SURVEY AND DISTRIBUTION OF PLANT PARASITIC NEMATODES INHABITING FARMLANDS AROUND KWARE LAKE

ABSTRACT

A survey was conducted on nematodes associated with soils of farmlands around Kware Lake, Kware local government area of Sokoto State. This research aims to determine the species composition and distribution of nematodes in farmlands around Kware Lake. Sampling was carried out from July to September 2016. Soil samples were collected to a depth of 0-15m. The centrifugation technique was used for the extraction of nematodes and viewed under the microscope. Results indicate that seven species were detected whose richness varied with respect to site . The nematodes detected were *Xiphinema spp., Heterodera spp., Trichodorus spp., Meloidogyne spp., Rotylenchus spp., Longidorus spp.,* and *Pratylenchus spp.* The most abundant nematodes isolated were *Meloidogynespp.* (29.63%) while *Pratylenchus spp.* were found to be least abundant (2.22%). This is because *Meloidogyne* was very widely distributed and affect a wide variety of crops while *Pratylenchus* was a migratory endoparasite and can be ascertained by its high population in the root. There was no significant difference in nematode species occurrence between the three sampling sites at $p<0.05$. The result showed there was a wide diversity of nematodes inhabiting the study area with a diversity index of 1.77. The presence of plant-parasitic nematodes in the soils of farmlands around Kware Lake highlights the need for prevention and control of nematode species, to reduce the risk of losses to agricultural yield.

Keywords; Nematode, Kware lake, Parasitic, Plants, Soil.

INTRODUCTION

Nematodes constitute one of the most numerically important components of the soil fauna [1] and thus significantly impact nutrient cycling and primary productivity in a diverse ecosystem. Nematodes are microscopic worms like organisms that make up the phylum Nematoda and are among one of the most abundant multicellular animals on the earth after arthropods [2] they live in water films and water-filled pore spaces in the soil. Members of the phylum Nematoda (roundworms) have been in existence for an estimated one billion years, making them one of the most ancient and diverse types of animals on earth [3]. They are thought to have evolved from simple animals, some 400 million years before the “Cambrian explosion” of invertebrates able to be fossilized [4].

Typically, they are found abundantly in the upper soil layers where organic matter, plant roots and other resources [5]. The soil is a particularly rich habitat for nematodes with about 26 percent described genera inhabiting soil as bacterivores, fungivores, omnivores, predators or plant parasites [6].

Most species of nematodes are free-living and sustain themselves by consuming bacteria, fungi or other microscopic organisms; others are parasites of plants or animals. Free-living nematodes are abundant multi-cellular animals that participate in fundamental ecological processes in the soil such as decomposition and nutrient cycling [7]. Free-living soil nematodes are sensitive to ecosystem disturbances [8]. They also possess several attributes that make them excellent indicators for evaluating soil conditions [9].

A great limitation to the worldwide production of food crops is damage caused by plant-parasitic nematodes [10]. Plant parasite nematodes are recognized as one of the greatest threats to crops throughout the world [11] and can devastate a wide range of crops plants, causing billions of dollars of agricultural losses each year [12]. All plant parasite nematodes are obligate parasites, feeding exclusively on the cytoplasm of living plant cells [13].

Although nematodes are generally regarded as silent enemies, losses up to 80 percent have been associated with them in vegetable fields that are heavily infested [14]. They have been described as important pests of horticultural crops [15] causing significant reduction in yield.

Among the most important genera of plant parasitic nematodes that have been reported worldwide are *Meloidogyne* (root-knot nematode) and *Heterodera* (cyst nematode). Both the cyst and root-knot nematodes have complex interactions with their host, but there are characteristic differences in their parasitic cycles. They are adapted to parasitize on a large number of plants [16] and are distributed worldwide over a wide range of geographical conditions of tropical, subtropical, and temperate regions of the world [17]. Others include *Pratylenchus spp.* (lesion nematodes), *Ditylenchus spp.* (stem and bulb nematodes) and *Rotylenchus spp.* (reniform nematodes) [18].

Materials and Methods

Study Area

Soils of farmlands around Kware Lake, Kware Local Government Area of Sokoto state were used for the study. Kware is located 20km northeast of the Sokoto metropolis in Nigeria. It is located within longitude 5°16'N and latitude 13°15'E.Kware is flanked by Sahel savanna to the northeast and by the eastern part of river Rima. The vegetation of the area is mostly dominated by grasses and trees (Sudan savannah). It is characterized by two distinct seasons, the short raining season which runs from May to September or October depending on the rainfall pattern of the year, the long dry season start from October to April. The humidity is less than 20% and a temperature range from 20ºc to 42ºc.

Sample collection

Soil samples were collected from three difference farmlands in Kware Lake. The sample was collected at the vicinity of the plant by digging to about 10cm to 15cm deep. The soil sample collected were placed in polythene bags separately and taken to the laboratory for analysis. Besides, part of the root was also collected.

Isolation of parasites

The isolation of the plant parasite nematodes was done in the laboratory using Cobb's decantation technique.

Cobb's decantation technique

This technique is used for the extraction of motile nematodes from soil. It was introduced by [19] and is mainly used for different species of nematodes. In principle, the soil will be washed in water and allow it to settle some minutes and later decanted and nematodes will be collected on sieves of different aperture.

In this method, the soil samples were brought to the laboratory were transferred into a container half-filled with water. The solution was mixed thoroughly for breaking lumps. The mixture stirred was then sieve by pouring it through sieves of varying mesh sizes into basin then the sieve was rinsed and the residue may contain very large nematodes.

To collect the residue, the sieve was turn upside down on the edge of the Petri dish, so that the residue was washed down using a gentle stream of water into a petridish. This was then observed under a dissecting microscope from here the nematodes that were found were put under in preserving bottle using a handling needle.

Isolation from root involves macerating the plant root which was then transferred into a container with water. The solution was missed thoroughly and sieve as above. The residue was observed under the microscope (×10).

Slides preparation

A drop of water was put on glass slide then, the forceps were used to pick the nematode from the Petri dish into the drop of water on the glass slide and a coverslip was used to cover it. Then a drop of iodine was used in staining the sample.

Nematode identification

The slides prepared were viewed using a compound microscope and their pictures were taken using the phone camera which later was compared using a different picture of different genera of plant-parasitic nematodes [20].

Statistical Analysis

Analysis of variance (ANOVA) was used in analyzing the data obtained from three sampling sites (A, B, and C) to ascertain the distribution of different plant-parasitic nematodes.

Results

The results below show the distribution of nematodes in soils of farmlands around Kware lake. A total number of 135 species of plant-parasitic nematodes were examined in both sampling sites A, B and C. Whereas the sampling site "A" has a total number of 40 different species of plant-parasitic nematodes. *Meloidogyne* species has the highest percentage (17.5%) and the least frequently examined species were *Pratylenchus* species with a total percentage of (5.0%), it appears to be less because they are migratory endoparasites that feed and reproduce in the root and move around. Unlike the cyst and root-knot nematodes, which stay in one place.

While the sampling site "B" also has a total of 36, the most abundant plant-parasitic nematodes observed were *Xiphinema species* with the total percentage of (27.78%), whereas the least species were *Rotylenchus species* and *Trichodorus species with* a total percentage of (13.89%). The genus Rotylenchus prefers sandy soil to survive in fallow soil for up to 6 months with mortality usually not exceeding 50%, it causes damage which affects the size and shape of corns. Whereas the sampling site "C" has the highest number with a total of 56 different genera of nematodes, and also *Meloidogyne species* were observed to be the most dominant species with a total percentage of (30.56%). The root-knot nematodes feed and mature inside the root of plants. Their feeding induces abnormal enlargement of the root, called galls. And they are also the most abundant plant-parasitic nematodes found in worldwide and whereas the least species were *Pratylenchus species* with a total percentage of (1.79%).

Table 1: Species of nematodes isolated from soil samples collected from Site A of Kware Lake, Sokoto State.

Species	**Number isolated from each soil sample**					**Total**	**Percentage**
	I	**II**	**III**	**IV**	**V**		**(%)**
Xiphinema spp.	2	0	3	0	2	7	17.5
Meloidogyne spp.	3	4	1	2	1	11	27.5
Heterodera spp.	1	1	2	0	1	5	12.5
Longidorus spp.	2	0	2	3	1	8	20.0
Trichodorus spp.	1	3	1	2	0	7	17.5
Pratylenchus spp.	1	1	0	0	0	2	5.0
Total	**10**	**9**	**9**	**7**	**5**	**40**	**100**
Species richness	**6**	**4**	**5**	**3**	**4**	**6**	

Table 2: Species of nematodes isolated from soil samples collected from site B of Kware Lake, Sokoto State.

Species	Number isolated from each soil sample					Total	Percentage
	I	**II**	**III**	**IV**	**V**		**(%)**
Xiphinema spp.	0	2	2	5	1	10	27.78
Meloidogyne spp.	3	2	2	0	2	9	25.00
Longidorus spp.	2	4	1	0	0	7	19.44
Trichodorus spp.	1	0	0	2	2	5	13.89
Rotylenchus spp.	1	2	0	2	0	5	13.89
Total	7	10	5	9	5	36	100
Species richness	4	4	3	3	3	5	

Table 3: Species of nematodes isolated from soil samples collected from Site C of Kware Lake.

Species	Number isolated from each soil sample					Total	Percentage
	I	**II**	**III**	**IV**	**V**		**(%)**
Xiphinema spp.	3	0	3	1	2	9	16.07
Meloidogyne spp.	5	4	2	5	1	17	30.56
Heterodera spp.	0	1	0	2	0	3	5.36
Longidorus spp.	2	1	0	1	3	7	12.5
Trichodorus spp.	1	2	1	2	4	10	17.85
Rotylenchus spp.	2	3	4	0	0	9	16.07
Pratylenchus spp.	1	0	0	0	0	1	1.79
Total	14	11	10	11	10	56	100
Species richness	6	5	4	5	4	7	

Table 4: Soil nematode species identified from farmland around Kware Lake, Kware Local Government Area, Sokoto State.

Species	Number isolated from each sampling sites			Total	Percentage
	A	**B**	**C**		**(%)**
Xiphinema spp.	7	10	9	26	19.25
Meloidogyne spp.	14	9	17	40	29.63
Heterodera spp.	5	0	3	8	5.93
Longidorus spp.	8	7	7	22	16.30
Trichodorus spp.	7	5	10	22	16.30
Rotylenchus spp.	0	5	9	14	10.37
Pratylenchus spp.	2	0	1	3	2.22
Total	43	36	56	135	100
Species richness	6	5	7	7	

F. Cal. = 0,714. df 2, 18 at P<0.05, F. Tab. = 3.56

Table 5: Diversity index of nematodes isolated from farmland around Kware lake.

Species	Number isolated	*Pi*		
Xiphinema spp.	26	0.193	– 1.64	0.32
Meloidogyne spp.	40	0.296	– 1.22	0.36
Heterodera spp.	8	0.059	– 2.83	0.17
Longidorus spp.	22	0.163	– 1.81	0.30
Trichodorus spp.	22	0.163	– 1.81	0.30
Rotylenchus spp.	14	0.104	– 2.26	0.24
Pratylenchus spp.	3	0.022	– 3.82	0.08
Total	135			1.77

Pi= Number of individual species /Total number
Evenness = 0.9

Discussion

From the study, it can be observed that seven genera of nematodes were identified in total, with variations in species richness with respect to sampling sites. The high density of nematodes occurred in site C (56 nematodes/400g of soil) while site B was the least in abundance (36 nematodes/400g of soil). Some species detected in site C were absent in the other sampling sites. Detection of plant parasitic nematodes in soils could be due to the function of soil as a medium by which the nematodes search for host plants [21]. This result agreed with the findings of [22] whereby nematodes were detected in the rhizosphere soils of farmlands in Nomansland and Salanta. The result also agreed with the findings of [23] in which some nematodes were found present in some sampling sites and absent in others.

The most occurring plant-parasitic nematodes identified were *Meloidogyne spp.* (29.63%) and *Xiphinema spp.* (19.25%) while the least species isolated were *Pratylenchus spp.* (2.22%). *Meloidogyne spp.* was species with the highest abundance in site A and site C as the crops grown there suitable hosts for the nematode [24]. The high density of *Meloidogyne spp.* was in line with the fact that *Meloidogyne spp.* was the widely most abundant nematode present worldwide [17].

Xiphinema spp. are also abundant in the soils of the study area. They are the most abundant in site B. They tend to occur more in vegetable crops [25] as they are the major crops grown there. This can also be ascertained by the ability of these nematodes to withstand harsh conditions in the soil [26].

Trichodorus spp. and Longidorus spp. are also present in the soil. These species tend to infest flowers and could be less in the soil samples [27]. *Rotylenchus spp.* are less in abundance in the soil. Their low densities could be ascertained by their slow rate of reproduction and their high sensitivity to disturbances [28].

Heterodera spp. was found in the two of the sampling sites but absent in the other and is found to be less in abundance. The rationale behind these was due to the fact that these nematode species tend to have narrow range of hosts due to crop rotation as confirmed by [29].

Pratylenchus spp. was least in population in the sampling sites detected as they are migratory endoparasites with all stages found in the root cortex. Low soil populations can be associated with high root populations. The nematodes feed mainly on cortex cells and form cavities [30];[31];[32].

According to [33] the ten most economically damaging nematode genera are; *Meloidogyne, Pratylenchus, Heterodera, Ditylenchus, Globodera, Tylenchulus, Xiphinema, Rotylenchus and Helicotylenchus*.

The result also showed a wide diversity of nematodes inhabiting the soil of the farmlands of the study area with diversity index of 1.77. The data according to statistical analysis shows there is no significant difference in nematode species occurrence between the three locations due to ANOVA calculated value (0.756) is less than the tabulated value (3.56) at $p<0.05$. This also supports the findings of [22] that, there was no significant difference in nematode species occurrence between Salanta and Nomans land farmlands.

Conclusion

Soils of farmlands around Kware Lake harbor nematodes. Nematodes are widely distributed within the study area and are most abundant in the Southern location of the lake (56 nematodes/400g of soil). The detected nematodes were *Xiphinema spp., Heterodera spp.,*

Trichodorus spp., Meloidogyne spp., Rotylenchus spp., Longidorus spp., and *Pratylenchus spp.* The most common nematode species present are the *Meloidogyne spp.* while *Pratylenchus spp* are the least in abundance. The presence of the detected plant-parasitic nematodes across all stations of the lake highlights the extent of risk the exposed cultivated crops are in, which might, in turn, affect crop yield and productivity.

Recommendations

Farmers should adopt a method of crop rotation that will narrow the host range of parasitic nematodes. Planting of resistant crop varieties is also recommended for the control of nematodes.

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