

Research Application Summary

**Plant parasitic nematodes associated with cassava in the west senatorial district
of Rivers State, Nigeria**

Tanimola, A.A., Wokoma, E.C. & Brown, Idier-Ipelme
Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt,
PMB 5323, Port Harcourt, Nigeria
Corresponding author: tanimoladebo@yahoo.com

Abstract

Nigeria, though not listed among the five highest yield per hectare producers of cassava is the world's largest producer of the crop while Thailand is the largest exporting country of dried cassava. Plant parasitic nematodes (PPNs) are severe pests contributing to poor growth and yield of the crop. Effective management of PPNs depends on identification and determination of their distribution and population over time and space. This study was conducted to determine the occurrence and population of PPNs in cassava from four Local Government Areas (LGAs): Ahoada East, Ahoada West, Asari-Toru and Degema of Rivers West Senatorial District, Rivers State, Nigeria. Multistage random sampling method was adopted to collect a total of 57 samples from cassava monoculture farms across the four LGAs in the senatorial district. Plant parasitic nematodes were extracted from roots and soil of cassava using standard procedures. Data were processed using descriptive statistics. Five genera of plant parasitic nematodes were encountered in the study: *Meloidogyne* spp., *Pratylenchus* spp., *Gracilacus* spp., *Helicotylenchus* spp. and *Scutellonema* spp. The frequencies of occurrence (FOC) of the PPNs in root samples were 57.78%, 31.1%, and 8.89%, for *Meloidogyne* spp., *Pratylenchus* spp., and *Gracilacus* spp., respectively. A similar trend in occurrence of PPNs was also observed in the soil samples. However, *Gracilacus* species were the most abundant in roots (22.5/10 g roots) and soil (28.75/200 ml soil) of cassava across the four LGAs. *Meloidogyne* species occurred most frequently while *Gracilacus* species was most abundant among the plant-parasitic nematodes of cassava in the study area.

Key words: Cassava, *Gracilacus* spp., *Meloidogyne* spp., Nigeria, plant parasitic nematodes

Résumé

Bien que le rendement du manioc au Nigéria ne soit pas parmi les cinq rendements par hectare les plus élevés, le pays est le premier producteur de manioc au monde pendant que la Thaïlande est la plus grande exportatrice de manioc séché. Les nématodes parasites des plantes sont de dangereux ravageurs qui contribuent à une mauvaise croissance et rendement de la plante. Une gestion efficace des nématodes parasites des plantes dépend de

l'identification et la détermination de leur distribution et de leur population dans le temps et dans l'espace. La présente étude a été menée afin de déterminer l'occurrence et la population de nématode parasites du manioc dans quatre zones gouvernementales locales: Ahoada East, Ahoada West, Asari-Toru et Degema de le district sénatorial de Rivers West dans l'Etat de Rivers au Nigeria. La méthode d'échantillonnage aléatoire stratifié a été adoptée pour recueillir un total de 57 échantillons provenant des champs de manioc en monoculture dans les quatre zones gouvernementales locales dans le district sénatorial. Nématodes parasites des plantes ont été extraits des racines de manioc et du sol en utilisant des procédures standards. Les données ont été traitées à l'aide de statistiques descriptives. Cinq genres de nématodes parasites des plantes ont été recensées dans le milieu d'étude: *Meloidogyne* spp., *Pratylenchus* spp, *Gracilacus* spp, *Helicotylenchus* spp. et *Scutellonema* spp. Les fréquences d'occurrence des nématodes parasites dans des échantillons de racines ont été respectivement de 57,78%, 31,1% et 8,89%, pour *Meloidogyne* spp., *Pratylenchus* spp., et *Gracilacus* spp. Une tendance similaire dans l'occurrence des nématodes parasites a également été observée dans les échantillons de sol. Cependant, les espèces *Gracilacus* étaient les plus abondants dans les racines (22,5 / 10 g de racines) et le sol (28,75 / 200 ml de sol) sous manioc dans les quatre zones gouvernementales locales. Les espèces de *Meloidogyne* ont été le plus souvent détectées alors que les espèces de *Gracilacus* étaient le plus abondant parmi les nématodes parasites des plantes de manioc dans la zone d'étude.

Mots clés: Manioc, *Gracilacus* spp, *Meloidogyne* spp, Nigéria, nématodes parasites des plantes

Background

Cassava (*Manihot esculenta* Crantz) is the fourth most important crop for farmers in the tropics after rice, wheat and sugar, and consumed by up to a billion people globally (FAOSTAT, 2010). It is the third largest source of carbohydrate in the tropics after rice and maize (Fauquet and Fargette, 1990). However, the importance of the crop and the demand to meet the nutritional and other utilization needs of the ever increasing population in Africa and the world has been of great concern. Nigeria is the largest producer of cassava in the world, but the production is characterized by low yield per hectare when compared with production from countries like India, Suriname, Malaysia, amongst others (FAOSTAT, 2015). Cassava suffers from a wide range of pests and pathogens that directly or indirectly reduce its yield both in quality and quantity (Coyne, 1994; James *et al.*, 2000; Coyne *et al.*, 2012).

Plant-parasitic nematodes (PPNs) contribute significantly to poor yield in cassava, causing up to 87-98% yield loss (Caveness, 1982; Coyne *et al.*, 2012). Effective management of PPNs on cassava is unlikely if there is no proper identification and quantification of these nematodes. It has been postulated that land use pattern, climate change and cropping patterns affect the type and distribution of nematodes over time and space (Nicol, 2002). Hence, periodic survey in time and space is necessary to determine the changes in species and population density of nematodes to ensure their proper management.

Studies associating PPNs with cassava in Nigeria have been previously reported (Caveness, 1982; McSorley *et al.*, 1983; Coyne, 1994). Recent information on nematodes of cassava in Nigeria and specifically in Rivers State is scant when compared with other crops. Recently, Asimiea *et al.* (2015) reported the emergence of *Gracilacus* species amongst other PPNs on cassava in a survey of nematodes from three Local Government Areas (LGAs) of Rivers State. *Gracilacus* species have not been reported on cassava in Nigeria earlier or in many cassava growing regions of the world. Hence, it is important to carry out extensive and detailed survey covering more cassava growing areas in Rivers State to ascertain whether the trend in the three LGAs reported by Asimiea *et al.* (2015) cuts across Rivers State, and possibly the South-South (Niger Delta) region of Nigeria. The objective of this study was to identify PPNs associated with cassava and determine their population densities with a view to ensuring their effective management and thereby improving cassava yield.

Literature summary

Cassava, *Manihot esculenta* Crantz probably originated from West Central Brazil where it was first domesticated 10,000 years ago (Oslen and Schaal, 1999). Cassava was introduced into Africa by Portuguese traders from Brazil in the sixteenth century (Agboola, 1968). It is now a staple food in the developing world, providing a basic diet for over half a billion people. Cassava was introduced into Southern Nigeria during the period of slave trade and proliferated by Portuguese explorers from Brazil (Adeniji *et al.*, 2005). It is the chief source of dietary food energy for the majority of the people living in the lowland tropics, and much of the sub-humid tropics of West Africa (Tsegia and Kormawa, 2002; Adeniji *et al.*, 2005).

Nigeria is the largest producer of cassava in the world with a production statistic of 53 million metric tonnes (MT) in 2013 (FAOSTAT, 2015). The other top four producers of cassava in the world are Thailand (30.2 million MT), Indonesia (23.9 million MT), Brazil (21.5 million MT) and Democratic Republic of Congo (16.5 million MT) (FAOSTAT, 2015). However, Nigeria and many African countries are not among the five top countries delivering highest yields of cassava in the world. The five countries with highest yield of cassava per hectare as listed are India, Suriname, Malaysia, Cook Islands, and Lao's People Democratic Republic (FAOSTAT, 2015). For instance, Nigeria recorded a lower yield of 13,947 kg/ha from cassava in 2013, whereas, India had a yield of 34,959 kg/ha (FAOSTAT, 2015). Africa holds almost 62% of the total world areas where cassava is cultivated, but only about 50% of the world's harvest. Asia produces 30% of the world's cassava in an area that represents 23% of the total, thus indicating that the continent has high productivity (IFAD and FAO, 2000; Howeler, 2006).

Cassava suffers from a wide range of pests and pathogens that directly or indirectly reduce its yield both in quality and quantity (Coyne, 1994; James *et al.*, 2000). Notable among these pests and pathogens are insects, viruses, bacteria, fungi and plant-parasitic nematodes (Coyne, 1994). Information on the type and population of PPNs of cassava in the Niger Delta region of Nigeria over time is scant, although there are few reports of nematodes attacking other field crops in Nigeria (Olaniyi 2014; Olaniyi and Osuloye, 2014; Nzeako *et al.*, 2015; Okafor *et al.*, 2015; Wokoma *et al.*, 2015).

Study description

The survey on PPNs of cassava in the Rivers West Senatorial District (RWSD) was conducted in February and March 2015 using the multi-stage random sampling method as described by Adesoye (2011). Four LGAs out of eight were randomly selected in the RWSD, then three farming communities in each selected LGA were also chosen and five farms where cassava was grown in monoculture were further selected per farming community for the survey. A total of 57 cassava monoculture farms were visited across the four LGAs in the RWSD.

Roots of cassava and soil at the rhizosphere were collected from the farms for extraction and identification of plant-parasitic nematodes. Fifteen cassava stands were randomly selected per farm and soil samples (250 ml) were collected at the rhizosphere of each cassava stand to a depth of 15 cm, with a hand trowel. Soil samples from each farm were bulked in a polyethylene bag. Subsequently, tender roots per cassava stand were cut with a knife after removing soil from the roots. The roots were bulked along with the soil collected from the same cassava stand per farm. A total of 57 bulked soil and root samples from the four LGAs in the RWSD, Rivers State, Nigeria were transported to the Nematology laboratory in the Department of Crop and Soil Science, University of Port Harcourt.

Plant parasitic nematodes were extracted from the soil in the laboratory using the extraction tray method (Whitehead and Hemming, 1965; Coyne *et al.*, 2007), while PPNs were extracted from cassava roots using the modified maceration and extraction tray method (Whitehead and Hemming, 1965; Coyne *et al.*, 2007). The identification and quantification of PPNs was carried out using standard procedure as described by Dropkin and Smith (1980) both at Nematology research laboratories of the Department of Crop and Soil Science, Port Harcourt and the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. Descriptive statistics (% frequency and mean) were used to present information on occurrence of plant-parasitic nematode and their abundance.

Research application

The frequency of occurrence (FOC) of PPNs in soil and roots of cassava across the four LGAs in the RWSD showed that *Meloidogyne* spp. were the most common in soil with (FOC 41.38%), followed by *Pratylenchus* spp. (FOC 26.73%), *Gracilacus* spp. (FOC 20.69%), *Helicotylenchus* spp. (FOC 10.34%), and *Scutellonema* spp. (FOC 0.86%) (Table 1). *Meloidogyne* spp. (FOC 57.78%) was the highest occurring genus of PPNs in the roots of cassava, followed by *Pratylenchus* spp. (FOC 31.11%), *Gracilacus* spp. (FOC 8.90%) and *Helicotylenchus* spp. (FOC 2.22%). *Scutellonema* species were not encountered in the roots of cassava RWSD (Table 1).

Gracilacus species had the highest mean population of 28.75/ 200 ml soil which translated to 32.5% of the total nematode population found in the soil cultivated with cassava across the four LGAs in RWSD. *Pratylenchus* spp. had a mean population of 22.9/200 ml soil (25.9%), and *Scutellonema* spp. had the lowest population of 5/200 ml soil (5.7%) (Table 2). In the roots, *Gracilacus* species were the most abundant with a mean population of 22.6/10g (33.6%), followed by *Pratylenchus* species (18.9/10g) (28.1%).

Table 1. Frequency of occurrence of plant parasitic nematodes associated with cassava from four local government areas of the West Senatorial District, Rivers State, Nigeria

Nematode genera	Medium	Samples containing species	Absolute frequency (%)	Relative frequency (%)
<i>Helicotylenchus</i> spp.	Root	1	1.75	2.22
<i>Pratylenchus</i> spp.		14	24.56	31.11
<i>Scutellonema</i> spp.		0	0	0
<i>Gracilacus</i> spp.		4	7.02	8.89
<i>Meloidogyne</i> spp.		26	45.61	57.78
Total			78.94	100
Sample size = 57				
<i>Helicotylenchus</i> spp.	Soil	12	21.05	10.34
<i>Pratylenchus</i> spp.		31	54.39	26.73
<i>Scutellonema</i> spp.		1	1.75	0.86
<i>Gracilacus</i> spp.		24	42.11	20.69
<i>Meloidogyne</i> spp.		48	84.21	41.38
Total			203.51	100
Sample size = 57				

Table 2. Population of plant-parasitic nematodes in soil and roots of cassava grown in the West Senatorial District of Rivers State, Nigeria

Nematode genera	Soil		Roots	
	Nematode population**	% Nematode population***	Nematode population/10 g	% Nematode population***
<i>Meloidogyne</i> spp.	21.33	24.1	15.69	23.4
<i>Gracillacus</i> spp.	28.75	32.5	22.5	33.6
<i>Scutellonema</i> spp.	5	5.7	0	0
<i>Pratylenchus</i> spp.	22.9	25.9	18.85	28.1
<i>Helicotylenchus</i> spp.	10.5	11.8	10	14.9
Total	88.48	100	67.04	100
Sample size = 57				

** Nematode population per 200 ml of soil

*** $\text{In/TN} \times 100/1$ (In = individual nematode in all the samples and TN = Total Population of all nematodes extracted in all the samples)

The outcome of the survey revealed important nematode genera such as *Meloidogyne*, *Helicotylenchus*, *Scutellonema*, *Pratylenchus* and *Gracilacus*. The present study showed *Meloidogyne* and *Pratylenchus* genera as the most frequently encountered PPNs on cassava. However, *Gracilacus* is also one of the emerging PPNs associated with cassava across the four LGAs. This finding corroborated the report of Asimiea *et al.* (2015) on the possibility of the emergence of *Gracilacus* as one of the key PPNs of cassava. The abundance of *Gracilacus* on cassava roots and soil more than the widely reported *Meloidogyne* (McSorley *et al.*, 1983) indicates that the environment is conducive for its development and reproduction. The findings further indicate that the cassava varieties cultivated in the RWSD are susceptible to *Gracilacus* species. Generally, the change in the trend of nematodes associated with cassava due to the emergence of *Gracilacus* species might be a consequence of changes in climate and cropping patterns, amongst others (Nicol, 2002).

The outcome of this study has stimulated further research in terms of more extensive survey on PPNs associated with cassava in Nigeria and other cassava growing countries in Africa. Also, detailed studies on histopathology, life cycle, pathogenicity and possibly management of *Gracilacus* species on cassava should be carried out to determine its status either as a key or just an associated nematode pest of cassava. Such studies would reveal the effect of *Gracilacus* spp. on cassava since high population of several nematodes can cause direct root destruction and eventual growth and yield reduction.

Acknowledgement

Funding for presenting this paper at the Fifth RUFORUM Biennial Conference, 17-21 October 2016 in Cape Town, South Africa, was provided by Carnegie Corporation of New York through support to RUFORUM. This paper is a contribution to the 2016 Fifth African Higher Education Week and RUFORUM Biennial Conference.

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