

## EVALUATION OF SOME CUCURBITACEOUS ROOTSTOCKS 1- FOR RESISTANCE / SUSCEPTIBILITY TO ROOT- KNOT NEMATODE AND FUSARIUM WILT UNDER SCREEN-HOUSE CONDITIONS

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### **Abstract**

**Southern** root-knot nematode, *Meloidogyne incognita* and Fusarium wilt, *Fusarium oxysporum* are the most serious soil borne diseases in soil of cucumber. The present study aimed to evaluate some cucurbit rootstocks for their resistance and/or susceptibility to root-knot nematode and fusarium wilt fungus in two successive seasons (2009 and 2010) under screen-house conditions. Data indicated that in autumn season, winter squash (*Cucurbita maxima*) was highly resistant and resistant when the pots were inoculated with *M. incognita* only or nematode plus fungus, respectively. *Lagenaria siceraria* rootstock was moderately resistant in both cases of inoculation. Other rootstocks were susceptible to nematode or nematode plus fungus except *Luffa aegyptiaca*, as it was highly susceptible to nematode. While, in spring season, *Benincasa hispida* and hybrid 6001 were moderately resistant to infection by the root-knot nematode. Other rootstocks were susceptible to nematode or nematode plus fungus except *Cucurbita moschata*, *Luffa acutangula*, and *Cucumis sativus* var. Hesham, as they were highly susceptible to *M. incognita* only. Also, *Lagenaria siceraria*, *Luffa acutangula* and *Cucumis sativus* var. Hesham were highly susceptible to nematode and fungus. The results obtained on the enzyme contents showed that some cucurbit rootstocks exhibited the highest contents of polyphenol oxidase, peroxidase and lignin contents being the lowest in some rootstocks. Significant and highly significant reductions in shoot and root fresh weights, root and shoot lengths were recorded in the most cucurbit rootstocks in autumn and spring seasons as a result of nematode, nematode plus fungus or fungus infections compared to non-infected rootstocks.

**Keyword:** Cucurbit rootstocks, Fusarium wilt, Root-knot nematode, soil-borne diseases.

### **INTRODUCTION**

As for in vegetable crops production in greenhouses, soil-borne diseases and nematodes cause most of the damage from continuous cropping (Oda, 1999). Cucumber crop suffers from several infections by serious nematodes and fungal diseases. Southern root-knot nematode, *Meloidogyne incognita* Chitwoodi and fusarium wilt fungus, *Fusarium oxysporum* are the most serious soil borne diseases in

cucumber rhizosphere (Sharma *et al* (1995). Owens and Novothy (1966) found that plant tissues infested with nematodes showed a considerable increase in the levels of free amino acids, organic acids and protein.

There are several ways to control the nematodes and fusarium wilt, none of them proved to be good and effective. No commercial cultivars or hybrids of cucumber are recorded as resistant to nematode diseases. Therefore, the only possible approach to overcome such diseases is using grafting of resistant rootstocks as an active, safe and clean method. Grafting onto resistant rootstocks of wild or domesticated species of cucurbit plant is the most known means to protect the scion from the attack by these diseases. Trionfetti *et. al.* (2002) mentioned that rootstock influence on disease resistance as well as productivity and quality of scion fruit is important in determining the potential utility of grafting applications. Zhang *et. al.* (2010) concluded that phenylpropane metabolites and key enzymes had close correlation with resistance to southern root-knot nematode in grafting cucumber seedling.

This work was planned to study the resistance and /or susceptibility of cucumber and some wild and domesticated cucurbit rootstocks to infection with root-knot, *M. incognita* nematode and *Fusarium oxysporum* as a part of our sequence study to evaluate cucumber plants grafted onto some cucurbitaceous plants to avoid infection with root-knot nematode and fusarium wilt diseases.

## **MATERIALS AND METHODS**

The fungus and nematode were isolated from diseased cucumber plants collected from the inspected fields and from the greenhouses located at Kaha Research Station, Qaluobiya governorate Horticultural Research Institute, Agricultural Research center. Cucumber plants showing the typical symptoms of wilt and galls of nematodes were collected during 2009-2010. The plant samples were uprooted and put in plastic bags which were kept in a cool container during transportation to the laboratory. The samples were kept in a refrigerator at 5c ° for further studies. The fungus was isolated on Potato Dextrose Agar (PDA). The inoculums used in the foregoing studies consisted of uniform agar discs of 4mm. in diameter bearing 7 days old growth of the desired fungus under aseptic conditions. The inoculum was grown in 500ml. milk bottles containing the following sterilized substrate per bottle: Washed dried maize 75gm, Washed dried coarse sand 100gm and tap water 65ml. The bottles were autoclaved before being incubated at 25C ° for two weeks to obtain sufficient growth of the fungus. The inoculum was then thoroughly mixed with the soil sterilized

at the desired rate and time. The level of infection as affected by the level of inoculums was 5 gm per kilogram for both sterilized and unsterelized growing media were used.

Thirteen cucurbitaceous rootstocks seeds (Table 1) were sown in 25 cm-d plastic pots filled with 1 kg sandy-loamy soil (1:1 v/v) free of plant fungus and parasitic nematodes.

#### Source of the tested plants

Seeds of the tested plants were obtained from various sources as mentioned in Table (1).

Table 1. Source of rootstocks evaluated against *F. oxysporum* and *M. incognita* isolated from infested cucumber plants.

Rootstocks	Scientific name	Source
Bottle gourd	<i>Lagenaria siceraria</i> var. <i>calabsha</i>	Pakistan
Bottle gourd	<i>Lagenaria siceraria</i>	Horticulture Research, Institute, Egypt
Butter nut squash (winter squash)	<i>Cucurbita maxima</i> * <i>Cucurbita moshata</i>	Horticulture Research, Institute, Egypt
<i>Cucurbita maxima</i> Varsity	<i>Cucurbita maxima</i>	Pakistan
Cucumber	<i>Cucumis sativus</i> var. Hesham	Royal Sluis Comp. Holland
Fig leaf gourd	<i>Cucurbita ficifolia</i>	Wild seeds
Hercules gourd	<i>Lagenaria longissima</i>	Horticulture Research, Institute, Egypt
Hybrid Arcola	<i>C. maxima</i> x <i>C. moshata</i> F1 No.6001	Nunhems Comp.
Hybrid Charmatoza	<i>Cucurbita maxima</i>	Taky seeds Comp.
Luffa black seed	<i>Luffa aegyptiaca</i>	Horticulture Research, Institute, Egypt
Luffa white seed	<i>Luffa acutangula</i>	Pakistan
Pumpkin	<i>Cucurbita moschata</i>	Horticulture Research, Institute, Egypt

Half number of pots was infested with 500 infective stages of *Meloidogyne incognita* (obtained from egg massing

by incubating in water) around the seedling roots. The pots were divided into four groups. The first group was inoculated with root-knot nematode, *Meloidogyne incognita* only and the second group received nematodes and *Fusarium oxysporum* around the seedling roots, the third group received of infested soil by *Fusarium oxysporum* only and the fourth group served as control plant (uninoculated).

There were five replicates for each treatment and the pots were arranged in a completely randomized design in greenhouse. The pots were watered as needed. After nine weeks of nematodes and fungus inoculations, roots of plants were carefully uprooted and nematodes in soil and roots were counted and recorded as root gall and egg-mass indices according to Taylor and Sasser (1978). Disease incidence caused by *Fusarium oxysporum* during the growth period was recorded. The number of galls, females and egg-masses and reproductive factor were calculated for root-knot nematodes as compared to uninoculated pots calculated for root-knot nematodes. Length and weight of shoots and roots were recorded at the end of autumn 2009 and spring 2010. The aforementioned characters were investigated in the presence of nematodes and/or wilt fungus diseases compared to control plants. This experiment Was repeated twice in autumn 2009 and spring 2010 with the tested cucurbit rootstocks. Data were statistically analyzed using new Least Significant Difference (New LSD) (Waller and Duncan, 1969).

#### **Chemical Analysis (Oxidative – reductive enzyme activities) and lignin content**

Roots of diseased plants were harvested at spring and autumn seasons after inoculation with *Fusarium* and nematodes by cutting them at the root system for determining the activity of peroxidase and polyphenoloxidase and lignin content. Enzyme activities were determined in the roots of inoculated plants as recommended by Maxwell and Batman (1967). Peroxidas assay was determined according to the methods described by Allam and Hollis (1972) and lignin content was determined according to by Anonymous (1951).

## RESULTS

### 1- Susceptibility of some cucurbit plant species grown in soil infected by *Meloidogyne incognita*, and / or *Fusarium oxysporum*

Most of the root system of the cucurbit rootstocks grown in soil infected by *M. incognita* was uniformly galled, where the gall/egg-masses index ranged from 1 to 5 in autumn season and from 3 to 5 in spring season (Tables 2, 4 and Figs. 1, 2).

In autumn season, data presented in Table (2) and Fig (1) indicates that the cucurbit rootstocks varied in their rates of susceptibility according to Taylor and Sasser 1978. It was found that *Cucurbita maxima* were highly resistant and resistant to *M. incognita* only or nematode plus fungus, respectively. *Lagenaria siceraria* was moderately resistant to root-knot nematode against nematode or nematode plus fungus. Other Cucurbit rootstocks were susceptible (S) to nematode or nematode plus fungus except rootstocks of *Luffa aegyptiaca* was highly susceptible to nematode only. When Cucurbit stocks, in autumn, were infected by fungus, *F. oxysporum*, all of them were highly resistant (HS) to fungus except *Cucumis sativus* var. Hesham, as it was susceptible (S) to fungus. In spring season (Table 4), *Benincasa hispida* and *cucurbita maxima* ( hybrid 6001) were moderately resistant (MR) to infection by *M. incognita* only and *M. incognita* plus *fusarium oxysporium*. Other Cucurbit rootstocks were susceptible (S) to nematode and nematode plus fungus except *Cucurbita mochata* was highly susceptible to nematode only. *Lagenaria siceraria*, *Luffa acutangula* and *Cucumis sativus* were highly susceptible to nematode plus fungus. When cucurbit rootstocks were inoculated with fungus only in spring, all of they were highly resistant to fungus except *cucumis sativus* var. Hesham, as it was susceptible to fungus. In Cucurbitaceous plants grown in soil infected with *M. incognita* only in autumn, the highest reproduction factor (RF) was 3.05 on *Cucumis sativus* var. Hesham followed by that (2.77) of the same plant variety when grown in soil infected with nematode plus fungus (Table 2) On the other hand, the highest RF in spring was 2.64 when *Cucumis sativus* var. Hesham was grown in soil infected with *M. incognita* only followed by RF (3.12) when the same plant species was grown in soil infected with nematode plus fungus (Table 4 and Fig (2)).

### 2- Cucurbit fresh plant criteria

Significant and highly significant reduction in shoot and root fresh weights were recorded in most cucurbit plants in autumn and spring seasons (Tables 3 and 5). Severe significant and highly significant reduction were recorded in root and shoot

length in both season on the cucurbit plants inoculated by *M. incognita* or/and *F. oxysporum*.

### **3- Peroxidase and Polyphenoloxidase activities and lignin content of some cucurbit plants in relation to nematode and fungus infection**

Data presented in Table 6 indicate that *Lagenaria siceraria*, *Cucurbita maxima* x *C. moschata* (H.6001), *Cucurbita maxima* (Winter squash) and *L. aegyptiaca* showed the highest polyphenol oxidase content, being 0.059, 0.052, 0.052 and 0.47, respectively. Meanwhile, *L. acutangula*, *C. maxima* x *C. moschata* (H.6001) and *Benincasa hispida* showed the highest values of peroxidase content as the corresponding values were 1.053, 0.985 and 0.944 on the average, respectively. Concerning lignin content, it was found that *C. maxima* (Charmatoza), and *L. siceraria* showed the highest values of lignin contents, being 0.419 and 0.378, respectively in spring season. On the other hand, in autumn season *L. siceraria* and *Cucurbita maxima* (Winter squash) showed the highest polyphenol oxidase content (0.065 and 0.063), respectively. Meanwhile, *Luffa acutangula*, *Cucurbita maxima* (Winter squash) and *Cucurbita ficifolia* showed the highest values of peroxides content. Their corresponding values were 1.049, 0.781 and 0.722 on the average, respectively. Concerning lignin content, it was found that *Lagenaria siceraria* and *L. siceraria* var *Calabsha* showed the highest values of lignin contents, being (0.379 and 0.274), respectively.

Table 2. Different parameters of *Meloidogyne incognita* or/and *Fusarium oxysporum* under Screen-house condition in autumn season.

Treatments	No. of gall	Number of nematodes				Total Population	RF*	GI/EI**	Fusarium wilt***	
		In soil	In roots						% of disease	Index
			Dev. stage	Females	Egg masses					
<i>Cucurbita ficifolia</i> (A)	103.0	83.0	29.3	86.3	78.3	198.6	0.40	5/4 (HS)*	-	-
<i>Cucurbita ficifolia</i> (B)	48.0	53.0	16.0	40.0	40.0	113.0	0.22	4/4 (S)	92.0	(HS)
<i>Cucurbita ficifolia</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita moschata</i> (Pumpkin) (A)	49.3	53.0	24.6	32.3	30.7	109.9	0.22	4/4 (S)	-	-
<i>Cucurbita moschata</i> (Pumpkin) (B)	49.3	52.0	27.3	37.3	35.3	116.6	0.23	4/4 (S)	1.0	(HR)
<i>Cucurbita moschata</i> (Pumpkin) (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita maxima</i> (winter squash) (A)	2.0	59.6	3.6	2.3	1.6	63.5	0.13	1/1 (HR)	-	-
<i>Cucurbita maxima</i> (winter squash) (B)	3.3	10.0	3.3	3.6	2.6	16.9	0.03	2/2 (R)	41.7	(R)
<i>Cucurbita maxima</i> (winter squash) (C)	-	-	-	-	-	-	-	-	28.3	(R)
<i>Lagenaria siceraria</i> (A)	31.0	10.0	7.3	26.7	25.7	44.0	0.09	3/3 (MR)	-	-
<i>Lagenaria siceraria</i> (B)	28.3	51.7	8.6	23.3	23.3	83.5	0.17	3/3 (MR)	32.7	(R)
<i>Lagenaria siceraria</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (A)	68.7	25.0	14.0	58.6	57.3	97.6	0.20	4/4 (S)	-	-
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (B)	35.0	10.0	14.0	49.0	28.0	72.0	0.15	4/4 (S)	62.3	(S)
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (C)	-	-	-	-	-	-	-	-	10.7	(HR)
<i>Luffa acutangula</i> (A)	41.3	10.0	23.6	39.3	31.6	72.9	0.15	4/4 (S)	-	-
<i>Luffa acutangula</i> (b)	44.3	10.0	24.6	76.6	47.6	74.9	0.15	4/4 (S)	95.3	(HS)
<i>Luffa acutangula</i> (C)	-	-	-	-	-	-	-	-	34.0	(R)
<i>Luffa aegyptiaca</i> (A)	124.6	54.0	46.3	91.6	87.3	191.9	0.38	5/4 (HS)	-	-
<i>Luffa aegyptiaca</i> (B)	72.6	10.0	26.7	66.6	56.6	103.2	0.21	4/4 (S)	61.0	(S)
<i>Luffa aegyptiaca</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Lagenaria longissima</i> (A)	75.3	10.0	30.0	74.0	73.0	114.0	0.22	4/4 (S)	-	-
<i>Lagenaria longissima</i> (B)	96.3	382.6	26.6	85.3	79.3	494.5	0.99	4/4 (S)	1.0	(HR)
<i>Lagenaria longissima</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucumis sativus</i> var. Hesham (A)	54.0	1381.6	53.3	90.0	45.6	1524.9	3.05	4/4 (S)	-	-
<i>Cucumis sativus</i> var. Hesham (B)	75.6	1293.3	13.3	77.0	72.0	1383.6	2.77	4/4 (S)	82.33	(HS)
<i>Cucumis sativus</i> var. Hesham (C)	-	-	-	-	-	-	-	-	58.3	(S)
<b>New L.S.D. (5%)</b>	<b>33.1</b>	<b>7.88</b>	<b>11.12</b>	<b>27.2</b>	<b>32.7</b>	-	-	-	-	-

A = Nematodes Infected Plants, B = Nematodes and fungi infected plants, C= fungi infected plants  
 Scales expressed by letter(S) in parenthesis are plant response to *M. incognita* infected according to Taylor and Sasser (1978)

Nematodes final population

\* RF = Reproductive factors = -----

Nematodes initial population

\*\* GI/EI = galls and egg-masses index according to Taylor and Sasser 1978

\*\*\*Disease symptoms index according to Kesevan and Chounhury, (1977),

(0)= Immune (1), (1)= Highly Resistant (HR), (2)= Resistant (R), (3)= Susceptible (S), (4)= Highly Susceptible (HS).

Table 3. Different parameters of some cucurbit rootstocks to infected with *Meloidogyne incognita* or/and *Fusarium oxysporum* under Screen-house condition in autumn season.

Treatments	Root Length (cm)	Root weight (g)	Shoot Length (cm)	Shoot weight (g)
<i>Cucurbita ficifolia</i> (A)	26.00	4.93	77.76	18.53
<i>Cucurbita ficifolia</i> (B)	19.26	2.40	54.80	9.60
<i>Cucurbita ficifolia</i> (C)	26.00	4.93	77.76	18.53
<i>Cucurbita ficifolia</i> (D)	24.66	5.40	170.33	17.1
<i>Cucurbita moschata</i> (Pumpkin) (A)	7.66	3.63	31.70	11.33
<i>Cucurbita moschata</i> (Pumpkin) (B)	12.50	2.30	47.66	15.07
<i>Cucurbita moschata</i> (Pumpkin) (C)	12.50	3.63	44.33	14.83
<i>Cucurbita moschata</i> (Pumpkin) (D)	21.00	5.10	135.00	16.66
<i>Cucurbita maxima</i> (winter squash) (A)	29.56	9.96	69.16	7.16
<i>Cucurbita maxima</i> (winter squash) (B)	19.70	6.73	50.83	6.00
<i>Cucurbita maxima</i> (winter squash) (C)	21.33	3.73	21.13	13.40
<i>Cucurbita maxima</i> (winter squash) (D)	33.66	10.86	131.66	10.16
<i>Lagenaria siceraria</i> (A)	9.33	3.90	70.96	12.17
<i>Lagenaria siceraria</i> (B)	20.66	1.95	66.00	13.70
<i>Lagenaria siceraria</i> (C)	20.66	3.90	66.00	13.68
<i>Lagenaria siceraria</i> (D)	18.33	4.46	137.66	17.10
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (A)	23.00	4.90	82.66	23.73
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (B)	12.16	3.16	64.40	19.03
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (C)	23.00	4.90	82.66	23.73
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (D)	35.33	7.87	147.33	15.66
<i>Luffa acutangula</i> (A)	23.00	6.53	79.16	9.80
<i>Luffa acutangula</i> (B)	23.46	2.40	70.80	7.66
<i>Luffa acutangula</i> (C)	17.00	2.66	36.00	9.70
<i>Luffa acutangula</i> (D)	24.33	5.60	163.66	11.86
<i>Luffa aegyptiaca</i> (A)	21.33	8.16	80.33	11.63
<i>Luffa aegyptiaca</i> (B)	19.06	3.90	50.36	8.00
<i>Luffa aegyptiaca</i> (C)	21.50	8.13	80.50	11.66
<i>Luffa aegyptiaca</i> (D)	25.33	14.00	154.00	18.00
<i>Lagenaria longissima</i> (A)	23.50	4.00	26.00	9.80
<i>Lagenaria longissima</i> (B)	18.66	1.73	24.16	7.33
<i>Lagenaria longissima</i> (C)	27.76	3.16	26.00	11.53
<i>Lagenaria longissima</i> (D)	22.00	6.90	140.33	14.40
<i>Cucumis sativus</i> var. Hesham (A)	19.26	3.20	67.96	4.10
<i>Cucumis sativus</i> var. Hesham (B)	21.13	2.36	36.86	3.76
<i>Cucumis sativus</i> var. Hesham (C)	18.33	1.63	56.00	4.20
<i>Cucumis sativus</i> var. Hesham (D)	27.33	3.10	162.00	4.86
New L.S.D. (5%)	10.10	3.10	33.50	5.90

A = Nematodes Infected plants

B = Nematodes and fungi infected plants

C = Fusarium infected plants

D = Non – infected plants (control)

Table 4. Different parameters of *Meloidogyne incognita* or/and *Fusarium oxysporum* under Screen-house condition in spring season.

Treatments	No. of gall	Number of nematodes				Total Population	RF*	GI/EI**	Fusarium wilt	
		In soil	In roots						% of disease ***	Index
			Dev. stage	Females	Egg masses					
<i>Cucurbita ficifolia</i> (A)	90.7	90.3	28.7	66.0	36.0	185.0	0.37	4/4 (S)*	-	-
<i>Cucurbita ficifolia</i> (B)	52.0	56.3	15.0	38.7	30.0	110.0	0.22	4/4 (S)	25.0	(HR)
<i>Cucurbita ficifolia</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita moschata</i> (Pumpkin) (A)	121.3	51.3	108.7	59.3	51.3	219.3	0.44	5/4 (HS)	-	-
<i>Cucurbita moschata</i> (Pumpkin) (B)	131.3	35.0	51.3	68.0	53.3	174.3	0.35	4/4 (S)	25.0	(HR)
<i>Cucurbita moschata</i> (Pumpkin) (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita maxima</i> (winter squash) (A)	57.0	51.0	13.0	30.0	20.0	94.0	0.19	4/4 (S)	-	-
<i>Cucurbita maxima</i> (winter squash) (B)	90.0	17.0	20.0	30.0	22.0	67.0	0.13	4/4 (S)	28.3	(R)
<i>Cucurbita maxima</i> (winter squash) (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Lagenaria siceraria</i> (A)	98.0	15.0	58.7	42.0	38.7	115.7	0.23	4/4 (S)	-	-
<i>Lagenaria siceraria</i> (B)	344.0	51.3	295.0	95.0	92.0	441.3	0.88	5/5 (HS)	65.3	(S)
<i>Lagenaria siceraria</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (A)	58.3	15.0	51.7	42.3	27.3	109.0	0.21	4/4 (S)	-	-
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (B)	72.0	17.0	20.0	42.0	42.0	75.0	0.15	4/4 (S)	10.7	(HR)
<i>Lagenaria siceraria</i> var <i>Calabsha</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Luffa acutangula</i> (A)	112.0	15.0	30.0	60.0	50.0	105.0	0.20	5/4 (HS)	-	-
<i>Luffa acutangula</i> (b)	226.0	17.0	35.0	130.0	110.3	182.0	0.36	5/5 (HS)	1.0	(HR)
<i>Luffa acutangula</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Luffa aegyptiaca</i> (A)	47.3	55.7	15.0	26.7	17.0	97.4	0.19	4/3 (S)	-	-
<i>Luffa aegyptiaca</i> (B)	90.0	15.0	25.0	40.0	40.0	80.0	0.18	4/4 (S)	9.0	(HR)
<i>Luffa aegyptiaca</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Benincasa hispida</i> (A)	21.6	10.0	17.7	27.2	24.0	54.8	0.11	3/3 (MR)	-	-
<i>Benincasa hispida</i> (B)	26.6	17.0	25.3	37.2	31.0	79.5	0.16	3/4 (S)	1.0	(HR)
<i>Benincasa hispida</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (A)	16.0	10.0	13.7	12.0	8.7	35.7	0.07	3/2 (MR)	-	-
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (B)	30.0	17.0	20.0	17.0	10.3	54.0	0.11	3/2 (MR)	1.0	(HR)
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (A)	57.0	10.0	7.7	25.0	15.0	42.0	0.10	4/4 (S)	-	-
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (B)	51.0	17.0	15.0	19.0	12.0	51.0	0.10	4/3 (S)	9.0	(HR)
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucurbita maxima</i> (A)	50.0	27.0	40.0	32.0	29.3	99.0	0.19	4/3 (S)	-	-
<i>Cucurbita maxima</i> (B)	60.0	26.7	50.0	44.7	39.3	121.4	0.24	4/4 (S)	17.0	(HR)
<i>Cucurbita maxima</i> (C)	-	-	-	-	-	-	-	-	1.0	(HR)
<i>Cucumis sativus</i> var. Hesham (A)	211.0	1180.0	40.0	100.0	94.0	1320.0	2.64	5/4 (HS)	-	-
<i>Cucumis sativus</i> var. Hesham (B)	306.0	1295.3	81.0	181.0	105.0	1559.3	3.12	5/5 (HS)	82.3	(HS)
<i>Cucumis sativus</i> var. Hesham (C)	-	-	-	-	-	-	-	-	58.3	(S)
<b>New L.S.D. (5%)</b>	<b>24.4</b>	<b>6.4</b>	<b>10.6</b>	<b>15.0</b>	<b>14.6</b>	-	-	-	-	-

A = Nematodes Infected Plants, B = Nematodes and fungi infected plants, C= fungi infected plants  
Scales expressed by letter(S) in parenthesis are plant response to *M. incognita* infestation according to Taylor and Sasser 1978

Nematodes final population

\* RF = Reproductive factors =  $\frac{\text{Nematodes final population}}{\text{Nematodes initial population}}$

\*\* GI/EI = galls and egg-masses index according to Taylor and Sasser 1978

\*\*\*Disease symptoms index according to Kesevan and Chounhury, (1977),  
(0) = Immune (1), (1) = Highly Resistant (HR), (2) = Resistant (R), (3) = Susceptible (S), (4) = Highly Susceptible (HS).

Table 5. Different parameters of some cucurbit rootstocks infected with *Meloidogyne incognita* or/and *Fusarium oxysporum* under Screen-house condition in spring season.

Treatments	Root Length (cm)	Root weight (g)	Shoot Length (cm)	Shoot weight (g)
<i>Cucurbita ficifolia</i> (A)	23.50	15.9	37.13	29.36
<i>Cucurbita ficifolia</i> (B)	28.66	12.50	39.00	31.80
<i>Cucurbita ficifolia</i> (C)	12.66	4.13	20.33	11.86
<i>Cucurbita ficifolia</i> (D)	33.83	18.53	37.60	39.03
<i>Cucurbita moschata</i> (Pumpkin) (A)	21.66	12.43	36.30	22.13
<i>Cucurbita moschata</i> (Pumpkin) (B)	25.66	8.46	37.66	31.96
<i>Cucurbita moschata</i> (Pumpkin) (C)	18.66	6.33	20.33	17.33
<i>Cucurbita moschata</i> (Pumpkin) (D)	29.33	14.6	39.03	30.43
<i>Cucurbita maxima</i> (winter squash) (A)	17.53	26.63	33.26	22.53
<i>Cucurbita maxima</i> (winter squash) (B)	19.00	21.60	33.93	24.77
<i>Cucurbita maxima</i> (winter squash) (C)	16.33	20.00	27.73	21.80
<i>Cucurbita maxima</i> (winter squash) (D)	21.06	21.50	39.20	27.96
<i>Lagenaria siceraria</i> (A)	14.83	8.00	21.00	15.33
<i>Lagenaria siceraria</i> (B)	15.33	6.10	25.00	21.96
<i>Lagenaria siceraria</i> (C)	20.00	12.83	16.66	15.46
<i>Lagenaria siceraria</i> (D)	21.13	15.20	110.13	28.83
<i>Lagenaria siceraria</i> var Calabsha (A)	21.23	12.86	33.10	16.63
<i>Lagenaria siceraria</i> var Calabsha (B)	25.23	10.33	39.66	23.53
<i>Lagenaria siceraria</i> var Calabsha (C)	19.00	14.76	20.66	16.73
<i>Lagenaria siceraria</i> var Calabsha (D)	28.40	16.86	42.50	30.06
<i>Luffa acutangula</i> (A)	23.33	10.73	48.80	22.13
<i>Luffa acutangula</i> (B)	25.66	9.03	62.06	23.56
<i>Luffa acutangula</i> (C)	15.66	9.73	72.33	15.40
<i>Luffa acutangula</i> (D)	29.56	15.33	63.36	24.53
<i>Luffa aegyptiaca</i> (A)	27.20	15.80	94.23	22.50
<i>Luffa aegyptiaca</i> (B)	34.83	13.00	139.66	29.03
<i>Luffa aegyptiaca</i> (C)	19.66	10.16	78.40	18.46
<i>Luffa aegyptiaca</i> (D)	44.73	18.90	141.33	34.30
<i>Benincasa hispida</i> (A)	22.66	4.36	42.00	31.00
<i>Benincasa hispida</i> (B)	20.30	2.86	35.73	26.80
<i>Benincasa hispida</i> (C)	22.00	9.06	29.36	18.76
<i>Benincasa hispida</i> (D)	20.60	10.76	35.76	19.26
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (A)	20.03	18.23	33.66	19.60
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (B)	21.66	15.03	35.90	22.87
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (C)	27.00	9.36	23.33	13.16
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001) (D)	28.86	15.96	42.16	29.46
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (A)	28.30	16.73	29.83	20.40
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (B)	32.66	16.20	34.93	25.93
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (C)	18.33	13.43	20.66	13.66
<i>Cucurbita maxima</i> (Hybrid Charmatoza) (D)	35.46	19.10	38.90	32.50
<i>Cucurbita maxima</i> (A)	8.36	37.23	12.33	10.30
<i>Cucurbita maxima</i> (B)	10.33	35.40	21.33	14.23
<i>Cucurbita maxima</i> (C)	10.66	13.73	28.66	5.00
<i>Cucurbita maxima</i> (D)	12.80	62.76	33.80	18.23
<i>Cucumis sativus</i> var. Hesham (A)	13.76	15.03	98.70	30.33
<i>Cucumis sativus</i> var. Hesham (B)	11.93	10.06	74.76	28.76
<i>Cucumis sativus</i> var. Hesham (C)	14.33	14.06	23.66	15.46
<i>Cucumis sativus</i> var. Hesham (D)	16.66	19.63	120.66	34.00
New L.S.D. (5%)	4.80	3.40	12.90	6.50

A = Nematodes Infection plants  
C = Fusarium infected plants

B = Nematodes and fungi infected plants  
D = Non – infected plants (Control)

Table 6. Enzyme and lignin contents of some cucurbit plants in relation to nematode and fungus infestation.

Cucurbit plants	In spring season			In autumn season		
	Polyphenol oxidase contents mg/g	Peroxidase contents mg /g	Lignin content mg /g	Polyphenol oxidase contents mg/g	Peroxidase contents mg /g	Lignin content mg /g
<i>Cucurbita ficifolia</i>	0.035	0.745	0.245	0.032	0.722	0.234
<i>Cucurbita moschata</i> (Pumpkin)	0.019	0.517	0.071	0.013	0.051	0.070
<i>Cucurbita maxima</i> (winter squash)	0.052	0.772	0.106	0.063	0.785	0.110
<i>Lagenaria siceraria</i>	0.059	0.456	0.378	0.065	0.460	0.379
<i>Lagenaria siceraria</i> var Calabsha	0.002	0.610	0.275	0.001	0.600	0.274
<i>Luffa acutangula</i>	0.014	1.053	0.122	0.016	1.049	0.144
<i>Luffa aegyptiaca</i>	0.047	0.375	0.264	0.051	0.330	0.240
<i>Lagenaria longissima</i> (Hercules gourd)	0.040	0.330	0.134	0.055	0.440	0.150
<i>Benincasa hispida</i>	0.042	0.944	0.277	0.046	0.936	0.280
<i>Cucurbita maxima</i> x <i>C. moschata</i> (Hybrid 6001)	0.052	0.945	0.224	0.055	0.942	0.228
<i>Cucurbita maxima</i> (Hybrid Charmatoza)	0.051	0.785	0.419	0.055	0.782	0.422
<i>Cucumis sativus</i> var Hesham (Cucumber)	0.016	0.544	0.023	0.011	0.560	0.028

## DISCUSSION

The present study indicates that cucumber (*Cucumis sativus* var. Hesham) was ranked as susceptible and highly susceptible to *M. incognita* and *F. oxysporum*. These data are in agreement with those Oteifa and Elgindi (1982), Todd *et al.* (1991) and Amin (1995) who indicated that none of cucumber cultivar was found to be resistant against *M. incognita* infestation.

Data indicate that winter squash, *Cucurbita maxima* was rated as resistant and highly resistant when the pots inoculated with nematode only and nematode plus fungus, respectively. *Lagenaria siceraria* rated as moderately resistant to root-knot nematode, *Meloidogyne incognita* in both cases in autumn season and resistant to Fusarium wilt fungus. While, in spring season when the pots inoculated with nematode only, *Benincasa hispida* and *Cucurbita maxima* hybrid 6001 were rated as moderate resistant to root-knot nematode, *Meloidogyne incognita* and resistant to Fusarium wilt fungus. Regarding the chemical response, data indicated that resistant

and highly resistant rootstocks to both diseases recorded the highest average of Polyphenol oxidase, Peroxidase and Lignin in most cases. These results are conformable to their resistant to infestation with nematode and fungus. These results are agree with results of Owens and Novothy (1966) who found that plant tissues infested by nematodes showed a considerable increases in the levels of free amino acids, organic acids and protein, also with Zhang *et al.*( 2010) who concluded that phenylpropane metabolites had close correlation with resistance to Southern root knot nematodes in grafted cucumber seedlings. Increase in the contents of such components responsible for synthesis of auxins, hormones and many other compounds are involved in the defense mechanisms of plant to nematodes and fungi diseases many plants respond to pathogens by eliciting a hypersensitive reaction of the site of infection and subsequently, a systemic resistance response develops (Sirohi and Dasgupta, 1993). It was reported that resistant cultivars infected by different pathogens activate oxidative enzymes mainly peroxidase and polyphenol oxidase whose oxidation products such as quinines are toxic to the invading microorganisms (Rajasekhar *et. al.*, 1997). Also, Mohamed *et. al.* (1999) showed that the contents of the enzymes, peroxidase and polyphenol oxidase increased within infected roots indicating consistency with the cultivar reaction to the root-knot nematode. Peroxidases have been reported to oxidise phenols and consequently have been assigned a role analogous to that proposed for polyphenol oxidases in the necrotic reaction (Sodium and Mohmood, 1992 and Zacheo *et. al.*, 1993). Peroxides act a role in four physiological processes, auxin catabolism, and defense mechanism against pathogens, some respiratory processes and synthesis of lignin (Siddiqui and Mahmood, 1992) .At the same trend, Osman *et al.*, (2012) showed that *Rotylenchulus rveniformis* as incompatible pathogen to potato, it increased the content of peroxidase, polyphenol oxidase and chitinase in the inoculated plants as indicator of inducing resistance to *M. incognita*. Because of this fact, the use of grafting onto resistant cucurbit rootstocks has proved to be effective for control of southern root-knot nematode, *M. incognita* and fusarium wilt fungus, *F. oxysporium*. These studies will be helpful in selection of cucurbit rootstocks for the development of cultivars resistant against both diseases. (Oda, 1999).



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TO ROOT- KNOT NEMATODE AND FUSARIUM WILT UNDER SCREEN-HOUSE CONDITIONS

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## تقييم بعض الاصول من نباتات الفصيلة القرعية للإصابة بنيماتودا تعقد الجذور والذبول الفيوزارمى تحت ظروف الصوبة السلكية

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تعتبر نيماتودا تعقد الجذور ميليوذوجين أنكوجنيتا والذبول الفيوزريومى المتسبب عن الفطر فيوزاريم اوكسيسبورم على بعض نباتات الفصيلة القرعية من أهم أمراض التربة. تهدف الدراسة الحالية لتقييم الخيار وبعض الأصول القرعية لمقاومة نيماتودا تعقد الجذور والذبول الفيوزريومى فى فصلى الخريف والربيع 2009 - 2010 تحت ظروف الصوبة السلكية.

تشير البيانات بأن الخيار *Cucumis sativus* حساس وشديد الحساسية لنيماتودا تعقد الجذور فى الخريف والربيع على التوالي ويكون حساس فى كلا الموسمين لذبول الفيوزريوم بينما فى الخريف كانت الكوسة الشتوى *winter squash, Cucurbita maxima* أصل عالى المقاومة ومقاوم للنيماتودا عند زراعتها فى تربة محقونه بالنيماتودا فقط أو بالنيماتودا والفيوزاريوم معاً على التوالي كما أعطت أعلى نسبة فى محتوى اللجنين (0.4208) اما الأصل *Lagenaria siceraria* وكان متوسط المقاومة للنيماتودا فى كل الحالات فى الخريف بينما فى الربيع كان كلا من *Benincasa hispida and Cucurbita maxima hybrid 6001* متوسط المقاومة لنيماتودا تعقد الجذور .

معظم الأصول القرعية مقاومة وعالية المقاومة للذبول الفيوزريومى فى حين الخيار كأصل اعتبر حساس وعالى الحساسية عند نمو الشتلات فى تربة محقونة بالفيوزاريوم فقط أو بالفيوزاريوم والنيماتودا معاً على التوالي. بينما الأصول القرعية النامية فى تربة محقونة بالفيوزاريوم والنيماتودا معاً معظمها حساس وشديد الحساسية للذبول الفيوزريومى ماعدا *Lagenaria* و *Cucurbita moschata* فى الخريف والأصل فى الربيع الذى أعطى أعلى نسبة *Luffa acutangula* سد يداز (350.1) فى محتوى أنزيم البروك يبرواك يليه الأصل *Cucurbita maxima x Cucurbita maxima* (0.985)Hybrid Charmatoza .

كما أوضحت النتائج حدوث انخفاض فى الطول والوزن الطازج للمجموع الخضرى والمجموع الجذرى لمعظم الأصول فى الخريف والربيع نتيجة العدوى بالفطر والنيماتودا. وعلى هذا ينصح باستخدام الاصول المقاومة فى برامج التربية لاصناف مقاومة ضد نيماتودا تعقد الجذور او فطر الذبول.