

Plant Parasitic Nematodes Associated with Wheat in Northern and Middle Egypt

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Received; 13 November 2018

Revised: 29 November 2018

Accepted: 4 December 2018

ABSTRACT

Distribution and identification of phytonematodes associated with wheat grown in twelve provinces of Northern and Middle Egypt were investigated during two growing seasons (2016-2017 and 2017-2018). A total of 929 soil and root samples were collected from 119 localities (villages/farms) belonging to 37 districts. Samples contained fourteen nematode genera and species viz., *Aphelenchoides*, *Criconemella*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hirschmanniella oryzae*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchulus reniformis*, *Tylenchorhynchus*, *Tylenchus* and *Xiphinema*. The stunt nematodes (*Tylenchorhynchus* spp.), the root-lesion nematodes (*Pratylenchus* spp.), the spiral nematodes (*Helicotylenchus* spp.) and the cyst nematodes (*Heterodera* spp.) were the most frequent nematodes in all samples. The stunt nematodes had the highest occurrence with 47.4%, population density with 48.2 and prominence value with 33.2. The root-lesion nematodes ranked the second after *Tylenchorhynchus* spp., in terms of frequency of occurrence (13.77%), while the cyst nematodes had the second order after the stunt nematodes, in terms of population density (24.8) and prominence value (5.4). The spiral nematodes occupied the third rank, in terms of frequency of occurrence (5.5%), and the last rank in terms of both of population density and prominence value (9 and 2.1, respectively).

Keywords: Distribution, Phytonematodes, Wheat, Egypt, Population density

INTRODUCTION

Wheat, *Triticum aestivum* L. is the most important cereal crop in Egypt, as it is the principle source of bread which form an essential part of Egyptian food of low cost protein, lipids and amino acids. Wheat is cultivated in Egypt on about 1.37 million hectares producing about 9 million tons (FAOSTAT, 2016). However, Egypt is the world's largest wheat importer with average of 10 million tons per year, (FAO, 2012), subjected to increase with increasing Egyptian population. Increasing yield of cultivated area is possible through recognition nematode problems affecting wheat production and application suitable methods of their management.

More than 33 phytonematodes were found in the rhizosphere of wheat growing in all regions of the world (Ibrahim, 2011). The most important nematodes affecting wheat are the cereal cyst nematodes, *Heterodera avenae*, the root lesion nematodes, *Pratylenchus* spp., the seed gall nematode, *Anguina tritici*, the root-knot nematodes,

Meloidogyne spp. and the stem nematode, *Ditylenchus dipsaci* (Kort, 1972; Griffin, 1984; Swarup and Sosa-Moss, 1990; Rivoal and Cook, 1993; Nicol et al., 2003; McDonald and Nicol, 2005; Nicol and Rivoal, 2008; Bockus et al., 2009; Smiley and Nicol, 2009; Dawabah et al., 2010).

The cereal cyst nematodes (*H.avenae*, *H.filipjevi*, *H.latipons*) are considered one of the major disease agents of wheat throughout the world. They are found in many countries of Europe, Asia, Africa, Australia, North and South America (Meagher, 1972 and 1977; Evans and Rowe, 1998; Smiley et al., 2005; Nicol and Rivoal, 2008; Smiley and Nicol, 2009; Ibrahim et al., 1982 and 2017). Loss in wheat yield caused by the cereal cyst nematodes was ranged between 15-20% in Pakistan (Maqbool 1988), 40-92% in Saudi Arabia (Ibrahim et al., 1999), 23-50% in Australia (Meagher, 1972), 26-96% in Tunisia (Namouchi – Kachouri et al., 2008), and about 10% in Western USA (Smiley and Nicol, 2009). The root-lesion nematodes (*Pratylenchus* spp.) are also, considered important pests of wheat. At least, eight species are parasites of wheat (Nicol et al., 2003; Castillo and Volvas, 2007).

Four species, *P.crenatus*, *P.neglectus*, *P.penetrans* and *P.thornei* occur throughout the cereal producing regions in Australia, Europe, India, Mediterranean Basin, Middle East, West Asia, North Africa and North America (Nicol and Rivoal, 2008). *P.thornei* is considered the most economically important species on wheat reducing yield as much as 85% in Australia, 37% in Mexico, 50% in Oregon (USA), 70% in Israel (Smiley and Nicol, 2009). Wheat is also subjected of attack by the root-knot nematodes (*Meloidogyne* spp.) in tropics, subtropics and Mediterranean regions (Lamberti, 1979; Swarup and Sosa-Moss, 1990; Ismail and Youssef, 1992). However, their economic importance on wheat is still not well documented, especially in tropics and subtropics.

The stem nematode, *D. dipsaci* is found in many regions of the world and attacks many varieties of wheat plants. It is, however a problem on cereals in heavy soils in areas of high rainfall and cool growing seasons (Griffin, 1984). The seed gall nematode (*Anguina tritici*) which cause "ear- cockle" disease is distributed in India, West Asia, Jordan and Saudi Arabia (Stephan and Antoon, 1990; Stephan and Abu-Gharbieh, 2010). *Anguina tritici* was also distributed in Egypt, but successful practice of seed cleaning stopped its distribution.

In Egypt, Ibrahim et al. (1988) carried out a survey on phytonematodes associated with wheat grown in eight governorates, they detected seven nematode genera and species found in wheat rhizosphere. Few of them were of wide occurrence, and had relatively high prominence value, including the root knot nematodes (*Meloidogyne* spp.), the root-lesion nematodes (*Pratylenchus* spp.), the cyst nematode (*H. avenae*) and the spiral nematodes (*Helicotylenchus* spp.). However studies on distribution and identification of phytonematodes associated with wheat throughout Egypt are still insignificant. Therefore, the present goal of this research is to carry out an extensive survey on phytonematodes associated with wheat grown in provinces of Lower and Middle Egypt.

MATERIALS AND METHODS

Locations and sampling: Survey was performed in 12 major wheat growing provinces (governorates) during 2016-2017 and 2017-2018 seasons. These provinces are situated in northern and middle of Egypt, viz., Beheira, Kafr-El-Sheikh, Dakahlia, Gharbia, Sharkia, Ismailia, Monufia, Qalyubia, Giza, Fayum, Beni-Suef and Minya (Fig. 1). Provinces of Upper Egypt were excluded due to they have a warmer climate

during winter season which negatively affect wheat yield, so they are categorized as low potential zone for wheat production (FAO, 2012). A total of 929 soil and root samples were collected from the rhizosphere region of wheat in 125 locations (villages) of 37 districts. Samples were collected during early vegetative period (40-50 days after wheat emergence), flowering and harvest stages, were kept in plastic bags supported with data, transported to the laboratory and stored in refrigerator at 4-5°C until processing for nematode analysis.

Nematode extraction and identification: Soil samples were carefully mixed and 250 g soil from each was processed for nematode extraction by sieving and decanting method according to Christie and Perry (1951). Root samples showing lesions were cut into small pieces and left in distilled water for 2-3 days for the extraction any migratory endo-parasitic nematodes (Young, 1954). Identification of nematode genera and species was made based on the morphology of adult and larval forms (Oteifa, 1964; Golden, 1971). For the cyst nematode (*Heterodera*) extraction, a 100g soil air-dried at room temperature was processed for cysts extraction according to methods of Shepherd (1970).

Data analysis: Population density of nematodes (PD), frequency of occurrence (FO %) and prominence values (PV) were calculated according to Norten (1978), as follows:

PD=Mean absolute densities of nematodes per250g in soil in all collected samples

$$FO\% = \frac{\text{Number of samples or district containing a nematode}}{\text{Total number of sample or districts}}$$

$$(PV) = PD \sqrt{FO\%} / 10$$

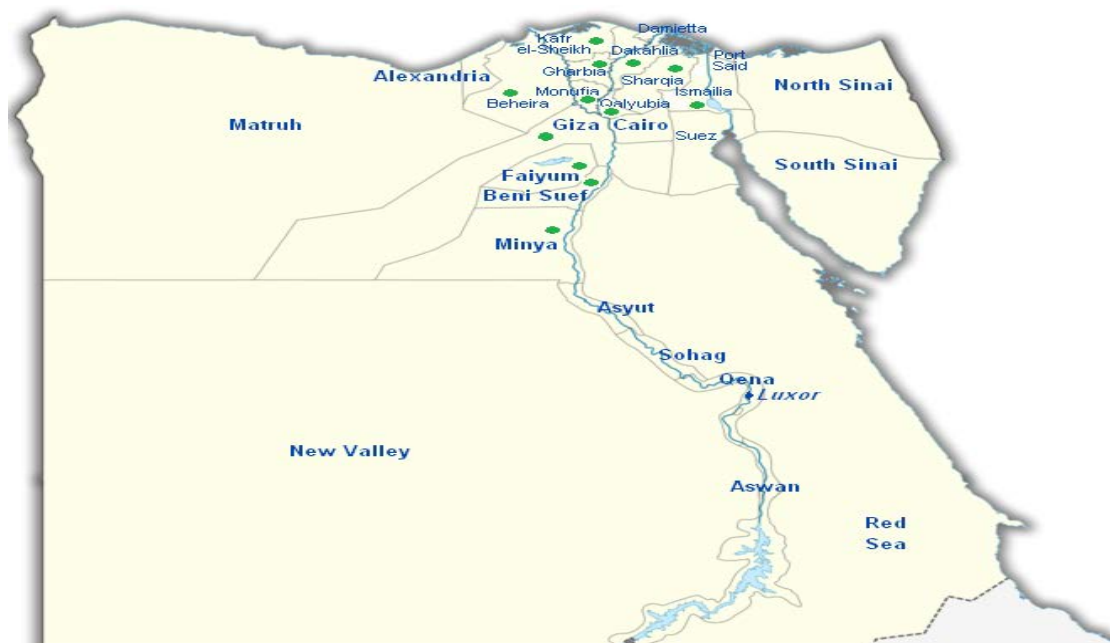


Fig 1. Map of Egypt indicating governorates in which samples were collected.

- Governorates were processed for sampling.

RESULTS

Fourteen nematode genera and species were recovered from samples collected from 37 districts (Table 1). These were *Aphelenchoides*, *Criconemella*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hirschmanniella oryzae*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchulus reniformis*, *Tylenchorhynchus*, *Tylenchus* and *Xiphinema*. Four of them i.e., *Tylenchorhynchus*, *Pratylenchus*, *Heterodera*, and *Helicotylenchus* were more common in the collected samples. *Tylenchorhynchus* was the most frequent nematode in all samples, as it occurred in all districts except of Desuk (Kafr El-Sheikh governorate), Ibsheaway (Fayum governorate) and Nasser (Beni –Suef governorate) with 91.9% FO (based on number of districts in which nematode was detected). *Pratylenchus* ranked the second position was detected in 26 districts with 70% FO. *Helicotylenchus* and *Heterodera* had a relatively less occurrence with 32.4% and 29.7% FO, respectively.

Occurrence of the other nematodes genera and species were less than 13.5%. Population densities (PD) of more common nematodes were presented in Fig. (2). *Tylenchorhynchus* had the highest PD (48.2) followed by *Heterodera* (24.8), *Pratylenchus* (9.7) and *Helicotylenchus* (9.0). Frequency of occurrence % (based on number of samples in which nematode was detected relating to all samples) was presented in Fig. (3). *Tylenchorhynchus* had the highest FO with 47.4% followed by *Pratylenchus* with 13.7%, *Helicotylenchus* with 5.5% and *Heterodera* with 4.7%.

Data presented in Table (2) showed the prominence value (PV) of phytonematodes genera and species found in samples collected from wheat fields in all surveyed provinces. The stunt nematode, *Tylenchorhynchus* spp. showed greatest PV average (33.2), followed by *Heterodera* (5.4), *Pratylenchus* (3.6) and *Helicotylenchus* (2.1). Highest PV of *Tylenchorhynchus* (90.5) was found in Beni-Suef province and the lowest (1.6) was found in Kafr-El-Sheikh province. Highest PV of *Pratylenchus* (15.0) was found in Beni-Suef and the lowest (0.16) in Dakahlia. Highest PV of *Heterodera* was (58) in Ismailia, while the highest PV of *Helicotylenchus* was found in Giza province (12.0).

DISCUSSION

As mentioned, survey of phytonematodes associated with wheat grown in 12 governorates of Egypt indicated the presence of fourteen nematode genera and species associated with wheat plants. Only four of them viz. *Tylenchorhynchus* spp., *Pratylenchus* spp., *Helicotylenchus* spp., and *Heterodera* spp. had the highest frequencies of occurrence (FO%), population densities(PD) and prominence values (PV). The stunt nematodes (*Tylenchorhynchus* spp.) were of wide spread occurrence in all collected samples. However, their economic importance on wheat still is not determined in Egypt and needs many studies to determine population density at which economic damage occurs, especially, they are not listed as a pathogen to wheat in the growing areas of wheat worldwide. The root lesion nematodes (*Pratylenchus* spp.) were also abundant in the collected samples. Many species of these nematodes are considered important pests of wheat throughout the world. Loss in yield of wheat grown in field infested with these nematodes may reach to 85% (Smiley and Nicol, 2009). The impact of the root lesion nematodes on wheat grown under Egyptian conditions has not been carefully estimated yet. The cereal cyst nematodes (*Heterodera* spp.) were recovered from samples of seven provinces. Their cysts and juveniles are

Table 1. Occurrence of phytonematodes associated with wheat grown in 37 districts of Egypt.

District	Nematode genera													
	Aph	Cri	Dit	Hel	Het	Hir	Hop	Lon	Mel	Pra	Rot	Tyl	Tyn	Xiph
Rosetta												+		
Kafr-El-Dawar										+		+		
Mahmoudia						+				+		+		
Badr		+								+		+		
Damanhur												+		
Wadi-El-Natrun		+								+		+		
Desuk	+					+				+				
Mit-Ghamr						+						+		
Aga						+				+		+	+	
El-Santa										+		+	+	
Zifta										+		+	+	
Menouf				+	+					+		+		
Ashmoon				+	+					+		+		
Sadat city				+	+				+	+		+		
Tukh												+		
Shibin ElQanater										+		+		
Qalyub												+		
El-Qanater El-Khayerya										+		+		
Belbeis										+		+		
New Salhia	+		+	+						+		+		+

Table 1. (continued)

Abu Suweir			+		+					+		+		+
Al Qassasein	+	+	+	+	+					+		+		
Fayed					+				+			+		+
Tell-El-Kebir	+									+		+		+
Kerdasa				+				+		+		+		
El-Manashi										+		+		
Al-Aiat					+					+		+		+
Attfeih		+		+	+					+		+		
Senuris												+		
Tamyia				+	+					+		+		
Ibsheway														
Fayum												+		
Al-Wasta				+	+				+	+		+		
Baiad Al-Arab				+	+		+			+		+		
Nasser		+		+					+		+			
Maghagha				+			+			+		+		
Beni-Mazar												+		

Aph.=*Aphelenchoides* Cri.=*Criconebella*, Dit =*Ditylenchus*, Hel=*Helicotylenchus*, Het=*Heterodera*, Hir=*Hirschmanniella oryzae*, Hop=*Hoplolaimus* , Lon =*Longidorus*, Mel=*Meloidogyne*, Pra= *Pratylenchus*, Rot= *Rotylenchulus reniformis*, Tyl=*Tylenchorhynchus*, Ty=*Tylenchus* and Xip=*Xiphinema*

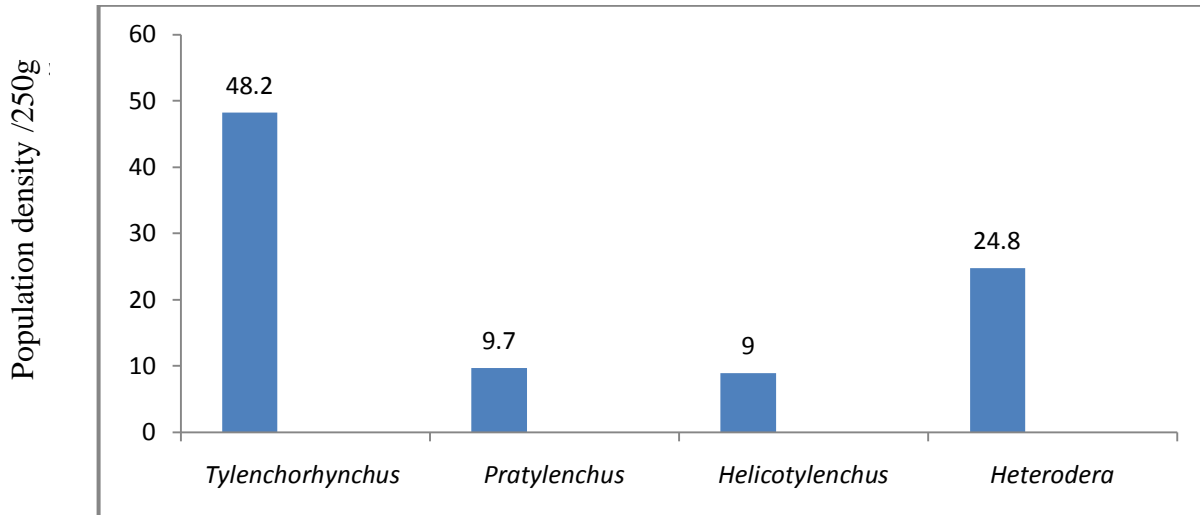


Fig.2. Population density of the more common phytonematodes associated with wheat grown in all provinces

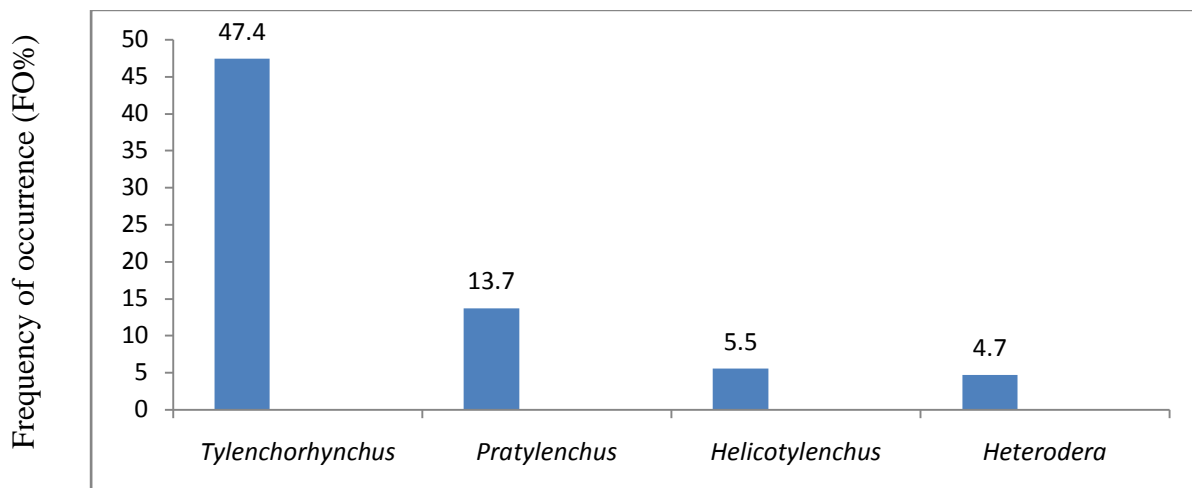


Fig.3. Frequency of the more common phytonematodes associated with wheat grown in all provinces.

now processing for identification. *Heterodera avenae*, *H. filipjevi* and *H. latipons* are considered one of the major disease agents of wheat throughout the world, causing loss in yield of wheat as much as 96% in Tunisia (Namouchi-Kachouri et al., 2008), 20% in Pakistan (Maqbool, 1988 and 50% in Australia (Meagher, 1972). *Heterodera avenae* was previously detected in Beheira province (Ibrahim et al., 1982) and in Ismailia province (Baklawa et al., 2011) causing loss in wheat yield estimated by 21.6% (Korayem and Mohamed, 2015), however, the population density which cause economic damage (economic threshold) was not studied. Therefore, many studies are needed for determining the pupation density which cause economic damage, and determining what ecological factors are suitable for disease development. The spiral nematode, *Helicotylenchus* spp. also occurred in some samples collected from some governorates. Effect of this nematode on wheat plants is still unknown, as well as it is not listed as pests for wheat up to now.

Table 2. Prominence value (PV) of phytonematodes associated with wheat in twelve provinces.

Phytonematodes Genera & species	Prominence value (PV)												
	Beheira	Kafr El-Sheikh	Dakahlia	Gharbia	Sharquia	Ismailia	Monufia	Qaliyobia	Giza	Fayum	Beni-Suef	Minya	Average
<i>Aphelenchoides</i>	-	0.7	-	-	0.78	0.14	-	-	-	-	-	-	0.14
<i>Criconemella</i>	0.22	-	-	-	-	-	0.06	0.1	0.9	-	1.0	-	0.19
<i>Ditylenchus</i>	-	0.3	-	-	0.3	0.13	-	-	-	-	-	-	0.06
<i>Helicotylenchus</i>	-	-	-	-	0.3	0.13	0.3	-	12.0	0.5	11.6	-	2.1
<i>Heterodera</i> (J ₂)	-	-	-	0.25	-	58	0.6	-	1.5	0.1	4.0	0.66	5.4
<i>Hirschmanniella oryzae</i>	0.14	1.0	0.8	-	-	-	-	-	-	-	-	-	0.16
<i>Hoplolaimus</i>	-	-	-	0.05	-	-	-	-	-	-	0.14	0.09	0.02
<i>Longidorus</i>	-	-	-	-	-	-	-	-	0.08	-	-	-	0.007
<i>Meloidogyne</i> (J ₂)	-	-	-	-	-	-	-	-	-	-	0.98	-	0.08
<i>Pratylenchus</i>	2.3	2.8	0.16	0.34	0.21	1.9	7.1	0.9	10.0	2.6	15.0	0.95	3.6
<i>Rotylenchulus reniformis</i>	-	-	-	-	1.0	-	-	-	-	-	-	-	0.08
<i>Tylenchorhynchus</i>	7.1	1.6	7.7	17.9	14.8	10.4	47.0	40.0	44.0	47.0	90.5	70.0	33.2
<i>Tylenchus</i>	0.2	-	0.8	1.0	-	-	-	-	-	-	-	-	0.17
<i>Xiphinema</i>	-	-	-	-	-	0.13	-	-	0.06	-	-	-	0.02

In summary, our results suggested that the cereal cyst nematodes (*Heterodera* spp.) and the root-lesion nematodes (*Pratylenchus* spp.) were common in samples collected from rhizosphere of wheat grown in many locations of Egypt. These nematodes were reported as major disease agents of wheat in many wheat producing areas worldwide. Thus their identification and effects on wheat under Egyptian conditions are strongly required.

ACKNOWLEDGEMENT

The research was supported through project No. 11030134 funded by National Research Center, Dokki, Egypt.

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الملخص العربي

النيماتودا المتطفلة على النبات والمصاحبة للقمح في محافظات مصر الشمالية والوسطى

احمد محمد كريم - محمود محمد احمد يوسف - معوض محمد محمد محمد -

اسامة سامي الكيلاني - مصطفى محمد عطية همام

قسم امراض النبات (معمل النيماتودا) - المركز القومي للبحوث - الدقي - جيزة

تم جمع 929 عينة تربة ونبات من منطقة جذور القمح المنزرع في 119 قرية في 37 مركز من المراكز التابعة لمحافظات مصر الشمالية ومصر الوسطى وهي محافظات البحيرة - كفر الشيخ - الغربية الدقهلية - الشرقية - الاسماعيلية - المنوفية - القليوبية - الجيزة - الفيوم - بني سويف - المنيا . وتم حصر اربعة عشر جنساً ونوعاً من أنواع النيماتودا المتطفلة على النبات وهي *Aphelenchoides*, *Criconemella*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hirschmanniella oryzae*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Pratylenchus*, *Rotylenchulus reniformis*, *Tylenchorhynchus*, *Tylenchus* and *Xiphinema*

واظهرت الدراسة ان نيماتودا تقزم الجذور (*Tylenchorhynchus*) ونيماتودا تقرح الجذور (*Pratylenchus*) والنيماتودا الحلزونية (*Helicotylenchus*) ونيماتودا الحوصلات (*Heterodera*) كانت هي الأكثر انتشاراً وكثافة عددية على مستوي كل المحافظات . وقد احتلت نيماتودا تقزم الجذور المرتبة الأولى من حيث الكثافة العددية (250 فرد/ 48,2 جم تربة) ومن حيث نسبة الظهور (47,4%) ، بينما احتلت نيماتودا تقرح الجذور المرتبة الثانية من حيث نسبة الظهور (13, 7%) والمرتبة الثالثة من حيث الكثافة العددية (9,7) . في حين احتلت نيماتودا الحوصلات المرتبة الثانية من حيث الكثافة العددية (24,8) اما النيماتودا الحلزونية فقد جاءت في المرتبة الثالثة من حيث نسبة الظهور (5,5%) والمرتبة الأخيرة من حيث الكثافة العددية (9,٠)

الكلمات الدالة : التوزيع - نيماتودا النبات - القمح - مصر