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Investigation and Occurrence of Plant - Parasitic Nematodes on Yam Varieties in Wushishi Local Government Area, Niger State, Nigeria

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ABSTRACT: Plant parasitic nematodes (PPNs) are biotrophic and obligate feeders that cause devastating Phyto economic damage to yam cultivation across the globe. The infestation of PPNs may lead to a spectrum of disorders like stunting, necrosis and wilting followed by lessening production. The present investigation embraces an extensive survey work (from June to December 2022) of yam crop production sites at wushishi in Niger State and throws light on the presence. A total number of 30 soil samples were collected from five yam growing area in the study location. Sieving and decanting extraction method was used to ensure that all kinds of nematode groups were identified. Eleven Plant Parasitic Nematodes were identified using morphological and morphometric characteristics. *Meloidogyne, Scutellonema, Tylenchus, Rotylenchus, Pratylenchus*, *Xiphinema*, *Trichodorus, Helicotylenchus, Heterodera, Aphelenchus,* and *Hemicyclophora* were the nematodes associated with yam in the area surveyed. *Pratylenchus*, *Scutellonema brady*, *tylenchus* and *Meloidogyne incognita* were isolated in all the yam field. The soil population mean for *Pratylenchus* is 156 while the lowest number for prominence value was recorded for *Hemicyclophora* 2.3.

KEYWORDS: Yam, plant parasitic nematodes, morphometric characteristics, Sieving and decanting methods,

1.0 INTRODUCTION

Yam (*Dioscorea* spp.) is consumed globally. It is a tuberous crop which serves as a staple food in people's diets in Africa, Asia's tropical and subtropical regions. Yam has approximately 600 species, which are either annual or perennial, and are primarily cultivated through the vegetative propagation of their tubers. It is a dioecious, monocotyledonous plants (Cornejo, et al., 2021). There is global production rate from 8.3 million tons to 88.2 million tons, covering an expanded production area from 1.15 million hectares (mha) to 10.3 mha. (Ochola, *et al*., 2020). There is increase rate from 60 to 100 million people who mainly depend upon it for food, making it the fourth most important root crop by production after potatoes, sweet potatoes, and cassava (FAO, 2016). *Dioscorea* species also contain important secondary metabolites, steroidal saponins, diterpenoids and alkaloids, which have been exploited in the pharmaceutical industry (Kumar *et al*., 2017). However, In African nation like Nigeria, yam is prevalent in mitigating hunger and establishing dietary sustainability across these regions. Its production encounters several biotic and abiotic constraints. However, stable yam production faces challenges from a variety of diseases caused by fungi, nematodes, viruses, and bacteria. Prominent diseases such as anthracnose, leaf spot, yam wilt, dry rot, and crazy root syndrome, currently pose serious threats to yam yields. These diseases not only result in quality degradation but also cause great economic losses. (Kouakou *et al*., 2021)

Parasitic Nematodes (PPNs) feed mostly on the softer tissues of plant roots Attacks by pathogens and pests also play a significant role in yam production. Yam stores relatively longer in comparison with other tropical fresh produce, and therefore represents stored wealth, which can be sold all-year-round. Plant-parasitic nematodes are known to have harmful effects on yam (Nicoli *et al.,* 2011). Plant parasitic Nematodes (PPNs) infection contributes to long term storage losses estimated as 50%, and in some instances, loss could be total. PPNs are usually concentrated between 2 mm and 6 mm in infected yam tubers (Kingsley *et al*., 2015). Several methods are used to control PPNs such as use of Chemicals bionematicides, cultural methods such as hot water treatment of infected seed yams prior to planting, crop rotation, biological control, the use of resistant varieties and integrated management control. Most of the management options are limited in use due to time, feasibility, high costs, and adverse effects on the environment and mammalian toxicity.

In this present study, five yam varieties in Wushishi Local Government Area of Niger State, Nigeria were surveyed and evaluated for their reaction to plant parasitic nematodes infestation under natural field conditions.

2.0 MATERIALS AND METHODS

2.1. Study Sites Description

The survey was conducted during 2022 planting season in Wushishi Local Government Area Location in Niger State of Nigeria. The sites were Zungeru, Bankogi, Tungan Wako, Kaliko, and Maliaka. These areas weer selected because yam is extensively cultivated in these localities and initial parasitic nematode population densities were perceived to be very high. All the sites experience uniform and steady rainfall pattern.

2.2. Experimental Design

Land preparation was done manually by clearing weeds with a cutlass and debris found were removed. Stumps were removed with a pickaxe before heaps were raised at a planting distance of 1 m x 1 m. There were 20 heaps of four rows on a 3 m x 4 m plot size. Trials were mounted on Randomized Complete Block Design (RCBD) with five replications on a total land area of 450 m^2 at each site.

2.3. Plant Material

Five popular yam varieties were used, Shakata, Yangbede, Kwasi, Army and Pamio commonly cultivated by farmers and highly patronized by buyers were selected for the trials. The varieties were sourced from Research institute. Yam seeds averaging 450 g were used for planting. Seeds were tested for presence of plant parasitic nematodes (PPNs) prior to planting. Seeds were placed in the hole made with a hoe in the heaps and properly covered with soil. Dry straw was placed on top of the heaps for moisture preservation after planting. After sprouting, yam vines were supported with stakes and the experimental trials were weeded five times before harvest. The trials had five replications at each location.

2.4. Soil Sampling for Nematodes

Initial soil sampling was collected prior to planting to determine plant parasitic nematodes population densities at the various sites. Stand establishment was taken 3 months after planting. At harvest, soil samples (200 cm^3 / mound) were randomly collected with a 2.5 cm diameter soil probe to a depth of 20 cm from the mounds. Three soil cores were collected from each mound. Five-gram tuber peel samples were processed for nematodes from the tubers at harvest. Three tubers per plot were peeled for extraction. Nematodes were extracted from soil using the modified Baermann funnel method. Plant parasitic nematode population data are expressed as number of nematodes/200 cm^3 soil.

2.5. Data Analysis

Data was analyzed using Statistical Analysis System (SAS) and the means separated using Duncan Multiple Range Test at 5% level of probability.

3. RESULTS AND DISCUSSIONS

The result in table 3.1 shows that Pratylenchus spp with absolute frequency 87.3% was highly significant than *Hemicyclophora* spp (4.11). But there was no significant difference in soil mean population of *Helicotylenchus* spp and *Heterodera* spp (28). There was significant difference in the prevalence of *Tylenchus* spp (41.5) and *Hemicyclophora* spp (2.3). The prominence value in *Scutellonema* spp (565) differs significantly from the prominence value of *Heterodera* spp (127). However, there was significant difference in the prevalence of *Xiphinema* spp (31.1) and *Heterodera* spp (37). The least absolute frequency was observed in *Hemicyclophora* spp (4.11) which was significantly different from *Meloidogyne* spp (63.5).

Table 3.1: Plant Parasitic Nematodes in Wushishi LGAs Yam Farm

Species	SPM	AF	PV	P
***Meloidogyne* spp**	95	63.5	769	77.3
***,Scutellonema* spp**	107	55.4	565	63.1
***Tylenchus* spp**	77	32.5	465	41.5
***Rotylenchus* spp**	86	41.2	687	53.2
***Pratylenchus* spp**	156	87.3	978.1	71.3
***Xiphinema* spp**	43	27.8	339.3	31.1
***Trichodorus* spp**	36	22.7	212.4	28.2

***Helicotylenchus* spp**	28	6.8	34.3	12.3
***Heterodera* spp**	28	12.5	127	3.7
***Aphelenchus* spp**	13	6.21	62.5	19.9
***Hemicyclophora* spp**	8	4.11	57.3	2.3

SPM= Soil Population mean, AF=Absolute frequency, P= prevalence, PV = Prominence value

The percentage frequency of occurrence of plant parasitic nematodes extracted from yam farms across Wushishi LGA is presented in Figure 3.2. The result shows that there was significant difference in *Xiphinema* spp (20.8 %) and *Pratylenchus* spp (58.7 %) in Wushishi LGA. However, *Tylenchus* spp (3.3 %) differs significantly from *Helicotylenchus* spp (1.2 %). Similar significant difference was observed in *Scutellonema* spp (7.9 %) and *Aphelenchus* spp (1.9 %) respectively. The lowest percentage in Wushishi LGA was observed in *Hemicyclophora* spp (1.9 %) while the highest percentage was observed in *Pratylenchus* spp (58.7 %).

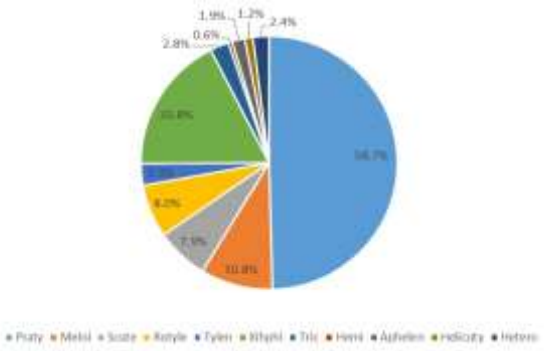

Figure 3.2: The Percentage Frequency of occurrence Presentation of Plant Parasitic Nematodes Extracted from Soil in Wushishi LGA of Niger State

The result in table 3.3 shows the mean population densities of plant parasitic nematodes associated with yam plants in the five selected villages of Wushishi Local Government Area of Niger State. In table 3.3, *Pratylenchus spp* in Zungeru differs significantly from *Rotylenchus* spp (44.24), *Tylenchus* spp (25.67), *Xiphinema* spp (12.86), *Helicotylenchus* spp (7.05), *Trichodorus* spp (4.12), *Aphelenchus* spp (10.0), *Heterodera* spp (6.0). Also, at Bankogi yam farms, there was no significant difference in *Aphelenchus* spp (1.12), Hemicyclophora spp (1.01), and Heterodera spp (0.00) respectively. No significant difference was observed in *Tylenchus* spp (31.12) and *Xiphinema* spp (34.86) in Bankogi yam farms. However, at Tungan Kawo, there was no significant difference in *Pratylenchus spp* (114.24) SP1, *Tylenchus* spp (25.67) SP2, and *Meloidogyne* spp (144.16) SP3 respectively. Also, there was no significant difference in *Rotylenchus spp* (34.33) SP4 and *Tylenchus* spp (31.67) SP5 at Maliaka yam farms and no significant difference was observed was observed in *Hemicyclophora* spp (SP10) and *Heterodera* spp (SP11) in all the yam farms.

Table 3.3: The Mean Population Densities of Plant Parasitic Nematodes Associated with Yam Plants in the Five Selected Villages of Wushishi Local Government Area of Niger State

Villages	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6	SP 7	SP 8	SP 9	SP 10	SP 11
Zungeru	164.24±	83.34±	144.16±	44.24±	25.67±	12.86±	7.05±	4.12±	1.00±	0.00±	0.00±
	8.45a	1.22ab	5.15a	3.63c	1.34c	1.18cd	0.03cd	0.00cd	0.00cd	0.00cd	0.00cd
Bankogi	153.11±	94.74±	123.16±	62.24±	31.12±	34.86±	23.35±	19.23±	1.12±	1.01±	0.00±
	7.75a	2.31b	5.25a	4.63bc	2.34c	1.18c	2.03c	3.00c	0.00cd	1.22cd	0.00cd
Tungan	114.24±	83.34±	144.16±	44.24±	25.67±	12.86±	7.05±	4.12±	1.00±	0.00±	0.00±
Kawo	11.44a	3.22ab	5.15a	2.63c	1.34c	1.06cd	0.03cd	0.00cd	0.00cd	0.00cd	0.00cd
Kaliko	86.24±	72.13±	64.16±	46.14±	25.67±	12.86±	6.12±	2.45±	1.00±	1.31±	0.00±
	9.45ab	4.23b	4.35bc	3.25c	2.42c	1.24acd	1.03cd	0.35cd	0.00cd	0.10cd	0.00cd
Maliaka	112.84±	67.23±	89.46±	34.33±	31.67±	23.13±	14.11±	4.12±	2.00±	0.21±	0.00±
	10.45a	5.21bc	9.25b	4.23c	3.21c	2.21c	1.01cd	1.01cd	0.11cd	0.01cd	0.10cd

Means in a column of any set of treatments followed by different letters are significantly different at 0.05%

KEYS: **SP 1 –** *Pratylenchus*, **SP 2 -** *Scutellonema,* **SP 3 -** *Meloidogyne,* **SP 4 –** *Rotylenchus,* **SP 5 -** *Tylenchus,* **SP 6 -** *Xiphinema,* **SP 7 –** *Helicotylenhchus,* **SP 8 -** *Trichodorus,* **SP 9 -** *Aphelenchus,* **SP 10 –** *Hemicyclophora,* **SP 11 -** *Heterodera*

In Table 3.4, the yam farms in Wushishi LGA, shows that Yangbede, Shakata and Kwasi yam varieties were grown in all the yam farms. However, Army yam variety was grown in Bankogi yam farm. Also, the only yam variety grown in Zungeru is Pamio. In Tungan Kawo, Pamio and Army yam varities were not cultivated but Yangbede, Shakata and Kwasi yam varieties were cultivated in Tungan Kawo. Also, Pamio variety was not cultivated in Bankogi Yam farms.

Table 3.4: Occurrence of Yam Varieties in Wushishi Local Government Areas of Niger State

Varieties	N	Villages Surveyed				
		Zungeru	Bankogi	Tungan Kawo	Kaliko	Maliaka
Shakata	15	+	+	+	+	+
Pamio	15	+	—	—	—	—
Yangbede	15	+	+	+	+	+
Kwasi	15	+	+	+	+	+
Army	15	—	+	—	—	—

+ is Present; — is absent, N is number of samples.

DISCUSSIONS

This study examined the investigation and occurrence of plant parasitic nematodes on yam varieties in wushishi local government area of Niger state of Nigeria. Investigating the occurrences of plant-parasitic nematode's potential impacts on economically important crops such as yam is one of the most important components in determining the biosecurity importance of most known nematode species in Nigeria. Yield loss estimates for species whose pathogenicity or disease-causing abilities have been studied are known for such species only. However, the economic impacts of many plant-parasitic nematodes remains scant or even not available at all (Lee *et al*., 2021). There are limitations in calculating yield losses associated with plant-parasitic nematodes because calculations from different studies and countries do not necessarily use the same standards. Some report damage as percentage yield losses, or as percentage yield gain after nematode control or as correlations of yield gains with lessening plant-parasitic nematode abundance. Their attack on crops constitutes multi pathogenic population in which this component species interacts continuously under field condition. Impacts can also be difficult to estimate or severely underestimated due to plant-parasitic nematode association with other pathogens resulting in disease complexes and severe damages (Nchore *et al*., 2012). These associations and damages may take many forms. Root damages caused by migratory endoparasites from the genera *Pratylenchus* and *Heterodera* allow admission of damaging rots caused by various bacteria and fungi. Currently, there are provisions under International Plant Protection Convention (IPPC) and International Standard for Phytosanitary Measures (ISPM) to assess the effects of plant-parasitic nematode species on different localities. However, surprising that information from these resources is rarely included in the occurence of plant parasitic nematodes species (Singh *et al*., 2013). According to Singh *et al*. (2013), another important aspect to consider when investigating plant parasitic nematodes status is intra-specific variation among species.

CONCLUSIONS AND RECOMMENDATION

From the result obtained, it was concluded that *Meloidogyne, Scutellonema, Tylenchus, Rotylenchus, Pratylenchus*, *Xiphinema*, *Trichodorus, Helicotylenchus, Heterodera, Aphelenchus,* and *Hemicyclophora* are the species of plant parasitic nematodes associated with yam in Wushishi Local Government Area of Niger State of Nigeria. The widespread distribution of these plant parasitic nematodes species can cause plant deformation, poor yield, and quality. A small percentage of the estimated species of plant parasitic nematodes have widerange distribution and cause significant losses to crop production (McNeill *et al*., 2011).

It is observed that free-Living Nematodes (FLNs) are a very low according to the result but important group of nematodes because they are bacteriovorus, algivores and detrivorous in nature. They recycle the nutrients for plant use and consolidate the structure of soil to retain water. During the present investigation, the count of FLNs, in all locations were quite low as compared to PPNs, like the observation of Juma *et al*. (2020). At the cultivation sites, the farmers were advised to use cow and buffalo dung in the soil because Organic Amendments (OAs) help enhance the FLN population and combat the population of PPNs as suggested by Hillocks and Waller (1997).

However, PPNs is a factor of serious concern as it can bring about low yield and poor quality of yam in the area. It is therefore recommended that sustainable PPNs management strategy be factored into yam production program in the study area to enhance yield and quality yam production. Further studies should be conducted to validate the result obtained in this study as well as to

clearly understand the mechanism of PPNs on yam in Wushishi LGAs of Niger State, Nigeria. Yam farmers should be aware of the presence of plant parasitic nematodes in their farms so that management decision can be taken to overcome the havoc of the nematodes. Sanitation programs should be embarked upon at the National and State Agricultural Development Programs.

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