Available Online at EScience Press
Plant Protection
ISSN: 2617-1287 (Online), 2617-1279 (Print)
http://esciencepress.net/journals/PP

SCREENING OF PEA GERMPLASM AGAINST ROOT KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*) UNDER FIELD CONDITION

Muhammad Anwar ul haq[1], Muhammad Shahid[1], Kamra Mahmood[1], Sundas Hanif[2], Shaher Bano[2]
[1] *Plant Pathology Research Institute, Faisalabad, Pakistan.*
[2] *Department of Plant Pathology, Faculty of Agriculture, University of Agriculture, Faisalabad Pakistan.*

ARTICLE INFO

Article history
Received: 18th September, 2017
Revised: 28th October, 2017
Accepted: 7th November, 2017

Keywords
Pea,
root knot nematode,
Meloidogyne,
in-vivo,
RKN

ABSTRACT

Vegetables play an important role in human nutrition and health by providing minerals, micronutrients, vitamins, antioxidants and dietary fiber. Pea is one of the most important cool season vegetable crops grown throughout the world. Therefore, this study was planned to screen out of pea germplasm against root knot nematode *Meloidogyne incognita* under field conditions. Seventeen varieties/lines of pea (Linapak, Sarsabz, PF-400, 9374, 2100-40, PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax, Samrina Zard, FS-2187, 1500-8 and Meteor) were sown in sick field at Plant Pathology Research Area. Experiment was laid out in a randomized complete block design in two blocks with ten replications. After 10-week pea plants were harvested and data were recorded on the basis of plant growth parameters and nematodes reproduction. Out of seventeen none of the variety/line was found immune against root knot nematode. Two (Linapak and Sarsabz) varieties were found resistant while three V/L (PF-400, 9374 and 2100-40) were found moderate resistant, nine V/L (PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax and Samrina Zard) were found moderate susceptible and two V/L (FS-2187 and 1500-8) were found susceptible. Meteor was found highly susceptible reaction to nematode.

Corresponding Author: Muhammad Anwar ul haq
Email: anwaruaf@gmail.com

INTRODUCTION

Pea (*Pisum sativum L.*) botanically it belongs to family Fabaceae is one of the most important cool season vegetables crop grown throughout the world. Peas are starchy, but high in fiber, protein, vitamin A, vitamin B6, vitamin C, vitamin K, phosphorus, magnesium, copper, iron, zinc and lutein (Pownall et al., 2010). In Pakistan, it is cultivated on an area of 46.5 thousand hectares having annual production of 30.8 thousand tonnes (FAO, 2015).
A variety of Pests affect peas through a number of pathogens including viruses, nematodes, bacteria and fungi. However, root knot nematode is most important plant pathogen which attacks on the roots of pea's crop. Farmers suffer heavy losses on account of these problems. Root knot nematode, *Meloidogyne spp.* are obligate, sedentary parasites of vascular tissues of plant roots. Root knot nematode second stage juveniles infect plant roots, causing the development of root knot that drains the plant's photosynthate and nutrients. Infection of young plants may be lethal, while infection of mature plants causes decreased yield. Root knot nematodes additional symptoms include reduction in plant vigor, fruit size and number, root lesions, rotting and deformation. The plant with nematode damaged root exhibit reduced root system with fewer feeder roots (Anwar and McKenry, 2010). About 3000 plant's species are susceptible to infection by root knot nematodes (Agrios,

2005). Five species of root knot nematode namely, *M. incognita*, *M. javanica*, *M. arenaria*, *M. hapla* and *M. graminicola* have been recorded in Pakistan (Anwar and McKenry, 2012).

The objective of the experiment is to screen the pea genotypes for their reaction to root knot nematodes under natural field conditions and to select the appropriate resistant pea genotypes for breeders to incorporate in their breeding programs against root knot nematodes.

MATERIALS AND METHODS

The experiment was conducted in Plant Pathology Research Institute, Ayub Agricultural Research Institute, Faisalabad in sick plot under natural field conditions. Seeds of 17 different pea varieties/lines (Linapak, Sarsabz, PF-400, 9374, 2100-40, PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax, Samrina Zard, FS-2187, 1500-8 and Meteor) were collected from Vegetable Research Institute, Faisalabad. Pea seeds were sown in sick field keeping bed to bed distance 30 cm and plant to plant distance 15 cm during 2nd week of October. Before sowing, at time of field preparation five random samples were collected to assess the RKN inoculum in 100 g of soil. On average, five hundred second stage Juveniles were found in each sample. Experiment was laid out in a randomized complete block design in two blocks with ten replications. All agronomic practice was carried out throughout the experiment period till harvesting. To remove weeds from the experimental area, hoeing operation was carried out at regular intervals. Moreover, earthing up was also done for the vigor of pea plants grown on beds. After 10 weeks pea plants were harvested with the help of spade. The plants were shaken carefully to remove the soil from roots and plants brought to the laboratory in polythene bag for further studies. Rinsed the roots further under running water until the soil particles were washed away from the roots and finally the root systems were dried with tissue paper. Each root system was placed in polythene bag and labeled separately. Data were recorded on basis of plant growth parameters (Plant weight, Root and Shoot length) and nematode reproduction parameters (Number of Egg masses, Galls, Females per root system, Egg masses/Galls % ratio, Egg masses/Females % ratio). Egg masses were counted by staining root system with phloxin B (Southey, 1986) and numbers of Females were counted by staining root system with acid fuchsin (Taylor, 1967). Data was subjected to ANOVA and significant differences among the treatments was portioned by Least significant difference test (LSD) at probability levels of $P \leq 0.05$ (Steel et al., 1997).

RESULTS

Seventeen Pea varieties/lines exhibited wide variability among themselves to *M. incognita* infection. Pea germplasm was evaluated for root knot nematode resistant based upon Number of Galls, egg masses, females per root system and egg masses/Galls % Ratio (E/g), egg masses/females' % Ratio (E/f) (Table 1).

Table 1. Reproduction of root knot nematode *M. incognita* on Pea's genotypes.

Varieties/Lines	No. of Gall	No. of Egg	No. of Female	E/g	E/f
Meteor	127.40 A	103.40 A	157.30 A	82.07 ABC	65.921 AB
FS 2187	72.90 C	68.90 B	104.30 B	95.31 AB	65.746 AB
Climax	26.30 D	22.50 C	35.80 C	88.80 AB	64.023 AB
1500-8	91.50 B	76.90 B	115.30 B	85.42 ABC	66.328 AB
9800-5	24.80 DE	22.80 C	36.10 C	96.76 AB	63.743 AB
2001-40	7.30 HI	6.100 DE	9.50 F	87.55 AB	65.331 AB
Samrina Zard	25.10 DE	21.60 C	35.10 C	89.06 AB	62.117 AB
PTL-1	20.90 DEF	17.70 CD	29.10 CD	83.41 ABC	59.486 AB
PF-400	9.00 GHI	6.90 DE	9.80 EF	77.26 ABC	71.973 A
PF-09	13.20FGH	11.30 CDE	21.40 DE	86.92 ABC	52.388 AB
Lina Pak	1.60 I	1.10 E	1.90 F	55.83 BC	49.000 AB
Sarabz	1.30 I	0.90 E	1.70 F	45.00 C	39.333 B
267	17.90 EFG	16.00 CD	24.70 CD	90.10 AB	64.735 AB
9374	8.60 GHI	6.70 DE	9.90 EF	79.80 ABC	67.657 AB
PTL-3	15.00 EFGH	15.10 CD	26.70 CD	104.48 A	57.160 AB
PTL-6	18.10 DEFG	17.00 CD	28.70 CD	96.47 AB	59.281 AB
PTL-7	20.10 DEF	16.30 CD	28.80 CD	83.71 ABC	56.395 AB

Maximum plant weight was found in Sarsabz (44.60 A) followed by Linapak, PF-400, 9374, 2100-40, PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax, Samrina Zard, FS-2187, 1500-8 and minimum plant weight (27.10 F) was found in Meteor. This showed that root weight increased due to more infection of RKN in susceptible and highly susceptible V/L while shoot weight decreased. Maximum root and shoot length (21.240 A & 50.350 A) was found in Sarsabz followed Linapak, PF-400, 9374, 2100-40, PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax, Samrina Zard, FS-2187, 1500-8 and minimum root and shoot length (14.170 F & 37.990 D) was found in Meteor respectively. This showed that root and shoots length decreased due to higher infection of RKN in susceptible (FS-2187 and 1500-8) and highly susceptible Meteor. Highly susceptible variety showed minimum plant weight, shoot and root length. But the root weight of highly susceptible variety is more as compared other germplasm (Table 2).

Table 2. Growth Response of Pea's genotypes against root knot nematode *M. incognita*.

Varieties/Lines	Plant weight(g)	Shoot length(cm)	Root length(cm)
Meteor	27.100 F	37.990 D	14.170 F
FS 2187	29.100 DEF	40.030 CD	15.190 DEF
Climax	35.200 CDE	44.660 ABCD	17.950 BC
1500-8	28.600 EF	39.730 CD	15.050 EF
9800-5	36.400 BCD	45.250 ABC	17.670 C
2001-40	40.300 ABC	47.880 AB	19.960 AB
Samrina Zard	33.700 CDEF	44.540 ABCD	17.460 C
PTL-1	34.700 CDE	45.050 ABC	17.210 CDE
PF-400	43.900 A	47.510 AB	20.080 AB
PF-09	35.600 CDE	44.740 ABCD	17.310 CD
Lina Pak	43.800 AB	50.040 A	21.060 A
Sarabz	44.600 A	50.350 A	21.240 A
267	34.100 CDEF	43.850 ABCD	17.510 C
9374	44.300 A	47.100 AB	20.260 A
PTL-3	32.500 DEF	44.300 ABCD	17.410 C
PTL-6	33.000 CDEF	45.310 ABC	17.550 C
PTL-7	34.400 CDEF	43.130 BCD	16.940 CDE

Maximum number of galls, number of egg masses and number of females per root system (127.40 A, 103.40 A & 157.30 A) was observed in Meteor and minimum number of knots, Number of egg masses and number of females per root system (1.300 I, 0.90 E & 1.70 F) was found in Sarsabz respectively. While (PF-400, 9374, 2100-40, PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax, Samrina Zard, FS-2187, 1500-8 and Linapak) were showed mediatory reproduction response of *M. incognita*. The maturity of female and egg laying was delayed due to response of resistant gene in plant which produce the certain chemicals. So there was no significant difference between genotypes on basis of egg masses/female % ratio and egg masses/gall % ratio, however minimum egg masses/female % ratio (39.33 B) was found in Sarsabz. Similarly, minimum egg masses/gall % ratio (45.00 C) also was found in Sarsabz (Table 1).

DISCUSSION

Vegetable crops usually are among the most susceptible and worst affected by these nematodes (Sharma et al., 2006). Out of seventeen none of the variety/line was found immune against root knot nematode. Two (Linapak and Sarsabz) varieties were found resistant while three V/L (PF-400, 9374 and 2100-40) were found moderate Resistant, nine V/L (PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax and Samrina Zard) were found moderate susceptible and two V/L (FS-2187 and 1500-8) were found susceptible. Meteor was found highly susceptible reaction to *M. incognita* (Table 3). Pea germlasm infection variation among the cultivars indicates that these cultivars vary in genetic make-up (Schwartz et al., 2010). Root knot nematode cause direct

and indirect effect on Plant growth. The nematode infection induces extensive galling and root damage which directly effects of root knot nematodes include restriction of water and nutrient supply to plants by direct feeding and restriction of xylem and phloem vessels which cause the poor growth. They showed indirect effects by breaking the host resistance mechanism and increasing susceptibility to other diseases.

The maximum number of galls, egg masses and females per root system were found highly susceptible variety, when germplasm were tested against *M. incognita* compared to moderate resistant, resistant and immune (Quesenberry et al., 1989). Different cultivars responses were observed due to presence of RKN resistant gene. These genes made plant less attractive to attacking (Hadisoeganda and Sasser, 1982; Quesenberry et al., 1989). Penetration of *M. incognita* juveniles in host roots activated the resistant gene that leaded to compatible and incompatible reaction in plant cells (Davis et al., 2000; Williamson, 1999). Root knot nematode failed to produce feeding sites in the host after penetration in roots due to hypersensitive response in resistant plants (Williamson and Kumar, 2006).

Table 3. Reaction of Pea's genotypes against root knot nematode *M. incognita*.

No. of galls*	Reaction	No. of Varieties/ Lines	Varieties/Lines
0 = No galls	Immune		
1 = 1-2 galls	Resistant	2	Linapak, Sarsabz,
2 = 3-10 galls	Moderately Resistant	3	PF-400, 9374, 2100-40
3 = 11-30 galls	Moderately Susceptible	9	PF-09, 267, 9800-5, PTL1, PTL3, PTL6, PTL7, Climax, Samrina Zard
4 = 31-100 galls	Susceptible	2	FS-2187, 1500-8
5 = > 100 galls	Highly Susceptible	1	Meteor
(Quesenberry et al., 1989)	Total	17	

The resistant cultivars have genes in their gene pool against root knot nematode *M. incognita* (Boiteux and Charchar, 1996) as our result indicated two cultivars (Linapak and Sarsabz) were found resistant and three cultivars (PF-400, 9374 and 2100-40) were found moderate Resistant which have minimum reproduction of nematodes as compared to other cultivars. This study helped to information on the reaction of various pea germlasm to *M. incognita*.

REFERENCE

Agrios, G.N., 2005. Plant diseases caused by fungi, Plant Pathology, 5th edition ed. Elsevier, pp. 385-614.

Anwar, S.A., McKenry, M.V., 2010. Incidence and reproduction of *Meloidogyne incognita* on vegetable crop genotypes. Pakistan Journal of Zoology 42, 135-141.

Anwar, S.A., McKenry, M.V., 2012. Incidence and population density of plant-parasitic nematodes infecting vegetable crops and associated yield losses in Punjab, Pakistan. Pakistan Journal of Zoology 44, 327-333.

Boiteux, L.S., Charchar, J.M., 1996. Genetic resistance to root-knot nematode (*Meloidogyne javanica*) in eggplant (*Solanum melongena*). Plant Breeding 115, 198-200.

Davis, E.L., Hussey, R.S., Baum, T.J., Bakker, J., Schots, A., Rosso, M., Abad, P., 2000. Nematode Parasitism Genes. Annual Review of Phytopathology 38, 365-396.

FAO, 2015. Faostat Database Collection. Food and Agriculture Organization, Rome, Italy.

Hadisoeganda, W.W., Sasser, J.N., 1982. Resistance of tomato, bean, southern pea and garden pea cultivars to root-knot nematodes based on host suitability. Plant Disease 66, 145-150.

Pownall, T.L., Udenigwe, C.C., Aluko, R.E., 2010. Amino acid composition and antioxidant properties of pea seed (*Pisum sativum* L.) enzymatic protein hydrolysate fractions. Journal of Agricultural and Food Chemistry 58, 4712-4718.

Quesenberry, K.H., Baltensperger, D.D., Dunn, R.A., Wilcox, C.J., Hardy, S.R., 1989. Selection for tolerance to root-knot nematodes in red clover. Crop Science 29, 62-65.

Schwartz, B.M., Kenworthy, K.E., Crow, W.T., Ferrell, J.A., Miller, G.L., Quesenberry, K.H., 2010. Variable

responses of zoysiagrass genotypes to the sting nematode. Crop Science 50, 723.

Sharma, A., Haseeb, A., Abuzar, S., 2006. Screening of field pea (*Pisum sativum*) selections for their reactions to root-knot nematode (*Meloidogyne incognita*). Journal of Zhejiang University 7, 209-214.

Southey, J.F., 1986. Laboratory methods for work with plant and soil nematodes. HMSO.

Steel, R.G.D., Torrie, J.H., Dickey, D.A., 1997. Principles and procedures of statistics: A biometrical approach, 3rd Edition ed. McGraw Hill Book Co., New York, USA.

Taylor, A.L., 1967. Introduction to research on plant nematology, An FAO guide to the study and control of plant-parasitic nematodes. Food and Agriculture Organization, Rome, Italy.

Williamson, V., Kumar, A., 2006. Nematode resistance in plants: The battle underground. Trends in Genetics 22, 396-403.

Williamson, V.M., 1999. Plant nematode resistance genes. Current Opinion in Plant Biology 2, 327-331.