Journal of Phytopathology and Pest Management

Volume (4), Issue (1)

2017

pISSN: 2356-8577
eISSN: 2356-6507

Journal of Phytopathology and Pest Management 4(1): 28-37, 2017
pISSN:2356-8577 eISSN: 2356-6507
Journal homepage: http://ppmj.net/

Plant-parasitic nematode communities associated with Moringa tree (*Moringa oleifera* Lam.) in western Niger

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Abstract

Moringa (*Moringa oleifera* Lam) is a crop that is becoming more and more important in Niger, but very little attention has been devoted to its pest problems. Nematode fauna survey was undertaken in three important Moringa producing sites in western Niger. Soil and roots samples were taken from the plant's rhizosphere at 20-30-cm deep. Nematological analysis of these samples revealed the presence of 11 genera of plant-parasitic nematodes among which the most frequent and abundant were *Meloidogyne* spp., *Helicotylenchus* spp. and *Hoplolaimus* spp. The average prominence values of these three nematodes were 236.69, 105.25 and 97.93, respectively. In roots, *Meloidogyne* spp. alone represented up to 90% of the plant-parasitic nematode communities. Its average prominent value was 591.46.

Key words: *Moringa oleifera,* vegetable crop, plant-parasitic nematodes, Niger.

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Introduction

Moringa (*Moringa oleifera*) plant belongs to the Moringaceae family and originates from the Indian subcontinent (Pandey et al., 2011). In Niger, it is grown as a vegetable crop; its leaves are usually consumed boiled; but sometimes they are eaten raw. Because of its high content in micronutrients (calcium, iron, and vitamins) and proteins (Kimba et al., 2010; Price, 2007), moringa can contribute to the nutritional quality improvement of Niger population. Moringa is grown under irrigation as sole crop or in association with other vegetable crops such as onions, lettuce, peppers, tomatoes or squash. The main producing areas are located in Maradi and Niamey regions. The area devoted to moringa was estimated at 100 000 ha (USAID, 2011). In Sahelian conditions only one insect pest and one pathogenic fungus have been reported in moringa. Abass et al. (2007) reported damages caused by insect pests that destroy foliage during the dried season. The main pest is a moth (*Noorda blitealis*, Lepidoptera, Crambidae) identified for the first time in Niger by Ratnadas et al. (2011). Haougui et al. (2014) identified for the first time *Botriodiplodia theobromae* as responsible of the moringa decline observed in the western part of the country. To date, no information is available on plant parasitic nematodes of Moringa in Niger. Information reported by Prot (1984) showed that this crop, like papaya and baobab tree, can also serve as a reservoir of root-knot nematodes belonging to the genus *Meloidogyne*. This author noticed that moringa did not show any symptoms of nematode attacks apart from having root galls. The objective of this study was to identify the plant- parasitic nematodes associated with Moringa in Niamey, one of the two largest producing areas of moringa in Niger.

Materials and methods

Site characteristics and sampling: The three main producing sites of Moringa in the Western region of Niger, Toulware, Karey-Gorou and Sarando were selected for study (Table 1). In these sites, Moringa coexists with other fruit trees such as mango (*Mangifera indica*), guajava (*Psidium guajava*, citrus (*Citrus* spp.) and hedge trees comprising (*Acacia Senegal*, *Bauhinia rufescens* or *Prosopis juliflora*. In the moringa plots, other vegetable crops such as tomatoes, peppers, eggplant and cucurbits (melon and zucchini) were planted. Ten to fifteen farms were surveyed based on the importance of the sites. Sampling was done using the zig-zag method of Barker (1985). On each plot, samples of soil and roots were taken in the rhizosphere of plants at a depth of 20-30 cm, with a trowel. Each sample (2 kg of wet soil + roots), composed of 5 sub-samples was put in a plastic bag, labeled and then placed in a strong box and transported to the laboratory for nematological analysis.

Table 1: location of study sites.

Sites	Geographic coordinates
Toulware	13° 28’’44.13’’N ; 2° 01’ 01.78’’E
Karey-gorou	13 ° 32' 15.91’’N ; 2° 00’ 23.70’’E
Sarando	13° 35’ 14.43’’ N ; 1° 55’ 49.32’’E

Nematode extraction, identification and data analysis: Nematodes were extracted from the soil and roots using Seinhorst methods (1950 and 1962). The importance of each genus or species of nematode was determined by calculating the mean density of nematodes per site, the relative density, the frequency of occurrence in the samples and the prominent value. The mean density is the average of individuals per 250 cm^3 of soil or 5 g of root. The relative density of each nematode was calculated using the following formula:

$$\text{RelativeDensity} = \frac{\text{Number of nematodes}}{\text{Total number of nematodes}} x100$$

The frequency (f) is the percentage of samples which contain the given nematode as calculated by the following formula:

$$\text{Frequency} = \frac{\text{Number of samples containing a nematode}}{\text{Total number of samples}} x100$$

The prominent value is given by the formula of De Waele et al. (1998) as follow:

$$\text{Prominent value} = \text{Density x } \frac{\sqrt{\text{(frequency of appearance)}}}{10}$$

Results

Importance of parasitic nematodes in the soil: The nematological analysis of soil samples showed 11 genera of plant-parasitic nematodes in the rhizosphere of moringa. *Meloidogyne* and *Pratylenchus* are respectively sedentary endoparasite and migratory endoparasites, while the other nematodes are ectoparasites, although *Scutellonema clathricaudatum* has endoparasitic phase. Karey-gorou showed the greatest biological diversity with 10 genera, followed by Sarando and Toulware infested by 9 and 8 kinds of plant-parasitic nematodes, respectively. Seven genera were common to all the three sites. These are *Meloidogyne*, *Xiphinema*, *Helicotylenchus*, *Pratylenchus*, *Hoplolaimus*, *Tylenchorhynchus* and *Criconemella* (Table 2). Analysis of plant-parasitic nematodes communities of the 3 sites showed that *Scutellonema* exhibited the highest prominent value (PV) at Toulware followed by *Meloidoyne*, *Hoplolaimus* and *Helicotylenchus*. The PVs were respectively 136.99, 117.06, 105.25 and 93.56. On the other two sites, *Meloidogyne* recorded the largest PV (204.33 and 388.67), followed by *Helicotylenchus* (117.79 and 104.48) and *Hoplolaimus* (115.89 and 72.65). The other nematodes were not abundant in all the 3 sites (Table 3). The figure 1 shows the relative densities of different nematodes in the soil. It appears that the three genera with the highest PVs alone represent up to 65% of the parasitic nematodes at Toulware. *Meloidogyne* alone accounted for almost a quarter of the nematode population in this site. *Hoplolaimus*, *Meloidoyne* and *Helicotylenchus* represented more than 90% of the nematodes at Karey-gorou and Sarando. *Meloidogyne* alone accounted respectively for 39 and 56% of the nematode communities. The most poorly represented genera were *Tylencorhynchus* (PV = 0.6) in the first site and *Psylenchus* (PV = 0.3) and *Tylenchus* (PV =0.50) respectively in the second and third sites.

Table 2: distribution of parasitic nematodes by site.

Parasitcnematodesspecies	Toulware	Karey-gorou	Sarando
*Meloidogyne*spp	+	+	+
Xiphinemaelongatum	+	+	+
Helicotylenchusdihystera	+	+	+
Pratylenchusbrachyurus	+	+	+
Hoplolaimuspararobustus	+	+	+
Tylenchorhynchusindicus	+	+	+
Criconemellacurvata	+	+	+
Scutellonemaclathricaudatum	+	-	-
Paratrichodorusminor	-	+	-
*Aphelenchus*sp	-	+	+
Tylenchus sp	-	+	+

Table 3: Importance of plant-parasitic nematodes from soil samples of moringa.

Sites	Nematodegenera	Nematode density (Nbr individuals/250 cm ^{3})	Frequency (%)	Prominence value
Toulware	*Meloidogyne*	117.06	100.0	117.06
	Xiphinema	7.44	51.6	5.34
	Helicotylenchus	93.56	100.0	93.56
	Pratylenchus	2.75	72.8	2.35
	Hoplolaimus	105.25	100.0	105.25
	Tylencorhynchus	0.75	64.6	0.60
	Criconemella	1.9375	55.1	1.44
	Scutellonema	152.97	80.2	136.99
Karey-Gorou	*Meloidogyne*	204.33	100.0	204.33
	Xiphinema	9.38	17.4	3.92
	Helicotylenchus	134.75	76.4	117.79
	Pratylenchus	16.38	50.2	11.60
	Hoplolaimus	133.38	75.5	115.89
	Tylencorhynchus	7.19	56.8	5.42
	Criconemella	2.06	25.0	1.03
	Paratrichodorus	7	61.0	5.47
	Psylenchus	0.56	32.2	0.32
	Scutellonema	8.06	100.0	8.06
Sarando	*Meloidogyne*	388.67	100.0	388.67
	Xiphinema	11.72	15.7	4.64
	Helicotylenchus	133.23	61.5	104.48
	Pratylenchus	20.47	53.7	15.00
	Hoplolaimus	122.58	35.2	72.67
	Tylencorhynchus	8.98	32.1	5.09
	Criconemella	2.58	52.4	1.87
	Aphelenchus	8.75	21.7	4.07
	Tylenchus	0.7	51.7	0.50

Importance of parasitic nematodes in the roots: Only three parasitic-nematodes were extracted from the roots of moringa. These were *Meloidogyne, Pratylenchus* and *Scutellonema*. At Sarando, only *Meloidogyne* and *Pratylenvhus* were found. Table 4 presents the importance of these parasitic-nematodes in the roots in the three sites. It appears that *Meloidogyne* was the most important parasitic nematodes in the roots. Its prominent values were 355.00, 908.22 and 511.15 at Toulware, Karey-gorou and Sarando, respectively. *Pratylenchus* and *Scutellonema* were very scarce with relatively very low densities ranging between 8 and 61 individuals / 5 g roots. Figure 2 shows the relative densities of the different parasitic-nematodes found in the roots. *Meloidogyne* species represented most of the endophytic nematode communities as it accounted for 84 to 96% of the total.

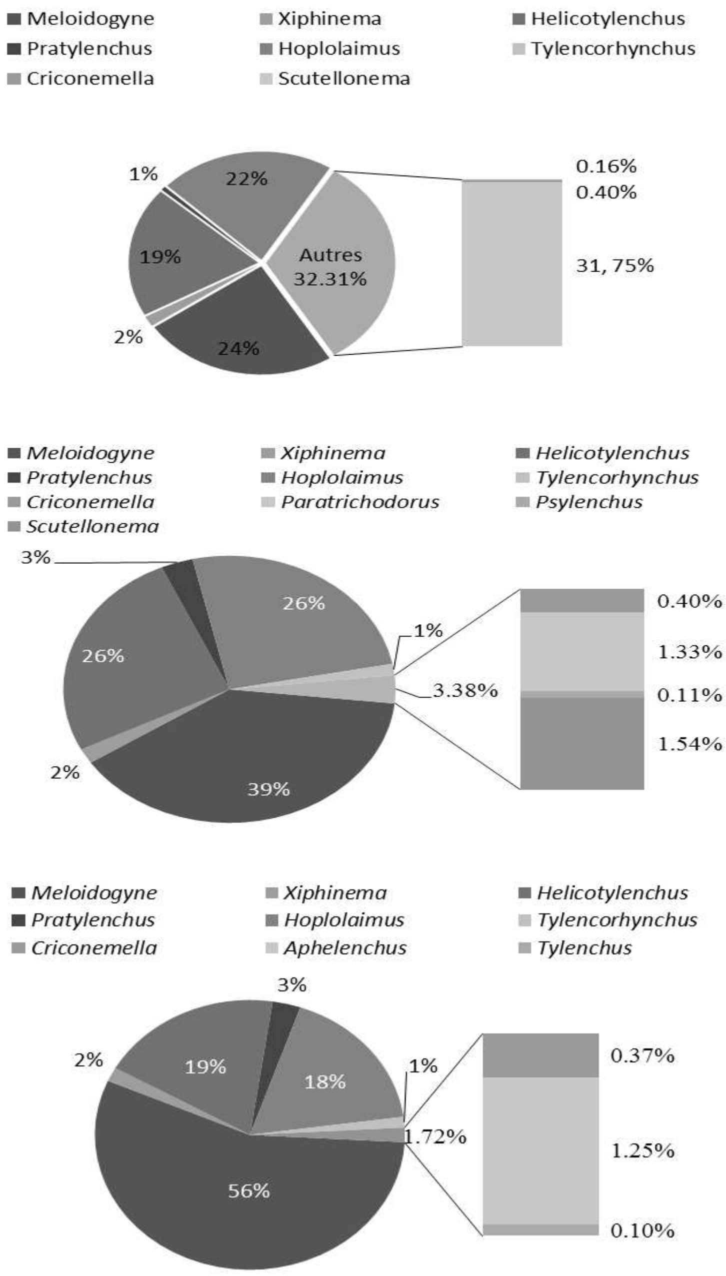

Figure 1: Relative densities of plant-parasitic nematodes in moringa rhizosphere.

Table 4: Importance of plant-parasitic nematodes from root samples of moringa.

Sites	Nematodegenera	Nematode density (Nbr individuals/ 5gr of roots [3])	Frequency (%)	Prominence values
Toulware	*Meloidogyne*	355	100	355.00
	Pratylenchus	61	55.67	45.51
	Scutellonema	8	23.46	3.87
Karey-gorou	*Meloidogyne*	908	100	908.22
	Pratylenchus	42	53.12	30.61
	Scutellonema	30	48.05	20.97
Sarando	*Meloidogyne*	511	100	511.15
	Pratylenchus	22	76.54	19.03

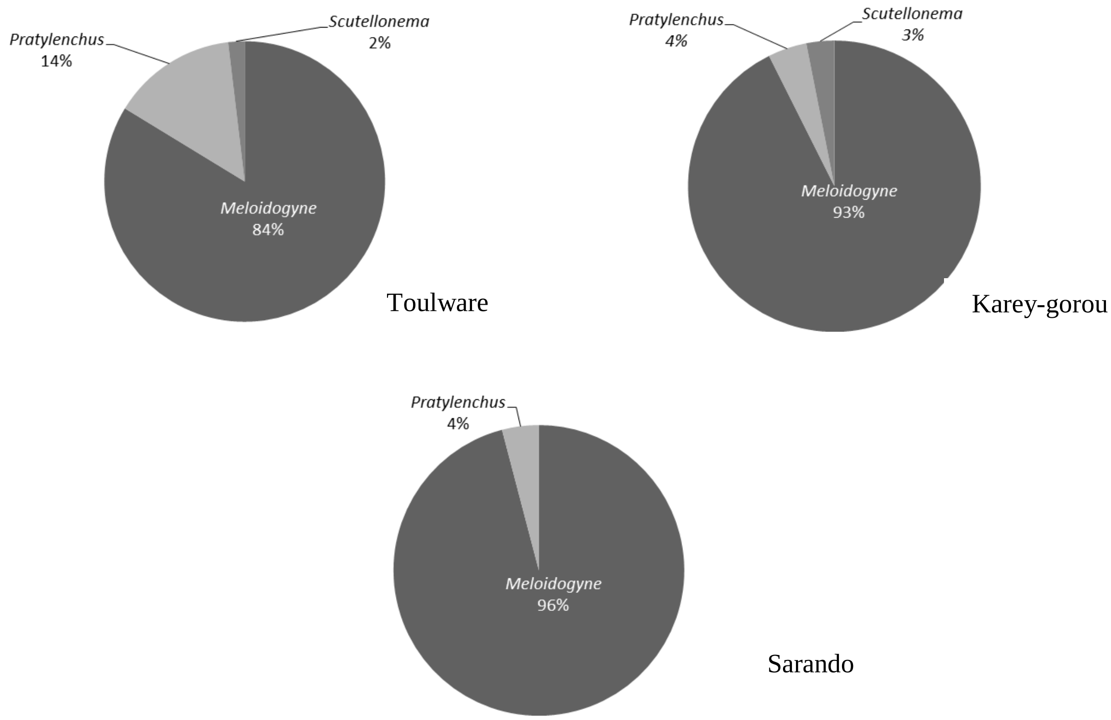

Figure 2: relative densities of plant-parasitic nematodes in moringa plant roots

Discussion

The results described in this study showed that on all the three sites, 11 genera of plant-parasitic nematodes were associated with moringa. In the same region, 8 to 12 genera of phytonematodes were found on Solanaceous crops and hedge tree species (*Acacia senegal*, *Prosopis juliflora* and *Bauhinia rufescens*), respectively (Haougui et al., 2013a and 2013b). All these nematodes were already reported on vegetable crops by Haougui (1999). The root-knot nematodes, *Meloidogyne* spp., the most devastating group on vegetable crops were found in all sites with high densities. In roots, they constitute the dominant group of parasitic-nematodes communities. In Niger, three species of *Meloidogyne*, *M. incognita* (Silva, 2005; Sikora et al., 1988), *M. javanica* (Haougui, 1999) and *M. enterolobii* (Nourh, 2012) are known to occur. Haougui et al. (2008) reported yield losses due to *M. javanica* up to 60% on tomato. They noted that heavy infested soil can lead to total yield loss. However, during our field survey, no symptoms of nematode infection were perceptible on moringa plants, despite the high densities of *Meloidoyne* in the roots. This is consistent with results reported by Prot (1984) who thinks that moringa is only a reservoir of *Meloidogyne* spp. So, like the hedges species, it contributes to contaminate vegetable crops that are in its immediate vicinity (Senego & Cadet, 2007). This study also confirmed the polyphagous status of *Meloidogyne* spp. that can infect more than 2000 plant species worldwide (Nourh, 2012). In addition, root-knot nematodes have been found in all vegetable producing areas of Niger where they constitute the main limiting factor to crop production (Haougui et al., 2013c and 2013d), especially since they most often act in synergy with some of the vascular disease pathogens. Haougui and Bizo (2009) reported the simultaneous presence of *Meloidogyne* spp, *Ralstonia solanacearum* and *Fusarium* spp on pepper in the Aguie area and they attributed the rapid decline of the crop production in the region of Maradi (Niger) to the action of the parasite complex. Other parasitic nematodes with large prominent values (*Helicotylenchus* and *Hoplolaimus* on all three sites and *Scutellonema* at Toulware), are not very dangerous for vegetable crops despite their high densities. Some authors considered *Helicotylenchus dihystera*as a minor pest and sometimes as an indicator species of mature fallow in which nematode biodiversity is very high (Villenave & Cadet, 1998). In such an environment, the free living nematodes and parasitic nematodes densities are very high (Serigne et al., 2003). Cadet (1998) reported that *H. dihystera* expressed a moderating effect on the pathogenesis of the communities to which it belongs. According to Rodriguez-Kabana (1987), when some plant-parasitic nematodes species are in a multispecies community, they have no significant depressive effect on the plants' growth. *Hoplolaimus* is mostly a parasitic nematode observed on millet, sorghum and cowpea in the Sahel area (Baujard et al., 1995). Its occurrence on our sites may be explained by the cultivation of these crops in association with moringa. *Scutellonema clathricaudatum*, the main species of the genus identified in Niger, causes significant damage only to peanuts under rainfed conditions (Baujard & Martiny, 1995; Sharma et al., 1992; Sharma et al., 1990). However, this crop is not grown in vegetable sites even in Maradi, one of the largest peanut basins of Niger. But if one day these lands should be allocated to the production of this crop, special attention should be paid to *S. clathricaudatum*. The study revealed that the rhizosphere of moringa has a multispecies community of phytopathogenic nematodes, including *Meloidogyne* spp which is a limiting factor in the vegetable crops production in Niger. So, any development program of moringa should consider its nematotological status in order to avoid associations with vegetable crops. The pathogeny of *Scutellonema clathricaudatum* and *Hoplolaimus pararobustus* on moringa should be tested both in a greenhouse and fields to understand their real effect on this plant.

Acknowledgement

The authors thank the Director General of Niger Agricultural Research Institute (INRAN) for funding this work. Thanks are also addressed to the moringa producers of Toulware, Karey-gorou and Sarando for all the information they provided.

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