



e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: [journals.aesacademy.org/index.php/aaes](http://journals.aesacademy.org/index.php/aaes)



ORIGINAL RESEARCH ARTICLE



## Studies on plant-parasitic nematodes associated with sweet potato (*Ipomoea batatas* L., Lam.) in Gombe State, Nigeria

Jidere Caleb Iliya<sup>1\*</sup> , Simon Lilian Dada<sup>2</sup>, Sulaiman Ibrahim<sup>1</sup> and Abraham Peter<sup>1</sup>

<sup>1</sup>Federal College of Horticulture Dadin Kowa Gombe, NIGERIA, <sup>2</sup>Federal University Gashua, Yobe State, NIGERIA

\*Corresponding author's E-mail: [calebjdr@gmail.com](mailto:calebjdr@gmail.com)

### ARTICLE HISTORY

Received: 30 September 2021  
Revised received: 22 November 2021  
Accepted: 15 December 2021

### Keywords

Plant-parasitic nematode  
Prevalence value  
Population density  
Survey  
Sweet potato

### ABSTRACT

Sweet potato (*Ipomoea batatas* L., Lam.) is one of the most frequently eaten food crops. Its production is affected by plant-parasitic nematodes as well as biotic factors. This study was conducted to document the different plant-parasitic nematodes (PPN) that limit the gainful production of sweet potato in Gombe State. Thirty soil core samples per hectare were collected at random from sweet potato farms in the three local government areas (Nafada, Kaltungo, and Yamaltu Deba) of Gombe state. The Whitehead and Hemming method and identification keys were used for the soil extraction and genera identification of the plant-parasitic nematodes respectively. A total of 15 plant-parasitic nematodes were recovered throughout the surveyed areas among which 7 are considered major nematode pests of global importance. Irrespective of the surveyed locations, *Meloidogyne* spp., was found to record the highest population density and prevalence value. The frequency of occurrence in Y/Deba and Nafada LGAs shows that *Meloidogyne* spp., was the most occurring (32 %) genera. In Kaltungo LGA however, *Scutellonema* spp., and *Rotylenchus* spp., were the most occurring (17 %) genera. There was a high similarity percentage ( $\geq 68$  %) of PPN genera where 8 genera (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Trichodorus* spp., and *Rotylenchus* spp.) were found to be common amongst the surveyed locations. This is the first report of plant-parasitic nematodes associated with sweet potato in Gombe state, Nigeria. Hence, it is critical to educate farmers in the regions about their effects on the crop and how to successfully manage them.

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**Citation of this article:** Iliya, J. C., Dada, S. L., Ibrahim, S., & Peter, A. (2021). Studies on plant-parasitic nematodes associated with sweet potato (*Ipomoea batatas* L., Lam.) in Gombe State, Nigeria. *Archives of Agriculture and Environmental Science*, 6(4), 477-482, <https://dx.doi.org/10.26832/24566632.2021.060409>

### INTRODUCTION

Sweet potato (*Ipomoea batatas* L., Lam.) is a dicotyledonous perennial cultivated in both the tropical and the warm temperate regions of the world grown as an annual crop (Patil, 2020; Bulus *et al.*, 2017). It ranks seventh in global food crop production and the third most important root crop after Irish potato and cassava (Loebenstein, 2015). Sweet potato is a versatile food that can be used as a source of energy, starch, protein, fat, and fibre. It is also used as a food additive (NAERLS *et al.*, 2007). It is a major cheap source of energy for more than 80% of Nigerians, especially in the northern part of the country, where

a large number of people live below the poverty line (Olabiyi *et al.*, 2016). Due to the decline in the country's economy, the production of sweet potatoes has increased significantly. In 2017, the total production of sweet potatoes in the country was approximately 4.1 million metric tons (FAOSTAT, 2018). Although sweet potato is nutritionally and economically important its gainful production has been hampered by the activities of plant-parasitic nematodes (Jibrin *et al.*, 2014). Several studies have reiterated the significance of plant-parasitic nematodes as economic pests of sweet potato (Ames *et al.*, 1997; Strange and Scott, 2005; Olabiyi, 2007; Chitwood, 2011; Olabiyi *et al.*, 2016). The top ten plant-parasitic

nematodes are *Meloidogyne* spp., *Heterodera* spp., *Globodera* spp., *Radopholus* spp., *Ditylenchus* spp., *Scutellonema* spp., *Rotylenchulus* spp., *Xiphinema* spp., *Nacobbus* spp., and *Aphelenchoides* spp., (Jones et al., 2013). Root-knot nematode (RKN, *Meloidogyne* spp.) is ranked as the most economically damaging nematode due to its ability to rapidly spread to and colonize new locations (Bebber et al., 2014; Abdulsalam et al., 2017) and wide host range (Jones et al., 2013). The first step towards successful and effective management of PPN in both fields and screen houses lies in their frequent surveillance to determine their occurrence, spread and pest population build-up (Abraham et al., 2018). Studies on the occurrence of PPN infecting sweet potato in some States (Osun, Kaduna, Oyo, Kwara, Abia, Kogi, Cross Rivers, Taraba, Benue, and Plateau) in Nigeria have been well reported (Olabiyi et al., 2016). However, an information gap exist about the PPNs causing sweet potato diseases in Gombe, which is one of the major sweet potato producing regions in the country. Potato farmers in the region are not aware of plant-parasitic nematodes as they are microscopic in nature and thrive within the soil rhizosphere. Therefore, disease symptoms expression on the plants due to attack by PPNs are often mistaken for nutritional deficiencies. Elucidating the status of PPNs infecting sweet potato in Gombe will avail vital information for the extension agents to orient farmers on these yield-reducing pests and their effective management. Hence, the current study was undertaken to determine plant-parasitic nematodes associated with sweet potato in three key producing locations in Gombe state.

## MATERIALS AND METHODS

### Survey site and soil sample collection

The survey was conducted in Yamaltu Deba located at (10°18'56"N 11°30'31"E), Kaltungo (9°49'31"N 11°24'42"E) and Nafada (11°07'3"N 11°22'02"E) LGA representing the senatorial district of Gombe State Nigeria. Soil samples were collected using an auger at a depth of 0-25cm and within 25cm around the rhizosphere of the sweet potato plants. A zigzag pattern of sampling technique was used to collect a total of 30 soil core samples per hectare from each surveyed sweet potato field. The soil samples were collected in sealed bags and labelled with the date, time and location. Samples collected were bulked together into a composite sample, carefully mixed and then passed through a mesh sieve to remove any debris or stones.

### Extraction and identification of phytoparasitic nematodes

The concept of the extraction tray was developed by Whitehead and Hemming (1965) to extract vermiform nematode samples from the soil. The procedure involved placing 200g of each composite sample into a modified Baermann tray. The samples were placed in an upper sieve that was modified to include a pair of plastic sieves. The samples were then gently poured into a bowl of water. The entire procedure was performed for 24 hours. Identification key for agricultural important plant-parasitic nematodes (Mekete et al., 2012) was used to identify the species

of nematodes.

## Data analysis

Norton (1989) equations nematode distribution and the population were used in the study.

Prominence values (PV) = Population Density × (Frequency of occurrence)  $\frac{1}{2} \times 10^{-1}$  were calculated for each nematode species (Fourie et al., 2000).

$$\text{Population Density} = \frac{\text{Number of nematodes in all samples}}{\text{Total number of samples collected}} \times 100$$

$$\text{Frequency of Occurrence} = \frac{\text{Number of samples containing nematodes}}{\text{Total number of samples collected}} \times 100$$

$$\text{Percentage Similarities} = \frac{KS}{a + b + c + \dots} \times 100$$

Where; K= Number of comparing locations; S = Number of nematode genera that the comparing locations have in common and a, b, c, = Number of nematode genera in each of the comparing locations.

## RESULTS AND DISCUSSION

To fill an important information gap on the occurrence and distribution of PPNs associated and significantly limiting the profitable yield of sweet potato in Gombe State (Yamaltu/Deba, Kaltungo and Nafada local government areas), the present study was initiated. The results showed that the highest number of 13 PPN genera (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Longidorus* spp., *Xiphinema* spp., *Trichodorus* spp., *Rotylenchus* spp., *Tylenchulus* spp., *Aphelenchoides* spp., *Helicotylenchus* spp., and *Ditylenchus* spp.) were identified in Y/Deba, followed by Kaltungo which had 12 PPN genera (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Tylenchus* spp., *Xiphinema* spp., *Trichodorus* spp., *Rotylenchus* spp., *Tylenchulus* spp., *Dispacis* spp., and *Ditylenchus* spp.) while the least number of 10 PPN genera were recovered in Nafada (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Trichodorus* spp., *Rotylenchus* spp., *Tylenchulus* spp., and *Helicotylenchus* spp.) as shown in Table 1. A total of 15 plant-parasitic nematode genera were recovered and identified to be associated with sweet potatoes in Gombe State. This result is in line with the findings of Karuri et al. (2017) and Olabiyi et al. (2016) who previously reported 7 and 13 genera of plant-parasitic nematodes associated with sweet potatoes in Kenya and some states in Nigeria respectively. However, the higher number of PPN genera documented from this present study might be due to some factors such as varietal difference, temperature, rainfall pattern, soil, location, cultural and management practices by the farmers. The result of the present study revealed that 7 (*Scutellonema* spp., *Nacobbus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Aphelenchoides* spp., and *Ditylenchus* spp.) out of the 15 recovered PPN genera have been

**Table 1.** Occurrence and geographical distribution of phyto-parasitic nematode genera in sweet potato farms at Yamaltu Deba, Kaltungo and Nafada Local Government Areas of Gombe State.

PPN Genera	Location		
	Y/Deba	Kaltungo	Nafada
<i>Scutellonema</i> spp.	+	+	+
<i>Nacobbus</i> spp.	+	+	+
<i>Pratylenchus</i> spp.	+	+	+
<i>Meloidogyne</i> spp.	+	+	+
<i>Heterodera</i> spp.	+	+	+
<i>Longidorus</i> spp.	+	-	-
<i>Tylenchus</i> spp.	+	+	-
<i>Xiphinema</i> spp.	+	+	+
<i>Trichodorus</i> spp.	+	+	+
<i>Rotylenchus</i> spp.	+	+	+
<i>Tylenchulus</i> spp.	-	+	+
<i>Dispaci</i> spp.	-	+	-
<i>Aphelenchoides</i> spp.	+	-	-
<i>Helicotylenchus</i> spp.	+	-	+
<i>Ditylenchus</i> spp.	+	+	-
Total	13	12	10

+ =Present - =Absent PPN= Plant parasitic nematode.

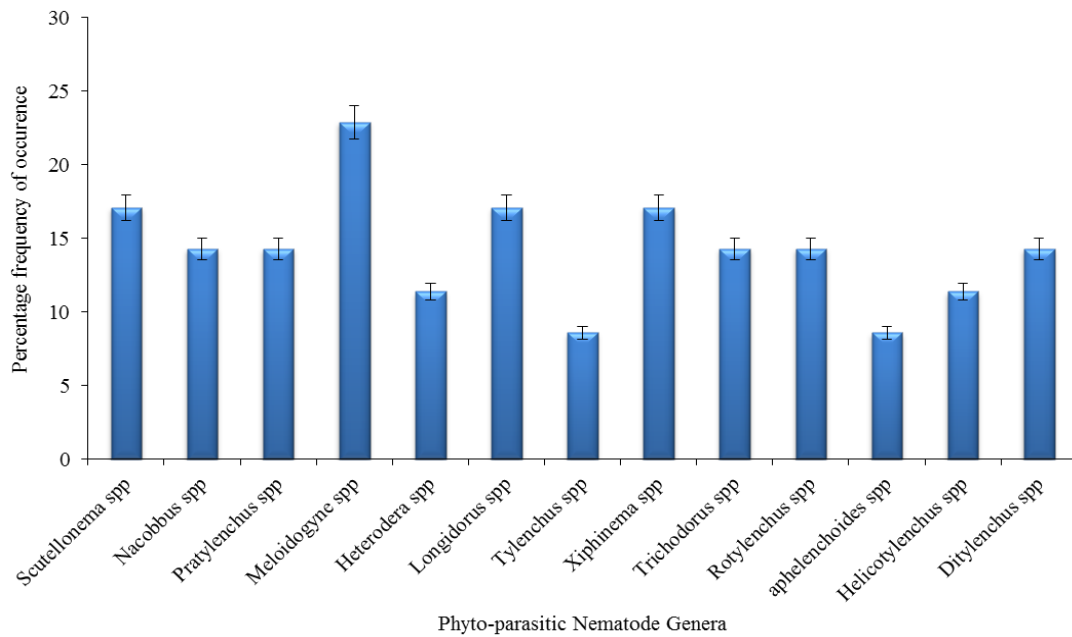
**Table 2.** Population density, and prevalence value of plant-parasitic nematode genera in the rhizosphere soil from sweet potato field of Yamaltu Deba, Kaltungo and Nafada Local Government Areas of Gombe State.

PPN Genera	Location					
	Y/Deba		Kaltungo		Nafada	
	PD	PV	PD	PV	PD	PV
<i>Scutellonema</i> spp.	31.4	1.30	40.0	1.66	34.3	1.53
<i>Nacobbus</i> spp.	17.1	0.64	11.4	0.33	20.0	0.83
<i>Pratylenchus</i> spp.	31.4	1.18	8.6	0.25	17.1	0.65
<i>Meloidogyne</i> spp.	128.6	6.14	40.0	1.51	37.1	1.66
<i>Heterodera</i> spp.	17.1	0.58	25.6	0.87	25.7	1.00
<i>Longidorus</i> spp.	20.0	0.82	0.0	0.00	0.0	0.00
<i>Tylenchus</i> spp.	11.4	0.33	11.4	0.33	0.0	0.00
<i>Xiphinema</i> spp.	31.4	1.30	11.4	0.39	17.1	0.58
<i>Trichodorus</i> spp.	25.7	1.00	8.6	0.20	28.6	1.18
<i>Rotylenchus</i> spp.	31.4	1.18	22.7	0.94	8.6	0.25
<i>Tylenchulus</i> spp.	0.0	0.00	17.1	0.58	14.3	0.48
<i>Dispaci</i> spp.	0.0	0.00	14.3	0.48	0.0	0.00
<i>Aphelenchoides</i> spp.	11.4	0.33	0.0	0.00	0.0	0.00
<i>Helicotylenchus</i> spp.	14.3	0.48	0.0	0.00	25.7	1.06
<i>Ditylenchus</i> spp.	22.8	0.88	8.6	0.20	0.0	0.00
Total	393.6	15.68	219.7	7.74	197.5	9.22

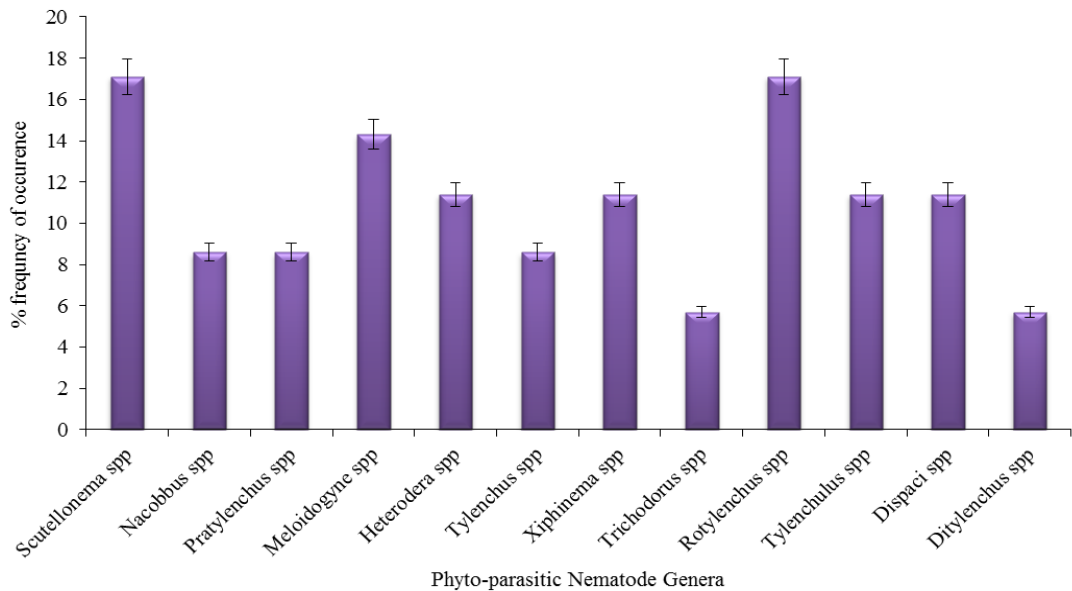
PD= Population density, PV=Prevalence Value, PPN= Plant-parasitic nematode.

enlisted among the top ten most important PPN pests of agricultural crops worldwide (Jones et al., 2013). Also, 8 PPN genera were identified to be common in all the surveyed locations (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Trichodorus* spp., and *Rotylenchus* spp.), of which some have been confirmed as nematode pests of sweet potatoes. The population density and prevalence value of plant-parasitic nematode genera in the rhizosphere soil from the sweet potato field are shown in Table 2. The result indicates that *Meloidogyne* spp., had the highest population density (128.6) and prevalence value (6) per 200g of soil while *Tylenchulus* spp., and *Dispaci* spp., recorded zero population and prevalence value respectively in Y/ Deba. Results from Kaltungo shows that *Scutellonema* spp., and *Meloidogyne* spp., had the highest population density (40) and prevalence value (2) per 200g of soil while *Longidorus* spp., *Aphelenchoides* spp., and

*Helicotylenchus* spp., did not record any population and prevalence value. In Nafada local government area *Meloidogyne* spp., recorded population density (37.1) and prevalence value (2) respectively per 200g of soil while *Longidorus* spp., *Tylenchus* spp., *Dispaci* spp., *Aphelenchoides* spp., and *Ditylenchus* spp., recorded zero population densities and prevalence value. Among the 15 encountered plants parasitic nematodes are those classified as the ten topmost important nematodes that are a threat to world agricultural production. These include *Meloidogyne*, *Pratylenchus*, *Heterodera*, *Ditylenchus*, *Globodera*, *Tylenchulus*, *Xiphinema*, *Radopholus*, *Rotylenchulus* and *Helicotylenchus* (Sasser and Freckman, 1987; Coyne et al., 2007; Nicol et al., 2011; Hodda et al., 2012; Olabiyi et al., 2016). *Meloidogyne* spp., *Ditylenchus destructor*, *Dipsaci* spp., *Rotylenchulus reniformis*, *Trichodorus* spp., *Nacobbus* spp., and *Pratylenchus* spp., have been confirmed as nematode pests of sweet potatoes (Olabiyi et al., 2016).



**Figure 1.** Frequency of occurrence of plant-parasitic nematodes associated with sweet potato in Yamaltu Deba Local Government Gombe State. Bars indicate standard error of means at 5% probability level.

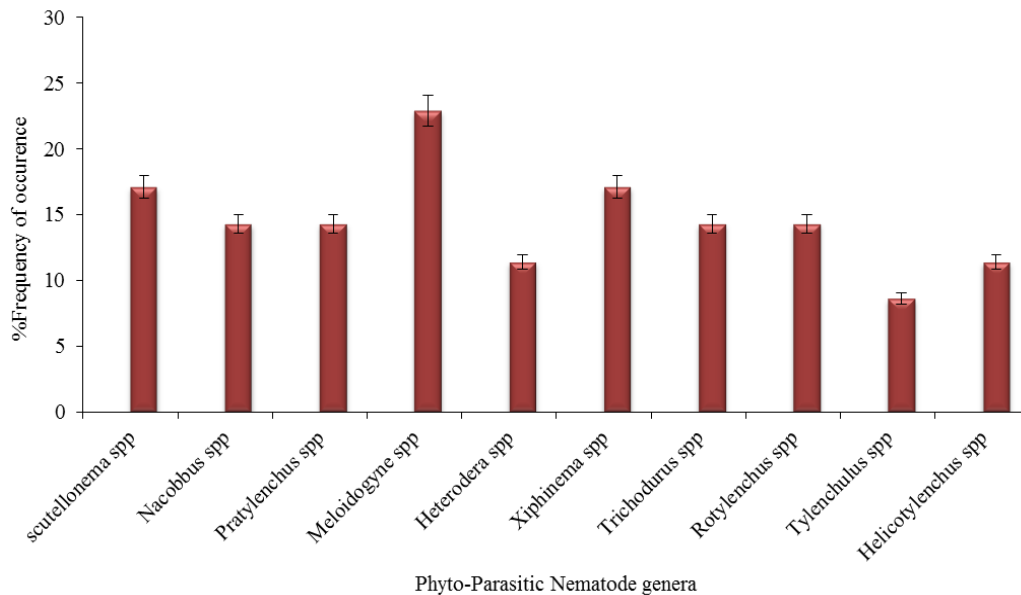


**Figure 2.** Frequency of occurrence of plant-parasitic nematode associated with sweet potato in Kaltungo Local Government Area Gombe State. Bars indicate standard error of means at 5% probability level.

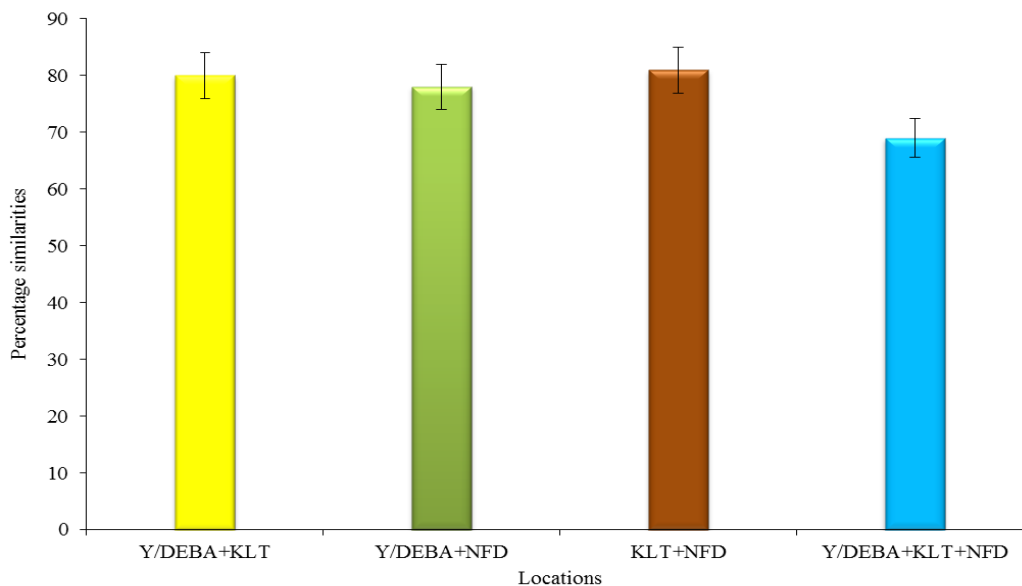
Irrespective of the surveyed locations, the study revealed that *Meloidogyne* spp., had the highest prevalence and population density. This could be attributed to the polyphagous nature and high variability (20) of *Meloidogyne* species in Africa, with *M. incognita*, *M. javanica*, and *M. arenaria* being the most common as observed by Onkendi et al. (2014).

The frequency of occurrences in Y/Deba LGA (Figure 1) and Nafada LGA (Figure 3) shows that *Meloidogyne* spp., was found to be the most occurring genus with 23%. In Kaltungo LGA however, *Scutellonema* spp., and *Rotylenchus* spp., were the genera that had the highest (17%) frequency of occurrence (Figure 2). This finding collaborates with the findings of Abraham et al. (2018) who reported that *Scutellonema*, *Xiphinema*, *Pratylenchus*, and *Meloidogyne* species were among the commonly observed genera in irrigated Fadama soils of Gombe state which are

under different crop cultivation. Figure 4 compares the similarities between and among the studied locations. Here, the results showed that there was a high similarities percentage ( $\geq 68\%$ ) of PPN genera irrespective of the studied locations with no significant ( $p \leq 0.05$ ) difference among any two comparing locations. However, there were significantly higher PPN similarities (%) between any two locations than similarities observed amongst the three locations. The exchange of potato vines as propagating materials which is a common practice among farmers across the state could be a factor for the high similarity index recorded among study locations. If necessary precautions for their control are not taken before the distribution/planting of the planting materials (vines or tubers) these nematodes are capable of causing significant economic loss on sweet potatoes (Olabiya et al., 2016).



**Figure 3.** Frequency of occurrence of plant-parasitic nematode associated with sweet potato in Nafada Local Government Area Gombe State. Bars indicate standard error of means at 5% probability level.



**Figure 4.** Percentage similarities of plant-parasitic nematode genera among associated with sweet potato field of Yamaltu Deba (YD), Kaltungo (KT), and Nafada (NF) Local Government Areas of Gombe State. Bars indicate standard error of means at 5% probability level.

## Conclusion

The present study revealed that a total of 15 plant-parasitic nematodes were found to be in association with sweet potatoes in Gombe, Nigeria, among which 7 are considered major nematode pests of global importance. Irrespective of the surveyed locations, *Meloidogyne* spp., was found to record the highest population density and prevalence value. *Scutellonema* spp., and *Rotylenchus* spp., were the most occurring PPN genera in Kaltungo while *Meloidogyne* spp., was the most occurring genus in Y/Deba and Nafada. There was a high similarity percentage ( $\geq 68\%$ ) of PPN genera where 8 genera (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Trichodorus* spp., and *Rotylenchus* spp.) were found to be common amongst the surveyed locations. The economic damage caused by these

nematodes cannot be overemphasized hence, the need to educate farmers of these hidden enemies and the dangers they posed toward the production of sweet potatoes in the surveyed areas.

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