

Screening of some Potato cultivars for Root- Knot Nematode (*Meloidogyne javanica*) and Reniform Nematode (*Rotylenchulus reniformis*) Infection under Greenhouse Conditions

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ABSTRACT

Evaluation of sixteen potato (*Solanum tuberosum*) cultivars (Banba, Belleni, Bresius, Burren, Cara, Diamant, Hermes, Kuras, Lady Balfour, Lady Rosetta, Metro, Mondial, Solana, Synergy, Spunta and Strux) for their susceptibility and resistance against both *Meloidogyne javanica* and *Rotylenchulus reniformis* infection was tested under greenhouse conditions. The behavior of both nematode species was greatly governed by the tested cultivars. None of the potato cultivars was immune host for both nematode species infection. *M. javanica* succeeded in invading and developing on all tested potato cultivars except Kuras and Solana cvs. which were considered as highly resistant and moderately susceptible hosts, respectively. On the other hand, Belleni, Bresius, Hermes, Lady Rosetta, Solana, and Synergy were ranked as highly resistant (HR) to *R. reniformis*, while the rest cultivars showed various degrees in their susceptibility to *R. reniformis* infection.

Key words: Potato, cultivars, screening, *Meloidogyne javanica*, *Rotylenchulus reniformis*, greenhouse.

INTRODUCTION

Potatoes are a major crop in Egypt and contribute immensely to human nutrition and food security (Karim et al., 2010). Major pests of potato include various plant parasitic nematodes causing significant damage by reducing number and size of tubers that resulting in low quality of tubers. Many nematode genera especially root-knot and the reniform nematodes have been reported to attack potato in Egypt (Salem, 2006). Evaluation of potato cultivars for their susceptibility to the root-knot nematodes *Meloidogyne* spp. and the reniform nematode, *Rotylenchulus reniformis* as a promising and safe method of control has been studied by several investigators (Giffin & Stoker, 1968; Gonzalez & Accatino, 1974; Robois, et al., 1978; Araujo 1982; Kheir, et al., 1982; Riveria-Smith et al., 1991 and Kandouh, 2012). Montasser, et al. (1992) examined eight potato cultivars for their relative susceptibility to the infection of each of *M. javanica* and *R. reniformis* and they reported that Alpha cv. was susceptible host to both nematode species. Also, Draga, Liest-A and Serana cvs. were susceptible hosts to *M. javanica*, but were moderately resistant, highly resistant and less susceptible

hosts to *R. reniformis*, respectively. Giant, Kondor and Mondial cultivars were very resistant hosts to *M. javanica* whereas, were moderately resistant, less susceptible and susceptible hosts to *R. reniformis*, respectively. On the other hand, the Serana-28 cultivar was slightly resistant and highly resistant host to *M. javanica* and *R. reniformis*, respectively.

Also, Abd-Alla (1999) screened eight potato cultivars for their susceptibility against the root-knot nematodes *M. incognita*, *M. javanica* and the reniform nematode, *R. reniformis*. He found that all the tested potato cultivars were susceptible hosts against both root-knot nematode species. While, Anka, Nicola, Oliva and Yasmina and Aida, Diamont, Draga and Spunta cultivars were immune and highly resistant hosts to *R. reniformis* infection, respectively. Ibrahim, et al. (2014) tested six potato cultivars against the root-knot nematode species, *M. arenaria*, *M. javanica* and *M. incognita*, in the greenhouse. They found that Diamant, Lady Rosetta cvs. were highly susceptible to the tested nematode species, while Desiree, Famosa, Spunta and King Eduard cvs. were susceptible to the tested nematode. El-Sherif, et al. (2017) evaluated four potato cultivars against their suitability to *M. incognita* infection. They indicated that Cara and Draga cvs. were classified as moderately resistant hosts while Spunta and Solana cvs. were rated as highly susceptible and susceptible hosts to nematode infection, respectively.

The objective of this study was to determine the susceptibility of sixteen potato cultivars to *M. javanica* and *R. reniformis* under greenhouse conditions.

MATERIALS AND METHODS

One sprout of potato tuber cultivars (Banba, Belleni, Bresius, Burren, Cara, Diamant, Hermes, Kuras, Lady Balfour, Lady Rosetta, Metro, Mondial, Solana, Synergy, Spunta and Strux) was separately planted in 20 cm diameter clay pots containing mixture of clay and sand soil (1:1) for two weeks. The pots were then inoculated with approximately 1000 newly hatched juveniles of *Meloidogyne javanica* or 1000 immature female of *Rotylenchulus reniformis* per plant by pipetting the nematode suspension in five holes around the root system. Each potato cultivar was replicated four times including those kept uninoculated serving as check. All pots were arranged in a randomized block design on a bench in a greenhouse. All pots were grown during the normal growing seasons at greenhouse temperature of 30 ± 5 °C for *M. javanica* and 20 ± 5 °C for *R. reniformis* after 45 days of inoculation. All plants were then harvested and removed gently washed in water then stained in lactophenol acid fuchsin (Goodey 1957). The numbers of juveniles in soil per pot, galls, developmental stages, egg masses per root were counted. Eggs of ten randomly selected egg masses of each root system was also counted. The rate of nematode reproduction was calculated. The host category of the tested potato cultivars infected with *M. javanica* based on nematode reproduction (Pf/Pi) was determined according to Montasser, et al. (2017) as follows: (Pf / Pi = 0.0) I = Immune host; (Pf / Pi < 0.4) HR = Highly resistant host; ($0.5 \leq \text{Pf / Pi} \leq 0.9$) R = Resistant host; ($1.0 \leq \text{Pf / Pi} \leq 4.9$) LS = Less susceptible host; ($5.0 \leq \text{Pf / Pi} \leq 14.9$) MS = Moderately susceptible host and (Pf / Pi > 15.0) HS = Highly susceptible host. Also, the potential of each

cultivar to support egg production of *R. reniformis* was calculated in relation to that of Burren potato cultivar which was regarded as a check potato cultivar and host category, based on percentage of egg production of each potato cultivar was estimated according to that scale given by Montasser (1986) as follows: 0%= Immune (I), 1-10%= Highly resistant(HR), 11-20%= Resistant (R), 21-40%= Less susceptible (LS), 41-60%= Moderately susceptible (MS), and 61-100%= Highly susceptible (HS). Data were subjected to analysis of variance (ANOVA) Gomez and Gomez (1984) followed by Duncan's multiple range test to compare means (Duncan, 1955).

RESULTS AND DISCUSSION

Response of sixteen potato cultivars was tested for their susceptibility to the infection with the root-knot nematode *M. javanica* under greenhouse conditions. Data presented in Table (1) and Fig.1 indicated that Kuras cv. had the lowest values of numbers of galls, juveniles in soil, nematode developmental stages, egg masses and eggs per egg mass. Also the calculated nematode final population was less than nematode inoculum population (RF=0.47). Significant differences ($p=0.05$) in nematode criteria on such cultivar were observed when compared with those of the other tested cultivars. On the other hand, the calculated values of nematode reproduction of the rest tested potato cultivars were ranged between 13.42 and 94.77 folds.

Plant growth response due to root knot nematode infection was determined through the estimation of the percentage reduction in plant height and fresh weights of shoots and roots (Table 2). Among the potato cultivars tested, the highest percentage reduction values of shoot length was showed in Diamant and Hermes cultivars (47.6 and 37.5%) followed by Mondial, Cara and Burren cultivars. Meanwhile, Solana, Belleni and Synergy cultivars showed the lowest percentage reduction values (3.7, 4.2 and 8.0 %) compared to the uninoculated one, respectively. However, in the root length parameter, the highest percentage reduction values were shown in Strux and Belleni cultivars (33.0 and 30.3 %) followed by Metro, Lady Balfour, Solana, Mondial and Kuras cultivars. While, Hermes, Cara and Lady Rosetta cultivars showed the lowest percentage reduction values (Fig. 1).

On the other hand, the highest percentage reduction values in shoot weight were recorded on Hermes, Kuras and cultivars (50.4, 50.0 and 49.0 %), respectively. Followed by Spunta and Lady Balfour cultivars, the lowest percentage reduction values included Metro and Lady Rosetta cultivars (1.3 and 1.5 %). Meanwhile, in root weight parameter, the highest percentage reduction values were shown in Belleni and Diamant cultivars (58.5 and 45.8 %), respectively, followed by Lady Rosetta and Metro cultivars. The lowest percentage reduction values were recorded on Burren and Cara cultivars (3.1and 7.8 %), respectively (Fig. 1).

Thereupon, the tested potato cultivars were classified for their susceptibility to the root knot nematodes, *M. javanica* as follows: Kuras cultivar was highly resistant host (HR), but Solana cultivar was moderately susceptible host (MS), while other cultivars tested were found to be highly susceptible hosts (HS) (Table 1). These

Table 1 .Susceptibility of potato cultivars as influenced by the infection of the root-knot nematode, *Meloidogyne javanica* under greenhouse conditions.

Potato cultivars	No.galls /root	Nematode population						Nematode Final Population (Pf)	Rate of Nematode reprod. *(RF)	Host Category
		No. juveniles in soil/pot	Nematode Develop. stages/root	No.adult females /root	No.egg masses /root	No. eggs/egg mass				
Banba	264 Ab	52 b	8 B	249 Ab	255 Ab	300 bcd	76819	76.81	HS	
Belleni	199 Abc	10 b	7 B	189 Abc	193 Abc	118 g	23088	23.08	HS	
Bresius	218 Abc	33 b	8 B	203 Abc	211 Abc	300 bcd	63544	63.54	HS	
Burren	293 Ab	80 b	133 A	265 Ab	285 Ab	257 cde	73723	73.72	HS	
Cara	247 Ab	803 a	2 B	242 Ab	242 ab	204 defg	50415	50.41	HS	
Diamant	276 Ab	25 b	2 B	273 Ab	275 ab	316 Bc	87200	87.2	HS	
Hermes	300 Ab	88 b	9 B	270 Ab	278 ab	298 bcd	83211	83.21	HS	
Kuras	10 D	75 b	2 B	2 D	2 D	150 Fg	479	0.47	HR	
Lady Balfour	182 Abc	183 b	6 B	171 abc	177 abc	175 efg	31335	31.33	HS	
Lady Rosetta	179 Abc	47 b	2 B	157 Bc	158 bc	252 cde	40022	40.02	HS	
Metro	264 Ab	80 b	2 B	256 Ab	258 ab	366 Ab	94768	94.77	HS	
Mondial	230 Abc	53 b	7 B	224 abc	228 abc	285 bcd	65264	65.26	HS	
Solana	93 Cd	133 b	8 B	78 Cd	82 cd	161 efg	13421	13.42	MS	
Synergy	311 Ab	108 b	11 B	289 Ab	300 ab	235 cdef	70908	70.91	HS	
Spunta	333 A	23 b	5 B	327 A	332 A	220 cdef	76715	76.72	HS	
Strux	158 Bc	160 b	5 B	151 Bc	156 bc	449 a	70360	70.36	HS	

Means in each column followed by the same letter(s) are not significantly different by (P=0.05) according to Duncan's multiple range test; *Rate of nematode reproduction (RF)= Pf / Pi; Final population, Initial population.

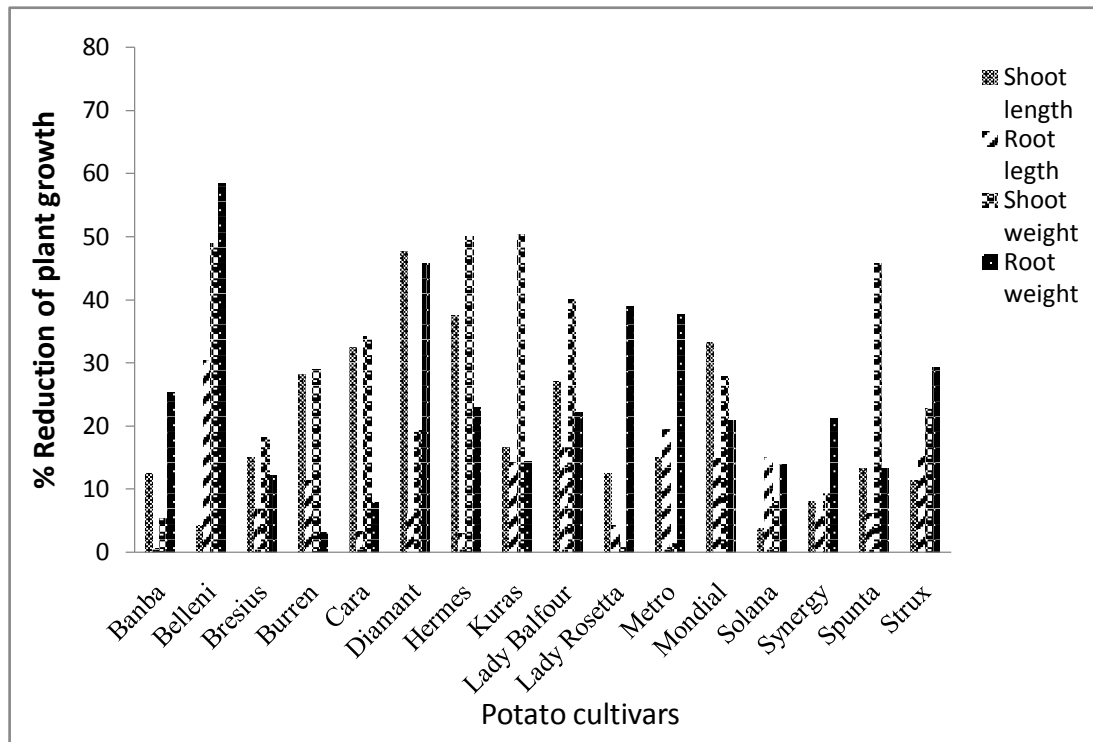


Fig 1. Plant growth parameters of potato cultivars as influenced with the infection of the root-knot nematode *Meloidogyne javanica* under greenhouse conditions.

results are in agreement with Montasser et al. (1992) and Bekhiet et al. (2010). Abd-Elgawad et al. (2012) indicated that Spunta and Diamant potato cultivars were susceptible to *M. incognita* infection. Youssef, (2013) who recognized root-knot nematodes as one of the major parasites of potato, found that losses vary depending upon the cultivar. Also, previous studies by Vovlas et al. (2005) reported a typical susceptible reaction of potato cultivars Cara and Spunta to infection by *M. javanica*.

The sixteen potato cultivars were also tested for their resistance to *R.reniformis* infection under greenhouse conditions. Data in Table (2) suggested that *R.reniformis* failed to develop and reproduce on Belleni, Bresius, Hermes, Lady Rosetta, Solana and Synergy cultivars resulting the lowest values of nematode reproduction and percentage of egg production which ranged between 0.26 & 1.06 folds and 2.57 – 7.78, respectively. On Diamant, Kuras, Metro and Spunta cultivars, the reniform nematode reproduced moderately yielding the moderate values of nematode reproduction (2.36, 2.18, 1.62 & 2.65 folds) and percentage of egg production (18.82, 17.32, 11.09 & 18.99 %), respectively. On the other hand, the rest potato cultivars gave the highest values of nematode reproduction and percentage of egg production which ranged between 3.18 and 12.66 folds and 24.19 and 100%, respectively (Fig. 2). Plant growth response due to reniform nematode infection was determined through the

Table 2. Susceptibility of potato cultivars as influenced with the infection of the reniform nematode, *Rotylenchulus reniformis* under greenhouse conditions.

Potato cultivars	Nematode population						Nematode Final Population (Pf)	Rate of Nematode reprod. *(RF)	**Egg Prod. %	Host Category
	No. juveniles in soil/pot	Nematode Develop. stages/root	No.adult females /root	No.egg masses /root	No. eggs/egg mass					
Banba	116 F	20 ef	113 D	111 E	54 cd		6243	6.24	51.15	MS
Belleni	190 E	1 i	10 I	6 J	70 a		621	0.26	3.58	HR
Bresius	80 F	5 hi	8 I	7 J	43 e		394	0.39	2.57	HR
Burren	600 a	112 a	223 A	217 A	54 cd		12653	12.66	100.0	HS
Cara	389 b	66 b	141 C	130 D	39 ef		5744	5.74	43.93	MS
Diamant	90 f	22 ef	38 F	35 G	63 d		2355	2.36	18.82	R
Hermes	70 f	6 hi	9 I	9 J	55 cd		580	0.58	4.22	HR
Kuras	102 f	8 gh	35 F	35 G	58 bc		2178	2.18	17.32	R
Lady Balfour	350 b	55 c	144 C	140 C	76 a		11189	11.19	90.80	HS
Lady Rosetta	70 f	3 hi	19 H	18 I	37 ef		757	0.75	5.68	HR
Metro	275 cd	13 g	28 G	26 H	50 d		1616	1.62	11.09	R
Mondial	590 a	40 d	210 B	165 B	33 fg		6285	6.29	46.46	MS
Solana	90 f	39 d	27 G	24 Hi	38 ef		1068	1.06	7.78	HR
Synergy	213 de	3 hi	11 I	10 J	52 cd		746	0.75	4.44	HR
Spunta	325 bc	25 e	78 E	89 F	25 h		2653	2.65	18.99	R
Strux	214 de	19 f	115 D	105 E	27 gh		3183	3.18	24.19	LS

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 (RF)= Pf / Pi; Final population , Initial population ; **Egg production % = $\frac{\text{Egg masses} \times \text{eggs}_{\text{test cultivar}}}{\text{Egg masses} \times \text{eggs}_{\text{Burren cultivar}}} \times 100$

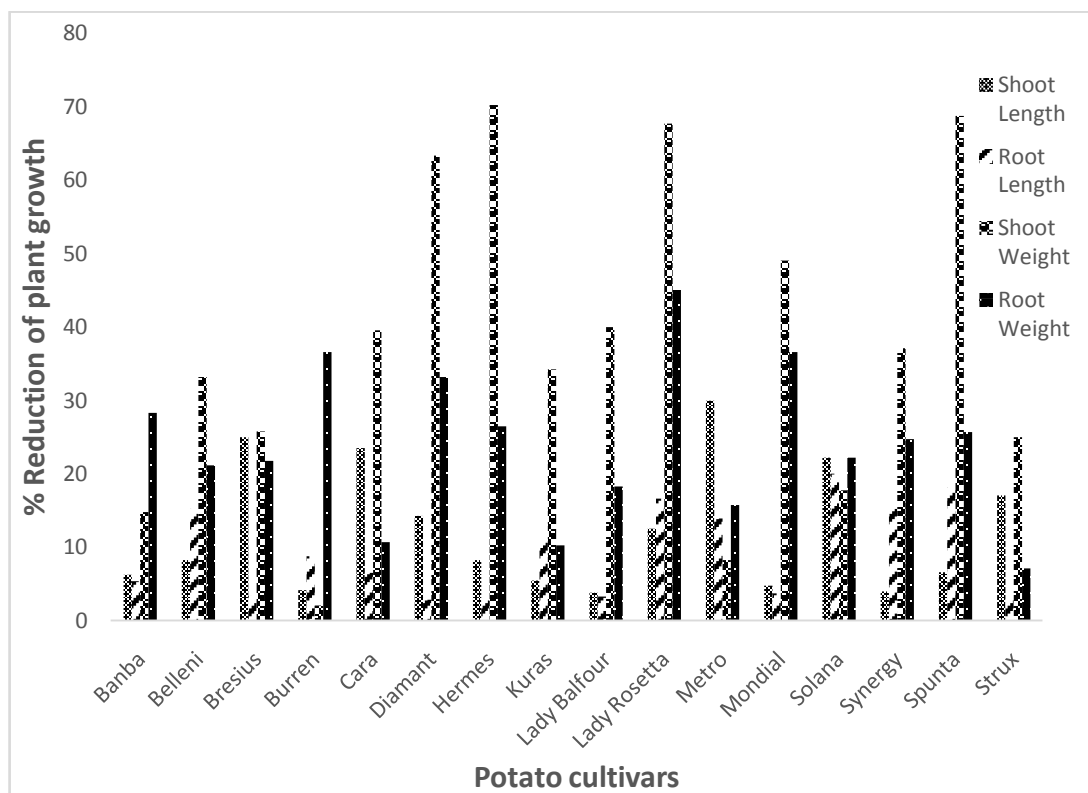


Fig 2. Plant growth parameters of potato cultivars as influenced with the infection of the reniform nematode, *Rotylenchulus reniformis* under greenhouse condition.

estimation of the percentage reduction in plant height and dry weights of shoots and roots (Fig. 2). Among the potato cultivars tested, the highest percentage reduction values of shoot length were shown in Metro cultivar (30.0%) followed by Bresius, Cara and Solana cultivars (25.0, 23.5 and 22.2 %, respectively). Meanwhile, Lady Balfour, Synergy, Burren and Mondial cultivars showed the lowest percentage reduction values (3.8, 4.0, 4.2 and 4.8 %) compared to the uninoculated one respectively. However, in the root length parameter, the highest percentage reduction values were shown in Solana (20.0%) and Spunta (18.2 %) cultivars followed by Lady Rosetta and Belleni cultivars. while, Diamant, Hermes, Strux, Lady Balfour and Mondial cultivars showed the lowest percentage reduction values. Also, the highest percentage reduction values in shoot weight were recorded on Hermes, Spunta, Lady Rosetta and Diamant cultivars (70.2, 68.7, 67.7 and 63.3 %), respectively. The lowest percentage reduction values included Burren(2.1%) and Metro (8.3 %) cultivars. Meanwhile, in root weight parameter, the highest percentage reduction values were shown in Lady Rosetta, Burren and Mondial cultivars (45.0, 36.6 and 36.6 %), respectively, followed by Diamant and Banba cultivars. The lowest percentage reduction values were indicated in Strux, Kuras and Cara cultivars (7.1, 10.3 and 10.7%), respectively (Fig.2).

Based on Burren cultivar used as a comparable plant to assess the response of the tested potato cultivars for *R. reniformis* infection, the cultivars Belleni, Bresius, Hermes, Lady Rosetta, Solana and Synergy could be classified as highly resistant hosts (HR), while Diamant, Kuras, Metro and Spunta cvs. were resistant hosts (R) to the reniform nematode infection. The rest tested potato cultivars were ranked as less moderate or highly susceptible hosts (Table 2). These results support the findings of Montasser et al. (1992) and Bekhiet et al. (2010). Alpha and Mondial cultivars were susceptible hosts to *R. reniformis* nematode, while Serana and Kondor were less susceptible hosts.

In conclusion, the present study declared that Kuras was the only potato cultivar that resist *M. javanica* and ten cultivars were classified as resistant and highly resistant to *R. reniformis*, a promising result that could be recommended to be used within integrated pest management after further studies under greenhouse and field conditions.

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الملخص العربي

إختبار حساسية بعض أصناف البطاطس للإصابة بكل من نيماتودا تعقد الجذور والنيماتودا الكلوية تحت ظروف الصوبة

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تم اختبار حساسية ستة عشر صنف من البطاطس المستوردة تبعاً لدرجة استجابتها للإصابة بنيماتودا تعقد الجذور والنيماتودا الكلوية وذلك تحت ظروف الصوبة وقد أظهرت جميع الأصناف المختبرة تبايناً كبيراً في درجة استجابتها للإصابة بالنيماتودا وفقاً لاختلاف صنف العائل ونوع النيماتودا . وقد تم قياس مدى الحساسية للإصابة على أساس معدل تكاثر نيماتودا تعقد الجذور والتي أشارت إلى أن صنف كوراز أظهر درجة عالية من المقاومة بينما الصنف سولانا أظهر درجة متوسطة من المقاومة بينما صنفت باقي الأصناف الأخرى المختبرة كعوائل عالية الحساسية للإصابة بنيماتودا تعقد الجذور وعلى الصعيد الآخر تم قياس مدى حساسية الأصناف للإصابة بالنيماتودا الكلوية على أساس قياس النسبة المئوية لمعدل إنتاج البيض والتي أشارت إلى أن الأصناف بيليني ، بريسي ، هرمس ، ليدى روزيتا ، سولانا ، سينارجي أظهرت درجة عالية من المقاومة بينما أظهرت الأصناف دايمنت ، كوراز ، مترو ، اسبونتو الدرجة الأقل من المقاومة في حين أظهرت باقي الأصناف درجات مختلفة من الحساسية للإصابة بالنيماتودا الكلوية .