Studies on plant-parasitic nematodes associated with sweet potato (*Ipomoea batatas* L., Lam.) in Gombe State, Nigeria

**Jidere Caleb Iliya**¹, Simon Lilian Dada², Sulaiman Ibrahim¹ and Abraham Peter¹

¹Federal College of Horticulture Dadin Kowa Gombe, NIGERIA, ²Federal University Gashua, Yobe State, NIGERIA

Corresponding author’s E-mail: calebdr@gmail.com

**ARTICLE HISTORY**

Received: 30 September 2021  
Revised received: 22 November 2021  
Accepted: 15 December 2021

**Keywords**

Plant-parasitic nematode  
Prevalence value  
Population density  
Survey  
Sweet potato

**ABSTRACT**

Sweet potato (*Ipomoea batatas* L., Lam.) is one of the most frequently eaten food crops. Its production is affected by plant-parasitic nematodes as well as biotic factors. This study was conducted to document the different plant-parasitic nematodes (PPN) that limit the gainful production of sweet potato in Gombe State. Thirty soil core samples per hectare were collected at random from sweet potato farms in the three local government areas (Nafada, Kaltungo, and Yamaltu Deba) of Gombe state. The Whitehead and Hemming method and identification keys were used for the soil extraction and genera identification of the plant-parasitic nematodes respectively. A total of 15 plant-parasitic nematodes were recovered throughout the surveyed areas among which 7 are considered major nematode pests of global importance. Irrespective of the surveyed locations, *Meloidogyne* spp., was found to record the highest population density and prevalence value. The frequency of occurrence in Y/Deba and Nafada LGAs shows that *Meloidogyne* spp., was the most occurring (32 %) genera. In Kaltungo LGA however, *Scutellonema* spp., and *Rotylenchus* spp., were the most occurring (17 %) genera. There was a high similarity percentage (≥ 68 %) of PPN genera where 8 genera (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Trichodorus* spp., and *Rotylenchus* spp.) were found to be common amongst the surveyed locations. This is the first report of plant-parasitic nematodes associated with sweet potato in Gombe state, Nigeria. Hence, it is critical to educate farmers in the regions about their effects on the crop and how to successfully manage them.

©2021 Agriculture and Environmental Science Academy

**INTRODUCTION**

Sweet potato (*Ipomoea batatas* L., Lam.) is a dicotyledonous perennial cultivated in both the tropical and the warm temperate regions of the world grown as an annual crop (Patil, 2020; Bulus et al., 2017). It ranks seventh in global food crop production and the third most important root crop after Irish potato and cassava (Loebenstein, 2015). Sweet potato is a versatile food that can be used as a source of energy, starch, protein, fat, and fibre. It is also used as a food additive (NAERLS et al., 2007). It is a major cheap source of energy for more than 80% of Nigerians, especially in the northern part of the country, where a large number of people live below the poverty line (Olabiyi et al., 2016). Due to the decline in the country’s economy, the production of sweet potatoes has increased significantly. In 2017, the total production of sweet potatoes in the country was approximately 4.1 million metric tons (FAOSTAT, 2018). Although sweet potato is nutritionally and economically important its gainful production has been hampered by the activities of plant-parasitic nematodes (Jibrin et al., 2014). Several studies have reiterated the significance of plant-parasitic nematodes as economic pests of sweet potato (Ames et al., 1997; Strange and Scott, 2005; Olabiyi, 2007; Chitwood, 2011; Olabiyi et al., 2016). The top ten plant-parasitic...
nematodes are Meloidogyne spp., Heterodera spp., Globodera spp., Radopholus spp., Ditylenchus spp., Scutellonema spp., Rotylenchulus spp., Xiphinema spp., Nacobbus spp., and Aphelenchoides spp. (Jones et al., 2013). Root-knot nematode (RKN, Meloidogyne spp.) is ranked as the most economically damaging nematode due to its ability to rapidly spread to and colonize new locations (Bebber et al., 2014; Abdulsalam et al., 2017) and wide host range (Jones et al., 2013). The first step towards successful and effective management of PPN in both fields and screen houses lies in their frequent surveillance to determine their occurrence, spread and pest population build-up (Abraham et al., 2018). Studies on the occurrence of PPN infecting sweet potato in some States (Osun, Kaduna, Oyo, Kwara, Abia, Kogi, Cross Rivers, Taraba, Benue, and Plateau) in Nigeria have been well reported (Olubiyi et al., 2016). However, an information gap exit about the PPNs causing sweet potato diseases in Gombe, which is one of the major sweet potato producing regions in the country. Potato farmers in the region are not aware of plant-parasitic nematodes as they are microscopic in nature and thrive within the soil rhizosphere. Therefore, disease symptoms expression on the plants due to attack by PPNs are often mistaken for nutritional deficiencies. Elucidating the status of PPNs infecting sweet potato in Gombe will avail vital information for the extension agents to orient farmers on these yield-reducing pests and their effective management. Hence, the current study was undertaken to determine plant-parasitic nematodes associated with sweet potato in three key producing locations in Gombe state.

MATERIALS AND METHODS

Survey site and soil sample collection
The survey was conducted in Yamaltu Deba located at (10°18’56”N 11°30’31”E), Kaltungo (9°49’31”N 11°24’42”E) and Nafada (11°07’3”N11°22’02”E) LGA representing the senatorial district of Gombe State Nigeria. Soil samples were collected using an auger at a depth of 0-25cm and within 25cm around the rhizosphere of the sweet potato plants. A zigzag pattern of sampling technique was used to collect a total of 30 soil core samples per hectare from each surveyed sweet potato field. The soil samples were collected in sealed bags and labelled with the date, time and location. Samples collected were bulked together into a composite sample, carefully mixed and then passed through a mesh sieve to remove any debris or stones.

Extraction and identification of phytoparasitic nematodes
The concept of the extraction tray was developed by Whitehead and Hemming (1965) to extract vermiform nematode samples from the soil. The procedure involved placing 200g of each composite sample into a modified Baermann tray. The samples were placed in an upper sieve that was modified to include a pair of plastic sieves. The samples were then gently poured into a bowl of water. The entire procedure was performed for 24 hours. Identification key for agricultural important plant-parasitic nematodes (Mekete et al., 2012) was used to identify the species of nematodes.

Data analysis
Norton (1989) equations nematode distribution and the population were used in the study; Prominence values (PV) = Population Density × (Frequency of occurrence) ⅓ × 10⁻¹ were calculated for each nematode species (Fourie et al., 2000).

\[
\text{Population Density} = \frac{\text{Number of nematodes in all samples}}{\text{Total number of samples collected}} \times 100
\]

\[
\text{Frequency of Occurrence} = \frac{\text{Number of samples containing nematodes}}{\text{Total number of samples collected}} \times 100
\]

\[
\text{Percentage Similarities} = \frac{\text{KS}}{a + b + c + \ldots} \times 100
\]

Where; K= Number of comparing locations; S = Number of nematode genera that the comparing locations have in common and a, b, c, = Number of nematode genera in each of the comparing locations.

RESULTS AND DISCUSSION

To fill an important information gap on the occurrence and distribution of PPNs associated and significantly limiting the profitable yield of sweet potato in Gombe State (Yamaltu/Deba, Kaltungo and Nafada local government areas), the present study was initiated. The results showed that the highest number of 13 PPN genera (Scutellonema spp., Nacobbus spp., Pratylenchus spp., Meloidogyne spp., Heterodera spp., Longidorus spp., Xiphinema spp., Trichodorus spp., Rotylenchulus spp., Aphelenchoides spp., Helicotylenchus spp. and Ditylenchus spp.) were identified in Y/Deba, followed by Kaltungo which had 12 PPN genera (Scutellonema spp., Nacobbus spp., Pratylenchus spp., Meloidogyne spp., Heterodera spp., Tylenchulus spp., Xiphinema spp., Trichodorus spp., Rotylenchulus spp., Tylenchulus spp., Displacedss., and Ditylenchus spp.) while the least number of 10 PPN genera were recovered in Nafada (Scutellonema spp., Nacobbus spp., Pratylenchus spp., Tylenchulus spp., Meloidogyne spp., Heterodera spp., Xiphinema spp., Trichodorus spp., Rotylenchulus spp., Xiphinema spp., and Helicotylenchus spp.) as shown in Table 1. A total of 15 plant-parasitic nematode genera were recovered and identified to be associated with sweet potatoes in Gombe State. This result is in line with the findings of Karuri et al. (2017) and Olabiyi et al. (2016) who previously reported 7 and 13 genera of plant-parasitic nematodes associated with sweet potatoes in Kenya and some states in Nigeria respectively. However, the higher number of PPN genera documented from this present study might be due to some factors such as varietal difference, temperature, rainfall pattern, soil, location, cultural and management practices by the farmers. The result of the present study revealed that 7 (Scutellonema spp., Nacobbus spp., Meloidogyne spp., Heterodera spp., Xiphinema spp., Aphelenchoides spp., and Ditylenchus spp.) out of the 15 recovered PPN genera have been
enlisted among the top ten most important PPN pests of agricultural crops worldwide (Jones et al., 2013). Also, 8 PPN genera were identified to be common in all the surveyed locations (Scutellonema spp., Nacobbus spp., Pratylenchus spp., Meloidogyne spp., Heterodera spp., Xiphinema spp., Trichodorus spp., and Rotylenchus spp.), of which some have been confirmed as nematode pests of sweet potatoes. The population density and prevalence value of plant-parasitic nematode genera in the rhizosphere soil from the sweet potato field are shown in Table 2. The result indicates that Meloidogyne spp. had the highest population density (128.6) and prevalence value (6) per 200g of soil while Tylenchulus spp. and Dipsaci spp., recorded zero population and prevalence value respectively in Y/Deba. Results from Kaltungo shows that Scutellonema spp., and Meloidogyne spp., had the highest population density (40) and prevalence value (2) per 200g of soil while Longidorus spp., Aphelenchoides spp., and Helicotylenchus spp., did not record any population and prevalence value. In Nafada local government area Meloidogyne spp., recorded population density (37.1) and prevalence value (2) respectively per 200g of soil while Longidorus spp., Tylenchus spp., Dipsaci spp., Aphelenchoides spp., and Ditylenchus spp., recorded zero population densities and prevalence value. Among the 15 encountered plants parasitic nematodes are those classified as the ten topmost important nematodes that are a threat to world agricultural production. These include Meloidogyne, Pratylenchus, Heterodera, Ditylenchus, Globodera, Tylenchulus, Xiphinema, Radopholus, Rotylenchulus and Helicotylenchus (Sasser and Freckman, 1987; Coyne et al., 2007; Nicol et al., 2011; Hodda et al., 2012; Olabiyi et al., 2016). Meloidogyne spp., Ditylenchus destructor, Dipsaci spp., Rotylenchulusreniformis, Trichodorus spp, Nacobbus spp., and Pratylenchus spp., have been confirmed as nematode pests of sweet potatoes (Olabiyi et al., 2016).

<table>
<thead>
<tr>
<th>PPN Genera</th>
<th>Location</th>
<th>Y/Deba</th>
<th>Kaltungo</th>
<th>Nafada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PD</td>
<td>PV</td>
<td>PD</td>
<td>PV</td>
</tr>
<tr>
<td>Scutellonema spp.</td>
<td>31.4</td>
<td>1.30</td>
<td>40.0</td>
<td>1.66</td>
</tr>
<tr>
<td>Nacobbus spp.</td>
<td>17.1</td>
<td>0.64</td>
<td>11.4</td>
<td>0.33</td>
</tr>
<tr>
<td>Pratylenchus spp.</td>
<td>31.4</td>
<td>1.18</td>
<td>8.6</td>
<td>0.25</td>
</tr>
<tr>
<td>Meloidogyne spp.</td>
<td>128.6</td>
<td>6.14</td>
<td>40.0</td>
<td>1.51</td>
</tr>
<tr>
<td>Heterodera spp.</td>
<td>17.1</td>
<td>0.58</td>
<td>25.6</td>
<td>0.87</td>
</tr>
<tr>
<td>Longidorus spp.</td>
<td>20.0</td>
<td>0.82</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Tylenchus spp.</td>
<td>11.4</td>
<td>0.33</td>
<td>11.4</td>
<td>0.33</td>
</tr>
<tr>
<td>Xiphinema spp.</td>
<td>31.4</td>
<td>1.30</td>
<td>11.4</td>
<td>0.39</td>
</tr>
<tr>
<td>Trichodorus spp.</td>
<td>25.7</td>
<td>1.00</td>
<td>8.6</td>
<td>0.20</td>
</tr>
<tr>
<td>Rotylenchus spp.</td>
<td>31.4</td>
<td>1.18</td>
<td>22.7</td>
<td>0.94</td>
</tr>
<tr>
<td>Tylenchulus spp.</td>
<td>0.0</td>
<td>0.00</td>
<td>17.1</td>
<td>0.58</td>
</tr>
<tr>
<td>Dipsaci spp.</td>
<td>0.0</td>
<td>0.00</td>
<td>14.3</td>
<td>0.48</td>
</tr>
<tr>
<td>Aphelenchoides spp.</td>
<td>11.4</td>
<td>0.33</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Helicotylenchus spp.</td>
<td>14.3</td>
<td>0.48</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Ditylenchus spp.</td>
<td>22.8</td>
<td>0.88</td>
<td>8.6</td>
<td>0.20</td>
</tr>
<tr>
<td>Total</td>
<td>393.6</td>
<td>15.68</td>
<td>219.7</td>
<td>7.74</td>
</tr>
</tbody>
</table>

PD= Population density, PV=Prevalence Value, PPN= Plant-parasitic nematode.
Irrespective of the surveyed locations, the study revealed that *Meloidogyne* spp., had the highest prevalence and population density. This could be attributed to the polyphagous nature and high variability (20) of *Meloidogyne* species in Africa, with *M. incognita*, *M. javanica*, and *M. arenaria* being the most common as observed by Onkendi et al. (2014).

The frequency of occurrences in Y/Deba LGA (Figure 1) and Nafada LGA (Figure 3) shows that *Meloidogyne* spp., was found to be the most occurring genus with 23 %. In Kaltungo LGA however, *Scutellonema* spp., and *Rotylenchus* spp., were the genera that had the highest (17 %) frequency of occurrence (Figure 2). This finding collaborates with the findings of Abraham et al. (2018) who reported that *Scutellonema*, *Xiphinema*, *Pratylenchus*, and *Meloidogyne* species were among the commonly observed genera in irrigated Fadama soils of Gombe state which are under different crop cultivation. Figure 4 compares the similarities between and among the studied locations. Here, the results showed that there was a high similarities percentage (≥ 68 %) of PPN genera irrespective of the studied locations with no significant (p ≤ 0.05) difference among any two comparing locations. However, there were significantly higher PPN similarities (%) between any two locations than similarities observed amongst the three locations. The exchange of potato vines as propagating materials which is a common practice among farmers across the state could be a factor for the high similarity index recorded among study locations. If necessary precautions for their control are not taken before the distribution/planting of the planting materials (vines or tubers) these nematodes are capable of causing significant economic loss on sweet potatoes (Olabiyi et al., 2016).
Conclusion

The present study revealed that a total of 15 plant-parasitic nematodes were found to be in association with sweet potatoes in Gombe, Nigeria, among which 7 are considered major nematode pests of global importance. Irrespective of the surveyed locations, *Meloidogyne* spp., was found to record the highest population density and prevalence value. *Scutellonema* spp., and *Rotylenchus* spp., were the most occurring PPN genera in Kaltungo while *Meloidogyne* spp., was the most occurring genus in Y/Deba and Nafada. There was a high similarity percentage (≥ 68 %) of PPN genera where 8 genera (*Scutellonema* spp., *Nacobbus* spp., *Pratylenchus* spp., *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp., *Trichodorus* spp., and *Rotylenchus* spp.) were found to be common amongst the surveyed locations. The economic damage caused by these nematodes cannot be overemphasized hence, the need to educate farmers of these hidden enemies and the dangers they posed toward the production of sweet potatoes in the surveyed areas.

Open Access: This is an open access article distributed under the terms of the Creative Commons Attribution NonCommercial 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) or sources are credited.

REFERENCES


