Research Article

Pathogenicity of Rice Root-Knot Nematode, *Meloidogyne graminicola* on Rice Nursery in Different Soil Types

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Abstract

The pathogenicity study of rice root root-knot nematode, *Meloidogyne graminicola* was carried on rice nursery in three types of soil *viz.* Sandy loam, clay loam and Loam. The physico-chemical properties and texture of various types of soil were analysed. Thirty seeds of susceptible rice variety Pusa 1121 were sown in 2 Kg capacity earthen pots filled with steamed sterilized soil. Five inoculum levels *viz.* 0, 1, 2, 3, 4 J_2/g soil were taken for each soil type. Inoculum level of 1 J_2/g soil was found to be pathogenic. The growth parameters of rice seedling were significantly more in clay loam soil followed by loam and sandy loam irrespective of inoculum levels. Maximum growth was observed in uninoculated check and growth decreased significantly with the increase in inoculum level from 1-4 J_2/g soil. Maximum reproduction of nematode was observed in clay loam and loam textured soil. The nematode reproduction increased with the increase in inoculum levels.

Keywords: Pathogenicity, Rice, Rice root-knot nematode, *Meloidogyne graminicola*, soil type

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Introduction

Rice root-knot nematode, *Meloidogyne graminicola* Golden and Birchfield, 1965 is a pest of international importance and it is reported to cause 17-30% yield loss in rice due to poorly filled kernels [1]. It is a serious problem in the nurseries and upland rice but has been found to be widespread in the deep water and irrigated rice also in many states of India [2-4]. Effect of varying degrees of incidence of root-knot nematode on the rice under inoculated conditions was studied [5]. For every unit increase of 1000 larvae in inoculum, there was 2.6, 30 and 42 % reduction in grain yield when plants were inoculated at an age of 12, 32 and 64 days, respectively. The major cause for high incidence of nematode infection is attributed to the presence of light textured soil, non-availability of ample water and transplantation of infected seedlings. As rice is grown in various soil types prevalent in different agro-climatic zones, so such study was carried out in different textured soils as the relationship between components of soil and nematode is linear [6]. Plants are more vulnerable at nursery stage than at later stage to this nematode [7].

Materials and Methods

Studies on the pathogenicity of *M. graminicola* on rice in different soil types of were conducted in Department of Nematology, CCS Haryana Agricultural University, Hisar, during *kharif* (July –August). The physico-chemical properties and texture of various types of soils were got analysed from Department of Soil Science, CCS HAU, Hisar (**Table1**).

Table 1 Physico-chemical properties of soils used in this experiment

Soil type	EC (dSm^{-3})	pH	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	Zn (kg/ha)	Cu (kg/ha)	Fe (kg/ha)	Mn (kg/ha)
Sandy loam	1.35	7.9	0.75	175	27	410	16.9	0.89	9.2	4.0
Clay loam	0.42	8.0	0.45	154	12	370	6.3	3.14	5.6	14.9
Loam	1.20	7.3	0.45	147	32	335	9.7	4.12	17.8	18.7

Different types of soils *viz.*, sandy loam, loam and clay loam collected in bulk from Hisar, Karnal, and Jind districts of Haryana, respectively. The soils were autoclaved for 30 minutes at 15 psi and filled in 2 Kg earthen pots. Thirty seeds of susceptible rice var. Pusa 1121 were sown in each pot. Different inoculum levels *viz.*, 0, 1, 2, 3, 4 J_2/g soil were kept for each soil type. Inoculum was obtained by teasing the infected roots of rice grown in culture pots.

Each treatment was replicated three times. Nematode inoculation was done at the time of sowing in each pot by making the pencil holes in soil. The nematode suspension was bubbled continuously for 10-15 seconds for uniform quantity and poured with pipette according to the desired inoculum, required for the experiment. The holes were immediately covered with soil and light watering was done. Recommended doses of fertilizers and micronutrients were added to the soil for the maintenance of the plants.

Forty days after inoculation, each plant was depotted carefully and kept in a pan of water to clear it from adhering soil. Observations on shoot length (cm), 20-seedling fresh and dry shoot weight (g), number of galls and number of eggs per seedling were recorded. For counting eggs, roots were teased in water under stereo microscope and eggs were counted in suspension.

Results and Discussion

Observations on the impact of different inoculum levels on plant growth and nematode reproduction parameters in different types of soils were recorded forty days after inoculation. Data indicated that irrespective of the soil types, maximum shoot length, fresh and dry seedling weight of rice was observed in uninoculated check. As the inoculum level increased from 1 J_2/g soil to 4 J_2/g soil, significant reduction in plant growth parameters were recorded.

Minimum shoot length (21.5 cm), fresh seedling weight (8.4 g) and dry seedling weight (1.9 g) was observed in rice seedling inoculated with 4 J2/ g soil. Inoculum level of 1 J2/ g soil was found pathogenic in all the soil types (**Tables 2-4**).

Table 2 Effect of different inoculum levels of *M. graminicola* on shoot length (cm) of rice seedling in different soil types

Inoculum levels (J_2/g soil)	**Soil types**			**Mean**
	Sandy loam	**Loam**	**Clay loam**	
0	25.4	29.4	37.9	30.9
1	24.1	26.4	36.3	29.0
2	21.1	24.2	33.1	26.1
3	17.7	22.5	31.8	24.0
4	12.5	21.2	30.8	21.5
Mean	20.2	24.7	34.0	
C.D. at 5 % level; Soil type: 0.8; Inoculum level: 1.0; Soil type × Inoculum level: 1.8				

Table 3 Effect of different inoculum levels of *M. graminicola* on 20-seedling fresh weight (g) of rice in different soil types

Inoculum levels (J_2/g soil)	**Soil types**			**Mean**
	Sandy Loam	**Loamy**	**Clay loam**	
0 (check)	9.3	10.7	19.0	13.0
1	8.3	9.5	17.4	11.7
2	6.9	8.5	17.1	10.8
3	5.3	6.8	16.5	9.5
4	3.5	6.4	15.3	8.4
Mean	6.7	8.4	17.0	
C.D. at 5 % level; Soil type: 0.4; Inoculum level: 0.5**;** Soil type × Inoculum level: 0.8				

Table 4 Effect of different inoculum levels of *M. graminicola* on 20-seedling dry weight (g) of rice in different soil types

Inoculum levels (J_2/g soil)	**Soil types**			**Mean**
	Sandy Loam	**Loam**	**Clay loam**	
0 (check)	3.1	3.6	4.5	3.7
1	2.4	3.1	4.6	3.4
2	1.7	2.6	4.3	2.8
3	0.6	1.8	4.2	2.2
4	0.2	1.7	3.9	1.9
Mean	1.6	2.5	4.3	
C.D. at 5 % level; Soil type: 0.2; Inoculum level: 0.3; Soil type × Inoculum level: 0.6				

All the plant growth parameters were significantly different among the soil types. Maximum shoot length, fresh seedling weight and dry seedling weight were observed in clay loam followed by loam and sandy loam irrespective of inoculum levels. These were significantly higher in clay loam soil than loam or sandy loam soil. The interactions between soil types and inoculum levels were also found significant for these characters, similar findings were found in [8] conducted an experiment to test the pathogenic effect of *M. graminicola* on growth of rice seedlings. Maximum reduction in all the plant growth parameters was recorded at 5000 J_2/ kg of soil. Significant reduction in shoot length, root length, fresh shoot and root weight was observed at 1000 J_2/kg of soil and considered as damaging threshold level of *M. graminicola.* Effect of incidence of root-knot nematode on the rice under inoculated conditions was studied [5]. For every unit increase of 1000 larvae in inoculum showed a reduction of 2.6 per cent in grain yield when plants were inoculated at 12 days' age, 30 per cent in plants inoculated at 32 days and 42 per cent in plants inoculated at 64 days' age. Effect of *M. graminicola* infection under simulated rainfed lowland on rice varieties CN 492, CR 1018, CR 1030, FR 13A and Jaladhi-1 at inoculum levels of 0, 1 and 2 nematodes /g soil has been studied [9].Seedling mortality was significantly higher at 2 nematodes/g of soil in all the varieties. Plant height was reduced by 5.1 to 19 per cent and 4.2 to 55.4 per cent in the nematode infected plants at 5 and 15 days after submergence respectively. Jaladhi-1 and CR 1018 recorded highest number of egg masses and adults. Thus all the plant growth parameters were significantly higher in clay loam soil this is may be due to high nutrient status as well as high water holding capacity of the soil.

Number of galls and eggs per seedlings was significantly different from each other in clay loam, sandy loam and loam soil (**Tables 5** and **6**). Minimum number of galls and eggs were observed in sandy loam followed by loam and clay loam soil irrespective of inoculum levels. As inoculum level increased from 1 to 4 J_2/g soil, numbers of galls increased.

Table 5 Effect of different inoculum levels of *M. graminicola* on number of galls per rice seedling in different soil types

Inoculum levels (J_2/g soil)	**Soil types**			**Mean**
	Sandy loam	**Loamy**	**Clay loam**	
0 (check)	0 (1.0)	0 (1.0)	0 (1.0)	0 (1.0)
1	18.5 (2.3)	20.6 (2.4)	23.7 (2.4)	20.9 (2.3)
2	21.0 (2.4)	23.7 (2.4)	24.9 (2.5)	23.2 (2.4)
3	24.6 (2.4)	26.4 (2.5)	28.1 (2.5)	25.7 (2.5)
4	24.4 (2.4)	27.1 (2.5)	29.4 (2.5)	27.0 (2.5)
Mean	22.1 (2.1)	24.4 (2.2)	26.5 (2.2)	

Figures in parentheses are square root transformations
C.D at 5 % level; Soil type: (0.01); Inoculum level: (0.01); Soil type × Inoculum level: (0.02)

Table 6 Effect of different inoculum levels of *M. graminicola* on number of eggs per seedling on rice in different soil types

Inoculum levels (J_2/g soil)	**Soil types**			**Mean**
	Sandy loam	**Loamy**	**Clay loam**	
0 (check)	0 (1.0)	0 (1.0)	0 (1.0)	0 (1.0)
1	1054 (5.8)	1108 (5.9)	1237 (6.0)	1133 (5.9)
2	1186 (6.0)	1260 (6.0)	1323 (6.1)	1256 (6.0)
3	1267 (6.1)	1325 (6.1)	1415 (6.2)	1335 (6.1)
4	1242 (6.1)	1373 (6.2)	1487 (6.3)	1367 (6.2)
Mean	950 (5.0)	1013 (5.1)	1092 (5.2)	

Figures in parentheses are square root transformations
C.D. at 5 % level; Soil type: (0.02); Inoculum level: (0.03); Soil type × Inoculum level: (0.05)

Number of galls and eggs were significantly different from each other at different inoculum levels and minimum number of galls (20.9/ seedling) was observed at inoculum 1 J2 per g soil. Both inoculum levels of 4 J2/g soil & 3 J_2 /g soil were showed the maximum number of galls and eggs per seedling.

In case of interaction between soil types and inoculum levels, maximum number of galls and eggs were observed in clay loam soil at 4 J_2/g soil which were significantly different from all other treatments. There was significant increase in multiplication with corresponding increase in nematode inoculum level starting from 1to 4 J_2/g. The

highest multiplication was observed at 4 J_2 /g soil which is at par with the inoculum level 3 J_2/g soil. The probable reason for this may be the high density of the nematode in a limited quantity of soil. Occurrence of these conditions might have lead to competition for space, nutrition and other requirement of the nematodes as it is clear from debilitation of roots having 4 J_2 in the form of lowest root growth similar results were found in [6] also observed the high rate of reproduction of *M. graminicola* in rice at low levels of inoculum, that could possibly be due to the positive factors like abundance of food, lack of competition, ability of the host to support these levels of population. On the other hand, reduction in nematode developmental parameters at high levels of inoculum is considered to be due to the negative density factor like crowding of endoparasites in the roots. While studying the effect of different soil types in rice fields, significantly larger nematode population densities were observed in the fields with light soil as compared to heavy soil [10]. But in the present studies, plant growth as well as nematode multiplication was more in heavy textured than in light soils. Similar results were obtained by [11] and the plausible reason for this has been given the profuse root system supported by heavy textured soil, allowing the plant to overcome root damage by the nematode.

Conclusion

From the study it can be concluded that, Inoculum level of 1 J_2/g soil of rice root-knot nematode (*Meloidogyne gramainicola*) was found to be pathogenic in all the three types of soils. However, pathogenicity in rice nurseries was more in sandy soil as compared to loam and clay loam soils. The multiplication rate of the nematode was higher in clay loam soils as compared to other soil types. Maximum growth of rice was observed in uninoculated check and it decreased significantly with the increase in inoculum level from 1-4 J_2/g soil

Acknowledgements

Authors are thankful to Professor and Head Soil science and Dr. Dinesh, Asstt soil scientist, CCSHAU, Hisar for helping in analysis of soil samples. Rice seeds were kindly provided by incharge of CCSHAU, Regional Rice Research Station, Kaul.

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Publication History
Received 11th Oct 2017
Revised 29th Oct 2017
Accepted 15th Nov 2017
Online 30th Nov 2017