Screening, confirmation and field evaluation of promising resistant germplasm of different pulses against root knot nematode, *Meloidogyne javanica*

A. Kumar, J.A. Patil*, S. Yadav and S. Ram

Department of Nematology, College of Agriculture, CCSHAU, Hisar-125 004, India

*Corresponding Author Email : rajhau99@gmail.com

Paper received: 13.06.2020

Revised received: 03.10.2020

Accepted: 30.10.2020

Abstract

Aim: Experiment conducted in the microplots infested with the root knot nematode, *Meloidogyne javanica* against the germplasm of the chickpea, pigeon pea, mungbean and urdbean.

Methodology: In this study, 71 genotypes of chickpea, 30 genotypes of pigeon pea, 14 genotypes of mungbean and 12 genotypes of urdbean were screened for their reaction to root-knot nematode, *M. javanica* in infested microplots. Initial nematode population was recorded. Various germplasms of pulses were sown in microplots. The plants were maintained as per the standard agronomic practices. All the germplasm were assessed to determine gall index.

Results: Seventy one genotypes of chickpea were screened against *M. javanica*, among them 19 were highly resistant, 8 resistant and 12 were found to be moderately resistant. Out of 30 genotypes of pigeon pea, 19 were highly resistant, 2 were resistant and 3 were moderately resistant to the root-knot nematode. Fourteen genotypes of mungbean screened against *M. javanica*, none of the germplasm was found resistant, however, four genotypes showed moderately resistant reaction.

Interpretation: It may be concluded that several types of reaction were observed in screened germplasm of pulse viz., highly susceptible, susceptible, moderately resistant and resistant. These types of reaction may be due to different genotypic content of the germplasms.

Key words: Gall index, *Meloidogyne javanica*, Nematode, Pulses, Resistance

How to cite : Kumar, A., J.A. Patil, S. Yadav and S. Ram: Screening, confirmation and field evaluation of promising resistant germplasm of different pulses against root knot nematode, *Meloidogyne javanica*. *J. Environ. Biol.*, **41**, 1594-1598 (2020).

Introduction

The word “pulses” commonly known as chickpea, pigeon pea, mungbean and urbean is today a household word. Pulses are the richest source of plant protein and play a vital role in the diet of vegetarians. India is a major pulse growing country of the world, sharing 35-36% area and 27-28% production (Anonymous, 2018). They have emerged as the most important crop group cultivated by humans since ancient times. They have become very important in our daily diet. Indian farmers grow a variety of pulse crops under a wide range of agro-climatic conditions and is recognized globally as a major player in pulses. The production of pulses is not satisfactory due to attacks of several plant parasitic nematodes, such as *Meloidogyne javanica*, *Meloidogyne incognita*, *Rotylenchulus reniformis* and *Heterodera cajani*. Among these phytonematodes, root knot nematodes, *M. javanica*, an obligate sedentary endoparasite are considered as a silent threat to pulses because they are distributed throughout India. Severe economic losses up to 19 to 22% yield loss in chickpea, 17-23% in urbean and 14 to 29% in mungbean has been reported (Sasser, 1989; Anonymous, 2014; Kumar et al., 2020).

Various management practices are used to reduce the nematode population in infested fields, such as use of chemicals, biological control agents (Vagelas and Gowen, 2012; Patil et al., 2017, 2018), agronomic practices such as crop rotation and antagonistic crops (Kayani et al., 2012; Yadav and Kanwar, 2019). However, the use of chemicals is not effective because of high cost benefit ratio and pollution (Mukhtar et al., 2013). The rotation of resistant cultivars and non-host crops is very important to reduce the nematode population (Mukhtar et al., 2013). Host plant resistance has been raised as an economically viable and highly effective management practice that boost crop yield in the presence of nematode population densities that exceed the damage threshold (Castagnone-Sereno, 2002; Sharma et al., 2006). Even though resistance to root knot nematodes is available in several crop species, including *Pisum sativum* (Verma and Gupta, 1993; Kumar et al., 2019), new sources of resistance are needed to improve the level of root-knot resistance in chickpea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*), mung bean (*Vigna radiata*) and urbean (*Vigna mungo*). Very limited information on responses of pulses accession is imperative for effective management of rootknot nematodes in Haryana. Therefore, the current study was undertaken to evaluate the promising resistant germplasm of pulses against root-knot nematode (*M. javanica*) under field conditions in microplots.

Materials and Methods

Collection of germplasms : Seeds of 29 genotypes of chickpea, 14 genotypes of mungbean, 30 genotypes of pigeonpea, 12 genotypes of urbean, were procured from AICRP (Nematodes), New Delhi while 42 genotypes of chickpea were procured from

the department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana.

Screening of pulses germplasms : Experiment was conducted in microplots for screening germplasms of pulses in the field of department of Nematology. Initial nematode population was above ETL in microplots. During *Rabi* season 29 genotypes of chickpea, and in *Kharif* season, 30 genotypes of pigeon pea, 14 genotypes of mungbean and 12 genotypes of urbean were screened for their reaction to root-knot nematode. Seeds of pulses were sown in micro plots. The plants were maintained as per the standard agronomic practices. Ninety days after germination, the plants were uprooted gently from the microplots, and roots were carefully washed in running water.

Treatment detail : Given genotypes was used in the experiment viz., FYT -1, FYT -2, FYT -3, FYT -4, FYT -5, FYT -6, FYT -7, FYT -8, FYT -9, FYT -10, FYT -11, FYT -12, FYT -13, FYT -14, FYT -15, FYT -16, FYT -17, FYT -18, FYT -19, FYT -20, FYT -21, FYT -22, FYT -23, FYT -24, MLT-1-1, MLT-1-2, MLT-1-3, MLT-1-4, MLT-1-5, MLT-1-6, MLT-1-7, MLT-1-8, MLT-1-9, MLT-1-10, MLT-1-11, MLT-1-12, MLT-1-13, MLT-1-14, MLT-1-15, MLT-1-16, MLT-1-17, MLT-1-18, GAG-1107, Phule G 0408, Phule G 0405, GL-10023, BG-3044, BG 3043, GJG 1202, GJG 1209, Phule G 12110, Phule G 12107, KGD 2011-1, GL- 10006, BGD 1082, GJG 0831, BG 3046, GJG 1208, Phule G 0609-15, Phule G 12407, Phule G 12404, Phule G 0302, Phule G 0611, GJG 1205, GJG 1207, GAG 1107, Phule G 10114, GLK 10100, Phule G 12302, Phule G 12310, Phule G 08108

Data collection : The data on number of galls and egg masses were recorded. Roots from these plants were indexed for galling and egg mass presence on a scale from 1 to 5 (1.0 = no galls or egg masses, 2.0= 1-10 galls or egg masses, 3.0= 11-30, 4.0= 31-100 galls or egg masses and 5.0= Above 100 galls or egg masses (Anonymous, 1989).

Results and Discussion

The genotypes of chickpea could be divided into five categories based on the gall and egg masses. Out of 71 genotypes, 10 lines viz., FYT-7, FYT-20, FYT-22, MLT-1-13, MLT-1-17, MLT-1-18, GJG-1208, Phule G-12407, Phule G-0611 and GAG-1107 had minimum gall and they were categorized as resistant (Table 1). Nineteen were moderately resistant to root knot nematode while rest of the genotypes had maximum number of galls and they were categorized as susceptible or highly susceptible reaction to the root knot nematode. Among 30 genotypes of pigeonpea, 19 lines viz., BDN-2010-1, BDN-2011-1, KA-12-3, MA-6, MAL-13, PT-307-1, RVSA-07-10, RVSA-07-29, SKNP-1005, WRGE-97, PUSA-33, UPAS-120, GT-100, MANAK, PARAS, PUSA-855, BANAS, PUSA-991, ICPL-151 had no gall and they were categorized as highly resistant, 2 (GT-101 and TAT-10) had minimum gall and they were categorized as resistant

Table 1 : Preliminary screening of chickpea genotypes against *Meloidogyne javanica*

Name of genotype	Root-knot index	Reaction
FYT-1	4-5	HS
FYT-2	3-5	HS
FYT-3	3-5	HS
FYT-4	2-5	HS
FYT-5	3-5	HS
FYT-6	2-3	MR
FYT-7	1-2	R
FYT-8	1-3	MR
FYT-9	3-4	S
FYT-10	3-5	HS
FYT-11	2-3	MR
FYT-12	2-4	S
FYT-13	2-5	HS
FYT-14	5	HS
FYT-15	3-5	HS
FYT-16	2-3	MR
FYT-17	1-3	MR
FYT-18	4-5	HS
FYT-19	4-5	HS
FYT-20	1-2	R
FYT-21	2-3	MR
FYT-22	2	R
FYT-23	4-5	HS
FYT-24	5	HS
MLT-1-1	4-5	HS
MLT-1-2	4-5	HS
MLT-1-3	4-5	HS
MLT-1-4	3-5	HS
MLT-1-5	4-5	HS
MLT-1-6	3-4	S
MLT-1-7	3	MR
MLT-1-8	Did not germinate	
MLT-1-9	4-5	HS
MLT-1-10	3-4	S
MLT-1-11	2-3	MR
MLT-1-12	1-4	S
MLT-1-13	1-2	R
MLT-1-14	3	MR
MLT-1-15	4-5	HS
MLT-1-16	3-4	S
MLT-1-17	1-2	R
MLT-1-18	1-2	R
GAG-1107	2-3	MR
Phule G 0408	3	MR
Phule G 0405	3	MR
GL-10023	4	S
BG-3044	3-4	S
BG 3043	3-4	S
GJG 1202	2-3	MR
GJG 1209	4	S
Phule G 12110	4	S
Phule G 12107	3-4	S
KGD 2011-1	3-4	S
GL- 10006	3-4	S
BGD 1082	5	HS

GJG 0831	3	MR
BG 3046	4	S
GJG 1208	2	R
Phule G 0609-15	3-4	S
Phule G 12407	1-2	R
Phule G 12404	2-3	MR
Phule G 0302	2-3	MR
Phule G 0611	1-2	R
GJG 1205	2-3	MR
GJG 1207	3-4	S
GAG 1107	2	R
Phule G 10114	3	MR
GLK 10100	4	S
Phule G 12302	2-3	MR
Phule G 12310	3-4	S
Phule G 08108	3-4	S

S = Susceptible; HS = Highly susceptible; MR = Moderately resistant; R = Resistant and HR = Highly Resistant

and 3 were moderately resistant to root-knot nematode while rest of the genotypes had maximum number of galls and they were categorized as susceptible or highly susceptible reaction to root knot nematode (Table 2).

Out of 14 genotypes of mungbean screened against *M. javanica*, none was resistant to root -knot nematode *M. javanica*. However, four genotypes viz., RMG-1028, ML2333, MH810 and ML-818 had 11 to 30 numbers of galls per plant and categorized as a moderately resistant reaction (Table 3). Rest of the genotypes was either 31 to 100 or more than 100 galls per plant and categorized as a susceptible or highly susceptible reaction to the root knot nematode. None of the 12 genotypes of urdbean showed resistant reaction to *M. javanica*. Moreover, genotypes viz., 6DKU-11, KU-96-7, MU-44, NUL-7 and KUG-479 had 11 to 30 numbers of galls per plant and categorized as a moderately resistant reaction (Table 4). Rest of the genotypes were susceptible or highly susceptible reaction to root knot nematode.

Resistance is described as the ability of a plant to suppress root-knot nematode development and/or reproduction (Sasser, 1954; Hussain et al., 2014). While, a susceptible plant allows nematodes to reproduce freely in plants (Cook and Evans, 1987). In practice, resistance is a relative concept, derived through genotype comparisons and frequently an indication of level of resistance within a continuum of host nematode interactions. A highly resistant genotype supports little root-knot nematode reproduction whereas a partially resistant genotype supports an intermediate level of reproduction relative to susceptible genotype. The screening protocol used to identify root-knot nematode resistant breeding lines should be capable of readily and reliably evaluating thousands of genotypes encountered in a breeding programme (Boerma and Hussay, 1992).

Table 2 : Preliminary screening of pigeonpea germplasm against *Meloidogyne javanica*

Name of genotype	Root-knot index	Reaction
BDN-2004-1	1-4	S
BDN-2010-1	1	HR
BDN-2011-1	1	HR
KA-12-2	Did not germinate	-
KA-12-3	1	HR
MA-6	1	HR
MAL-13	1	HR
PT-257	Did not germinate	-
PT-307-1	1	HR
RVSA-07-10	1	HR
RVSA-07-22	1-3	MR
RVSA-07-29	1	HR
RVSA-07-31	1-4	S
SKNP-1005	1	HR
WRGE-97	1	HR
PUSA-33	1	HR
UPAS-120	1	HR
GT-101	1-2	R
PUSA-84	1-3	MR
TAT-10	1-2	R
TJT-501	Did not germinate	-
GT-100	1	HR
VAMBAN-1	Did not germinate	-
MANAK	1	HR
PARAS	1	HR
PUSA-855	1	HR
BANAS	1	HR
PUSA-2001	1-3	MR
PUSA-991	1	HR
ICPL-151	1	HR

S = Susceptible; HS = Highly susceptible; MR = Moderately resistant; R = Resistant and HR= Highly Resist

Resistance and susceptibility to plant parasitic nematodes reflect the effect of plant on the ability against plant parasitic nematodes and to their reproduce (Sharma *et al.*, 2006; Kumar *et al.*, 2019). Resistant and moderately resistant germplasm reduce nematode reproduction thereby directly affect the residual nematode reproduction factor under field conditions (Cook and Evans, 1987). Breeding programs for resistance to plant parasitic nematodes would be best served by selecting resistant genotypes based on root-knot index in preliminary evaluations, followed by selection based on nematode reproduction in advanced evaluations (Hussey and Janssen, 2004). Thus, resistance in plants is therefore an attractive approach for controlling nematode populations. There is clearly an imperative to develop new control strategies as current chemical compounds, used successfully for control, are being increasingly withdrawn for environmental reasons. There is also a greater need for improved, sustainable control in developing countries, to underpin food security, particularly for the rural poor.

Table 3 : Preliminary screening of mungbean genotypes against *Meloidogyne javanica*

Name of genotype	Root-knot index	Reaction
IPM-410-3	3-4	S
NVL-516	3-4	S
RMG-1028	3	MR
DGG-5	Did not germinate	
PUSA-1371	4	S
GM-11-02	4-5	HS
HUM-27	Did not germinate	
ML-2333	2-3	MR
MH-810	3	MR
Pusa-1472	4	S
SGC-20	Did not germinate	
MH-2-15	3-4	S
IPM-02-14	3-4	S
ML-818	3	MR

S = Susceptible; HS = Highly susceptible and MR = Moderately resistant

Table 4 : Preliminary screening of urdbean genotypes against *Meloidogyne javanica*

Name of genotype	Root-knot index	Reaction
PUNT-U-31	3-4	S
DKU-11	2-3	MR
NDUK-13-6	Did not germinate	
TU-67	3-4	S
KU-96-7	3	MR
MU-44	3	MR
KU-96-3	4	S
NUL-7	3	MR
VAMBAN-7	3-4	S
IPU-2-43	3-4	S
TU-94-2	Did not germinate	
KUG-479	3	MR

S = Susceptible; MR = moderately resistant

M. javanica showed different level of infection in terms of the gall and eggs masses in pulses genotypes. The present investigation concluded that the root knot nematode infestation in soil could be minimized to a greater extent by using moderately resistant cultivars. Therefore, these highly resistant and resistant genotypes can be used to select resistance genes for breeding programme to develop resistant varieties. Crop rotations with non host or resistant crop have great potential for management of root knot nematode in pulses.

Acknowledgment

The authors are highly obliged to the Project Coordinator, AICRP, Nematodes and Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar for providing germplasm and other required materials.

References

- Anonymous: Biennial Report (1987-1989). All India Coordinated Research Project on Plant Parasitic Nematodes with Integrated Approach of their control. Department of Nematology, HAU, Hisar, pp.35, (1989).
- Anonymous: Field guide of mungbean and urdbean. NCIPM, New Delhi, India (2011).
- Anonymous: Root knot nematodes in India- A Comprehensive Monograph. AICRP on Plant Parasitic Nematodes with Integrated Approach for their Control, IARI, New Delhi, India: **3**, (2014).
- Boerma, H.R. and R.S. Hussey: Breeding plants for resistance to nematodes. *J. Nemat.*, **24**, 242-252 (1992).
- Castagnone-Sereno, P.: Genetic variability in parthenogenetic root-knot nematodes, *Meloidogyne* spp., and their ability to overcome plant resistance genes. *Nemat.*, **4**, 605-608 (2002).
- Cook, R. and K. Evans: Resistance and Tolerance In: Principles and Practices of Nematode Control in Crops (Ed.: R.H. Brown and B.R. Kerry). pp. 179-231 (1987).
- Hussain, M.A., T. Mukhtar and M.Z. Kayani: Characterization of susceptibility and resistance responses to root-knot nematode (*Meloidogyne incognita*) infection in okra germplasm. *Paki. J. Agri. Sci.*, **51**, 319e324 (2014).
- Hussey, R.S. and G.J.W. Janssen: Root-knot Nematode: *Meloidogyne* Species. In: Plant Resistance to Parasitic Nematodes (Ed.: J.L. Starr, R. Cook and J. Bridge), pp. 43-70 (2004).
- Kayani, M.Z., T. Mukhtar and M.A. Hussain: Evaluation of nematicidal effects of *Cannabis sativa* L. and *Zanthoxylum alatum* Roxb. against root-knot nematodes, *Meloidogyne incognita*. *Crop Prot.* **39**, 52-56 (2012).
- Kumar, A., J. Patil and S. Ram: screening of pigeonpea germplasm against cyst nematode, *Heterodera cajani*. *Haryana Agri. Uni. J. Res.*, **44**, 11-13 (2019).
- Kumar, V., M.R. Khan and R.K. Walia: Crop loss estimations due to plant-parasitic nematodes in major crops in India. *Nation. Acad. Sci. Lett.* (2020) <https://doi.org/10.1007/s40009-020-00895-2>.
- Mukhtar, T., M.Z. Kayani and M.A. Hussain: Response of selected cucumber cultivars to *Meloidogyne incognita*. *Crop Prot.*, **44**, 13-17 (2013).
- Patil, J., S.R. Goel and S. Yadav: Bio-management of cucumber wilt complex caused by root-knot nematode, *Meloidogyne incognita* and *Fusarium oxysporum* f. sp. *cucumerinum* in polyhouse under protected cultivation. *J. Pur. Appl. Micro.*, **11**, 1909-1917 (2017).
- Patil, J., A. Kumar, S. Yadav and S.R. Goel: Nematicidal effect of fumigants on the *Meloidogyne incognita* and *Fusarium oxysporum* F. sp. *cucumerinum* on cucumber in polyhouse. *P. Path. J.*, **17**, 25-32 (2018).
- Sasser, J.N.: Plant parasitic nematodes the farmers hidden enemy. North Carolina State University Graphics. Raleigh, U.S.A., p. 115 (1989).
- Sasser, J.N.: Identification and host-parasite relationships of certain root knot nematodes (*Meloidogyne* spp.). *Bull. Md. Agri. Exp. Stat.*, **31**, A-77 (1954).
- Sharma, A., H. Akhtar and A. Syed: Screening of field pea (*Pisum sativum*) selections for their reactions to root-knot nematode (*Meloidogyne incognita*). *J. Zhejiang Uni. Sci.*, **B7**, 209-214 (2006).
- Vagelas, I. and S.R. Gowen: Control of *Fusarium oxysporum* and root-knot nematodes (*Meloidogyne* spp.) with *Pseudomonas oryzae* habitans. *Pak. J. Phytopathol.*, **24**, 32e38 (2012).
- Verma, K.K. and D.C. Gupta: Germplasm evaluation of some rabi pulses against root-knot nematode, *Meloidogyne javanica*. *Indian J. Nemat.*, **23**, 209-210 (1993).
- Yadav, S. and R.S. Kanwar: Effect of crop rotation with legumes and some other crops on soil health and population of *Heterodera avenae*. *Indian J. Nemat.*, **49**, 44-52 (2019).