The Pharma Innovation Journal 2021; 10(4): 1023-1029

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(4): 1023-1029

www.thepharmajournal.com
Received: 07-02-2021
Accepted: 10-03-2021

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Screening of urd bean germplasm for their reactions to root-knot nematode, *Meloidogyne incognita*

Silpi Patel and BK Dash

Abstract
Pot studies under net house conditions of Department of Nematology, OUAT, BBSR were conducted in 2015 and 2016 to evaluate the reaction of 149 germplasm of urd bean for resistance against *Meloidogyne incognita*. After 45 days of inoculation, the roots of all the germplasm were assessed to determine gall indices on a 0-5 scale. After 45days data were recorded on the basis of nematodes reproduction. Out of one hundred fortynine (149) germplasm none was found immune against root knot nematode. Nineteen (19) germplasm RU-1-9-1, KUG-715, NUL-205, TU99-5-1, UG-950, DBG-17, NDU 99-2, OBG 19, KU 96-3, IU 02-1-3, VBG 11-031,TU 94-2, AKU-11-8, MASH-479, MASH-391, KUG-715, NUL-205, PU 11-14, VBG-11-016 were categorized as resistant against *M. incognita* while twenty four (24) germplasm DPU-88-5, KU 99-4, OBG-630, TPU-4, UG 1017, USJD111, KU 99, PU 09-37, COBG 1-06, TU-67, NUL-244, DPU-88-2, NDU-88-9, WBU-104, BDU-1, Phule-U-0011-1, KU-12-53, SBC-47, AKU 10-2, AKU 10-6, KU-96-7, DKU-11, NDUK-13-6, KU-96-7 were categorized as moderately resistant against *M. incognita* and rest germplasm were found susceptible and highly susceptible reaction to nematode.

Keywords: Germplasm, *Meloidogyne incognita*, gall index, resistance

Introduction
Pulses production is most vulnerable to the attacks of pests and diseases causing yield losses (Anonymous, 2011) [1]. These biotic and abiotic factors widened the gap between potential and actual yield in pulse crops. To Bridge this gap proper management practices against pest and diseases would compensate India's pulses production. Root-knot nematode *M. incognita* is one of the prime limiting factor for low productivity of pulses in India. It is among major five plant pathogens and on top among the ten most important genera of plant parasitic nematodes in the world (Mukhtar *et al*., 2017a) [15]. It has been reported to cause severe economic losses of up 17-23% in urd bean (Anonymous, 2014) [1]. Buildup of inoculum of the nematode and repeated cultivation of same cultivars in the same land every year is the prime reason for yield losses by root-knot nematodes (Hussain *et al*., 2016) [9]. Hostplant resistance is effective management tool that increases yield in spite of nematode population densities that exceed the damage threshold (Castagnone-Sereno, 2002; Sharma *et al*., 2006) [2, 23]. Detailed information on responses of various pulse germ plasm is essential for effective management of root-knot nematodes. Resistant germ plasm is considered to be eco-friendly and economically feasible (Mukhtar *et al*., 2017b) [16]. These germ plasm can also be integrated with other management practices in integrated nematode management (Shahzaman *et al*., 2015; Khan *et al*., 2017; Rahoo *et al*. 2018a) [22, 14, 20]. Therefore, the study was undertaken to evaluate the resistance of urd bean germplasm to root-knot nematode (*M. incognita*) under net house conditions.

Materials and Methods
A population of root-knot nematode (*Meloidogyne incognita*) isolated from urd bean roots, identified on the basis of perineal pattern and maintained) was used in the assessment. The nematode was mass produced as described previously (Mukhtar *et al*., 2013) [17]. Second stage juveniles (J2s) were extracted from the infected roots for inoculation of plants as described by Whitehead and Hemming (1965) [24].
Pot experiments on screening of germplasm urd bean was conducted during 2015 and 2016 under net house conditions following the complete randomized block design (CRD) to assess the source of resistance against *Meloidogyne incognita.* During 2015, 149 germplasm of urd bean obtained from Indian Institute of Pulses Research (IIPR), Kanpur, India were evaluated for their reaction to *M. incognita* after artificial inoculation under controlled conditions.
A single egg mass of *M. incognita* picked by hand with a fine forceps from the infected pulse

roots was surface sterilized in 1:500 (*V/V*) aqueous solution of "chlorax" (Sodium hypochlorite) for 5 min (Hussey and Barker, 1973) [10] and was then transferred to a small coarse sieve lined with tissue paper to cover the bottom of the sieve that was within a petriplate containing sufficient amount of water. The petriplate was incubated at room temperature (27±5°C) for 5 days (Den Ouden, 1958) [4]. Seedlings of the tested germplasm grown in autoclaved soil were inoculated with the progeny of the single egg mass in order to get regular supply of the inoculum for the experiment (Sharma *et al.,* 2006) [23].

Germinated seeds of urd bean germplasm were sown in earthen pot of diameter 10 cm containing 500 cm3 of sterilized soil. Ten days after germination, seedlings were thinned to one seedling per pot and were inoculated with *M. incognita* @ 1.1 g/g soil Four replications for each entry were maintained. Forty five days after inoculation, plants were uprooted carefully, roots were separated and cleaned and fixed in 4% formalin, stained with lactophenol-acid fuchsin, cleared in pure lactophenol and recorded the number of egg masses and number of galls per plant by observing under stereo-zoom microscope (Devi *et al.,* 2014) [5]. Following the standard method of scoring the root-knot gall index as well as reactions was determined.

The lines were categorized in different reactions on the basis of gall index as below.

Gall index	Observations	Reactions
1	No egg masses/galls/plant	Highly Resistant(HR)
2	1-10 egg masses/galls/plant	Resistant(R)
3	11-30 egg masses/galls/plant	Moderately Resistant(MR)
4	31-100 egg masses/galls/plant	Susceptible(S)
5	> 100 egg masses/galls/plant	Highly Susceptible(HS)

After stipulated period data regarding number of galls, egg masses and reproductive factor were taken. The egg masses-stained roots were rinsed with tap water and counted under stereomicroscope at 25x. The final nematode population was computed by adding up the eggs extracted from the infected roots (Hussey and Barker, 1973) [11] and nematodes extracted from the soil (Whitehead and Hemming, 1965) [24]. This final population was divided by the initial population to find out the reproductive factor.

Statistical analysis

To find out the significant difference in the different germplasm lines of black gram, the all data were statistically analysed at 5 per cent level.

Results and Discussion

Significant differences were found among all the cucumber cultivars regarding formation of galls, egg masses, fecundity and reproductive factor. Maximum galls were observed on highly susceptible cultivars followed by susceptible ones. On the other hand, minimum galls were recorded on resistant and moderately resistant cultivars. Similarly, the nematode produced maximum egg masses on the highly susceptible cultivars followed by cultivars showing susceptible reactions. Contrarily, minimum egg masses were found on resistant and moderately resistant cultivars. the nematode produced the minimum number of eggs per egg mass on resistant cultivar followed by moderately resistant cultivars. The reproductive factor of the nematode was also found to be the minimum on resistant cultivar followed by moderately resistant ones. Contrariwise, the highest reproductive factor was observed on the highly susceptible cultivars followed by susceptible ones. Significant variations in reproductive factor were also observed among cultivars showing different levels of susceptibility. Reproductive factors of highly susceptible, susceptible, moderately susceptible, moderately resistant and resistant cultivars were found to be statistically different from each other and were in the order: HS>S>MS>MR>R.

During 2015 and 2016, 149 urd bean germplasm were preliminarily screened under net house conditions against *Meloidogyne incognita*. Host reaction to root knot nematode was determined following the standard method for scoring of gall index Out of which RU-1-9-1, KUG-715, NUL-205, TU99-5-1, UG-950, DBG-17, NDU 99-2, OBG 19, KU 96-3, IU 02-1-3, VBG 11-031, TU 94-2, AKU-11-8, MASH-479, MASH-391, KUG-715, NUL-205, PU 11-14, VBG-11-016germplasmwere categorized as resistant against *M. incognita.*DPU-88-5, KU 99-4, OBG-630, TPU-4, UG 1017, USJD111, KU 99, PU 09-37, COBG 1-06, TU-67, NUL-244, DPU-88-2, NDU-88-9, WBU-104, BDU-1, Phule-U-0011-1, KU-12-53, SBC-47, AKU 10-2, AKU 10-6, KU-96-7, DKU-11, NDUK-13-6, KU-96-7germplasm were categorized as moderately resistant against *M. incognita.*

Table 1: Varietal Screening of urd bean germplasm against *Meloidogyne incognita*
Screening of germplasm against root knot nematode in urd bean (pooled)

Sl No	Germplasm	No of galls/plant	Gall Index	Reaction	Final RKN population (soil+root)(Log value)*	Multiplication Factor
1	Vijay	72	4	S	(1601)3.20*	1.6
2	PU-401-3	102	5	S	(1730)3.24	1.73
3	BDU-1	27	3	MR	(1467)3.17	1.47
4	PAU-1	144	5	HS	(3430)3.54	3.43
5	Phule-U-003	69	4	S	(1594)3.20	1.59
6	KU-12-33	48	4	S	(2256)3.35	2.26
7	Phule-U-504-4	76	4	S	(1614)3.21	1.61
8	KU-12-37	154	5	HS	(3075)3.49	3.07
9	Phule-U-0011-1	25	3	MR	(1450)3.16	1.45
10	KU-12-38	88	4	S	(1603)3.21	1.6
11	Phule-U-50214	106	5	HS	(3262)3.51	3.26
12	KU-12-40	123	5	HS	(3161)3.50	3.16
13	AKU-10-1	119	5	HS	(2816)3.45	2.82

14	KU-12-42	89	4	S	(2603)3.42	2.6
15	AKU-10-6	148	5	HS	(3313)3.52	3.31
16	KU-12-43	111	5	HS	(2983)3.47	2.98
17	AKU-15	79	4	S	(1603)3.21	1.6
18	KU-12-52	105	4	S	(1835)3.26	1.84
19	TAU-2	87	4	S	(1734)3.24	1.73
20	KU-12-53	26	3	MR	(1435)3.16	1.44
21	TPU-4	99	4	S	(1719)3.24	1.72
22	KU-12-54	119	5	HS	(2403)3.38	2.4
23	PU-0014	91	5	S	(2689)3.43	2.69
24	KU-12-56	86	4	S	(1652)3.22	1.65
25	PU-401-1	124	5	HS	(2563)3.41	2.56
26	KU-12-57	151	5	HS	(2621)3.42*	2.62
27	PUNT-U-31	147	4	HS	(2597)3.41	2.6
28	DRU-11	76	4	S	(1601)3.20	1.6
29	NDUK-13-6	29	3	MR	(1809)3.26	1.81
30	TU-67	83	4	S	(2480)3.39	2.48
31	KU-96-7	27	3	MR	(1818)3.26	1.82
32	MU-44	87	4	S	(2667)3.43	2.67
33	KU-96-3	82	3	S	(2663)3.43	2.66
34	NUL-7	171	4	HS	(3337)3.52	3.34
	SE(m)±	5.14	0.18	-	0.019	-
	CD	14.3	0.5	-	0.053	-

Sl No	Germplasm	No of galls/plant	Gall Index	Reaction	Final RKN population(soil+root)(Log value)*	Multiplication Factor
35	VAMBAN-7	85	4	S	(2507)3.40	2.51
36	IPU-2-43	83	3	S	(2363)3.37	2.36
37	TU-94-2	79	4	S	(2239)3.35	2.24
38	KUG-479	86	3	S	(2512)3.40	2.51
39	MASH-479	10	1	R	(870)2.94	0.87
40	MASH-391	9	2	R	(919)2.96	0.92
41	PU 09-36	176	4	HS	(3402)3.53	3.4
42	MU-44	159	5	HS	(3229)3.51	3.23
43	KUG-715	9	2	R	(863)2.94	0.86
44	NUL-205	8	1	R	(944)2.98	0.94
45	DPU-88-2	14	2	MR	(1144)3.06	1.14
46	NDU-88-9	17	3	MR	(1233)3.09	1.23
47	T-65	31	3	S	(2222)3.35	2.22
48	WBU-104	28	3	MR	(1347)3.13	1.35
36	IPU-2-43	83	3	S	(2363)3.37	2.36
37	TU-94-2	79	4	S	(2239)3.35	2.24
38	KUG-479	86	3	S	(2512)3.40	2.51
39	MASH-479	10	1	R	(870)2.94	0.87
40	MASH-391	9	2	R	(919)2.96	0.92
41	PU 09-36	176	4	HS	(3402)3.53	3.4
42	MU-44	159	5	HS	(3229)3.51	3.23
43	KUG-715	9	2	R	(863)2.94	0.86
44	NUL-205	8	1	R	(944)2.98	0.94
45	DPU-88-2	14	2	MR	(1144)3.06	1.14
46	NDU-88-9	17	3	MR	(1233)3.09	1.23
47	T-65	31	3	S	(2222)3.35	2.22
48	WBU-104	28	3	MR	(1347)3.13	1.35
49	UG-170	119	5	HS	(3485)3.54	3.49
50	PU-30	33	4	S	(2248)3.35	2.25
51	PU 09-36	117	4	HS	(3289)3.52	3.29
52	H-80-9	32	3	S	(2252)3.35	2.25
53	COBG 1-06	20	3	MR	(1230)3.09	1.23
54	TAU-5	44	4	S	(2423)3.38	2.42
55	PU 11-14	10	2	R	(909)2.96	0.91
56	LBG-626	140	5	HS	(3559)3.55	3.56
57	UG-567	137	5	HS	(3696)3.57	3.7
58	TU-67	22	3	MR	(1251)3.10	1.25
	SE(m)±	5.14	0.18	-	0.019	-
	CD	14.3	0.5	-	0.053	-
Sl No	**Germplasm**	**No of galls/plant**	**Gall Index**	**Reaction**	**Final RKN population(soil+root)(Log value)***	**Multiplication Factor**
59	VBG-11-016	10	2	R	(927)2.97	0.93
60	LBG-402	141	5	HS	(3667)3.56	3.67
61	NUL-244	11	3	MR	(1018)3.01	1.02

62	LGG-629	88	5	HS	(3315)3.52	3.32
63	VBG-11-031	9	2	R	(742)2.87	0.74
64	VB-3	32	4	S	(2192)3.34	2.19
65	SBC-47	29	3	MR	(1269)3.10	1.27
66	PDU-104	142	5	HS	(3735)3.57	3.74
67	AKU 10-2	18	3	MR	(1409)3.15	1.41
68	PANT U-19	149	5	HS	(3492)3.54	3.49
69	AKU 10-6	28	3	MR	(1167)3.07	1.17
70	DPU-101	137	5	HS	(3574)3.55	3.57
71	KU-96-7	23	3	MR	(1248)3.10	1.25
72	TU 94-2	8	2	R	(885)2.95	0.89
73	PANT-U-30	127	5	HS	(3411)3.53	3.41
74	AKU-11-8	10	2	R	(945)2.98	0.95
75	PDU-1	37	4	S	(2078)3.32	2.08
76	DKU-11	16	2	MR	(1252)3.10	1.25
77	WBG-6	140	5	HS	(3231)3.51	3.23
59	VBG-11-016	10	2	R	(927)2.97	0.93
60	LBG-402	141	5	HS	(3667)3.56	3.67
61	NUL-244	11	3	MR	(1018)3.01	1.02
62	LGG-629	88	5	HS	(3315)3.52	3.32
63	VBG-11-031	9	2	R	(742)2.87	0.74
78	IU 02-1-3	10	2	R	(912)2.96	0.91
79	PU-19	33	4	S	(2218)3.35	2.22
80	PU 09-37	27	3	MR	(1256)3.10	1.26
81	B-18-4-4	39	3	S	(2257)3.35	2.26
82	KU-2013-1	38	3	S	(2094)3.32	2.09
83	DPU-88-8	133	5	HS	(3509)3.55	3.51
84	MU-06	26	3	S	(2230)3.35	2.23
85	UG-218	131	5	HS	(3530)3.55	3.53
86	ADT-4	38	3	S	(2232)3.35	2.23
87	GU-87-15	149	5	HS	(3543)3.55	3.54
88	PU-26	39	4	S	(2364)3.37	2.36
89	PDU-102	26	3	S	(2302)3.36	2.3
90	UL-338	35	4	S	(2422)3.38	2.42
91	UG-218	136	5	HS	(3599)3.56	3.6
	SE(m)±	5.14	0.18	-	0.019	-
	CD	14.3	0.5	-	0.053	-
Sl No	**Germplasm**	**No of galls/plant**	**Gall Index**	**Reaction**	**Final RKN population(soil+root)(Log value)***	**Multiplication Factor**
92	ADT-5	33	4	S	(2182)3.34	2.18
93	COBG-10	143	5	HS	(3288)3.52	3.29
94	DPU-23	32	4	S	(2242)3.35	2.24
95	DPU-88-9	32	4	S	(2374)3.38	2.37
97	WBU-105	33	4	S	(2337)3.37	2.34
98	DPU-88-1	146	5	HS	(3264)3.51	3.26
99	GU-87-15	146	5	HS	(3333)3.52	3.33
100	DPU-90-3	33	4	S	(2386)3.38	2.39
101	LBG-20	129	5	HS	(3371)3.53	3.37
102	PDU-2	34	4	S	(2630)3.42	2.63
103	GU-90-12	28	4	S	(2571)3.41	2.57
104	B-12-4-4	145	5	HS	(3448)3.54	3.45
105	UG-135	34	4	S	(2529)3.40	2.53
106	TU-40	31	4	S	(2223)3.35	2.22
107	OBG-33	34	4	S	(2350)3.37	2.35
92	ADT-5	33	4	S	(2182)3.34	2.18
93	COBG-10	143	5	HS	(3288)3.52	3.29
94	DPU-23	32	4	S	(2242)3.35	2.24
95	DPU-88-9	32	4	S	(2374)3.38	2.37
97	WBU-105	33	4	S	(2337)3.37	2.34
98	DPU-88-1	146	5	HS	(3264)3.51	3.26
99	GU-87-15	146	5	HS	(3333)3.52	3.33
100	DPU-90-3	33	4	S	(2386)3.38	2.39
101	LBG-20	129	5	HS	(3371)3.53	3.37
102	PDU-2	34	4	S	(2630)3.42	2.63
103	GU-90-12	28	4	S	(2571)3.41	2.57
104	B-12-4-4	145	5	HS	(3448)3.54	3.45
105	UG-135	34	4	S	(2529)3.40	2.53
106	TU-40	31	4	S	(2223)3.35	2.22
107	OBG-33	34	4	S	(2350)3.37	2.35

104	B-12-4-4	145	5	HS	(3448)3.54	3.45
105	UG-135	34	4	S	(2529)3.40	2.53
106	TU-40	31	4	S	(2223)3.35	2.22
107	OBG-33	34	4	S	(2350)3.37	2.35
108	LBG-623	36	4	S	(2411)3.38	2.41
109	TU-3	31	4	S	(2281)3.36	2.28
110	PDU-1	35	4	S	(2444)3.39	2.44
111	COBG-593	40	4	S	(2236)3.35	2.24
	SE(m)±	5.14	0.18	-	0.019	-
	CD	14.3	0.5	-	0.053	-
Sl No	**Germplasm**	**No of galls/plant**	**Gall Index**	**Reaction**	**Final RKN population(soil+root)(Log value)***	**Multiplication Factor**
112	LBG-17	33	4	S	(2296)3.36	2.3
113	PU-31	141	5	HS	(3215)3.51	3.22
114	MU-44	140	4	HS	(2892)3.46	2.89
115	PU 09-36	137	5	HS	(2989)3.48	2.99
116	TU 99-5-1	10	2	R	(864)2.94	0.86
117	UG-950	9	2	R	(968)2.99	0.97
118	TPU-4	28	3	MR	(1236)3.09	1.24
119	UG 1017	23	3	MR	(1211)3.08	1.21
120	DBG-17	10	2	R	(918)2.96	0.92
121	NDU 99-2	10	2	R	(973)2.99	0.97
122	USJD111	25	3	MR	(1268)3.10	1.27
123	KU 99	25	3	MR	(1145)3.06	1.14
124	LBG-685	37	4	S	(1872)3.27	1.87
125	OBG-17	25	4	S	(1751)3.24	1.75
126	TPU-4	146	5	HS	(2564)3.41	2.56
127	PU-30-16	39	4	S	(2305)3.46	2.31
128	PU-30-13	131	4	HS	(3313)3.52	3.31
129	KU-99	33	4	S	(1816)3.26	1.82
130	PU-19	31	4	S	(1730)3.24	1.73
131	OBG-31	38	4	S	(1856)3.27	1.86
132	TU-94-2	146	5	HS	(2518)3.40	2.52
133	OBG-19	19	3	R	(886)2.95	0.89
134	KU 96-3	9	2	R	(976)2.99	0.98
135	KU 99-4	22	3	MR	(1345)3.13	1.35
136	OBG-630	24	3	MR	(1249)3.10	1.25
137	RU-1-9-1	10	2	R	(866)2.94	0.87
138	KUG-715	8	2	R	(879)2.94	0.88
139	NUL-205	8	2	R	(969)2.99	0.97
140	DPU-88-5	17	3	MR	(1181)3.07	1.18
135	KU 99-4	22	3	MR	(1345)3.13	1.35
136	OBG-630	24	3	MR	(1249)3.10	1.25
137	RU-1-9-1	10	2	R	(866)2.94	0.87
138	KUG-715	8	2	R	(879)2.94	0.88
139	NUL-205	8	2	R	(969)2.99	0.97
140	DPU-88-5	17	3	MR	(1181)3.07	1.18
141	H-10	33	4	S	(2244)3.35	2.24
142	T-77	34	4	S	(2284)3.36	2.28
143	PU-30	37	4	S	(1807)3.26	1.81
	SE(m)±	5.14	0.18	-	0.019	
	CD	14.3	0.5	-	0.053	

Sl No	**Germplasm**	**No of galls/plant**	**Gall Index**	**Reaction**	**Final RKN population(soil+root)(Log value)***	**Multiplication Factor**
144	UJALA	34	4	S	(1752)3.24	1.75
145	TAU-6	141	5	HS	(3395)3.53	3.4
146	SARALA-8	39	4	S	(1845)3.26	1.84
147	GU-90-13	133	4	HS	(2698)3.43	2.69
148	PAU-1	148	5	HS	(3436)3.54	3.44
149	T-9	163	5	HS	(3830)3.54	3.83
	SE(m)±	5.14	0.18	-	0.019	-
	CD	14.3	0.5	-	0.053	-

Figures in parantheses* are log transformed value

The results revealed considerable variation in response to *M. incognita* among the different germplasm of urd bean screened. Such variability in tolerance to the root knot nematode might be influenced by host plant genetics and other environmental factors. Presence of nematode resistance genes makes the plant root less attractive for attacking nematodes. Resistance and susceptibility to plant parasitic nematodes reflect the effect of the plant on the nematode's ability to reproduce (Sharma *et al*., 2006) [23]. Resistant and moderately resistant germplasm reduce nematode reproduction thereby directly affect the residual nematode population density under field conditions (Cook and Evans, 1987) [3]. Breeding programs for resistance to plant parasitic nematodes 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) [12]. Thus, the use of resistant germplasm is very important component for the management of root knot nematode population in pulse ecosystem.

One of the most prime factors for selecting cultivars for cultivation is their multiplication or reproductive factors. Cultivars having lower multiplication factors will be appropriate for the management of root-knot nematodes. The host status of any crop is determined by the multiplication factor of the nematode which quantifies its reproductive potential on a specified crop plant (Windham and Williams, 1988) [25]. When the multiplication factor of a nematode on a selected host is less than one, it means the nematode is unable to reproduce on that host whereas if the multiplication factor exceeds one, the nematode can successfully multiply on that host (Pofu *et al*., 2010) [19]. The sensitivity of a host is determined on the basis of host status and its responses to nematode infectivity (Seinhorst, 1967) [21]. When a host permits the nematode to reproduce on it and cause yield losses, the host is referred as susceptible, whereas if a host does not suffer yield losses, it is referred to be tolerant to the nematode. However, if the host does not allow the nematode to reproduce and resultantly there is no yield loss, the host will be a resistant one (Seinhorst, 1967) [21].

In the present study, urd bean germplasm showed highly significant differences regarding reproduction of *M. incognita* categorized on the basis of number of egg masses and multiplication factor. Production of egg masses on roots by the nematode were the key factor of variations among urd bean germ plasm and these variations subsequently determined final nematode populations and reproductive factors. The variations in reproductive rates may differ as the result of genetic factors which impart resistance or susceptibility to the host or due to genetic variations in nematode populations (Griffin, 1982; Jacquet *et al*., 2005; Castagnone-Sereno, 2006) [8, 13, 2].

The differences in the host can affect various phases of the life cycle of the nematode. The resistant host does not allow the nematode to enter the roots or kill the nematode after it penetrated the roots or the nematode is unable to develop or reproduce in the host. The variations in reproduction and multiplication of *M. incognita* on urd bean cultivars are due to variations in their genetic makeup which can be described in terms of number of egg masses. The production of maximum egg masses and eggs on the roots of highly susceptible and susceptible cultivars concludes that maximum numbers of juveniles entered the roots ad were successful in completing their life cycles in the host. Again, in case of resistant and moderately resistant germplasm only few juveniles can enter into the roots and developed which is obvious by the number of egg masses and their reproductive factors. Resistant cultivars contain a limited number of developed nematodes as compared to susceptible cultivars (Dropkin and Nelson, 1960) [6]. Hindrances in invasion by second stage juveniles of the nematode due to failure of maximum numbers of juveniles to develop in the infected roots and/or hypersensitive reactions in the host (Dropkin, 1969) [7]. In Susceptible hosts, juveniles had the highest capacity to fully develop as evident by their multiplication factors. Whereas in resistant and moderately resistant cultivars the development of the juveniles was either curtailed or delayed (Nelson *et al*., 1990) [18].

Conclusion

Resistant and moderately resistant germplasm reduce nematode reproduction thereby directly affect the residual nematode population density under field conditions. 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. Thus, the use of resistant germplasm can be a vital component for the management of root knot nematode population in pulse ecosystem. The reproductive potential of *Meloidogyne incognita* was found to be significantly low on resistant and moderately resistant germplasm. These cultivars are likely to suffer less damage by the nematode as compared to susceptible ones with highest rate of nematode multiplication and hence are recommended for cultivation in fields infested with *M. incognita*.

Acknowledgement

The authors are highly obliged to the Indian Institute of Pulses Research (IIPR), Kanpur and Department of Plant Breeding and Genetics, CA, OUAT, Bhubaneswar for providing germplasm and other required materials and Department of nematology, CA,OUAT,BBSR for providing necessary infrastructural facilities to carry out the research work.

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