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Characterization of Plant-Parasitic Nematode Communities Associated with Tomato (*Lycopersicum esculentum*) in the Peri-Urban Area of Niamey (Niger)

Alou Rabi[1], Haougui Adamou[2*], Bibata Ali Outani[2], Adam Toudou[1], Abdoulaye Abdoul Kadri[2], Idrissa Ousseini[2]

[1]Unisverité Abdou Moumouni de Niamey, Université Abdou Moumouni de Niamey, Niamey, Niger
[2]Institut National de la Recherche Agronomique du Niger, Inran

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***Corresponding author:** Haougui Adamou
Institut National de la Recherche Agronomique du Niger, Inran

Abstract **Original Research Article**

Tomato (*Lecopersicon esculentum* L) is a crop that is very important in Niger, but very little attention has been devoted to its nematode problems. The objective of this study was to identify parasitic nematodes associated with moringa tree. For this, a survey was undertaken in height important tomato producing sites of peri urban zone of Niamey. Soil and roots samples were taken from the plant's rhizosphere at 20 to 30 cm deep. Nematological analysis of the samples Samples revealed the presence of 11 genera of plant-parasitic nematodes among which the most frequent and abundant were Root-knot nematodes belonging to the genus *Meloidogyne.*
Keywords: Faunistic, *Meloidogyne*, root-knot nematodes, tomato, Niger.

INTRODUCTION

In Niger, the importance of market gardening is well known. Indeed, they contribute a large part of the agricultural GDP. They help to reduce the rural exodus and improve the conditions of producers by providing them with the income they need. The main vegetable crops are, in order of economic importance, onions, peppers, cabbage and tomatoes. The latter is grown under irrigation in the dry season as well as in the rainy season with supplementary irrigation. The production level is 10170 t in 2020 with an average yield of 20 t/ha (Republic of Niger, 2021). This yield is very low compared to the crop's potential. The constraints to tomato production, are several abiotic and biotic factors such as climatic conditions, pests and diseases. including plant parasitic nematodes. The losses caused by such a pest are very important and can reach 30 to 40% (Hama, 2010).

Previous work has shown that the root-knot nematodes of the genus *Meloidogyne* are the most important on vegetable crops (Haougui *et al*., 2013a; Haougui *et al*., 2013b; Toukal *et al*., 2017). Haougui *et al*., (2013a) reported 7 genera of parasitic nematodes in the region of Maradi (central Niger) while Haougui *et al*., (2013c) counted eight genera in the Niamey region in the wester part of the on different vegetable crops. Haougui *et al*., (2013b) found 12 species on pepper in the three main pepper producing regions of the country. Little work has been done on the study of nematode pests of tomato alone in the entire country.

The objective of the present study was to characterize the nematode communities associated with tomato in the peri-urban area of Niamey (Western Niger).

MATÉRIAL AND METHOD

- Sites surveyed

The survey was carried out in the main tomato production sites of Niamey (Table I). In all plots, tomatoes were at the flowering or early fruiting stage.

Table I: Vegetation and location of sites

Sites	Vegetation	Geographical coordinates
Goudel	Vegetables : tomato, lettuce, pepper, carrot and moringa; Tree stratum : *Acacia nilotica*, mango tree , *Eucalyptus* sp, ; Herbaceous stratum : *Pacnicum* sp, *Dactyloctenium* sp, *Brachiara* sp, *Ludwigia* spp, *Portulaca oleracea*,	03°30'+4.00''N 02°03'20.24''E
Saga	Vegetables : tomato, moringa, lettuce, pepper and cabbage : tree stratum : mango tree, *Acacia radiana, A. nilotica, A. senegal, Bauhinia rufescens, Piliostigma reticulatum,* Herbaceous stratum : *Cenchrus biflorus, Panicum* sp, *Cynodon dactylon,*	03°27'34.68''N 02°08'24.92''E
Saga gourou	vegetables : tomato, lettuce, moringa, okra Tree stratum : *Combretum glutinosum*, mango tree Herbaceous stratum : *Alisocarpus ovalicarpus, Sida sp, Corchorus tridens, Ancanthospermum hispidum*	03°+2'05.48''N ; 02°07'46.29''E
Tolkoboye	Vegetables : tomato, moringa, okra tree stratum : *Guiera senegalensis, Eucalyptus* sp, *Fedherbia albida,* Herbaceous stratum : *Alisocarpus ovalifolus, Cenchrus biflorus, Digitaria exilis, Eragrostis, tremula, Ludwigia* sp, *Panicum* sp, *Chorcorus tridens, C. olitorus*	04°03'07'27''N 02°07'27.56''E
Sarando	Vegetables : Tomato, onion, moringa, okra. Tree stratum : Mango tree, *Euclyptus sp, Bauhinia rufescens, Ziziphus mauritiana, Guiera senegalensis, Combretum aequilatum, Piliostigma reticulatum,* Herbaceous stratum : *Amaranthus spp, Cenchrus biflorus, Alisocarpus ovalicarpus, Ancanthospermum hispidum, Sida cordifolia, Sida* sp, *Chorcorus tridens, C. olitorus*	03°35'00.40''N 00'55'52.57''E
Sebou-Sebou	Vegetables : Tomato, maize, potato, cabbage, moringa Tree stratum: *Combretum micantum, C. glutinosum, Guiera senegalensis,* Mango tree, *Acacia senegal, Acacia* sp. Herbaceous stratum : *Acanthospermum hispidum, crotalaria sp, amaranthus spinosus, A. viridis, triantema prtulacastrum, Portulaca oleracea, Hyptis suaveolens,*	03°07'29.85''N 00°54'58.29''E
Agrhymet	Vegetables : Tomato, cabbage, okra, eggplant Tree stratum : *Ecalyptus, Ziziphus maritiana*, gojava, mango tree Herbaceous stratum : *Boerhavia diffusa, Corchorus tridens, C. olitorus, Sida* spp, *portulaca oleracea, Trianthema pourtulacastrum, Bidens spilosa, Ageratum conizoides*	03°29'58.48''N 02°06'05.70''E
Bourbour-Kabé	Vegetables : tomato, moringa, eggplant Tree stratum : *Prosopis juliflora, Acacia senegal,* Mango tree, *Eucalyptus* sp, Herbaceous stratum : *Amaranthus* spp, *Panicum* spp, *Cynodon dactylon, Digitaria exilis, Eragrostis tremula, Ageratum conizoides,*	03°38'32.07''N 02°09'02.34''E

- Sampling and extraction of nematodes

Soil and root samples were collected from the tomato farms in the rhizosphere of the 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 subsamples and was put in a plastic bag and brought to the Nematology Laboratory of the Regional Center of Agrhymet. Nematodes were extracted from soil and roots by the methods of Seinhorst (1950 and 1962). Soil nematodes were extracted from 250 cc of soil taken from each sample.

- Determination of the importance of parasitic nematodes and data analysis

After extraction of nematodes from the roots, the roots were dried and their dry weight was recorded. The importance of each nematode species or genus was determined from the Frequency/Abundance diagram of Fortuner and Merny (1973).

The Frequency (F) is the percentage of samples that contain the nematode of interest and is calculated by the following formula:

$$F = \frac{e}{n} \times 100$$

e: number of samples containing the given genus;
n: total number of samples

The Abundance (A) of a nematode genus is the average of the densities of the samples in which the genus was found. It is calculated using the following formula:

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

Xi = number of individuals of the given genus per dm^3 of soil or per gram of dry roots
e = number of samples in which the genus considered is present.
This parameter is then transformed into a decimal logarithm.

According to these authors, a species is considered as frequent when it is present in more than 30% of the samples; it is said to be abundant when it is present at more than 300 individuals per dm^3 of soil or 20 individuals/g of roots.

RESULTS

Parasitic nematodes found at the sites

Eleven genera of parasitic nematodes were found (Table II) among which only *Meloidogyne* was endoparasitic representing 9.09%. Seven of the 11 genera were found at all sites while the genera *Longidorus* and *Psylenchus* were found in 6 sites and *Paratrichdorus* in only 5 sites. The sites of Bourboukabé and Saga have all the genera of nematodes recorded while the other sites have between 10 and 9 genera.

Tableau II: Répartition des nématodes parasites par site

Echantillons	***Meloidogyne***	***Helico***	***Tylencho***	***Paratrichdorus***	***Criconemella***	***Scutellonema***	***Hoplo***	***Longidorus***	***Xiphinema***	***Psylenchus***	***Tylenchus***	**Total**
BBK	+	+	+	+	+	+	+	+	+	+	+	11
Saga	+	+	+	+	+	+	+	+	+	+	+	11
Sebou Sebou	+	+	+	+	+	+	+	+	+	0	+	10
Agrhy	+	+	+	+	+	+	+	0	+	+	+	10
Tolkboy	+	+	+	0	+	+	+	+	+	+	+	10
Saga Gorou	+	+	+	+	+	+	+	0	+	+	+	10
Goudel	+	+	+	0	+	+	+	+	+	+	+	10
Sarando	+	+	+	0	+	+	+	+	+	0	+	9
Total	8	8	8	5	8	8	8	6	0	6	8	

Table III shows that the nematodes recorded belong to 7 families. Hoplolaimidae and Longidoridae have two genera each, while all other families are represented by one genus.

Table III: Classification of parasitic nematodes

Familles	**Genera**	**Species**
Meloigynidae	*Meloidogyne*	*Meloidogyne* sp
Hoplolaimidae	*Helicotylenchus*	*H. dihystera*
	Scutellonema	*S. clatricaudatum*
	Hoplolaimus	*H. pararobustus*
Tylenchidae	*Tylenchus*	*Tylenchus* sp
	Psylenchus	*Psylenchus* sp
Belonolaimidae	*Tylenchorynchus*	*Tylenchorynchus* sp
Trichodoridae	*Paratrichodorus*	*P. minor*
Longidoridae	*Longidorus*	*Longidorus* sp
	Xiphinema	*X. americanum*
Criconematidae	*Criconemella*	*C. curvata*

Quantitative analysis

1. Agrhymet

On this site three (3) genera of nematodes are frequent and abundant ; thsese are *Meloidogyne*, *Helicotylenchus* and *Tylenchorhynchus*. The other five were frequent but no abundant. Their presence were not harmful to the plant. These are *Paratrichodorus*, *Xiphinema*, *Hoplolaimus*, *Criconemella*, *Tylenchus* (Figure 1). And other three (3) were neither frequent nor abundant: *Psylenchus, Scutellonema Longidorus*.

The root-not nematode *Melodogyne* had the highest relative density (19%) followed by *Tylenchus*, *Hoplolaimus*, *Tylenchorynchus*, *Pratylenchus*, *Helicotylenchus*, *Xiphinema* (11%), Criconnemella

(7%) and *Scutellonema* and *Psylenchus* (4%) and that of *Longidorus* was less than 1% (Figure 2).

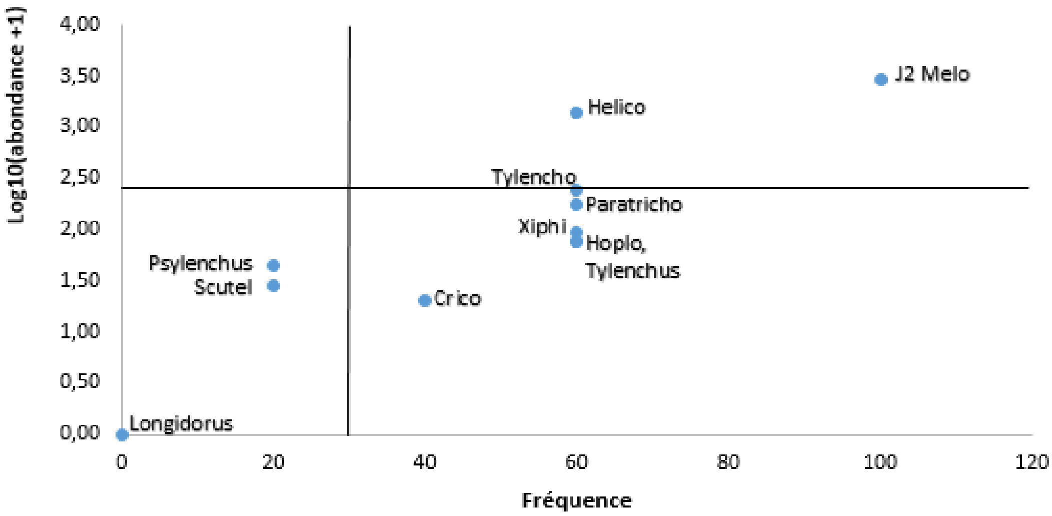

Figure 1: Importance of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*, J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

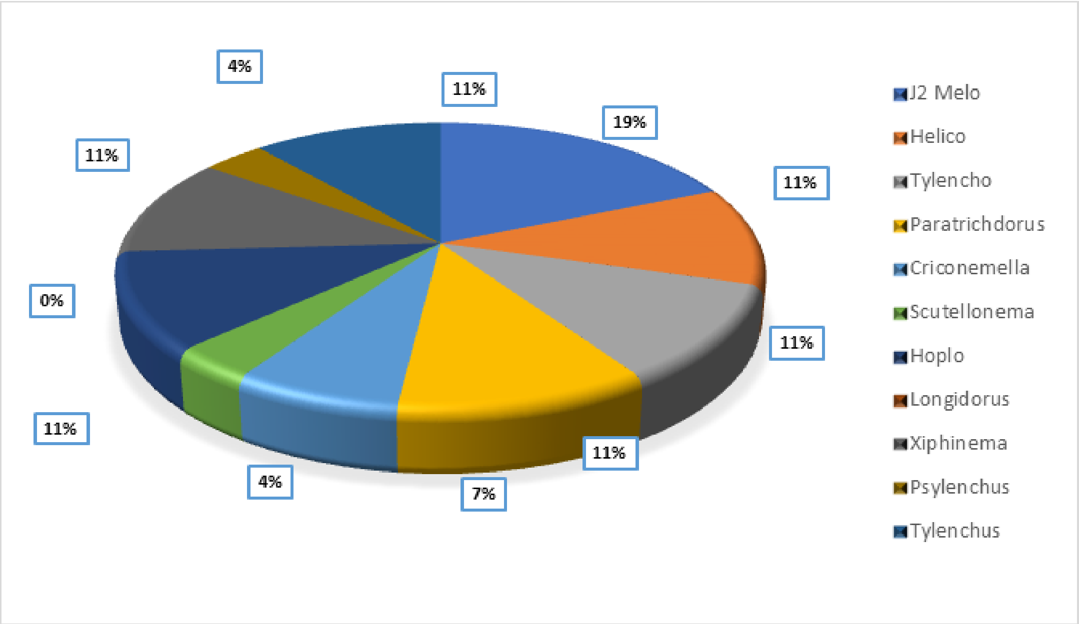

Figure 2: Community structure of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

2. Bourbourkabé

Four (4) genera are frequent and abundant. these are *Melodogyne*, *Pyslenchus*, *Tylenchotylenchus*, *Xiphinema*. Six others were frequent but abundant so their presence were not harmful to the plant: *Paratrichodorus*, *Scutellennema*, *Hoplolaimus*, *Tylenchus*, *Longidorus*, *Helicotylenchus* and *Criconnemella* were neither frequent nor abundant (Figure 3).

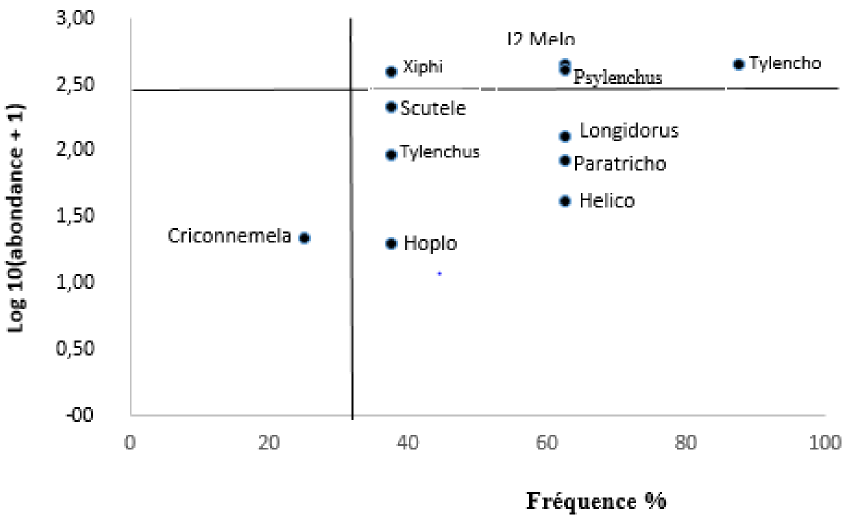

Figure 3: Importance of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

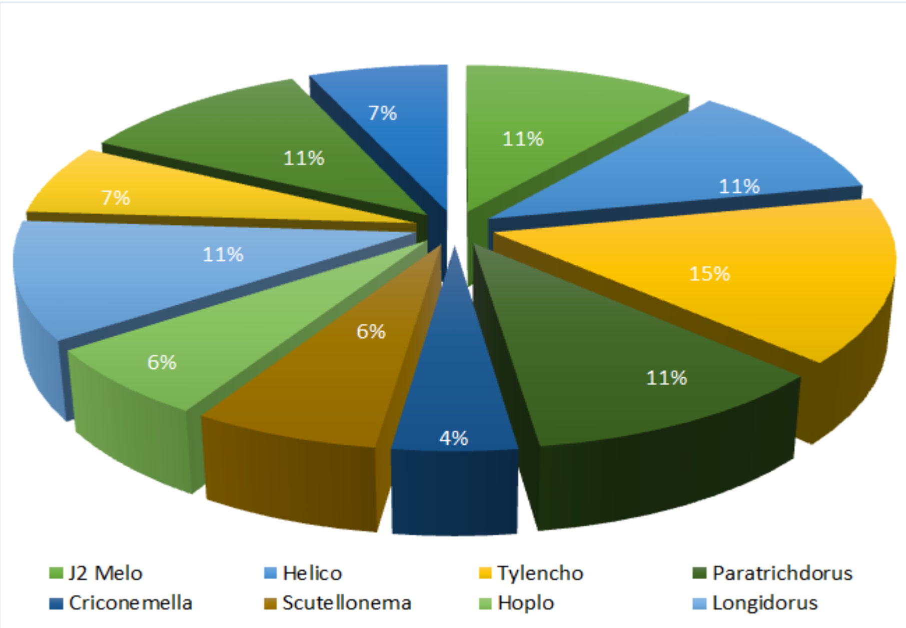

Figure 4: Community structure of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

3. Goudel

At this site no genus was both abundant and frequent, but 6 genera were frequent but not, 4 were neither abundant nor frequent (Figure 5).

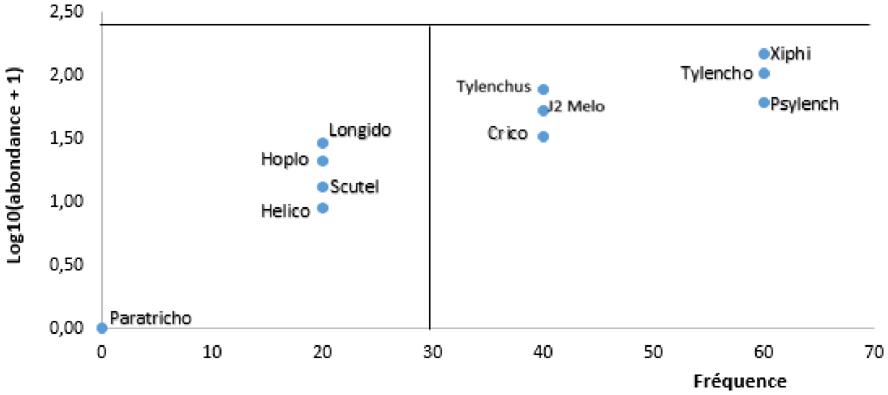

Figure 5: Importance of plant-parasitic nematodes at goudel
Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of Meloidogyne; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

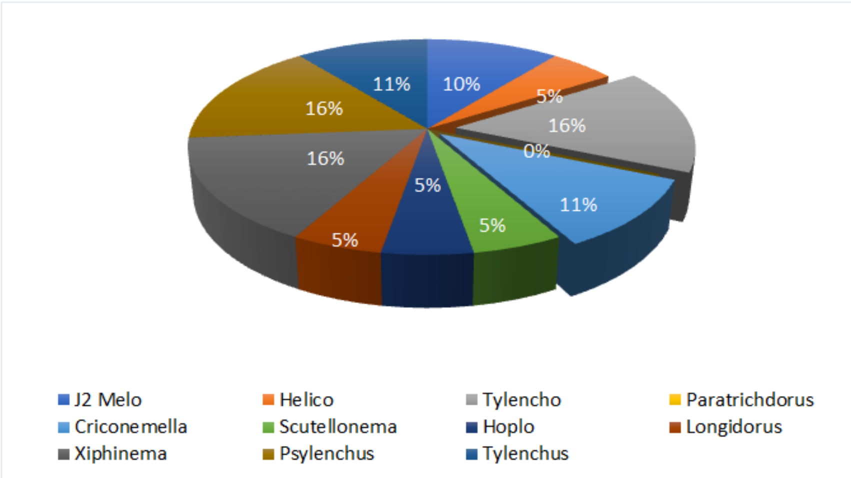

Figure 6: Community structure of plant-parasitic nematodes
Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of Meloidogyne; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

At this site *Helicotylenchus*, *Psylenchus* and *Xpihnema* had the highest relative frequency (16% each). *Meloidogyne*, *Tylenchus*, and *Criconemella* had relative frequencies of 11, 11, and 10% respectively (Figure 6).

4. Saga

In the soil at the Saga site, five (5) genera of plant-parasitic nematodes were frequent and abundant, two (2) were frequent but not abundant and two (2) were neither abundant nor frequent (Figure 7).

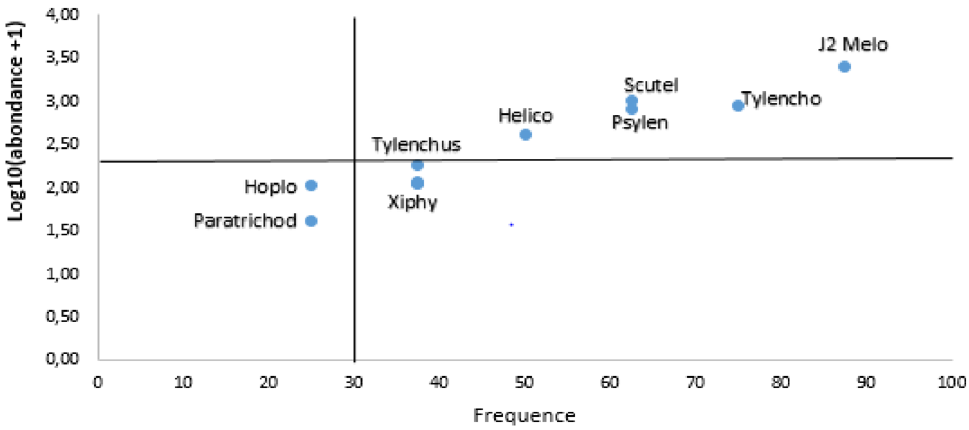

Figure 7: Importance of plant-parasitic nematodes at goudel
Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of Meloidogyne; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

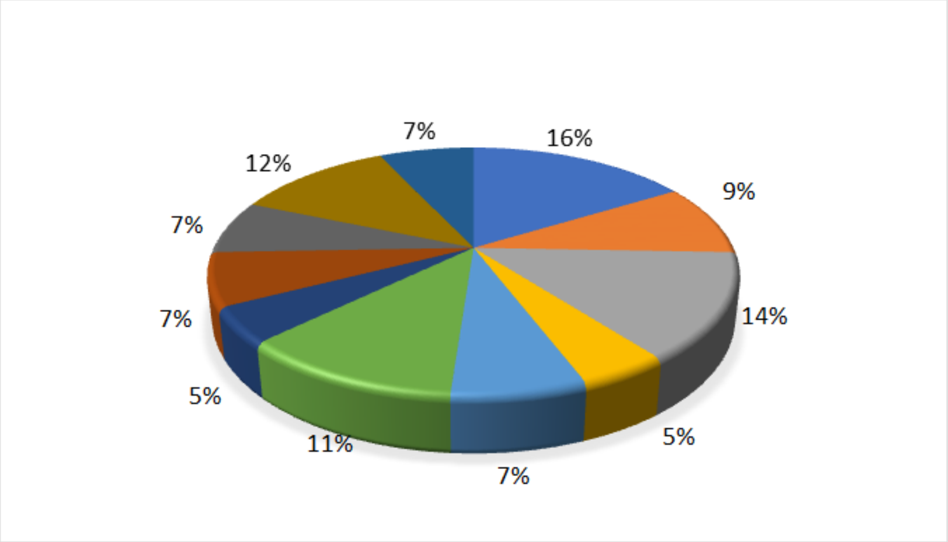

Figure 8: Community structure of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of Meloidogyne; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

Meloidogyne J2 have the highest relative density (16%) followed by *Tylenchorynchus* (14%), *Pratylenchus* (12%), *Scutellonema* (11%). The others all had a relative frequency of less than 10% (Figure 8).

5. Saga-Gorou

Figure 9 shows that 4 genera of plant-parasitic nematodes namely, *Criconemella*, *Meloidogyne*, *hemicotylenchus*, *Longidorus* and *Xiphinema* were both frequent and abundant while *Psylenchus* and *Tylenchus* were neither frequent nor abundant. The others were frequent but not abundant. These were *Tylenchorynchus*, *Scutellonema*, *Paratrichodorus* and *Hoplolaimus*.

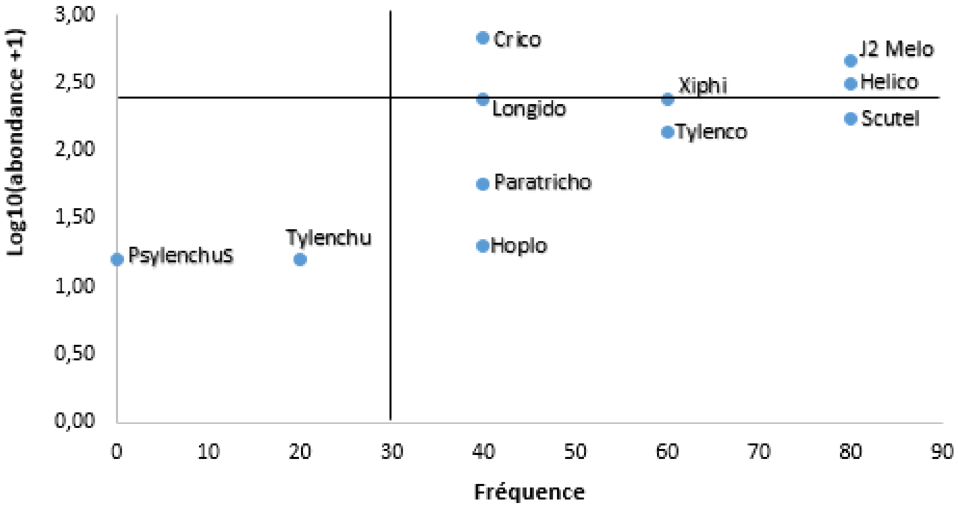

Figure 9: Importance of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

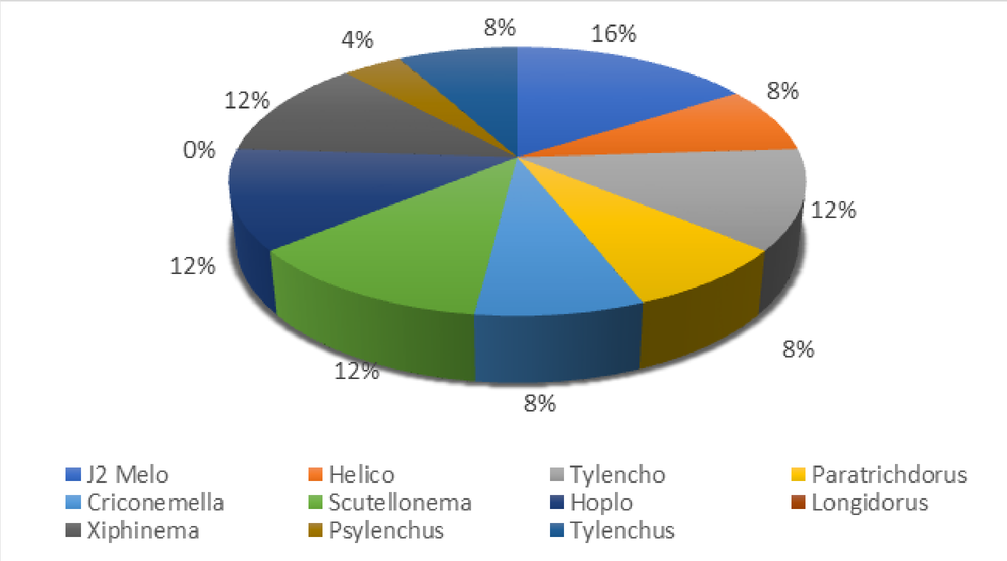

Figure 10: Community structure of plant-parasitic nematodes
Legend : Tylencho= *Tylenchorhynchus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

Root-knot nematodes of the genus *Meloidogyne* represent 16% of the total population of parasitic nematodes at the site. They were followed by *Xiphinema*, *Tylenchorynchus*, *Hoplolaimus* and *Scutellenema*, each of which with 12% of the total population (Figure 10).

6. Sarando

Of the eleven (11) genera identified, four (4) were frequent but not abundant, five were neither abundant nor frequent, and one was neither abundant nor frequent. In Sarando, six (6) of the 11 nematode genera ware abundant and frequent while three others were frequent and not abundant.

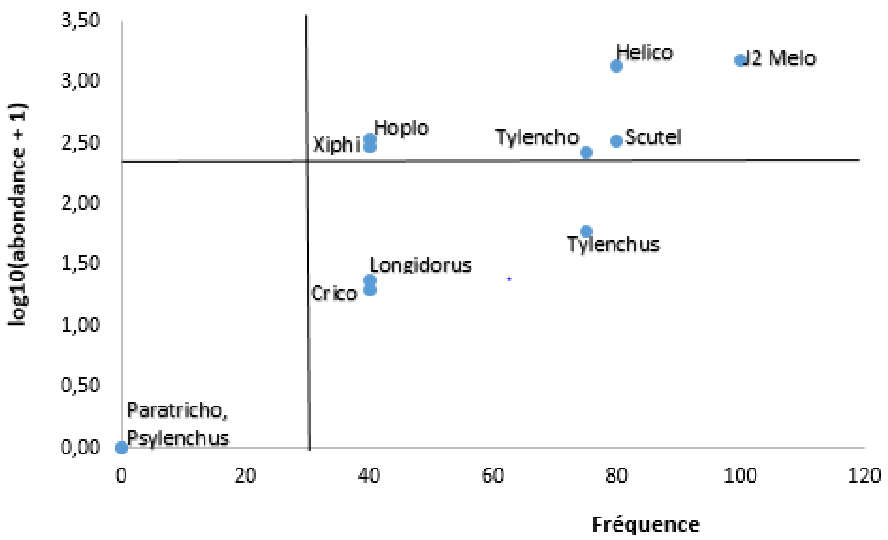

Figure 11: Importance of plant-parasitic nematodes
Legend : Tylencho= *Tylenchorhynchus* ; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

Figure 12 shows that the highest relative frequency was held by *Meloidogyne* (18%) followed by *Helicotylenchus* (14%).

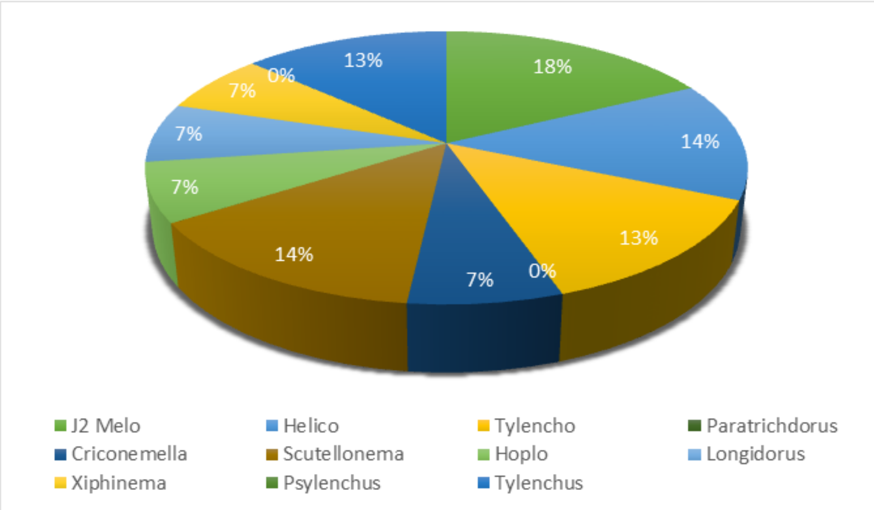

Figure 12: Community structure of plant-parasitic nematodes

7. Sebou-Sebou

In Sebou-Sebou, four (4) genera were found among the 11 were abundant and frequent while five (5) others were frequent but not abundant and two were neither abundant nor frequent.

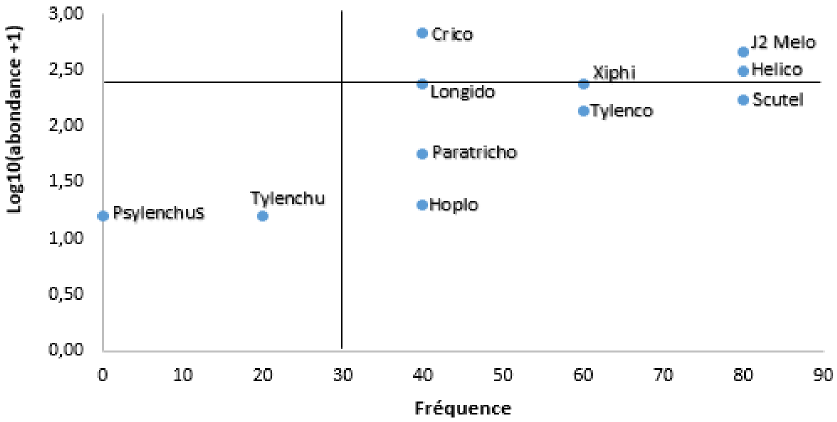

Figure 13: Importance of plant-parasitic nematodes

Legend : Tylencho= *Tylenchorhynchus* ; Longido=*Longidorus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

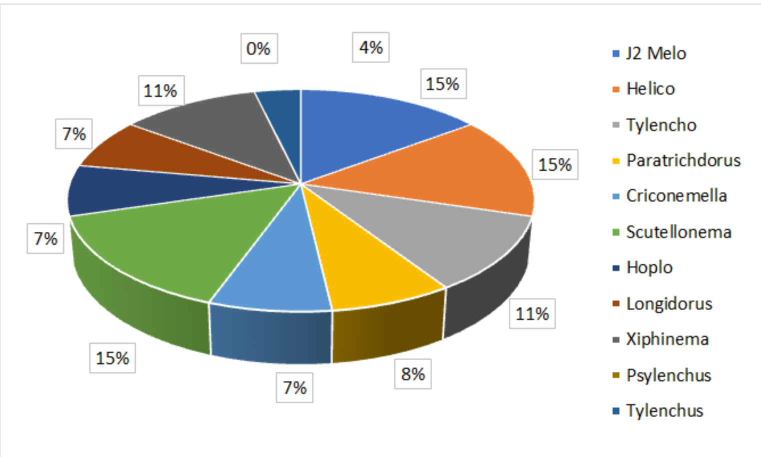

Figure 14: Community structure of plant-parasitic nematodes

Legend : Tylencho= *Tylenchorhynchus* ; Longido=*Longidorus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema* ; Paratricho= *Partridorus*

Figure 14 shows that *Meloidogyne*, *Helicotylenchus*, and *Scutellonema* each had a relative frequency of 15%. *Xiphinema* and *Tylenchorhynchus* each have 11%.

8. Tolkoboye

In Tolkoboye, five (5) of the 11 genera were abundant and frequent while three (3) were frequent and not abundant and one was neither abundant nor frequent (Figure 15).

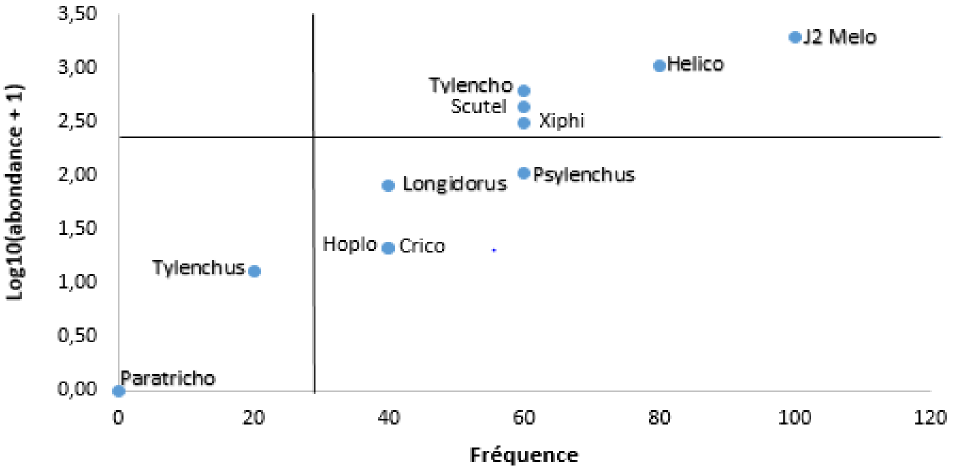

Figure 15: Importance of plant-parasitic nematodes

Legend: Tylencho= *Tylenchorhynchus*; Longido=*Longidorus*; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus*; Crico= *Criconemella*; Scuto=*Scutellonema*; Paratricho= *Partridorus*

Figure 16 shows that *Meloidogyne* had the highest relative frequency (18%), followed by *Helicotylenchus* (14%).

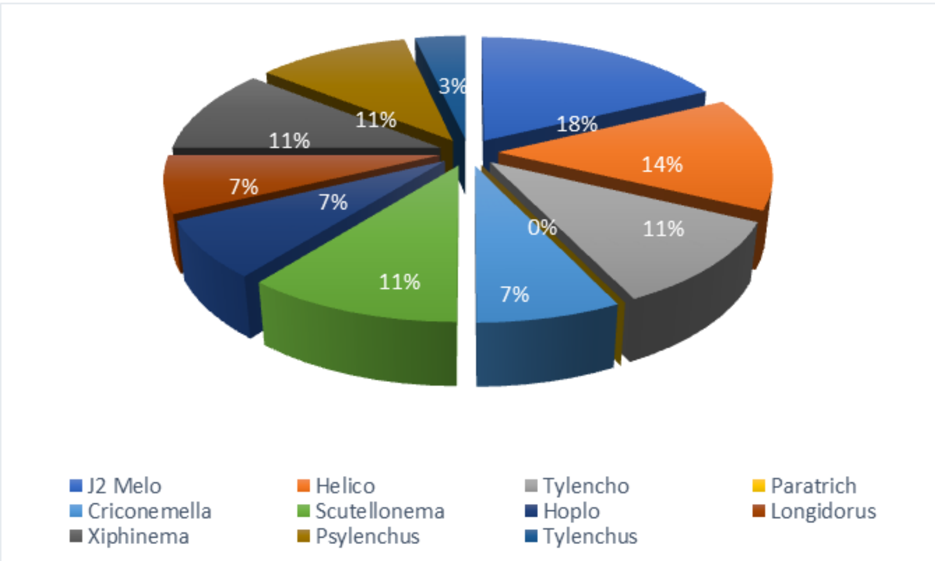

Figure 16: Community structure of plant-parasitic nematodes

Legend : Tylencho= *Tylenchorhynchus* ; Longido=*Longidorus* ; J2= second stage juveniles of *Meloidogyne*; Helico= *Helicotylenchus* ; Crico= *Criconemella* ; Scuto=*Scutellonema* ; Paratricho= *Partridorus*

Correlations between nematode genera and between sites and nematodes

Figure 17 shows that the two axes of the correlation circle describe more than 56% of the information and that nematodes such as *Meloidogyne*, *Helicotylenchus*, were carried by axis 1 and are positively correlated. *Tylenchus* and *Pslylenchus* were also strongly correlated but carried by axis 2. *Tylenchorunchus* wa carried by both axes and was positively correlated to *Tylenchus* and *Pslylenchus*.

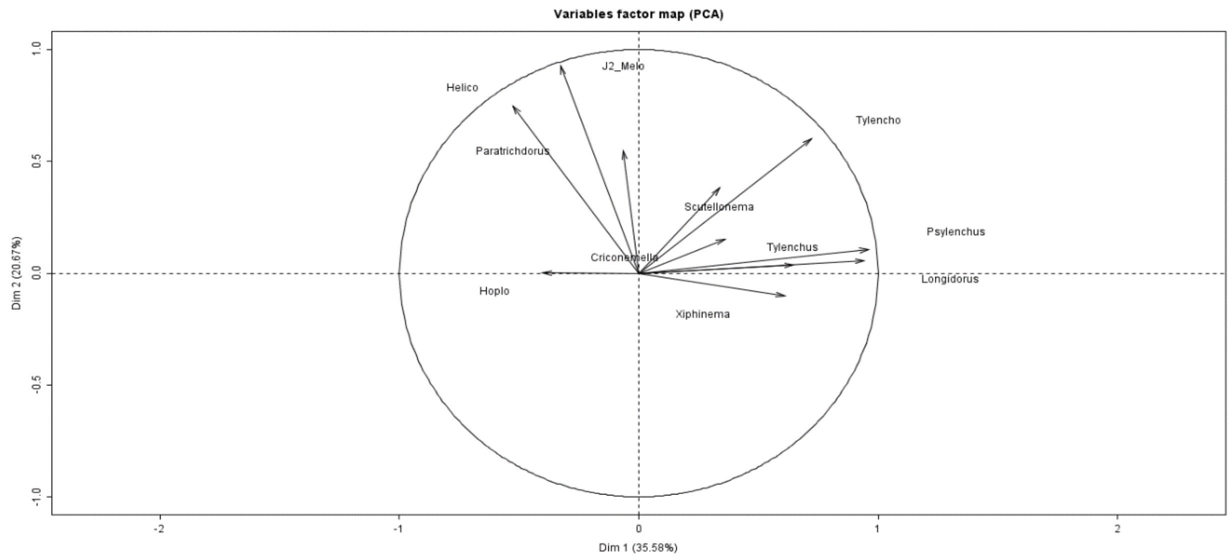

Figure 17: Correlation circle of the principal component analysis

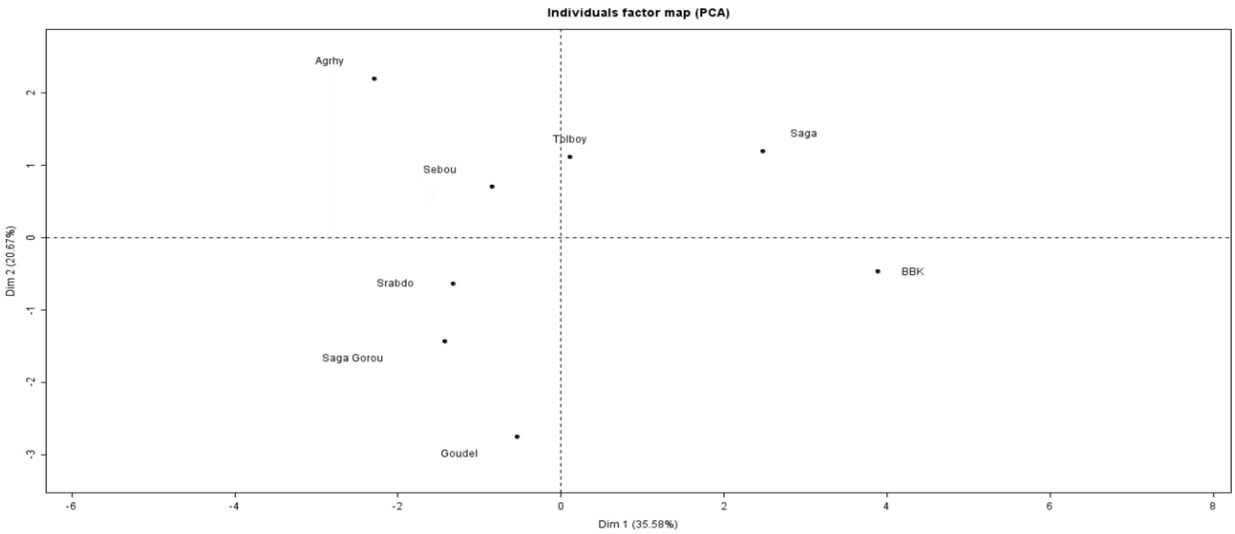

Figure 18: Correlation between sites and nematodes

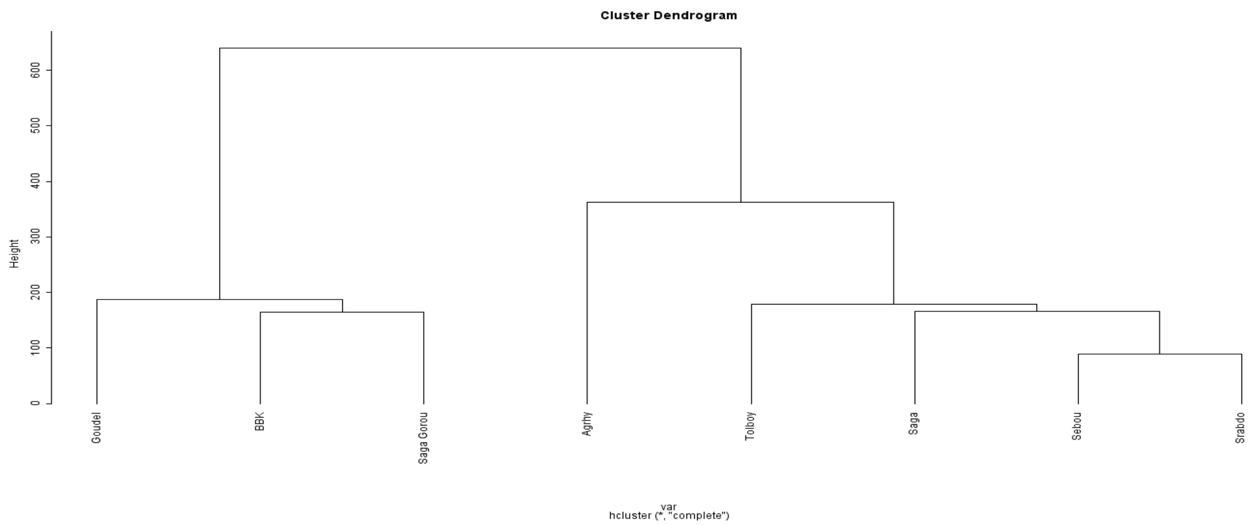

Figure 19: Dendrogram

Figure 18 shows that *Meloidogyne* were associated mostly with Agrhymet. *Tylenchorynchus* with the Saga site while *Psylenchus* and *Longidorus* were much more associated with Bourbourkabé.

The dendrogram shows two groups of similarity. Group 1 consists of Goudel, Bourbourkabé, Saga gorou and the second group of Agrhymet, Sebou-Sebou, Tolkboye, Sarando and Saga (Figure 19).

DISCUSSIONS

The faunistic study identified eleven (11) genera of nematodes on the 8 sampled sites. The biological diversity is comparable to the 13 genera of parasitic nematodes found respectively on vegetable crops in Niger by Haougui (1999) and Zakari (2008). It is higher than the 7 genera found on pepper in the Aguié region (central Niger) by Haougui *et al*., (2013a) and also in the Niamey area on tomato, pepper and eggplant (Haougui *et al*., 2013b).

Among the nematodes found, *Melodogyne* is endoparasitic and the other ten (10) are ectoparasites. This is different from the situation reeported by Haougui (1999) which found found *Meloidogyne* and another endoparasite (*Pratylenchus*) and a semi-endoparasite (*Rotylenchulus*) on several vegtable crops in the country. *Meloidogyne* was present in all sites. This prevalence of this nematode could be explained by an exchange of plant material from one site to another (Djibey, 2012). In the central region of Maradi, Haougui *et al*., (2013a) found that several pepper, farmers purchased plants produced in nurseries in Nigeria. However, these plants already bore galls induced by nematodes of the genus *Meloidogyne*. Given the importance of this nematode on tomato, any development program for this crop must take into account its nematological status to avoid significant yield losses (Haougui *et al.*, 2017).

Nematodes such as *Helicotylenchus dihystera* have very low parasitism on irrigated crops such as tomato. According to Villenave and Cadet (1998), it is an indicator species of fallow land maturity. It can therefore appear as a minor pest especially when it is in multi-specific populations (Rodriguez-Kabana (1987). *Scutellonema clathricaudatum*, the main species of the genus, is catalogued as a major parasite only on groundnut, on which it can cause crop failure under rainfed conditions (Baujard & Martiny, 1995; Sharma *et al*., 1992; Sharma *et al*., 1990). But if one day, these lands should be allocated to the production of this crop, special attention should be given to this species.

Also, this species diversity is reminiscent of that generally found in tropical areas where crop associations are common (Cadet, 1998). Indeed, in several plots tomatoes are associated with other crops such as lettuce, maize, cabbage, etc. Sometimes, we even observed farms where tomatoes were associated with moringa. Yet this crop is known to be a reservoir plant for root-knot nematodes (Haougui *et al*., 2017). This type of association should be avoided, as should certain other crops such as papaya. It is therefore advisable to also avoid certain species of windbreaks such as *Euphorbia balsamifera* and *Prosopis juliflora*, which are very often used on many sites and are very susceptible to root-knot nematodes and can therefore contaminate the crops associated with them (Cadet, 1998).

The presence of the *Xiphinema*, *Longidorus* may constitute another threat to tomato crops. These two genera can be capable of transmitting viruses with more devastating action to plants. *Psylenchus* was found in most of the sites, indicating the swampy nature of these sites.

This prospective study is important because it provides researchers, students and vegetable growers' organizations with the prevalence and importance of nematode parasites of tomato in this region of Niger.

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REFERENCES

- Baker, K. R. (1985). Sampling nematode communities. In: An advanced treatise on *Meloidogyne*, Vol. 2: Methodology: Baker, R. K. (eds)". North Carolina State University Graphics, Raleigh, USA, pp: 3-14.
- Baujard, P., Martiny, B. (1995). Ecology and pathogenicity of the Hoplolaimidae (Nemata) from the sahelian zone of WestAfrica. 3: *Scutellonema clathricaudatum* Whitehead, 1959. Fundamental and Applied Nematology, 18(4), 347-353.
- Cadet P. (1998). Gestion écologique des nématodes phytoparasites tropicaux. Cahiers d'Agricultures, 7 ! 187-1994. United States Agency for International Développent Régional Food Crop Protection Projet 625.0928
- Djibey H. R. (2012). Characterization of parasitic nematodes communities associated with pepper in Diffa and Dosso regions and reaction of two pepper ecotypes and *Pasteuria penetrans* to *Meloidogyne* sp in greenhouse". M. Sc. thesis, Agrymet Regional Centre, Niger.
- Fortuner, R. R., & Merny, G. (1973) Les nématodes parasites des racines associés au riz en Basse-Casamance (Sénégal) et en Gambie. Cah. O.R.S.T.O.M., ser. Biol. 21, pp.3-20.
- Jepson, S. B. (1987). Identification of Root-Knot Nematodes, CAB International, Angleterre, 265 P.

- Haougui, A. (1999). The nematode parasites of vegetable crops in Niger: importance and control methods using plants. PhD thesis, University of Dschang, Cameroon.
- Haougui, A., Basso, A., & Mossi, M. I. (2017). Plant-parasitic nematodes communities associated to Moringa (*Moringa oleifera* Lam., Moringaceae) western Niger. *Journal of Phytopathology and Pest Management*, 4(1), 28-37.
- Haougui, A., Nouri K., Basso, A., Doumma, A., & Adam, T. (2013a) Plant parasitic nematode communities associated with pepper in Aguie region (Niger republic). *Bot Res Int*, 6(1), 1-6.
- Haougui, A., Basso, A. Abdou, H. O., Sidikou, R. D. S., & Adam, T. (2013b). Characterization of plant-parasitic nematode communities associated with tomato, eggplant and pepper in the suburban area of Niamey (Niger). *Intl J Agri Crop Sci*, 5(20), 2488-2494.
- Haougui, A., Sarr, E., & Djibey, R. (2013c). Biodiversity of plant-parasitic nematodes associated with pepper in the regions of Diffa and Dosso (Niger republic). *Intl J Farm Al. Sci*, 2(15), 482-487.
- Haougui, A., Mamadou, A., Basso, A., Doumma, A., & Adam T. (2013d). On-Farm Testing of savanem 20 EC (Ethoprophos) for control of plant-parasitic nematodes associated with pepper (*Capsicum annuum*) in Tillaberi (Niger). *Asian J Agric Sci*, 5(4), 83-87.
- Haougui, A., Toufique, M., Facourou, S., Doumma, A., & Adam, T. (2013e). Effet de quatre types de fumiers d'animaux sur le développement de *Meloidogyne javanica* et la croissance du poivron (*Capsicum annum*) sou serre. *J Appl Biosc*, 67, 5228-5235.
- Haougui, A., Sarr, E., Balde, H., Doumma, A., & Adam, T. (2013f). Characterization of Plant-Parasitic-Nematode Communities Associated with three Species used in Hedges in Western Niger and their Susceptibility to *Meloidogyne Javanica*. *Asian J Agric Rural Devel*, 3(6), 378-386.
- Moussa, M. D. (2012). Prevalence and morphological characterization of plant-parasitic nematodes on cereals in South-West of Níger. M. Sc. Thesis, University of Gent, Belgium. 48 P.
- Nourh, Y. G. (2012). Prevalence and characterization of plant parasitic nematodes on eggplant, pepper, tomato and guava in the western part of Niger. M.Sc. thesis, University of Gent, Belgium.
- Rodriguez-Kabana R., & Morgan-Jones, G. (1987). Biological control of nematodes: Soil amendments and microbial antagonists. Soil and plant, 100, 237-247.
- Sasser J. N. (1979). Economic importance of Meloidogyne in Tropical countries. In: Lamberti, F., & Taylor, C. E (Eds). Root-Knot nematodes (*Meloidogyne* species): Systematics, Biology and Control. London, *Academic Press*, 359-374.
- Sharma, S. B., Subrahmanyam, P., & Sarr, E. (1990). Plant parasitic nematodes associated with grounudnut in Niger. *Tropical Pest Management*, 36, 71-72.
- Sharma, S. B., Waliyar, F., Subrahmanyam, P., & Ndunguru, B. J. (1992). Role of *Scutellonema clathricaudatum* in etiology of groundnut growth variability in Niger. *Plant and Soil*, 143, 133-139.
- Senhorst, J. W. (1950). De beteckenis van de toestand van de grond voor het optreden van aan stasing door het stengelaaltje *Ditylenchus dipsaci* (Kuhn Filipjev) tijidschr. Pl ziekt, 56, 291-349.
- Seinhorst, J. W. (1962). Modifications of the elutriation method for extracting nematodes from soil. Nematologica, 8, 117-128.
- Touka, A. A. (2016). Effect of temperature on the population dynamycs of *Meloidogyne* spp and Fusarium spp infesting sweet pepper in Niger. PhD thesis, University of University of Cape Coast (Ghana). 187 p.
- Villenave, C., & Cadet, P. (1998). Interaction of *Helicotylenchusdihystera*, *Pratylenchus pseudopratensis* and *Tylenchorhynchus gladiolatus*on two plants from the soudano-sahelian zone of West Africa. *Nematologica*, 28, 31-39.