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Dinesh Singh Dhurwey
Ex. Ph.D. Scholar, Department of Plant Pathology, C.O.A, JNKVV, Jabalpur, Madhya Pradesh, India

Jayant Bhatt
Professor and HEAD, Department of Plant Pathology, C.O.A, JNKVV, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Dinesh Singh Dhurwey
Ex. Ph.D. Scholar, Department of Plant Pathology, C.O.A, JNKVV, Jabalpur, Madhya Pradesh, India

Root-knot nematode (*Meloidogyne graminicola*): An emerging problem of wheat in Kaymore plateau and Satpura hills

Dinesh Singh Dhurwey and Jayant Bhatt

Abstract
Random survey was conducted during course of investigation in 2016-17 in different tribal districts of the state *viz.*, Anuppur, Dindori, Mandla, Shahdol and Umaria demonstrated that root-knot nematode is of wides occurrence. The most common species *Meloidogyne graminicola* was found associated with rice - wheat cropping system and related weeds, in different localities**.** All these localities were found infested with root knot nematode, (*M. graminicola*). The plant infected with *M. graminicola* were found devitalized, stunted with yellow leaves. The root system of such plants had severe galling with poorly developed roots. The soil samples were collected from the infested fields and the samples were analysed using Baermann's funnel technique followed by Cobb sieving and decanting methods. The soil population of *M. graminicola* was found associated with rice-wheat cropping system and total population of the nematode ranged from 180 to 390 nematodes (J_2) per 200 cm^2 soil. The soil sample collected from rice – wheat areas of Anuppur (10), Dindori (5), Mandla (2), Shahdol (8) and Umaria (24) encountered *M. graminicola*. The maximum (390 N) and minimum (130 N) population densities of *M. graminicola* was recorded in Badwar and Raipur village of Umaria district respectively.

Keywords: Root-knot nematode, meloidogyne graminicola, wheat, population densities

Introduction
Wheat (*Triticum aestivum* L.) is one of the important cereal crops of the Madhya Pradesh and belongs to family Poaceae which includes major cereal crops such as sorghum, maize, rice, millet and barley [7]. The first cultivation of wheat**,** as per the records**,** was about 10,000 years ago as part of the "Neolithic Revolution" which saw a transmission from hunting and gathering of food to settled agriculture [11, 9]. Wheat is one of the eight food sources which provides 70-90 per cent calories and 66-90 per cent protein. Globally, wheat provides nearly 55 percent of carbohydrate and 20 per cent calories [6]. Many factors affect yield of wheat but diseases are one of the most serious causes for low yields of irrigated wheat due to severe competition. Since the crop is cultivated in wide range of climatic conditions, *Meloidogyne graminicola* is known to infect and cause serious damage especially in rice and wheat, in many countries [3, 5, 17, 13, 15]. The characteristic symptoms of *Meloidogyne graminicola* are the enlargement of roots and formation of Hooke like galls on the root tips of infested plants. Usually, there are no distinct symptoms on foliage of affected plants unless the nematode infestation becomes severe. In very severe cases, newly emerged leave appears distorted and dried up along the margins and show chlorosis. Infested plants show stunted growth resulting considerable yield loss [12].

Meloidogyne graminicola has now emerged as a major threat to wheat cultivation throughout the world and has occupied a place of "National Pest" owing to its severity and has become a major constraint in successful wheat cultivation leading to significant loss to the crop. *M. graminicola*, is now an important nematode pest of wheat in many parts of the country. The first report of its occurence in Madhya Pradesh [14]. It has now established itself in the tribal belt *viz.*, Anuppur, Dindori, Shahdol, Mandla and Umaria exposing the crop to a serious biotic stress and severe attack on *rabi* wheat due to the adoptable nature, broad host range and ability of causing potential yield losses. The soil population of nematode is increasing drastacally due to continuous cropping of rice and wheat. *Meloidogyne graminicola* was reported to cause uo to 21 per cent yield loss in rainfed and well drained soils throughout the country [16].

Material and Methods

Collection of soil and root samples

A random survey of tribal areas of Madhya Pradesh *viz.*, Anuppur, Dindori, Mandla, Shahdol and Umaria districts was conducted during 2016 -17 to find out the infestation of root knot nematode in wheat and paddy fields. The plants showing uneven patches with yellowing of foliage and stunted plant growth, reduced tillering with delayed ear head emergence and galls on the root system were uprooted with the help of spade so as to get the intact root system. The roots were wrapped in a moist paper towel and kept in a polythene bag. An amount of 500 kg soil was also collected from the vicinity of infected wheat plant after discarding top ten soil strata. The soil samples include wheat and weed roots. The samples were brought to the laboratory for further examination and extraction of nematodes. The information on cropping history, namely type of soil, method of sowing, varieties, date of sowing, seed and soil treatment were collected from the farmers.

Extraction of nematode

The soil samples that were collected from the infested fields were mixed thoroughly to get homogeneous mixture and a sub sample of 200 cm^3 soil was drawn and analysed to ascertain nematode population. The soil samples were analysed using Baermann's funnel technique followed by modified Cobbs Sieving and decanting method [2].

Extraction of nematode population

Baermann's funnel technique followed modified Cobb's Sieving and decanting method was employed. Egg masses were collected over 400 mesh British Standard (BS) sieve and were further subjected to extraction assembly at room temperature (25°C ± 2) [8]. An extraction assembly contained PVC ring of 110-millimetre diameter holding double layered wet tissue paper supported by a gauze cloth and tightly stretched with the help of a rubber band. Extraction dish was placed over a piece of sponge measuring 18x15x15 cm for providing firm support from the bottom to the tissue paper and allowing a fast passage of water suspension containing freshly washed egg masses on 400 mesh sieves. The content was poured with the help of a gentle stream of water. Assembly was later kept on a glass bowl (Yera make) holding 60 ml of aqua guard water.

Extraction assembly was placed in such a way that the upper layer of water in glass bowl touches the stretched base of extraction dish to ensure no air bubble. The extraction was carried out at room temperature (25°C ± 2) and the second stage juveniles (J_2) were collected 24 and 48 hr after. The extraction was further continued till 72 to 96 hr and juveniles emerged within 96 hr were used for the inoculation after calibrating the population.

Results and Discussion

Survey: Random survey of tribal districts of the state *viz.*, Anuppur, Dindori, Mandla, Shahdol and Umaria (Plate 1 Fig 1) demonstrated that root-knot nematode is of wides occurrence. The most common species *Meloidogyne graminicola* was found associated with rice - wheat cropping system and related weeds, in different localities**.** All the localities surveyed during the course of investigation were found infested with root knot nematode, (*M. graminicola*). The plant infected with *M. graminicola* were found devitalized, stunted with yellow leaves. (Plate 1 Fig A) The root system of such plants had severe galling with poorly developed roots. (Plate 1 B, C) The data presented in the Table 6 indicated that the soil population of *M. graminicola* was found associated with rice-wheat cropping system and total population of the nematode ranged from 180 to 390 nematodes (J_2) per 200 cm^2 soil. The soil sample collected from rice – wheat areas of Anuppur (10), Dindori (5), Mandla (2), Shahdol (8) and Umaria (24) encountered *M. graminicola*. The maximum (390 N) population of *M. graminicola* was recorded in Badwar village of Umaria district with red sandy loam soil followed by in Vannaudha village of Umaria district (385 N). With the same soil condition Sarwahi kala recorded 370 N, Bandha and Dubbhar recorded (360 nematode) per 200 cm^2 soil with sandy to red sandy loam soil type. Maximum 130 N/200 cm2 soil nematodes were recorded with Diyabar Village of Dindori and Raipur of Umaria districts. However, the nematode population varied from 130 to 390 N in the district surveyed (Table 2). The destructive plant parasitic nematodes are one of the major limiting factors in the production of cereal crops throughout the country. Roots damaged by the nematodes are not efficient in the utilization of available moisture and nutrients in the soil resulting in reduced functional metabolism. The visible symptoms of nematode attack often include reduced growth of individual plants. The deleterious effects on plant growth result in reduced yield and poor quality of crop.

The random surveys conducted during the course of investigation in tribal areas of the state have revealed the predominant frequency (100%) of root knot nematode *Meloidogyne graminicola* [1]. The data indicated that the high population of *M. graminicola* was recorded with light soil as compared to heavy soils. Similarly, the gall formation was more on wheat roots with sandy soils than with heavy soils. [10] and [18] observed significantly larger nematode population densities in the field with light soils as compared to heavy soils may be the result of better growth and multiplication of the nematodes favoured by light soil. Similarly, soil population densities of *M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla* were positively correlated with that of the sand content of soil [19]. This nematode has greater survival and infectivity in flooded soil than in non-flooded soils in context to most other *Meloidogyne* species [13].

Table 1: District wise survey of *Meloidogyne graminicola* in Tribal districts of Madhya Pradesh

District	Sample number	Village	Host plants		Season	Age of crop (DAS)	Soil type	Population densities of root-knot nematode
			Present	Previous				
Anuppur	1	Dhanpuri	Rice	Wheat	Kharif	35	Red sandy loam	270
	2	Dhanpuri	Rice	Wheat	Kharif	45	Red sandy loam	240
	3	Dhanpuri	Badi Sanvak	Fallow	Kharif	40	Red sandy loam	180
	4	Majheeta	Rice	Chickpea	Kharif	45	Light black	240
	5	Majheeta	Wheat	Rice	Rabi	40	Light black	260
	6	Majheeta	Wheat	Rice	Rabi	50	Sandy loam	250
	7	Dondia	Wheat	Rice	Rabi	50	Sandy loam	230
	8	Badra	Wheat	Rice	Rabi	50	Sandy loam	240
	9	Piper Tola	Wheat	Rice	Rabi	50	Light black	170
	10	Piper Tola	Wheat	Rice	Rabi	50	Light black	160
Dindori	11	Barwara	Rice	Fallow	Kharif	45	Sandy loam	165
	12	Barwara	Rice	Wheat	Kharif	50	Sandy loam	140
	13	Diyabar	Rice	Wheat	Kharif	60	Light black	130
	14	Diyabar	Rice	Wheat	Kharif	60	Light black	155
	15	Newsa	Rice	Fallow	Kharif	50	Red sandy loam	160
Mandla	16	Umardeeh	Rice	Wheat	Kharif	60	Light black	180
	17	Umardeeh	Rice	Wheat	Kharif	60	Light black	185
Shahdol	18	Jaitpur	Rice	Fallow	Kharif	50	Red sandy loam	270
	19	Jaitpur	Rice	Fallow	Kharif	45	Red sandy loam	210
	20	Kanchanpur	Rice	Fallow	Kharif	60	Red sandy loam	240
	22	kanchanpur	Rice	Wheat	Kharif	60	Red sandy loam	250
	23	Rasmohani	Wheat	Rice	Rabi	40	Red sandy loam	265
	24	Rasmohani	Wheat	Rice	Rabi	40	Red sandy loam	245
	25	Devgarh	Wheat	Rice	Rabi	45	Red sandy loam	250
	26	Dhurwar	Rice	Fallow	Kharif	60	Red sandy loam	240

*= Population density = Average number of root-knot nematode 2nd stage juveniles/200 cm^2 soil.

Table 2: Contd….

District	Sample number	Village	Host plants		Season	Age of crop (DAS)	Soil type	Population densities of root-knot nematode
			Present	Previous				
Umaria	27	Badwar	Wheat	Rice	Rabi	45	Red sandy loam	390
	28	Badwar	Rice	Wheat	Karif	50	Red sandy loam	370
	29	Dubbhar	Wheat	Rice	Rabi	50	Sandy	380
	30	.Dubbhar	Badi sanwak	Fallow	Kharif	45	Sandy	350
	31	Nayaganv	Wheat	Rice	Rabi	60	Red sandy loam	340
	32	Jatwar	Wheat	Rice	Rabi	50	Sandy loam	250
	33	Chandia	Wheat	Rice	Rabi	50	Red sandy loam	230
	34	Chhotipali	Wheat	Rice	Rabi	50	Sandy loam	240
	35	Nariyara	Wheat	Rice	Rabi	50	Red sandy loam	270
	36	Bharoula	Wheat	Rice	Rabi	50	Red sandy loam	260
	37	Amha	Wheat	Rice	Rabi	45	Red sandy loam	165
	38	Rakheli	Rice	Wheat	Khrif	50	Sandy loam	240
	39	Raipur	Wheat	Rice	Rabi	60	Red sandy loam	130
	40	Chachariya	Wheat	Rice	Rabi	60	Red sandy loam	255
	41	Bandha	Wheat	Rice	Rabi	50	Red sandy loam	360
	42	Bharouli	Wheat	Rice	Rabi	60	Red sandy loam	280
	43	Vannaudha	Wheat	Rice	Rabi	60	Red sandy loam	385
	44	Dhaurai	Wheat	Rice	Rabi	50	Red sandy loam	270
	45	Salaiya	Wheat	Rice	Rabi	45	Red sandy loam	210
	46	Bhimdongari	Wheat	fallow	Rabi	60	Red sandy loam	240
	47	Amliha	Rice	Wheat	Karif	60	Red sandy loam	250
	48	Sarwahi kala	Wheat	Rice	Rabi	40	Red sandy loam	360
	49	Nariyara	Wheat	Rice	Rabi	40	Red sandy loam	245
	50	Pali	Wheat	Fallow	Rabi	45	Red sandy loam	350

*= Population density = Average number of root-knot nematode 2nd stage juveniles/200 cm^2 soil.

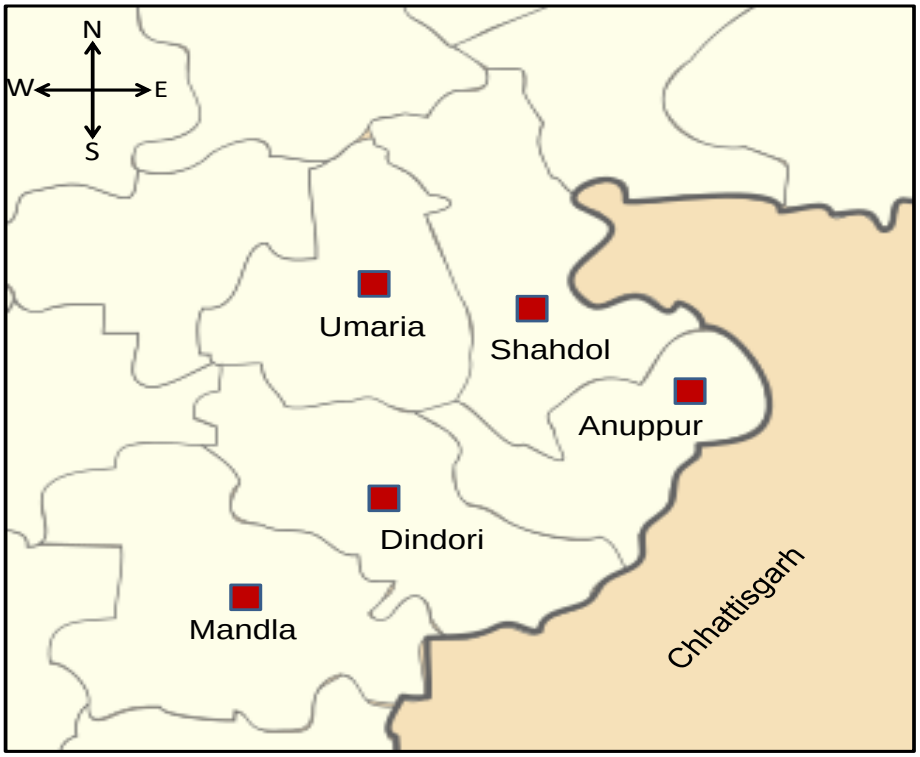

Fig 1: Area showing Infestation of *Melodogyne gramnicola* on wheat in tribal district of Madhya Pradesh

A. Initial Symptoms on Plant **B.** Galls on Root

C. Field View

Plate 1: Wheat field infested with root-knot nematode *Meloidogyne graminicola*

Conclusion

In this investigation a random survey was conducted in different localities of tribal district of Madhya Pradesh. The root knot nematode (*M. graminicola*) was associated rice-wheat cropping system and related weeds. The root system of such plant had severe galling with poorly developed roots. The maximum population densities were found 390 in Badwar Village of Umaria district.

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