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Survey on plant parasitic nematode associated with grapevine (*Vitis vinifera* L.) at federal college of horticulture Dadin-Kowa Gombe Nigeria

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Abstract
The grapevine (*Vitis vinifera* L.) from the Vitaceae family is one of the world's most important economic fruit crops. It is consumed fresh and processed into various products such as wine, juice, and raisins; 71% of global grape production is used for wine, 27% for fresh fruits, and 2% for raisins (dried fruit). Grapevines have numerous nutritional and economic benefits; however, their production faces numerous challenges, one of which is the pathogen plant parasitic nematodes, which cause significant losses. The goal of the study was to identify plant parasitic nematodes associated with five grapevine varieties at the Federal College of Horticulture in Dadin-Kowa Gombe State. A total of 150 soil samples were collected from five different varieties of grapevines (Bangalore blue, Muscadine, Pinotnoir, Pantara, and Jitawa) using soil augers at a depth of 0–25 cm. PPN were extracted using the whitehead and Hemming tray methods, and a pictorial key was used for PPN identification. A total of ten PPNs (*Meloidogyne* spp., *Paratylenchus* spp., *Xiphinema* spp., *Scutellenema* spp., *Longidorus* spp., *Heterodera* spp., *Aphelenchoides* spp., *Trichodorus* spp., *Hoplolaimus* spp., and *Rotylenchus* spp. *M. incognita* had the highest population density, frequency of occurrence (100%), and relative abundance (>20%) of the varieties studied. When compared to the other grapevine varieties sampled, the Shannon-H index revealed a high diversity of nematode species on Pinotnoir and Bangalore Blue. The evenness (eH/S) index indicated that there was no even distribution of PPN among the varieties studied, and Meloidogyne spp**.** were found to be dominant on some varieties. Similarly, species richness according to the Margalef index was very high among all five varieties.
This is the first report of plant parasitic nematodes associated with grapevine in Gombe State. As such, there is a need for policy makers, researchers, and extension workers to give more attention to this farmer's hidden enemy in terms of control strategies and raising awareness among the farmers on its effects and how to effectively manage them.

Keywords
survey, plant Parasitic nematodes, grapevine

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Introduction

The Vitaceae family's grape (*Vitis vinifera*) is one of the world's most important economic fruit crops ,it is consumed fresh and processed into various products such as wine, juice, and raisins. According to FAO (2020), 71% of global grape production is used for wine, 27% for fresh fruits, and 2% for raisins (dried fruit). Grape peel, on the other hand, contains essential oil and pectin. It can also be used as a raw material in the production of cattle feed and the manufacture of candies. Raisins are high in sugar, the majority of which is fructose, and antioxidants. Its juice is used to make cosmetics. The total global grape production was estimated to be 78.034 million metric tones (MT) as reported by FAOSTAT, (2020). The top five world grape producing countries include China leading with 14.8 million MT followed by Italy (8.2 million MT), Spain (6.8 million MT), France Mta (5.9 million MT) and the United States (5.4 million MT), accounting for approximately 51.42% of total global production (FAOSTAT, 2020). Grapes are grown in many African countries , with South Africa leading the continent and ranking 10th in the world with 2.0 million MT (FAOSTAT, 2020). Many developing nations are beginning to venture in to grape production because of its potential economic benefits and availability of improved grape varieties that can thrive in varying climatic conditions. In recent times, the cultivation of grape vines yards at commercial scale is being explored in different parts of Nigeria.

The nutritional and economic benefit of grapevine cannot be over emphasized however, its production is been faced with numerous challenges one of such is the pathogen plant parasitic nematodes, causing considerable reduction in the yield of many crops including vegetables (Nchore et al. 2010). According to Chitwood (2003), phyto parasitic nematodes cause annual crop losses worth USDI 25 billion worldwide. Nematodes can infect all crops (Gregory et al., 2017). When crops are planted in areas with high nematode populations, total crop failures can occur (Noling, 2012). Plant parasitic nematodes have often been found in soils where grapevines are cultivated which showed reduced vigor, and cause economic loss (Brown et al., 1993). The root knot nematodes alone cause about 20% of economic loss (Riga, 2008). This species *Meloidogyne* spp. are widely distributed throughout the tropical and subtropical regions. Symptoms associated with nematode damage lead to general reduction in vine vigor and fruit production. Khan and Chindo 1993, Brown et al., 1993 reported that one of the most serious disease problems affecting grapevine production is the grapevine fan leaf virus (GFLV) transmitted by the nematode (*Xiphinema* spp.,). Furthermore, several authors (Baklawa, 2004; El-Moflehi , 2009;Aballay*et al.,* 2009; Mohammad Deimi & Mitkowski, 2010) have earlier reported the root damaging effect on grapes due to infection by plant parasitic nematodes such as *Pratylenchus*, *Tylenchulus semipenetrans*, *Helicotylenchus*, *Meloidogyne, Xiphinema*, *Hoplolaimus, Tylenchorhynchus*, *Rotylenchulus* ,*Criconemella* and *Longidorus*.

The first step toward successful and effective PPN management in both fields and screen houses is regular surveillance to determine pest occurrence, spread, and pest population build-up (Abraham et al., 2018).

The status of PPNs infecting grapevine will provide vital information for extension agents to educate farmers about these yield reducing pests and effective manage-ment (Iliya *et al*., 2021). There exists a paucity of information on the status of the phyto parasitic nematodes associated with commercial grapevine of Federal College of horticulture Dadin-Kowa Gombe State. Findings from this study will give an insight on the plant parasitic nematode present which will help in feature management and decision making. Therefore, a study was initiated to survey the plant parasitic nematodes associated with grapevine yard of Federal College of Horticulture Dadin Kowa, Gombe Nigeria.

The study may have implications for grapevine farmers in Nigeria and other countries with similar climates and soil conditions. The research could lead to the development of new methods to protect grapevines from parasitic nematodes, which could increase crop yields and improve the profitability of grape farming

Materials and methods

Study area

The experiment was conducted at Federal college of horticulture Dadin-Kowa grapevine farm located along Gombe Biu Road. The area lies between the latitude 10^0-15^0N and longitude 11^0-15^0E of northern guinea savannah zone. The climate in this region considered of two districts season rainy season (May to October) and dry season (November to April) the mean annual rainfall is about 350mm per annum mostly temperature ranges from 30^0C to 32^0C. The soil type in Dadin Kowa is predominantly sandy-loam, with some patches

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of clayey soil. According to a study by Adeyemi et al. (2017), the soil in the area is generally low in organic matter content, nitrogen, and available phosphorus.

Figure 1. *Map of Gombe State Nigeria. Source Al-mujtaba et al., 2020*

Soil Sample collection

Soil samples were collected with a soil auger at depths ranging from 0 to 25cm and within 25cm of the grapevine's rhizosphere. The grapevine field yielded a total of 30 core soil samples per variety. The soil samples from each variety were bulked together to form a composite sample, which was carefully mixed and passed through a mesh sieve to remove any debris or stones. The soil samples were taken to the laboratory to be extracted of nematodes.

Extraction of Plant parasitic nematodes from soil

Modified Extraction Tray method developed by Whitehead and Hemming in (1965) was used to extract nematodes samples from soil. Two hundred grams of sample soil were evenly spread on a circle of double ply paper towel (serviette) supported on a coarse meshed plastic screen standing on plastic container, then water was added gently to the container until the soil became moist but not be completely immersed. After least 24hrs, soils were removed and discarded and the nematode suspension was poured into a sample bottles.

Identification and Counting of Plant parasitic nematode

Identification key for agricultural important plant-parasitic nematodes (Mekete *et al.*, 2012,Mai and Lyon 1975) was used to identify the plant parasitic nematodes which was done by drawing 2ml nematode suspension with a micropipette and placed into a counting dish. The counting was done under a compound microscope at 40x magnification and the numbers of the phyto parasitic nematodes identified were recorded. The Population density and Frequency of occurrence of the PPN genera were determined using the formulae of Norton, (1989) respectively below:

$$\text{Population density} = \frac{\text{Number of nematodes in all samples}}{\text{Total number of samples collected}} \times 100 \quad [1]$$

$$\text{Frequency of occurrence} = \frac{\text{Number of samples containing nematodes}}{\text{Total number of samples collected}} \times 100 \quad [2]$$

Results and Discussion

The study's findings, as shown in Table 1, revealed the presence of plant parasitic nematode genera in soil collected from a grape vine farm at the Federal College of Horticulture Dadin-kowa in Gombe State. The PPN species, *Meloidogyne* spp, *Paratylenchus* spp, *Xiphinema* spp, *Scutellenema* spp, *Longidoru s* spp, *Heterodera* spp, *Aphelenchoides* spp, *Trichodorus* spp, *Hoplolaimus* spp. and *Rotylenchus* spp. from five grapevine varieties (Bangalore blue, Muscadine, Pinotnoir, Pantara and Jitawa) were found all positive in all the soil samples collected.

Table (2) shows different population densities were observed among the plant parasitic nematode genera identified in soil samples collected from grapevine farm. The root-knot nematode Meloidogyne spp. recorded Population Density (PD) of 1160, 1160, 260, 530 and 550 among five different vine varieties respectively. While the second widely distributed genus is the dagger nematode, *Xiphinema* spp, *Scutellenema* spp, *Longidorus* spp. (needle nematode) and *Heterodera* spp., with PD of 790, 720, 630 and 560 among the five grapevine varieties. In the mean time the *Trichodorus* spp, *Aphelenchoides* spp, and *Rotylenchus* spp.were found with PD of 460, 420 and 390. In addition, the

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*Paratylenchus*spp. and *Hoplolaimus*spp. was found both with PD 330. And in Pantara variety *Xiphinema*spp., *Hoplolaimus*spp. and *Rotylenchus* spp. were less common found with PD of 90, 50 and 30 respectively.

Table 1. *Occurrence of phyto-parasitic nematodes genera in grapevine farm, Dadin-kowa, Gombe State*

PPN genus	Grapevine varieties				
	Bangalore blue	Muscadine	Pinotnoir	Pantara	Jitawa
Meloidogyne spp	+	+	+	+	+
Paratylenchus spp	+	+	+	+	+
Xiphinema spp	+	+	+	+	+
*Scutellenema*spp	+	+	+	+	+
Longidorus spp	+	+	+	+	+
Heterodera spp	+	+	+	+	+
Aphelenchoides spp	+	+	+	+	+
Trichodorus spp	+	+	+	+	+
Hoplolaimus spp	+	+	+	+	+
Rotylenchus spp	+	+	+	+	+

PPN- Phyto Parasitic Nematodes, + =Present, - =Absent

Table 2. *Phyto-parasitic nematodes population density (250 gr) of soil associated with grapevine in Dadin-kowa, Gombe State.*

PPN Genus	Grapevine varieties				
	Bangalore Blue	Muscadine	Pinotnoir	Pantara	Jitawa
Meloidogyne spp.	1160	1160	260	530	550
Paratylenchus spp.	330	250	140	270	200
Xiphinema spp.	790	250	100	90	230
Scutellenema spp.	720	110	160	260	120
Longidorus spp.	630	220	130	130	240
Heterodera spp.	560	200	100	80	130
Aphelenchoides spp.	420	90	110	70	130
Trichodorus spp.	460	90	110	90	50
Hoplolaimus spp.	330	70	120	50	90
Rotylenchus spp.	390	150	80	30	40

PPN- Phyto Parasitic Nematode

The results in Table 3 shows the Relative Abundance RA (%) of phyto parasitic nematodes associated with grapevine farm at Dadin-kowa, Gombe Nigeria.The root-knot nematode, *Meloidogyne* spp. was found to record the highest Relative Abundance (RA) of 20%, 20%, 20%, 33% and 31% per 250g soil in Bangalore blue, Muscadine, Pinotnoir, Pantara and Jitawa varieties respectively.

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Table 3. *Relative abundance (%) of phyto parasitic nematodes of grapevine in Dadin-kowa, Gombe State.*

PPN Genus	Grapevine varieties				
	Bangalore Blue	Muscadine	PinotNoir	Pantara	Jitawa
Meloidogyne spp	20	20	20	33	31
Paratylenchus spp	6	14	11	17	11
Xiphinema spp	14	14	8	6	13
Scutellenema spp	12	6	12	16	7
Longidorus spp	11	12	10	8	13
Heterodera spp	10	11	8	5	7
Aphelenchoides spp	7	5	8	4	7
Trichodorus spp	8	5	8	6	3
Hoplolaimus spp	6	4	9	3	5
Rotylenchus spp	7	8	6	2	2

PPN- Phyto Parasitic Nematodes

*Paratylenchus*spp. with 17% RA in Pantara, *Scutellenema*spp .with 16% RA in Pantara and *Xiphinema*spp with 14% RA in Bangalore blue and Muscadine varieties have became the second. The needle nematode, *Longidorus* spp. has 13% and 12% RA in Jitawa and Muscadine varieties and *Heterodera* spp has 11% and 10% RA in Mucadine and Bangalore Blue varieties which were the third most common genera. In the meantime, *Hoplolaimus* spp.,*Aphelenchoides* spp. and *Trichodorus* sppwere found to have 9% RA in Pinotnoir , 7% RA in Jitawa and 8% RA in Bangalore Blue. The reniform nematode, *Rotylenchulus spp* was having the lowest RA of 2%, 6% and 2% in Pantara, Pinotnoir and Jitawa varieties respectively.

In Figure 2, the root-knot nematode, *Meloidogyne* spp. was the most frequently occurring genus with 100% FO per 250 g soil. This is followed by the *Scutellenema* spp., and *Heterodera* spp. with FO of 90%,*Longidorus*spp. and *Xiphinema* spp. with 80% FO, *Rotylenchulus* spp and *Trichodorus* spp.with FO of 70% while *Aphelenchoides* spp has 60% FO. The *Paratylenchus* spp. and *Hoplolaimus* were less common genera associated with grape soil samples with FO of 50% respectively.

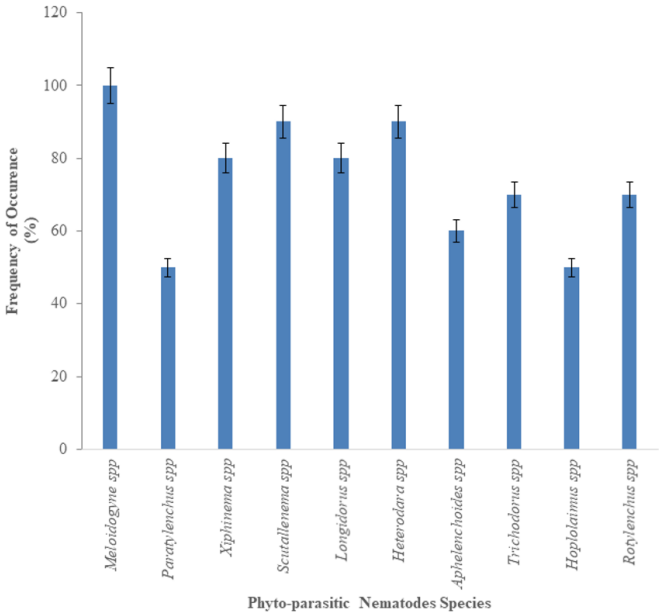

Figure 2. *Frequency of occurrence (%) of phyto parasitic nematodes associated with Bangalore Blue variety of grapevine in Dadin-kowa, Gombe Nigeria. Bars indicate the standard error of means at a 5% probability level.*

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Figure 3, shows the root-knot nematode, *Meloidogyne* spp., *Longidorus* spp. and *Heterodera* spp were found the most prevalent genus in Muscadine variety with 100% FO. Followed by *Paratylenchus* spp and *Xiphinema* spp. with FOof 80%. *Scutellenema* spp., *Aphelenchoides* spp. and *Rotylenchulus* spp were found the third most common genus with 70% FO, followed by the *Trichodorus* spp. and *Hoplolaimus* sppwith FO of 60% respectively.

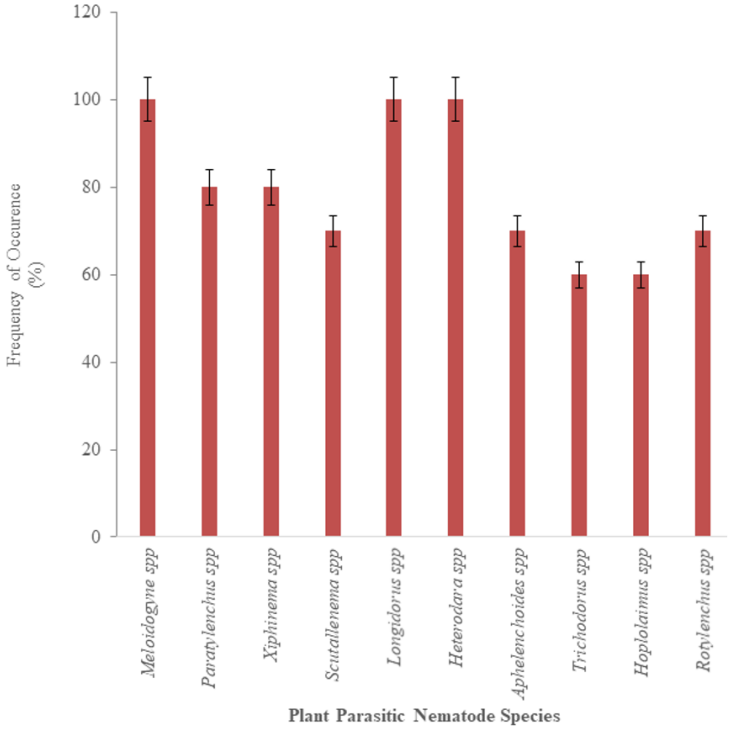

Figure 3. *Frequency of occurrence (%) of phyto parasitic nematodes associated with Muscadine variety of grapevine in Dadin-kowa, Gombe State. Bars indicate the standard error of means at a 5% probability level.*

Figure 4, show that *Paratylenchus* spp. was the most occurring genus in Fantara with 100% FO per 250g soil. Followed by *Longidorus* spp. and *Meloidogyne* spp. were the second most prevalent genera with FO of 90%, *Trichodorus* spp. and *Scutellenema* spp. were the third most common genus with 70% FO and followed by the *Xiphinema* spp with FO of 60% while *Aphelenchoides* spp has 50% FO. In the meantime, the *Heterodera* spp. spp were having 40% and *Rotylenchulus* spp with 30% FO.

Figure 5, shows the root-knot nematode, *Meloidogyne* spp. was the most frequently genus in Jitawa variety with 100% FO per 250g soil. The needle nematode, *Paratylenchus* spp. and *Xiphinema* spp. were the second genera with FO of 90%, and *Longidorus* spp. with 80% FO. *Heterodera* spp with FO of 70% while *Scutellenema* spp., *Aphelenchoides* spp and *Hoplolaimus* spp has 60% FO. However, the *Trichodorus* spp, and *Rotylenchulus* spp. has FO of 40% respectively.

Figure 6, shows *Meloidogyne* spp., *Paratylenchus* spp. and *Aphelenchoides* spp rank the most frequently occurring genus with 70% FO. *Xiphinema* spp., *Trichodorus* spp and *Hoplolaimus* spp are the second genera with FO of 60%, while *Longidorus* spp., *Heterodera* spp. and *Rotylenchulus* spp. has FO of 50%. *Scutallenema* spp. was the less occurring genus in pinotnoir variety with 40% FO respectively.

Phyto- parasitic nematodes have often been found in soils where grapevines are grown and showed reduced vigor, and cause economic loss. The root knot nematodes alone cause about 20% of economic loss (Riga, 2008). Plant parasitic nematodes are widely distributed throughout the tropical and subtropical regions. Symptoms associated with nematode damage lead to general reduction in vine vigor and fruit production. In addition, grapevine roots can be infected and damaged by root-lesion nematode, *Paratylenchus*, citrus *Tylenchulus semipenetrans*, *Helicotylenchus*, *Meloidogyne, Xiphinema*, *Hoplolaimus, Tylenchorhynchus*, *Rotylenchulus, Criconemella* and *Longidorus* (Baklawa 2004. El-Moflehi (2009), Aballay et al., (2009) and Mohammad Deimi & Mitkowski (2010). The results obtained from this studies revealed the presence of *Meloidogyne* spp. *Longidorus* spp,

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Hoplolaimus spp., *Paratylenchus* spp., *Heterodera* spp., *Scutallenema* spp., *Aphelenchoides* spp., *Trichodorus* spp., *Rotylenchus* spp., and *Xiphinema* spp associated with 5 varieties of grapevine this in line with the findings of El-Sherif (2002) Mohammed (2009) who reported the nematode genera *Aphelenchoides* spp, *Meloidogyne* spp, *Xiphinema*, *Helicotylenchus* ,*Paratylenchus, Meloidogyne and Longidorus to be associated with grapevine* in Yemen. Currently, one of the most serious disease problems affecting grapevine production is the Grapevine fan leaf virus (GFLV) transmitted by the dagger nematodes *Xiphinema* spp. (Brown et al., 1993). This is line with the finding of this work where by Xiphinema spp was reported from both five varieties of grapevine surveyed. Also a similar result was reported from 4 northern states on Nigeria viz., Kaduna, Bauchi, Plateau and Kano (Khan and Chindo 1993) which revealed the presence of 24 different genera of phyto parasitic nematode including *Meloidogyne* spp., *Xiphinema* spp. *and Rotylenchus reniforms* which are considered most prevalent genera and most important nematode pest of grapevine in northern Nigeria

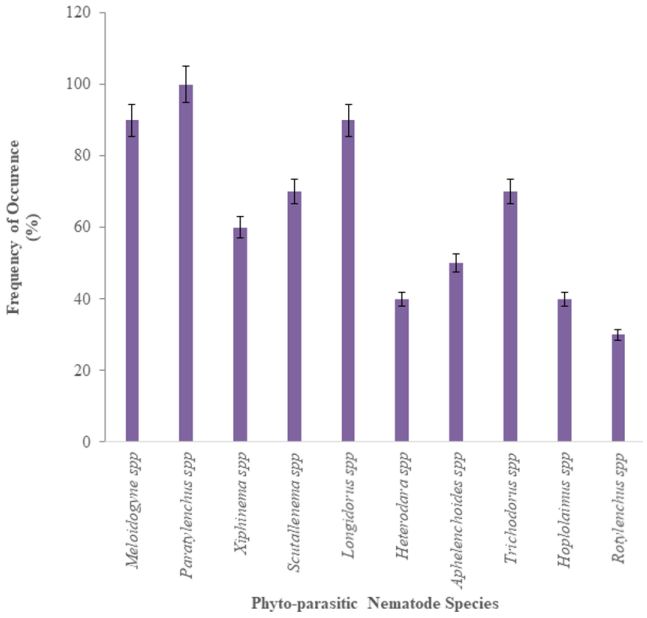

Figure 4. *Frequency of occurrence (%) of phyto parasitic nematodes associated with Pantara variety of grapevine in Dadin-kowa, Gombe Nigeriars indicate the standard error of means at a 5% probability level.*

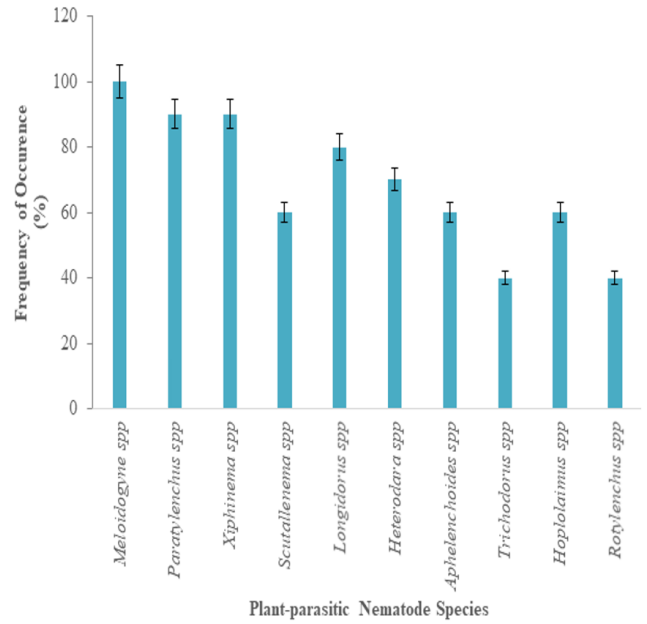

Figure 5. *Frequency of occurrence (%) of phyto parasitic nematodes associated with Jitawa variety of grapevine in Dadin-kowa, Gombe Nigeria.Bars indicate the standard error of means at a 5% probability level*

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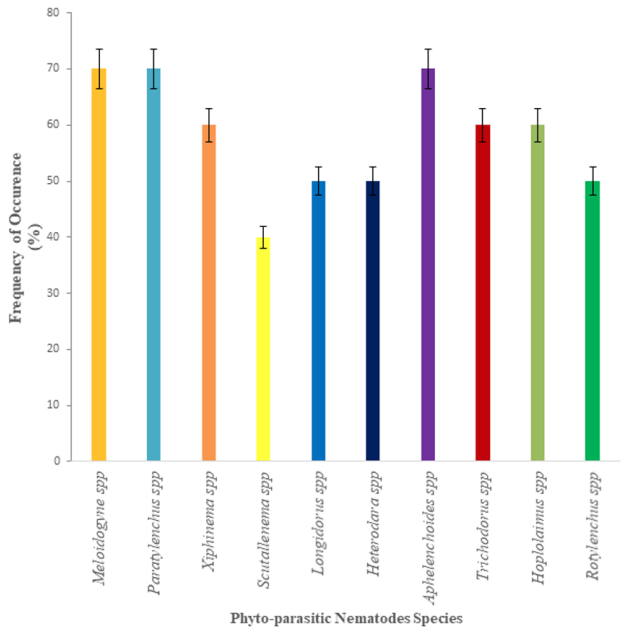

Figure 5. *Frequency of occurrence (%) of phyto-parasitic nematodes associated with Pinotnoir variety of grapevine in Da-din-kowa, Gombe Nigeria. Bars indicate the standard error of means at a 5% probability level.*

Conclusion

Findings from this study reveals the presence of 10 genera of phyto-parasitic nematodes(*Meloidogyne*spp., *Hoplolaimus*spp., *Scutellenema*spp., *Xiphinema*spp., *Paratylenchus*spp., *Rotylenchulus*spp., *Heterodera*spp., *Trichodorus*spp., *Aphelenchoides*sppand *Longidorus*spp) were found to be associatedwith grapevine in Gombe State Nigeria among which are considered major nematode pest of grapevine worldwide, which can caused serious economicdamage. Therefore, there is a need to initiated effective management measures against the PPN genera reported as they are a serious threat to the profitable production of grape vines in the study area.Identification of these PPN genera to species level and their molecular characterization for comparison with previously reported species elsewhere across the globe is recommended.

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