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Effect of irrigation water salinity on the infectivity and reproduction of the root-knot and the reniform nematodes on some vegetable crops.

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Abstract

The influence of NaCl on the infectivity and reproduction of the root-knot and the reniform nematodes was studies using four concentrations (500, 1000, 2000 and 3000 ppm) of sodium chloride (NaCl) in the irrigation water of eggplant, squash and cowpea. Increasing salt concentration and consequently soil Ec resulted in significant increase in number of *M. incognita* galls and egg-masses/ eggplant roots as compared with the check plants (0 salt). The highest number of galls was observed at 3000 ppm NaCl. Increasing NaCl concentration in irrigation water increased females fecundity on the roots of eggplant and squash. However opposite results were observed on cowpea roots. The reniform nematode behaved differently, whereas the nematode counts increased with increasing salt concentration on cowpea and decreased on eggplant and squash.

The present results indicated that higher salt concentration adversely affected the growth of treated plants and significantly increased the damage caused by nematodes. The influence of salt stress on the nematode development and reproduction depend on nematode species, salt concentration (soil EC) as well as the host plant. In general damage in plants under salt stress and infected with the reniform nematode was more pronounced than those infected with the root-knot nematode.

Key words: *M. incognita, R. reniformis,* salinity.

Introduction

Salinity of either soil or irrigation water has become one of the important abiotic factors that affect agricultural production especially in countries suffering from shortage of their fresh water resources. In Egypt, the dependence on the ground water in the newly reclaimed sandy soil of the desert inflated the problem whereas soil salinity increased gradually year after year. Such increase in soil salinity adversely affected the growth of the cultivated field or fruit crops. In such kind of soil type, the sandy soil, nematodes also take part in the crop losses and intensifying the problem which may threat the sustainable agriculture. Positive correlations between citrus nematode populations and chloride content of soil water was observed by **Kirkpatrick and Van Gundy 1966, Venkates and Das 1980, Youssef *et al.* 1989, Mashela *et al.* 1992.** Different effects, increasing or decreasing nematode hatching, developing and reproduction have been observed with different mineral or salt concentrations on various nematode species **(Jairajpuri *et al.* 1974, Lal and Yadav 1975, Edongali and Ferris 1980,1981, Ray and Das 1980, Edongali *et al.* 1982,Khan and Khan 1990and Sweelam 1994). Vermak *et al.* 2007** reported negative correlation between *M. incognita* galling, eggmasses, eggs/eggmass, final population and increasing saline conductivity. *R. reniformis* tolerated strongly saline conditions **(Ray and Das 1980).** No available recent references in literature illustrating the role of the gradual increase in soil salinity on plant nematodes dynamics. Accordingly this study was carried out to clarify such role under greenhouse conditions especially the root-knot, *Meloidogyne incognita* and the reniform, *Rotylenchulus reniformis* on three different host plants.

Materials and methods

The development and reproduction of the root-knot and the reniform nematodes under the stress of soil salinity was studied under greenhouse conditions of 30±5 °C. Nematode cultures were belonged to the pure stock cultures of Nematology Research Center, Faculty of Agric. Cairo University. The study was carried out using 5 different salt concentrations (0, 500, 1000, 2000 and 3000 ppm) of sodium chloride (NaCl). The solutions were used to irrigate eggplant,*Solanum melongena* (gloyana F1), squash, *Cucurbita maxima* (Tabark F1) and cowpea, *Vigna unguiculata* (cv Qaha1) grown in 15 cm diameter clay pots filled with loamy sand soil (1 sand : 1 loam v/v). Fifteen days after cultivation pots of each crop were divided into three groups and thinned to one plant/pot. Pots of the first group were inoculated with 2000 J_2 of the root-knot nematode, *M. incognita.* Those of the second group were inoculated with 2000 infective stage of the reniform nematode, *R. reniformis* however pots of the third group were kept without inoculation to serve as checks. For each nematode species in each crop, 4 replicates were used in each salt concentration. Similar treatments were carried out with the uninoculated healthy plants, as well as 4 replicates were kept without any treatment to compare the results. Plants were irrigated every other day with 200 ml of the prepared solutions, check treatments were irrigated with the same volume of tab water until the end of the experiment. Soil electrical conductivity (EC) was measured twice, after 22 days and at the end of the experimental time (Table 1) using Muliparameter analysis (pH, EC and temperature) at the Reclamation & development Center for Desert Soils, Soil Department, Fac. of Agric. Cairo University. At the end of the experimental time, plants were harvested, plant growth criteria were registered and soil and nematode populations were counted.

The obtained results were statistically analyzed according to the SPSS software package version 12 **(SPSS, 2003).**

Table (1). Electrical conductivity of soils (1:2.5 soil extract) treated with different concentrations of NaCl after 22 days and at the end of the experiment.

Salt concentration (ppm)	EC mmhos/ cm					
	Eggplant		Squash		Cowpea	
	22days	45days	22days	45days	22 days	45 days
0	0. 26	0.30	0.27	0.30	0.26	0.29
500	0.84	0.89	0.83	0.87	0.81	0.94
1000	1.52	1.62	1.48	1.52	1.88	2.13
2000	3.16	3.21	3.12	3.17	3.02	3.22
3000	3.54	3.68	3.31	3.74	3.16	3.42

Results

Data in table (2) indicated that increasing salt concentration and consequently soil ECs resulted in significant increase in the number of galls and egg-masses/ eggplant root as compared with the untreated plants (0 salt).

The highest number of galls was observed at 3000 ppm NaCl and varied significantly with other treatments. Almost similar results were observed with the number of galls/squash root but the highest significant number of galls was observed when squash was irrigated with 1000 ppm of sodium chloride solution. On cowpea, the opposite was observed, whereas, increasing salt concentration from 1000 to 3000 decreased significantly the observed numbers of galls and egg-masses as compared with 0 and 500 ppm. The lowest numbers of galls and egg-masses / cowpea roots were observed at the higher salt concentrations and varied significantly with the other treatments.

The number of eggs/egg-mass significantly increased with increasing salt in irrigation solutions in case of eggplant and squash, however, on cowpea roots the opposite was observed. The total number of eggs/pot and the number of eggs/g soil decreased with increasing salt concentration in case of squash and cowpea and increased in case of eggplant. Finally, the highest rate of build up was observed at 2000 ppm of NaCl on eggplant and squash (EC 3.21, 3.17, respectively) and at 1000 ppm on cowpea (EC 2.13). With the reniform nematode, negligible numbers of developmental stages and mature females were counted on the roots of the three host plants, so no obvious trend could be observed due to salt concentrations (Table 3). Numbers of egg-masses significantly decreased at 1000, 2000 ppm on eggplant, at all concentrations on squash and at higher concentrations on cowpea as compared with the check. The number of eggs laid in the egg-masses on eggplant roots were not affected by different NaCl concentrations. While, it significantly decreased by all concentrations on squash and by only the highest concentration on cowpea as compared with the check. Consequently, the number of eggs/g soil and the total number of eggs/ pot behaved the same.

Table (2): Development and reproduction of *M. incognita* on some vegetable crops as affected by different concentrations of sodium chloride.

Vegetable crop	Salt concentration	Nematode counts							
		No. galls / plant	Eggmasses / plant	Eggs/ eggmass	Total no. eggs	Eggs/ g soil	Soil population	Final population	Pf/Pi
Eggplant (Gloyana F1)	**0**	134.8 d	76.3 d	158.8 d	12104.7 d	6.1 d	0.0	76.3 d	0.04 c
	500	257.8 b	129.8 c	241.3 b	31302.2 c	15.7 c	0.0	129.8 c	0.06 b
	1000	165.3 c	163.8 b	201.0 c	32913.8 c	16.5 c	0.0	163.8 b	0.08 a
	2000	272.3 b	179.3 a	211.8 c	37975.7 b	19.0 b	0.0	179.3 a	0.09 a
	3000	364.0 a	164.3 b	283.0 a	46497.0 a	23.3 a	0.0	164.3 b	0.08 a
Squash (Tabarak F1)	**0**	1130.8 cd	404.0 a	152.3 c	61509.0 b	30.8 b	688.3 b	1092.3 a	0.55 a
	500	1962.8 b	262.0 c	219.3 b	57456.6 b	28.7 b	419.3 d	681.3 c	0.34 c
	1000	2356.8 a	294.8 b	308.8 a	91034.2 a	45.5 a	553.3 c	848.0 b	0.42 b
	2000	1074.5 d	143.3 d	314.3 a	45039.2 c	22.5 c	922.8 a	1066.0 a	0.53 a
	3000	1309.0 c	119.3 d	251.0 b	29944.3 d	15.0 d	167.0 e	286.3 d	0.14 d
Cowpea (Qaha 1)	**0**	432.3 a	275.0 a	501.8 a	137995.0 a	69.0 a	198.0 b	473.0 b	0.24 b
	500	447.0 a	281.3 a	474.3 a	133420.6 a	66.7 a	138.3 c	419.5 b	0.21 c
	1000	324.3 b	240.0 b	423.8 b	101712.0 b	50.9 b	382.5 a	622.5 a	0.31 a
	2000	310.8 b	186.0 c	404.8 b	75292.8 c	37.7 c	127.8 c	313.8 c	0.16 d
	3000	265.3 c	187.3 c	329.3 c	61677.9 c	30.8 c	404.0 a	591.3 a	0.30 a

In each column, values of a crop cultivars followed by the same letter(s) are not significantly different (P=0.05).

Table (3): Development and reproduction of *R. reniformis* on some vegetable crops as affected by different concentrations of sodium chloride.

Vegetable crop	Salt concentration	Nematode counts								
		D.S/ plant	M.females/ plant	Eggmasses / plant	Eggs/ eggmass	Eggs/ g soil	Total no. eggs	Soil population	Final population	Pf/Pi
Eggplant (Gloyana)	0	5.3 a	5.0 bc	140.0 a	80.3 a	5.6 a	11242.0 a	634.0 c	784.3 c	0.39 c
	500	1.5 b	4.3 c	150.3 a	73.0 a	5.5 a	10971.9 a	1093.8 a	1249.8 a	0.62 a
	1000	1.0 b	4.3 c	120.0 b	83.0 a	5.0 a	9960.0 a	964.0 b	1089.3 b	0.54 b
	2000	5.5 a	6.8 b	109.8 b	72.0 a	4.0 b	7905.6 b	154.0 e	276.0 e	0.14 e
	3000	3.3 ab	10.3 a	139.0 a	70.8 a	4.9 a	9841.2 a	478.8 d	631.3 d	0.32 d
Squash (Tabarak F1)	0	5.3 b	9.0 a	622.8 a	82.8 a	25.8 a	51567.8 a	3105.3 a	3742.3 a	1.87 a
	500	8.0 a	10.8 a	276.8 c	77.0 a	10.7 b	21313.6 b	2644.0 b	2938.8 b	1.47 b
	1000	1.0 c	5.8 b	279.8 c	44.8 b	6.3 c	12535.0 c	2640.0 b	2926.5 b	1.46 b
	2000	1.8 c	5.3 b	441.3 b	52.8 b	11.7 c	23300.6 b	1573.5 c	2021.8 c	1.01 c
	3000	3.8 b	4.5 b	281.8 c	39.5 b	5.6 c	11131.1 c	2378.8 b	2668.8 b	1.33 b
Cowpea (Qaha 1)	0	5.3 b	13.5 b	226.8 c	103.0 bc	11.7 c	23380.4 c	2724.0 b	2969.5 b	1.48 b
	500	7.5 a	23.0 a	258.8 b	112.0 b	14.5 b	28985.6 b	2666.8 bc	2956.0 b	1.48 b
	1000	3.0 c	6.8 c	316.3 a	135.8 a	21.5 a	42953.5 a	1904.3 d	2230.3 c	1.12 c
	2000	5.0 b	9.3 c	170.8 d	95.3 cd	8.1 d	16277.2 d	2337.5 c	2522.5 c	1.26 c
	3000	2.8 c	13.8 b	182.0 d	80.0 d	7.3 d	14560.5 d	3718.3 a	3916.8 a	1.96 a

In each column, values of a crop cultivars followed by the same letter(s) are not significantly different (P=0.05).

Soil population behaved in different pattern, the lowest numbers of soil population were counted on eggplant comparing to the other tested hosts. The 500 ppm NaCl concentration achieved the highest significant soil population when compared to the check and other treatments. On squash, soil populations significantly decreased by all salt concentrations.

On the contrary, the highest soil population of the reniform nematode on cowpea was counted at the highest concentration of salt. Similar results were observed with the final population and the rate of nematode build up. It could be generally concluded that the influence of salt concentration on the development and reproduction on nematode depend on nematode species, salt concentration and soil EC as well as the cultivated host plant.

Data in tables (4,5) illustrate the response of the host plants to nematode infection under the stress of salt. It is obvious, in the majority of cases, that salt stress significantly increased the damage caused by nematodes. The percentages of reduction in plant growth criteria were as follows: In case of *M. incognita,* 0.0 - 25.2% in shoot length, 0 – 79.4% in shoot fresh weight, 14.9 – 82.4% in shoot dry weight, 0-41.0 % in root length and 12.8- 80.8 % in root weight. The highest percentages of reduction were observed on eggplant. In case of *R. reniformis,* 0-44.9, 32.0-82.6, 27.7-87.3, 0-34.1 and 25.2-85.9%, respectively. It is clear that, damage in plants under the stress of salt and infected with the reniform nematode was more pronounced than those infected with the root-knot nematode. Such damage emphasized that the tested vegetables are sensitive to salt especially when the measured electrical conductivity of the soil ranged between < 1- 3.74 which ranked as low – slight saline soil.

Discussion

The effect of increasing salt concentrations in irrigation water was studied to clarify the role of salinity on the development and reproduction of the root-knot and reniform nematodes and the response of the cultivated vegetable crops. The present results are staggering whereas the influence of NaCl on the root-knot nematode *M.incognita* depended on salt concentration and the growing crop. On eggplant, increasing salt concentration resulted in significant increase in the number of galls, egg-masses, the number of eggs/g soil as well as the final population. Increasing NaCl concentration in irrigation water increased females fecundity on the roots of eggplant and squash, however, on cowpea roots the opposite was observed. The highest rates of build up were observed at 2000 ppm of NaCl (EC. 3.16-3.21, 3.12-3.17) on eggplant and squash and at 1000 ppm on cowpea (EC. 1.88-2.13). **Venkates and Das (1980)** observed positive correlation between nematode population and chloride salts content of soil water. Kirkpatrick and **VanGundy (1966)** found that development of *Tylenchulus semipenetrans* increased by increasing salinity until 6.5 mmhos/cm. Salinity increased egg production of

Table (4): Growth of some vegetables as affected by *M. incognita* and NaCl concentrations.

Host	Shoot						Root				Total weight	
	length	% red.	F. weight	% red.	D.weight	% red.	length	% red.	weight	% red.	weight	% red.
Eggplant												
Untreated	26.00 d		6.31 a		1.02 a		28.38 a		4.58 a		10.89 a	
0 salt	32.25 b	-	2.63 b	58.32	0.43 b	57.84	20.25 bc	22.21	2.48 b	33.28	5.10 b	53.17
500 ppm	30.00 bc	-	1.60 c	74.64	0.23 c	77.45	19.50 bc	31.13	2.28 c	50.21	3.88 c	62.87
1000 ppm	28.00 cd	-	1.50 c	76.23	0.18 c	82.35	19.38 bc	31.71	1.48 d	57.69	2.98 d	72.64
2000 ppm	26.50 d	-	1.30 c	79.40	0.18 c	82.35	19.38 bc	40.97	1.08 e	76.42	2.38 d	78.15
3000 ppm	35.25 a	-	1.50 c	76.23	0.18 c	82.35	21.75 b	23.36	0.88 f	80.79	2.38 d	78.15
Squash												
Untreated	46.40 a		20.34 a		2.79 a		23.00 ab		3.34 a		23.68 a	
0 salt	34.73 d	25.15	12.81 b	37.02	1.93 b	30.82	20.25 bc	11.96	2.71 b	18.86	15.52 b	34.46
500 ppm	37.58 cd	19.01	8.87 c	56.46	1.18 c	57.71	26.50 a	-	2.93 b	12.78	11.79 c	50.21
1000 ppm	42.83 ab	7.69	7.48 d	63.23	1.08 c	61.29	21.75 bc	5.43	2.26 c	32.34	9.74 d	54.69
2000 ppm	40.33 bc	13.08	6.30 e	69.03	0.88 d	68.46	15.50 d	32.61	1.76 d	47.31	8.06 e	59.56
3000 ppm	42.42 b	8.56	5.96 e	70.69	0.86 d	69.48	18.50 cd	19.50	1.22 e	63.47	7.18 e	65.50
Cowpea												
Untreated	21.75 d	-	7.50 a		1.88 a		20.50 b		5.88 a		13.38 a	
0 salt	49.75 a	-	7.93 a	-	1.60 b	14.89	23.75 ab	-	4.28 b	27.21	12.20 b	8.82
500 ppm	32.38 c	-	5.88 b	21.60	1.08 c	42.55	23.13 ab	-	4.18 b	28.41	10.06 c	15.55
1000 ppm	37.95 b	-	4.73 c	36.93	0.60 d	68.09	24.25 ab	-	3.00 c	48.98	7.73 d	42.23
2000 ppm	26.93 cd	-	4.80 c	36.00	0.68 d	63.83	27.00 a	-	2.43 c	58.67	7.23 d	45.96
3000 ppm	31.58 c	-	4.23 c	43.60	0.73 d	61.17	24.08 ab	-	2.18 c	62.93	6.40 e	52.16

In each column, values of a crop cultivars followed by the same letter(s) are not significantly different (P=0.05).

Table (5): Growth criteria of some vegetables as affected by *R. reniformis* and NaCl concentrations.

Host	Shoot						Root				Total weight	
	Length	%red.	F. weight	%red.	D.weight	%red.	Length	% red.	Weight	%red.	weight	% red.
Eggplant												
Untreated	26.00 c		6.31 a		1.02 a		28.25 a		4.58 a		10.89 a	
0 salt	31.25 b	-	3.85 b	38.96	0.65 b	36.27	18.88 c	33.17	2.35 b	48.69	6.02 b	56.57
500 ppm	29.63 b	-	1.60 d	74.64	0.13 d	87.25	18.63 c	34.05	1.33 c	70.96	2.93 cd	73.09
1000 ppm	31.00 b	-	1.48 d	76.55	0.25 cd	75.49	19.38 c	31.34	0.90 d	80.35	2.38 e	78.15
2000 ppm	36.25 a	-	2.90 c	54.04	0.28 c	72.55	22.63 b	19.89	0.73 e	84.06	3.63 c	66.67
3000 ppm	38.75 a	-	2.53 c	59.90	0.20 c	80.39	23.25 b	17.70	0.65 e	85.91	3.25 cd	70.16
Squash												
Untreated	46.40 a		20.34 a		2.79 a		23.00 bc		3.34 a		23.68 a	
0 salt	27.43 c	40.88	13.03 b	35.94	1.83 b	34.41	22.13 c	3.78	2.50 b	25.15	12.53 b	45.52
500 ppm	25.55 c	44.94	4.98 c	78.96	0.60 c	78.49	24.00 bc	-	0.95 d	71.56	5.93 c	74.22
1000 ppm	33.65 b	27.48	4.28 cd	75.52	0.58 c	79.21	25.30 b	-	1.25 cd	62.57	5.53 c	75.96
2000 ppm	26.05 c	43.86	3.55 d	82.55	0.55 c	80.29	25.38 b	-	1.28 c	61.68	4.83 c	79.00
3000 ppm	29.00 c	37.50	3.60 d	82.30	0.57 c	79.57	30.50 a	-	1.23 cd	63.17	4.83 c	79.00
Cowpea												
Untreated	21.75 b		7.50 a		1.88 a		20.50 ab		5.83 a		13.33 a	
0 salt	27.58 a	-	5.10 b	32.00	1.36 b	27.66	23.25 ab	-	3.25 b	44.25	8.35 b	37.36
500 ppm	25.70 ab	-	4.00 cd	46.67	0.60 c	68.09	20.38 b	0.59	1.18 c	79.76	5.18 d	61.14
1000 ppm	24.68 ab	-	4.80 bc	36.00	0.53 c	71.81	23.75 a	-	1.30 c	77.70	6.10 c	54.24
2000 ppm	25.33 ab	-	3.63 d	51.60	0.50 c	73.40	20.00 b	2.44	1.40 c	75.99	5.03 d	62.27
3000 ppm	23.70 ab	-	4.00 cd	46.67	0.53 c	71.81	20.75 ab	-	1.00 c	82.84	5.00 d	62.49

In each column, values of a crop cultivars followed by the same letter(s) are not significantly different (P=0.05).

T. semipenetrans by 2-10 folds when NaCl was added in irrigation water every other day **(Mashela *et al.*, 1992).** Other research workers observed reduction in nematode activities as a result of increasing salt concentrations. **Sweelam (1994)** found that gall numbers caused by *Meloidogyne javanica* on tomato roots were reduced by increasing sodium chloride concentrations from 1000 to 4000 ppm. **Vermak *et al.,* (2007)** as well, stated that galling, egg-masses, eggs/egg-mass and final population in the soil decreased with increasing EC. levels from 5.6-11.2 as compared to non-saline (EC. 1.15).

With the reniform nematode, the opposite was observed, whereas nematode counts increased with increasing salt concentration on cowpea and decreased on eggplant and squash. But, the results emphasized that damage of plants under the stress of salt and the reniform nematode infection was more pronounced than those infected with the root-knot nematode. **Heald and Heilman (1971)** stated that the reniform nematode occurred equally in relatively low saline (4.0 mmhos) and highly saline (16.5 mmhos/cm) soils. Generally, limits of nematode tolerance to salt concentration varied to great extent according to nematode genera and/or species. Many nematode species tolerate slightly saline conditions (EC. 2-4 mmhos/cm) e.g *Tylenchus*, *Tylenchorhynchus*, *Pratylenchus* and *Aphelenchoides. Helicotylencus dihystera,* *Hirshmanniela gracilis* and *Macropsthonia ornata* thrived moderately saline soils with ECs around 6 mmhos/cm. Few other species like *Rotylenchulus reniformis, Meloidogyne sphaerocephala, Hemicriconemoides cocophilus and Caloosia exitis* tolerate saline soil conditions (EC. 10.25 mmhos/cm); **Ray and Das, 1980.** The nematode activities affected by salt concentrations are egg hatching **(Dropkin *et al.*, 1958; Lal and Yadav, 1975),** invasion of plant roots (**Wallace, 1970),** Development **(Kirkpatrick and Van Gundy, 1966; Youssef *et al.*, 1989),** reproduction **(Edongali and Ferris, 1980)** and survival **(Jairajpuri *et al.*, 1974).**

The present results also indicated that slightly saline soils adversely affected the growth of plants especially vegetables. These results coincide with those of **Vermak *et al.*(2007) and Karajeh and Al-Nasir (2008).**

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الملخص العربي

تأثير ملوحة مياه الري على القدرة الإمراضية وتكاثر نيماتودا تعقد الجذور والنيماتودا الكلوية على بعض نباتات الخضر

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تم في هذا البحث دراسة تأثير زيادة تركيز الملح في التربة على تطور وتكاثر نيماتودا تعقد الجذور أوالنيماتودا الكلوية وذلك باستخدام أربعة تركيزات من كلوريد الصوديوم (٥٠٠، ١٠٠٠، ٢٠٠٠، ٣٠٠٠ جزء في المليون) في ري نباتات الباذنجان والكوسة واللوبيا والتي تم عدواها ب ٢٠٠٠ طور معدي من أي من نوعي النيماتودا وكانت النتائج كما يلي:

- **أدى زيادة تركيز كلوريد الصوديوم في محلول الري إلى زيادة كتل التوصيل الكهربي (EC) حيث أدى ذلك إلى زيادة أعداد العقد وكتل البيض على جذور نباتات الباذنجان زيادة معنوية وذلك عند مقارنتها بالنباتات غير المعاملة بالملح وكانت أكبر زيادة في أعداد العقد عند أعلى تركيز (٣٠٠٠ جزء في المليون). أيضاً أدي إلى زيادة القدرة التناسلية للإناث (عدد البيض في الكتلة الواحدة) في كل من الباذنجان والكوسة، أما اللوبيا فقد لوحظ العكس حيث أدى زيادة التركيز إلى انخفاض في أعداد النيماتودا على الجذور. أما في حالة النيماتودا الكلوية فكانت النتائج عكس ذلك حيث أدى زيادة التركيز إلى زيادة الأعداد على جذور اللوبيا ونقصها على جذور الباذنجان والكوسة.**

- **أوضحت النتائج أيضًا التأثير العكسي للملح على نمو النباتات، كما أوضحت أن زيادة التركيز أدى إلى زيادة الضرر الناتج عن الإصابة بالنيماتودا وخاصة في حالة النيماتودا الكلوية. أكدت النتائج على أن تأثير الملح على تكاثر النيماتودا يتوقف على نوع النيماتودا وتركيز الملح والمحصول المنزرع.**