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A survey of plant-parasitic nematodes of yam farms in Awka-North local government area, Anambra state, Nigeria.

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ABSTRACT

Objective: Soil-inhabiting plant parasitic nematodes of yam were investigated in yam fields in Awka-North Local Government Area of Anambra state, Nigeria.

Methodology and Results: Three farmlands each were randomly selected for sampling from the seven communities that make up the study area. Five yam plants were also randomly selected from each farm for sampling. Soil samples around the roots of each plant were collected using a hand trowel at a depth of 15-30 cm. The relative percentage composition of nematodes in soils and yam tubers from each of the sampled communities (in 10mL of extract suspension) was determined at the International Institute of Tropical Agriculture (IITA), Ibadan. The results showed that *Pratylenchus sp.* 140 (40.60%) were the most prevalent species in the soil samples followed by *Meloidogyne sp*. 95 (27.54%), *Scutellonema sp*. 50 (14.50%), *Helicotylenchus spp*. 25 (7.25%), *Criconema sp*. 20 (5.80%), *Radopholus sp*. 10 (2.90%) and cysts of *Heterodera sp*. being the least prevalent with prevalence rate of 5 (1.45%). Similarly, out of the 180 plant parasitic nematodes recovered from the yam tubers, 130 (72.22%) were *Pratylenchus spp*., 40 (22.24%) were *Scutellonema spp*., 5 each (2.78%) were *Meloidogyne spp*. and *Radopholus spp*. respectively. However, *Helicotylenchus spp., Criconema spp*. and cyst nematodes were not encountered in yam tuber samples. Amansea and Isuaniocha had the highest level of both soil and yam parasitic nematode infestation, although difference with respect to percentage composition of nematodes in the samples and the communities were not significantly different (P>0.05). However, there was a significant difference (P< 0.05) between the number of nematode genera encountered in the soil and tuber samples.

Conclusion and application of results: The presence of these parasitic nematodes in the study area suggests that they can be important pathogens of yams although their presence has usually been neglected. The presence of these plant parasitic nematodes could constitute serious impediments to the growth and yield of yams in Awka-North L.G.A.

Key Words: Soil nematodes, *Meloidogyne*, *Helicotylenchus*, *Dioscorea* spp.

INTRODUCTION

Yam (*Dioscorea* spp.) is an annual or perennial tuber-bearing and climbing plant that grows for 6-12 months depending on the cultivar, ecology and soil properties in the production area (NRCRI, 1998). It belongs to the genus *Dioscorea* and family Dioscoreaceae. There are over 600 species out of which 6 are economically important in terms of food and medicine (IITA, 2009). Though it originated in South-East Asia, it is cultivated mostly in West Africa where approximately 95% of world annual production (37 million tonnes) is grown (FAO, 2004). Yam is grown on 5 million hectares in about 47 countries of the world with Nigeria as the leading world producer (FAO, 2005; IITA, 2009). In 2005, 48.7 million tons of yams were produced in the world and 97% of these were in Sub-Saharan Africa, which accounts for 70% of world production grown on 2.83 million hectares of land (CGIAR, 2009 and IITA, 2009). Food and Agricultural Organisation (FAO, 1985) reported that Nigeria produced 18.3 million tonnes of yam, representing 73.8% of total yam production in Africa. According to their year 2008 figures, yam production in Nigeria has nearly doubled since 1985 with Nigeria producing 35.017 million tonnes, value equivalent to US$ 5.654 billion. In addition, International Institute of Tropical Agriculture (IITA, 2011) reported that Nigeria accounted for about 70% of the world production amounting to 17 million tonnes from land area of 2,837,000 hectares. It is a tropical tuber crop grown as a source of carbohydrate but also for use in ceremonial activities (Mudiope *et al*., 2007). Yam serves as staple food in many tropical and sub-tropical countries of the world and in Nigeria the principal source of carbohydrate. In Nigeria also, it is one of the principal tuber crops in the nation's economy in terms of land under cultivation, in the volume and value of production (Bamire and Amujoyegbe, 2005). The crop is also used for cultural events including marriages and annual festivals especially in the South-Eastern part of the country. Among the various constraints to yam production are nematode pests, which are of significant importance (Bridge *et al*., 2005). Plant-parasitic nematodes are microscopic roundworms that are widely distributed and persist as soil plant pest for indefinite period (Obuezie and Ikpeze, 2012). A large number of plant parasitic nematodes associated with yam cultivation have been reported from various yam-producing areas of the world. In West Africa, the yam nematode, *Scutellonema bradys*, is a major causal agent of dry rot (Coyne *et al*., 2006) while in Central America, *Pratylenchus sp*. causes similar damage to that of *S. bradys* (Acosta and Ayala, 1976). *Meloidogyne sp.* can also cause in field and post-harvest losses to yam (Bridge *et al*., 2005). In Nigeria, a host of plant parasitic nematodes were encountered from both root and soil samples from Edo, Ekiti and Oyo states. *Scutellonema sp., Pratylenchus sp. and Meloidogyne sp.* were most widely distributed in both samples from the three states (Adegbite *et al*., 2006). Presently, there is a dearth of published information on parasitic nematodes of yam in Anambra State, South-eastern part of Nigeria where yam is cultivated and used in large quantities. Against this background, the present study therefore was undertaken to establish the species and prevalence rate of plant parasitic nematodes causing damage to yams in farms in Awka North Local Government Area of Anambra state, Nigeria.

MATERIALS AND METHODS

Study Area: Awka-North Local Government Area is located in the central senatorial zone of the geopolitical arrangement of Anambra State. It is one of the twenty-one Local Government Areas that make up the State. It is comprised of ten different communities with Achalla the headquarters. Other communities are Amansea, Amanuke, Ebenebe, Awba-ofemili, Isuaniocha, Mgbakwu, Ugbene, Ugbenu and Urum. The study area was within the tropical rainforest biome of Nigeria. Two seasons, dry and wet operate within the study area. The dry season usually runs from November to March while the wet season runs from April to October. The annual rainfall ranges from 2,000 to 3,000 mm. Occupation of the people include agriculture, trading and civil service. Fertility of their soil supports the cropping of yams, cocoyam, maize and vegetables.

Some communities like Achalla, Awba-ofemili and Ebenebe cultivate rice as well. Many homesteads in addition to crop cultivation keep domestic livestock such as chicken, goats and sheep.

Sampling techniques for nematodes of yam: Three farmlands each were randomly selected for sampling from the seven communities that make up the study area namely; Achalla, Amansea, Amanuke, Ebenebe, Mgbakwu, Isuaniocha and Urum. Five yam plants were also randomly selected from each farm for sampling. Soil samples around the roots of each plant were collected using a hand trowel at a depth of 15-30 cm as recommended by Coyne *et al*. (2009). Samples of whole yam tubers were collected from the farmers. For each yam tuber collected, the level of damage was scored as recommended by Coyne *et al*. (2009).

Nematode Extraction and Identification: Samples of both soil and whole yam tuber from each farm were sealed in black polythene bags and placed in a cooler to protect them from the heat of the sun. The samples were properly labelled and taken to the International Institute of Tropical Agriculture (IITA), Ibadan Nematology laboratory for extraction and identification of the parasitic nematodes.

Extraction of nematodes from the soil samples: The extraction of plant parasitic nematodes from the soil sample was carried out using the extraction tray method, which is the modified Baerman's funnel method (Ravichandra, 2012). Each soil sample was thoroughly mixed and using a coarse sieve, debris and stones were removed by passing the soil through the sieve into a plastic plate. A sub-sample of 100mL of soil was removed using a calibrated beaker. The extraction paper was placed in a plastic sieve that was subsequently placed on a plastic plate. The base of the sieve was fully covered by the extraction paper, and then the apparatus was labelled. The soil sample (100mL) was placed on the extraction paper in the sieve. Water (150mL) was initially added to the extraction plates between the edges of the sieve and the sides of the plate, ensuring that water was not poured onto the extraction paper or the soil. The set up was left to stand for 48hours. This was repeated for each sample from each farm from the seven communities involved. Nematodes were expected to move from the soil sample through the paper into the water below, resting on the plate. After the extraction period, excess water from the sieve was drained into the plate. The soil and the paper were then disposed and water from the plates emptied into labelled beakers. However, during the counting and identification, the volume of the water was reduced by gently pouring off through a 20µm sieve. Then 10mL of the extract suspension were eventually viewed for presence of nematodes using Compound microscope.

Extraction of nematodes from samples of yam tuber: Yam tubers from each farm were carefully peeled with a kitchen knife below the surface. The tuber peels were chopped finely with the knife, further blended with an electric blender and then placed in labelled plates. All chopped tuber peels from each farm in each of the communities were properly labelled and kept separately according to communities where they were collected. Subsequently, sub-samples of 5 g each of the chopped tuber peels were weighed onto the extraction paper in the labelled sieve and placed on a plate. 100mL of water was added to the extraction plates and left to stand for 24 hours. Then, 10ml of the extract suspension were eventually viewed for presence of nematodes using Compound microscope.

RESULTS AND DISCUSSIONS

The results of the present study showed that seven different genera of plant parasitic nematodes were identified in the soil and yam tubers collected from the seven communities**.** Identification was done at the International Institute of Tropical Agriculture (IITA), Ibadan, Headquarters. The nematodes identified were *Meloidogyne* spp*.; Pratylenchus* spp*.; Radopholus* spp*., Helicotylenchus* spp*., Scutellonema spp., Criconema* spp. *and cyst nematodes (Heterodera* sp.) (Tables 1 and 2).The percentage composition of nematodes in soils from each of the sampled communities as shown in Table 1 indicated that *Pratylenchus sp.* With population of 140 (40.60%) were the most prevalent followed by *Meloidogyne sp*. 95 (27.54%), while the least prevalent was the cysts of *Heterodera sp*. This had population of 5 (1.45%) (Table 1). Similarly, out of the four genera of the parasitic nematode recovered from the yam tubers, which are; *Pratylenchus spp., Meloidogyne spp., Scutellonema spp., and Radopholus spp.* The result showed that *Pratylenchus spp.* also recorded the highest prevalence of 130 (72.22%) while *Meloidogyne and Radopholus spp.* recorded the least prevalence of 5 (2.78%) respectively. The analysis of variance (ANOVA) showed that there was a significant difference ($P<0.05$) in the numbers of the different genera of nematodes recovered both from the soil and yam tubers. The mean separation of the numbers of nematodes obtained from the soil showed that *Pratylenchus sp.* was significantly higher than all other nematodes except *Meloidogyne sp*. while in that of the

nematodes from the yam tubers, *Pratylenchus* species was significantly higher than all the other genera of nematodes recovered. The result also showed that of the soil sampled from the seven communities, Amansea (Ams) recorded the highest number of parasitic nematodes of 110 (31.88%) followed by Isuaniocha (Isu)and Amanuke (Amn) recording 55 (15.94%) respectively while the least number of parasitic nematode was recorded in Urum (Uru) community (15 (4.35%)) (Table 1). Also of the yam sampled from the seven communities, Amansea recorded the highest number of nematodes of 45 (25.00%) followed by Amanuke and Ebenebe with 35 (19.44%) and 30 (16.67%) respectively while the least 10 (5.56%) was recorded in Mgbakwu (Table 2). Considering the infection rate, the result showed that Amansea and Isuaniocha recorded the highest infection of 100% of all soils and yam tubers collected from the farms from both communities (Figures 1 and 2), although the ANOVA showed that there was no significant difference ($P>0.05$) in the number of parasitic nematodes obtained from the different communities (Tables 1 and 2).

Table 1: Number and percentage composition of nematodes (in 10mL of extract) found in soils from each of the sampled communities

Communities	Melo No (%)	Praty No (%)	Rado No (%)	Helico No (%)	Scut No (%)	Crico No (%)	Cyst No (%)	Total No (%)	Mean ± SE
Ach	10 (10.52)	15 (10.71)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	**25 (7.25)**	**3.60±2.37**
Ams	45 (47.37)	15 (10.71)	10 (100)	5 (20.00)	15 (30.00)	20 (100)	0 (0.00)	**110 (31.88)**	**15.7±5.50**
Amn	15 (15.79)	25 (17.86)	0 (0.00)	0 (0.00)	15 (30.00)	0 (0.00)	0 (0.00)	**55 (15.94)**	**7.90±3.91**
Ebe	25 (26.32)	15 (10.71)	0 (0.00)	5 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	**45 (13.04)**	**6.40±3.73**
Isu	0 (0.00)	25 (17.86)	0 (0.00)	15 (60.00)	10 (20.00)	0 (0.00)	5 (100)	**55 (15.94)**	**7.90±3.60**
Mgb	0 (0.00)	30 (21.43)	0 (0.00)	0 (0.00)	10 (20.00)	0 (0.00)	0 (0.00)	**40 (11.59)**	**5.70±4.29**
Uru	0 (0.00)	15 (10.71)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	**15 (4.35)**	**2.10±2.14**
TOTAL	**95 (27.54)**	**140 (40.58)**	**10 (2.90)**	**25 (7.25)**	**50 (14.49)**	**20 (5.79)**	**5 (1.45)**	**345 (100)**	
Mean±SE	**13.6±6.34**	**20.0±2.44**	**1.40±1.43**	**3.60±2.10**	**7.10±2.64**	**2.90±2.86**	**0.70±0.74**		

*community--- P=0.268. Nematode--- P<0.001, LSD = 8.91

Table 2: Number and percentage composition of nematodes (in 10mL of extract) found in samples of yam tubers from each community.

Communities	Melo No (%)	Praty No (%)	Rado No (%)	Scut No (%)	Total No (%)	Mean±SE
Ach	0 (0.00)	10 (7.69)	0 (0.00)	10 (25.00)	20 (11.11)	**5.0±2.89**
Ams	5 (100)	35 (26.92)	5 (100)	0 (0.00)	45 (25.00)	**11.2±8.00**
Amn	0 (0.00)	35 (26.92)	0 (0.00)	0 (0.00)	35 (19.44)	**8.8±8.75**
Ebe	0 (0.00)	25 (19.23)	0 (0.00)	5 (12.50)	30 (16.67)	**7.5±5.95**
Isu	0 (0.00)	15 (11.54)	0 (0.00)	10 (25.00)	25 (13.89)	**3.8±3.75**
Mgb	0 (0.00)	5 (3.85)	0 (0.00)	5 (12.50)	10 (5.56)	**2.5±1.44**
Uru	0 (0.00)	5 (3.85)	0 (0.00)	10 (25.00)	15 (8.33)	**3.8±2.39**
Total	**5 (2.78)**	**130 (72.22)**	**5 (2.78)**	**40 (22.22)**	**180 (100)**	
Mean±SE	**0.7±0.71**	**18.6±4.97**	**0.7±0.71**	**5.7±1.70**		

*Community---P=0.926.Nematode--- P<0.01, LSD=7.80

This study has shown that plant parasitic nematode infection of agricultural fields could constitute an important economic problem in yam production in Awka-North L.G.A. Seven genera of plant parasitic nematodes were encountered in soil and root samples collected from the sampled area and these are; *Meloidogyne sp., Pratylenchus sp., Scutellonema sp., Radopholus sp., Helicotylenchus sp., Criconema* sp. and cyst nematodes (*Heterodera sp .).* This is in line with the study carried out by Adegbite *et al.* (2008) who reported the same genera of parasitic nematodes their study area. The presence of these parasitic nematodes suggests they can be important pathogens of yams although their economic importance has been usually undermined in these areas. The reason for the number of positive samples encountered in these communities could be continuous cultivation of the farms with yam, which provides these parasites with constant nutrition (Windham, 1998; Adegbite *et al*. 2005). The highest number of plant parasitic nematodes recorded in Amansea and Isuaniocha might be the reason for the high rate of damage to yam tubers observed in these communities as compared to other communities. Plant parasitic nematode damage is an important factor in tuber quality reduction and yield loss in yam both in the field and in storage. Yams are vulnerable to nematode damage as they reduce the yield and quality of the tubers because of root galling caused by *Meloidogyne sp.,* root lesions caused by *Pratylenchus sp*. and dry and soft rots caused by *Scutellonema sp.* The presence of these plant parasitic nematodes could constitute serious impediments to the growth and yield of yams in Awka-North L.G.A. Enlightenment programme for the yam farmers should therefore be embarked upon by the Local Government and State Agricultural Development Programmes in the zone, to inform the farmers of the presence of plant parasitic nematodes in their farms and attendant implications.

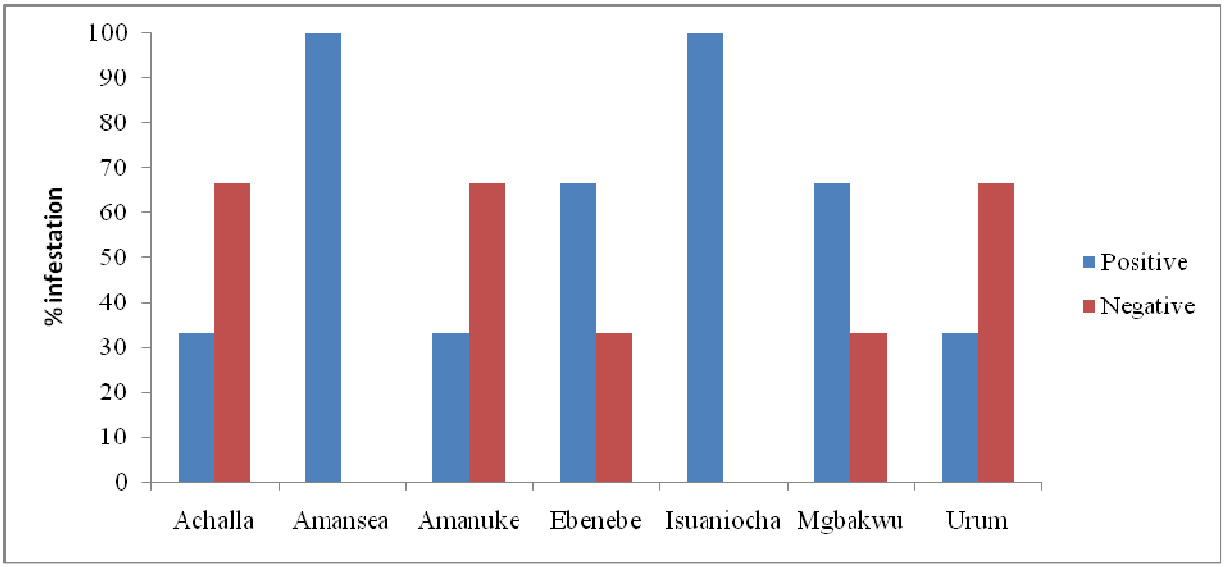

Figure 1: Percentage infection of soil collected from the seven communities in Awka-North Local Government of Anambra State.

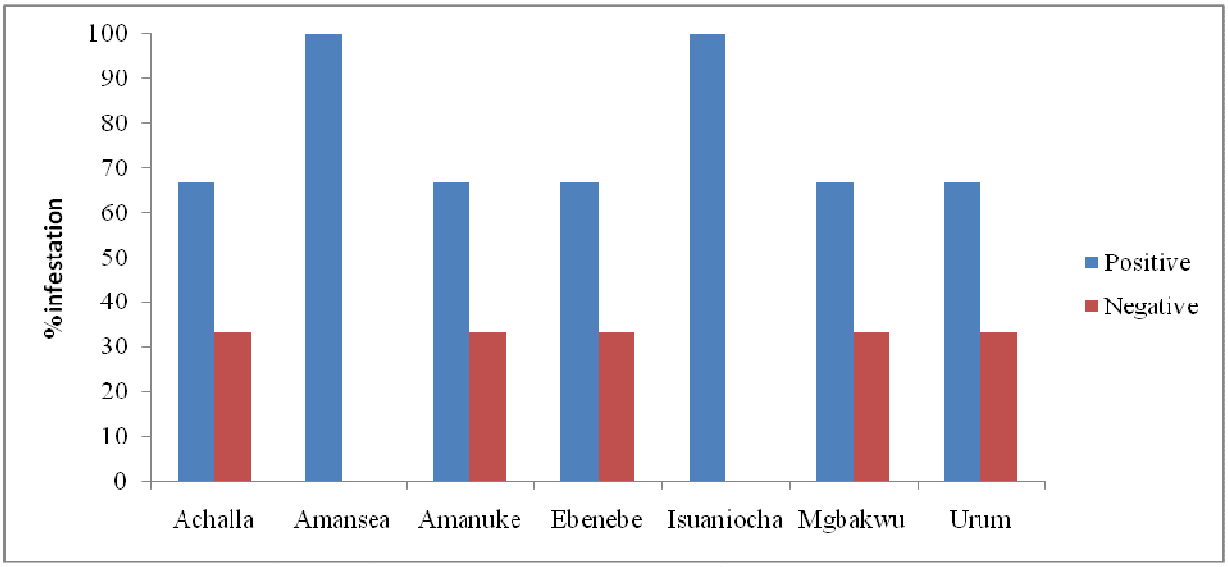

Figure 2: Percentage infection of yam tuber samples collected from seven communities in Awka-North Local Government of Anambra State.

Figure 3: Picture of a yam damaged by nematode infections

Figure 4: picture of internal lesion and necrosis caused by nematodes on a yam.

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