

Effect of duration of irrigation on the infectivity and reproduction of the root-knot and the reniform nematodes on some vegetable crops grown in two different soil types.

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Abstract

Influence of changes of soil moisture due to the durations of irrigation on the development and reproduction of the root-knot (*M. incognita*) and the reniform (*R. reniformis*) nematodes infecting eggplant, squash and cowpea in two different soil types was studied under greenhouse conditions. Results showed that the highest counts of the root-knot nematode were recorded on roots of eggplant grown in loamy sand soil and irrigated at the fourth day. On squash, the highest nematode counts were recorded on plants grown in sandy loam soil and irrigated every day, and on cowpea roots grown in the same soil type but irrigated every four days. Higher reproductivity values of the reniform nematode on eggplant roots were accomplished in loamy sand soil and irrigated every four days. Significant higher final population and rate of reproduction on squash and cowpea were recorded on plants grown in the same soil type but irrigated daily or every other day, respectively. The influence of the duration of irrigation on nematode development depend on many factors most of which are the soil type, duration of irrigation, nematode species as well as the growing crop. The prolonging irrigation period (decreasing soil moisture) significantly reduced the growth of the infected plants. Such effect was pronounced with the longest period between irrigation (3 days) in loamy sand soil.

Key words: *M. incognita*, *R. reniformis*, vegetables, soil type, soil moisture.

Introduction

Soil moisture varies considerably as a result of many biological and physical actions. In the broad sense, some of the most obvious factors regulating soil moisture are intensity and frequency of irrigation, rainfall, the drainage pattern, and the precipitation/evaporation ratio. Other factors governing the amount of moisture in nematode's environment include the amount of available soil moisture for the particular soil type, the stage of plant maturity, the length of growing seasons, the water requirements of individual plants or crops, and elements relating to individual characteristics of the leaves and roots. The relative capacity of moisture is so dependent upon the soil texture and other factors that determine the soil phase that they cannot be separated. The coarser the soil, the larger the pores; the smaller the total soil surface area, the less water retained (Norton, 1978).

It has been shown that movement and the invasion of host roots by the root knot nematode *Meloidogyne* spp. and the reniform nematode, *Rotylenchulus reniformis* is reduced at low moisture (Couch and Bloom, 1960; Rebois, 1973). Daulton and Nusbaum (1962) studied the effect of soil moisture and relative humidity on root-knot nematode *Meloidogyne javanica*. They found a greater and more rapid reduction in egg viability in wet soil (20.4 % moisture) than in dry soil (3.4% moisture). Eggs of the Southern Rhodesia population withstood exposure to both wet and dry soil better than those of Georgia population. The more rapid reduction in viability in wet soil may be due to relatively quick hatching of eggs and increased activity of larvae in this environment, resulting in depletion of stored energy. The tolerance differences, they added, of the *M. javanica* populations to extremes of soil moisture may be due to the different environmental conditions in the areas from which they were taken.

Because of the difficulty of maintaining constant soil moisture, little direct evidence can be gained on moisture and nematode increase. Kable and Mai (1968) found that the population increase of *Pratylenchus penetrans* was greatest at moderate soil moisture tensions (pF 2 to 3) but there was an interaction with soil moisture and soil type; the greater the amount of silt and clay present, the greater the soil moisture tension for plant growth. Khanizadeh *et al.* (1994) tested the relative susceptibility of five strawberry (*Fragaria x ananassa* Duch.) cultivars to the root-knot nematode (*Meloidogyne hapla*) under three different soil water deficit levels and three nematode densities. Percent water deficit had a positive linear effect on the number of galls on strawberry roots, and on egg production and number of *M. hapla* larvae in the soil, regardless of cultivar type. In 2007, Bakonyi *et al.* stated that alteration of the nematode community structure induced by global change may have a considerable influence on the ecosystem functioning, however, it is not clear whether minor changes in soil temperature and/or moisture have any significant effect on nematode community structure. They modified soil temperature and moisture to the extent expected for near future due to global changes. They proved that community diversity and multivariate structure of the nematode community were sensitive to minute changes in soil temperature and moisture than different indices such as specific richness, maturity index, plant parasite index. Nematode genera with high densities (>0.1 individual g⁻¹ soil) were better indicators of the temperature and moisture changes than those of low density (<0.1 individual g⁻¹ soil) in sandy soil.

This study was undertaken to assess the influence of soil moisture and soil types as abiotic factors on the development and reproduction of the root-knot and reniform nematodes on some vegetable crops.

Materials and methods

Pure cultures of the root-knot nematode, *Meloidogyne incognita* and the reniform nematode, *Rotylenchulus reniformis* obtained from the stock cultures belong to Nematology Research Center, Department of Zoology and Agric. Nematology, Faculty of Agriculture. Eggplant, *Solanum melongena* (gloyana F1 hyb.), squash, *Cucurbita maxima* (Tabarak F1 hyb.) and cowpea, *Vigna unguiculata* (cv Qaha 1) were used in the present study.

Influence of the changes of soil moisture due to the durations of irrigation on the development and reproduction of the root-knot and the reniform nematodes infecting eggplant, squash and cowpea was studied under the greenhouse conditions of $30\pm 5^{\circ}\text{C}$. The experiment was conducted in two soil types loamy sand and sandy loam in 15 cm diameter clay pots (Table 1). Soil types were mechanically analysed at Reclamation & development Center for Desert Soils, Soil Department, Fac. of Agric. Cairo University. After cultivation, plants (one/pot) were inoculated with 2000 infective stages of either *M. incognita* or *R. reniformis*. Irrigation durations were at 1,2,3 and 4 days intervals with 200ml of tab water throughout the experimental time (6 weeks). Four replicates were used for each irrigation time. Pots of each nematode species were arranged randomly on a clean bench of the greenhouse. At the end of experiment plants were taken off, plant growth criteria were measured and soil and root nematode populations were counted.

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

Table (1): Mechanical analysis of soil.

Soil type	% Soil particles				
	Coarse sand	Fine sand	Silt	Clay	Texture class
1 loam :1 sand (v:v)	47.7	33.6	9.1	8.9	Loamy sand
Loamy soil	1.8	70.6	11.3	16.3	Sandy loam

Results

A. The root-knot nematode

Data present in table (2) indicate that the highest significant number of galls formed on eggplant roots was accomplished on plants grown in loamy sand soil and irrigated at the fourth day (the longest period that plants tolerate water deficiency) followed by those grown in sandy loam soil and irrigated day after day. The highest numbers of egg-masses were also formed in the same treatment which varied significantly with the other treatments in both types of soil. Concerning the number

Table (2): Impact of irrigation duration on the development and reproduction of *M. incognita* infecting vegetable crops grown in two types of soil.

Crop	Soil type	Irrigation duration	Galls/root	Eggmasses/Root	Eggs/eggmass	Total no. eggs	Eggs/g soil	Soil population	Final population	P/PI
Eggplant Gloyana F1	Loamy sand	Every day	312.8 od	187.0 bc	249.8 c	46712.6 c	23.4 c	0.0	187.0 bc	0.09 bc
		2 nd day	293.8 d	207.8 bc	323.8 b	67285.6 b	33.6 b	0.0	207.8 bc	0.10 bc
		3 rd day	307.0 cd	225.8 b	336.3 b	75936.5 b	38.0 b	0.0	225.8 b	0.11 b
	Sandy loam	Every day	501.3 a	314.0 a	557.3 a	174992.2 a	87.5 a	120.0 a	434.0 a	0.22 a
		2 nd day	380.0 b	182.5 bc	173.8 d	31718.5 d	16.0 d	0.0	182.5 bc	0.09 bc
		3 rd day	392.0 b	200.3 bc	223.0 c	44666.9 c	22.4 c	0.0	200.3 bc	0.10 bc
Squash Tabarak F1	Loamy sand	Every day	716.5 a	120.8 bc	9.5 c	1147.6 c	0.6 c	0.0	120.8 bc	0.06 bc
		2 nd day	578.0 b	154.3 b	12.3 c	1897.9 c	1.0 c	0.0	154.3 b	0.08 b
		3 rd day	454.5 c	108.8 cd	16.0 c	1740.8 c	0.9 c	0.0	108.8 cd	0.05 cd
	Sandy loam	Every day	316.5 d	87.3 cd	16.0 c	1396.8 c	0.7 c	0.0	87.3 cd	0.04 d
		2 nd day	564.5 b	256.8 a	291.3 a	74805.8 a	37.4 a	0.0	256.8 a	0.13 a
		3 rd day	434.8 c	113.8 c	172.0 b	19573.6 bc	9.8 bc	134.0 b	247.8 a	0.12 a
Cowpea Gaha 1	Loamy sand	Every day	281.8 d	122.8 bc	237.3 ab	29140.4 b	14.6 b	162.0 a	284.8 a	0.14 a
		2 nd day	170.0 e	70.8 d	239.8 ab	16977.8 bc	8.5 bc	0.0	70.8 d	0.04 d
		3 rd day	491.3 od	351.8 c	450.0 e	158310.0 cd	79.2 od	1244.8 od	1596.5 od	0.80 od
	Sandy loam	Every day	396.8 d	260.8 d	777.8 ab	202850.2 c	101.4 c	813.3 d	1074.0 d	0.54 d
		2 nd day	530.0 bc	375.0 c	568.3 d	213112.5 c	106.6 c	3776.0 b	4151.0 b	2.08 b
		3 rd day	511.3 od	375.3 c	806.0 a	302491.8 b	151.2 b	1968.3 c	2343.5 c	1.17 c
Sandy loam	Every day	650.8 b	489.8 b	469.3 e	229863.1 c	114.9 c	1007.5 od	1497.3 od	0.75 od	
	2 nd day	532.8 bc	173.3 e	661.8 c	114689.9 d	57.3 d	413.3 d	586.5 d	0.29 d	
	3 rd day	636.5 b	316.0 od	354.8 f	112116.8 d	56.1 d	1316.0 od	1632.0 od	0.82 od	
		4 th day	832.8 a	721.3 a	734.5 b	529794.9 a	264.9 a	6534.0 a	7255.3 a	3.63 a

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

of eggs/egg-mass, the number of eggs/g soil as well as the total number of eggs/root, the highest numbers were formed on plants grown in loamy sand soil and irrigated at 4, 3, 2 days intervals, in that order. Significant lower numbers of such counts were observed on roots of plants grown in sandy loam soil. As well, the final population and the rate of nematode build up was recorded in loamy sand soil irrigated every four days.

On squash, the highest significant numbers of egg-masses/root, eggs/egg-mass, eggs/g soil, total number of eggs/plant, final population and rate of nematode build up were recorded on plants grown in sandy loam soil and irrigated every day. Except for number of galls and egg-masses /root, other nematode counts are higher in sandy loam soil than those in loamy sand soil and irrigated at different intervals. On cowpea, different behavior was observed whereas the highest significant nematode counts were recorded on roots of plants grown in sandy loam soil and irrigated every four days followed by those grown in loamy sand and irrigated at the same interval. Apparently, no significant differences could be observed within and between different irrigation intervals in both types of soil.

Concerning growth response of the tested vegetables, data in table (3) indicated that growth criteria (especially shoot criteria) of plants grown in loamy sand either infected or none infected with the root-knot nematode are significantly higher than those grown in sandy loam soil. Increasing the intervals of irrigation adversely affected the growth of infected plants of the three vegetables in both types of soil. The longer the period between irrigation intervals the greater the reduction in plant growth.

B. The reniform nematode

Data in table (4) designated that the highest numbers of egg-masses/root, eggs/g soil, total number of eggs, final population as well as the rate of reproduction on eggplant roots were accomplished in loamy sand soil irrigated every four days. Irrespective of intervals of irrigation, nematode counts in the loamy sand soil were significantly higher than those in the sandy loam soil. Generally, increasing soil moisture (daily irrigation) was not in favor to nematode reproduction, however, prolonging the period of irrigation enhanced the reniform nematode reproduction. Conversely, increasing soil moisture (daily irrigation or irrigation each another day) was found to be in favor to nematode reproduction on squash and cowpea especially in loamy sand soil. The most significant highest final population and rate of reproduction on squash was recorded in loamy sand soil irrigated every day and on cowpea in sandy loam soil irrigated every other day.

Regarding growth response to the infection of the reniform nematode and the stress of soil moisture, data in table (5) illustrate that prolonging irrigation period (decreasing soil moisture) significantly reduced the growth of the infected plants. Such effect was pronounced with the longest period between irrigation (3 days) and in loamy sand soil.

Table (3): Growth of eggplant, squash and cowpea infected with *M. incognita* and grown in two different soil types as affected by the duration of irrigation.

Crop	Soil type	Irrigation duration	Shoot			Root		Total length (cm)	Total fresh weight (gm)
			length(cm)	fresh weight (gm)	dry weight (gm)	length(cm)	fresh weight (gm)		
Eggplant Gloyana F1	Loamy sand	Every day	26.88 a	4.68 a	0.56 b	15.33 d	2.00 b	42.20 bc	6.68 ab
		2 nd day	26.13 a	4.63 a	0.62 b	17.68 c	1.27 bc	43.80 b	5.90 b
		3 rd day	25.28 a	3.15 b	0.45 c	14.07 de	0.50 d	39.34 c	3.65 c
		4 th day	22.75 b	2.93 bc	0.44 c	13.33 de	0.85 cd	36.08 d	3.78 c
		Healthy	26.50 a	4.60 a	0.95 a	26.00 a	2.91 a	52.50 a	7.51 a
	Sandy loam	Every day	20.50 c	1.40 e	0.16 e	14.00 de	1.48 bc	34.50 de	2.88 c
		2 nd day	19.13 c	1.57 e	0.18 e	14.88 de	1.40 bc	34.00 de	2.97 c
		3 rd day	20.38 c	2.43 cd	0.27 d	13.63 de	1.28 bc	34.00 de	3.71 c
		4 th day	19.63 c	2.61 bc	0.24 de	12.88 e	1.35 bc	32.50 e	3.96 c
		Healthy	20.50 c	1.79 de	0.55 b	20.00 b	1.40 bc	40.50 c	3.19 c
Squash Tabarak F1	Loamy sand	Every day	32.06 ab	4.88 b	0.49 d	18.68 c	1.05 b	50.73 b	5.92 c
		2 nd day	25.30 cd	2.80 c	0.27 e	16.68 d	1.05 b	41.98 c	3.85 d
		3 rd day	25.35 cd	3.13 c	0.20 e	11.68 e	0.57 c	37.03 d	3.71 d
		4 th day	23.00 d	2.70 c	0.26 e	12.68 e	0.50 c	35.68 d	3.20 de
		Healthy	33.05 a	7.70 a	1.20 a	24.00 b	2.45 a	57.05 a	10.15 a
	Sandy loam	Every day	28.70 bc	7.25 a	0.73 c	20.38 c	1.22 b	49.08 b	8.47 b
		2 nd day	24.43 d	1.73 d	0.35 de	12.75 e	0.64 c	37.18 d	2.38 ef
		3 rd day	23.03 d	2.97 c	0.30 e	13.00 e	0.61 c	36.03 d	3.58 d
		4 th day	18.13 e	1.30 d	0.25 e	9.50 f	0.28 c	27.63 e	1.58 f
		Healthy	31.00 ab	7.21 a	1.00 b	26.50 a	2.40 a	57.50 a	9.61 a

Table (3) Continued

Crop	Soil type	Irrigation duration	Shoot			Root		Total length (cm)	Total fresh weight (gm)
			length(cm)	fresh weight (gm)	dry weight (gm)	length(cm)	fresh weight (gm)		
Cowpea Qaha 1	Loamy sand	Every day	25.50 b	3.33 de	0.50 od	23.00 b	1.95 od	48.50 b	5.28 d
		2 nd day	23.15 bc	3.10 de	0.45 de	18.00 c	1.51 ode	41.15 c	4.61 de
		3 rd day	22.03 ode	2.23 ef	0.31 ef	16.08 od	2.00 c	38.10 od	4.23 e
		4 th day	22.75 bod	2.80 de	0.39 de	14.33 d	1.36 def	37.08 od	4.16 e
	Sandy loam	Healthy	33.00 a	11.20 a	1.40 a	27.18 a	4.20 a	60.18 a	15.40 a
		Every day	22.13 ode	4.50 c	0.65 c	18.38 c	2.96 b	40.51 c	7.46 c
		2 nd day	20.13 de	3.53 od	0.49 od	15.68 od	1.40 odef	35.80 d	4.93 de
		3 rd day	19.73 e	1.13 g	0.21 f	14.00 d	0.79 f	33.73 de	1.92 f
		4 th day	16.96 f	1.20 fg	0.21 f	13.63 d	1.10 ef	30.59 e	2.30 f
		Healthy	23.00 bc	6.80 b	1.07 b	24.00 b	3.90 a	47.00 b	10.70 b

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

Table (4): Impact of irrigation duration on the development and reproduction of *R. reniformis* infecting vegetable crops grown in two types of soil.

Crop	soil type	Irrigation duration	D. stages	Mature females	Eggmasses/ root	Eggs/ eggmass	Total no. eggs	Eggs/g soil	Soil population	Final population	PI/PI
Eggplant Glojana F1	Loamy sand	Every day	2.3 cd	7.8 de	126.3 de	95.3 a	12036.4 bc	6.0 bc	1222.3 a	1358.7 a	0.68 a
		2 nd day	5.3 a	9.0 d	166.3 c	80.8 b	13437.0 b	6.7 b	321.8 od	502.3 c	0.25 c
		3 rd day	1.8 d	6.0 de	203.0 b	52.8 d	10718.4 c	5.4 c	1005.3 ab	1216.0 a	0.61 a
		4 th day	3.8 abc	18.3 b	242.8 a	71.3 bc	17311.6 a	8.7 a	1090.0 a	1354.8 a	0.68 a
	Sandy loam	Every day	3.8 abc	8.5 d	38.0 f	53.8 d	2044.4 e	1.0 e	446.0 c	496.3 c	0.25 c
		2 nd day	3.5 abcd	5.3 e	30.3 f	40.0 e	1212.8 e	0.6 e	452.3 c	491.3 c	0.25 c
		3 rd day	4.3 ab	23.5 a	115.0 e	62.3 od	7164.5 d	3.6 d	184.0 d	326.8 c	0.16 c
		4 th day	3.3 bcd	14.8 c	148.3 od	64.8 c	9602.4 c	4.8 c	786.5 b	952.8 b	0.48 b
Squash Tabarak F1	Loamy sand	Every day	12.8 a	13.0 c	630.3 b	42.3 ode	26661.7 c	13.3 c	1847.8 a	2503.8 a	1.25 a
		2 nd day	3.8 b	29.5 ab	686.0 b	65.0 b	44590.5 b	22.3 b	387.0 de	1106.3 d	0.55 d
		3 rd day	1.0 d	30.8 ab	243.8 f	36.3 e	8849.9 e	4.4 e	1125.3 bc	1400.8 od	0.70 od
		4 th day	4.3 b	32.8 a	346.3 e	52.3 c	18111.5 d	9.1 d	1155.3 bc	1538.5 c	0.77 c
	Sandy loam	Every day	2.8 bc	15.0 c	562.5 c	47.8 cd	26859.4 c	13.4 c	607.3 d	1187.5 d	0.59 d
		2 nd day	1.5 cd	25.0 b	938.0 a	79.3 a	74383.4 a	37.2 a	903.8 c	1868.3 b	0.93 b
		3 rd day	0.8 d	12.0 c	426.3 d	40.0 de	17052.5 d	8.5 d	1221.0 b	1660.0 bc	0.83 bc
		4 th day	0.0	3.8 d	111.8 g	31.0 e	3465.8 e	1.7 e	293.0 e	406.5 e	0.20 e
Cowpea Gaha 1	Loamy sand	Every day	0.0	17.8 ab	333.3 b	105.8 a	35263.1 a	17.6 a	5024.0 a	5375.0 a	2.69 a
		2 nd day	0.0	12.0 c	380.3 a	100.0 ab	38000.5 a	19.0 a	2340.5 c	2732.8 c	1.37 c
		3 rd day	0.0	14.3 bc	346.0 b	105.8 a	36606.8 a	16.3 a	1792.3 c	2152.5 d	1.08 d
		4 th day	0.0	12.5 c	220.0 c	45.3 e	9966.8 c	5.0 c	1127.3 d	1359.8 e	0.68 e
	Sandy loam	Every day	8.3 b	15.5 bc	379.5 a	86.0 bc	32637.0 ab	16.3 ab	3652.0 b	4255.3 b	2.13 b
		2 nd day	21.8 a	20.0 a	359.3 ab	77.3 od	27773.9 b	13.9 b	5306.8 a	5707.8 a	2.85 a
		3 rd day	6.3 c	17.8 ab	146.0 d	70.0 d	10220.0 c	5.1 c	900.5 d	1070.5 ef	0.54 ef
		4 th day	0.0	7.8 d	76.0 e	67.3 d	5114.8 c	2.6 c	536.0 d	619.8 f	0.31 f

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

Table (5): Growth of eggplant, squash and cowpeas infected with *Rotylenchulus reniformis* and grown in two different soil types as affected by the duration of irrigation.

Crop	Soil type	Irrigation duration	Shoot			Root		Total length	Total fresh weight
			length(cm)	fresh weight (gm)	dry weight (gm)	length(cm)	fresh weight (gm)	(cm)	(gm)
Eggplant Glojana F1	Loamy sand	Every day	24.05 b	3.00 b	0.52 b	23.00 a	1.34 b	47.05 b	4.35 b
		2 nd day	20.10 cd	1.36 de	0.20 d	16.33 c	0.55 c	36.43 d	1.91 d
		3 rd day	21.85 bc	1.66 cd	0.29 c	25.33 a	1.40 b	47.18 b	3.06 c
		4 th day	17.50 e	1.24 e	0.17 de	12.25 de	0.42 c	29.75 fg	1.65 def
		Healthy	26.48 a	4.60 a	0.95 a	26.00 a	2.90 a	52.48 a	7.50 a
	Sandy loam	Every day	16.73 e	0.63 g	0.08 f	10.33 e	0.44 c	27.05 g	1.07 g
		2 nd day	16.93 e	0.76 fg	0.13 ef	14.50 cd	0.50 c	31.43 ef	1.26 fg
		3 rd day	17.03 e	0.83 fg	0.11 ef	13.25 cde	0.64 c	30.28 fg	1.47 efg
		4 th day	18.50 de	1.11 ef	0.15 de	16.00 c	0.63 c	34.50 de	1.73 de
		Healthy	20.50 cd	1.80 c	0.55 b	20.00 b	1.40 b	40.50 c	3.20 c
Squash Tabarak F1	Loamy sand	Every day	32.75 a	5.47 b	0.71 c	22.00 b	1.23 b	54.75 ab	6.70 b
		2 nd day	28.00 bc	3.98 cd	0.62 cd	18.75 c	0.93 bc	46.75 c	4.90 c
		3 rd day	25.00 c	1.63 f	0.32 ef	19.25 c	0.80 bc	44.25 cd	2.43 e
		4 th day	25.25 c	1.10 f	0.21 f	17.78 cd	0.67 bc	43.03 cd	1.77 e
		Healthy	33.03 a	7.68 a	1.20 a	24.00 ab	2.45 a	57.03 a	10.12 a
	Sandy loam	Every day	28.68 bc	4.77 bc	0.67 c	24.18 ab	1.98 a	52.85 b	6.74 b
		2 nd day	28.45 bc	3.70 cd	0.46 de	23.63 b	1.25 b	52.08 b	4.95 c
		3 rd day	26.25 c	3.15 de	0.41 e	17.25 cd	0.83 bc	43.50 cd	3.98 cd
		4 th day	26.00 c	1.97 ef	0.29 ef	15.67 d	0.60 c	41.67 d	2.57 de
		Healthy	31.03 ab	7.23 a	1.00 b	26.48 a	2.38 a	57.50 a	9.60 a

Table (5). *Continued*

Crop	Soil type	Irrigation duration	Shoot			Root		Total length	Total fresh weight
			length(cm)	fresh weight (gm)	dry weight (gm)	length(cm)	fresh weight (gm)	(cm)	(gm)
Cow pea Gaha 1	Loamy sand	Every day	30.25 b	9.53 b	1.20 ab	26.75 a	3.09 b	57.00 a	12.61 b
		2 nd day	27.85 b	7.60 c	0.87 cd	22.38 bc	3.80 a	50.23 bc	11.40 c
		3 rd day	30.30 b	6.43 d	1.07 bc	21.25 c	2.44 c	51.55 b	8.87 d
		4 th day	25.03 c	4.80 e	0.77 de	23.25 bc	1.30 d	48.28 bc	6.10 ef
		Healthy	33.00 a	11.20 a	1.40 a	27.00 a	4.23 a	60.00 a	15.43 a
	Sandy loam	Every day	20.35 e	4.55 e	0.63 ef	22.50 bc	2.20 c	42.85 d	6.75 e
		2 nd day	20.88 de	4.20 e	0.47 fg	21.63 bc	1.11 d	42.50 d	5.31 f
		3 rd day	19.83 e	4.00 e	0.50 fg	22.00 bc	3.06 b	41.83 d	7.06 e
		4 th day	16.43 f	1.53 f	0.30 g	24.75 ab	1.95 c	41.18 d	3.48 g
		Healthy	23.00 cd	6.80 cd	1.10 b	24.00 abc	3.93 a	47.00 c	10.73 c

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

Discussion

Results of the influence of water stress on the reproduction of the root-knot and the reniform nematodes indicated that such influence depends to great extent on soil type, nematode species and the cultivated crop. As for the root-knot nematode, *Meloidogyne incognita*, the present results showed that the highest nematode counts were observed on roots of eggplant grown in loamy sand soil and irrigated at 3 days intervals (at the fourth day). However, on squash, the highest nematode counts were recorded on plants grown in sandy loam soil and irrigated every day. On cowpea, different behavior was observed whereas the highest significant nematode counts were recorded on roots of plants grown in sandy loam soil and irrigated every four days followed by those grown in loamy sand and irrigated at the same interval. Apparently, no significant differences could be observed within and between different irrigation intervals in both types of soil.

The highest numbers of egg-masses/root, eggs/g soil, total number of eggs, final population as well as the rate of reproduction of the reniform nematode, *Rotylenchulus reniformis* on eggplant roots were accomplished in loamy sand soil irrigated every four days. Irrespective of intervals of irrigation, nematode counts in the loamy sand soil were significantly higher than those in the sandy loam soil. Generally, increasing soil moisture (daily irrigation) was not in favor to nematode reproduction, however, prolonging the period of irrigation enhanced the reniform nematode reproduction. Conversely, increasing soil moisture (daily irrigation or irrigation every other day) was found to be in favor to nematode reproduction on squash and cowpea especially in loamy sand soil. The most significant highest final population and rate of reproduction on squash was recorded in loamy sand soil irrigated every day and on cowpea in sandy loam soil irrigated every other day.

Regarding growth response to the infection of the root-knot and the reniform nematodes and the stress of soil moisture, present data illustrated that prolonging irrigation period (decreasing soil moisture) significantly reduced the growth of the infected plants. Such effect was pronounced with the longest period between irrigation (3 days) and in loamy sand soil.

The present results are supported by the opinion of Norton, 1978 when he said that, soil moisture varies considerably as a result of many biological and physical actions. In the broad sense, some of the most obvious factors regulating soil moisture are intensity and frequency of irrigation, rainfall, the drainage pattern, and the precipitation/evaporation ratio. Other factors governing the amount of moisture in nematode's environment include the amount of available soil moisture for the particular soil type, the stage of plant maturity, the length of growing seasons, the water requirements of individual plants or crops, and elements relating to individual characteristics of leaves and roots. The relative capacity of moisture is so dependent upon the soil texture and other factors that determine the soil phase

that they cannot be separated. The coarser the soil, the larger the pores, the smaller the total soil surface area, the less water retained. Clays, which are composed of extremely small particles, have an enormous surface area, small pores and thus a great water retaining ability.

Movement, development and survival of nematodes in soil are regulated by the interaction between soil porosity and water potential. Depending on pore size and hydrology, a nematode may reside in a pore that is filled with water or in a film of water adhering to soil particle or root surface. Large, water-filled soil pores require nematodes to swim, an inefficient form of locomotion for most species. Reduced aeration in saturated soil is often detrimental to nematodes (**Sotomayor *et al.*, 1999; Soriano *et al.*, 2000**), although it can induce quiescence to extend longevity in some species (**Van Gundy *et al.*, 1967**).

As water drains or evaporates become increasingly constrained within a film of water and locomotion is more efficient due to the resistance to nematode thrusting provided by the surface tension of the water film. This may illustrate the high rates of reproduction of the reniform nematode wherever the frequency of irrigation decreased. Egg hatch is the most important biological process influenced by soil moisture. **Van Gundy (1958)** speculated that the interval between irrigations of citrus infected with *Tylenchulus semipenetrans* is important in the life cycle of the nematode because free water necessary to flush the juveniles from the egg-masses.

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الملخص العربي

تأثير مواعيد الري على إصابة وتكاثر كل من نيماتودا تعقد الجذور والنيماتودا الكلوية لبعض محاصيل الخضر النامية في نوعين مختلفين من التربة.

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تم في هذا البحث دراسة تأثير التغير في رطوبة التربة والنتاج عن التغير في مواعيد الري على تطور وتكاثر نيماتودا تعقد الجذور والنيماتودا الكلوية على كل من الباذنجان (هجين جلويانا (F1) والكوسة (هجين تبارك (F1) واللوبيا (صنف قها 1) تحت ظروف الصوبة حيث كانت النتائج كما يلي:

- سُجلت أكبر أعداد لنيماتودا تعقد الجذور على نباتات الباذنجان المنزوع في التربة الرملية الطميية والتي تروى كل أربعة أيام (أطول فترة عطش تتحملها النباتات تحت ظروف الصوبة) – أما على الكوسة واللوبيا فقد سجلت أكبر الأعداد في التربة الطميية الرملية والتي تروى يومياً أو كل أربعة أيام على التوالي.
- سُجلت أكبر أعداد من كتل البيض ، عدد البيض/جم تربة والعدد الكلي/أصيص والتعداد النهائي للنيماتودا الكلوية على جذور الباذنجان المنزوع في التربة الرملية الطميية والتي تروى أيضاً كل أربعة أيام. أما أكبر زيادة معنوية في التعداد النهائي وفي معدل التكاثر فقد سُجلت في نفس نوع التربة على الكوسة واللوبيا والتي تروى يومياً أو يوماً بعد يوم ، على التوالي.