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Frequency Occurrence and Population Density of Plant-Parasitic Nematodes Associated with Solanaceous Plantations Grown in Dakahlia Governorate

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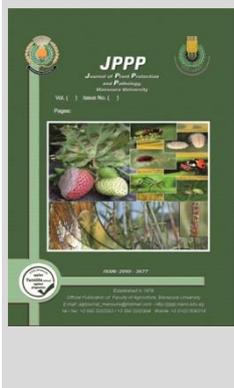
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ABSTRACT

Survey of plants parasitic nematodes gives information about parasitic nematodes distribution and delivers supplementary information to agronomists about phyto-nematodes importance. A survey of four solanaceous plants i.e., potato, tomato, pepper, and eggplant grown within three counties in Dakahlia governorate i.e., El- Sinbillawain, Mansoura and Aga revealed the presence of 10 nematode genera i.e., *Dorylaimus*, *Helicotylenchus*, *Hoplolaimus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchulus*, *Trichodorus*, *Tylenchorhynchus*, *Tylenchus* and *Xiphinema*. The root knot nematode, *Meloidogyne* spp. appeared to be the key pest as its documented 108 times with total percent incidence of 72.0 %, whereas, the nematode genera, *Rotylenchulus* and *Trichodorus* exhibited modest spreading as they occurred at rates of 55 and 50 times with percent incidence of 36.6 and 33.3%, respectively. On the other hand, *Helicotylenchus* and *Xiphinema* had the lowermost values of spreading as they occurred at rate of 13 times with percent incidence of 8.6 % for each one. However, *Meloidogyne* spp. showed greater rate of occurrence in clayey soil texture at El- Sinbillawain county with value of occurrence 75.8%. Potato and eggplants encountered highest nematode genera numbers with equal number (9), followed by tomato (8), while pepper have the lowest number (7) respectively.

Keywords: Survey, solanaceous plants, Dakahlia governorate, *Meloidogyne*, nematode genera



INTRODUCTION

The Solanaceae family dispersed throughout the world with a countless multiplicity fluctuating from yearly and perennial herbs to trees. The Solanaceae contains numerous plant species with economic importance as nutrition and medicinal floras and ornamentals. Potato, *Solanum tuberosum*, tomato, *Solanum lycopersicum*, eggplant, *Solanum melongena* and peppers *Capsicum annuum* are the furthestmost chief cultivated crops. Plant parasitic nematodes are considered one of the most significant pests for commercially cultivated solanaceous plantations (Castro *et al.*, 2011; Orrico *et al.*, 2013). Nematodes caused losses on *S. betaceum* reach to 90% as well as ensuing in about 50% reduction in this crop life cycle (Ramírez *et al.*, 2015). *Meloidogyne* sp. is recorded the foremost nematode genus stated in solanaceous plantations as sedentary endoparasite of the root, stirring galls and caused unadorned plant growth delays (Castro *et al.*, 2011; Hussain *et al.*, 2016). Accumulation of nematode population density caused intense yield losses and prevent continuous growing of same crop at the infected fields (Pakeerathan *et al.*, 2009; Hussain *et al.*, 2016). Procedure of plants parasitic nematodes survey not only gives the prospect to enhance the thoughtful about nematodes spreading throughout the zone, but also offers supplementary instruction to cultivators about importance of nematodes. Phyto-nematodes are accountable for serious damages in ornamental plant vegetation (roots and shoots) and decrease its beauty and accordingly its economic value. Plant parasitic nematodes are accountable for 11.1% losses through the world as well as give upsurge to crucial to different farming crops at different world

regions (Sasser and Freckman 1987 and Luc *et al.*, 2005). The nematological survey is required for providing data on the prospect and crop losses degree cause by nematode infection. Their wide host range and ecological promising conditions give appropriate management quantity to attain practical results. As for the solanaceous plants economic importance, a nematological survey was done to determine the phyto-nematode incidence and population density associated with solanaceous plantations grown in Dakahlia governorate, Mansoura, Egypt

MATERIALS AND METHODS

One hundred and fifty soil samples were gathering from the solanaceous plants rhizosphere (potato, tomato, pepper, and eggplant) during the growing seasons 2019 to 2021. The collected soil samples performed different fields at three counties (El- Sinbillawain, Mansoura and Aga) of Dakahlia governorate. The soil samples were gained by digging soil to a depth of about 15-30 cm and about one kg from each site were placed in labelled plastic bags and sent directly to laboratory of Plant Pathology Department, Faculty of Agriculture, Mansoura University, Egypt and kept in the refrigerator at 4°C until extract nematode from soil. Nematode extraction technique was done by sieving and modified Baermann technique (Goodey, 1957). Nematode genera identification of in frequent aliquots (1ml) was based on the morphological nematode characters (adult and larval forms) rendering to Mai and Lyon (1975). Numbers of each genus were determined and recorded by Hawksely counting slide under microscope.

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RESULTS AND DISCUSSION

The collected soil samples from the solanaceous plants rhizosphere, at the growing seasons of 2019 to 2021 that presented different areas at three counties (El- Sinbillawain, Mansoura and Aga) of Dakahlia governorate stated 10 nematode genera belonging to eight nematode families. These genera were *Dorylaimus* (Dorylaimidae), *Helicotylenchus* (Hoplolaimidae), *Hoplolaimus* (Hoplolaimidae), *Meloidogyne* (Meloidogynidae), *Pratylenchus* (Pratylenchidae), *Rotylenchulus* (Hoplolaimidae), *Tylenchorhynchus* (Tylenchorhynchidae), *Tylenchus* (Tylenchidae), *Trichodorus* (Trichodoridae) and *Xiphinema* (Longidoridae). The plant parasitic nematode genera *Meloidogyne* and *Rotylenchulus* as well as *Trichodorus*, were the furthestmost predominate of solanaceous surveyed plants. All nematode genera were recorded at the four surveyed solanaceous species (potato, tomato, pepper, and eggplant) at the three different localities of Dakahlia governorate (Table 1).

El-Sinbillawain county soil samples indicated the presence of eight true plant-parasitic nematode genera plus two of the suspected ones. These nematode genera were: *Helicotylenchus*, *Hoplolaimus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchulus*, *Trichodorus*, *Tylenchorhynchus* and *Xiphinema*, besides *Dorylaimus* and *Tylenchus*. Meanwhile, *Meloidogyne*, *Hoplolaimus* and *Rotylenchulus* genera appeared to be the furthestmost dominant nematode genera, as they found at the rates of 44, 22 and 20 times with frequency occurrence of 75.8, 37.9 and 34.4 %, respectively (Table 2). Moreover, *Trichodorus*, *Tylenchus* and *Pratylenchus* exposed modest spreading as they stated at the rates of 15, 12, and 7 times with frequency occurrence of 25.8, 20.6 and 12.0 %, respectively, whereas *Xiphinema* was less common, as it occurred one time with percent occurrence of 1.7%.

Meanwhile, Aga county recorded eight of true plant-parasitic nematode genera; and two of suspected ones. These nematode genera were: *Helicotylenchus*, *Hoplolaimus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchulus*,

Trichodorus, *Tylenchorhynchus* and *Xiphinema*; besides *Dorylaimus* and *Tylenchus*. Meanwhile, *Dorylaimus*, *Trichodorus* and *Meloidogyne* genera seemed to be the most dominant nematode genera on solanaceous surveyed plant species, as they stated at the rates of 30, 26 and 25 times with-frequency occurrence of 81.0, 70.2 and 67.5 %, respectively. *Rotylenchulus*, *Tylenchorhynchus*, *Pratylenchus*, *Xiphinema* and *Helicotylenchus* exhibited reasonable distributions as they recorded at the rates of 22, 16, 8, 8, and 6 times with percent occurrence of 59.4 and 43.2, 21.6, 21.6 and 16.0%, respectively, whereas, *Hoplolaimus* and *Tylenchus* were less common as they each occurred at the rate of 4 times with frequency occurrence of 10.0 and 10.8%, respectively (Table 2).

Table 1. Nematode genera stated with the four surveyed solanaceous species at different counties of Dakahlia governorate.

Nematode genera	Plant species	‡No. of inf. plant species
Plant parasitic nematodes		
<i>Helicotylenchus</i> (Steiner,1945)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Hoplolaimus</i> (Daday, 1905)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Meloidogyne</i> (Goeldi, 1887)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Pratylenchus</i> (Filipjev, 1934)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Rotylenchulus</i> (Linford and Oliveira, 1940)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Trichodorus</i> (Cobb, 1913)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Tylenchorhynchus</i> (Cobb, 1913)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Xiphinema</i> (Cobb, 1913)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Dorylaimus</i> (Dujardin, 1845)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4
<i>Tylenchus</i> (Bastian, 1865)	<i>S. tuberosum</i> , <i>S. lycopersicum</i> , <i>C. annuum</i> , and <i>S. melongena</i>	4

Table 2. Frequency occurrence and population density of nematode genera associated with solanaceous plantations at three counties of Dakahlia governorate.

Nematode genera	Occurrence of nematode genera per 250g soil within each county of solanaceous plants							
	El- Sinbillawain *n=58	% F.O	Aga *n=37	% F.O	Mansoura *n=55	% F.O	Total n=150	% F.O
True plant parasites								
<i>Helicotylenchus</i>	2(15)	3.4	6(27)	16.0	5(14)	9.0	13	8.6
<i>Hoplolaimus</i>	22(45.2)	37.9	4(25)	10.0	2(18)	3.6	28	18.6
<i>Meloidogyne</i> (J2)	44(50.3)	75.8	25(22.3)	67.5	39(33.3)	70.0	108	72.0
<i>Pratylenchus</i>	7(3.5)	12.0	8(9.5)	21.6	4(5.6)	7.2	19	12.6
<i>Rotylenchulus</i>	20(34.4)	34.4	22(36.4)	59.4	13(25.4)	23.6	55	36.6
<i>Trichodorus</i>	15(28.2)	25.8	26(23.1)	70.2	9(40.7)	16.3	50	33.3
<i>Tylenchorhynchus</i>	4(18.3)	6.8	16(19.5)	43.2	12 (30.8)	21.8	32	21.3
<i>Xiphinema</i>	1(26)	1.7	8(19)	21.6	4(8)	7.2	13	8.6
Total	115	--	115	---	88	---	---	--
Suspected plant parasites								
<i>Dorylaimus</i>	2(18)	3.4	30(33.1)	81.0	3(20.1)	5.4	46	30.6
<i>Tylenchus</i>	12(25.2)	20.6	4(20.3)	10.8	6(16.3)	10.9	22	14.6
Total	14	--	34	...	9	...	--	---
Total occurrence	129	--	149	97	...	---	---
Nematode genera/ County	10	---	10	10	...	---	---

*n= number of soil samples. Number between parentheses represented the average of nematode population density per 250 g. soil. % F.O = (Number of samples containing a genus / number of collected samples) ×100.

Mansoura county revealed the presence of 8 true plant-parasites and two of the suspected ones. *Meloidogyne*, *Rotylenchulus* and *Tylenchorhynchus* genera seemed to be the greatest dominant nematode genera that recorded the rates of

39, 13 and 12 times with frequency occurrence of 70.0, 23.6 and 21.8 %, respectively. Moreover, the nematode genera *Trichodorus*, *Tylenchus*, *Helicotylenchus*, *Pratylenchus* and *Xiphinema* showed modest distribution as they occurred at the

rates of 9, 6, 5, 4 and 4 times with percent occurrence of 16.3, 10.9, 9.0, 7.2 and 7.2%, respectively. However, *Dorylaimus* and *Hoplolaimus*, were less common genera as they occurred at the rate of 3 and 2 times with percent occurrence of 5.4 and 3.6%, respectively.

Meloidogyne seemed to be the major nematode genera as its recorded at the rate of 108 times with percent occurrence of 72.0 %, whereas, the nematode genera, *Rotylenchulus* and *Trichodorus* recorded modest distribution, as they occurred at rates of 55 and 50 times, with percent occurrence of 36.5 and 33.3%, respectively. On the other hand, *Helicotylenchus* and *Xiphinema* had the lowest distribution values as they occurred at rate of 13 times with percent occurrence of 8.6 % for each one.

The two suspected plant parasitic nematode genera (*Dorylaimus* and *Tylenchus*) demonstrated to be of temperately importance as they occurred at rates of 46 and 22 times with frequency occurrence of 30.6 and 14.6 % respectively.

Referring to surveyed soil types (clayey, clay sandy and loamy soils), they appeared to encounter equal number of ten nematode genera (Table 3). *Meloidogyne*, *Rotylenchulus* and *Trichodorus* were frequently recorded at all soil types studied with total frequency of occurrence 72.0 , 36.6 and 33.3 %, respectively whereas, *Helicotylenchus* and *Xiphinema* had the lowest values of distribution with percent occurrence of 8.6 for each. However, *Meloidogyne* spp. showed greater occurrence in clayey soil (El-Sinbillawain county) with value of 75.8%. (Table 3).

Table 3. Frequency occurrence and population density of nematode genera associated with solanaceous plantations at three counties of Dakahlia governorate.

Nematode genera	Occurrence of nematode genera per 250g soil within each county of solanaceous plants							
	El- Sinbillawain (Clayey) *n=58	% F.O	Aga (Sandy Clay) n=37	% F.O	Mansoura (Loamy) n=55	% F.O	Total n=150	% F.O
True plant parasites								
<i>Helicotylenchus</i>	2(15)	3.4	6(27)	16.0	5(14)	9.0	13	8.6
<i>Hoplolaimus</i>	22(45.2)	37.9	4(25)	10.0	2(18)	3.6	28	18.6
<i>Meloidogyne</i> (J2)	44(50.3)	75.8	25(22.3)	67.5	39(33.3)	70.0	108	72.0
<i>Pratylenchus</i>	7(3.5)	12.0	8(9.5)	21.6	4(5.6)	7.2	19	12.6
<i>Rotylenchulus</i>	20(34.4)	34.4	22(36.4)	59.4	13(25.4)	23.6	55	36.6
<i>Trichodorus</i>	15(28.2)	25.8	26(23.1)	70.2	9(40.7)	16.3	50	33.3
<i>Tylenchorhynchus</i>	4(18.3)	6.8	16(19.5)	43.2	12 (30.8)	21.8	32	21.3
<i>Xiphinema</i>	1(26)	1.7	8(19)	21.6	4(8)	7.2	13	8.6
Total	115	--	115	----	88	---	---	--
Suspected plant parasites								
<i>Dorylaimus</i>	2(18)	3.4	30(33.1)	81.0	3(20.1)	5.4	46	30.6
<i>Tylenchus</i>	12(25.2)	20.6	4(20.3)	10.8	6(16.3)	10.9	22	14.6
Total	14	--	34	...	9	...	--	---
Total occurrence	129	--	149	97	...	---	---
Nematode genera/ County	10	---	10	10	...	---	--

*n= number of soil samples.

Number between parentheses represented the average of nematode population density per 250 g. soil.

% F.O = (Number of samples containing a genus / number of collected samples) ×100

Regarding the one hundred and fifty soil samples that were collected from the rhizosphere of four solanaceous plants i.e., potato, tomato, pepper, and eggplant grown within three counties in Dakahlia governorate, results in Table (4) indicated that the potato and eggplants plants encountered highest nematode genera numbers (9), followed by tomato (8), while pepper had the lowest number (7), respectively. Data also revealed that the highest densities of root-knot nematode, *Meloidogyne* spp. individuals per 250 g. soil that averaged 50.6/250g soil with frequency occurrence 85.7% were

associated with soil collected from eggplant. On the other hand, *Helicotylenchus*, *Meloidogyne*, *Trichodorus*, *Dorylaimus*, and *Tylenchus* were the most prevailing nematode genera as they were found in the rhizosphere of the four surveyed solanaceous crops, followed by *Hoplolaimus*, *Pratylenchus*, *Rotylenchulus* and *Tylenchorhynchus* that were recorded from rhizosphere of three solanaceous crops. However, *Xiphinema* was the least prevailing nematode genera in the rhizosphere of two surveyed crops (Table 4).

Table 4. Frequency occurrence percentages of nematode genera associated with four solanaceous crops grown at three counties of Dakahlia governorate.

Nematode genera	Occurrence and population density of nematode per 250g. of four solanaceous crops.									
	Potato n=40	F.O %	Tomato n= 40	F.O %	Pepper n= 35	F.O %	Eggplant n= 35	F.O %	Total n=150	% F.O.
True plant parasites:										
<i>Helicotylenchus</i>	2(16)	5.0	4(6.6)	10.0	4(3.3)	11.4	3(12.8)	8.6	13	8.6
<i>Hoplolaimus</i>	8(21)	20.0	7(8.1)	17.5	0	0.0	13(16.8)	37.1	28	18.6
<i>Meloidogyne</i>	30(77.4)	75.0	20(19.3)	50.0	28(6.9)	80.0	30(50.6)	85.7	108	72.0
<i>Pratylenchus</i>	10(8.8)	25.0	9(7.9)	22.5	0	0.0	0	0.0	19	12.6
<i>Rotylenchulus</i>	0	0.0	14(10.1)	35.0	21(13.2)	60.0	20(13.9)	57.1	55	36.6
<i>Trichodorus</i>	20(13.6)	50.0	10(15.0)	25.0	11(7.4)	31.4	9(16.9)	25.7	50	33.3
<i>Tylenchorynchus</i>	7(20.1)	17.5	0	0.0	20(20.3)	57.1	5(12.9)	14.3	32	21.3
<i>Xiphinema</i>	10(79.1)	25.0	0	0.0	0	0.0	3(15.2)	8.6	13	8.6
Total	87	--	102	---	117	--	83	---	---	--
Suspected plant parasites:										
<i>Dorylaimus</i>	25(107.7)	62.5	8(6.7)	20.0	7(3.5)	20.0	6(30.6)	17.1	46	30.6
<i>Tylenchus</i>	2(70.2)	5.0	8(6.6)	20.0	10(6.2)	28.6	2(10.3)	5.7	22	14.6
Total	27	--	16	--	17	--	8	---	--	---
Total occurrence	114	---	118	--	134	---	91	--	---	---
Nematode genera per crop	9	---	8	---	7	---	9	---	---	---

* n = number of soil samples

** Number of infested soil type.

% F.O (Frequency occurrence)

Seemingly, the present study revealed that 10 nematode genera belonging to eight families were detected from rhizosphere of solanaceous plants, during the growing seasons of 2019 to 2021 at different localities within three counties of Dakahlia governorate (El- Sinbillawain, Mansoura and Aga). *Meloidogyne*, *Rotylenchulus* and *Trichodorus* were frequently stated at all studied soil types with total frequency of incidence 72.0 , 36.6 and 33.3 % , respectively whereas, *Helicotylenchus* and *Xiphinema* had the lowermost values. The present results are in accordance with those reported by El-Nuby *et al* (2019), who detected those tomatoes and eggplants are Solanaceae favorable hosts for nematode infection. It was noticed that tomato plants harbored the maximum number of nematode genera (12) followed by eggplant (8), however pepper possessed the lowest number of genera (4). The highest population density and frequency occurrence of *Meloidogyne* were observed in eggplant rhizosphere (2265 individuals/250 cm³ soil and 55.6%, respectively), followed by tomato (825 individuals and 37.3%), the pepper came in the last category (806 individuals and 34.3%). However, *Meloidogyne* spp. showed greater occurrence in clayey soil with value of 75.8% at El- Sinbillawain county. Presence of these serious phytoparasitic nematodes on solanaceous cultivations must be taken seriously by growers, especially they live in warmed areas. The association of these nematodes with vegetable crops has been reported to diminish yields (Anwar and McKenry, 2010). Many investigations were carried out to analyze the parasitic nematode community in several vegetable fields. Another investigator found that seven PPN genera associated with vegetable crops viz. *Helicotylenchus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchus*, *Scutellonema*, *Quinisulcius*, and *Tylenchus* in Uganda (Bafokuzara, 1996). *Meloidogyne* is by far the most dominant PPNs both in Dakahlia governorate. This widespread distribution of *Meloidogyne* in all solanaceous regions is consistent with results from earlier surveys (Ibrahim, 1994; Ibrahim *et al.*, 2000; Korayem and Mohamed, 2010; Korayem *et al.*, 2014). The global distribution of *Meloidogyne* compared with the rest nematode genera, especially in tropical, subtropical and Mediterranean climates, are due to wide and various host ranges that lacking specificity in parasitism (Sasser, 1979 and Anwar *et al.*, 2006). The status of vegetable crops as a good host for *Meloidogyne* has been previously reported (Siddiqi, 2000; Sikora and Fernandez, 2005; Kaskavalci, 2007; Baimey *et al.*, 2009; Chaudhary *et al.*, 2011; Anwar *et al.*, 2013 and Rani, 2017) and this was also supported by the present survey. Surveying phyto-nematodes associated with solanaceous plantation is valuable for assessment the nematode problems status and forecasting yield loss estimates which can be encouraged by a clear understanding of nematode distribution which may be an important point in developing a successful strategy for nematode control.

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**نسبة التواجد والكثافة العددية للنيماتودا النباتية المصاحبة لنباتات العائلة الباذنجانية في محافظة الدقهلية.
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تم جمع 150 عينية تربة مركبة من منطقة المجال الجذري لأربعة نباتات هي البطاطس والطماطم والفلل والباذنجان التابعة للعائلة الباذنجانية وذلك خلال مواسم النمو 2019-2020-2021 من ثلاثة مراكز مختلفة تابعة لمحافظة الدقهلية وهي السنبلوين، أجا والمنصورة. وأسفرت النتائج عن: 1- وجود 10 أجناس من النيماتودا نباتية التطفل وهي: *Dorylaimus* و *Helicotylenchus* و *Hoplolaimus* و *Meloidogyne* و *Pratylenchus* و *Rotylenchulus* و *Trichodorus* و *Tylenchorhynchus* و *Tylenchus* و *Xiphinema*. 2- تم تسجيل نيماتودا تعقد الجذور (*J2*) *Meloidogyne* كافة رئيسية في زراعات العائلة الباذنجانية تحت الدراسة حيث سجلت بمعدل 108 مرة بنسبة تواجد (72,0%) . 3- أظهرت جنسي النيماتودا و *Rotylenchulus* و *Trichodorus* قيم توزيع معتدلة بمعدل 55 و 50 مرة وبنسبة تواجد 36.6 و 33.3% على التوالي. 4- سجل جنسي *Helicotylenchus* و *Xiphinema* أقل قيم التوزيع بمعدل 13 مرة بنسبة تواجد 8.6% لكل منهما. 5- بالإشارة إلى أنواع التربة، فقد أظهرت دراسة الحصر أن أنواع التربة الثلاثة التي تم مسحها، وهي التربة الطينية، والطينية الرملية، والطينية، تضم عدداً متساوياً (عشرة أجناس) من النيماتودا. 6- كما تم تسجيل الأجناس *Meloidogyne*، *Rotylenchulus* و *Trichodorus* بشكل شائع في جميع أنواع التربة التي تمت دراستها بمعدل تواجد 72.0 و 36.6 و 33.3% في حين كانت نيماتودا تعقد الجذور *Meloidogyne* الأكثر تواجد في التربة الطينية (السنبلوين) بقيمة 75.8% يليها التربة الطينية (المنصورة) بقيمة 70%. 7- سجلت نباتات البطاطس والباذنجان أعلى أعداد أجناس نيماتودا (9)، تليها الطماطم (8)، بينما سجلت الفلفل أقل عدد (7) على التوالي.