	76.959	Charodu	Taoru		300
3	28.126	76.982	Biwan	Taoru		0
4	28.073	77.054	Adbar	Taoru		180
5	28.076	77.054	Adbar	Taoru		0
6	28.076	77.054	Adbar	Taoru		180
7	28.099	77.018	Salaheri	Taoru		180
8	28.114	77.059	Sohabha	Hodal	Pal-	0
9	28.129	77.231	Badha	Hodal	wal	300
10	28.185	77.254	Dhatir	Hodal		60
11	28.139	77.302	Hodal	Hodal		180

During 2019-20, a total of 27 samples of cotton were collected from Nuh and Palwal districts. Out of 27 samples, 14 were found infected with *Meloidogyne incognita* with 51.8% frequency of occurrence (Table 1). Other plant parasitic nematodes which were found associated with the cotton were *Hoplolaimus* sp., *Helicotylenchus* sp., *Pratylenchus* sp. and *R. reniformis* with frequency of occurrence as 40.7, 25.9, 62.9 and 40.7%, respectively. A total of 21 samples were collected from Nuh district (Table 4). Similarly, six samples were collected from Palwal district. The results revealed that out of 21 samples (Nuh), 12 were found infested with root-knot nematode with 57.1% frequency of occurrence. In Palwal district, this nematode had 33.3% frequency of occurrence with density range of 135-435 j₂ 200⁻¹ cc soil (Table 5).



Table 3: Survey of cotton growing areas for root-knot nematode infestation in Haryana (2018-19)

District	Incidence		GPS information	Frequency of occurrence (%)	Density range (j ₂ 200 ⁻¹ cc soil)	Nematode identified
	No. of cultivation units					
	Surveyed	Infected				
Nuh	7	5	N 28.073-28.180 E76.958-77.054	71.4 %	180-1080	Meloidogyne incognita
Palwal	4	3	N 28.114-28.185 E77.059-77.301	75.0 %	60-300	Meloidogyne incognita

Table 4: Distribution of root-knot nematode (*M. incognita*) in Haryana associated with cotton crop (2019-20)

Sr. No.	GPS Information		Sample information				Root-knot nematode 200 ⁻¹ cc soil
	Lat.	Long.	Village	Block	District		
1.	28.186	76.952	Bajelaka	Taoru	Nuh		275
2.	28.123	76.987	Choroda	Taoru			0
3.	28.031	77.015	Malab	Nuh			310
4.	28.031	77.017	Malab	Nuh			148
5.	28.031	77.016	Malab	Nuh			0
6.	28.032	77.016	Malab	Nuh			295
7.	28.032	77.016	Malab	Nuh			417
8.	28.032	77.016	Malab	Nuh			0
9.	28.034	77.015	Malab	Nuh			0
10.	28.038	77.073	Bhirshika	Nuh			690
11.	28.038	77.074	Bhirshika	Nuh	Palwal		0
12.	28.043	77.073	Ujina	Nuh			95
13.	28.015	77.146	Bhiunshi	Nuh			0
14.	28.208	76.914	Nizampur	Taoru			435
15.	27.950	77.832	Sukpuri	Nagina			280
16.	27.952	77.097	Sukpuri	Nagina			0
17.	27.952	77.123	Sikarava	Punana			0
18.	27.959	73.137	Sikarava	Punana			325
19.	27.939	77.123	Mohandhpur	Punana			608
20.	27.925	77.114	Mohandhpur	Punana			0
21.	28.139	76.991	Sonkh	Nuh			262
22.	27.995	77.175	Utavard	Hathin			0
23.	28.030	77.229	Hathin	Hathin			435
24.	28.041	77.231	Hathin	Hathin			0
25.	28.584	77.219	Gharot	Hathin			135
26.	28.954	77.194	Jainpur	Hathin			0
27.	28.206	77.200	Saroli	Mandkola			0

Of the nematodes recovered in this survey, only *M. incognita* and *R. reniformis* are currently considered to be economically damaging to cotton. The *M. incognita* was found to be the most predominant species in the soil samples of cotton

rhizospheres collected from different locations. This was followed by the *R. reniformis*, *Hoplolaimus* sp., *Helicotylenchus* sp., *Tylenchorhynchus* sp. and *Pratylenchus* sp. The reniform nematode is prevalent in higher densities in cotton-growing



Table 5: Survey of cotton growing areas for root-knot nematode infestation in Haryana (2019-20)

District	Incidence		GPS information	Frequency of occurrence (%)	Density range (j ₂ 200 ⁻¹ cc soil)	Nematode identified
	No. of cultivation units					
	Surveyed	Infected				
Nuh	21	12	N 27.950-28.186 E76.952-77.832	57.14 %	95-690	<i>Meloidogyne incognita</i>
Palwal	6	2	N 27.995-28.954 E77.175-77.231	33.3%	135-435	<i>Meloidogyne incognita</i>

areas of Punjab, Haryana and Uttar Pradesh (Bucker and Seshadri, 1968; Verma and Jain, 1999; Das and Gaur, 2009). A random survey undertaken in the Bt cotton-growing districts of northern Karnataka for the associated nematodes in cotton rhizosphere soil and root samples showed the presence of plant pathogenic nematodes, mainly reniform nematode (*Rotylenchulus reniformis*), lesion nematode (*Pratylenchus* sp.) and some dorylaimid pathogens (Lingaraju et al., 2012).

Of 184 samples collected from 15 'municipios' (roughly comparable to counties) in MatoGrosso do Sul State in Brazil, 28.0% and 17.0% were positive for *M. incognita* and *R. reniformis* with 45.0% and 32.0% of those samples, respectively, above the damage threshold (Asmus, 2004). In Florida, *M. incognita* was found in 61.0% of the cotton fields infested (Kinloch and Sprenkel, 1994), and in Georgia 38.0% of the fields were infested (Baird et al., 1996). Typically, Florida and Georgia cotton-production areas are in soils that contain a high percentage of sand. *M. incognita* also has been found in 30.0% of the cotton fields in Missouri (Wrather et al., 1992), 20.0 to 30.0% in Arkansas (Bateman et al., 2000), and 10.0 % in Mississippi (Lawrence et al., 1997), respectively. This survey indicates that *M. incognita* and *Rotylenchulus reniformis* are widespread in the cotton production regions of Haryana (Nuh and Palwal districts). The presence and prevalence of these two economically important nematodes of cotton in this region may account for some of the widespread yield suppression that has been seen. Strategies for nematode management will be needed to improve the cotton yield in this area.

4. Conclusion

The association of plant parasitic nematodes especially the most important nematodes species like *Meladogyne incognita*, *Rotylenchulus reniformis*, *Helicotylenchus* sp., *Hoplolaimus* sp., *Tylenchorhynchus* and *Paratylenchus* sp. can cause severe economic yield loss to cotton crop in Nuh and Palwal districts of Haryana, if proper strategies are not adopted for their management. In order to overcome this problem, integrated nematode management schedule has to be adopted to reduce the yield losses in cotton.

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