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Response of different rice genotypes against rice root-knot nematode, *Meloidogyne graminicola* under screen house condition

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Abstract
The present study was carried out in screen house of the Department of Nematology, CCS Haryana Agricultural University, Hisar during *kharif* season, 2023. In present investigations, 46 rice genotypes (basmati & non-basmati) evaluated under DSR condition against *M. graminicola.* Seeds of each genotype were sown in the earthen pots (2 kg soil capacity) containing steam sterilized sandy loam soil and inoculated with freshly hatched second stage juveniles of *M. graminicola* @ 2000 J2/pot. Forty-five days after inoculation, observations were recorded on various nematode multiplication parameters. The result clearly revealed that all the genotypes showed varying degree of reaction against *M. graminicola.* Among basmati (22) group seven genotypes (Noori-Bas, HB-1, PB-1718, PB-1885, PB-1637, HKR-03-408, CSR-90) moderately resistant reaction against *M. graminicola.* Minimum number of galls and eggmasses were obtained in PB-1718, PB-1885, HKR-03-408 having 29 &23, 34.67 & 23.67 and 33 & 23.67, respectively. Among non-basmati (24) group two genotypes (PR-130 and PR-106) showed resistant and eight (HKR-127, HKR-18-24, ASP-407, Jaya, HKR-16-1, IR-64, HKR-17-33, HKR-16-35) genotypes were moderately resistant against M. graminicola. Minimum number of galls and eggmasses were obtained in PR-130 and PR-106 having 31.67 &19.67 and 29.67 &19.67, respectively. Maximum number of galls & eggmasses/plant was observed in Pusa 1121 (102.33 & 82.67). Remaining genotypes were either susceptible or highly susceptible reaction against *M. graminicola* including local susceptible check (Pusa 1121).

Keywords: Genotypes, *Meloidogyne graminicola,* reaction, direct seeded rice, screening

Introduction
Rice (*Oryza sativa* L.) is a staple food crop for more than half of the world's population and plays a vital role in global food security (Anon., 2025a) [1]. In India, 1490.74 million tonnes of rice is produced annually on an area of 47.83 million hectares (DA&FW, 2025). In recent years, Direct Seeded Rice (DSR) cultivation has gained attention as an alternative to conventional puddled transplanted rice due to its advantages in saving water, reducing labour requirements, and allowing timely sowing (Gill *et al*., 2014; Kaur and Singh 2017) [7, 9]. Currently, about 23% of the world's rice is produced using direct seeding methods (Rao *et al*., 2007) [16]. The government is actively promoting the shift from traditional puddled transplanting to DSR in states like Haryana and Punjab to address region-specific challenges such as labor shortages and groundwater depletion, respectively. In Haryana, a subsidy-based scheme was launched in 2021 with a target of 20,000 acres, and by 2024, the area under DSR increased to 3.02 lakh acres, showing a continuous upward trend (Anon., 2025b) [2]. However, the shift towards DSR has also altered the pest and disease dynamics in rice ecosystems, making certain soil-borne pathogens and nematodes more prominent (Singh *et al*., 2016; Kumar *et al*., 2024) [18, 10]. Among these, the rice root-knot nematode (*Meloidogyne graminicola*) has emerged as a serious constraint to rice production in both traditional and non-traditional areas. This obligate sedentary endoparasite infects roots, inducing gall formation, impairing nutrient uptake, and ultimately causing significant yield losses. The problem is particularly severe in aerobic and water-limited conditions, such as those encountered in DSR systems, where the nematode completes its life cycle more efficiently compared to flooded conditions (Yung *et al*., 2023) [19]. But now, it has become a serious

and challenging problem in rice-producing areas, as the loss is more severe in DSR than in transplanted rice, due to the absence of flooded conditions in DSR. In India, *M. graminicola* has been found to cause yield losses upto 16-32 per cent in rainfed and upland rice (Prasad *et al.,* 2010) [15]. Management of *M. graminicola* is challenging due to its wide host range (Mann *et al.,* 2024) [13], survival in the absence of rice, and limited effectiveness of chemical control measures. The use of resistant or tolerant genotypes is considered one of the most sustainable and eco-friendly approaches to mitigate nematode damage. Screening DSR genotypes for their response to *M. graminicola* can provide valuable information for breeding programmes and integrated nematode management strategies. The present study was undertaken to evaluate the reaction of selected DSR genotypes against *M. graminicola*, with the aim of identifying potential sources of resistance or tolerance that could be incorporated into future varietal development programmes.

Material and Methods

In present investigations, of 46 rice genotypes (basmati & non-basmati) along with Pusa 1121 as standard check were evaluated for resistant against rice root-knot nematode, *M. graminicola* under screen house conditions, in the Department of Nematology, CCS HAU, Hisar during *kharif* 2023.

Preparation of pure culture of rice root-knot nematode, *M. graminicola*

For the inoculation, pure culture of *M. graminicola* was maintained on rice variety Pusa 1121 & PB-1509 (locally available susceptible) in screen house conditions of Department of Nematology, CCS HAU, Hisar, Haryana. Pure cultures were raised in screen house in 5 kg soil capacity earthen pots filled with steam sterilized sandy loam soil. Rice seeds soaked overnight were sown in pots. Second stage juveniles (J2) of *M. graminicola* were obtained from eggs from the pure culture which was maintained in the screen house; the seedlings of rice in pots were inoculated with these J2. The cultures were allowed to multiply for 4-5 generations and used in screening experiment for inoculation in pots under screen house conditions.

Collection of rice genotypes

Forty-six rice genotypes (basmati & non-basmati), including rice variety Pusa 1121 as standard check obtained from Rice Research Station, Kaul (Haryana) for experimental purpose. Statistical design was complete randomized design (CRD). Seeds of the test genotypes were sown in two kg soil capacity earthen pots filled with steam-sterilized sandy loam soil. One week after germination, one plant was retained per pot and each plant was inoculated with 2,000 freshly hatched J2 of *M. graminicola*. Forty-five days after inoculation, plants were carefully uprooted, and root systems were gently washed under running tap water to remove adhering soil particles and recorded the observations on various nematode multiplication parameters. The genotypes were categorized (eggmass index) as resistant, moderately resistant, susceptible and highly susceptible for confirmation as per standard protocols by AICRP, Nematodes (Table 1).

$$\text{Eggmass Index} = \frac{\text{No. of egg masses per plant in tested variety} \times 4}{\text{No. of egg masses per plant in standard variety (susceptible check)}}$$

Table 1: Rice root-knot nematode scale for categorization of rice genotypes

Eggmass Index	Reaction
0-1.0	Resistant (R)
1.1-2.0	Moderately resistance (MR)
2.1-3.0	Susceptible (S)
3.1 and above	Highly susceptible (HS)

Results and discussion

Forty-six rice genotypes were evaluated for resistant against *M. graminicola* under screen house conditions during *kharif* 2023 and data is presented in Table 2&3. The result clearly indicated that the rice genotypes showed greater variation in response to *M. graminicola* from resistant to highly susceptible. Out of 46 genotypes of rice screened, among basmati (22) group seven genotypes (Noori-Bas, HB-1, PB-1718, PB-1885, PB-1637, HKR-03-408, CSR-90) moderately resistant reaction against *M. graminicola.* Remaining genotypes were either susceptible or highly susceptible reaction against rice root-knot nematode (Plate B). Minimum number of galls (Fig. 1) and eggmasses were obtained in PB-1718, PB-1885, HKR-03-408 having 29 &23, 34.67 & 23.67 and 33 & 23.67, respectively. Maximum number of galls and eggmasses was observed in Pusa-1121 (102.33 & 82.67) followed by PB-7 (89.67 &74) and PB-1401 (84 & 70). Among non-basmati (24) group two genotypes (PR-130 and PR-106) showed resistant and eight (HKR-127, HKR-18-24, ASP-407, Jaya, HKR-16-1, IR-64, HKR-17-33, HKR-16-35) genotypes were moderately resistant against *M. graminicola* while rest of the genotypes showed either susceptible or highly susceptible reaction including local susceptible check (Pusa 1121). Minimum number of galls (Fig. 5) and eggmasses were obtained in PR-130 and PR-106 having 31.67 &19.67 and 29.67 &19.67, respectively. Maximum number of galls & eggmasses was observed in Pusa-1121 (102.33 & 82.67) followed by PR-113 (75.67 & 61.67). The eggmaas index also found maximum in Pusa-1121 (4.00) followed by PR-113 (2.98). The remaining genotypes exhibited either susceptible or highly susceptible responses to the rice root-knot nematode. Out of 12 commonly cultivated Nepalese rice varieties, only two (Masuli and Chaite-6) were found moderate resistance to the *M. graminicola* (Sharma-Poudyal *et al.,* 2004) [17]. Similarly, the reaction of 50 basmati rice germplasms was observed by Gitanjali and Thakur in the year 2007, of which only one (Pusa 1637-18-7-6-20) was found resistant whereas, rest of germplasms susceptible or highly susceptible to *M. graminicola*. Out of 20 rice genotypes, only one genotype (KMP-179) was highly resistant towards rice root-knot nematode as reported by Narasimhamurthy and Ravindra in the year 2016.

Berliner *et al.* (2017) screened 414 rice cultivars in order to identify resistant source against *M. graminicola.* Only two entries cultivars, 127-28-1-1-1 & 183-6-1-1-3 were observed resistant. Similarly, Devaraja *et al*., (2017) [6] evaluated 33 rice genotypes against *M. graminicola*, of which NDR-97 exhibited showed highly resistant reaction in DSR method. Kumar *et al*., (2020) [12] evaluated 79 rice genotypes against *M. graminicola*, of which two genotypes (AR-08 and AR-31) were found resistant reaction. Results were also supported by Kumar *et al.* (2022) [11] who evaluated 47 rice genotypes against rice-root nematode under screen-house condition through artificial inoculation and reported Pusa 1121 as highly susceptible against *M. graminicola*, same results were observed in the present study. Das *et al.* (2025) [5] evaluated 57 rice genotypes and found all of them to be either susceptible or highly susceptible to *M. graminicola*.

Table 2: Reaction of rice varieties (Basmati) for resistance against *M. graminicola* (Mean of four replications)

Sr. no.	Rice varity Scented (Basmati)	Average no. of Eggmasses/plant	Egg mass index	Host Reaction
1	PB-1847	61.67	2.98	S
2	R-408	49.33	2.39	S
3	CSR-30	50.33	2.44	S
4	Noori-Bas	38.33	1.85	MR
5	Bas-370	52.33	2.53	S
6	PB-7	74.00	3.58	HS
7	HB-1	25.33	1.23	MR
8	PB-1	55.33	2.68	S
9	PB-1886	66.33	3.21	HS
10	PB-1692	60.67	2.94	S
11	HKR-15-488	45.67	2.21	S
12	PB-1718	23.00	1.11	MR
13	PB-1401	70.00	3.39	HS
14	PB-1885	23.67	1.15	MR
15	PB-1509	72.00	3.48	HS
16	Tur Bas	44.00	2.13	S
17	PB-1637	29.33	1.42	MR
18	HB-2	45.33	2.19	S
19	HKR-03-408	23.67	1.15	MR
20	CSR-89	44.00	2.13	S
21	CSR-90	24.33	1.18	MR
22	PB-1121 (susceptible check)	82.67	4.00	HS

HS =Highly Susceptible, S = Susceptible, MR= Moderately Resistant, R= Resistant INP: >1J2/gram soil, Date of sowing: 21 June, 2023; Date of termination: 24 August, 2023

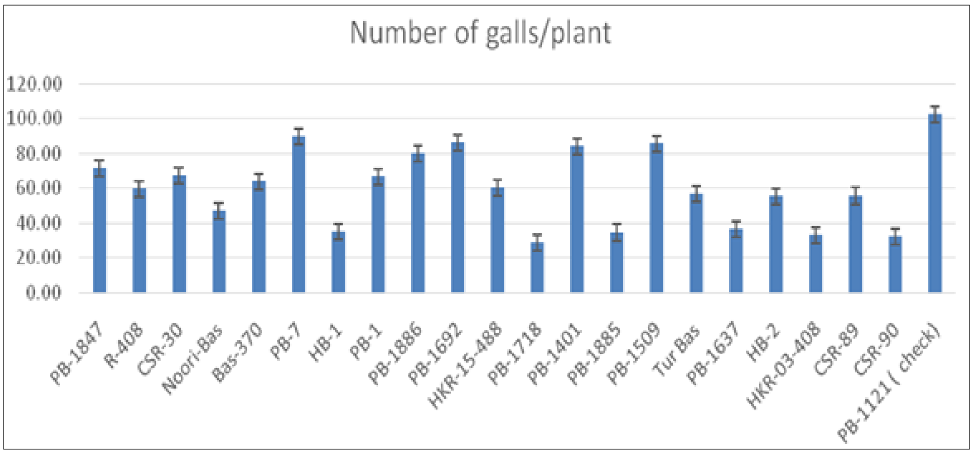

Fig 1: Variation in gall formation among different basmati-rice genotypes inoculated with *M. graminicola*

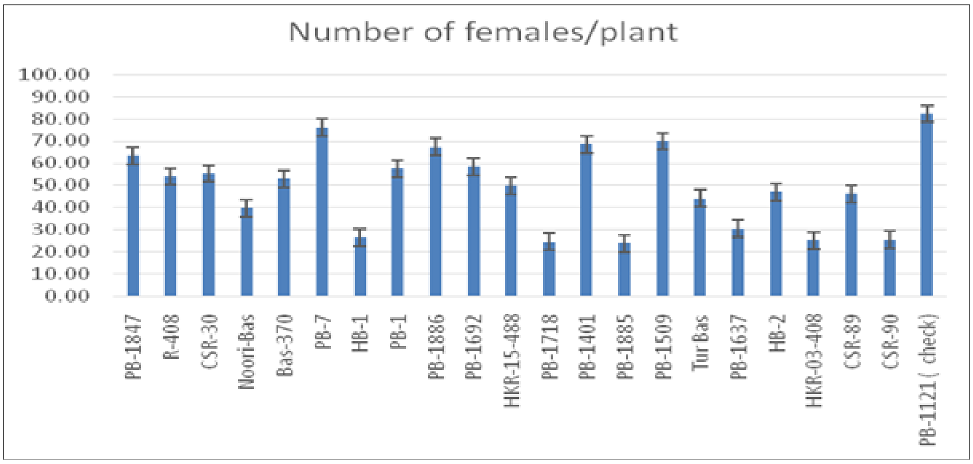

Fig 2: Variation in females per plant among different basmati-rice genotypes inoculated with *M. graminicola*

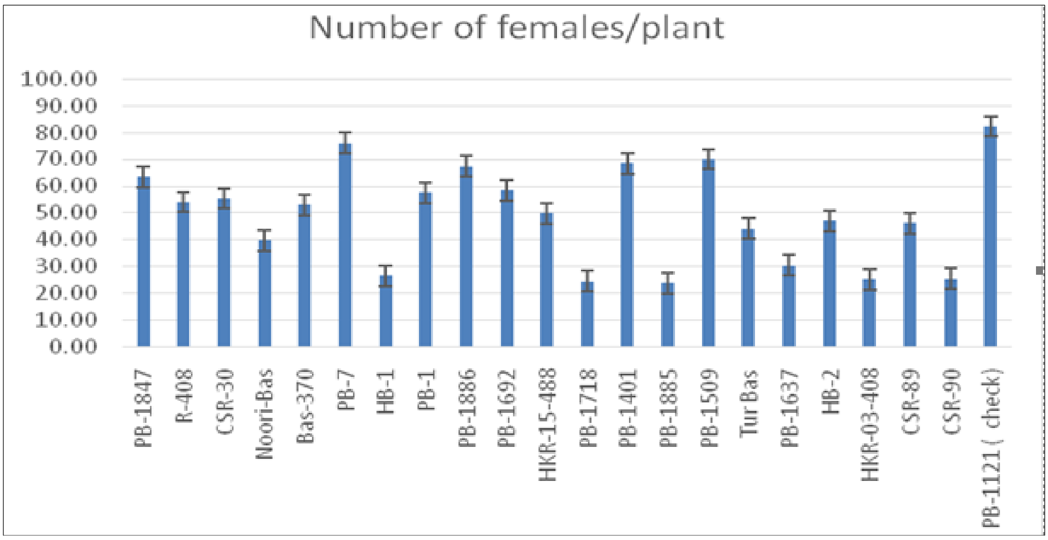

Fig 3: Variation in final nematode population among different basmati-rice genotypes inoculated with *M. graminicola*

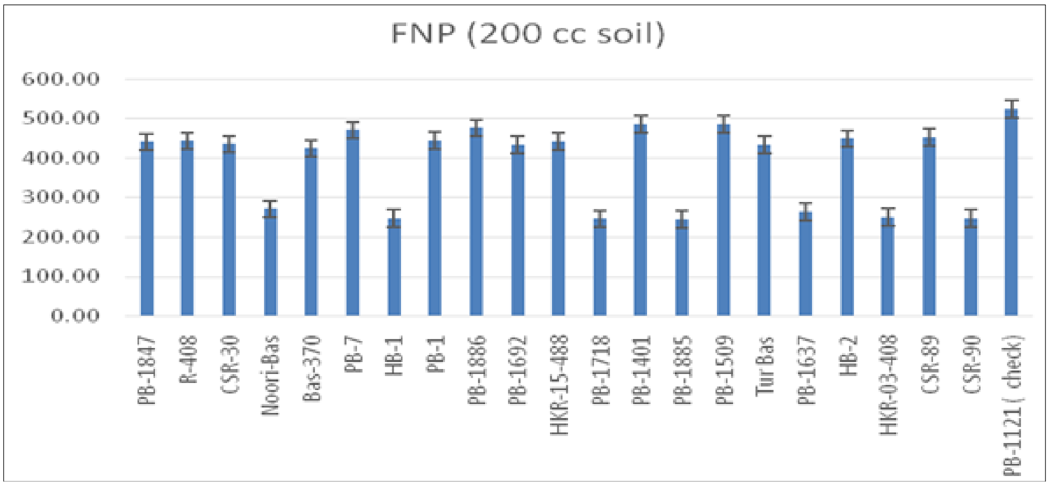

Fig 4: Variation in nematode eggs per plant among different basmati-rice genotypes inoculated with *M. graminicola*

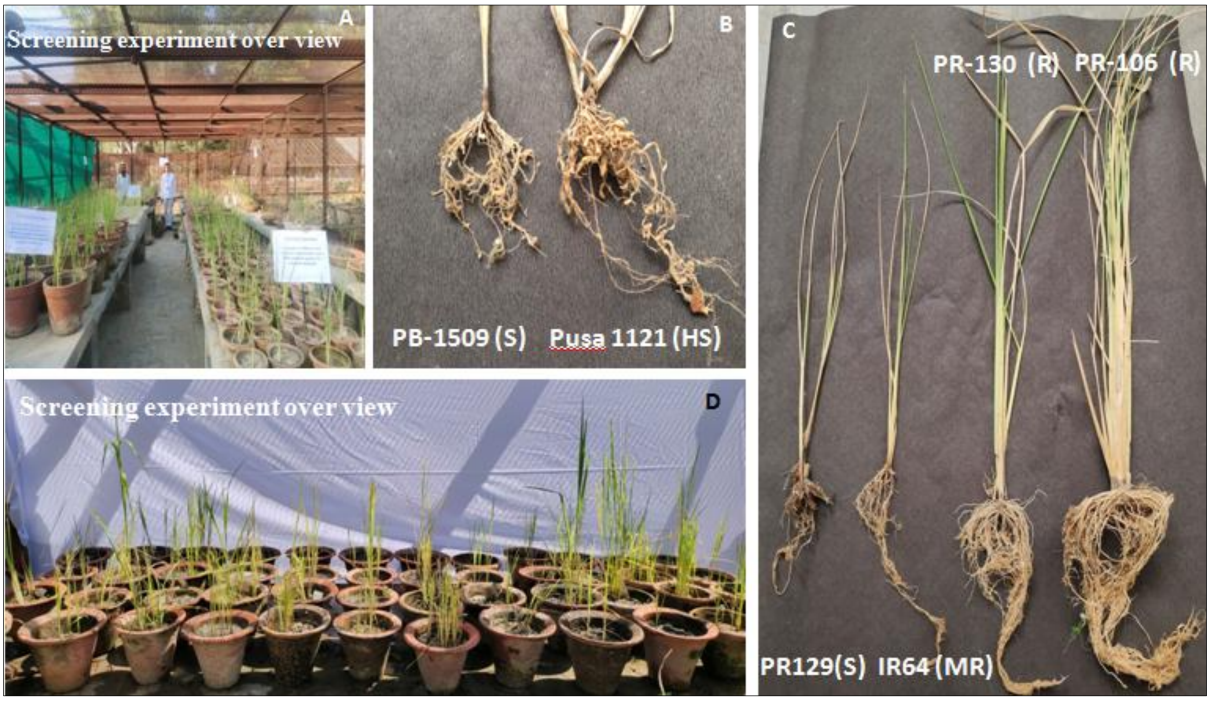

Table 3: Reaction of rice varieties (Permal group) for resistance against *M. graminicola*

(Mean of four replications)

Sr. no.	Rice varity non-scented (Permal group)	Average no. of Eggmasses/plant	Egg mass index	Host Reaction
23	HKR-127	24.33	1.18	MR
24	PR-114	44.33	2.15	S
25	PR-129	49.67	2.40	S
26	HKR 17-422	53.00	2.56	S
27	HKR-17-35	53.00	2.56	S
28	PR-130	19.67	0.95	R
29	HKR 15-32	48.00	2.32	S
30	HKR-18-24	28.00	1.35	MR
31	ASP-407	25.00	1.21	MR
32	PR-113	61.67	2.98	S
33	PR-131	53.00	2.56	S
34	HKR 16-58	55.00	2.66	S
35	HKR-48	50.00	2.42	S
36	Jaya	28.67	1.39	MR
37	HKR-128	44.33	2.15	S
38	HKR-16-1	25.33	1.23	MR
39	PR-128	43.67	2.11	S
40	HKR-47	45.33	2.19	S
41	Govind	45.00	2.18	S
42	IR-64	31.33	1.52	MR
43	HKR-17-424	47.00	2.27	S
44	HKR-17-33	27.67	1.34	MR
45	HKR-16-35	32.33	1.56	MR
46	PR-106	19.67	0.95	R
47	PB-1121 (susceptible check)	82.67	4.00	HS

HS =Highly Susceptible, S = Susceptible, MR= Moderately Resistant, R= Resistant INP: >1J2/gram soil, Date of sowing: 21 June, 2023; Date of termination : 24 August, 2023

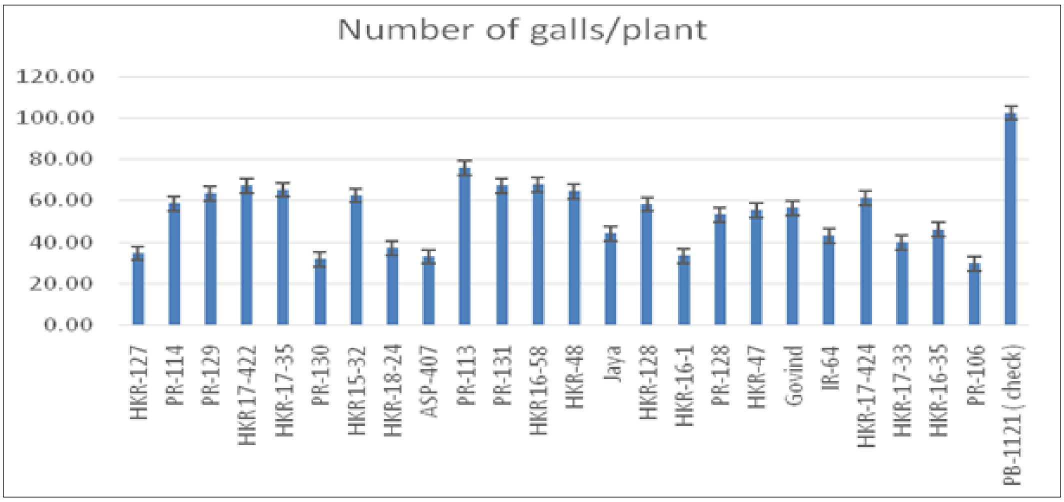

Fig 5: Variation in gall formation among different non- basmati rice genotypes inoculated with *M. graminicola*

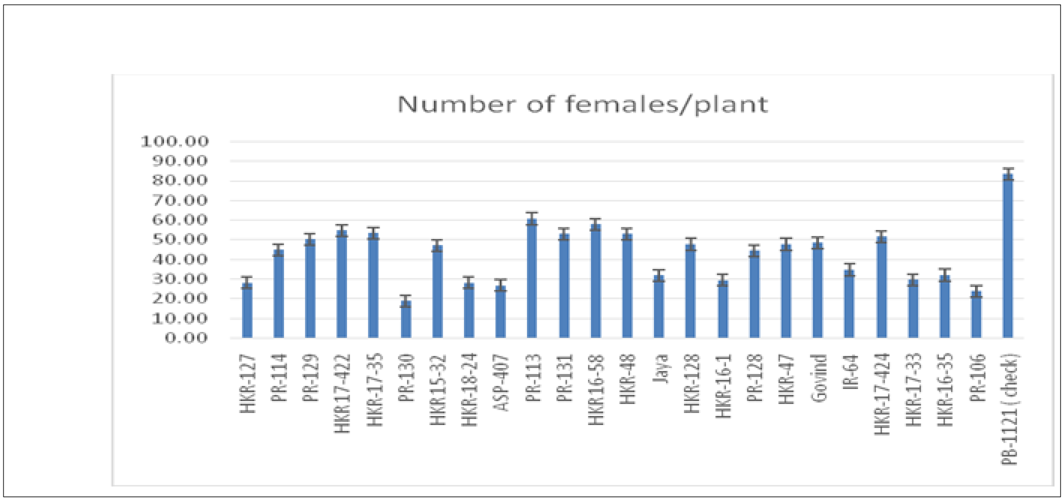

Fig 6: Variation in females per plant among different non- basmati rice genotypes inoculated with *M. graminicola*

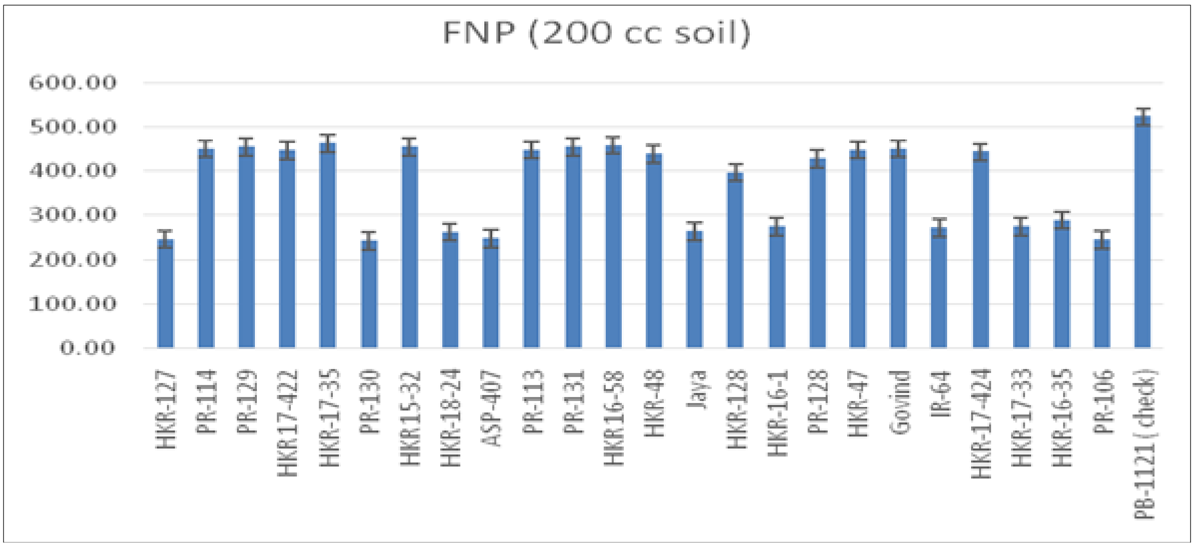

Fig. 7 Variation in final nematode population among different non- basmati rice genotypes inoculated with *M. graminicola*

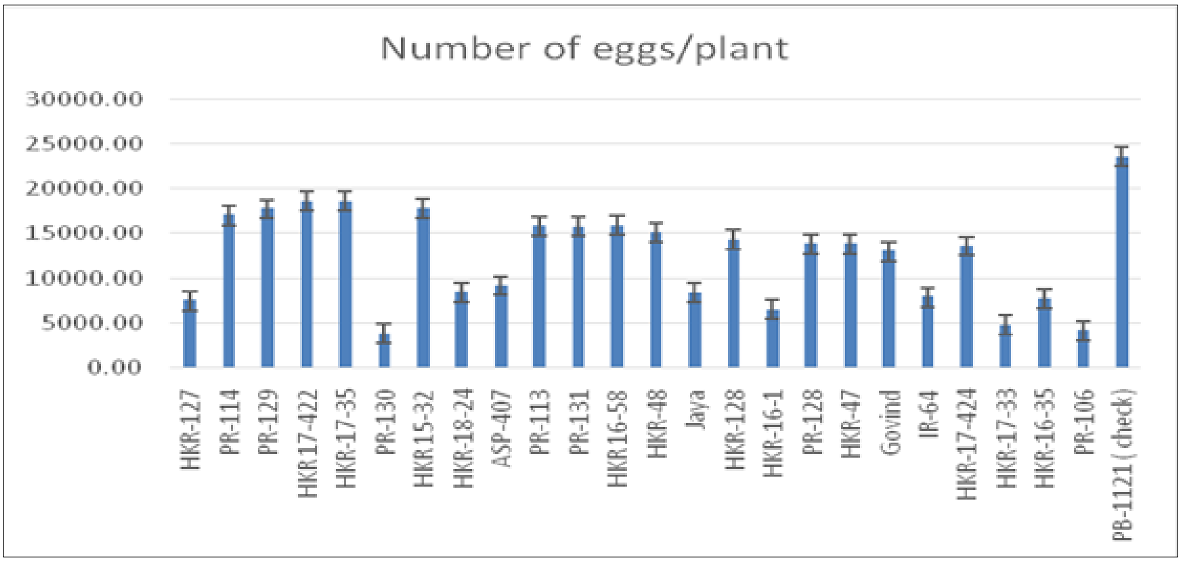

Fig 8: Variation in nematode eggs per plant among different non- basmati rice genotypes inoculated with *M. graminicola*

Conclusion

The finding of our present study revealed that significant different among rice genotypes under DSR condition in their reaction toward *M. graminicola.* A total of 46 genotypes of rice were screened, among basmati (22) group seven genotypes (Noori-Bas, HB-1, PB-1718, PB-1885, PB-1637, HKR-03-408, CSR-90) showed moderately resistant reaction against *M. graminicola.* Among non-basmati (24) group two genotypes (PR130 and PR106) showed resistant and eight (HKR-127, HKR-18-24, ASP-407, Jaya, HKR-16-1, IR-64, HKR-17-33, HKR-16-35) genotypes were moderately resistant against *M. graminicola.* Overall basmati genotypes are more susceptible as compare to non-basmati against *M. graminicola.* These genotypes suffered less damage by *M. graminicola* as compared to susceptible or highly susceptible genotypes. Furthermore, these genotypes can be used in future breeding programmes for introduction of nematode resistant varieties. Based on our study, it is suggested that farmers grow the varieties/genotypes found to be resistant or moderately resistant, so that they can benefit to some extent in areas of Haryana affected by rice root-knot nematode.

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