



RESEARCH ARTICLE

Occurrence, abundance and community diversity of plant-parasitic nematodes in vegetable production fields across selected local government areas of Gombe State, Nigeria

Iliya Caleb Jidere^{1*}, Gurama Abubakar Umar², Simon Lilian Dada³, Usman Gwarjo Magaji², and Abraham Peter¹

¹Department of Horticultural Technology, Federal College of Horticulture, Dadin-Kowa, Gombe, Nigeria.

²Department of Agronomy, Federal University of Kashere, Gombe, Nigeria.

³Department of Agronomy, Federal University Gashua, Yobe, Nigeria.

Edited by:

Dr E. E. Ernest, Joseph Sarwuan Tarka
University, Makurdi, Benue State, Nigeria.

Reviewed by:

Dr T. Sathyan, Institute of Agriculture
Research and Technology (IART),
Virudhunagar, TN, India; Dr G. Rajadurai,
Tamil Nadu Agricultural University,
Coimbatore, India.

Article history:

Received: July 22, 2026

Accepted: September 16, 2026

Published: September 30, 2026

Citation:

Jidere, I. C., Umar, G. A., Dada, S. L., Magaji, U. G., & Peter, A. (2026). Occurrence, abundance and community diversity of plant-parasitic nematodes in vegetable production fields across selected local government areas of Gombe State, Nigeria. *Journal of Current Opinion in Crop Science*, 7(3), 155-164. <https://doi.org/10.62773/jcocs.v7i3.412>

*Corresponding author e-mail address:
calebjdr@gmail.com (Iliya Caleb Jidere)

ABSTRACT

Plant-parasitic nematodes (PPNs) are among the major biological constraints limiting vegetable production worldwide because they

reduce plant growth, yield, and quality. Despite the economic importance of vegetable farming in Gombe State, Nigeria, information on the occurrence and diversity of PPNs remains limited. This study investigated the distribution, population density, relative abundance, frequency of occurrence, and diversity of plant-parasitic nematodes associated with cultivated vegetable fields across five major vegetable-producing Local Government Areas (Akko, Balanga, Dukku, Yamaltu Deba, and Kaltungo) in Gombe State. Soil samples were collected from farmers' fields and processed using the modified Whitehead and Hemming tray extraction technique. Recovered nematodes were identified to genus level using standard morphological keys. Thirteen genera of plant-parasitic nematodes were identified during the survey. *Meloidogyne* was the dominant genus, recording the greatest relative abundance (20.4%), highest population density (464.4 nematodes per 200 g of soil), and occurrence in all surveyed locations. Akko exhibited the greatest nematode diversity, whereas Dukku recorded the lowest diversity indices. Shannon diversity values ranged from 2.15 in Dukku to 2.62 in Akko. Chi-square analysis showed that most genera were uniformly distributed across the study area ($P > 0.05$), although *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Rotylenchulus*, and *Tylenchulus* varied significantly among locations ($P < 0.05$). The widespread occurrence of economically important genera, particularly *Meloidogyne*, indicates a considerable threat to vegetable production in Gombe State. The findings provide baseline information that will support the development of sustainable and integrated nematode management strategies aimed at improving vegetable productivity in northeastern Nigeria.

Keywords: Gombe State, plant-parasitic nematodes, vegetable production, diversity, *Meloidogyne*, prevalence.

INTRODUCTION

Vegetable production plays a vital role in global agriculture by contributing to food security, human nutrition, employment generation, and rural livelihoods. Vegetables are rich sources of vitamins, minerals, dietary fibre, and health-promoting phytochemicals, making them indispensable components of balanced diets. In Nigeria, vegetable cultivation is an important agricultural enterprise practiced under both rain-fed and irrigated conditions, providing income for thousands of smallholder farmers while contributing significantly to household nutrition and the national economy (FAOSTAT, 2022; FAOSTAT, 2024; Khyati & Kirti, 2022). Productive vegetable farming, however, is constrained by several biotic and abiotic factors that reduce crop performance. Among the biotic constraints, plant-parasitic nematodes are particularly important because they attack plant roots, interfere with water and nutrient uptake, and weaken plant growth. Infested plants commonly exhibit symptoms such as stunting, chlorosis, poor vigour, root deformation, and reduced yield. Consequently, plant-parasitic nematodes are recognized as one of the most economically damaging groups of pests affecting agricultural production worldwide (Sikora et al., 2018; Maleita et al., 2023).

Recent global assessments indicate that annual crop losses attributed to plant-parasitic nematodes amount to billions of dollars, making them a major challenge to sustainable crop production (Abd-Elgawad, 2024). Their destructive effects are especially pronounced in tropical and subtropical environments, where favourable temperatures, continuous cultivation, intensive irrigation, and the availability of susceptible host plants promote rapid multiplication and persistence of nematode populations (Sikora et al., 2018). Plant-parasitic nematodes damage crops through both direct and indirect mechanisms. Direct injury results from feeding on root tissues, leading to gall formation, lesions, necrosis, and deterioration of root function. Indirectly, nematode infection predisposes plants to invasion by fungal, bacterial, and viral pathogens, thereby increasing disease severity and reducing crop productivity beyond the effects of individual pathogens alone (Parrado & Quintanilla, 2024).

Among the numerous genera associated with vegetable crops, *Meloidogyne* species are regarded as the most destructive because of their extensive host range, rapid reproductive capacity, and worldwide distribution. Root-knot nematodes induce characteristic galls on roots, restricting water and nutrient absorption and ultimately causing substantial yield losses. Other economically important genera frequently associated with vegetable production include *Pratylenchus*, *Helicotylenchus*, *Scutellonema*, *Rotylenchulus*, *Longidorus*, *Heterodera*, and *Xiphinema* (Ahmed et al., 2020; Sandrine et al., 2023). Certain species of *Xiphinema* and *Longidorus* also serve as vectors of economically important plant viruses, further increasing their significance in crop production systems (Andret-Link et al., 2024; Abraham et al., 2024).

Several interacting factors, including soil characteristics, climatic conditions, cropping history, irrigation practices, host plant availability, and management practices, influence the abundance and distribution of plant-parasitic nematodes. Continuous cultivation of susceptible crops without adequate crop rotation often results in increased nematode populations and greater crop damage (Ogunsola et al., 2018; Sunita Devi et al., 2024). Therefore, periodic surveys are essential for monitoring nematode populations, identifying dominant genera, and providing the information necessary to develop effective management strategies.

Several investigations have documented the occurrence of plant-parasitic nematodes associated with vegetable production in different parts of Nigeria. Imam and Garba (2013) reported diverse nematode communities in irrigated farmlands in Kano State, while Bulus et al. (2017) described the distribution and population densities of economically important nematodes in irrigated vegetable fields in Kaduna State. Similarly, Aminu-Taiwo et al. (2016) identified eleven plant-parasitic nematode genera associated with cucumber cultivation in major production areas across Nigeria. Ahmed et al. (2020) also reported the occurrence of several economically important genera in agricultural soils of Kwara State. Collectively, these studies demonstrate the widespread occurrence and agricultural importance of plant-parasitic nematodes in Nigerian farming systems.

In Gombe State, available information on plant-parasitic nematodes remains relatively limited despite the rapid expansion of vegetable cultivation. Abraham et al. (2018) recorded twenty-four nematode genera from irrigated Fadama vegetable fields across selected Local Government Areas of the state, while Jidere et al. (2023) reported several plant-parasitic nematodes associated with grapevine production in the region. Although these investigations have provided valuable information, up-to-date data on the current occurrence, abundance, and diversity of nematodes associated with vegetable crops across the major production areas of Gombe State

remain scarce. Given the increasing importance of vegetable production in the state and the potential threat posed by plant-parasitic nematodes, comprehensive information on their distribution is required to support sustainable crop management. Accordingly, this study was conducted to determine the occurrence, frequency of occurrence, population density, relative abundance, and diversity of plant-parasitic nematodes associated with cultivated vegetable fields in selected Local Government Areas of Gombe State, Nigeria. The findings provide baseline information to assist researchers, extension personnel, and policymakers in developing integrated nematode management strategies to improve vegetable productivity and promote sustainable agricultural development in the region.

MATERIALS AND METHODS

Description of the study area

The survey was conducted during the 2024 cropping season in five major vegetable-producing Local Government Areas (LGAs) of Gombe State, north eastern Nigeria. The selected LGAs were Akko (10°33'N, 11°17'E), Balanga (10°11'N, 12°51'E), Dukku (10°49'25.64"N, 10°46'19.96"E), Yamaltu Deba (10°18'56"N, 11°30'31"E), and Kaltungo (9°49'31"N, 11°24'42"E). These locations were purposively selected because they are among the leading vegetable-producing areas in the state and support intensive cultivation under both rain-fed and irrigated conditions. Farmers' willingness to participate, accessibility of farms, and the intensity of vegetable production were also considered during site selection.

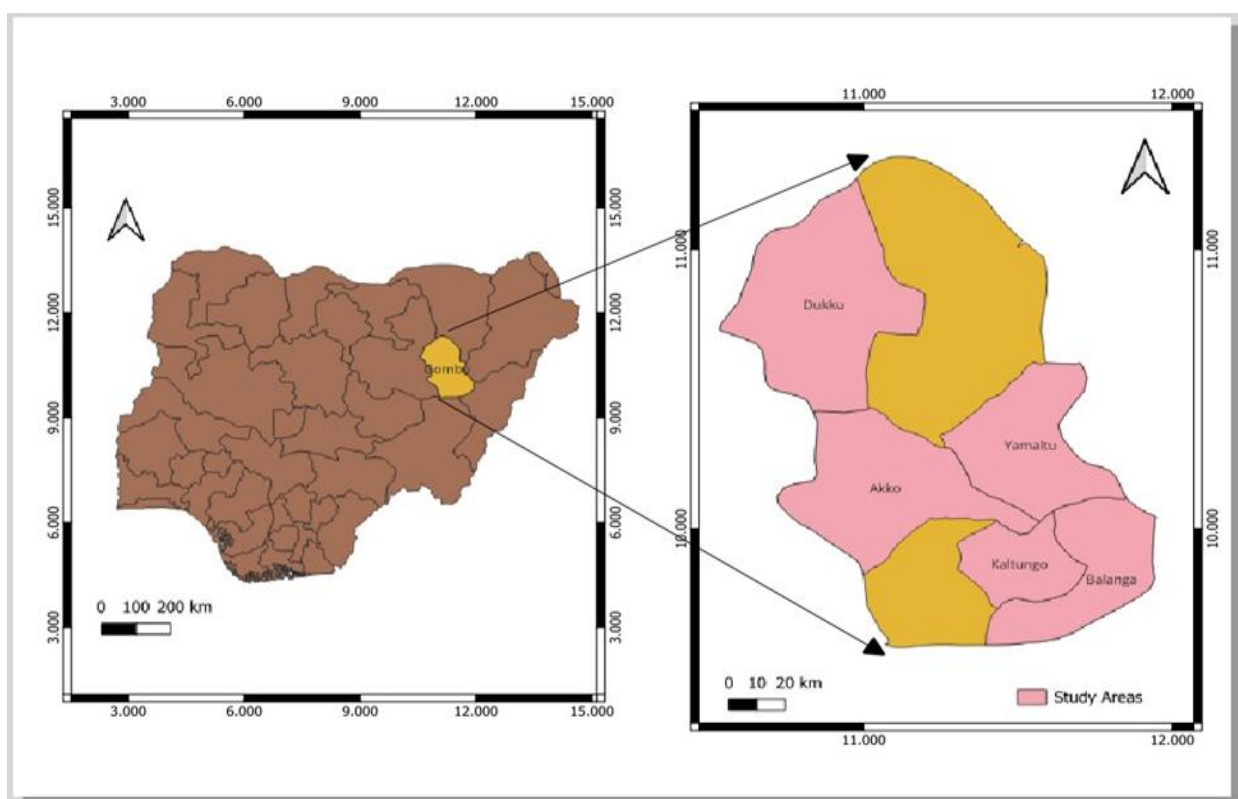


Figure 1. Map of Nigeria from left and Gombe State Showing the Local Government Council where the Survey was conducted.

Soil Sampling Procedure

Field sampling was carried out between July and September 2024. Soil samples were collected from vegetable fields planted with tomato (*Solanum lycopersicum* L.), pepper (*Capsicum* spp.), cucumber (*Cucumis sativus* L.), okra (*Abelmoschus esculentus* L.), eggplant (*Solanum melongena* L.), and amaranth (*Amaranthus* spp.). Since the objective of the study was to evaluate nematode distribution across locations rather than among crops, samples from all cultivated vegetables within each location were considered collectively. A hand-held soil auger measuring approximately 5–7 cm in diameter was used to collect soil from the rhizosphere at a depth of 0–30

cm and within approximately 25 cm of the plant base. A zigzag sampling pattern was adopted to obtain representative samples from each field. Thirty soil cores were collected per hectare and combined to produce one composite sample for each field. Composite samples from different farms within the same LGA were maintained separately, appropriately labelled, and transported to the Nematology Laboratory for extraction and identification.

Extraction and Identification of Plant-Parasitic Nematodes

Plant-parasitic nematodes were extracted from the soil samples described by Gough et al. (2021). Before extraction, each composite soil sample was thoroughly mixed to ensure uniformity. Approximately 200 g of soil was placed on a double layer of facial tissue, supported by two plastic sieves, inside a plastic tray containing distilled water. The water level was adjusted to maintain continuous contact between the tissue paper and the soil without submerging the soil.

The extraction units were left undisturbed under laboratory conditions (25–28°C) for 24–48 hours, allowing active nematodes to migrate through the tissue into the surrounding water. The nematode suspension was then collected and examined under a stereomicroscope to count. Identification to genus level was subsequently carried out with a compound light microscope at magnifications of 40× and 100×, following the diagnostic keys of Eisenback et al. (1981), with support from recent advances in nematode taxonomy and diagnostic approaches (Shao et al., 2023). Each sample was processed in triplicate to improve accuracy and reproducibility.

Determination of Population Density and Frequency of Occurrence

Population density (PD) and frequency of occurrence (FO) of plant-parasitic nematodes were determined using the following equations:

Relative abundance of each nematode genus was calculated by expressing the number of individuals of a particular genus as a percentage of the total nematodes recovered from all samples

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

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

Diversity Analysis

The diversity of plant-parasitic nematode communities was assessed using the Shannon–Wiener diversity index (H'), Margalef's species richness index (D), and Buzas and Gibson's evenness index (e^H/S). These indices were calculated using PAST version 3.14 (Hammer et al., 2001). Diversity values were used to compare nematode community structure among the five surveyed Local Government Areas.

Statistical Analysis

Descriptive statistics were used to summarize the occurrence, abundance, and population density of plant-parasitic nematodes across the study locations. Chi-square (χ^2) analysis was performed to determine whether the frequency of occurrence of each nematode genus differed significantly among the five Local Government Areas (R Core Team 2024). Statistical significance was determined at the 5% probability level ($P < 0.05$).

RESULTS

The geographical distribution of plant-parasitic nematode (PPN) genera recovered from vegetable fields across the five surveyed Local Government Areas (LGAs) is presented in Table 2. Thirteen genera were identified during the survey, namely *Xiphinema*, *Meloidogyne*, *Scutellonema*, *Pratylenchus*, *Tylenchulus*, *Rotylenchus*, *Rotylenchulus*, *Helicotylenchus*, *Paratylenchus*, *Trichodorus*, *Longidorus*, *Heterodera*, and *Hoplolaimus*. The composition of nematode communities varied among the surveyed locations. Akko recorded the highest richness, with all thirteen genera present, whereas Dukku had the lowest richness with only eight genera. Kaltungo and Yamaltu Deba each recorded eleven genera, while Balanga had ten. Several genera, including *Meloidogyne*, *Scutellonema*, *Pratylenchus*, *Rotylenchus*, *Longidorus*, *Trichodorus*, and *Xiphinema*, were present at most or all locations, indicating a broad geographical distribution. In contrast, *Heterodera*, *Hoplolaimus*,

Rotylenchulus, and *Tylenchulus* exhibited a more restricted occurrence, being absent from some LGAs (Table 1).

The relative abundance and population density of the recovered nematode genera are summarized in Table 2. Among all genera identified, *Meloidogyne* was the most dominant throughout the study area. It recorded the highest mean relative abundance (20.4%) and the greatest average population density (464.4 individuals per 200 g of soil). *Scutellonema* ranked second in abundance, with a mean relative abundance of 9.6% and an average population density of 231.2 individuals per 200 g of soil. Other frequently encountered genera included *Xiphinema*, *Pratylenchus*, *Longidorus*, and *Helicotylenchus*. However, their populations were considerably lower than those of *Meloidogyne*, while *Rotylenchulus*, *Heterodera*, *Hoplolaimus*, and *Tylenchulus* occurred at relatively low population densities and were absent from some sampling locations. Based on relative abundance (Table 3), *Meloidogyne* was classified as highly abundant (HA) in all five Local Government Areas. *Scutellonema* and *Xiphinema* were also highly abundant in selected locations, particularly Akko and Kaltungo. Most of the remaining genera were categorized as abundant (A) or moderately abundant (MA) depending on their population levels within individual LGAs.

Diversity parameters for individual nematode genera are presented in Table 4. *Meloidogyne* recorded the highest number of individuals (269), together with the greatest Shannon diversity value (1.62), highest Margalef richness index (0.95), and an evenness value of 0.99, indicating both numerical dominance and wide distribution across the surveyed locations. In contrast, *Tylenchulus* recorded the lowest abundance, with only 43 individuals, and consequently exhibited the lowest Shannon diversity (0.63) and Margalef richness (0.27). Although *Hoplolaimus* occurred infrequently, it showed complete evenness (1.00), reflecting a relatively uniform distribution wherever it was detected.

The diversity indices calculated for each surveyed LGA are shown in Table 5. Akko exhibited the highest overall nematode diversity, with a Shannon diversity index of 2.62 and an evenness value of 0.92. Yamaltu Deba also showed relatively high diversity (Shannon index = 2.56), followed by Kaltungo (2.48) and Balanga (2.44). Dukku recorded the lowest diversity (2.15), indicating a comparatively less diverse nematode community. Similarly, Akko maintained high species richness, whereas Dukku consistently recorded the lowest richness among all surveyed locations.

The frequency of occurrence of plant-parasitic nematode genera across the five LGAs and the corresponding Chi-square analysis are presented in Table 6. Chi-square analysis revealed no significant differences ($P > 0.05$) in the distribution of several genera, including *Meloidogyne*, *Xiphinema*, *Scutellonema*, *Pratylenchus*, *Longidorus*, *Paratylenchus*, *Rotylenchus*, and *Trichodorus*. Their widespread occurrence suggests that these genera are well established throughout the vegetable-growing areas of Gombe State. Conversely, significant differences ($P < 0.05$) were observed for *Helicotylenchus* ($\chi^2 = 10.86$), *Heterodera* ($\chi^2 = 15.74$), *Hoplolaimus* ($\chi^2 = 24.00$), *Rotylenchulus* ($\chi^2 = 14.98$), and *Tylenchulus* ($\chi^2 = 18.00$), indicating that the occurrence of these genera varied significantly among the surveyed Local Government Areas.

Table 1. Geographical distribution of plant parasitic nematodes associated with some vegetables in Gombe State during the 2023 rainy season.

Nematode Genera	Family	Local Government Areas				
		Akko	Balanga	Dukku	Y/Deba	Kaltungo
<i>Xiphinema</i>	Longidoridae	+	+	+	+	+
<i>Meloidogyne</i>	Meloidogynidae	+	+	+	+	+
<i>Scutellonema</i>	Hoploilaimidae	+	+	+	+	+
<i>Pratylenchus</i>	Pratylenchidae	+	+	+	+	+
<i>Tylenchulus</i>	Tylenchulidae	+	+	-	-	-
<i>Rotylenchus</i>	Hoplolaimidae	+	+	+	+	+
<i>Rotylenchulus</i>	Hoplolaimidae	+	-	-	+	+
<i>Helicotylenchus</i>	Hoplolaimidae	+	+	-	+	+
<i>Paratylenchus</i>	Tylenchulidae	+	+	+	+	+
<i>Trichodorus</i>	Trichodoridae	+	+	+	+	+
<i>Longidorus</i>	Longidoridae	+	+	+	+	+
<i>Heterodera</i>	Heteroderidae	+	-	-	+	+

<i>Hoplolaimus</i>	Hoplolaimidae	+	-	-	-	-
Total		13	10	8	11	11

Table 2. Relative abundance and population density of PPN genera associated with some vegetable fields in Gombe State.

PPN Genera	Akko		Balanga		Y/Deba		Kaltungo		Dukku		Mean	
	RA%	PD	RA%	PD	RA%	PD	RA%	PD	RA%	PD	RA%	PD
<i>Helicotylenchus</i>	5	180	9	170	8	180	6	138	-	-	7.0	167.0
<i>Heterodera</i>	5	193	-	-	6	147	4	92	-	-	5.0	144.0
<i>Hoplolaimus</i>	5	167	-	-	-	-	-	-	-	-	5.0	167.0
<i>Longidorus</i>	7	247	6	120	6	140	5	131	10	182	6.8	164.0
<i>Meloidogyne</i>	15	520	22	430	17	500	20	492	28	380	20.4	464.4
<i>Paratylenchus</i>	7	253	7	140	5	107	6	138	5	82	6.0	144.0
<i>Pratylenchus</i>	6	227	8	150	8	180	8	192	10	173	8.0	184.4
<i>Rotylenchulus</i>	3	120	-	-	4	93	5	115	-	-	4.0	109.3
<i>Rotylenchus</i>	3	113	7	130	9	200	4	92	6	100	5.8	127.0
<i>Scutellonema</i>	10	353	7	130	8	187	11	277	12	209	9.6	231.2
<i>Trichodorus</i>	4	140	7	130	7	153	5	115	8	145	6.2	136.6
<i>Tylenchulus</i>	5	193	7	140	-	-	-	-	-	-	6.0	166.5
<i>Xiphinema</i>	10	360	6	120	8	173	11	277	9	164	8.8	218.8

Note, PD=Population density/200g soil, RA= Relative abundance (%)

Table 3. Status of plant-parasitic nematode species based on relative abundance in Gombe State

PPN Genera	Akko	Balanga	Dukku	Kaltungo	Y/Deba
<i>Helicotylenchus</i>	A	A	-	A	A
<i>Heterodera</i>	A	-	-	MA	A
<i>Hoplolaimus</i>	A	-	-	-	-
<i>Longidorus</i>	A	A	HA	A	A
<i>Meloidogyne</i>	HA	HA	HA	HA	HA
<i>Paratylenchus</i>	A	A	A	A	A
<i>Pratylenchus</i>	A	A	HA	A	A
<i>Rotylenchulus</i>	MA	-	-	A	MA
<i>Rotylenchus</i>	MA	A	A	A	A
<i>Scutellonema</i>	HA	A	HA	HA	A
<i>Trichodorus</i>	MA	A	A	A	A
<i>Tylenchulus</i>	A	A	-	-	-
<i>Xiphinema</i>	HA	A	A	HA	-

+ = present - = absent, HA = highly abundant, MA = moderately abundant. A = abundant

Table 4. Diversity of plant parasitic nematodes genera

PPN Genera	NOS	Shannon_H	Evenness_e^H/S	Margalef
<i>Helicotylenchus</i>	89	1.36	0.93	0.67
<i>Heterodera</i>	63	1.04	0.94	0.48
<i>Hoplolaimus</i>	48	0.69	1.00	0.26
<i>Longidorus</i>	106	1.54	0.93	0.86
<i>Meloidogyne</i>	269	1.62	0.99	0.95

<i>Paratylenchus</i>	95	1.49	0.88	0.88
<i>Pratylenchus</i>	120	1.57	0.96	0.84
<i>Rotylenchulus</i>	63	1.05	0.96	0.48
<i>Rotylenchus</i>	67	1.50	0.94	0.87
<i>Scutellonema</i>	153	1.51	0.91	0.80
<i>Trichodorus</i>	88	1.59	0.98	0.89
<i>Tylenchulus</i>	43	0.63	0.94	0.27
<i>Xiphinema</i>	174	1.43	0.84	0.78

Table 5. Diversity of plant parasitic nematodes across the LGAs surveyed

Particulars	Akko	Balanga	Y/Deba	Kaltungo	Dukku
Sample Size	15	13	14	14	10
Individuals	527	193	340	314	200
Shannon_H	2.62	2.44	2.56	2.48	2.15
Evenness_e^H/S	0.92	0.88	0.92	0.85	0.86
Margalef	2.23	2.28	2.23	2.26	1.70

Table 6. Frequency of occurrence and chi-square analysis of plant-parasitic nematodes across LGAs in Gombe State

Genus	Akko	Balanga	Dukku	Kaltungo	Y/Deba	χ^2	DF	p-value
<i>Helicotylenchus</i>	10	7	0	7	11	10.86	4	0.028*
<i>Heterodera</i>	10	0	0	8	11	15.74	4	0.003*
<i>Hoplolaimus</i>	6	0	0	0	0	24.00	4	<0.001*
<i>Longidorus</i>	10	6	7	8	9	1.25	4	0.87
<i>Meloidogyne</i>	15	10	11	13	15	2.31	4	0.68
<i>Paratylenchus</i>	10	6	5	8	9	1.92	4	0.75
<i>Pratylenchus</i>	11	7	7	10	10	1.96	4	0.74
<i>Rotylenchulus</i>	9	0	0	8	10	14.98	4	0.005*
<i>Rotylenchus</i>	10	6	6	8	10	1.60	4	0.81
<i>Scutellonema</i>	9	7	6	9	10	1.18	4	0.88
<i>Trichodorus</i>	8	5	6	8	10	1.06	4	0.90
<i>Tylenchulus</i>	10	5	0	0	0	18.00	4	0.001*
<i>Xiphinema</i>	10	7	7	11	10	1.54	4	0.82

DISCUSSION

Plant-parasitic nematodes (PPNs) remain a major biological constraint to vegetable production due to their capacity to impair root efficiency, reduce nutrient and water uptake, and predispose plants to secondary infections. Their cumulative effects often result in poor crop growth, yield losses, and significant economic damage, particularly in tropical systems where favorable conditions promote rapid multiplication (Sikora et al., 2018; Maleita et al., 2023; Abd-Elgawad, 2024). The present study provides updated insights into the occurrence, abundance, and diversity of PPNs in vegetable fields of Gombe State, confirming their widespread establishment across major production areas. The recovery of thirteen genera highlights the richness of nematode communities in these systems. Although fewer than the twenty-four genera reported by Abraham et al. (2018) from irrigated Fadama farms, the findings nevertheless demonstrate that vegetable fields harbor diverse assemblages capable of causing substantial damage. Differences between studies may reflect variations in sampling sites, cropping systems, soil characteristics, seasons, and extraction methods. Comparable diversity levels reported in Kaduna (Bulus et al., 2020), Kano (Imam & Garba, 2013), Kwara (Ahmed et al., 2020), and Côte d'Ivoire (Sandrine et al., 2023) suggest that diverse nematode communities are typical of intensively cultivated vegetable fields across tropical Africa.

Marked variation in nematode diversity was observed among Local Government Areas, with Akko recording the highest richness and Dukku the lowest. These differences likely reflect environmental conditions,

soil texture, irrigation intensity, cropping history, and host diversity. Intensive cultivation and frequent irrigation favor nematode survival and multiplication, whereas less intensive systems may restrict establishment. Similar spatial variation has been noted previously in Gombe State (Abraham et al., 2018).

Meloidogyne emerged as the dominant genus, recording the highest abundance, density, and frequency across all locations. This aligns with global reports identifying root-knot nematodes as the most economically important PPNs in vegetable crops (Ralmi et al., 2016; Abdulsalam, 2016; Maleita et al., 2023). Their broad host range, high reproductive potential, short life cycle, and adaptability explain their prevalence. Continuous cultivation of susceptible crops such as tomato, pepper, cucumber, okra, and eggplant likely contributed to the high densities observed. Severe infestations can reduce yields by over 40% (Anwar et al., 2013), underscoring their significance as a major constraint to vegetable productivity in Gombe State.

Other economically important genera, including *Pratylenchus*, *Scutellonema*, *Xiphinema*, *Longidorus*, *Rotylenchus*, *Rotylenchulus*, and *Helicotylenchus*, were also recovered, indicating complex nematode communities rather than single-species infestations. Mixed populations often exacerbate crop damage by simultaneously exploiting different root regions, a phenomenon reported in Nigeria (Ahmed et al., 2020; Ogunsola et al., 2018) and other tropical systems (Sandrine et al., 2023). The detection of *Xiphinema* and *Longidorus* is particularly noteworthy, as these genera are recognized virus vectors. Although virus transmission was beyond the scope of this study, their presence signals additional phytosanitary risks. *Xiphinema* species are known vectors of nepoviruses (Andret-Link et al., 2024), and Tomato ringspot virus has been reported in northern Nigeria (Abraham et al., 2024). This highlights the need for future research on nematode-virus interactions in northeastern Nigeria.

Diversity indices further illustrate differences in community structure, with higher Shannon diversity and evenness in Akko and Yamaltu Deba compared to Dukku. These metrics provide insights into both species richness and distribution (Hammer et al., 2001), reflecting ecological and agronomic factors such as cropping intensity, irrigation, and soil conditions. Chi-square analysis indicated that most genera were widely distributed, suggesting their establishment across vegetable-growing areas. This may result from contaminated soil, infected planting materials, irrigation water, farm equipment, and continuous cultivation of susceptible hosts. Similar widespread distribution has been reported in northern Nigeria (Bulus et al., 2017; Abraham et al., 2018). In contrast, genera such as *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Rotylenchulus*, and *Tylenchulus* showed significant spatial variation, likely influenced by soil texture, moisture, host preference, and cropping history. Understanding these ecological relationships is critical for developing site-specific management strategies that improve nematode control while minimizing production costs.

CONCLUSION

This study provides an updated assessment of the occurrence, abundance, and diversity of plant-parasitic nematodes affecting vegetable production in Gombe State, Nigeria. The identification of thirteen genera across five Local Government Areas underscores their widespread distribution, with *Meloidogyne* emerging as the dominant and most damaging genus. Variations in diversity indices highlight the influence of local environments, cropping systems, and management practices, emphasizing the need for location-specific surveillance and control strategies. The prevalence of economically important genera such as *Meloidogyne*, *Pratylenchus*, *Scutellonema*, *Xiphinema*, *Longidorus*, *Helicotylenchus*, and *Rotylenchulus* confirms nematodes as a persistent threat to sustainable vegetable production. These findings provide a valuable baseline for researchers, extension agents, and policymakers, reinforcing the importance of integrating routine nematode monitoring into crop protection programs. Future research should prioritize molecular identification, seasonal dynamics, host–nematode interactions, and eco-friendly management approaches to enhance productivity, strengthen food security, and support sustainable agriculture in northeastern Nigeria.

ACKNOWLEDGEMENTS

Not applicable

AUTHOR CONTRIBUTION STATEMENT

I.C. J. and S.L.D. conducted the research and prepared the initial draft of the manuscript. G.A.U., U.G.M., and A.P. provided supervision and contributed to manuscript editing. All authors reviewed and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL APPROVAL

Not applicable.

CONSENT FOR PUBLICATION

Not Applicable.

FUNDING

Funding was not involved in this study.

AVAILABILITY OF DATA AND MATERIALS

All datasets analyzed and described during the present study are available from the corresponding author upon reasonable request

REFERENCES

- Abd-Elgawad, M. M. M. (2024). Global losses by plant-parasitic nematodes: Revised figures and new insights. *Frontiers in Plant Science*, 14, 1355670. <https://doi.org/10.3389/fpls.2023.1355670>
- Abdulsalam, S. (2016). *Survey of plant-parasitic nematodes associated with eggplant (Solanum species) in Kaduna and Kano States of Nigeria* [Seminar paper, Department of Crop Protection, Ahmadu Bello University].
- Abraham, P., Joshua, M., Shittu, E. A., & Abdullahi, M. (2018). Studies on the distribution of plant-parasitic nematodes associated with vegetables under irrigated fadama in Gombe State, Nigeria. *Journal of Environment, Technology & Sustainable Agriculture*, 2(1), 1–12.
- Abraham, P., Banwo, O. O., Kashina, B. D., Alegbejo, M. D., & Abraham, M. P. (2024). Occurrence of Tomato ringspot virus infecting tomato plants in northern Nigeria. *Arab Journal of Plant Protection*, 42(1), 43–48. <https://doi.org/10.22268/AJPP-001214>
- Ahmed, O., Izuogu, N. B., Baba, H. S., & Kalejaiye, N. (2020). Plant-parasitic nematodes associated with selected agricultural soils in Kwara State, Nigeria. *Agrosearch*, 20(2), 56–66. <https://doi.org/10.4314/agrosh.v20i2.5>
- Aminu-Taiwo, B. R., Fawole, B., & Claudius-Cole, A. O. (2016). Survey of plant-parasitic nematodes associated with cucumber (*Cucumis sativus* L.) in major production areas of Nigeria. *Nigerian Journal of Nematology*, 3, 31–40.
- Andret-Link, P., Schmitt-Keichinger, C., Demangeat, G., Komar, V., & Fuchs, M. (2024). Acquisition and transmission of Grapevine fanleaf virus (GFLV) by *Xiphinema index* and *Xiphinema italiae* (Longidoridae). *Journal of Helminthology*, 98, e26. <https://doi.org/10.1017/S0022149X24000154>
- Bulus, J., Abraham, P., Joshua, M., Shamaki, D. E., Okolo, C. T., & Chindo, P. S. (2020). Distribution and population densities of plant-parasitic nematodes associated with ginger (*Zingiber officinale*) in Kaduna State, Nigeria. *FUDMA Journal of Sciences*, 4(3), 496–504. <https://doi.org/10.33003/fjs-2020-0403-396>
- Bulus, J., Aminu, A. S., Chindo, P. S., Namakka, A., & Abdulsalam, S. (2017). Distribution and population densities of plant-parasitic nematodes under irrigated vegetable cultivation in Galma Fadama, Zaria, Kaduna State, Nigeria. *FUW Journal of Agriculture and Life Science*, 1(1), 71–77.
- Eisenback, J. D., Hirschmann, H., Sasser, J. N., & Triantaphyllou, A. C. (1981). *A guide to the four most common species of root-knot nematodes (Meloidogyne spp.) with a pictorial key*. North Carolina State University and U.S. Agency for International Development.
- FAOSTAT. (2022). *FAOSTAT statistical database*. Food and Agriculture Organization of the United Nations.
- FAOSTAT. (2024). *FAOSTAT statistical database*. Food and Agriculture Organization of the United Nations.
- Gough, E. C., Owen, K. J., Zwart, R. S., & Thompson, J. P. (2022). The role of nutrients underlying interactions among root-nodule bacteria (*Bradyrhizobium* sp.), arbuscular mycorrhizal fungi (*Funneliformis mosseae*) and root-lesion nematodes (*Pratylenchus thornei*) in nitrogen fixation and growth of mung bean (*Vigna radiata*). *Plant and Soil*, 472(1–2), 421–449. <https://doi.org/10.1007/s11104-021-05254-8>
- Hammer, Ø., Harper, D. A. T., & Ryan, P. D. (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, 4(1), 1–9.

- Imam, T. S., & Garba, K. S. (2013). A survey of nematodes inhabiting rhizosphere soils in two selected irrigated farmlands in Kano Metropolis, Nigeria. *BEST Journal*, 10, 13–18.
- Jidere, C. I., Simon, L. D., Usman, I., Abraham, P., & Sulaiman, I. (2023). Survey on plant-parasitic nematodes associated with grapevine (*Vitis vinifera* L.) at Federal College of Horticulture, Dadin-Kowa, Gombe, Nigeria. *EQA-International Journal of Environmental Quality*, 55, 33–41. <https://doi.org/10.6092/issn.2281-4485/16767>
- Khyati, V., & Kirti, M. (2022). An analysis of health benefits of carrot. *International Journal of Innovative Research in Engineering & Management*, 9(1), 211–214.
- Maleita, C., Esteves, I., Fonseca, L., Abrantes, I., & Curtis, R. (2023). Plant-parasitic nematodes and their interactions with host plants. *International Journal of Molecular Sciences*, 24(3), 2736.
- Ogunsola, K. E., Ogunfunmilayo, A. O., Solomon, S., Oluitan, J. A., Kazeem, S. A., Folorunso, D. O., & Ibrahim, S. (2018). Occurrence and population distribution of plant-parasitic nematodes associated with roselle (*Hibiscus sabdariffa* L.) in northern Nigeria. *Agro-Science*, 17(2), 18–26.
- Parrado, L. M., & C., M. (2024). Plant-parasitic nematode disease complexes as overlooked challenges to crop production. *Frontiers in Plant Science*, 15, Article 1439951. <https://doi.org/10.3389/fpls.2024.1439951>
- R Core Team. (2024). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Ralmi, N. H. A. A., Khandaker, M. M., & Mat, N. (2016). Occurrence and control of root-knot nematode in crops: A review. *Australian Journal of Crop Science*, 10(12), 1649–1654. <https://doi.org/10.21475/ajcs.2016.10.12.p7444>
- Sandrine, Y. A., Gnenakan, Y., Jacob, N., Eric-Olivier, T., Martial, K. K. F. J., Gilchrist, K. E. Y., Urbain, K. U. U., Junior, K. D., Théodore, K. K., & Kouabenan, A. (2023). Plant-parasitic nematodes associated with vegetable crops in the main agroecological zones of Côte d'Ivoire. *Asian Journal of Agriculture and Biology*, Article 128. <https://doi.org/10.35495/ajab.2023.128>
- Sikora, R. A., Coyne, D., Hallmann, J., Timper, P., & Bridge, J. (2018). *Plant-parasitic nematodes in subtropical and tropical agriculture* (3rd ed.). CABI.
- Sunita Devi, T. H., Behera, H. S., Madhu, A., Samreen, S., Chaudhary, S., Koushal, S., & ReddyPriya, P. (2024). A comprehensive review on integrated pest management in nematodes. *International Journal of Research in Agronomy*, 7(12), 760–765. <https://doi.org/10.33545/2618060X.2024.v7.i12j.2252>
- Shao, H., Zhang, P., Peng, D., Huang, W., Kong, L., Li, C., Liu, E., & Peng, H. (2023). Current advances in the identification of plant nematode diseases: From lab assays to in-field diagnostics. *Frontiers in Plant Science*, 14, Article 1106784. <https://doi.org/10.3389/fpls.2023.1106784>



Copyright: © 2026 by the authors. This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.