Plant Archives Vol. 20, Supplement 1, 2020 pp. 1814-1818 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

SCREENING OF THREE SOLANACEAE PLANT VARIETIES TO *MELOIDOGYNE INCOGNITA* INFECTION WITH REFERENCE TO NEMATODE ABUNDANCE IN IRAQ

Saasdoon Saadoon Murad[1]*, Jabbar Ahmed Shamkhi [2], Waheed Ali Ahmed[1] and Gad Samir Borham[3]

[1*]Department of Horticulture, College of Agriculture, Qadisiyah University, Iraq.
[2]Plant Protection Department, Agriculture College, Al-Muthanna University, Iraq.
[3]Department of Agricultural Zoology, Mansoura University, Egypt.

Abstract

A nematological survey was conducted at the rhizosphere of Solanaceae plants the growing seasons of 2017-2018 that represented different fields in five counties of Iraq state *i.e.*, Alsaniyha, Shamiyah, Ghamas, Shaafa'i and Sudair. Alsaniyah area recorded the highest rate of root nematode infection (105.88%), followed by Al-Shamiya area (70.0%), while Al-Sudair came in last one (27.58%). *Meloidogyne* assumed to be the key pest of vegetable crops in the five surveyed counties. Solanaceae cultivars were affected by nematode infection at various degrees. Among tested two tomato cultivars, cv. Ahlam accomplished the highest reduction of the tested parameters while the eggplant cultivar, Long purple stated the highest reduction percentage and pepper cv California Wonder showed the highest reduction percentage for the same plant growth criteria as well.

Key words : Solanaceae, *Melidogyne incognita*, nematode.

Introduction

Eggplant, *Solanum melongena* L., pepper, *Capsicum annuum* L. and tomato plant *Lycopersicon esculentum* Mill. are the major economic solanaceae crops grown all over the world. The plants of this family are well known as a natural source of tropan alkaloids including hyoscyamine, scopolamine and atropine (Kartle *et al*. 2003) and are cultivated for their medicinal importance (Etminan *et al*., 2012). Several plant parasitic nematodes especially root-knot nematodes, *Meloidogyne* spp. were recorded as pathogens of eggplant, pepper, potato and tomato plants in many soil types all over the world. plant parasitic nematodes, viz. *Meloidogyne* spp. caused significant damage and losses to most agricultural crops in the tropical and sub-tropical regions (Luc *et al.,* 2005). The root-knot nematodes, *M. incognita* (Kofoid & White) Chitwood is considered to be the most popular species which affect major field and vegetable crops and caused great economic damages. They were widely distributed in the cultivated areas all over the world causing remarkable crop losses, particularly with eggplant, pepper, potato and tomato yields. Moreover, the estimated loss in yield caused by all plant parasitic nematode on 24 vegetable crops in the USA was approximately 11% (Feldmesser *et al.,* 1971). Nematological survey is necessary in providing information on the probability and magnitude of crop losses due to nematode infection, especially with *Meloidogyne* spp. Their wide host range and favourable environmental conditions provoked suitable control measure to achieve reasonable results. The suitability of a host for plant-parasitic nematodes is expressed as the ability of the nematode to multiply on the plant. Host suitability may be expressed objectively as the ratio of the number of nematode units recovered at the end of the test, the final nematode population density (P_f), to the number of nematode units used to inoculate the plant, the initial population density (Pi) (Lewis, 1987). It is well known that plants reacted differently to various nematodes. So, a part of this work was carried out to test certain cultivars of solanaceae plants *i.e.* eggplant,

***Author for correspondence :** E-mail : Saadoon.murad@eq.edu.iq

pepper and tomato suitability to root knot nematode, *M. incognita* infection under greenhouse conditions.

Materials And Methods

Nematode seasonal fluctuation and abundance at Iraq state

One hundred and fifty composite soil samples were collected from the rhizosphere of Solanaceae plants the growing seasons of 2017-2018. These soil samples represented different fields in five counties of Iraq state *i.e.*, alsaniyah, Shamiyah, Ghamas, Shaafa'i and Sudair. **S**amples were obtained by digging the soil to a depth of about 15-30cm of the rhizosphere of the Solanaceae plants. Samples were collected twice, first before planting and the second after two months during the growing season. **S**oil samples of about 1kg each were placed in labeled plastic bags and sent directly to of the laboratory of horticulture and garden Engineering Dept. Faculty of Agriculture / University of Qadisiyah, Iraq and kept in the refrigerator at 4ºC until nematode extraction. Separation of nematodes from soil was accomplished by sieving and modified Baermann technique (Goodey,1957). Identification of the root knot nematode in repeated aliquots (1m/each) in each soil sample was based on the morphological characters of the adult and larval forms according to Mai and Lyon (1975). The Hawksely counting slide was used for determining the number of nematode and recorded.

Pathogenicity test

A greenhouse experiment was conducted in order to evaluate six Solanaceae cultivars namely: tomato (two cultivars *i.e.* Rutger and Ahlam), eggplant, (two cultivars *i.e.* Black Beauty and Long Purple) and pepper, (two cultivars *i.e.* California Wonder and Lamyo) for their susceptibility to the root knot nematode, *M. incognita* infection. Sixty plastic pots 10-cm-d filled with 900 g steam sterilized sandy loam soil (1:1) (v:v) were used in this experiment. Sterilized seedlings of each cultivar were sown growing at the rate of one plant per each plastic pot. After 15 days, five pots were used for each plant cultivar, where five pots of them were inoculated with 1000 (J2) of *M. incognita* after 15 days from germination that were obtained from a pure culture of *M. incognita* that was initiated by single eggmass and propagated on coleus plants, while the other five pots were left free of nematode inoculum to serve as control. The inocula were introduced to plants by pippeting the inoculum suspension in three holes made around the seedlings covered with sand and irrigated gently with tap water.

All pots were arranged at a randomized complete block design on a bench of a greenhouse at 22±3 ºC. Plants were watered and regularly receiving conventional pesticides against mites and insects as needed and horticulturally treated the same.

Plants were harvested after 45 days from nematode inoculation, and plant growth criteria *i.e.* shoot and root lengths and fresh weights, as well as shoot dry weight were determined and recorded. Number of *M. incognita* J_2 in 250 g. soil/pot were extracted by sieving and modified Baermann- technique (Goodey, 1957), then calculated for each pot, counted by Hawksely counting slide under x 10 magnification and recorded. Infected roots of each plant were washed with tap water, fixed in 4% formalin for 24 hrs and stained in 0.01 lactic acid-fuchsin (Byrd *et al.,* 1983) and then examined for the number of galls, developmental stages, females and egg-masses. Host category based on the relationship between host growth response (% reduction in total plant fresh weight) and reproduction factor (RF) as follows: 0-10% reduction in plant growth; RF=0 Immune (I), RF<1 Resistant (R), RF>1 Tolerant (T); 11-30% reduction in plant growth; RF<1 Moderately Resistant (MR), RF>1 Susceptible (S); and 30% < reduction in plant growth; RF<1 Intolerant (IT), RF>1 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

The results of the nematode field survey indicate that the farms in the Alsaniyah area recorded the highest rate of root nematode infection (105.88%), followed by Al-Shamiyah area (70.0%), while Al-Sudair came in last one (27.58%). *Meloidogyne* assumed to be the key pest of vegetable crops in the five surveyed counties. This survey study was useful for detecting the importance of certain nematode problems on a regional basis and yield loss estimates can be promoted by a clear understanding of nematode distribution. The present findings are in accordance with Robertson *et al*. (2005) who stated that a total of 136 populations of *M. arenaria*, *M. hapla,* and *M. incognita*, *M. javanica* were collected from infected soil from representative horticultural regions of Spain and Uruguay in a bioassay designed to characterize the virulence on cultivars of pepper, tomato, cotton tobacco and watermelon. On the other hand, Sikora and Fernandez (2005) reported that root knot nematodes, which increase to damaging levels within a few seasons under susceptible crops, are so common in subtropical and tropical vegetable production that frequently they are taken to represent nematodes in general.

Table 1: Numerical density of root nematode *Meloidogyne* spp. associated with solanaceae plants at five counties of Iraq state as well as rate of reproduction at summer season 2017-2018.

Area	Nematode number before planting	Nematode number after 2 month	% Reproduction rate
Alsaniyah	4250	8750	105.88
Shamiyah	2100	3570	70.0
Spread	1060	1440	35.84
Shaafa'is	945	1285	35.97
Sudair	725	920	27.58

Reproduction rate = [Number of nematodes in 1 kg soil (during the season) - Number of nematodes in 1 kg soil (before planting) / Number of nematodes in 1 kg soil (before planting)] x 100.

Data in table 2 represent the host suitability of six solanaceae cultivars as affected by *M. incognita* infection under greenhouse conditions. Results revealed that plant growth of all tested solanaceae cultivars were affected by nematode infection at various degrees. Among tested two tomato cultivars, cv. Ahlam accomplished the highest reduction values in fresh weight (38.6%), plant length (41.3%), dry weight (75.1%), flowers number (10.5%), Branch numbers (25.0%) and fruits number (17.6%) respectively. With respect to two eggplant cultivars, Long purple stated the highest reduction percentage for the same plant parameters with values of 35.3, 28.0, 51.7, 64.2, 39.8 and 78.0%, respectively. Meanwhile, among two tested pepper cultivars, California Wonder showed the highest reduction percentage for the same plant growth criteria as well.

The screening of solanaceae plant cultivars revealed that none of the tested cultivars were immune to root-knot nematode, *M. incognita*, though the incidence varied from cultivar to another. Evaluated solanaceae plant cultivars differed greatly in their abilities to support *M. incognita* populations. Of the screened six plant cultivars, pepper cv. California Wonder exhibited the highest rate of nematode reproduction (RF=3.9) followed by tomato cv. Rutger (2.5) and eggplant cv. Long Purple (1.6), respectively.

Moreover, number of galls and egg-masses recovered from roots differed among tested plant species. Likewise, the greatest number of galls were recorded pepper cv. California Wonder, with root gall indices (RGI) 5.0.

Host category at the tested solanaceae plants was determined based on the relationship between host plant growth response (% reduction of total plant fresh weight) and nematode reproduction factor (RF), (Table 3):-

Table 2: Plant growth response of three Solanaceae plant cultivars to *M. incognita* infection under greenhouse conditions (22±3 ºC).

Plant species	Cultivar	Plant Parameters											
		Plant length	% Reduction	Plant fresh weight	% Reduction	Plant dry weight	% Reduction	Flowers number	% Reduction	Branch numbe	% Reduction	Fruits no	% Reduction
Tomato	Rutger+ N	31.00	22.5	15.40	29.4	4.20	57.5	10.00	9.1	5.25	8.7	6.00	4.0
	Rutger	40.00	.....	21.82		9.89		11.00		5.75		6.25	
	Ahlam+N	22.75	41.3	11.55	38.6	3.0	75.1	8.50	10.5	6.00	25.0	7.00	17.6
	Ahlam	38.75	.....	18.80		12.06		9.50		8.00		8.50	
Eggplant	Black Beauty+N	19.25	27.4	11.21	21.2	5.64	47.5	7.0	58.2	5.00	31.0	6.75	46.0
	Black Beauty	26.50	.....	14.23		10.75		16.75		7.25		12.5	
	Long Purple +N	24.30	28.0	9.21	35.3	3.84	51.7	6.00	64.2	5.00	39.8	2.75	78.0
	Long Purple	33.75	.....	14.23		7.95		16.75		8.30		12.50	
Pepper	California Wonder +N	33.12	25.2	12.45	38.9	5.18	54.0	6.00	46.7	6.25	10.7	4.25	46.9
	California Wonder	44.25	.....	20.36		11.25		11.25		7.00		8.00	
	Lamyo+N	33.50	20.2	18.00	3.0	10.11	1.4	6.25	43.2	6.50	7.1	4.75	44.1
	Lamyo	42.00	.....	18.55		10.25		11.00		7.00		8.50	
	$LSD_{5\%}$	1.65		0.75		0.58		1.43		1.15		1.30	

N=1000 J2 of *M. incognita*

Each value is a mean of five replicates.

* Reduction % = $\frac{\text{Control (without N) - N}}{\text{Control}} \times 100$

Table 3: Relative susceptibility of six solanaceae cultivars within three plant species to *M. incognita* infection.

Plant species	Cultivar	Fresh weight Red. %	Reproduction Factor (RF)	RGI	*Host category 1	**Host category 2
Tomato	Rutger	29.4	2.5	4.0	S	S
	Ahlam	38.6	1.8	1.0	HS	T
Eggplant	Black Beauty	21.2	1.5	2.0	S	T
	Long Purple	35.3	1.6	2.0	HS	T
Pepper	California Wonder	38.9	3.9	5.0	HS	S
	Lamyo	3.0	1.3	2.0	T	T

*Host category (1) based on the relationship between host response and R factor as follows:
0-10% reduction in plant growth; RF=0 Immune (I)
RF<1 Resistant (R)
RF>1 Tolerant (T).
11-30% reduction in plant growth; RF<1 moderately Resistant (MR)
RF> 1 Susceptible (S).
30 %< reduction in plant growth; RF < 1 Intolerant (IT)
RF>1 Highly Susceptible (HS).
**Host category (2)based on root gall index (RGI) according to Canto-Saez and Brodie (1987) as follows:
(RGI $\leq$ 2 & RF$\leq$ 1) resistant (R), (RGI $\leq$ 2 & RF > 1) tolerant (T) and (RGI $\geq$ 2 & RF >1) susceptible (S).

- Tomato cv. Ahlam, eggplant cv. Long Purple and pepper cv. California Wonder were rated as highly susceptible hosts (HS) since plant growth was highly affected with reproduction factor >1.
- Tomato cv. Rutger and eggplant cv. Black Beauty were rated as susceptible hosts (S) since plant growth was moderately affected with reproduction factor >1.
- Finally, pepper cv. Lamyo was rated as tolerant host (T) since plant growth weakly affected and reproduction factor (RF) > 1.

However, when the relationship between root gall index as indicator of plant damage and rate of nematode increase (R factor) as indicator of nematode reproduction or host efficiency were used (Canto-Saenz and Brodie 1987), different host categories in this work was detected. Moreover, results of the present findings agreed with those reported by Ibrahim *et al.,* (1998) whom tested the reaction of 3 eggplant [aubergine] and 4 pepper "*Capsicum annuum"* cultivars to *M. arenaria* (Neal) Chitwood,) was tested in a glass house experiment. Eggplant cvs Black beauty, Black long and White long were highly susceptible while pepper cvs California wonder, Sweet long and Anaheim were only susceptible, but cv. Redhot short was resistant. On the other hand. Abad *et al.,* (2003) revealed that solanaceous crops are the targets of a wide range of pathogens and pests, including nematodes. In particular, root-knot nematodes (RKNs) of the genus *Meloidogyne* are among the most damaging nematode species attacking these plants. The typical morphological response of compatible plants to infection by root knot nematodes is root galling, which alters water and nutrient uptake by the root system, resulting in a subsequent reduction in plant growth and yield.

References

Abad, P., B. Favery, M.N. Rosso and P. Castagnone Sereno (2003). Root knot nematode parasitism and host response: Molecular basis of a sophisticated interaction. *Molecular Plant Pathology*, **4:** 217-224.

Byrd, D.W., T. Kirapatrick and K. Barker (1983). An improved technique for clearing and staining plant tissues for detection nematodes. *J. Nematol*., **15(3):**142-143.

Canto-Saenz, M. and B.B. Brodie (1987). Comparison of compatible and incompatible response of potato to *Meloidogyne incognita*. *J. Nematol.*, **19(2):** 218-221.

Duncan, D. B. (1955). Multiple range and multiple F. test. Biometrics 11, 1-42.

Etminan, A., M. Omidi, E.M. Hervan, M.R. Naghavi, S.R. Zadeh and M. Pirseyedi (2012). The study of genetic diversity in some Iranian accessions of *Hyoscyamus* sp. using amplified fragment length polymorphism (AFLP) and retro transposon/AFLP markers. *African J. Biotech*., **11(43):** 10070-10078.

Feldmesser, J., D.I. Edwards, J.M. Epps, C.M. Heald, W.R. Jenkins, H.J.B. Johnson, C.W. Lear, C.W. McBeth, E.L. Nigh and V.G. Perry (1971). Estimated crop losses from plant-parasitic nematodes in the United States. Comm. Crop losses. Special publication No. 1. Soc. Nematologists, Hyattsville, Maryland.

Gomez, K.A. and A.A. Gomez (1984). Statistical procedures for Agricultural Research.2nd Ed., John Wiley & Sons: Inc., New York.

Goodey, J.B. (1957). Laboratory methods for work with plant and soil nematodes. Tech. Bull. No.2 Min. Agric. Fish Ed. London, 47.

Ibrahim, I.K.A., W.T. Shahda and O.A.I. Dawood (1998). Reaction of eggplant and pepper cultivars to *Meloidogyne arenaria* and its biological control on eggplant. *Alexandria J. Agric. Res.*, **43(3):** 151-157.

Kartle, M., S. Kurucu and L. Altun (2003). Quantitative analysis of 1-Hyoscyamine in *Hyoscyamus reticulatus* L. by GC-MS. *Turk. J. Chem*., **27:** 565-569.

Lewis, S.A. (1987). Nematode-plant compatibility in Veech, A. & Dickson, D. W. (Eds). Vistas on Nematology. Hyattsville, MD. USA, Society of Nematologists, 246-252.

Luc, M., R.A. Sikora and J. Bridge (2005). Plant Parasitic Nematodes in subtropical and tropical Agriculture. 2nd edn. CAB international, Wallingford, UK.

Mai, W.F. and H.H. Lyon (1975). Pictorial key to genera of plant parasitic nematodes. 4th Ed., Cornell Univ. Press, Ithaca, N.Y. 172..

Robertson, L., J.A. Lopez-Perez, A. Bello, M.A. Diez-Rojo, M. Escuer; Ana Piedra-Buena, C. Ros and C. Martinez (2005). Characterization of *Meloidogyne incognita, M. arenaria* and *M. hapla* populations from Spain and Uruguay parasitizing pepper (*Capsicum annum* L.). Crop Protection. *J. Nematol.* , **31(1) :** 27-36.

Sikora, R.A. and E. Fernandez (2005). Nematode parasites of vegetables (ch 9) In plant parasitic nematodes in subtropical and tropical Agriculture 2nd edition edited by Luc, M.; R.A. Sikora and J. Bridge, 841.