

Evaluation of six leguminous crops against the root-knot nematode, *Meloidogyne javanica* infection

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Abstract

Twenty seven leguminous cultivars were tested for their host response to *Meloidogyne javanica*. The nematode species succeeded in developing and multiplying on almost all the tested crops. According to rating scale based on nematode reproduction, Lencoln and Victory cultivars of pea were considered as highly susceptible hosts with (R_f) values 36.5 and 25.68 folds, respectively. While Maser-1 cultivar of broad bean and Bronco, Exira, Giza-6, Polista and Savana cultivars of common bean were classified as moderately susceptible hosts to nematode infection with (R_f) values ranged between 5.27 and 14.21 folds. Thirteen other tested cultivars were found least susceptible with (R_f) values ranged between 1.13 and 4.86 folds. On the other hand, *M. javanica* failed to reproduce and multiple on Giza-2 and Giza-30 of fenugreek and Giza-1 and Giza-2 of lupine which were ranked as highly resistant hosts with (R_f) values 0.12, 0.33, 0.19 and 0.42 folds, respectively, whereas Giza-843 and Giza-51 of broad bean and lentil were regarded as resistant hosts to nematode infection with (R_f) values 0.59 and 0.80 folds, respectively.

Keywords: Screening, *Meloidogyne javanica*, broad bean, common bean, fenugreek, lentil, lupine, pea, leguminous.

Meloidogyne javanica is one of the important pests which attack the leguminous crops. The root-knot nematode species significantly reduce the yield of leguminous crops grown in infested soils. *M. javanica* has a wide host range of leguminous crops and cultivars (Bernard *et al.*, 1990; Saka, 1990; Devi & Kumari, 2014). Therefore, the use of resistant leguminous cultivars in areas infested with root-knot nematode species is the best agricultural method of its control (Montasser, 1986; Roberts, 1995; Hafez & Sundararaj, 1999; Varshney *et al.*, 2000; Ferreira *et al.*, 2010). Van Den Oever (1982) reported that two varieties of *Phaseolus vulgaris* L. were proved to be good hosts to *Meloidogyne* spp. Santo & Ponti (1985) found that some common bean and pea cultivars were excellent hosts for two root-knot nematode species viz., *Meloidogyne chitwoodi* and *M. hapla*.

However, the reproduction factor of *M. hapla* was greater than that of *M. chitwoodi* on common bean cultivars (Viva Pink & Pinto UI-114) and pea cultivars (Dark Skin Perfection, Puget and Venus). Sharma & Trivedi (1988) studied the host suitability of thirty six varieties and lines of fenugreek (*Trigonella foenum-graecum*) to the root-knot nematode, *Meloidogyne incognita*. They suggested that UM-75 and UM-83 varieties were found to be highly susceptible, CO-1 variety was susceptible; UM-34 was highly resistant and the rest of varieties tested were either resistant or moderately resistant. Soliman (2002) tested five cultivars of broad bean against *Meloidogyne incognita* and *M. javanica* to detect their susceptibility or resistance under greenhouse conditions. They found that three cultivars (Giza 1, Giza 3 and Giza 716) were very resistant to both nematode species

infection whereas, only one cultivar (Giza 402) was susceptible and very resistant to *M. incognita* and *M. javanica*, respectively. While, one cultivar (Giza 463) was found to be very resistant to both nematode species. Ferreira *et al.*, (2010) assessed the reaction of dry common bean to infectivity by *Meloidogyne incognita* (races 1 & 3) and *M. javanica* and reported that the common bean cultivars Apore and Talisma were highly resistant hosts to *M. javanica*, slightly resistant hosts to *M. incognita* race 1, respectively while they were moderately resistant host and slightly resistant hosts to *M. incognita* race 3.

Materials and Methods

Seeds of local cultivars of broad bean (*Vicia faba*), common bean (*Phaseolus vulgaris*), fenugreek (*Trigon foenum-graecum*), lentil (*Lens culinaris*), lupine (*Lupinus termis*) and pea (*Pisum sativum*) were planted in clay pots of 25 cm diameter, filled with mixture of clay and sand soil (2:1 v:v) for two weeks. After germination, plants in each pot were thinned to one healthy seedling and inoculated with approximately 1000 newly hatched juveniles (J_2) of *Meloidogyne javanica* per pot obtained from stock pure cultures maintained and propagated on tomato cv. Rutgers. Each inoculated cultivars was replicated four times. The uninoculated plants pots served as controls. All pots were randomized on a bench in greenhouse and horticulturally treated the same. Plants were allowed to grow during the normal growing season at greenhouse temperature of 20 ± 5 °C, for 60 days or 30 ± 5 °C, for 45 days after inoculation. At the end of the experiment, plants were harvested and roots were stained. Number of nematode juveniles in soil, galls, developmental stages, mature females and egg laying females per root were estimated. Numbers of egg-masses per root and eggs per egg-mass were counted then the rate of nematode reproduction (R_f) was calculated. Plant growth criteria involving fresh weights of both roots and shoots and their percentages of reduction were also calculated. The potential of each

cultivar to the nematode reproduction ($R_f = P_f / P_i$) was calculated as per the following scale:

($P_f / P_i = 0.0$) I = Immune host.

($P_f / P_i < 0.4$) HR = Highly resistant host.

($0.5 \leq P_f / P_i \leq 0.9$) R = Resistant host.

($1.0 \leq P_f / P_i \leq 4.9$) LS = Less susceptible host.

($5.0 \leq P_f / P_i \leq 14.9$) MS = Moderately susceptible host.

($P_f / P_i > 15.0$) HS = Highly susceptible host.

The data were subjected to analysis of variance (ANOVA) and least significant difference (LSD) were determined at $P=0.05$ according to Duncan's multiple range test.

Results and Discussion

Twenty seven local and important leguminous cultivars belonging to six crop species were tested for their susceptibility to the root-knot nematode, *M. javanica* infection. Data in Table (1) suggested that the behavior of *M. javanica* varied greatly according to the cultivar type and the nematode species succeeded in developing and multiplying on almost all the tested broad bean cultivars. Lincoln and Victory cvs. of pea were highly susceptible as these cultivars gained the highest values of number of galls, adult female, egg-masses per root, eggs per egg-mass and rate of nematode reproduction. No significant differences were found on such nematode criteria on such root cultivars when compared with those of the other tested cultivars. Therefore, the calculated values of rates of nematode reproduction were 36.51 and 25.68 folds, respectively. On Maser-1 cultivar of broad bean and Bronco, Exira, Giza-6, Polista and Savana cultivars of common bean supported the moderately values of nematode criteria, however, the calculated numbers of galls per root and values of rates of nematode reproduction (R_f) of common bean cultivars were ranged between 45 & 95 galls and 5.27 & 14.21 folds, respectively. Also, *M. javanica* reproduced and multiplied low on thirteen other cultivars with the number of galls per root and rates of nematode reproduction (R_f) values ranged between 9 & 35 galls and 1.13 & 4.86 folds, respectively.

On the other hand, *M. javanica* failed to reproduce and multiply on Giza-843 cv. of broad bean, Giza-2 and Giza-30 cvs. of fenugreek, Giza-51 cv. of lentil and Giza-1 and Giza-2 cvs. of lupine. The nematode final population per plant was less than its initial population in these plant cultivars. There upon, the calculated number of galls and rates of nematode reproduction (R_f) on such cultivars were 11 & 0.59, 15 & 0.12, 28 & 0.33, 10 & 0.80, 8 & 0.19 and 12 galls & 0.42 folds, respectively (Table 1). The influence of the root-knot nematode, *M. javanica* on plant growth of fresh weights of shoots and roots of twenty seven cultivars belonging to six leguminous crop species as well as percentage reductions when compared with healthy once were registered in Table (2). Fresh weights of shoots and roots of the tested Lincoln and Victory cvs. were highly significantly affected by the nematode infection when compared with their controls. The percentage of reductions in shoots and roots fresh weights on such cultivars were 42.85-46.32 % and 59.18-62.11 %, respectively. Whereas, the lowest reductions in shoots and roots fresh weights were recorded on Giza-843 cv. of broad bean, Giza-2 cv. of fenugreek, Giza-51 cv. of lentil and Giza-1 and Giza-2 cvs. of lupine. The collected plant growth parameters (decreased percentage) on such cultivars were 29.01 – 33.33 %, 23.97 – 18.82, 31.79 – 18.76 %, 16.17 – 3.15 % and 23.76 – 17.20 %, respectively. Thereby, according to rating scale based on nematode reproduction as plant damage, Giza-2 and Giza-30 cvs. of fenugreek and Giza-1 and Giza-2 cvs. of lupine were ranked as highly resistant hosts while Giza-843 cv. of broad bean and Giza-51 cv. of lentil were regarded as resistant host to nematode infection. On the other hand, Lincoln and Victory cvs. of pea were considered as highly susceptible hosts; whereas Maser-1 cv. of broad bean, Bronco, Exira, Giza-6, Polista and Savana cvs. of common bean were classified as moderately susceptible hosts to the nematode infection but another thirteen of tested cultivars were regarded as least susceptible hosts. These results are in agreement with those of O'Bannon & Santo

(1982); Oteifa & Elgindi (1982); Mullin *et al.*, (1991 a,b); Omwega & Roberts (1992); Chen & Roberts (2003) and Sharma *et al.*, (2006).

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Table 1. Susceptibility of twenty seven leguminous cultivars to *Meloidogyne javanica* under greenhouse conditions.

Crop	Cultivar	Galls/ root	Juv. in soil / pot	Egg- masses / root	Eggs/ egg-mass	P _f	R _f	Host type
Broad bean	Giza 3	26 fg hi	114 c	25 defghi	169 bcde	4378	4.37	LS
	Giza 40	32 efg	53 de	26 defghi	166bcdef	4404	4.40	LS
	Giza 843	11 jk	0 f	8 hij	73 ijk	596	0.59	R
	Maser 1	39 ef	113 c	34 de	187 bc	6524	6.52	MS
	Maser 3	19 ghij	100 c	13 ghij	78 hij	1136	1.13	LS
	Wade1	9 jk	43 de	14 fghij	153 bcdef	2206	2.20	LS
Common bean	Bronco	86 bc	110 c	66 c	193 bc	12961	12.96	MS
	Exira	95 b	150 b	87 b	160bcdef	14216	14.21	MS
	Giza 6	73 c	43 de	65 c	155 bcdef	10218	10.21	MS
	Nebraska	32 efg	108 c	19 defgj	118 efghi	2379	2.37	LS
	Neuten	29 efg	150 b	16 defhij	127 defgh	2115	2.11	LS
	Polista	53 d	44 de	35 d	180bc	6418	6.41	MS
Fenugreek	Savana	45 de	100 c	33 def	155bcdef	5277	5.27	MS
	Giza 2	15 hijk	0 f	3 j	33jk	121	0.12	HR
Lentil	Giza 30	28 fgh	0 f	4 j	70ijk	335	0.33	HR
	Giza 4	16 hijk	88 c	15 fghij	89 hi	1442	1.44	LS
	Giza 9	35 ef	400 a	31 defg	143cdefg	4868	4.86	LS
	Giza 29	33 efg	169 b	27 defg	116fghi	3337	3.33	LS
	Giza 37	16 hijk	48 de	16 efghi	99ghi	1658	1.65	LS
	Giza 51	10 jk	60 d	9 gh	91hi	800	0.80	R
Lupine	Siena 1	33 efg	94 c	25 defghi	183 bc	4702	4.70	LS
	Dagon 2	28 fgh	43 de	27 defg	176bcd	4830	4.83	LS
	Giza 1	8 k	0 f	7 ij	27k	193	0.19	HR
Pea	Giza 2	12 ijk	0 f	15 fghij	27 k	427	0.42	HR
	Lincoln	115 a	100 c	117 a	310a	36511	36.51	HS
	MasterBe	10 jk	28 ef	17 fgh	103ghi	1801	1.80	LS
	Victory	112 a	100 c	126a	202b	25689	25.68	HS

Means in each column followed by the same letters are not significantly different by (P=0.05) according to Duncan's multiple range test; Rate of nematode reproduction= R_f; Final population=P_f

Table 2. Plant growth of twenty seven leguminous cultivars as influenced with the infection of *Meloidogyne javanica* under greenhouse conditions.

Crops	Cultivars	Fresh weight (g)					
		Shoot			Root		
		Infected	Non-infected	Decr. %	Infected	Non-infected	Decr. %
Broad bean (<i>Vicia faba</i>)	Giza 3	34.25**	54.75	37.44	17.10*	28.50	40.60
	Giza 40	16.00*	27.00	40.74	12.90**	21.75	40.68
	Giza 843	28.75	40.50	29.01	12.00*	18.00	33.33
	Maser 1	16.25**	27.75	41.44	12.92*	23.25	44.43
	Maser 3	19.00*	26.75	28.97	10.00	14.25	29.82
	Wade 1	18.75*	28.50	34.20	14.50	19.50	25.64
Common bean (<i>Phaseolus vulgaris</i>)	Bronco	3.32*	5.62	40.92	2.27*	5.15	50.00
	Exira	3.67*	6.77	45.79	2.85*	4.90	41.83
	Giza 6	7.75*	11.47	32.43	3.50*	4.95	29.29
	Nebraska	8.77**	13.00	32.54	4.50	6.50	30.76
	Neuten	9.55	11.30	15.48	3.80	4.11	7.54
	Polista	10.71*	14.57	26.48	5.03*	7.50	33.00
	Savana	3.66 *	5.75	36.34	3.22*	4.9	34.28
Fenugreek (<i>Trigon foenum-graecum</i>)	Giza 2	2.60	3.42	23.97	1.38*	1.70	18.82
	Giza 30	1.48**	2.93	49.48	1.53**	2.92	47.60
Lentil (<i>Lens culinaris</i>)	Giza 4	2.88	3.62	20.44	1.70	1.43	24.64
	Giza 9	1.98**	4.05	51.11	0.55*	1.01	45.54
	Giza 29	3.31**	5.22	36.59	2.19	3.30	33.63
	Giza 37	3.03	3.95	23.54	0.83	1.10	24.54
	Giza 51	1.48*	2.17	31.79	0.79	0.97	18.76
	Siena 1	1.07*	1.70	37.05	0.36	0.58	37.81
Lupine (<i>Lupinus termis</i>)	Degon 2	25.00	32.50	35.38	7.22**	13.50	46.52
	Giza 1	14.25**	17.00	16.17	7.99	8.25	3.15
	Giza 2	19.25*	25.25	23.76	10.35	12.50	17.20
Pea (<i>Pisum sativum</i>)	Lincoln	10.00**	17.50	42.85	0.82**	1.77	46.32
	Master Be	4.53	5.48	14.96	1.00	1.11	9.90
	Victory	5.00**	12.25	59.18	0.86**	2.27	62.11

*Significant at 0.05 level of probability.

**High significant at 0.01 level of probability

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