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Biodiversity of plant-parasitic nematodes associated with pepper in the regions of Diffa and Dosso (Niger republic)

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ABSTRACT: The pepper (*Capsicum annum*) is one of the most important vegetable crops grown in Niger. It is attacked by many pests and diseases. In the regions of Diffa and Dosso, plant-parasitic nematodes are often suspected of being responsible of significant yield losses on pepper. The study aimed to characterize the plant-parasitic nematode communities associated with this crop. Sampling was undertaken in six main pepper producing sites of the 2 regions. Samples of soil and roots were collected from the plant rhizosphere and brought to the laboratory for the analysisof nematodes. Twelve (12) species of plant-parasitic nematodes associated with pepper were found, including root-knot nematodes belonging to the genus *Meloidogyne* that were both frequent and abundant in all sites.

***Keywords*:** Biodiversity, pepper, plant-parasitic nematodes, Meloidogyne, Niger

INTRODUCTION

In Niger, pepper is the second exported vegetable after onion. Diffa region alone produces over 85% of national production (Pret and Konate, 2005). According to Anonymous (2010), this crop occupied 7300 ha with an output of 126,000 tons of fresh pepper. The average yield is 17 t / ha. A small part of the production is consumed or sold on local markets and the surplus is exported to Nigeria, a bordering country, providing significant foreign currency. According to Djibey (2012), the value of production is estimated at 11.8 billion FCFA.

Despite the importance of this crop in the economy of the country r, relatively limited attention is paid to its insect pests in general and parasitic nematodes in particular. Nematodes are a major pest of crops causing extensive yield loss to farmers, it therefore constitute a limiting factor to crop production. According to Haougui and Kollo (2006), yield loss of up to 60 % can occur if high infestation of nematodes is not controlled. Another study conducted in Niger on heavily infested vegetable plots showed that nearly 50% of the plants died before fruiting while 12.5 % wilted. (Haougui et al., 2008). In Niger, The plant-parasitic nematodes, especially root-knot nematodes belonging to the genus *Meloidogyne* are the main constraints in horticultural systems (Sikora et al., 1988; Sylva, 2005; Moussa, 2012; Nourh, 2012).

The study aim is to examine the biological diversity of nematode parasites communities associated with pepper in Diffa and Dosso regions of Niger.

MATERIALS AND METHODS

The study was conducted in Diffa and Dosso regions. In each location, three main pepper producing sites were selected (table 1)

Table 1. Study sites in the two regions

Regions	Sites	Geographic Coordinates
Diffa	Boulangouri	13°19'57"N ; 12°37'58.50" E
	Trouban-Guida	13°16'49.47''N; 12°34'42.10"E
	Bagara	13°15'54''N; 12°33'47. 26"E
Dosso	Doutchi	13°38'47.05"N; 4°03'45.03"E
	Maikalgo	13°15'28.12"N; 03°55'7.99"E
	Tchibiri	13°06'29.49"N; 03°59'48.39"E

Samples of soil and roots were taken randomly from the pepper farms in the rhizosphere of plants, according to the method of Barker (1985), at a depth of 5-20 cm using a trowel. Each sample (2 kg of wet soil + roots) was composed of three sub-samples and was put in a plastic bag and then brought to the Nematology Laboratory of the Regional Centre of Agrhymet. Nematodes were extracted from the soil and roots by the Seinhorst (1950 and 1962) methods. Soil nematodes were extracted from 250 cc of soil collected from each sample. After extraction of root nematodes, roots were dried and their dry weight was recorded.

The importance of each species or genus of nematodes has been determined from the Fortuner and Merny (1973) Diagram of Frequency / Abundance. The frequency (*F*) is the percentage of samples that contain a given species or genus. This parameter was calculated by using the following formula:

$$F = \frac{e}{n} \text{ x100}$$

Where *e* = total number of samples containing a given species of nematode, and, *n* = total number of samples at given site.

Abundance (A) of a nematode species is the average density per sample in which the nematode was found, and calculated by using the following formula:

$$A = \frac{\sum X_i}{e}$$

Where X_i = number of nematodes per liter of soil or gram of root, *e* = number of samples in which the given nematode was present. Then the A values were log transformed. A species is considered abundant and frequent when it was present in at least 30% of samples with at least 300 individuals per liter of soil or 20 individuals per gram of dry root.

RESULTS

Qualitative analysis nematofauna

Twelve genera of plant-parasitic nematodes belonging to 10 families were encountered in this study (Table II). Three of them (*Meloidogyne*, *Pratylenchus* and *Ditylenchus*) are endoparasites, *Rotylenchulus*, a semi-ectoparasite and eight other ectoparasites, although *Scutellonema clathricaudatum* has endoparasitic phase. Analysis of results by region shows that eight(8) genus/species were identified in the three surveyed sites of Diffa region. Among them, *Meloidogyne* sp and *Tylenchorynchus indicus* were found in all the three sites.

In Dosso, 10 genera/species were encountered among which five were present in all the three sites namely *Meloidogyne* sp, *H. dihystera*, *S. clathricaudatum*, *Tylenchorynchus indicus* and *Pratylenchus* sp. The Table II also shows that only two species, *Meloidogyne* sp and *T. indicus* were found across the six sites of the study . *S. clathricaudatum* was found in 5 of the 6 surveyed sites.

Quantitative analysis of nematofauna

Diffa

The quantitative importance of plant-parasitic-nematodes is given in figure 1. It appears that in the soil *T. indicus* was the most common (present in 50% of samples), followed by *Meloidogyne* and *Ditylenchus*. However, none of nematodes encountered were abundant, meaning that the average densities remained below 300 individuals/cubic decimeter of soil. In the roots, only *Meloidogyne* sp were present in all the three sites of the region. The juvenile stage (L2) was both frequent and abundant in all the three sites.

Dosso

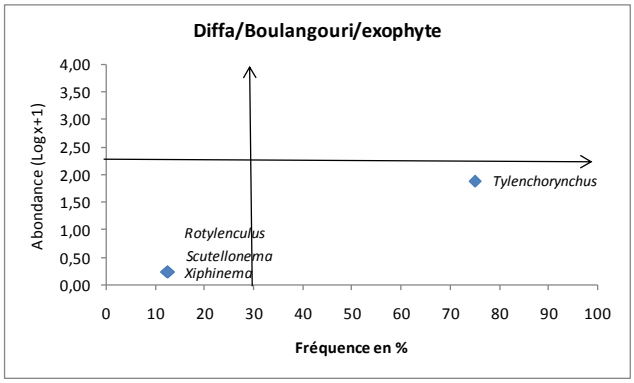
In the soil, *Meloidogyne* sp. was the only nematode which was both frequent and abundant in all the three sites of the region. *Scutellonema* is however both frequent and abundant at Tchibiri while *Pratylenchus* was frequent but not abundant in Doutchi and Tchibiri.

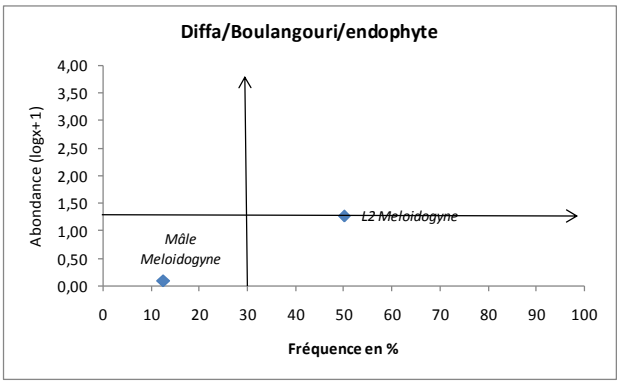
Xiphinema, *Psilenchus* and *Criconemella* were frequent but not abundant at Maikalgo, Doutchi and Tibiri (Figure 2).

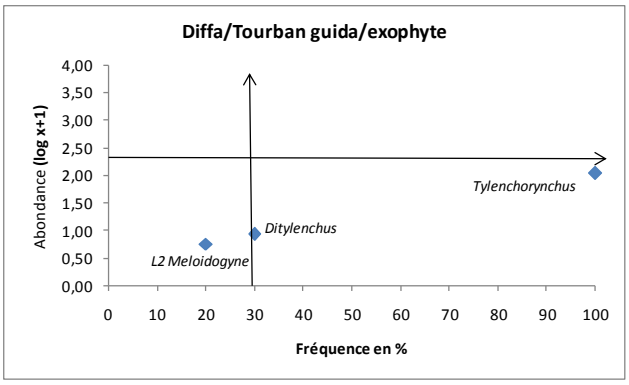
In the roots, several genera, including some ectoparasites, were found. The infective stage (L2) of *Meloidogyne* sp was both frequent and abundant in all sites while *Scutellonema*, *Helicotylenchus* and *Criconemella* were only frequent and abundant at Tchibiri. In the latter site, *Pratylenchus*, a migratory endoparasite was frequent but not abundant.

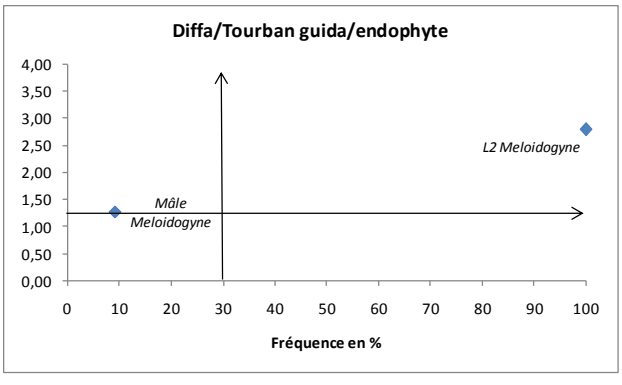
Table 2. Plant-parasitic nematodes encountered in the 2 regions

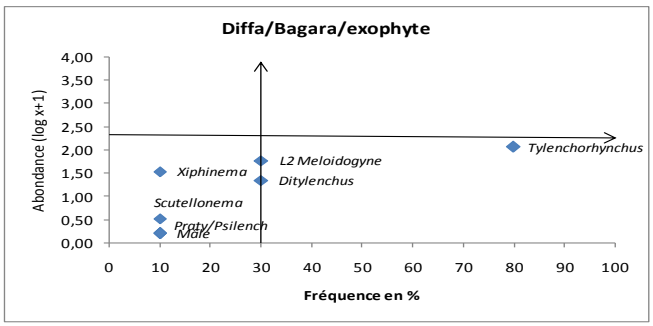
Nematode Genera/ species			Diffa			Dosso		
	Genera	Species	Boulangouri	Bagara	Tourban- guida	Doutchi	Maikalgo	Tibiri
Order Tylenchida								
Heteroderidae	*Melodoigyne*	*Meloidogyne sp*	+	+	+	+	+	+
Belonolaimidae	*Tylenchorynchus*	*T.indicus*	+	+	+	+	+	+
Hoplolaimidae	*Scutellonema*	*S. clathricaudatum*	+	+	-	+	+	+
Hoplolaimidae	*Helicotylenchus*	*H. dihystera*	-	-	-	+	+	+
Hoplolaimidae	*Rotylenchulus*	*R. reniformis*	+	-	-	-	-	-
Pratylenchidae	*Pratylenchus*	*Pratylenchus sp*	-	+	-	+	+	+
Anginidae	*Ditylenchus*	*Ditylenchus sp*	-	+	+	-	-	-
Criconematidae	*Criconemella*	*C. curvata*	-	-	-	-	+	-
Tylenchidae	*Psilenchus*	*Psilenchus sp*	-	-	+	+	-	-
Aphelenchidae	*Aphelenchus*	*A. avenae*	-	-	-	-	+	-
Order Dorylaimida								
Trichodoridae	*Paratrichodorus*	*P. minor*	-	-	-	-	+	-
Longidoridae	*Xiphinema*	*Xiphinema sp*	+	+	-	+	-	-











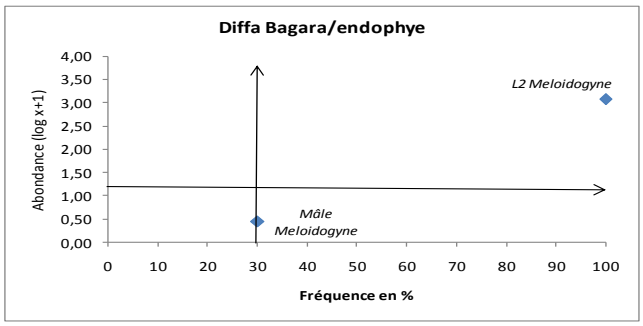
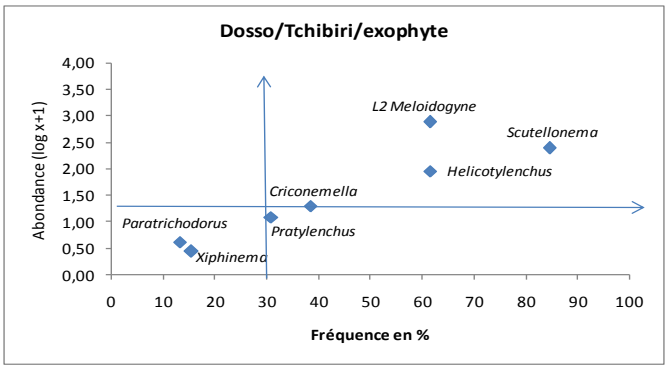
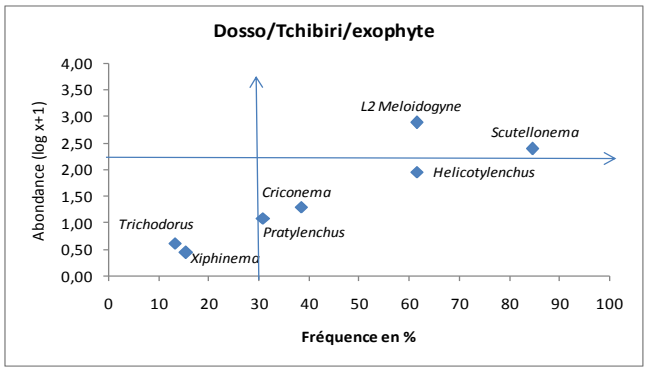
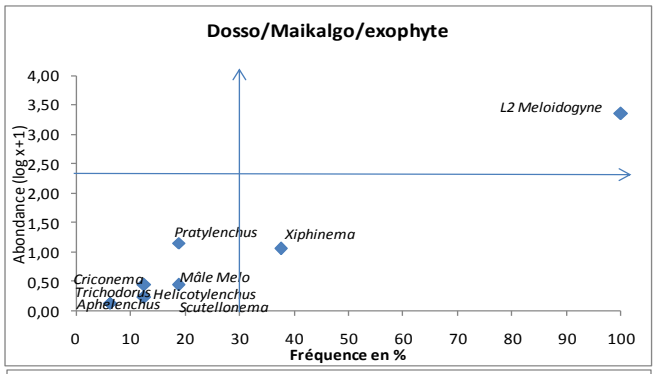
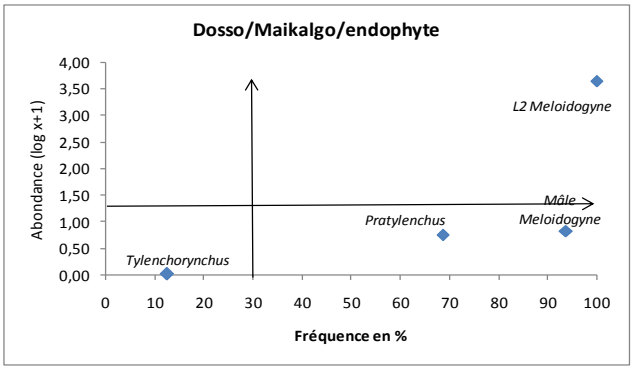


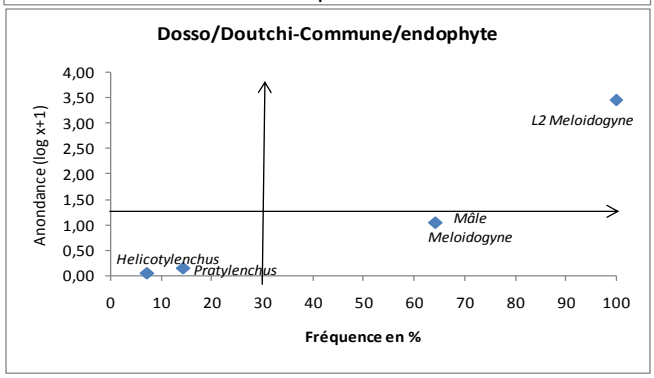
Figure 1. Frequency and abundance of exophytic and endophytic nematodes in the region of Diffa











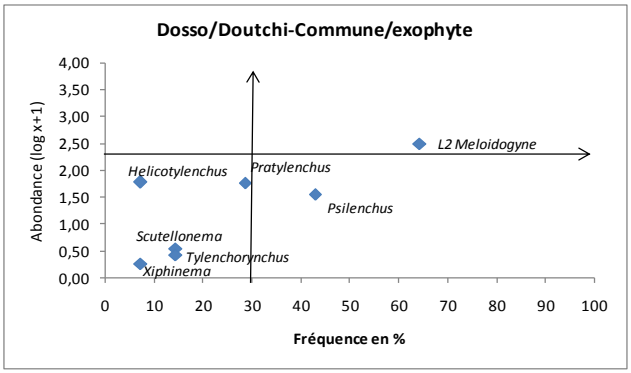


Figure 2. frequency and abundance of exophytic and endophytic nematodes in the region of Dosso

DISCUSSION

This study revealed that 12 genera/species of plant-parasitic nematodes were associated with pepper in the regions of Diffa and Dosso. Previous studies (Haougui 1999 ; Sarr, Pers com) have reported the presence of all these parasitic nematodes genera in the region of Diffa. The biological diversity is comparable to the one obtained by Haougui (1999) on pepper. It is however higher than the 7 and 8 genera reported respectively by Oumarou (2010) and Haougui et al. (2013). The present study is not also consistent with the result of Zakari (2008) who conducted a study on pepper in the suburban area of Niamey as well as that of Sylva (2005) in the regions of Niamey, Maradi and Dosso.

The root-knot nematodes belonging of the genus *Meloidogyne* (the most devastating group) was present in all the six sites, suggesting that these parasitic nematodes play a very important role in the decline of pepper production observed by extension services of these two regions (Moumouni, com. Pers.). Indeed, the observations made in the field during sampling show that, in some plots, plants were stunted and wilted. In some cases, the plants died before fruiting. The infested roots exhibited galls and discolored veins. Haougui et al. (2008) reported that in the Sahelian conditions, this group of nematodes can cause more than 50% yield losses in tomato and in some cases they can lead to complete crop loss. The distinctiveness of plant-parasitic nematodes is due to the fact that they are polyphagous that means they can attack more than 200 plant species (Nourh, 2012). The relatively high nematodes biodiversity in pepper rhizosphere in these two regions is typical of the tropical and subtropical conditions where most plants are attacked simultaneously by several species of nematodes. The existence of multi-species communities in these regions can be explained by the agronomic diversity (Cadet et al., 1994). Even in Diffa where monoculture is the rule, producers maintain okra or eggplant plants in plots or on the edges, creating a floristic diversity in favor of maintaining the biodiversity of parasitic nematodes.

On the sites of Dosso, the practice of combining several crops on the same plot is common. In some cases there are 3 to4 different crops in the same plot in addition to perennials plants or weeds that may be host to one or more plant-parasitic nematodes species. *Meloidogyne* spp, are the only species found in the roots of pepper on almost all the 3 sites of Diffa; this phenomenon is typical of the nematological situation in temperate zones. In these areas, the plants are usually attacked by one dominant species (Haougui, 1999). The widespread distribution of *Meloidogyne* in all sites could be explained by an exchange of plant material from one site to another. Indeed, in some parts of Niger, the producers of seedlings do not take any care to avoid contamination of their nurseries by parasitic nematodes. Therefore, the plants grown in such nurseries can carry nematodes in the roots and passively disseminate parasites over very long distances. Haougui et al. (2013) found that in the region of Maradi, several pepper growers buy plants grown in nurseries of villages located at more than 40 km and the observations done showed that the roots of many seedlings from such transactions had galls induced by *Meloidogyne*.

Other important plant parasitic nematodes that have also been identified are *T. indicus* which was abundant but not frequent in Diffa, *H. dihystera* and *S. clathricaudatum* very frequent at Tibiri (Dosso). These plant parasitic nematodes could be additional threats to pepper at these sites. The presence of *Xiphinema* and *Paratrichodorus* on pepper in the two regions is worrisome because they are potential vectors of virus infecting some Solanaceous crops like, peppers, tomato and tobacco. Indeed, several authors have reported that species of the family Trichodoridae (*Trichodorus* and *Paratrichodorus*) transmit tobravirus while others belonging to the family Longidoridae as *Xiphinema* are involved in the transmission of nepoviruses to Solanaceae (Vesrchot-Lubicz, 2003; Robinsson 2003; Andret-Link et al., 2004).

CONCLUSION

This study has clearly demonstrated the importance of parasitic nematodes associated with pepper in the regions of Diffa and Dosso. So, any development program on pepper production in these areas should include control measures against these important pests which can be a limiting factor.

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