SUSCEPTIBILITY OF TWENTY ONE SUGARBEET VARIETIES TO THE ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA* AT WEST NUBARIYA DISTRICT

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Abstract

This study was carried out to evaluate twenty one sugarbeet varieties for susceptibility to *Meloidogyne incognita* nematode under field and greenhouse condition. The data cleared that the different sugarbeet varieties have a great variation in their susceptibility to infection with this pest . Thus could be classified according to their susceptibility into four significantly separated groups, two varieties were very highly susceptible , four were susceptible and 11 were moderately susceptible. The remaining ones, Emma, Kawemira, Marathon and Sultan were resistant and, in addition, had low reduction percentages in sugar contents under West Nubariya District conditions. So, they could be considered excellent commercial varieties for this region .

INTRODUCTION

Plant parasitic nematodes are known among the most serious pests of sugarbeet in almost every country that has along traditional of beet cultivation in the world. The cyst nematodes, *Heterodera schachtii* and the root-knot nematodes, *Meloidogyne* spp. were reported to infect and cause damage to this crop by Whitehead (1969), Benlloch (1971), Grujicic and Paunovic (1971), Inserra *et al.*, (1984) , Abd El-Massih (1985), Maareg *et al.*, (1988), Ismail *et al.* ,(1996) and Gohar (2003). Steele (1984) reported that field symptoms produced by root-knot nematodes are similar to those of *H. schachtii.* Damage caused by *Meloidogyne* spp. Or by *H. schachtii* my appear as localized area of plant with cholorotic leaves, or plants being stunted or missing.

In general there has been more progress in breeding for resistance to sugarbeet diseases (e.g. downy mildew, powdery mildew and rhizomania) than to pests, which usually have a less intimate physiological relationship. An exception to this is the work on endoparasitic nemtodes such as beet cyst nematode and root-knot nematode which induces specific tissue responses in the root resulting in the

formation of transfer cells which without it, the nematode cannot complete its life cycle. Resistance to beet cyst nematode, based upon a hypersensitivity reaction in which juveniles within the root become surrounded by necrotic tissue, occurs in other *Beta* species, particularly those in the section proambents (*Beta patellaris, B. procumbens* and *B. webbiana*). The chromosome fragment bearing the gene (s) for resistance has been transferred from *B. procumbens* , via the use of monosomic addition lines, to produce diploids which are highly resistance to nematode (Heijbroek *et al.,* 1988 and Lange *et al.*, 1990). This material is now incorporated into commercial breeding lines, so the appearance of nematode resistance cultivars is at last in prospect, although reports from Germany of resistance breaking pathotypes indicate that there are continuing problems in store for the plant breeder if resistant varieties become widely used (Muller, 1992).

On the other hand, resistance to root-knot nematode has been identified in several crops, such as tomato (*Lycopersicon esculentum* Mill.) and common beans (*phaseolus vulgaris* L.) (Gilbert and Mc Guire, 1956; Omwega *et al.,* 1989). In sugarbeet, resistance to root-knot nematode has been rarely reported. The three patllares species (*B. patellaris* Moq., *B. procumbens* Chr. *Sm.,* and *B. webbiana* Moq.) that have high levels of resistance to cyst nematode, *Heterodera shachtii* Schm. (Yu, 1984) did not confer such resistance to *Meloidogyne spp.* (Golden, 1959 and Di vito, 1983).

The objective of present study was to evaluate the relative suscpblity or resistanace of twenty one sugarbeet varieties to root-knot nematode *Meloidogyne incognita*

MATERIALS AND METHODS

1. Field experiment :

The experiment was run for evaluating the sensitivity of twenty-one sugarbeet varieties against the most dominant nematode species, *M. incognita* in the tested area. The tested varieties are maintained from Sugar Crops Research Institute, Agriculture Research Center, Giza, Egypt. The origins and germ types of these varieties are listed in Table (1).

The study was carried out during the growing season of 2003/2004. Field plots were established in a naturally nematode infested soil at commercial field in the Ten-thousand feddans settled zone, West of Nubaryia. Each variety was cultivated in

plantation yard of 1/400 feddan; divided into six replicates implied 6 ridges (each 3.5 m long and 0.5 m apart), distance between hills was 20 cm to obtain approximately 40,000 plant/feddan. The site for these studies has a sandy soil contained distinctly low amount of organic matter (0.25%), and characterized by relatively low soluble cations (Ca^{2+}, Mg^{2+}, Na^{+}, and K^{+} with values of 2.72, 1.82, 4.27 and 0.79 meq L^{-1}, respectively) and anions (CO_2^{-3}, HCO^{-3}, CL^{-} and SO_4-2 with values of 0.0, 1.66, 6.81 and 1.13 meq L^{-1}, respectively). The soil had electrical conductivity of 0.96 ds/m, and pH 8.09. Also, it had 9.74 % $CaCo^3$, and relatively low N, P, and K with values of 31.20, 3.10 and 77.50 ppm, respectively. Normal agricultural processes were followed, without any pesticides treatment.

At harvest time, a random sample of 25 plants was uprooted from each plot. Roots of each sample were freed from the adhering soil particle by running tap water. The number of galls and egg-masses on sugarbeet root, were counted under a stereo microscope. The roots were, then graded for gall and egg-mass numbers, gall size(GS), gall area (GA),gall index (G.I), egg-mass index (E.I) and nematode damage index (DI)were evaluated according to Sharma *et al.* (1994).

2. Greenhouse experiment :

In this study, eight selected sugarbeet varieties ; Viz Emma, Kawemira, Marathon, Sultan (as resistant), Elan, Mito, (as susceptible), Chems and Nejema (as very high susceptible) under natural infection field conditions to *Meloidogyne* spp. for determination their susceptibility to artificial of this nematode pest under green house condition. Beet seeds of each tested variety were sown in 25 cm diameter earthen pots, filled with steam sterilized sandy soil collected from the Ten-thousand faddans region.

Seedlings were thinned to two per pot. At the four to six leaves stage, each plant was inoculated with about 2000 eggs. The eggs inoculum's was obtained from egg-masses drown from roots of sugarbeet maintained for several seasons on susceptible tomato culture (*Lycopersicon esculentum* cv. Moneymaker). Each variety was replicated eleven times one of them was free of nematode inoculation (as a control). All pots were arranged in a complete randomized block design in the greenhouse with set temperature of 22±4°C. Nutrients were supplied as liquid feed one each week with 5 ml per pot of diluted Vitafeed III (N 19%, P_2O_5 19%, K_2O 19%) and watered daily as required. Pots were maintained for four months after eggs inoculum. At the termination of the experiment, roots were washed free of sand by

placing them in bucked and rinsing with a gentle jet of water. Roots of each plant were cut off and stained with acid fuchsin lactophenol to estimate the number of nematode stages in the root system according to method described by Ehwaeti *et al.* (1999). Any juveniles or males in the sand were collected for counting by pouring the washing water through 100, 200 and 325 µm sieves and then placing the sieving on Baermann funnel for 24 hours.

Number of root galls, immature stages, mature females and egg-masses for root system were determined, and rates of nematode penetration, reproduction, maturation and build-up were also estimated according to the following adopted formulae by Maareg *et al.* (1998) :

$$\text{Rate of penetration} = \frac{\text{Count of total nematodes in the root tissues}}{\text{Count of nematodes used for inoculation}} \times 100$$

$$\text{Rate of reproduction} = \frac{\text{Count of egg laying females}}{\text{nematodes used for inoculation}} \text{ Count of}$$

$$\text{Rate of maturation} = \frac{\text{Counts of mature females + egg-masses}}{\text{Count of nematodes used for inoculation}} \times 100$$

$$\text{Rate of build-up} = \frac{\text{Total Counts of nematodes in root and soil}}{\text{Count of nematodes used for inoculation}} \times 100$$

Also, sugar content was determined according to Reinefield method as described by Harvey and Dutton (1993).

RESULTS AND DISCUSSION

1. Field experiment:

Twenty- one sugarbeet varieties were tested for their susceptibility or resistance to the root-knot nematode, *M. incognita* under field conditions. Data in Table (2) revealed that significant differences (P= 0.05 and 0.01) were found in gall index (GI), gall size (GS) and gall area (GA).

The GI value ranged 1.7-8.3. Marathon and Sultan varities having the lowest value of GI (1.7), however, Chems, Nejema, Helena and Mito verities having the highest values (8.3, 7.0, 6.3 and 6.0, respectively). The other varities, having moderate values of GI.

Concerning of GS, the varieties, Emma, Kawemira, Marathon and Sultan having the lowest value (1.7 for each), however, the varities Chems, Helena, Mito, Nejema, Elan and Del.939 having the highest GS values (7.1, 6.3, 6.9, 6.9, 5.9, 5.8, respectively).

Values of GA ranged from 1.7 (with each of Emma, Kawemira, Marathon and Sultan varieties) to 8.0 with Chems variety. The other varieties having moderate value.

Comparing sugarbeet varieties according to numbers of *M. incognita* egg-masses expressed as egg-mass index (EI), the data show significant differences (P= 0.05 and 0.01). The values of EI ranged generally from 2.7 for Baraka variety to 8.3 for Nejema. Eventually, the varieties Nejema, Elan, Helena, Mito and Del. 939 attained the highest (EI) values, with an average of 8.3, 7.7, 7.7, 7.3 and 7.0, respectively. However, Baraka, Kawemira, Emma, Marathon, Sultan and Tarios varieties had the lowest (EI) values with an average of 2.7, 2.3, 3.3, 3.0, 3.3 and 3.3, respectively (Table 2).

Categorization with the tested varieties according to the damage index (DI) of Sharma *et al.* (1994) is shown in the same Table. The DI categorized the varieties into four as resistant, eleven moderately resistant, four susceptible and two highly susceptible (Table,2). Emma, Kawemira, Marathon and Sultan varieties were resistant to *M. incognita* nematode. While, Baraka, Farida, Ivv Romano, Lados, Laser, Orio, M 9680, Av poly, M 9383, Ras poly and Tarios were moderately resistant. On the contrary, the sugarbeet varieties Helena, Mito, Elan and Del. 939 were considered susceptible, Chems and Nejema varieties were highly susceptible.

2. Greenhouse experiment:

The data in Table (3) indicate that, Chems and Nejma sugarbeet varieties had the highest numbers of galls (520 & 460) , total nematode stages (1820 & 1740), eggmasses (620 & 580 per root) and final population (2520 & 2540 in soil), respectively of *M. incognita*. While, Elan and Mito varieties had moderate galls , total nematode stages , eggmasses and final population numbers (100, 1100, 260 & 1720, respectively) and (155, 930,200 & 1670, respectively), respectively. On the other hand, the other tested varieties, Emma, Kawemira , Marathon and Sultan had the lowest numbers. Nematode development as well as the rates of penetration, reproduction, maturation and build-up of *M incognita* recorded in Table (4). Also, Chems and Nejema showed to be the most susceptible varieties. Their rates of penetration, reproduction, maturation and build-up were 91 & 87, 42 & 45, 80 & 75 and 127 & 127, respectively. On contrary, Emma, Kawemira, Marathon and Sultan varieties had a low rate of penetration (4.6, 7.8, 8.9 & 15, respectively) , reproduction (1.7. 3.7, 4.3 & 5.4, respectively), maturation (1.9, 5.1, 4.6 & 6.3, respectively) and build-up (6.1, 10.0, 11.4 & 16.6, respectively) for *M. incognita* . The other tested varieties (Elan & Mito) had moderate rates.

In short, the evaluation of twenty one sugarbeet varieties for their susceptibility to *M. incognita* root-knot nematode, the most dominant nematode under field and greenhouse conditions, cleared that, varieties, Emma, Kawemira, Marathon and Sultan were the most resistant . So they could be used as commercial varieties that would be cultivated in the soil infected by *M. incognita* Nematode

3- Effects of *M. incognita* on sugar content :

Data shown in Table (5) revealed that, in roots of plants inoculated with *M. incognita*, the sugar content % generally decreased in all tested sugarbeet varieties than that of uninoculated plants . Reduction in sugar contents in the resistant varieties as influenced by *M. incognita* was very low and ranged from 0.15 to 0.40 %. On the contrary, the reduction % in the very highly susceptible varieties was over than 20 % .

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Table (1): Germ type and origin of selected sugarbeet varieties screened for resistance to the root-knot nematode, *Meloidogyne incognita.*

No.	Sugarbeet varieties	Origin
I. Monogerm varieties		
1	Elan	Sweden
2	Emma	Sweden
3	Helena	Netherlands
4	Ivv Romano	Netherlands
5	Marathon	Denmark
6	Orio	Sweden
II. Polygerm varieties		
7	Av poly	Sweden
8	Baraka	Sweden
9	Chems	Sweden
10	Del.939	Germany
11	Farida	Netherlands
12	Kawemira	Germany
13	Lados	Netherlands
14	Laser	Netherlands
15	M 9383	Denmark
16	M 9680	Denmark
17	Mito	Italy
18	Nejema	Sweden
19	Ras poly	Sweden
20	Sultan	Netherlands
21	Terios	Netherlands

Derived from Varieties Program, 5 years plan (2002-2005), Sugar Crops Research Institute, Agriculture Research Center, Ministry of Agriculture, Cairo, Egypt.

Table (2): Relative susceptibility of twenty-one sugarbeet varieties against *Meloidogyne incognita* infection under field conditions at the West Nubaryia District, 2003 / 2004 season

varieties	Gall index (GI)	Galled size index (GS)	Galled area index (GA)	Egg-masses index (EI)	Computed Damege index (DI)	Varieties reaction
Av poly	4.7	5.0	5.0	5.0	4.9	MR
Baraka	2.3	3.7	3.0	2.7	3.0	MR
Chema	8.3	7.1	8.0	5.7	7.8	HS
Del. 939	5.3	5.8	6.3	7.0	5.8	S
Elan	5.7	5.9	7.0	7.7	6.2	S
Emma	2.0	1.7	1.7	3.3	1.8	R
Farida	4.3	4.9	3.7	4.0	4.3	MR
Helena	6.3	6.3	5.7	7.7	6.1	S
IvvRomano	3.3	3.8	4.3	3.7	3.8	MR
Kawemira	2.3	1.7	1.7	2.3	1.9	R
Lados	2.7	3.8	3.7	3.7	3.4	MR
Laser	4.3	4.3	3.7	4.3	4.1	MR
M 9383	3.0	2.9	3.7	4.0	3.2	MR
M 9680	4.0	4.9	4.3	4.3	4.4	MR
Marathon	1.7	1.7	1.7	3.0	1.7	R
Mito	6.0	6.9	5.7	7.3	6.2	S
Nejema	7.0	6.9	7.7	8.3	7.2	HS
Orio	4.3	4.9	4.3	4.7	4.5	MR
Ras poly	3.3	4.4	4.3	3.7	4.0	MR
Sultan	1.7	1.7	1.7	3.3	1.7	R
Tarios	2.7	3.0	3.0	3.3	2.9	MR
L.S.D. 0.05	1.21	1.25	1.88	1.90	1.21	
0.01	1.63	1.65	2.16	2.54	1.61	

HS = Highly susceptible S = Susceptible
MR = Moderately Resistant R = Resistant

Table (3): Numbers of *Meloidogyne incognita* galls, developmental stages and total nematodes on root system of sugarbeet varieties as well as second-stage juveniles in soil.

varieties	Nematode stages in root system				No. of gall/root system	Second stage juveniles In soil	Total final
	Immature stage	Mature females	Total stages	Egg-masses			
Emma	59	33	92	5	11	30	122
Kawemira	83	73	156	29	13	62	218
Marathon	93	85	178	13	12	49	227
Sultan	191	108	299	17	21	33	332
Elan	700	400	1100	260	100	620	1720
Mito	620	310	930	200	155	740	1670
Chems	980	840	1820	620	520	700	2520
Nejema	1020	720	1740	580	460	800	2540
L.S.D. 0.05	9.70	9.63	9.42	4.51	5.57	4.55	88.02
0.01	14.11	14.01	13.71	6.57	8.11	6.63	128

Table (4): Rates of penetration, reproduction, maturation and build-up as a behavior of *Meloidogyne incognita* on roots of sugarbeet varieties in pots tests.

varieties	Penetration rate	Reproduction rate	Maturation rate	Build-up rate
Emma	4.6	1.7	1.9	6.1
Kawemira	7.8	3.7	5.1	10.1
Marathon	8.9	4.3	4.9	11.4
Sultan	15.0	5.4	6.3	16.6
Elan	55	39	60	86
Mito	46.5	39	55	94
Chems	91	42	80	127
Nejema	87	45	75	127
L.S.D. 0.05	5.11	0.68	0.55	0.95
0.01	7.12	0.98	0.80	1.38

Table (5) Sugar content % in roots of both healthy and root- knot nematode, *Meloidogyne incognita* infected plants after four months from nematode inoculation

varieties	Control	*M. incognita* treatments	Reduction %
Emma	20.60	20.57	0.15
Kawemira	20.20	20.12	0.40
Marathon	18.87	18.82	0.26
Sultan	21.70	21.65	0.23
Elan	19.80	18.51	6.52
Mito	20.20	18.75	5.30
Chems	21.71	17.26	20.50
Nejeam	19.92	15.52	22.10

حساسية أحدى وعشرون صنفا من بنجر السكرلنيماتودا تعقد البذور " مليدوجين إنكوجنيتا" بغرب النوبارية

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في هذه الدراسة تم تقيم إحدى وعشرون صنفاً من بنجر السكر لمعرفة مدى قابليتها للإصابة بنيماتودا تعقد الجذور النوع مليدوجين إنكوجنيتا بإدارة غرب النوبارية تحت ظروف الحقل و الصوبة. و من النتائج المتحصل عليها أمكن تقسيم هذه الأصناف إلى أربع مجموعات منفصلة تبعاً لمدى قابليتها للإصابة و تطور النيماتودا على جذورها و التعداد النهائي لهذه النيماتودا في التربة – وهذه المجاميع هي:-

المجموعة الأولى تتضمن صنفان فائقا الحساسية للإصابة وهما جيمس ونجمة

المجموعة الثانية تتضمن أربعة أصناف حساسة وهى ديل ٩٣٩، ايلان ، هيلينا ، ميتو

المجموعة الثالثة تتضمن أحد عشر صنفاً متوسطى الحساسية للإصابة.

المجموعة الرابعة تتضمن أربعة أصناف مقاومة للإصابة و هي **إيما** ، **كاويميرا** ، **ماراثون**، **سلطان** وأحدثت أدنى فقد في السكر ولهذا يمكن استخدمها كأصناف تجارية في الأراضي الملوثة بالنيماتودا في منطقة غرب النوبارية