Plant Parasitic Nematodes Status of Seed Yams in Khana L.G.A, Rivers State, Nigeria

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Abstract. The plant parasitic nematode status of four yam species; D. alata, D. cayensis, D. dometurum and D. rotundata in four communities in Khana LGA, Rivers State, Nigeria was carried out. 160 randomly selected seed yam samples comprising 40 yam samples from each of the communities in the study area were sampled. 40 yam samples from each of the communities comprising ten yams each from the four species of yams examined. Each yam sample was processed by peeling the periderm (one inch thick) and separately macerating them with a blender at low speed. These were placed on Bearmann’s Trays for nematode extraction. A total of 886 nematodes were recovered from all the samples out of which 83.26% of the nematodes came from D. rotundata, 16.0% came from D. cayensis, 0.48% from D. alata and 0.24% from D. dometurum. Five nematode genera and species were recovered from the sampled yams; Aphelenchus spp., (8.5%), Pratylenchus spp. (14.65%), Meloidogyne spp. (22.66%), Scutellonema spp. (53.88%) and Tylenchus spp. (0.24%). Nematode infectivity was greatly influenced by host specific factors which manifested in the variability in susceptibility, tolerance and resistance of the yam species. D. dometurum was resistant to the parasitic worms while D. rotundata was highly susceptible to nematodes. There was slight geographical specificity in the distribution of Aphelenchus and Tylenchus species in the four study sites. The study revealed that Aphelenchus and Tylenchus species were poor parasites of Dioscorea spp. whose presence may be attributed to accidental infection due mixed cropping that is the prevalent cultural practice in the study area.

Keywords: Accidental infection, genera and species, geographical specificity, Host specific factors Nematodes and variability in susceptibility.

1. INTRODUCTION

The common yam; a starchy tuberous vine in the Dioscorea spp. of crops is a staple in West Africa; a region that accounts for the highest production of the crop worldwide with Nigeria recording more than 32million metric tons out of the 47.8million metric tons produced annually (FAO, 1998; Amusa et al., 2003; IITA, 2006; NBS, 2011; Nsikak et al., 2013). Aside its status as staple food in Nigeria, commercial and subsistence yam production provides stable vocation for the teeming population that resides in the rural areas and a veritable avenue to economic independence (Coursey, 1967; Nweke et al., 1991; Orkwor and Ekenyeke, 1998; Adegbite et al., 2006). The cultivated varieties of yam in Nigeria include; D. rotundata (white yam), D. cayensis (yellow yam); D. alata (water yam) and D. dometorum (three leaf yam or the African bitter yam) with a few wild varieties that are cherished during periods of food scarcity (Amusa et al., 2003; Orkwor and Ekenyeke, 1998; Adegbite et al., 2006). Yam as a crop and a stable is integrally woven into the socio-cultural fabrics of the Nigerian society due to its significance in religious rites, marriages and fertility ceremonies (Ibityoye and Onimisi, 2013). The excellent storage property of yam that spans beyond six months without refrigeration makes it a good crop for food security and an important food safety net between growing seasons (GCDT, 2014).

1.1. Yam Production in Nigeria

Yam production in Nigeria has increased in the past 45years from 6.8million tons in 1961 to more than 35million tons in 2014 (GCDT, 2014). This increase is attributed to increase in the hectare of land cultivated and the population of individuals that embark on yam farming, but not due to increase in productivity of the cultivated yams (NRCRI, 1998; FAO, 2007; Izekor and Olumes, 2010; Nsikak et al., 2013). According to GCDT report (2014); 23% of
households amongst the poorest households in West Africa consume yams, compared to 63% of households in the richest quintile in both post planting and post harvesting seasons. The report concluded that poorer households consume fewer yams, but depend more heavily on yam sales and income than their richer counterparts. This trend indicates that yam is not truly affordable to the poor of the society and does not truly qualify as a crop for food sustainability and poverty alleviation intervention strategy.

### 1.2. Factors that contribute to decline in Yam Production

The drastic decline in yam productivity in recent times has been associated with myriads of causes such as poor management practices, poor seeds, ignorance or low level of education of the farmers, poor access to funds by the farmers and infestation by numerous pests such as plant parasitic nematodes (Kushwaha and Polycarp, 2001; Shehu et al.; 2010; Ibitoye and Attah, 2012). The susceptibility of yam to nematodes is so great that the pathogenicity involve the field phase and the storage phase making them one of the persistent problems of commercial yam production (Kushwaha and Polycarp, 2001; Amusa et al., 2003; Ogaraku and Usman, 2008; Shehu et al.; 2010; Ibitoye and Attah, 2012) in Nigeria.

### 1.3. Plant Parasitic Nematodes of * Dioscorea* species of Plants

It is true that several plant parasitic nematodes attack yam in the field, however, a few pose great danger to the crop in cultivation and in storage. *Scutellonema* spp.: *Meloidogyne* spp. *Pratylenchus* spp. stand out in their pathogenicity to yam in Nigeria and other yam producing regions of the world due to their post-harvest effect on stored yam (Adegbite et al., 2008). However, nematodes such as *Xiphinema* spp. *Rotylenchus* spp. and *Aphelenchoides* spp. are not significant parasites of the crop but definitely create channels exploited by opportunistic microorganisms (bacteria and fungi) to establish disease complexes which further deteriorate the tuber to unsalvageable degree (Onwume, 1978, Ogaraka and Usman, 2008). Dry rot of yam tuber caused by *Scutellonema* spp. and multiple knots of the yam tuber caused by *Meloidogyne* spp. reduce the viability, virility and marketability of the yam tuber. Aside this obvious effects, a field infected yam sustains its infection in storage thereby serving as a superb means of dispersal of the parasites. The fore-going shoots-up the scarcity of viable and virile seed-yams, escalates the cost of yam production and cost of harvested tubers (Ugwumba, 2011). Based on the outlined disadvantages of nematodes infestation in yams the study tends to determine the parasite load of nematodes in four yam varieties in Khana L.G.A of Rivers State, Nigeria, and to document the specific nematodes of *D. dometerium* (three leave yam); a cherished yam variety in the southern region of Nigeria.

### 2. MATERIALS AND METHODS

#### 2.1. Study Area

The study was carried out in four communities; Beeri, Taaba, Kaani and Nyo-buru in Khana L.G.A of Rivers State. The Local Government Area is located between 4.700'N and 7.350'E, occupies an area of 560km² and has a population of 294.217 (NNC, 2006). The study area experiences an annual maximum temperature of 32°C and a minimum of 27°C. The average annual rainfall of the area is 2500 mm with July and September having the highest. The vegetation of the study area is the tropical rainforest type (Figure 1).

#### 2.2. Sample Collection

Seed yams of the designated varieties; *D. rotundata* (white yam), *D. cayensis* (yellow yam); *D. alata* (water yam) and *D. dometorum* (three leaf yam or the African bitter yam) were randomly selected from yam barns located in the four communities where the study was carried out. These were tagged, put into hand woven baskets and taken to the laboratory for extraction of nematodes.

#### 2.1. Extraction and Identification of Nematodes

Individual seed yams were washed in running tap water to remove soil and debris. Thereafter, the designated seed yams were separately cut transversely into 2 cm discs. The outermost layer (periderm) of the yam discs were peeled-off up to 2 inches deep into the yam tissue (parenchyma).The peeled-off layers were separately macerated and placed on the modified Bearmann’s funnel for nematode extraction according to Hooper, (1970) and Barker et al. (1985). The extraction set-up was left for 36 hours after which the aliquots were decanted and fixed with 4% formaldehyde for microscopy. The binocular compound light microscope was used in the counting and identification of the nematodes into genera and species at x40 and x100 magnification according to Goodey (1963) and Golden (1885).
2.2. Data Analysis

Data analysis was done with measures of central tendency and ANOVA.

3. RESULT AND DISCUSSIONS

The study showed great variability in parasite speciation and density in specific yam samples. On individual yam species infectivity, *D. rotunda* manifested the highest nematode load of 6816 (83.26%), followed by *D. cayensis* with 1310 (16.0%), *D. alata* had 40 (0.48%) and *D. dometrium* 20 (0.24%) parasites. This result partially agrees with Coyne et al. (2006) who observed relatively high parasite load of *S. bradys* in *D. alata* and *D. rotunda*. The high parasitic load observed in *D. rotundata* and *D. cayensis* suggested that the yam species were highly susceptible to plant parasitic nematodes infestation. The relatively variable low parasitism observed in *D. alata* and *D. dometrum* indicated variable resistance to plant parasitic nematodes by the yam species due to host specific factors (Nsikaki, 2013). *D. dometurum* exhibited the highest resistances to the five families of nematodes extracted from the samples a result contrary to the assertion by Bridge et al. (2005) that there is no resistance against nematodes in yam. There was relative variability in site specific parasitism in the study (Table 1). The overall parasitic load on geographical specificity showed that yam samples from Nyo-kuru had the highest load of nematodes 2774 (33.88%), followed by Taabaa seed yams, 2480 (30.29%), yams from Beeri had 1900 (23.21%) and yams from Kaani had 1032 (12.60%). The consistent manifestation of parasites in almost all the yam samples from the Kaani and Nyo-kuru communities could be associated with multiple factors such as specific edaphic factors, cultural practices and host specific factors (Adegbite et al., 2006; Ibitoye and Onimisi, 2013; GCDT, 2014).
Table 1: Plant parasitic nematode load in the various yam species in the study area

<table>
<thead>
<tr>
<th>Sampling Areas</th>
<th>No of Seed Yams Sampled</th>
<th>D. alata</th>
<th>D. cayensis</th>
<th>D. dometorum</th>
<th>D. rotunda</th>
<th>Overall Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taabaa</td>
<td>40</td>
<td>0</td>
<td>230</td>
<td>0</td>
<td>2250</td>
<td>2480(30.29)</td>
</tr>
<tr>
<td>Beeri</td>
<td>40</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>1800</td>
<td>1900(23.21)</td>
</tr>
<tr>
<td>Nyo-kuru</td>
<td>40</td>
<td>20</td>
<td>380</td>
<td>0</td>
<td>2374</td>
<td>2774(33.88)</td>
</tr>
<tr>
<td>Kaani</td>
<td>40</td>
<td>20</td>
<td>600</td>
<td>20</td>
<td>392</td>
<td>1032(12.60)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>160</td>
<td>40(0.48)</td>
<td>1310(16.0)</td>
<td>20(0.24)</td>
<td>6816</td>
<td>8186</td>
</tr>
</tbody>
</table>

3.1. Specific Parasitism and Host Range

Specific parasitism and parasitic load revealed that five nematode families parasitized yam in the study area namely; *Aphelenchus* spp., 700 (8.55%); *Pratylenchus* spp., 1200 (14.65%); *Tylenchus* spp., 20 (0.24%); *Meloidogyne* spp., 1855(22.66%) and *Scutellonema* spp., 4411 (53.88%). The pattern of infection showed host specificity as observed in the infections of *Tylenchus* spp. on *D. alata*, *Aphelenchus* spp. on *D. cayensis* and the heavy manifestation of *Meloidogyne* spp. only on *D. rotunda* (Figure 2). The infection of the seed yams by *Tylenchus* and *Aphelenchus* species of nematodes is unexpected and attributed to accidental infectivity because these nematodes are not associated with stored yam tubers. However, the susceptibility of *Dioscorea* spp. to nematode infections was accentuated in the infection of *D. dometurum* by *Scutellonema* spp. (Izeko and Olumese, 2010).

*Pratylenchus* spp. was second to *Scutellonema* spp. in terms of host range and geographical distribution, this was attributed to the common practice of intercropping tubers with cereals such as maize that are suitable hosts of *Pratylenchus* and *Aphelenchus* species of nematodes (Ibitoye et al., 2012). The occurrence of *Aphelenchus* spp. and *Tylenchus* spp. in the study may also be due to the cultural farming practice common in the study areas which rely greatly on the application of organic amendment (Figure 2 and Table 2). This result supports the assertion by Abuzar and Haseeb (2010) that the application of organic manures could pose some level of suppression to plant parasitic nematode pathogenicity.

4. CONCLUSION

The study revealed that yam; *Dioscorea* spp. is a suitable host to a wide range of plant parasitic nematodes both in the field and in storage. The degree of field infection influences the level of post-harvest symptoms manifested by different species. Amongst the sampled yam species *D. dometurum* exhibited the highest resistance to the five families of nematodes extracted from the samples which confirm that some yam species are really resistant to nematodes infections. The study also revealed that yam cultivars could be accidentally infected by various nematodes which may not be specific to yam due to cultural practices common in the area. The study also revealed that seed yams which are usually the suitable propagation means for *Dioscorea* spp. of crops retain their pre-harvest infections in storage. This situation demands an effective and efficient pre-harvest treatment of yam propagates against nematodes to forestall the reduction in yield due to the establishment and spread of these plant pests in the region.
Table 2: The speciation of plant parasitic nematodes in seed yam from four communities in Khana LGA

<table>
<thead>
<tr>
<th>Nematode spp.</th>
<th>Taabaa</th>
<th>Beeri</th>
<th>Nyo-kuru</th>
<th>Okwale</th>
<th>Overall total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>c</td>
<td>d</td>
<td>R</td>
<td>A</td>
</tr>
<tr>
<td><strong>Aphelenchus spp</strong></td>
<td>0</td>
<td>200(28.57)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Pratylenchus spp</strong></td>
<td>0</td>
<td>30 (2.5)</td>
<td>0</td>
<td>170 (14.16)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Meloidogyne spp</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>910 (49.05)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Scutellonema spp</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1170 (26.52)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Tylenchus spp</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0</td>
<td>230 (0.028)</td>
<td>0</td>
<td>2250 (27.48)</td>
<td>0</td>
</tr>
</tbody>
</table>

Key: a = D.alata; c = D.cayensis; d = D.dometurum; r = D.rotundata

Fig. 2: Specific parasitism on yam species
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Competing Interest: Authors declare that there are no competing interests.

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