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Full Length Research Article

Screening of *Vigna radiata* Against Root Knot Nematode *M. incognita* in Greenhouse Conditions

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ABSTRACT

Plant-parasitic nematodes are pest that antagonistically influences the production from one side of the planet to the other, principally in India. *Meloidogyne incognita* is one of which antagonistically influences *Vigna radiata*. Consequently, the destinations of this experiment were to decide the viability of nematode pervasion upon the *V. radiata* and to screen out the safe and defenseless genotypes of *V. radiata*. For this study, seeds of fifteen genotypes were shown in clay pots, with uninoculated (healthy) and inoculated (2000 J2s of *M. incognita*) sets. Every arrangement was watered and kept up with until the end of the experiment. Out of fifteen genotypes of *V. radiata* none of them were found immune to the *M. incognita* pervasion, however, PDM-139 was observed highly resistant with 1.92 number of galls development. Nine were moderately resistant, three were respectably moderately susceptible and just one was highly susceptible with 103.30 quantities of galls development. It was found that highly resistant showed the higher growth and yield.

***Key words*:** *Vigna radiata, Meloidogyne incognita,* Screening, Resistance, Susceptible

Meloidogyne species, the most detrimental genera of root-knot nematode on our cropping results into an estimated US $ 100 billion loss worldwide an annual basis [1]. Root-knot nematode distributed worldwide and is an obligate parasite of hundreds of plant species. However, more than eighty species of *Meloidogyne* have been described, of which *M. incognita* (Kofoid and White) Chitwood, *M. javanica* (Treub) Chitwood and *M. arenaria* (Neal) Chitwood are extremely polyphagous, apomictic species, these are found throughout the world, typically in tropical and subtropical areas but are also present in more temperate areas especially in protected cultivation [2]. This may be the reason behind considered among the most prevalent economic crop pests [3,4] as well as the most destructive and devastating important crop pests. Root-knot nematodes cause quite different morphological and anatomical results in different plants and within the different parts of the plant, two or more species can show different responses in an individual plant [5]. The symptoms caused by nematode infection in the plant may be severe stunting, chlorosis, wilting and drooping of leaves, delay in flowering, fruit formation and yield aggregation of nutrition deficiency and retardation of growing point of shoot and root system. As the chemical treatment in the form of pesticides are quite effective but may be proved as hazardous to the human being as well as animals also, so organic and biological treatments will help the farmers to cope up with the effects of chemicals. This is not only eco-friendly but also the economic option for the management of nematode's effect on the host crops.

Vigna radiata (L.) Wilzeck is commonly known as green gram or mungbean. This is one of the best options of protein-rich pulse in the Indian subcontinent as well as some other Asian and South-East Asian countries. Though India is the largest pulse producing country in the world but imports heavy amounts of pulses every year to fulfill the requirements of its population. This import of pulses can be reduced by increasing pulse production, best disease management practices and awaking the farmers about various types of plant pathogens and its effect on their crops, which is one of the big reasons behind low production. Usually, root-knot nematode e.g. *M. incognita* alters the metabolic processes of the host plant, these alternations can be evidenced by the help of cellular, physiological and biochemical transmutes that occupy in the host. Transmute of morphology and physiology of host plants caused by root-knot nematode is measurable[6]. Yellowing of leaves and stunt plant growth are some consequences of nematode infection. A wide host range of root-knot nematode decreases the effectiveness of crop rotation. The chemical amendments are beneficial but hazardous to farmers and the environment. Instead of this, they are so costly that a poor farmer cannot bear, sometimes market supply affected. According to Sasser [7], the roots of resistant plants were hard to invade as rapid as susceptible plants. Therefore, revolutionary steps like high yielding resistant genotypes, best

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disease management practices and use of eco-friendly organic manure, etc. can be proved as beneficial in avoiding losses caused by plant pathogens like root-knot nematode *M. incognita*.
This inspection was carried out as safe screening of fifteen of the most commonly grown genotypes of *V. radiata* (L.) Wilzeck of some North Indian states against root-knot nematode *M. incognita* (Kofoid and White) Chitwood under greenhouse conditions to suggest the immune, highly resistant and moderately resistant genotypes for the suppression of root-knot nematode *M. incognita* (Kofoid and White) in eco-friendly management practices.

MATERIALS AND METHODS

To conduct this experiment seeds of nine on genotypes were collected from IIPR, Kanpur, three genotypes from IARI, New Delhi and three genotypes from local seed sellers, Aligarh. These seeds were the first surface sterilized with the help of 0.1% $HgCl_2$ than rinsed with tap water followed by drying on blotting sheets until water absorbed before the sowing.

Egg masses of *M. incognita* were collected from a pure culture that already maintained on roots of susceptible brinjal plants in the Department of Botany A.M.U. Aligarh. These were incubated in distilled water at 28°C, after hatching second-stage juveniles (J2) were obtained and maintained for inoculation of *V. radiata* genotypes.

Clay pots of 20 and 12 cm diameter at top and bottom respectively were sterilized after filling the sandy loam soil with sand and organic manure in the ratio of 3:1:1 @ 4 Kg /pot at 121°C and 15 lb pressure for 30 minutes. Seeds were sown in these pots @ 4-5 seeds /pot after a single day gap. After germination seedlings were thinned out and a single plantlet was left in each pot with five replicates in each case i.e., five inoculated and five uninoculated (uninoculated as control). One week later, these seedlings of *V. radiata* were inoculated with freshly hatched J2 larvae of root-knot nematode *M. incognita* @ 2000 J2/pot by removing soil near to the stem up to roots exposition. The crop was examined every day until harvested. Seven-week after the inoculation, screening of *V. radiata* genotypes for resistance and susceptibility against root-knot nematode *M. incognita* was completed after gently uprooting of the crop. Nematode reproduction parameters like number of egg masses, number of eggs per egg mass, number of galls and root-knot index [8] and final nematode population. Growth and yield parameters were also taken during this study were shoot length, root length, fresh weight, dry weight, number of pods per plant, weight of 100 seeds and number of seeds per pod. Calculation of parameters like growth and yield parameters viz. plant length in terms of shoot and root, fresh and dry weight of shoot, fresh and dry weight of root, number of pods per plant, weight of 100 seeds and number of seeds per pod; pathological parameters viz. number of egg masses per plant, number of egg per egg mass, number of galls, nematode population and root-knot index and physiochemical parameters viz. total chlorophyll content, carotenoid content and protein content in fresh leaves.

Growth and yield parameters

Plant growth and yield parameters were evaluated in terms of plant length, fresh weight and dry weight of shoot and root combined with the number of pods, weight of 100 dried seeds and number of seeds per pod. Plant from each case was taken out from the pots and soil particles adhering to roots were eliminated by washing with the running water and labeled well. Shoot and root length were measured by measuring tape, fresh and dry weight of plants and weight of 100 seeds were measured with the help of electronic balance (WENSAR ISO 9001 CERTIFIED) in the laboratory. For dry weight measurement, plants from each case were wrapped in blotting sheets, labeled and dried in a hot air oven running at 60°C for 24-48 hours. The number of pods and number of seeds per pod were counted manually.

The percentage increase and decrease in parameters over control were calculated by the following formula [9].

$$\%\ \text{Increase or decrease} = \frac{\text{Uninoculated value} - \text{Inoculated value}}{\text{Uninoculated value}} \times 100$$

ANOVA, Duncan's Multiple Range Test and SPSS 12.00 software (SPSS Inc., Chicago, IL, USA) were conducted to compare the analysis at C.D. at P=0.05 level. Pearson correlation and multiple linear regression analysis were also performed to found relationships between the parameters.

Physiological parameters

Arnon's [10] method was used for the estimation of chlorophyll content for which 1.0 gm finely cut fresh leaves of test samples were homogenized in a mortar in the presence of a sufficient quantity of 80% acetone. The obtained extract was centrifuged at 5000 RPM for 5 minutes then supernatant collected in the volumetric flask. The process was repeated three times and each time supernatant was collected in the same volumetric flask, the final volume was made up to 10 ml by adding 80% acetone and kept at 4 ^{0}C overnight in dark. The absorbance was observed at the wavelength of 645 nm and 663 nm against a blank (80% acetone) on a spectrophotometer (UV 1700, Shimadzu, Japan). The final chlorophyll content (per gram fresh leaves) in the sample was measured by using the equations given below:

$$\text{Total chlorophyll content (mg g}^{-1}) = 20.2(A\,645) + 8.02\,(A663) \times \frac{V}{1000} \times W$$

Where;
A645 = absorbance at 645 nm
A663 = absorbance at 663 nm
V = volume of solution (taken in Cuvette)
W = weight of leaf tissue used for extraction of pigments i.e., 1gm

Carotenoid content

Henery and Price [11] technique was used for the estimation of total carotenoid in the leaf extract after taking the absorbance at 480, 645 and 663 nm wavelength against the blank on the spectrophotometer.

$$\text{Total carotenoids (mg per gram of fresh leaf tissue)} = \frac{(A480+(0.114\times A663) - (0.638 - A645)) \times V}{1000} \times W$$

Here;
A= Absorbance at specific wavelengths
V= Final volume of leaf extract in 80% acetone
W= Fresh weight of leaf tissue, used for extraction

Protein estimation

Estimation of protein done by the process of the Lowry method [12].

Nematode related parameters

Eggs and eggs masses

The egg masses were counted following the procedure of Daykin and Hussey [13]. The roots were dipped in Phloxine B solution (0.015%) for 20 min and were then washed with running tap water to remove the residual Phloxine B. The egg masses stained a pink-red color whereas the roots remain colorless or stain lightly. The numbers of eggs/egg mass were determined by randomly selecting 10 Control uniform size egg masses from each root system and shaking in 1% NaOCl solution for 3 min. The egg suspension was then sieved through 200 and 500 mesh (75 and 26 µm) with gentle tap water to remove the debris on the first sieve and collecting the eggs on the second one [14]. Released eggs were collected in 50 ml water suspension and numbers of eggs were counted in 1 ml with the help of a light microscope under low power (10X). The average number of eggs/egg mass was calculated. Galls formation on plant roots easily observable and countable with the necked eyes in case of moderately susceptible and susceptible genotypes while in other cases counted by using a dissecting microscope.

Nematode population

The final nematode population in the soil was measured by the process of Decanting and sieve or Cobb's Method [15-16].

Root-knot index

The degree of root-knot nematode infection was recorded according to the root-knot index given by Taylor and Sasser [8] as under (Table 1).

Table 1 Root-knot index scale [8]

Root-knot index	Number of galls/root system	Reactions
0	0	Immune
1	1-2	Highly resistant
2	3-10	Moderately resistant
3	11-30	Moderately susceptible
4	31-100	susceptible
5	>100	Highly susceptible

Table 2 Reaction of *Vigna radiata* genotypes against root-knot nematode meloidogyne incognita

S. No.	Reactions based on root-knot index	Genotypes
1	Immune	None
2	Highly Resistant	PDM-139
3	Moderately Resistant	Krishna 8, Pusha Ratna, Pusha Vishal, Avasthi, Varsha, HUM-16, HUM-12, HUM-1 and SML 668.
4	Moderately Susceptible	TMV-37, IPM-02-03 and IPM-2-14
5	Susceptible	KM-2241 and
6	Highly Susceptible	RMG 62

Table 3 Evaluation of growth parameters after the root-knot nematode *Meloidogyne incognita* infestation on the different varieties of *Vigna radiata*

Genotype / Varieties	Treatments	Shoot length	Root length	Total plant length	% Reduction over control	Fresh weight of shoot	Fresh weight of root	Total Fresh weight	% Reduction over control	Dry weight of shoot	Dry weight of root	Total dry weight	% Reduction over control
SAMRAT	Control	38.55^{a}	14.85^{a}	53.40^{a}	8.05	20.6^{a}	2.11^{a}	22.71^{a}	7.22	4.66^{a}	0.56^{a}	5.22^{a}	8.14
	Inoculated	35.40^{a}	13.70^{abc}	49.10^{abcd}		19.^{11abcd}	1.96^{abc}	21.07^{abcd}		4.28^{abcd}	0.51^{bc}	4.79^{abcd}	
KRISHNA 8	Control	38.06^{a}	14.60^{ab}	52.66^{a}	9.49	20.11^{ab}	2.01^{ab}	22.12^{ab}	9.36	4.67^{a}	0.53^{ab}	5.20^{ab}	9.23
	Inoculated	34.37^{bcde}	13.29^{bcde}	47.66^{bcde}		18.22^{cdef}	1.83^{bcde}	20.05^{cdef}		4.24^{bcd}	0.48^{cde}	4.72^{cde}	
PUSHA RATNA	Control	37.89^{ab}	14.65^{a}	52.54^{a}	12.85	20.12^{ab}	1.97^{abc}	22.09^{ab}	10.548	4.65^{ab}	0.48^{cde}	5.13^{abc}	11.69
	Inoculated	33.12^{def}	12.67^{cdef}	45.79^{cdef}		18.00^{defg}	1.76^{defg}	19.76^{defg}		4.10^{cde}	0.43^{fgh}	4.53^{defg}	
PUSHA VISHAL	Control	37.88^{ab}	14.41^{ab}	52.29^{ab}	13.12	19.89^{abc}	1.89^{bcd}	21.78^{abc}	10.744	4.46^{abc}	0.46^{def}	4.92^{abcd}	12.19
	Inoculated	32.98^{def}	12.45^{def}	45.43^{cdef}		17.77^{defgh}	1.67^{efgh}	19.44^{defgh}		3.91^{def}	0.41^{ghij}	4.32^{efgh}	
AVASTHI	Control	37.49^{ab}	14.39^{ab}	51.88^{ab}	13.47	19.07^{abcd}	1.90^{bcd}	20.97^{abcd}	10.92	4.40^{abc}	0.42^{fghi}	4.82^{abcd}	12.86
	Inoculated	32.55^{def}	12.34^{efg}	44.89^{cdef}		17.01^{efghi}	1.67^{efgh}	18.68^{efghi}		3.83^{efg}	0.37^{jk}	4.20^{ghij}	
VARSHA	Control	37.43^{ab}	14.42^{ab}	51.85^{ab}	14.08	18.97^{abcd}	1.92^{bcd}	20.89^{abcd}	11.68	4.42^{abc}	0.48^{fghi}	4.90^{abcd}	13.45
	Inoculated	32.34^{defg}	12.21^{efg}	44.55^{def}		16.78^{fghi}	1.67^{efgh}	18.45^{fghij}		3.82efg	0.42^{fghi}	4.24^{fghi}	
HUM-16	Control	37.21^{ab}	14.07^{ab}	51.28^{ab}	14.84	18.92^{abcd}	1.87^{bcd}	20.79^{abcd}	13.083	4.36^{abc}	0.44^{efg}	4.80^{abcd}	13.75
	Inoculated	32.00^{efg}	11.67^{fgh}	43.67^{efg}		16.45^{ghij}	1.62^{fgh}	18.07^{ghijk}		3.76^{efgh}	0.38^{ij}	4.14^{ghijk}	
HUM-12	Control	37.06^{abc}	13.99^{ab}	51.05^{ab}	15.29	18.86^{abcd}	1.81^{cde}	20.67^{bcd}	14.37	4.45^{abc}	0.46^{def}	4.91^{abcd}	15.48
	Inoculated	31.69^{efg}	11.55^{fgh}	43.24^{efg}		16.14^{hij}	1.56^{h}	17.70^{hijk}		3.76^{efgh}	0.39^{hij}	4.15^{ghijk}	
HUM-1	Control	36.66^{abc}	13.96^{abc}	50.62^{ab}	15.59	18.77^{bcd}	1.83^{bcde}	20.60^{bcd}	14.72	4.32^{abc}	0.49^{bcd}	4.81^{abcd}	16.01
	Inoculated	31.23^{efg}	11.50^{fgh}	42.73^{fg}		16.00^{ij}	1.57^{h}	17.57^{hijk}		3.63^{fgh}	0.41^{ghij}	4.04^{hijk}	
SML 668	Control	36.87^{abc}	13.91^{abc}	50.78^{ab}	16.69	18.93^{abcd}	1.79^{cdef}	20.72^{bcd}	14.87	4.34^{abc}	0.48^{cde}	4.82^{abcd}	16.59
	Inoculated	31.00^{efg}	11.30^{ghi}	42.30^{fg}		16.11^{hij}	1.53^{h}	17.64^{hijk}		3.62^{fgh}	0.40^{ghij}	4.02^{hijk}	
TMV-37	Control	36.91^{abc}	13.94^{abc}	50.85^{ab}	16.93	18.67^{bcde}	1.88^{bcd}	20.55^{bcde}	15.43	4.15^{cde}	0.51^{bc}	4.66^{def}	17.17
	Inoculated	31.01^{efg}	11.23^{ghi}	42.24^{fg}		15.78^{ij}	1.60^{gh}	17.38^{ijk}		3.44^{gh}	0.42^{ghij}	3.86^{ijk}	
IPM-2-14	Control	36.64^{abc}	14.22^{ab}	50.86^{ab}	18.38	17.96^{defg}	1.93^{bcd}	19.89^{defg}	16.59	4.13^{cde}	0.43^{fgh}	4.56^{defg}	17.76
	Inoculated	30.07^{fgh}	11.44^{fgh}	41.51^{fg}		14.96^{j}	1.63^{fgh}	16.59^{jk}		3.41^{h}	0.34^{kl}	3.75^{k}	
IPM-02-03	Control	35.67^{abcd}	13.62^{abcd}	49.29^{abc}	19.09	17.87^{defg}	1.94^{abcd}	19.81^{defg}	17.31	4.35^{abc}	0.41^{ghij}	4.76^{bcde}	20.79
	Inoculated	29.00^{gh}	10.88^{hi}	39.88^{gh}		14.78^{j}	1.60^{gh}	16.38^{k}		3.45^{gh}	0.32^{l}	3.77^{jk}	
KM-2241	Control	35.56^{abcd}	13.80^{abc}	49.36^{abc}	24.62	16.13^{hij}	1.96^{abc}	18.09^{ghijk}	21.67	4.31^{abcd}	0.43^{fgh}	4.74^{cde}	21.10
	Inoculated	27.08^{h}	10.13^{i}	37.21^{h}		12.61^{k}	1.56^{h}	14.17^{l}		3.41^{h}	0.33^{l}	3.74^{k}	
RMG62	Control	33.67^{cde}	13.79^{abc}	47.46^{bcde}	40.37	14.99^{j}	1.86^{bcd}	16.85^{ijk}	39.59	4.09^{cde}	0.42^{fghi}	4.51^{defg}	35.03
	Inoculated	20.26^{i}	8.04^{j}	28.30^{i}		9.03^{l}	1.15^{i}	10.18^{m}		2.66^{i}	0.27^{m}	2.93^{l}	

Values are means of five replicates

Values in each column followed by the same letters are not significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$)

RESULTS AND DISCUSSION

Effect of nematode infections on plant growth parameters

Screening experiment revealed that the minimum and maximum reduction in average shoot length found in PDM-139 (8.17%) and RMG-62 (39.83%) genotypes of *V. radiata* respectively. Similarly, minimum and maximum reduction in average root length found in PDM-139 (7.74%) and RMG-62 (41.69%) genotypes. Total plant length also reduced in similar manner by 8.05% and 40.37% of PDM-139 and RMG-62 respectively. The minimum and maximum reduction in total fresh weight found in PDM-139 (7.22%) and RMG-62 (39.59%) respectively. Similarly, minimum and maximum reduction in total dry weights of found in PDM-139 (8.14%) and RMG-62 (35.03%) respectively (Table 3).

Table 4 Evaluation of the yield and physiological parameters after the infestation caused by root-knot nematode *Meloidogyne incognita* on fifteen genotypes of *Vigna radiata*

Genotype / varieties	Treatments	Total chlorophyll	Carotenoids	Proteins (mg/gm)
SAMRAT	Healthy	2.11[a]	0.37[a]	5.24[a]
	Inoculated	1.96[abcde]	0.34[bcd]	4.81[abcde]
KRISHNA 8	Healthy	2.07[ab]	0.36[ab]	5.20[ab]
	Inoculated	1.88[cdefg]	0.33[cd]	4.71[bcdef]
PUSHA RATNA	Healthy	2.08[ab]	0.36[ab]	5.23[a]
	Inoculated	1.87[cdefg]	0.32[de]	4.72[bcdef]
PUSHA VISHAL	Healthy	2.00[abc]	0.34[bcd]	5.16[ab]
	Inoculated	1.76[fgh]	0.30[efg]	4.55[cdefg]
AWASTHI	Healthy	1.98[abcd]	0.33[cd]	5.16[ab]
	Inoculated	1.71[ghij]	0.29[fgh]	4.50[defg]
VARSHA	Healthy	2.01[abc]	0.34[bcd]	5.11[ab]
	Inoculated	1.73[fghi]	0.29[fgh]	4.43[efg]
HUM-16	Healthy	1.91[bcdef]	0.32[de]	5.08[ab]
	Inoculated	1.64[hijk]	0.27[hij]	4.39[efg]
HUM-12	Healthy	1.88[cdefg]	0.33[cd]	5.10[ab]
	Inoculated	1.58[ijk]	0.27[hij]	4.40[efg]
HUM-1	Healthy	1.89[cdefg]	0.32[de]	5.19[ab]
	Inoculated	1.56[jk]	0.26[ijk]	4.45[efg]
SML 668	Healthy	1.89[cdefg]	0.35[abc]	5.13[ab]
	Inoculated	1.51[kl]	0.28[ghi]	4.34[efgh]
TMV-37	Healthy	1.91[bcdef]	0.31[def]	5.10[ab]
	Inoculated	1.49[kl]	0.25[jkl]	4.30[fgh]
IPM-2-14	Healthy	1.87[cdefg]	0.29[fgh]	5.12[ab]
	Inoculated	1.48[kl]	0.23[lm]	4.23[gh]
IPM-02-03	Healthy	1.97[abcde]	0.30[efg]	5.06[ab]
	Inoculated	1.53[kl]	0.24[kl]	4.15[gh]
KM-2241	Healthy	1.79[efgh]	0.27[hij]	4.98[abc]
	Inoculated	1.37[l]	0.21[m]	3.91[h]
RMG62	Healthy	1.81[defgh]	0.25[jkl]	4.92[abcd]
	Inoculated	0.92[m]	0.13[n]	2.67[i]

*Values are means of five replicates

Values in each column followed by the same letters are not significantly different according to Duncan's Multiple Range Test (P≤0.05)

Physiological parameters

The screening experiment also shows the variation in physiological parameters like total chlorophyll content, total carotenoid content and protein content in the fresh leaves of *V. radiata* after the inoculation of 2000 J2 of *M. incognita*. Minimum percentage reduction in total chlorophyll content, total carotenoid content and protein content compares to control one was found in PDM-139 genotype as 7.10, 8.108 and 8.21 percent respectively but the maximum percentage change found in RMG62 genotype as 49.17, 48.00 and 45.73 percent respectively (Table 4).

Nematode related parameters

The number of egg masses per plant and the number of eggs per egg mass are unnoticed in control sets of all genotypes but their concentration found vary in number from genotype to genotype. The minimum number of egg masses and number of eggs per egg mass found in the PDM-139 genotype of *V. radiata* that is 6 and 9 respectively. This is followed by other genotypes like moderately resistant, moderately susceptible and highly susceptible to *V. radiata*. The maximum number of egg masses per plant and number of eggs per egg mass was found in the case of RMG62 genotype that is 132 and 159 respectively (Table 5). There was no gall formation noticed in control sets of all genotypes of *V. radiata* but in nematode inoculated plant @ 2000 J2, galls were noticed. The galls were smaller and almost inconspicuous on the roots of the highly resistant genotype of *V. radiata* viz. PDM-139 genotype. Galls were easily observed in moderately resistant, moderately susceptible and susceptible genotypes viz Pusha Ratna, Pusha Vishal, HUM 16, HUM 12, HUM 1, IPM KM and RMG62. Their number is varied from genotype to genotype that is minimum number of gall formation was find in case of PDM 139 (0.98) genotype of *V. radiata* while maximum number of gall formation was observed in case of highly susceptible genotype of *V. radiata* that is RMG 62 (8.54) (Table 5).

The Minimum average population of *M. incognita* (1,960) was retrieved from the soil of pots in which highly resistant genotype of *V. radiata* were shown that is PDM-139 genotype which was followed by other moderately resistant, moderately susceptible, susceptible genotypes and highly susceptible genotype. The highest average population of *M. incognita* (17,078) was retrieved from the pots in which RMG62 genotype. Gradually increase in the value of Reproduction Factor (Rf) was found from highly resistant genotype to highly susceptible genotype. This variation in nematode population and Rf value may be due to the varying in interaction in the host plant (Table 5).

Table 5 Reproduction of the root-knot nematode *Meloidogyne incognita* on fifteen varieties of *Vigna radiata*

Genotype / Varieties	Treatments	No of egg masses	No. of eggs / egg mass	No. of galls	Reproduction factors (Rf)	Root knot index	Final nematode population
SAMRAT	Control	-	-	-			-
	Inoculated	6.00^{m}	9.00^{l}	2.00^{ij}	0.98^{j}	1^{e}	1960^{i}
KRISHNA 8	Control	-	-	-			-
	Inoculated	9.00^{m}	24.00^{k}	4.00^{hi}	1.26^{i}	2^{d}	2510^{i}
PUSHA RATNA	Control	-	-	-			-
	Inoculated	14.60^{l}	26.40^{jk}	5.60^{gh}	2.21^{h}	2^{d}	4,410^{h}
PUSHA VISHAL	Control	-	-	-			-
	Inoculated	19.40^{k}	30.00^{ij}	6.80^{fg}	3.21^{h}	2^{d}	6410^{g}
AWASTHI	Control	-	-	-			-
	Inoculated	24.00^{j}	31.40^{i}	7.00^{fg}	3.60^{f}	2^{d}	7,200^{f}
VARSHA	Control	-	-	-			-
	Inoculated	29.40^{i}	33.00^{hi}	7.40^{fg}	3.77^{ef}	2^{d}	7,544^{ef}
HUM-16	Control	-	-	-			-
	Inoculated	32.20^{hi}	36.60^{gh}	9.00^{ef}	3.85^{ef}	2^{d}	7,700^{ef}
HUM-12	Control	-	-	-			-
	Inoculated	33.20^{gh}	39.20^{g}	10.20^{e}	3.87^{ef}	2^{d}	7,744^{ef}
HUM-1	Control	-	-	-			-
	Inoculated	35.80^{fg}	44.20^{f}	10.40^{e}	3.90^{ef}	2^{d}	7,800^{ef}
SML 668	Control	-	-	-			-
	Inoculated	38.40^{f}	52.20^{e}	10.60^{e}	3.96^{e}	2^{d}	7,910^{e}
TMV-37	Control	-	-	-			-
	Inoculated	51.20^{e}	61.80^{d}	13.00^{d}	5.11^{d}	3^{c}	10,220^{d}
IPM-2-14	Control	-	-	-			-
	Inoculated	55.80^{d}	65.00^{d}	14.00^{d}	5.31^{d}	3^{c}	10,620^{d}
IPM-02-03	Control	-	-	-			-
	Inoculated	79.20^{c}	87.00^{c}	25.80^{c}	6.02^{c}	3^{c}	12,040^{c}
KM-2241	Control	-	-	-			-
	Inoculated	95^{b}	98.00^{b}	68.00^{b}	7.14^{b}	4^{b}	14,280^{b}
RMG62	Control	-	-	-			-
	Inoculated	132^{a}	159.00^{a}	103.20^{a}	8.54^{a}	5^{a}	17,078^{a}

Values are means of five replicates
Values in each column followed by the same letters are not significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$)

Present study was the exhibition of screening of fifteen genotypes of *V. radiata* against the *M. incognita*. Screening of them was done according to the root-knot index scale (Taylor and Sasser 1978). On this premise, no genotype is found immune to *M. incognita* infestation. Single genotype (PDM-139) is found profoundly safe (highly resistant) due to 2.00 galls development, nine genotypes found reasonably safe (modestly susceptible) in view of on a normal 4.00-10.60 number of galls arrangement, three were tolerably helpless (modestly susceptible) due to on a normal 13.00-25.80 number of galls arrangement, one found defenseless (susceptible) and one exceptionally powerless or highly susceptible (RMG 62) on account of more than 103.20 number of galls arrangement.

M. incognita infestation unfavorably influences the length and weight of the plant. Physiological parameters like total chlorophyll, carotenoids and proteins content additionally antagonistically influenced after the immunization. But, level of adequacy of *M. incognita* infestation is differing in each set [17]. In case of PDM-139, percent decrease in total plant length; fresh weight and dry weight were 8.05, 7.22 and 8.14 percent respectively. Similar results were found on various crops by several researchers [18-21]. But this distinction is high in case of highly susceptible genotype (RMG 62) of *V. radiata*, here it rose to 40.37, 39.59, 35.03 percent respectively. The physiological parameters like total chlorophyll, carotenoids and protein content additionally showed the huge decreases contrast with their healthy ones [22-23] and in PDM-139 these findings were 1.96, 0.34 and 4.81 percent respectively; same boundaries were diminished to 0.92, 0.13 and 2.67 percent individually in RMG 62 (highly susceptible). The variations in the findings among healthy and inoculated plant are because of *M. incognita* pervasions [24]. The impact of pervasion if there should be an occurrence of exceptionally healthy is least contrast with the remainder of the genotypes so decrease in the different parameters was less. However, in case of highly susceptible genotype it was high so the decrease in the parameters findings was high. *M. incognita* connected on the root arrangement of host plant and burst or disfigured the cells which are responsible for the conduction of water and supplements [25]. Researchers also saw that contaminated cells go through to hypertrophy and impeded the course of conductions [26].

CONCLUSION

From this study it is concluded that screening of *V. radiata* against *M. incognita* in green house conditions exhibited that none of the fifteen genotypes immune to the *M. incognita* infestations. Ten genotypes showed resistant, these were highly resistant (PDM-139) or moderately resistant (Krisna 8, Pusha Ratna, Pusha Vishal, Avasthi, Varsha, HUM-16, HUM-12, HUM-1 and SML 668). Futher, five genotype fallen under the susceptible, these were moderately susceptible (TMV-37, IPM-02-03 and IPM-2-14), susceptible (KM-2241) or highly susceptible (RMG 62). PDM-139 is awesome for the soil tainted by *M. incognita* and can be proposed for famers after further study.

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