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Screening of resistance against rice root-knot nematode *Meloidogyne graminicola* in some common paddy cultivars of Odisha

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Abstract
Screening of some common paddy cultivars of Odisha were evaluated against rice root-knot nematode *Meloidogyne graminicola*, in green house condition in Department of Nematology, OUAT, Bhubaneswar, Odisha, replicated thrice in Complete Randomized Design (CRD) during kharif seasons of 2019 and 2020. One hundred ten paddy varieties were tested for the nematode in pot culture condition then inoculum density and root-galling severity of *M. graminicola* in terms of different plant growth parameters were classified as per root-knot index (0-5 scale). Reduction in length and weight of both the roots & shoots in most of the common varieties like Lalat, Naveen, Khandagiri, Udayagiri etc found highly susceptible. However, 9 varieties namely Vanaprava, Manik, Abhisek, Pratikhya, BAS-63, BBSR Local-2, Udaya, FR-13-A, Keshari were found moderately resistance with root-knot index-2. The most of the popular varieties of Odisha like Narendra, CR-1014, Swarna sub-1, Lunishree, Vandana, Panidhan etc were shown to be susceptible against the nematode with low growth rate due to improper nutrient flows in post-nematode infestation. No varieties were observed highly resistance for the nematode during the investigation.

Keywords: Screening, evaluation, paddy (*Oryza sativa*) cultivars, *Meloidogyne graminicola*

1. Introduction

Paddy (*Oryza sativa*) is commonly known as rice belongs to Poaceae family, an important primary food crop for two-third of the human population worldwide, mostly in Asia. Rice is grown almost throughout the year in hot and humid regions of eastern and southern parts of India. *Meloidogyne graminicola*, a menace to rice, is an obligate damaging parasite nematode that infest most of the rice cultivars in all types rice ecosystems. Due to the immense diversity in growth conditions, makes classification & characterization of the paddy environment a challenging task. Among the various phytonematodes *Meloidogyne spp*. are the most prevalent economical crop pests worldwide (Oka *et al*, 2000) [9]. *Meloidogyne graminicola* is a major nematode pest of most of the paddy varieties in Odisha condition as well as all round the country. Estimated average yield loss annually due to this PPN in upland, rainfed and direct seeded rice cultivars was upto 50% (Lorenzana *et al*. 1998) [8] & in pot condition was about 98% (Plowright and Bridge 1990) [1] with poorly filled kernels. Infecting J_2 of *M. graminicola* penetrates through the root tips and form galls within 72 hrs, which is well adopted in flooded condition & can survive in waterlogged soil as egg in egg masses or as juveniles for long period. It invades inter cellularly and forms multinucleate giant cells near the infection site that check nutrients flow which leads to disturbance in metabolic activities and causes measurable changes in morphological, physiological & biochemical in plant (Williamson and Gleason 2003) [14].

In most of agricultural production sustainable development techniques for small and medium holder farmers with costs according to their economic condition is required. In modern intensive agricultural practices in order to meet the nutritional requirements for the ever-increasing world population chemical fertilizers and pesticides are applied in large scale to increase crop production. However their frequent use has been restricted due to high costs, environmental problems such as pollutions & ozone depletion and non-availability of potent nematicides. Various management practices have been applied so far to control of the nematode, but an effective and eco-friendly approach is use of resistant varieties. Breeding of resistant varieties against rice root-knot nematode in a cost effective way for farmer use in field condition is a better option during sustainable agriculture era.

One hundred ten common rice varieties were screened with the purpose of finding resistance donors. Screening of several high yielding varieties for complete resistance were done but it still lacked major variations in resistance induction against the nematode.

2. Materials and Methods

Rice root-knot nematodes are polyphagus in nature. Hence, 110 number of genotypes (varieties) procured were used for testing and scoring against test nematode for resistance/ susceptibility. Pots containing soil were arranged on greenhouse benches in complete randomized design with three replications during two cropping seasons 2019-20, in the Department of Nematology, OUAT, Bhubaneswar. Seeds were sown and sprinkled with water passed through 500 mesh sieve. After 2 weeks of sowing J_2 of *M graminicola* were released into holes near the base of the plant of each pot. Watering was done just to drench the soil avoiding over flooding. Forty five days after sowing the pots were washed under tap water. Water was allowed to pass upon the pot soil with sufficient pressure so that the soil particles were flooded away. Whole of the root system was obtained by this method. Roots were observed under a stereoscopic microscope and the numbers of galls produced on each plant roots were counted.

Table 2: Root-knot index in 0 to 5 scale for *M. graminicola*

Scale	No of galls/root system	Reaction
0	0	Immune (I)
1	1-2	Resistant (R)
2	3-10	Moderately Resistant (MR)
3	11-30	Moderately Susceptible (MS)
4	31-100	Susceptible (S)
5	>100	Highly Susceptible (HS)

The average number of galls of all replications are presented in (Table 3). Subsequently the root system was fixed in 4% formalin and stored in small plastic containers with proper label, for observation of egg-masses. The root system of each plant was chopped and out of this, one gram was stained with lacto-phenol acid fuchsine. The egg masses present in it were counted through a stereoscopic microscope. Similarly 250 cc of soil were collected from each pots by following passive methods include filtration, decanting and sieving techniques. Paddy varieties or germplasms were categorized as per the 0-5 gall index given below.

3. Result and Discussion

From the experiment, out of 110 paddy varieties 9 varieties namely Abhisek, FR-13-A, Vanaprava, Manik, Pratikhya, BBSR Local-2, BAS-63, Udaya, Keshari were found moderately resistant, 45 susceptible and remaining 56 highly susceptible varieties. The common varieties like Narendra, Rudra, Vandana, BAS12, Rajeswari, CR-1014, Lunishree etc were showing susceptible. Most of the popular varieties of Odisha namely Hanseswari, Pratap, Birupa, Jaganath, Khandagiri, Udayagiri, Lalat, Sonalika etc. were highly susceptible to the nematode.

The measurable effects of nematode infection on various plant growth parameters like shoot height, root length, fresh & dry weight of both shoot and root were observed. Formation of giant cells inside galls in the roots of all resistant, susceptible & highly susceptible plants has shown reduction in fresh shoot weight and root weight of the susceptible rice cultivars which was different from the other resistant varieties. Disease potential and intensity of infection caused by the nematode results improper nutrient uptake, disturbance in water & elements flow and alteration in physiological as well as biochemical metabolic activities of plant.

Decrease in shoot height and root length of susceptible varieties like Naveen, CR-1014, Swarna sub-1, Panidhan were measured 47.1 cm-16.9 cm, 53.1 cm-15.1 cm 58.5 cm-18.7 cm, 50.7 cm-17.6 cm respectively. There were singnificant reduction in fresh weights of both shoot & root due to nematode sever infestation observed in varieties like Lalat, Pooja, Samalei, Surendra were 13.1g-4.0 g, 13.6 g-3.6 g, 15.0 g-3.0 g, 15.2 g-1.8 g respectively. The above experiment follows review literatures such as Getanjali *et al* (2007) [4] screened 8 varieties for resistance against *M. graminicola* and Anil Prashar *et al* (2004) [11] clearly demonstrated that the severity of *M. graminicola* to rice increases with increase of water stress, hence the important of using rice cultivars that are tolerant to water stress could be resistant to nematode.

Table 3: Screening and Evaluation of some common paddy cultivars against rice root-knot nematode *Meloidogyne graminicola* (Average of three replication)

Sl. No.	Varieties	Shoot length (cm)	Root length (cm)	Fresh shoot weight (g)	Fresh root weight (g)	Dry shoot weight (g)	Dry root weight (g)	RKI 0-5 scale	Reaction	Final population* in 250 cc soil
1.	Chandrama	44.3	11.6	15.4	3.2	3.7	0.23	5	HS	2.82
2.	Narendra	46.8	12.1	16.7	3.4	3.9	0.27	4	S	2.84
3.	Ajaya	38.6	10.3	12.8	2.8	2.6	0.18	5	HS	3.02
4.	Hanseswari	41.9	9.6	15.2	2.3	3.4	0.12	5	HS	3.21
5.	Sankar	37.5	12.8	11.7	2.6	2.5	0.16	5	HS	2.84
6.	Pratap	33.2	18.3	10.9	4.9	2.1	0.31	5	HS	2.73
7.	Abhisek	51.9	16.5	15.0	4.7	3.4	0.30	2	MR	0.90
8.	Fr-13-a	46.5	14.8	11.2	3.8	2.5	0.29	2	MR	1.00
9.	Beena	37.1	15.1	11.6	3.9	2.6	0.29	5	HS	2.76
10.	Asutosh	29.6	13.0	9.3	2.7	2.1	0.08	5	HS	2.65
11.	Konark	30.3	17.7	9.8	4.2	2.4	0.27	5	HS	2.93
12.	Gajapati	41.8	16.5	15.1	3.9	3.5	0.17	5	HS	2.94
13.	Supriya	40.6	18.0	14.6	4.6	3.3	0.30	5	HS	3.11
14.	Birupa	28.3	17.9	9.1	4.3	2.1	0.29	5	HS	2.60
15.	Neela	27.1	15.6	8.8	3.9	2.7	0.26	5	HS	3.20
16.	Lalitgiri	26.9	15.3	8.6	3.1	0.3	0.24	5	HS	3.54
17.	Vanaprava	69.3	22.3	22.0	5.3	4.9	0.76	2	MR	0.77
18.	Naveen	47.1	16.9	16.0	3.3	3.4	0.25	4	S	2.44

19.	Sarathi	37.5	18.0	14.2	4.2	3.1	0.29	5	HS	3.87
20.	Kharvel	33.0	19.1	13.1	4.4	2.9	0.30	5	HS	1.58
21.	Bas-63	64.1	18.7	20.7	4.1	3.7	0.29	2	MR	1.29
22.	Pooja	36.8	16.8	13.6	3.6	3.0	0.22	5	HS	2.65
23.	Manik	71.6	24.8	23.1	5.8	5.4	0.81	2	MR	1.04
24.	Gayatri	42.9	17.3	15.6	3.9	3.1	0.24	4	S	2.01
25.	Annanya	34.3	14.1	13.2	2.5	2.9	0.12	5	HS	2.76
26.	Samanta	43.7	13.2	15.9	2.2	3.2	0.11	4	S	2.00
27.	Kalinga-3	39.2	9.5	15.1	0.8	3.0	0.03	5	HS	2.68
28.	Khitish	37.5	17.4	14.2	4.3	2.8	0.30	5	HS	2.73
29.	Rudra	51.2	16.8	21.8	3.9	4.0	0.24	4	S	1.95
30.	Indira	30.9	15.0	12.8	3.3	2.7	0.21	5	HS	2.51
31.	Suphala	33.1	12.3	13.6	2.7	2.9	0.14	5	HS	3.52
32.	Vandana	49.1	13.1	17.0	2.8	3.3	0.14	4	S	2.00
33.	Jaganath	36.6	14.6	14.6	3.1	3.1	0.24	5	HS	3.75
34.	Pathara	34.7	15.1	12.1	3.3	2.7	0.25	5	HS	4.01
35.	Utkalprava	27.9	19.2	9.4	4.9	0.5	0.34	5	HS	3.76
36.	Daya	50.8	22.1	22.0	5.1	4.6	0.37	4	S	2.11
37.	Varshadhan	35.1	13.8	14.2	2.7	3.3	0.15	5	HS	3.61
38.	Tulsi	24.6	16.2	7.1	3.1	0.3	0.23	5	HS	2.15
39.	Anjali	37.1	17.5	14.0	3.2	2.4	0.23	5	HS	2.65
40.	Bas-12	62.1	20.1	18.4	5.1	4.1	0.41	4	S	2.76
41.	Durga	41.2	18.0	14.8	4.5	2.6	0.34	5	HS	2.51
42.	Udayagiri	40.4	13.4	14.2	2.3	1.9	0.13	5	HS	2.12
43.	Tapaswini	39.3	8.5	13.9	0.6	0.4	0.02	5	HS	2.53
44.	Bhubaneswar local-1	63.2	21.6	15.2	4.6	3.7	0.32	4	S	2.28
45.	Savitri	53.2	10.6	22.2	1.1	0.7	0.04	4	S	3.24
46.	Sonalika	37.0	14.9	14.6	2.3	2.1	0.12	5	HS	2.21
47.	Khandagiri	33.9	18.1	14.4	4.2	3.4	0.33	5	HS	2.53
48.	Tara	50.6	17.3	21.2	3.9	3.2	0.32	4	S	2.75
49.	Kalinga-1	37.5	16.9	14.1	3.2	2.9	0.29	5	HS	2.59
50.	Rajeswari	48.9	17.1	17.2	3.4	3.0	0.30	4	S	2.74
51.	Pratikhya	47.3	14.9	16.7	2.6	2.8	0.14	2	MR	1.11
52.	Rajalaxmi	39.1	15.6	14.6	2.9	2.7	0.15	5	HS	3.01
53.	Lalat	55.3	14.3	13.1	4.0	3.1	0.27	5	HS	3.88
54.	Lalat mas	38.4	18.3	14.7	4.3	4.1	0.28	5	HS	2.14
55.	Sidhanta	33.2	17.1	13.3	4.0	3.9	0.27	5	HS	2.75
56.	Mahalaxmi	34.6	13.9	13.8	2.6	2.8	0.16	5	HS	2.51
57.	Anjana	29.5	8.8	9.7	0.7	0.7	0.03	5	HS	3.88
58.	Kanchan	30.9	10.7	10.1	1.2	1.0	0.07	5	HS	2.92
59.	Lunishree	49.1	13.5	17.8	2.2	3.9	0.11	4	S	2.24
60.	Radhi	31.4	19.6	12.1	4.7	1.3	0.05	5	HS	2.59
61.	Keshari	47.7	11.5	16.1	1.6	4.0	0.08	2	MR	1.15
62.	Satabdi	31.2	17.2	12.3	4.4	1.2	0.35	5	HS	3.30
63.	Bas-63	48.6	18.3	17.4	4.7	3.7	0.36	4	S	2.28
64.	Padma	33.3	17.2	12.2	4.3	1.4	0.32	5	HS	2.56
65.	Bas-56	50.3	16.7	19.6	3.9	4.5	0.30	4	S	1.20
66.	Cr-1014	53.1	15.1	20.9	3.2	4.7	0.27	4	S	1.21
67.	Heera	49.6	13.0	18.4	2.3	4.0	0.12	4	S	1.10
68.	Bas-18	30.9	18.8	12.2	4.3	2.2	0.31	5	HS	1.84
69.	Panidhan	50.7	17.6	17.9	4.1	3.4	0.30	4	S	1.19
70.	Moti	31.7	16.1	14.2	3.9	2.7	0.28	5	HS	2.95
71.	Indravati	51.8	12.6	20.8	1.9	4.4	0.06	4	S	1.61
72.	Nuakalajeera	53.6	9.9	15.8	0.8	3.3	0.02	4	S	1.46
73.	Swarna sub-1	58.5	18.7	17.6	4.1	3.5	0.29	4	S	1.11
74.	Mahanadi	33.2	10.8	13.2	1.4	2.7	0.04	5	HS	2.64
75.	Urvashi	37.8	16.4	13.7	3.8	2.7	0.14	5	HS	3.21
76.	Dharitri	39.5	17.1	14.4	4.0	2.9	0.24	5	HS	3.17
77.	Dhalaheera	33.3	18.3	13.2	4.1	2.7	0.24	5	HS	2.36
78.	Upahar	38.9	14.6	14.6	3.1	3.0	0.26	5	HS	3.24
79.	Samalei	40.1	14.2	15.0	3.0	3.1	0.25	5	HS	2.68
80.	Ramachandi	50.9	11.9	18.1	1.2	4.3	0.04	4	S	1.33
81.	Parijat	42.6	18.6	15.4	4.5	3.1	0.33	5	HS	2.77
82.	Jogesh	49.8	17.5	17.3	4.4	3.6	0.33	4	S	1.58
83.	Udaya	51.2	16.7	15.6	3.9	3.2	0.30	2	MR	1.17
84.	Saktiman	43.5	15.5	15.9	3.4	3.3	0.28	5	HS	2.32
85.	Arnnapoorna	40.9	12.9	14.8	2.7	3.1	0.14	5	HS	2.12

86.	Surendra	41.2	11.7	15.2	1.8	3.2	0.05	5	HS	2.65
87.	Ratna	39.8	17.3	14.0	4.1	2.7	0.35	5	HS	3.49
88.	Saket-4	48.3	9.7	17.4	0.8	3.6	0.02	4	S	1.56
89.	Bhoi	45.6	17.4	15.2	4.2	2.7	0.37	4	S	1.33
90.	Bhubaneswar local-2	46.7	16.8	15.9	3.7	2.8	0.28	2	MR	1.30
91.	Rambha	37.9	11.5	14.4	1.4	2.6	0.03	5	HS	2.75
92.	Nuadhusara	39.3	12.7	14.6	1.7	2.6	0.04	5	HS	2.24
93.	Bhubaneswar local-3	40.1	17.3	15.3	4.0	2.8	0.34	5	HS	2.75
94.	Gouri	42.6	14.6	15.8	3.2	2.7	0.27	5	HS	1.98
95.	Annand	43.3	18.2	15.6	4.6	2.6	0.37	5	HS	2.14
96.	Keakijoha	38.1	12.0	13.9	2.2	1.1	0.09	5	HS	1.91
97.	Bhabani	39.0	10.9	14.1	1.7	2.2	0.05	5	HS	2.57
98.	Prachi	40.6	18.6	15.1	4.3	2.7	0.34	5	HS	2.76
99.	Bhubana	53.1	14.9	20.3	3.1	4.1	0.30	4	S	1.07
100.	Kalani	46.1	17.0	15.6	3.9	3.1	0.28	4	S	1.01
101.	Sarasa	42.5	16.7	14.7	3.7	2.9	0.29	5	HS	2.15
102.	Golak	41.3	14.3	14.0	2.4	2.0	0.14	5	HS	2.43
103.	Samba Mashoori	44.1	17.5	14.9	3.1	2.7	0.21	4	S	1.34
104.	Tejaswini-mas	39.5	16.1	13.1	2.9	1.9	0.12	5	HS	2.15
105.	Badami	37.8	15.9	12.6	2.4	1.4	0.11	4	S	1.24
106.	Hema	33.6	20.2	11.9	4.8	1.0	0.37	4	S	1.22
107.	Mrunalini	35.1	17.1	13.7	4.2	1.7	0.33	4	S	1.23
108.	Pradeep	29.2	11.8	10.1	1.3	0.7	0.04	5	HS	2.84
109.	Manaswini	33.6	12.3	12.6	1.7	1.4	0.05	5	HS	2.37
110.	Hasanta	39.1	16.4	14.1	2.8	2.6	0.12	5	HS	2.39
	SE(m)	0.55	0.43	0.43	0.16	0.17	0.34	0.53		1.54
	CD(0.05)	2.11	2.06	0.91	0.64	0.34	0.18	0.12		4.52

*log transformed values

4. Conclusion
From the present investigation, finding resistant donors which can play a strong source for induction of resistance in paddy cultivars against the rice root-knot nematode in integrated nematode management practices. There was significant reduction in shoot growth parameters like shoot length, fresh & dry shoot weights of different commonly used paddy cultivars, due to nematode infestation. Similarly, significant decrease of root growth parameters in highly susceptible cultivars were higher than resistant cultivars. The nematode population in 10 g root samples and 250 cc soil samples were calculated. The effect of varietal differences in root gall index and susceptibility were also found to be significant. The nine moderately resistant varieties could be an effective eco-friendly low cost paddy cultivars for farmers field in nematode prone areas in various nematode management approaches.

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