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Nematodes Assessment in Cucumber and Melon farms in Rivers State, Nigeria

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Abstract

Plant parasitic nematodes are of agricultural importance, causing loss of crop fields, poor yield and the subsequent impact on livelihood of the farmers. The aim of this study was to evaluate the abundance of parasitic nematodes on selected crop fields in the study area. Soil samples were collected from cucumber, cassava, melon and maize farms, using a soil auger into a black cellophane bag and transported to the laboratory for parasitological analysis using Baermann's method. Soil physico-chemical parameters were measured using standard methods. A total of 879 plant parasitic nematodes from 16 species were extracted from cucumber and melon farms during the study, out of which 442 (50.28) and 437(49.72%) were extracted from the cucumber and melon farms respectively. Of the 442 plant parasitic nematodes recovered from the cucumber farm, *Meloidogyne* spp., 66(14.93%) recorded the highest abundance followed by *Paratylenchus* spp., 56(12.67%), *Rotylenchu* spp., 51(11.54%) while *Pratylenchus* spp., 17(3.85%) recorded the abundance. In the melon farm, 12 species of PPNs were extracted comprising of *Tylenchus* spp., 37(8.47), *Meloidogyne* spp., 60(13.73%), *Pratylenchus* spp., 4(0.92%), *Radophodus* spp., 53(12.13%), *Hemicyclophora* spp., 26(5.95%), *Paratylenchus* spp., 65(14.87%), *Mesocriconema xenoplex*, 18(4.12), *Heterodera* spp., 51(11.67%), *Rotylenchus* spp., 26(5.95%), *Tylenchorhynchus* spp., 47(10.76), *Hemicriconomoides* spp., and 28(6.41%). Physico-chemical parameters recorded insignificant negative correlation with nematode abundance ($p > 0.05$). Farms in the study area are infested with various plant parasitic nematodes. Farmers should be encouraged to carry crop rotation which helps in nematode control.

Keywords: Nematodes; Parasites; Plants; Farms; Physico-chemical; Parameters

Received: 29th January 2026 / Accepted: 11th April 2026 / **Published online:**30th April 2026

© The Author(s), under exclusive license to Bio-Research-Journal-of-Biological-Research-and-Biotechnology (JBRB), ISSN: 2705-3822; print-ISSN: 1596-7409 (Online); Open Access This article is available at <https://bio-research.com.ng/index.php/home>, 2026.

DOI: <https://dx.doi.org/10.4314/br.v24i1.13>

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INTRODUCTION

Food crops including plantain, rice, maize, beans, cucumber, and melon, play a crucial role in ensuring food security and providing nutrition for populations worldwide (Nkwonta et al., 2023; Ndlovu et al., 2024). Cucumber (*Cucumis sativus*) contains silicon, potassium, sulfur, vitamins, sodium and other substances that ensures and preserve the alkalinity of blood (Okpani et al., 2024). It contains silica which helps in connective tissue strength and, therefore, has the potential to relieve joint pain; and lignans, pinorexinol, secoisolariciresinol and lariciresinol that are associated with a reduced risk of many cancers (Okpani et al., 2024). Being a part of the Cucurbitaceae family, cucumber is a source of a cucurbitacin, a bitter tasting nutrient. Cucumbers can reduce the potential likelihood of high blood pressure by decreasing sodium and increasing potassium consumption. The crop was originally grown in India but spread to other parts of the globe, being introduced into the West African world by Europeans in the 1940s; it is commonly cultivated and consumed in West Africa, including Nigeria, where it is farmed commercially and eaten by numerous ethnic groups (Okpani et al., 2024). Egusi or melon (*Colocynthis citrullus*) is a good source of the dehulled seeds, which contain white kernel consisting of about 50-60% oil, 28-30% protein, 10-20% carbohydrate, 2-3% ash and 3-4% fiber (Akubor & Ogbadu, 2003). These seeds produce milk with 3.6%, 4.0%, 2.5% of proteins, fat and carbohydrate respectively, similar to those of the soy milk and, therefore, egusi could be used to enrich modern and traditional food (Akubor & Ogbadu, 2003). In Africa, *C. lanatus* seeds are eaten due to their nutritional value, and it is reported to contain high fat, high protein, and the oil is edible as a biofuel feedstock (Solomon & Taiwo, 2020). Due to the low cost of growing melons and the fact that the plant is more resistant to drought than a number of oil crops, egusi oil is a viable alternative to other types of vegetable oils (Solomon & Taiwo, 2020). Plant-parasitic nematodes are severe as they lead to alteration of the plant functionality with symptoms that depend on the host and result in diminished plant activity, reduced or deformed root system, root galls, rotting of feeder roots and even death (Khan, 2012). Their effect may be difficult to evaluate since they do not cause overt tissue necrosis as other pests or diseases; destruction may not be overt but may be manifested by reduced root functionality, which limits water and nutrient uptake, and thus the affected plants may appear to be drying out or have nutrient deficiency and are often underdiagnosed (Nicol et al., 2011). Long lag times between the manifestation of the infection and the observable symptoms also complicate detection (Brasier, 2008). Therefore, to improve plant health and effective management, it is necessary to identify nematodes and evaluate their population, and it is paramount to understand new or potentially dangerous species in order to control them (Oseni et al., 2020). The aim of the study is to determine the abundance of plant parasitic nematodes in two selected crop farms in Aluu, Rivers State.

Materials and Method

Study area and design

The study was a descriptive study in which soil samples were taken from two farms, melon and cucumber. The study area was Aluu clan in Ikwerre Local Government Area, Rivers State, Nigeria. Aluu is an agrarian community involved in many economic crops and vegetables. It lies within latitude 4.9339° N, and longitude 6.9437° E. Residents plant crops and vegetables such as cassava. Melon, pumpkin, plantain, garden egg, cucumber, okra, etc. other economic activities include fishing. It has a tropical rainforest climate characterized by very high rainfall throughout the year, with a distinct wet season and a short dry period, high humidity, and consistently warm temperatures with only a small annual temperature range; essentially, a hot and humid climate with heavy rainfall almost year-round. Temperatures remain relatively stable throughout the year, with average highs around 89°F (32°C) and average lows around 73°F (23°C).

Sampling method

A total of 20 soil samples were randomly collected from each of cucumber and melon farm soils, using a soil auger into a black cellophane bag and transported to the laboratory of the Department of Animal and Environmental Biology, University of Port Harcourt for analysis.

Extraction of plant-parasitic nematodes from soils and roots

The Baermann's method (Barker, 1985) as modified by Nzeako et al. (2013) was used for the extraction of plant-parasitic nematodes from the soil. Modified sieves were used to filter out stones and debris from soil. The bulked soil sample was thoroughly mixed in a plastic container and 200 ml of soil was measured out using a beaker. Tissue papers were placed in a plastic sieve and later placed on a plastic plate. The 200 ml soil was poured on the tissue in the sieve and placed on the extraction plate already filled with water to wet the soil. The set-up was left undisturbed for 48 hours in the laboratory. After the extraction period, the suspension containing nematodes and water in the plate was poured into a labelled sterile sample bottle and were allowed to settle. The suspension in the bottle was decanted to a volume of 10 ml. The concentrated suspension of water and nematodes from the soil was preserved with equal volume of 10% formaldehyde pending identification and counting (Nzeako, 2013).

Identification of plant-parasitic nematodes

Plant-parasitic nematodes identification was carried out at the Parasitology laboratory of the Animal and Environmental Biological Department. The content of the sample bottle were allowed to sediment and the supernatant carefully discarded to about a quarter of the volume using a Pasteur pipette. 2 ml suspension was pipetted on a clean slide and a drop of liquid iodine added before placing a cover slip on it for microscopy (Golden, 1985). The X4, X10, and X40 objectives were used in counting and identification of nematodes present.

Identification was done to genus level using a guide by Goodey (1963).

Physico-chemical parameters analysis

Temperature

The water temperature was measured in-situ with the sample in the multi-meter water parameter checker; optical PRODO with model number 17C102826. after rinsing twice. The temperature button was switched on and the values recorded. It was repeated three times and the mean was recorded at the different stations.

Salinity

The Salinity of the water samples was measured using SPER BENCH – TOP WATER QUALITY METER (860033 Model). The probe of the multi water meter was inserted into a beaker containing the test water and the switched on and to stabilize for 10min. the salinity reading were recorded when it became stable

Total dissolved solid (TDS)

The measurements were done with (Ultra meter 11 6PFC) a multi meter water quality water checker. The total Dissolved Solid button was switched on and the values recorded. The measurements were repeated three times and the mean recorded.

Hydrogen in concentration (pH)

The pH was determined with a multi-meter (ultra meter 11 6 PFC). The equipment was rinsed five times with the sample solution to ensure that only the sample is in the meter. The meter was switched on and the pH reading was taken. The ultra meter was calibrated with sensor storage solution. The same was repeated in triplicates and the values recorded.

Electrical conductivity

The electrical conductivity was measured using the multifunction pen type multi- meter meter with model number pH-03/618/K13. The procedure was used as in temperature but the electrical conductivity button was switched on, and values recorded. It was repeated three times and the mean was recorded.

Dissolved Oxygen (DO)

Dissolved Oxygen was measured with the optical DO with model number 17C102826. The DO meter probe was lowered to about 20 - 30cm inside the water. The checker was switched on and the dissolved oxygen reading was taken when the reading became stable. The same was done in repeatedly for three times and the values recorded.

Data analysis

Data were analysed using Microsoft Excel Windows 10. Results was presented in tables, figure and texts. Multilinear matrix correlation was carried to examine the relationship between soil nematode abundance and physico-chemical parameters. Difference was considered significant at $p < 0.05$.

Results

A total of 879 plant parasitic nematodes from 16 species were extracted from cucumber and melon farm soils during the study, out of which 442 (50.28) and 437(49.72%) were extracted from the cucumber and melon farm soils respectively. Of the 442 PPNs recovered from the cucumber farm soil, *Meloidogyne spp.*, 66(14.93%) recorded the highest abundance followed by *Paratylenchus spp.*, 56(12.67%), *Rotylenchu spp.*, 51(11.54%) while *Pratylenchus spp.*, 17(3.85%) recorded the abundance. In the melon farm soil, 12 species of PPNs were extracted comprising of *Tylenchus spp.*, 37(8.47), *Meloidogyne spp.*, 60(13.73%), *Pratylenchus spp.*, 4(0.92%), *Radophodus spp.*, 53(12.13%), *Hemicyclophora spp.*, 26(5.95%), *Paratylenchus spp.*, 65(14.87%), *Mesocriconema xenoplex*, 18(4.12), *Heterodera spp.*, 51(11.67%), *Rotylenchus spp.*, 26(5.95%), *Tylenchorhynchus spp.*, 47(10.76), *Hemicriconomoides spp.*, and 28(6.41%) as shown in Table 1. Table 2 below presents a summary of biodiversity indices in the two crops farm soils. Cucumber farm soil recorded the highest richness (13 taxa), followed by melon (12 taxa). Cucumber farm soil had the lowest dominance (0.093), suggesting high evenness. The PPNs in cucumber farm soil had the highest Simpson index (0.907), while those in the melon farm soil (0.8965) recorded the least. Nematodes in cucumber farm soil recorded a Shannon index of 2.466 while those in the melon farm soil recorded 2.348. Other measures of diversity are shown in Table 2.

Table 1: Overall abundance based on crop type

Nematode species	Farms		Total
	Cucumber (%)	Melon (%)	
<i>Tylenchus spp.</i>	39(8.82)	37(8.47)	76(8.65)
<i>Meloidogyne spp.</i>	66(14.93)	60(13.73)	126(14.33)
<i>Pratylenchus spp.</i>	17(3.85)	4(0.92)	21(2.39)
<i>Radophodus spp.</i>	26(5.88)	53(12.13)	79(8.99)
<i>Hemicyclophora spp.</i>	28(6.33)	26(5.95)	54(6.14)
<i>Paratylenchus spp.</i>	56(12.67)	65(14.87)	121(13.77)
<i>Mesocriconema xenoplex</i>	0(0.0)	18(4.12)	18(2.05)
<i>Heterodera spp.</i>	32(7.24)	51(11.67)	83(9.44)
<i>Rotylenchu spp.</i>	51(11.54)	26(5.95)	77(8.76)
<i>Tylenchorhynchus spp.</i>	0(0)	47(10.76)	47(5.35)
<i>Longidorus spp.</i>	43(9.73)	0(0)	43(4.89)
<i>Dorylaimus spp.</i>	26(5.88)	0(0)	26(2.96)
<i>Hemicyclophora spp.</i>	25(5.66)	0(0)	25(2.84)
<i>Hemicriconomoides spp.</i>	20(4.52)	28(6.41)	48(5.46)
<i>Bursapha lencus</i>	0(0)	22(5.03)	22(2.50)
<i>Rotifer spp.</i>	13(2.94)	0(0)	13(1.48)
Grand Total	442	437	879

Table 2: Nematode diversity indices

	Cucumber farm	Melon farm
Taxa_S	13	12
Individuals	442	437
Dominance_D	0.093	0.103
Simpson_1-D	0.907	0.896
Shannon_H	2.466	2.348
Evenness_e^H/S	0.905	0.872
Margalef	1.97	1.809

The concentrations of physic-chemical parameters in the farm soils showed that dissolved oxygen (DO) levels in the

studied farms soils were 4.87 ± 0.71 ppm in cucumber farm and 4.80 ± 0.92 ppm in melon farm, and there was no statistically significant difference in concentration between the farms ($p > 0.05$). Soil pH was lower in melon farm soils (6.37 ± 0.21) than in cucumber farm soil (6.91 ± 0.34 , $p > 0.05$); soil temperature was lower in the cucumber farm soil ($28.13 \pm 0.64^\circ\text{C}$) than melon farm soil ($28.33 \pm 0.69^\circ\text{C}$) ($p > 0.05$). Total dissolved solids (TDS) showed highest value in cucumber farm soil (63.33 ± 18.76 mg/l) and lowest in melon farm soil (41.67 ± 13.68 mg/l) ($p > 0.05$); soil electrical conductivity showed mean highest value in cucumber farm soil (122.67 ± 35.22 $\mu\text{s/cm}$) and lowest in melon farm soil (75.33 ± 18.41 $\mu\text{s/cm}$) ($p > 0.05$); and the mean salinity level was highest in cucumber farm soil ($66.00 \pm 17.04\%$) and lowest in melon farm soil ($31.00 \pm 2.65\%$) ($p > 0.05$) (Table 3).

Table 3: Mean of physico-chemical parameters of the soils

Farm soils	DO (ppm)	pH	Temperature ($^\circ\text{C}$)	TDS (mg/l)	Conductivity ($\mu\text{s/cm}$)	Salinity (%)
Melon	4.80 ± 0.92^a	6.37 ± 0.21^a	28.33 ± 0.69^a	41.67 ± 13.68^a	75.33 ± 18.41^a	31.00 ± 2.65^a
Cucumber	4.87 ± 0.71^a	6.91 ± 0.34^a	28.13 ± 0.64^a	63.33 ± 18.76^a	122.67 ± 35.22^a	66.00 ± 17.04^a

Key: mean \pm SE of physico-chemical parameters with the same alphabetic superscript are not statistically significant from each other.

In the melon farm DO recorded a positive correlation with temperature (0.745) and a weak positive correlation with pH (0.249), no correlation with salinity (0.0) and only weak positive correlations with TDS (0.287) and EC (0.237). However, DO showed a negative correlation with PPNs abundance (-0.463). pH exhibited a strong positive correlation with TDS (0.999), EC (1.000), and salinity (0.969). On the other hand, pH had a negative correlation with temperature (-0.462) and PPNs abundance (-0.974). Temperature correlated negatively with most parameters, including TDS (-0.426), EC (-0.472), and salinity (-0.668), but has a slight positive correlation with PPNs abundance (0.248). TDS recorded a strong positive correlation with pH (0.999), EC (0.999), and Salinity (0.958). These relationships suggest that TDS levels rise concurrently with increases in pH, EC, and salinity. Also, TDS recorded strong negative correlation with PPNs abundance (-0.982). Electrical Conductivity mirrored the relationships of TDS, showing a strong correlation with pH

(1.000), TDS (0.999), and Salinity (0.972). EC exhibited a significant negative correlation with abundance (-0.971), underscoring its role in influencing nematode populations. Salinity correlated strongly with pH (0.969), TDS (0.958), and EC (0.972), and with PPNs abundance (-0.887) (Table 4). In the cucumber farm, dissolved oxygen (DO) showed a very strong positive correlation with pH (0.977) and temperature (0.806). Conversely, DO has a very strong negative correlation with PPN abundance (-0.975). The pH parameter showed a perfect negative correlation with PPN abundance (-1.000). but positively correlated with other parameters. Temperature also shows a strong negative correlation with PPN abundance (-0.809) and moderate negative correlation with other parameters. Interestingly, TDS, EC, and salinity are highly correlated with each other, reflecting their interdependent nature in measuring water quality. They each show moderate negative correlations with PPN abundance (-0.504, -0.487, and -0.487, respectively) (Table 5).

Table 4: Multivariate correlation between physico-chemical parameters and PPN abundance in the melon farm soil

	DO	PH	TEMP	TDS	EC	Salinity	Abundance
DO	1						
PH	0.249	1					
TEMP	0.745	-0.462	1				
TDS	0.287	0.999	-0.426	1			
EC	0.237	1.000	-0.472	0.999	1		
Salinity	0.000	0.969	-0.668	0.958	0.972	1	
Abundance	-0.463	-0.974	0.248	-0.982	-0.971	-0.887	1

Table 5: Multivariate correlation between physico-chemical parameters and PPN abundance in the cucumber farm soil

	DO	PH	TEMP	TDS	EC	Salinity	Abundance
DO	1						
PH	0.977	1					
TEMP	0.660	0.806	1				
TDS	0.682	0.509	-0.10	1			
EC	0.682	0.509	-0.10	1.0	1		
Salinity	0.667	0.492	-0.120	1.0	1.0	1	
Abundance	-0.975	-1.000	-0.809	-0.504	-0.504	-0.487	1

Discussion

Plant parasitic nematodes are of great economic and agricultural importance, impacting adversely on food production and insecurity. The study on plant parasitic nematodes in cucumber and melon farms revealed that a total of 879 plant parasitic nematodes from 16 species were extracted and included *Tylenchus* spp., *Meloidogyne* spp., *Pratylenchus* spp., *Radophodius* spp., *Hemicyclophora* spp., *Paratylenchus* spp., *Mesocriconea xenoplex*, *Heterodera* spp., *Rotylenchus* spp., *Tylenchorhynchus* spp., *Longidorus* spp., *Dorylaimus* spp., *Hemicydoiphora* spp., *Hemicriconomoides* spp., *Bursapha lencus* and *Rotifer* spp. Species richness of nematodes in the various farms revealed that 13 and 12 nematodes species were extracted from cucumber and melon farm soils respectively. This species number is smaller than the 16, 20 and 27 reported by Amulu et al. (2024), Coffi et al. (2025) and Ikoyi et al. (2023) respectively. Significant differences exist in the soil nematode diversity and richness across the farms as the result of a complex of biotic, abiotic, and anthropogenic factors. These differences are largely dependent on soil type, management systems, and practices in addition to environmental conditions (Zhang et al., 2024; Liu et al., 2025). The physical and chemical properties of soil play a crucial role in determining nematode diversity. Also, the choice of crops grown in farms directly affects nematode diversity due to host specificity. In particular, crop specific parasites, like *Meloidogyne* spp. (root-knot nematodes), which are more abundant in the absence of crop rotation, can be increased by monoculture farming (Maina et al., 2022). Crop rotation, on the contrary, can lower the population of nematodes by disrupting their life cycles, which favor a more-diverse community of nematodes, including non-parasitic species (Schumacher et al., 2022). The soils with the high density of organic matter sustain the increased diversity of free-living nematodes like bacterivores, fungivores, etc, which are involved in nutrient cycling. Generally, degraded soils as a result of intensive farming are more susceptible to plant-parasitic nematodes because of the decrease in competition (Osei et al., 2024). The introduction of organic amendments like compost can restore the diversity of the nematodes by having a source of food to the useful nematodes (Martinez, 2025). Also, the intensive farming activities, which include excess use of chemical fertilizers and pesticides, are detrimental to the nematode diversity. Pesticides may cause causes of population decline against the non-target nematodes favoring resistant parasitic species

(Garcia-Sanchez & Lopez, 2024). Conversely, conservation agriculture such as lowered tillage and cover cropping, encourages nematodes biodiversity by conserving soil structure and microbial habitats. The negative relation between DO and pH, and PPNs abundance in the melon and cucumber farm soils could be that in these farms, excessive dissolved oxygen levels created oxidative stress for nematodes, negatively impacting their survival and reproduction. Some nematodes usually do well in conditions with low oxygen concentrations, and high oxygen concentrations may cause them to die (Zhu et al., 2024; Ma et al., 2023; Xue et al., 2024). Nematodes are also sensitive to pH, and they cannot perform optimally under different pH conditions. As an example, very acidic or alkaline soils may affect the metabolism and reproduction of nematodes leading to the existence of a negative relationship between the pH level and the existence of nematodes (Zhang et al., 2023; Wang et al., 2023). The study also showed that TDS, salinity and electrical conductivity recorded a negative relationship with PPNs in both farm soils. The proximity of farms could indicate they share same parent material, climate, topography, and history of land-use with astonishingly similar soil physico-chemical properties. It is these common environmental and management processes that cause parallel mineral weathering, organic matter deposition, and nutrient cycling, and convergences in soil texture, pH, nutrient status, water-holding capacity, and cation exchange capacity - a characteristic commonly referred to as CEC (Rossi et al., 2024; Kaur et al., 2025; Dunn et al., 2024). The soils of the same geologic substrate have similar mineral assemblage. The texture of soil is determined by quartz, feldspar, and clay minerals formed during the weathering of the parent rock and determines the proportions of sand, silt, and clay in the soil along with its capacity to retain and release nutrient ions and its base-saturation level (Tanaka & Sato, 2024). Climatic effects include patterns of rainfall, changes in temperature, and seasonality that determine the rate at which rocks disintegrate, the rate of organic matter breakdown, and the amount being washed away. In wet tropical regions, plant debris decomposes rapidly and heavy rains may carry away nutrients, so adjacent fields will be chemically similar. Similarly, low slopes or plain lands do not allow erosion to transport tiny particles, so the texture and nutrient content remain strikingly uniform throughout both farms (Kaur et al., 2025).

Conclusion

The physico-chemical parameters recorded a negative correlation with the plant parasitic nematodes abundance. There should be enlightenment campaign on the adverse effect of nematodes on crop yield in the study area. Farmers should be encouraged to carry crop rotation which helps in nematode control.

References

- Akubor, P. I., & Ogbadu, G. H. (2003). Physicochemical properties and functional attributes of melon (*Colocynthis citrullus* L.) protein isolate. *Journal of Food Science and Technology*, 40(6), 597–602.
- Amulu, L.U., Oyedele, D.J., Adekunle, O.K. (2024). Plant Parasitic Nematodes Associated with Three African Indigenous Vegetables in Southwest Nigeria. *Trends in Agricultural Sciences*, 3(2), 69-82. <https://doi.org/10.17311/tas.2024.69.82>
- Brasier, C. M. (2008). Rapid emergence of forest pathogens: History and prospects. *Plant Disease*, 92(6), 637–646.
- Coffi, E. N., Affokpon, A., Souna, D. A., De Troij, A., Adanmaho, A. S., & Sero, S. (2025). Distribution of plant-parasitic nematode genera in relation to host vegetable crops and ecological regions in Benin, West Africa. *Tropical Agriculture-London then Trinidad-*, 102(4), 516-536. <https://journals.sta.uwi.edu/ojs/index.php/ta/article/view/9632>
- Dunn, B. W., Harris, P., & Clarke, M. (2024). Soil physico-chemical convergence across agricultural landscapes. *Geoderma*, 445, 116546. <https://doi.org/10.1016/j.geoderma.2024.116546>
- Goodey, J. B. (1963). *Soil and freshwater nematodes*. Butterworths.
- Ikoyi, I., Grange, G., Finn, J. A., & Brennan, F. P. (2023). Plant diversity enhanced nematode-based soil quality indices and changed soil nematode community structure in intensively-managed agricultural grasslands. *European Journal of Soil Biology*, 118, 103542. <https://doi.org/10.1016/j.ejsobi.2023.103542>
- Kaur, R., Singh, H., & Kaur, M. (2025). Influence of land-use patterns on soil properties and nutrient cycling. *Environmental Monitoring and Assessment*, 197(2), 118. <https://doi.org/10.1007/s10661-025-11834-2>
- Khan, M. R. (2012). Plant-parasitic nematodes: Biology, pathogenicity and management strategies. *International Journal of Nematology*, 22(1), 1–18.
- Liu, Q., Wang, T., & Zhao, L. (2025). Environmental drivers of soil nematode diversity in agroecosystems. *Soil Systems*, 9(1), 12. <https://doi.org/10.3390/soilsystems9010012>
- Ma, T., Pan, X., Wang, T., Li, X., & Luo, Y. (2023). Toxicity of per- and polyfluoroalkyl substances to nematodes. *Toxics*, 11(7), 593. <https://doi.org/10.3390/toxics11070593>
- Maina, S., Karuri, H., & Mugweru, J. (2022). Nematode diversity and its association with soil properties in monocrop pigeon pea. *Journal of Agriculture and Food Research* 9: 100336.
- Ndlovu, T., Moyo, L., & Zulu, D. (2024). Contribution of staple crops to food security in sub-Saharan Africa. *African Journal of Agricultural Research*, 19(2), 101–115.
- Nicol, J. M., Turner, S. J., Coyne, D. L., Den Nijs, L., Hockland, S., & Maafi, Z. T. (2011). Current nematode threats to world agriculture. In R. N. Perry & M. Moens (Eds.), *Plant nematology* (2nd ed., pp. 21–43). CABI.
- Nkwonta, C. N., Chukwuemeka, H. P., & Onyeka, A. O. (2023). Role of rice, maize, potatoes, cassava, cucumber and melon in ensuring food security and nutrition: A review. *Journal of Food Security and Nutrition*, 11(3), 55–68.
- Nzeako, U. D., Eze, C. C., & Obi, M. A. (2013). A modified Baermann technique for efficient extraction of plant-parasitic nematodes from soil. *Nigerian Journal of Nematology*, 14(1), 45–52.
- Okpani, E. O., Ibezim, U. J., & Nnadi, F. O. (2024). Introduction and spread of cucumber (*Cucumis sativus* L.) in West Africa: Historical perspectives. *Horticultural History and Economics*, 5(1), 45–53.
- Oseni, T. O., Akinyemi, J. T., & Adewale, O. E. (2020). Diversity and distribution of plant-parasitic nematodes in Nigerian agroecosystems. *Nigerian Journal of Nematology*, 23(2), 75–88.
- Rossi, G., Bianchi, L., & Conti, F. (2024). Soil mineral weathering and nutrient cycling in cultivated fields. *Catena*, 233, 107412. <https://doi.org/10.1016/j.catena.2024.107412>
- Schumacher, L. A., Grabau, Z. J., Wright, D. L., Small, I. M., & Liao, H. L. (2022). Effects of grass-based crop rotation, nematicide, and irrigation on the nematode

community in cotton. *Journal of Nematology*, 54(1), 20220046.

outcomes in host nematodes. *BMC Biology*, 22, 224. <https://doi.org/10.1186/s12915-024-02021-w>

Solomon, A. O., & Taiwo, K. O. (2020). Egusi melon (*Colocynthis citrullus* L.) oil as a sustainable alternative for vegetable oils and biofuels. *Renewable Agriculture and Food Systems*, 35(3), 234–242.

Zhang, W., Li, J., & Sun, Q. (2024). Biotic and abiotic factors shaping soil nematode communities. *Applied Soil Ecology*, 193, 104982. <https://doi.org/10.1016/j.apsoil.2024.104982>

Tanaka, H., & Sato, K. (2024). Mineral composition and soil texture relationships in agricultural soils. *Soil Science and Plant Nutrition*, 70(2), 134–143. <https://doi.org/10.1080/00380768.2024.2345678>

Zhang, X., Johnston, E. R., Barberán, A., Ren, Y., & Zhou, J. (2023). Effect of soil pH on nematode community structure and diversity in agricultural ecosystems. *Soil Biology and Biochemistry*, 180, 108990. <https://doi.org/10.1016/j.soilbio.2023.108990>

Wang, Y., Liu, T., Zhang, W., & Li, Q. (2023). Responses of soil nematode communities to environmental gradients including pH in agroecosystems. *Ecological Indicators*, 154, 110755. <https://doi.org/10.1016/j.ecolind.2023.110755>

Zhu, Z., Dai, D., Zheng, M., Shi, Y., Siddique, S., Wang, F., ... Zheng, J. (2024). Root-knot nematodes exploit catalase-like effectors to manipulate plant reactive oxygen species levels. *Molecular Plant Pathology*, 25(9), e70000. <https://doi.org/10.1111/mpp.70000>

Xue, Y., Xie, Y., Cao, X., et al. (2024). The marine environmental microbiome mediates physiological

Appendix

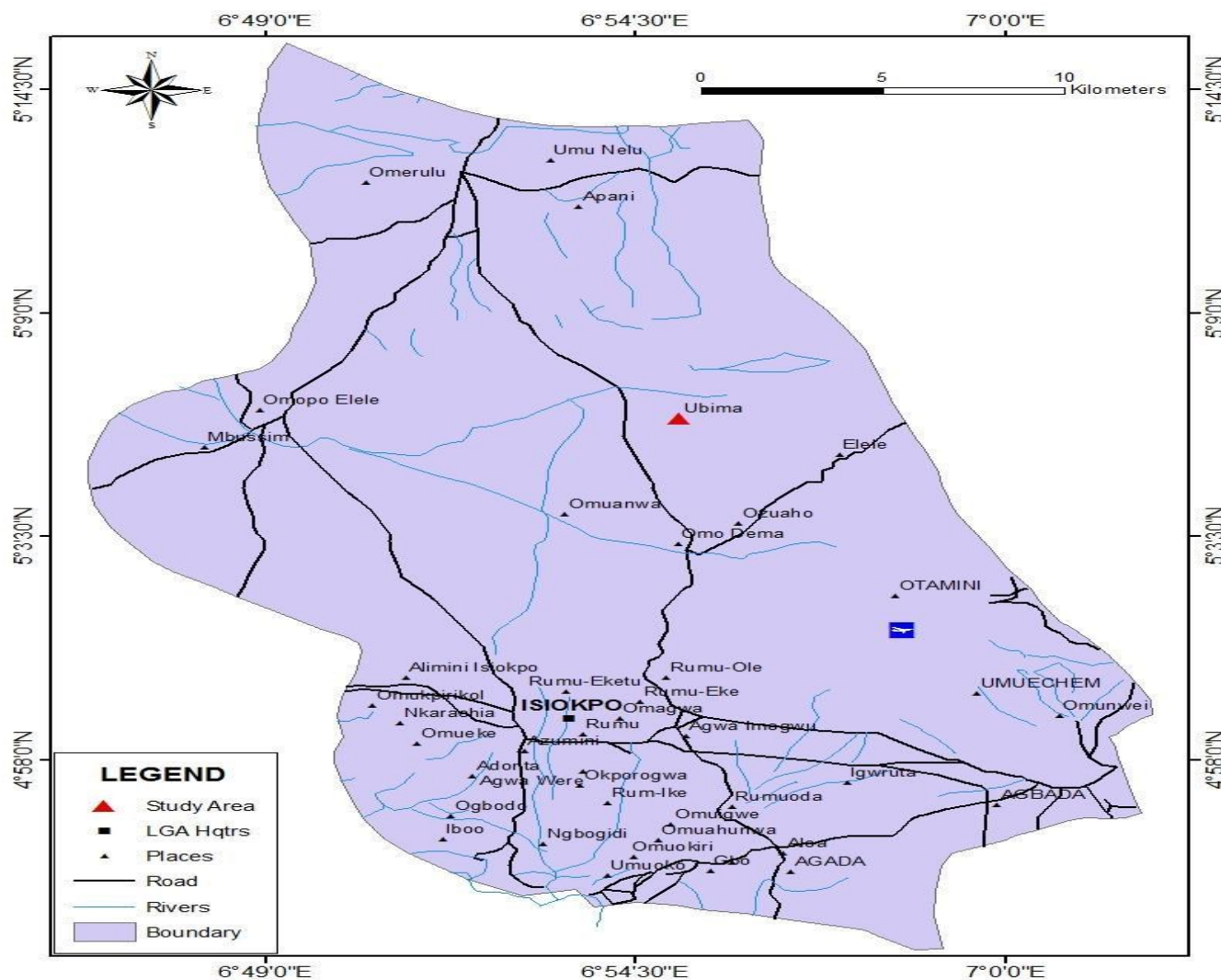


Figure 1: Study Area