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Susceptibility of some Cruciferae crops cultivars against the root-knot nematode, *Meloidogyne Javanica*

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Abstract

Ten Cruciferae crops species were evaluated for their host's response to root-knot nematode, *Meloidogyne javanica*. The nematode succeeded in developing and multiplying on all most tested cultivars (cvs.). The ten plant species were divided by their degree of susceptibility to root-knot nematode, *Meloidogyne javanica* as follows: Radish Baladi cv., Cabbage Brunswick cv. and Cabbage Japanese cv. were very resistant host to nematode infection. The calculated values of the numbers of galls per root and rates of nematode reproduction on such cultivars were (24.50–0.15), (9.00 –0.04) and (6.25–0.02) respectively. While Cabbage Sabeini cv., Cauliflower Sultani cv. and Cabbage Dutch cv. were slightly resistant hosts to nematode infection. The calculated values of the numbers of galls per root and rates of nematode reproduction on such cultivars recorded moderate values were 63.75–0.58, 62.25–0.02, and 61.75–0.76 respectively. Turnip Baladi cv., Turnip Japanese cv., Red Radish cv. and Cauliflower Chinese cv. were susceptible hosts to nematode infection, their calculated values of the numbers of galls per root and rates of nematode reproduction on such cultivars were 290.75–9.29, 232.75–4.92, 169.50–4.29 and 120.75–0.29, respectively.

Keywords: *Meloidogyne javanica*, susceptibility, Cruciferae, cultivar.

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1. Introduction

Plant-parasitic nematodes, especially root-knot nematodes (*Meloidogyne*), are among the most important soil-borne pests that cause severe yield and/or quality losses to a wide range of agricultural crops (Jones *et al*., 2013). Moreover, more than 2000 species of plants have already been identified as hosts for root-knot nematodes (Bird *et al*., 2008), and more than 90 species of root-knot nematodes are described so far (Hunt and Handoo, 2009). Ten of these species are of importance from an agricultural point of view, and four species, *Meloidogyne hapla*, *M. arenaria*, *M. javanica and M. incognita*, are considered as major pests in many areas of the world (EPPO/OEPP, 2004). Root-knot nematodes cause considerable problems in intensive agricultural cropping (Caillaud *et al*., 2008) leading to substantial economic losses, mainly as a result of quality damage, to tuber-forming annual crops (Bird *et al*., 2008; Boydston *et al*., 2007). Interestingly, cabbage *(Brassica oleracea var. capitata)* is that is rich in vitamin C, it is regarded as the most significant member of the *Brassicaceae* (Cruciferae) family and has remained one of the world's leading vegetable crops. Also, cabbage is an economically important vegetable crop in several Mediterranean countries (FAOSTAT, 2010). In the Mediterranean basin, under field conditions, cabbage is usually transplanted in late summer and harvested in early spring, and is exposed to infection by several diseases, particularly those caused by soil-borne pathogens. Several diseases have been reported damaging cabbage worldwide. While some of them may simply cause minor spotting, others can be devastating for the crop. Among them plant-parasitic nematodes, particularly root-knot nematodes, *Meloidogyne spp.*, are considered major diseases (Rimmer *et al*., 2007). *Meloidogyne* spp. prevailing in the Mediterranean basin, such as *M. arenaria, M. incognita* and *M. javanica* are warm climate species. However, the low soil temperatures reached in the Mediterranean basin in fall and winter are not suitable for infection and development of these *Meloidogyne species* (Moens *et al*., 2009) and, therefore, the incidence of root-knot nematodes in cabbage in this region is usually low (Buczacki *et al*., 1978). The pathogenicity of the sugar beet cyst nematode *Heterodera schachtii* and the root-knot nematodes *Meloidogyne arenaria, M incognita* and *M javanica* on cabbage cvs. Balady, Brunswick and Ganzouri, cauliflower cv. Balady, turnip cv. Balady, and radish cv. Balady was determined in several greenhouse tests. The results showed that the tested cruciferous plant cultivars were either susceptible or highly susceptible to the tested nematodes except radish cv. balady, which was moderately resistant to *H schachtii* and moderately susceptible to the tested root- knot nematode species (Ibrahim *et al*., 2013). Although some studies exist on the host status of various Brassicaceae to root-knot nematodes (Khan and Khan, 1991; McSorley and Frederick, 1995; Netscher and Sikora, 1990), little infonnation exists on the host status of Egyptian crucifers to *Meloidogyne* spp., or control measures for them (Ibrahim *et al*., 2013). Other vegetables are reported in the literature as

susceptible to root-knot nematodes, including brassicaceae, solanaceae, cucurbitaceae and liliaceae (Brito *et al*., 2007; McSorley and Frederick, 1995, Ponte *et al*., 1996; Walker, 2002). The root-knot nematode species most damaging to cabbage are *M. arenaria* (Neal) Chitw, *M. artiellia* Franklin, *M. hapla* Chitw., *M. incognita* (Kofoid ET White) Chitw., *M. javanica* (Treub) Chitw. and *M. enterolobii* Yan ET Eisenback (= *M. mayaguensis* Rammah ET Hirschmann) (Abrantes *et al*., 1994; Potter and Olthof, 1993; Sikora and Fernández, 2005). *Meloidogyne spp.* prevailing in the Mediterranean basin, such as *M. arenaria, M. incognita* and *M. javanica* are warm climate species. However, the low soil temperatures reached in the Mediterranean basin in fall and winter are not suitable for infection and development of these *Meloidogyne species* (Moens *et al*., 2009). The results showed that *M. incognita* and *M. javanica* responded in a similar fashion to the different cover cultivars. Indian mustard (*Brassica juncea*) and turnip (*B. rapa*) were generally good hosts, whereas most oil radish cultivars *(Raphanus. sativus ssp. oleiferus)* were poor hosts. However, some oil radish cultivars were among the best hosts for *M. hapla*. The arugula (*Eruca sativa*) cultivar Nemat was a poor host for all three nematode species tested (Edwards and Ploeg, 2014). Egg masses from the Brassicaceae species contained fewer eggs than tomato egg masses. Differences were not significant at 5 weeks, but all Brassicaceae species differed from tomato at 6 weeks. Only rape cv. Korina differed significantly from tomato at 7 weeks and hybrid turnip cv. Purple Top and tomato did not differ significantly at 8 weeks (McLeod *et al*., 2001). Although Brassicaceae crops are hosts, they are poorly invaded and suppress nematode growth and development, thereby reducing the risk of *M. javanica* increasing on Brassicaceae crops (Stanton and Eyres, 1994).

2. Materials and methods

2.1 Culture of nematodes

Root knot nematode *Meloidogyne javanica* was selected as test organism. The culture of root knot nematode, *Meloidogyne javanica*, is maintained on potted eggplant plants in the glasshouse. The infected plants will be uprooted, carefully washed in running tap water and egg- masses will be collected into Petri dishes containing distilled water.

2.2 Greenhouse screening tests

Seeds of ten Cruciferae crops Sultani and Chinese, (Cauliflower), Sabeini, Dutch, Japanese and Brunswick (Cabbage), Red and Baladi (Radish) and Baladi and Japanese (Turnip) were germinated in 15 cm diameter clay pots filled with a 2:1 mixture of loamy sand soil. Six weeks - old, germinated seedlings were thinned to one healthy plant per pot. Each pot was inoculated with approximately 3000 newly hatched juveniles of each *Meloidogyne javanica* per plant by pipetting the nematode suspension in three holes around the root system. Four pots were used as replicates for each plant species. Inocula of each nematode species

were obtained from available pure stock cultures maintained on suitable hosts in a greenhouse. Each plant species was replicated four times including those kept non-infected serving as check. All pots were then, arranged in a randomized block design on a bench in a greenhouse. All plants were grown during the normal growing seasons at greenhouse temperature of 20±5 °C. Fifty days after inoculation, all plants were harvested, and the root system of each plant was carefully removed gently washed in water and stained in lactophenol acid fuchsine (Goodey, 1957). The number of juveniles in soil per pot, galls, nematode developmental stages on root, egg-masses per root was counted. Eggs of ten randomly selected egg-masses of each root system were also counted by sodium hypochlorite. The rate of nematode reproduction was calculated. Plant growth criteria involving length and fresh weight of both roots and shoots were calculated. The percentages of reduction of such parameters of each plant were also collected. Root gall index values were estimated according to the following scales: 0 = 0 galls, 1 = 1–2 galls, 2 = 3–10 galls, 3 = 11–30 galls, 4 = 31–100 galls and 5 = > 100 galls (Taylor and Sasser, 1978). The host category of the tested crop cultivars plants infected with the root-knot nematode, based on root galls index ranges was determined according to Hadisoeganda and Sasser (1982), as follow 0 = Immune host (I), 0.0–1.0 = highly resistant (HR), 1.1–3.0 = very resistant (VR), 3.1–3.5 = moderately resistant (MR), 3.6–4.0 = slightly resistant (SR), 4.1–5.0 = susceptible (S).

3. Results and Discussion

Ten Cruciferae crops species were exposed under greenhouse conditions against attack by the root-knot nematode *Meloidogyne javanica* it is evident that, the nematode reproduction and nematode fecundity were greatly affected by host type. Results in Table (1) showed that *M. javanica* larvae succeeded in developing and multiplying on all the tested Cruciferae family cultivars. Therefore, the nematode population was significantly affected by the tested cultivars under the same conditions, thereupon Turnip Baladi cv., Turnip Japanese cv., Red Radish cv. and Cauliflower Chinese cv. gained the highest values of number of galls per root, nematode juveniles in soil, nematode developmental stages per root, egg-masses per root, eggs per egg-mass, nematode final population, and rate of nematode reproduction among at the tested cultivars. Significant differenced ($P \geq 0.05$) in the nematode criteria on such plant cultivars were observed when compared with those of the other tested cultivars. Also, their calculated values of the numbers of galls per root and rates of nematode reproduction on such cultivars were 290.75–9.29, 232.75–4.92, 169.50–4.29 and 120.75–0.29, respectively. While, tested Cabbage Sabeini, Cauliflower Sultani and Cabbage Dutch cultivars the recorded moderate values of

the numbers of galls per root and rates of nematode reproduction on such cultivars were 63.75–0.58, 62.25–0.02, and 61.75–0.76, respectively. On the other hand, Radish Baladi, Cabbage Brunswick and Cabbage Japanese cultivars supported the lowest values of nematode juveniles in soil, number of galls per root, nematode developmental stages per root, egg-masses per root, eggs per egg-mass, rate of nematode reproduction and nematode final population. The calculated values of the numbers of galls per root and rates of nematode reproduction on such cultivars were 24.50–0.15, 9.00–0.04 and 6.25–0.02, respectively (Table 2).

Table (1): Susceptibility of some Cruciferae crop cultivars to the root-knot nematode *Meloidogyne javanica* under greenhouse conditions.

Scientific name	Common name	Cultivars	Number of galls/root	Nematode population					Nematode final population (P_f)	Rate of nematode reproduction (P_f /P_i)	Egg production (%)	Host category
				Juveniles in soil/pot	Nematode develop stage/root	Adult female/root	Number of egg masses /root	Number of eggs/egg mass				
Brassica oleracea var. *botrytis*	Cauliflower	Sultani	62.25 e	0.00 e	56.50 cd	7.00 c	5.00 c	0.00 f	63.50	0.02	0.00	SR
		Chinese	120.75 d	60.00 de	88.75 ab	30.00 c	27.75 c	25.25 f	879.44	0.29	2.61	S
Brassica oleracea var. *capitata*	Cabbage	Sabeini	63.75 e	65.50 de	29.00 def	31.00 c	24.75 c	65.00 de	1734.25	0.58	5.99	SR
		Dutch	61.75 e	117.25 d	39.00 cde	24.50 c	25.75 c	81.75 cd	2285.81	0.76	7.84	SR
		Japanese	6.25 f	0.00 e	5.75 f	2.00 c	1.50 c	33.75 ef	58.38	0.02	0.19	VR
		Brunswick	9.00 f	0.00 e	6.00 f	4.75 c	2.50 c	43.00 ef	118.25	0.04	0.40	VR
Raphanus sativus	Radish	Red Radish	169.50 c	617.50 b	62.00 bc	106.50 b	83.25 b	145.25 b	12878.06	4.29	45.04	S
		Baladi	24.50 ef	266.50 c	13.25 ef	9.00 c	6.00 c	26.25 f	446.25	0.15	0.59	VR
Brassica rapa var. rapifera	Turnip	Baladi	290.75 a	736.50 a	108.00 a	182.00 a	148.75 a	180.50 a	27875.88	9.29	100.00	S
		Japanese	232.75 b	652.50 b	90.25 ab	152.75 a	135.50 a	102.25 c	14750.38	4.92	51.60	S

Means in each column followed by the same letter are not significantly different by (p=0.05) according to Duncan's multiple range test.

Table (2): Plant growth of some Cruciferae crop cultivars as influenced with the infection of the root-knot nematode *Meloidogyne javanca* under greenhouse conditions.

Scientific name	Common name	Cultivars	Length in (cm)						Fresh weight in (gm)						Host Category
			Shoot			Root			Shoot			Root			
			Infected	Non-infected	Decr. %	Infected	Non-infected	Decr. %	Infected	Non-infected	Decr. %	Infected	Non-infected	Decr. %	
Brassica oleracea var. *botrytis*	Cauliflower	Sultani	29.75	30.75	3.25	27.11	27.00	-0.41	15.33	16.31	6.36	3.50	3.81	8.86	SR
		Chinese	19.50	20.00	2.50	24.75	26.75	7.48	12.41	12.40	-0.10	2.62	2.65	1.15	S
Brassica oleracea var. *capitata*	Cabbage	Sabeini	19.25	21.00	8.33	9.00	9.25	2.70	5.09	5.99	17.57	0.78*	1.03	32.80	SR
		Dutch	19.75*	23.25	15.05	18.50	19.00	2.63	11.36	11.51	1.37	6.33	7.56	19.52	SR
		Japanese	23.75	24.25	2.06	16.50	16.50	0.00	14.71	14.49	-1.50	3.74	4.66	24.52	VR
		Brunswick	23.25*	24.25	4.12	11.00	11.50	4.35	12.38	13.39	8.10	2.61	2.62	0.48	VR
Raphanus sativus	Radish	Red Radish	24.00*	31.25	23.20	29.25*	33.00	11.36	9.65*	13.27	37.46	3.43	5.00	45.73	S
		Baladi	25.75	27.75	7.21	25.25	27.00	6.48	10.77	13.85	28.55	2.74	3.01	9.85	VR
Brassica rapa var. rapifera	Turnip	Baladi	25.00	32.25	22.48	22.50**	30.25	25.62	9.76	11.07	13.40	13.47	14.43	7.13	S
		Japanese	20.25*	26.50	23.58	21.00*	24.50	14.29	7.42	10.55	42.18	2.75	3.35	21.73	S

* Significant at 0.05 level of probability. ** Highly significant at 0.01 level of probability.

These results are in accordance with findings of McLeod *et al*. (2001), McSorley and Frederick (1995) and Ibrahim *et al*. (2013). The ten plant species were divided by their degree of susceptibility to *Meloidogyne javanica* as follows:

- Radish Baladi, Cabbage Brunswick and Cabbage Japanese cultivars were very resistant host to nematode infection.
- Cabbage Sabeini, Cauliflower Sultani and Cabbage Dutch were slightly resistant host to nematode infection.
- Turnip Japanese, Red Radish and Cauliflower Chinese cultivars were susceptible host to nematode infection.

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