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PLANT PARASITIC NEMATODES ASSOCIATED WITH SELECTED AGRICULTURAL SOILS IN KWARA STATE, NIGERIA

Ahmed, O., Izuogu, N. B., Baba, H. S & Kalejaiye, N. A

Department of Crop Protection Faculty of Agriculture University of Ilorin PMB 1515 Ilorin, Nigeria
Corresponding author email: ahmelad2007@yahoo.com

ABSTRACT

Plant parasitic nematodes have caused huge yield loss on all agricultural crops. Knowledge of the type and quantity of these pathogens in soils is an indication of the risk of disease development in the crops grown on the soils. This study was carried out to determine the plant parasitic nematode composition of selected agricultural soils in Kwara State, Nigeria. Three sample locations from each of the forest and savannah agro-ecological zones of the state were selected for the study. Soil samples were taken from the rhizosphere of five crops commonly grown in each of the six sample locations (Celosia sp. Cowpea, Maize, Soybean and Teak) using soil auger. Nematodes were extracted using the modified Bearmann technique and the nematodes were identified using standard identification key. The identity of the nematodes was confirmed at the International Institute for Tropical Agriculture (IITA), Ibadan. A total of six nematode genera namely, *Meloidogyne* sp., *Helicotylenchus* sp., *Scutellonema* sp., *Pratylenchus* sp., *Rotylenchus* sp., and *Tylenchus* sp. were isolated with *Meloidogyne* sp. having the highest frequency of occurrence in most of the sampled locations and crops. The implication of nematodes in agricultural soils is discussed.

Key words: Nematodes; Agricultural soils; Kwara State; Agro-ecology

INTRODUCTION

Plant parasitic nematodes are non-segmented, bilaterally symmetrical worm-like invertebrates that possess a body cavity and a complete digestive system but lacks respiratory and circulatory systems (Chitwood, 2002). Nematodes are found in all agricultural soils where they play different roles. According to Ingham and Moidenke (2000), they can help in nutrient cycling. Nutrients such as ammonium ($NH4+$), stored in the bodies of bacteria and fungi, are released when nematodes eat them. The bacteria and fungi contain more nitrogen than the nematodes need, so the excess is released into the soil in a more stable form where it can be used by plants or other soil organisms. Nematodes also physically break down organic matter which increases its surface area, making it easier for other organisms to break it down further. They can also bring about dispersal of microbes. Bacteria and fungi cannot move around in the soil without 'hitching a ride' inside or on the back of nematodes.

Nematodes are common economic pests of agricultural crops causing considerable reduction in the yield of many crops including vegetables (Nchore *et al*., 2010). Yield losses normally results from changes brought about in the morphology and physiology of the roots of affected crops.

Chitwood (2003) reported that plant parasitic nematodes cause annual crop losses estimated at USDI 25 billion worldwide.

All crops are susceptible to nematodes (Gregory et al., 2017). Total crop failures may occur when crops are planted in areas with high nematode population levels (Noling, 2012). Plant symptoms which develop in response to nematode parasitism are generally those associated with root dysfunction (Noling, 2012). Development of small, stunted and chlorotic plants generally reflects reduced water and nutrient uptake caused by injury to the root system. The damage to plant tissues by nematodes infecting the shoot includes reduced vigor, distortion of plants parts and death of infected tissues depending upon the nematode species (Lambert and Bekel, 2002).

Damages due to plant parasitic nematodes have been reported on sugar cane (Afolami et al, 2014) *Musa* spp. (Okafor et al, 2015) and other crops in Nigeria. Nematode disease episodes may cause losses of, up to 80%, on vegetables (Galip, 2007; Nchore *et al.,* 2011).

There have been several other reports on the effect of plant parasitic nematodes on the crops they parasitize and their management (Jackson, 1962; Egunjobi, 2014; Talwana et al, 2016; Baba et al, 2018). There is, however, limited available reports on the diversity of nematodes populations in agricultural soils particularly in Kwara State, Nigeria. This study was, therefore, carried out to provide information on the types of plant parasitic nematodes associated with the soils. The information will no doubt help in informing farmers on the likely risks of disease development in crops planted in the soils with the view to planning effective management strategies to forestall the problem.

MATERIALS AND METHODS

Description of the study areas

Soil samples were collected from six locations in Kwara State. Three of the six locations belong to the Forest agro-ecology of the state while the other three locations belong to the Savannah agro-ecology of the state. The soil samples were taken from five commonly grown crops in all the six locations. The three locations selected from forest agro-ecology were Ifelodun, Offa and Oyun Local Government Areas and those from the savannah agro-ecology were Ilorin East, Ilorin South and Moro Local Government Areas. The five commonly grown crops in the sampled areas were *Celosia* sp. Cowpea, Maize, Soybean and Teak. Table 1 gives the summary of the description of the sample areas. The location of the sample areas on map is shown in Table 1.

Table1: **List of sampling sites**

Sample No	Site location	GPS Coordinates	Classification
S1	Ilorin South	Lat 8.4347ºN Long4.6657ºE	Savannah agro ecology
S2	Ilorin East	Lat 8.6083ºN Lat 4.7899ºE	Savannah agro ecology
S3	Ifelodun	Lat 8.5381ºN Long 5.1432ºE	Forest agro ecology
S4	Moro	Lat 8.8449ºN Long 4.5567ºE	Savannah agro ecology
S5	Offa	Lat 8.1393ºN Long 4.7174ºE	Forest agro ecology
S6	Oyun	Lat 8.1633ºN Long 4.6606ºE	Forest agro ecology

Source: Authors' field survey (2018)

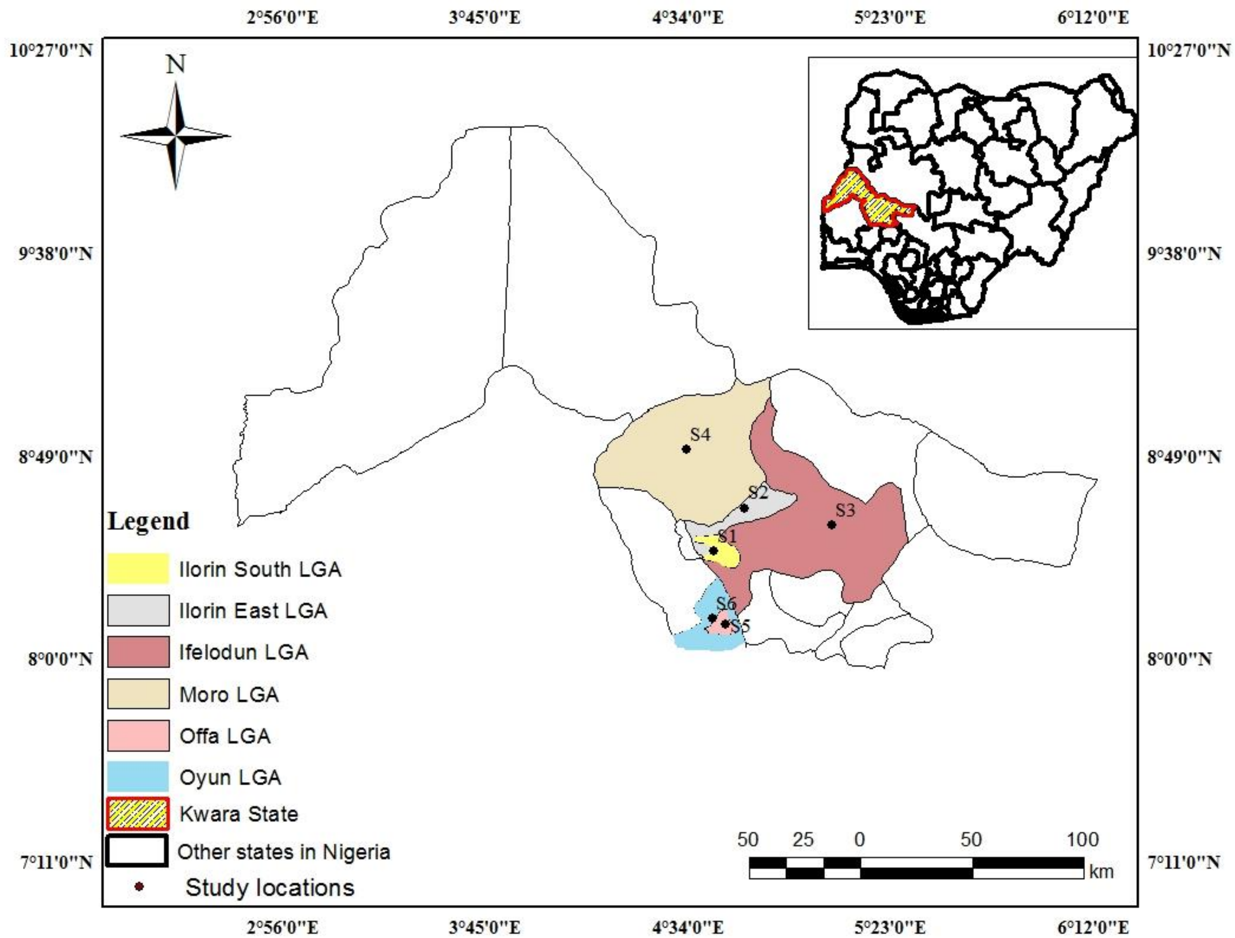

Plate 1: Map of Kwara State showing the sampling locations

Soil Samples Collection

Three farms under intensive production of each crop were randomly selected from each of the areas described above. Soil samples were taken from the rhizosphere of each crop in each farm from five points using a soil auger. The soil auger was sterilized using ethanol after every sampling point to avoid cross contamination.

The soil samples collected from all the five points in each crop farm were mixed in a bucket to make one composite sample. A 1kg of soil was then re-sampled from the composite sample, put in plastic bags. All the samples were later transported to the Research Laboratory of the Department of Crop Protection Faculty of Agriculture, University of Ilorin for extraction of nematodes.

Extraction and Identification of Nematodes

Nematodes were extracted using the modified Bearmann technique as described by Kleynhans, (1999). Soil lumps were broken, stones and plant debris removed. 200 grams of the sampled soil was spread evenly on a circle of double ply paper towel (serviette) supported on a coarse meshed plastic screen standing in a plastic container. Water was added to the container until the soil was thoroughly wet but not immersed. The container was covered with a large Petri dish to reduce evaporation of the water. The set up was left for at least 24 hours. Soil was then removed, discarded and the nematode suspension was poured from the container into sample bottles. Preliminary identification and counting of the extracted nematodes were carried out. The nematodes were identified using nematode identification key as described by Armen *et al*. (1977), counting was done by drawing 2ml of nematode suspension with a micropipette, the suspension was then placed into a counting dish where counting was done under a compound microscope at 40x magnification. Further identification and counting were requested in the Pathology Laboratory of the International Institute for Tropical Agriculture (IITA) for confirmation.

Data analysis

Data on the occurrence of the different types and the numbers of nematodes was recorded and transformation was done using log transformation. Analysis of variance was carried out using the SPSS Statistical package version 21. Comparison of means was done using the Tukey's HSD at 5% level of significance.

RESULTS

A total of six nematode genera were isolated and identified in all the sampled soils in the different agro ecological zones of Kwara State. They were; *Meloidogyne* sp., *Helicotylenchus* sp., *Scutellonema* sp., *Pratylenchus* sp., *Rotylenchus* sp., and *Tylenchus* sp. The nematodes and their population (mean number) are shown in Table 2. The results showed a significantly different ($p<0.05$) mean number of *Meloidogyne* sp. and *Helicotylenchus* sp while there was no significant difference ($p>0.05$) in the mean number of the other nematodes. The mean number of *Meloidogyne* sp. was highest in Offa (1.62) followed by Ilorin East (0.99). The mean number of *Helicotylenchus* sp. was highest in Ilorin east (2.90) followed by Ilorin south (1.25) and Offa (1.03).

Table 2: Occurrence of Nematodes in the Rhizosphere of soils in the selected agro ecologies of Kwara State

	Mean number of Nematodes 200g-¹ dry weight of soil					
Location	*Meloidogyne* sp.	*Helicotylenchus* sp.	*Scutellonema* sp.	*Pratylenchus* sp.	*Rotylenchus* sp.	*Tylenchus* sp.
Ifelodun	0.93a	0.71a	0.71	0.71	0.71	0.71
Ilorin south	0.93a	1.25a	0.82	0.93	0.71	0.82
Ilorin east	0.99ab	2.90b	0.82	1.04	0.82	0.71
Moro	0.71a	0.88a	0.71	0.71	0.71	0.71
Offa	1.62b	1.03a	0.82	0.71	0.71	0.82
Oyun	0.71a	0.88a	0.71	0.71	0.07	0.82
SEM	0.17*	0.28*	0.08NS	0.09NS	0.07NS	0.09NS

Mean values followed by the same letter are not significantly different at α = 0.05 by Tukey's HSD

NS (Not significantly different α = 0.05)

***(Significantly different at α = 0.05)**

Results in Table 3 revealed that the nematodes have preference for different crops, even though the mean numbers of the isolated nematodes were not different significantly ($p>0.05$) for the crops. It was shown that *Meloidogyne* sp. was most predominant in cowpea and soybean with mean numbers of 1.1 and 1.21 respectively, *Helicotylenchus* sp. was most predominant in *Celosia* sp. and soybean with mean numbers of 1.41 and 1.44 respectively. *Celosia* sp. appears to be the host for largest number of *Scutellonema* sp. (0.89), *Pratylenchus* sp. (0.89) and *Tylenchus* sp. (0.94), while Teak had the lowest number of almost all the nematodes.

Table 3: Occurrence (Mean number) of Nematodes in the Rhizosphere of the selected crops in Kwara State

	Mean number of Nematodes 200g-^{1} dry weight of soil					
Crops	*Meloidogyne* sp.	*Helicotylenchus* sp.	*Scutellonema* sp.	*Pratylenchus* sp.	*Rotylenchus* sp.	*Tylenchus* sp.
Celosia sp.	0.8	1.41	0.89	0.89	0.71	0.94
Cowpea	1.1	1.3	0.71	0.71	0.71	0.8
Maize	0.8	1.32	0.8	0.8	0.85	0.71
Soybean	1.21	1.44	0.71	0.89	0.71	0.71
Teak	0.99	0.89	0.71	0.71	0.71	0.71
SEM	0.15NS	0.26NS	0.07NS	0.09NS	0.07NS	0.08NS

Mean values followed by the same letter are not significantly different at α = 0.05 by Tukey's HSD

NS (Not significantly different at α = 0.05)

Discussion

This study showed that there were differences in population of nematodes in the soils sampled in Kwara State, Nigeria. There was diversity in the population of *Meloidogyne* sp. and *Helicotylenchus* sp. at the different sampled locations which showed nematodes preference for particular sampled soils. The difference in the population may be due to difference in soil moisture and temperature regimes of the different agro-ecologies of the sampled locations. Soil moisture in particular determines nematodes activity rate and food provisions, and consequently changes in its availability may directly impact soil nematode development and community composition (Steinberger *et al.* 2001)

Incidentally, temperature and moisture difference are the major factors that characterised the study areas into the different agro-ecological zones. The forest zone with higher soil moisture and lower temperature supported larger population of the nematodes than the savannah zones with lower soil moisture and higher temperature. The predominance of certain nematodes in certain soil types as observed in this study may be as a result of preference of the nematodes for the crops grown on the soils.

CONCLUSION AND RECOMMENDATIONS

This study revealed that the population of nematodes in the different sampled soils differed. The differences were as a result of the agroecological disparity in the different study areas. Nematodes population was higher in the forest agro-ecology than the savanna agro-ecology. *Meloidogyne* sp. and *Helicotylenchus* sp. were the most predominant nematodes in most of the crops in the sampled soils.

REFERENCES

Afolami S., Solomon S. and Daramola F. (2014) Biodiversity of plant- parasitic nematodes of Sugarcane in Bacita, Nigeria. ***Journal of Entomology and Nematology*** 6(6): 71 – 79.

Armen, C. Tarjan, R. Esser, T and Shih, C. I. (1977). An illustrated key to nematodes found in freshwater. *WPCF*., pp: 2318-2337.

Baba, H. S. Izuogu N. B. Olajide, M. C. Dosunmu, O. O. Ahmed, O. and Saliu, A. R. (2018). Pathogenicity of *Meloidogyne incognita* in Selected Groundnut Varieties and its Management with Aqueous Leaf Extracts of Wild sage (*Lantana camara* L.) and Locust bean (*Parkia biglobosa* Jacq.). ***Agrosearch*** 18 (2): 1 – 14

Chitwood, D. J. (2002). Phytochemical based strategies for nematode control. ***Annual Review Phytopathol.,*** 40: 221-249.

Chitwood, D. J. (2003). Research on plant-parasitic nematode biology conducted by the United States Department of Agriculture–Agricultural Research Service. *Pest* ***Management Science.,*** 59: 748-753.

Egunjobi, O. A. (2014). Nematode and man's welfare. ***Nigerian journal of Nematology*** 2: 3-7

Galip, K. (2007). Effects of soil solarization and organic amendment treatments for controlling Meloidogyne incognita in tomatoe cultivars in western Anatolia. *Turkish* ***Journal of Agriculture and Forestry.,*** 31: 159-167.

Gregory, C. B Marceline, E and Conrad, B (2017). The impact of Plant Parasitic Nematodeson Agriculture and Methods of Control. Nematology Concepts, Diagnosis and Control, Mohammad, M. S and Mohammad, M Intech Open DOI: 10.5772/intechopen. 68958. Available from: https://www.intechopen.com/books/nematology-concepto-diagnosis-and-control/the-impact-of-plant-parasitic-nematodes-on-agriculture-and-methods-of-control

Ingham, R. E. and Moidenke, A. (2000). Soil and water conservation Society. Soil biology Primer. Rev. Ed. Ankeny, Iowa: Soil and water Conservation Society. www.gov/sqi/concepts/soil-biology/biology.html. Accessed on 12/10/2017.

Jackson T. H. (1962). Nematode control trials at Thika, Kenya. In 1960 CCTA Inter-African Plant Nematology Conference, pp. 21–22. Kikuyu, Kenya: CCTA

Kleynhans, K. P. (1999). Collecting and preserving nematodes. A manual for nematology. www.cassavabiz.org/..../NEM-SCR.Pdf. Accessed on 23/10/2012.

Lambert, K. and Bekel, S. (2002). Introduction to plant parasitic nematodes. The plant Health instructor. ***The plant Health instructor.***

Nchore, S.B. Waceke, J.W. and Kariuki, G.M. (2010) Incidence and prevalence of root-knot nematode Meloidogyne species in selected indigenous leafy vegetables in Kisii and Trans-Mara Counties of Kenya. In: **Transforming Agriculture for improved livelihoods through Agricultural Product Value Chains. 12th KARI Biennial Scientific Conference, November 8-12, 2010, Nairobi, Kenya.** KARI, pp. 675-681.

Nchore , S., Waceke, J. W., and Kariuki, G. M. (2011). Use of agro-industrial waste and organic amendments in managing root-knot nematodes in black night shade in selected parts of Kenya. Paper presented at the 10th African Crop Science Conference Proceedings, Maputo, Mozambique Nematophagous Fungi in Soil Visualized by Low Temperature Scanning Electron Microscopy. ***Mycologia.,*** 92: 10-15.

Noling, J. W. (2012). Movement and Toxicity of Nematicides in the Plant Root Zone. edis.ifas.ufl.edu/ng002 Accessed on 15/11/2012.

Ndana, R. W. Oyedunmade, E. E. A. (2010). In-vitro studies of effectiveness of plant extracts compared to Carbofuran in Controlling the Root Knot Nematode *Meloidogyne incognita*. ***Agrosearch*** 10 (1&2): 1-10

Okafor O. E., Ugwuoke K. I., Mba C. L., Okafor F. C. and Mbadianya J. I. (2015). The distribution of plant-parasitic nematodes of Musa spp. in Nsukka Agricultural Ecological zone, Enugu State, Nigeria. ***African Journal of Agricultural Research.*** 10(48): 4338-4347

Oyedunmade, E. E. A and Izuogu, N. B. (2011). Efficacy of Aqueous Extract of Lemon Grass (*Andropogon citratus* L.) against Root-Knot Nematode Pests of Okra. (*Abelmoschus esculentus* (L.) Moench). ***Agrosearch*** 11 (1&2): 31 – 38

Steinberger, Y., Liang, W., Savkina, E., Meshi, T., and Barness, G. (2001). Nematode community composition and diversity associated with a topoclimatic transect in a rain shadow desert. ***European Journal of Soil Biology.,*** 37: 315-320.

Talwana H, Sibanda Z, Wanjohi W, Kimenju W, Luambano-Nyoni N, (2016). Agricultural nematology in East and Southern Africa: problems, management strategies and stakeholder linkages. ***Pest Management Science,*** 72:226–45