

Plant-Parasitic Nematodes Associated with Garlic in Yemen

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Abstract

A survey was undertaken to determine the frequency and abundance of plant-parasitic nematodes associated with garlic (*Allium sativum* L.) in major garlic production governorates in Yemen. Twenty nematode genera were found in association with garlic in Sana'a, Ibb and Hadramout governorates of which *Antarctenchus*, *Aphelenchoides*, *Aphelenchus*, *Basiria*, *Boleodorus*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Meloidogyne*, *Microposthonia*, *Nothanguina*, *Pratylenchus*, *Rotylenchulus*, *Rotylenchus*, *Scutellonema*, *Tetylenchus*, *Tylenchorhynchus*, *Tylenchus* and *Zygotylenchus*. All nematode genera except *Aphelenchus*, *Helicotylenchus*, *Meloidogyne* and *Tylenchorhynchus* have been reported for the first time on garlic in Yemen. The most prevalent plant nematode genera associated with garlic cultivars in all surveyed districts were *Aphelenchus*, *Ditylenchus*, *Pratylenchus*, *Tylenchorhynchus* and *Tylenchus*. The largest number of nematode genera was recorded in Sana'a governorate (19 genera) compared to Ibb (14 genera) and Hadramout (12 genera). *Antarctenchus*, *Hoplolaimus*, *Microposthonia*, *Nothanguina*, *Scutellonema* and *Zygotylenchus* genera were only found in Sana'a governorate, while *Heterodera* was recorded only in Ibb governorate. The most serious pests on garlic, stem and bulb nematode (*Ditylenchus*) exhibited the highest average population density of 4214 nematodes/250gm soil with frequency of occurrence 49%. Therefore, effects of nematode damage on growth, vigor and yield of garlic need further investigation.

Key words: Survey, Associated nematode genera, Garlic, Yemen.

Introduction

Garlic (*Allium sativum* L.) is one the most important vegetable crops in Yemen. Sana'a, Ibb and Hadramout governorates are the main garlic growing areas. The total cultivated area attained over 933 hectares with a yield production of about 4332 meter tons in 2012, and more than 79% of garlic production was produced in Sana'a, Ibb and Hadramout governorates (43%, 18.5% and 17.5%, respectively; Agricultural Statistics, 2013). A considered number of plant-parasitic nematode genera in association with garlic cultivation have been isolated from various garlic producing areas all over the world (Sundaram *et al.*, 1990; Silva, and Carneiro, 1992; Doucet, 1999; Aballay and Eriksson, 2006; Patel, 2007, Yu *et al.*, 2012 and Qiao *et al.*, 2013). Relatively, few reports have been published about plant parasitic nematodes in Yemen. Most of which only revealed the status

of root-knot nematodes, *Meloidogyne* spp. on some economic crops including garlic in Yemen (Oteifa, 1975, Sikora, 1982 & 1986 and Ibrahim, 1987). El-Zoumair (1998) recorded in his list of plant diseases in the Republic of Yemen the presence of some plant parasitic nematode genera associated with some economic crops. Moreover, only the report of plant parasitic nematodes distribution on some plant crops in Yemen (Sana'a area) was published by El-Sherif, (2002) who recovered members of *Aphelenchoides*, *Ditylenchus*, *Helicotylenchus*, *Meloidogyne*, *Paratylenchus*, *Trichodorus*, *Tylenchorhynchus* and *Xiphinema* from garlic soil.

The stem and bulb nematode (*Ditylenchus dipsaci*) has been reported as a serious pest on garlic in many regions of the world especially in the colder and temperate regions causing necrosis or rotting of bulbs, swelling and distortion of aerial plant parts, leaf stunting, thickening, looping and yellowing and death of young plants (Netscher and Sikora, 1990; Potter and Olthof, 1993; Johnson Roberts, 1995 and Tenente, 1996).

In Yemen the stem and bulb nematode causes extensive deterioration to garlic production and can cause complete failure of the host plants (Awadh et al., 2008). Moreover, the European and Mediterranean Plant Protection Organization (EPPO) has placed *D. dipsaci* as No. 174 on the A2 list of phytosanitary categorization, which is distributed locally in EPPO countries, and it is regulated as a quarantine pest (EPPO, 1997).

Information of plant parasitic nematodes associated with garlic and the damage or severity caused in field plants is a meager problem in Yemen. Therefore, the present study was conducted to identify nematode genera and determine their current distribution and population density, especially in the major garlic production areas (Sana'a, Ibb and Hadramout governorates).

Materials and Methods

An extensive survey was carried out in the major garlic production areas in Yemen. A total of 134, 56, and 62 samples were collected from Sana'a (Al Haymah, Bani Matar, Bilad Al Rus and Hamdan districts), Ibb (Al Nadirah, Al Saddah and Ba'dan districts) and Hadramout (Al Qatn, Sayun and Tarim districts) governorates, respectively. Soil samples were taken from roots rhizosphere of growing plants to a depth of 10-15cm with a garden spade at random locations in the field. Soil samples from each field were placed in polyethylene bags and protected from sun. The collected samples were properly labeled and taken to Plant Protection Laboratory of the Faculty of Agriculture, Sana'a University for analysis and identification of the recovered plant parasitic nematodes. Soil from each sample was thoroughly mixed and nematodes were extracted from a 250gm soil sample with a combination of sieving and Baerman-pan technique (Goodey, 1957). The extracted nematodes were counted using a Hawkesly counting slide and identified to generic level based on morphological characters of the adults and juveniles forms according to Mai and

Lyon, (1975) and Siddiqi, (2000). Population density (PD) and frequency of occurrence (FO) of the extracted nematode genera were calculated and documented.

Results and Discussion

Approximately 95% of the collected samples were positive for nematode prevailing. Average abundance of nematodes ranged from 47-4214 individuals/250gm soil (Table, 1). Data reveal presence of twenty nematode genera associated with the rhizosphere of garlic plants in Sana'a (Al Haymah, Bani Matar, Bilad Ar Rus and Hamdan districts), Ibb (Al Nadirah, Al Saddah and Ba'dan districts) and Hadramout (Al Qatn, Sayun and Tarim districts) governorates. The genera are *Antarctenichus*, *Aphelenchoides*, *Aphelenchus*, *Basiria*, *Boleodorus*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Meloidogyne*, *Microposthonia*, *Nothanguina*, *Pratylenchus*, *Rotylenchulus*, *Rotylenchus*, *Scutellonema*, *Tetylenchus*, *Tylenchorhynchus*, *Tylenchus*, and *Zygotylenchus*. The largest number of nematode genera was recorded in Sana'a governorate (19) compared to Ibb (14) and Hadramout (12). Evidently genera, of *Aphelenchus*, *Ditylenchus*, *Pratylenchus*, *Tetylenchus* and *Tylenchorhynchus* were recovered from samples of all surveyed districts. Members of the stem and bulb nematode (*Ditylenchus*) were observed in all the surveyed districts with average frequency occurrence ranging between 14-49% and population densities 62-4214 nematodes/250 gm soil.

Antarctenichus, *Hoplolaimus* and *Microposthonia* were only found in Sana'a governorate, Bani Matar district with low FO and population densities of 235, 72 and 305 nematodes/250 gm soil, respectively, while *Nothanguina* was only found in Hamdan with low occurrence 4% and population density of 78 nematodes/250 gm soil. *Scutellonema* and *Zygotylenchus* were detected only in Sana'a governorate except Bilad Al Rus district. On the other hand, *Heterodera* was only recorded in Al Nadirah district Ibb governorate with 24% FO and population density of 154 nematodes/250 gm soil, while *Rotylenchus* was found in Bani Matar and Al Nadirah districts with low FO and population densities.

In Sana'a governorate, it was evident that Bani Matar district sustained the largest number of nematode genera (18) compared to Hamdan (14), Al Haymah (10) and Bilad Al Rus (9). Seven genera, *Aphelenchus*, *Basiria*, *Ditylenchus*, *Helicotylenchus*, *Pratylenchus*, *Tylenchorhynchus* and *Tylenchus* were found in all surveyed districts in Sana'a governorate. The Highest density of *Helicotylenchus* was found in samples of Al Haymah district with 1377 nematodes/250 gm soil. In Hamdan district, *Ditylenchus* exhibited the highest percent of occurrence (67%) and the highest population density of 8745 nematodes/250 gm soil.

In Ibb governorate, Al Nadirah, Al Saddah and Ba'dan districts, fourteen genera were identified from soil samples in all surveyed districts except, *Heterodera*, *Rotylenchus* and *Tetylenchus* which were only found in Al Nadirah

Table (1): Density and frequency of occurrence of nematode genera in major garlic production governorates in Yemen.

Genera	Sana'a								Ibb								Hadram out										
	Al Haymah		Bani Matar		Bilad Al Rus		Hamdan		Average		Al Nadirah		Al Suddah		Bridan		Average		Al Qatn		Sayun		Tarim		Average		
	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	P.D	F.O%	
*Anisorenchus	0	0	235	5	0	0	0	0	235	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Apehnenchoides	0	0	75	5	210	7	216	4	145	4	106	43	3203	30	63	20	640	30	10	17	66	6	0	0	0	47	5
*Aphenchus	102	71	211	45	203	73	374	61	264	55	611	61	211	70	270	80	393	79	86	17	41	14	360	38	227	23	
*Basiria	241	43	137	20	88	13	84	4	141	15	80	5	525	10	153	48	174	25	0	0	74	6	94	10	84	6	
*Boleodorus	0	0	160	20	260	7	114	17	148	16	0	0	280	80	140	4	257	11	0	0	77	17	0	0	77	10	
Ditylenchus	121	43	144	41	557	33	8745	67	4214	49	102	5	243	80	70	8	182	14	57	50	68	17	54	10	62	18	
Hallothotylenchus	1377	57	216	29	105	7	354	11	396	22	244	48	22	10	182	60	200	46	0	0	70	6	0	0	70	3	
*Heterodera	0	0	0	0	0	0	0	0	0	0	154	24	0	0	0	0	154	9	0	0	0	0	0	0	0	0	
*Hoplolaimus	0	0	72	2	0	0	0	0	72	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Meloidogyne	0	0	92	8	0	0	139	2	100	4	209	24	0	0	67	8	188	13	70	17	0	0	0	0	70	2	
*Microspostonia	0	0	305	2	0	0	0	0	305	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
*Nothogulma	0	0	0	0	0	0	78	4	78	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
*Paratylenchus	112	14	273	74	173	33	121	43	224	56	131	48	73	10	94	16	118	27	140	17	179	26	378	14	222	21	
*Rotylenchus	0	0	66	2	0	0	0	0	147	1	92	5	0	0	0	0	92	2	0	0	0	0	0	0	0	0	
*Rotylenchulus	0	0	112	24	0	0	540	63	388	34	148	19	35	10	90	8	115	13	0	0	0	0	158	43	158	15	
*Scutellonema	279	86	250	42	0	0	94	22	218	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
*Tylenchus	70	14	280	14	0	0	0	0	259	7	102	5	0	0	0	0	102	2	0	0	252	14	0	0	252	8	
Tylenchorhynchus	224	14	279	48	180	27	251	61	280	49	183	19	554	80	126	36	312	39	70	17	253	80	294	76	263	73	
*Tylenchus	224	14	214	70	194	67	197	37	208	55	300	81	388	80	188	80	286	80	70	17	60	20	123	14	78	18	
*Zygotylenchus	158	29	134	6	0	0	62	2	131	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

PD= Population Density

FO%= Frequency of

* New record

district, while *Boleodorus* and *Meloidogyne* were only found in Ba'dan and Al Saddah districts or Ba'dan and Al Nadirah districts, respectively. *Aphelenchus* and *Meloidogyne* genera exhibited the highest percent of occurrence and population densities in Al Nadirah district compared to different surveyed districts with 81% and 24% FO and population densities of 611 and 209 nematodes/250 gm soil, respectively. In Al Saddah district population densities of *Aphelenchoides*, *Tylenchorhynchus*, *Basiria*, *Tetylenchus* and *Boleodorus* were the highest among the other surveyed districts with 3203, 554, 525, 388 and 280 nematodes/250 gm soil, respectively, while *Tylenchorhynchus* and *Boleodorus* genera exhibited the highest percent of occurrence with 90% and 50% FO, respectively. The highest frequency occurrence of *Helicotylenchus* and *Basiria* were found in Ba'dan district among the other districts with 60% and 48%, respectively.

In Hadramout governorate Al Qatn, Sayun and Tarim districts twelve genera were identified from soil samples in all districts except, *Meloidogyne* and *Rotylenchulus* which were only found in Al Qatn and Tarim districts, respectively, while *Boleodorus*, *Helicotylenchus* and *Tetylenchus* were only found in Sayun district. On the other hand *Aphelenchoides* or *Basiria* were found in Sayun and Al Qatn or Sayun and Tarim districts, respectively.

With reference to Hadramout governorate, it was evident that most of detected genera occurred with low frequencies and population densities. *Tylenchorhynchus* was widely distributed especially in Sayun and Tarim with an average of 73% FO and with highest average population density of 263 nematodes/250 gm soil. The highest population density of *Pratylenchus* was found in Tarim district comparing to different surveyed districts in all governorates with 378 nematodes/250 gm soil and with a limited distribution (14%).

In this survey, nematode population densities and frequency occurrences differed from one district to another, which could be explained in terms of varying local soil and weather conditions, weed types, cropping, land history, and farming practices. The lower frequency and population density of root-knot nematode (*Meloidogyne*) in this survey compared to *Ditylenchus* could be due to low temperature at the time of sampling, or to the soil types which are loamy, or clay loam being unfavorable to this nematode and may be due to differences of garlic varieties.

Members of *Criconemoides* (ring), *Longidorus* (needle), *Paratylenchus* (pin), *Trichodorus* (stubby root) and *Xiphinema* (dagger) which were occurred on garlic in Sana'a governorate (El-Sherif, 2002) were not found in the present survey. On the other hand, fifteen nematode genera; *Antarctenichus*, *Aphelenchoides*, *Basiria*, *Boleodorus*, *Heterodera*, *Hoplolaimus*, *Microposthonia*, *Nothanguina*, *Pratylenchus*, *Rotylenchulus*, *Rotylenchus*, *Scutellonema*, *Tetylenchus*, *Tylenchus*, and *Zygotylenchus* were recorded for the first time on garlic in Yemen.

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الملخص العربي

النيماتودا نباتية التطفل المصاحبة لنبات الثوم في اليمن

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تم إجراء حصر لتحديد نسبة التواجد والكثافة العددية للنيماتودا نباتية التطفل المصاحبة لمحصول الثوم في المحافظات الرئيسة لإنتاج الثوم في اليمن، سجل تواجد عشرون جنس نيماتودي مصاحب لمحصول الثوم في محافظات صنعاء وآب وحضرموت وهي *Antarctenchnus*, *Aphelenchoides*, *Aphelenchus*, *Basiria*, *Boleodorus*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Meloidogyne*, *Microposthonia*, *Nothanguina*, *Pratylenchus*, *Rotylenchulus*, *Rotylenchus*, *Scutellonema*, *Tetylenchus*, *Tylenchorhynchus*, *Tylenchus*, و *Zygotylenchus*. كل الأجناس سجلت لأول مرة على الثوم في اليمن عدا الأجناس *Aphelenchus*, *Helicotylenchus*, *Meloidogyne* و *Tylenchorhynchus*. كانت الأجناس *Ditylenchus*, *Aphelenchus*, *Pratylenchus*, *Tylenchorhynchus* و *Tylenchus* أكثر انتشارًا على محصول الثوم في كل المديرية التي تم بها الحصر. صاحب محصول الثوم أكثر عدد من الأجناس النيماتودية في محافظة صنعاء (١٩ جنس) يليها محافظة آب (١٤ جنس) ثم محافظة حضرموت (١٢ جنس). سجل تواجد الأجناس *Hoplolaimus*, *Antarctenchnus*, *Scutellonema*, *Microposthonia*, *Nothanguina*, و *Zygotylenchus* في محافظة صنعاء فقط بينما سجل جنس *Heterodera* في محافظة آب. أظهر جنس نيماتودا السوق والأبصال *Ditylenchus* الذي يعد أخطر جنس نيماتودي على الثوم أعلى معدل كثافة عددية ٤٢١٤ نيماتودا / ٢٥٠ جم تربة وبمعدل تواجد تكراري ٤٩%. لذا هنالك حاجة لمزيد من البحث لدراسة تأثير النيماتودا على نمو وإنتاج محصول الثوم.