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Research Article

Assessment of Yam Varieties Reaction to Plant Parasitic Nematodes Infestation in -Two Agro-Ecologies of FCT, Nigeria

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Abstract

Yams (*Dioscorea* spp.) are monocotyledonous plant that belongs to the family Dioscoreaceae, originated from Southeast Asia. In this study, five popular Yam varieties namely Kwasi, Yangbede, Shakata, Army and Pamio were evaluated for their reactions to Plant Parasitic Nematodes (PPNs) infestation in two locations Kwali and Kuje of FCT, Nigeria where yam is cultivated. Percentage frequency of PPNs, Mean population densities of PPNs and Occurrence of yam varieties were analyzed using Analysis of Variance where means were separated using Duncan Multiple Range Test at 5% level of probability. The percentage frequency *Pratylenchus* spp of Kwasi yam variety at Kwali was 51.3% higher than at Kuje 47.5%. Three nematodes; *Pratylenchus* spp, *Meloidogyne* spp, and *Scutellonema* spp were isolated from rhizosphere soils across the locations. *Pratylenchus* spp mean population was 121.08% and 97.24% higher than *Meloidogyne* spp was 113.01% and 91.23% and *Scutellonema* spp was 82.21% & 36.13% at Kwali respectively. However, the mean population at Kuje shows that *Pratylenchus* spp has 77.08% which is higher than, *Scutellonema* spp and *Meloidogyne* spp (28.23% and 23.37%) Similarly, 77.08% and 55.11% of Pamio yam variety were found more than Army at Kwali and Kuje respectively. This research has highlighted the presence of Shakata, Yangbede, Kwasi, Army and Pamio and yangbede yam varieties infestation of PPNs in all locations. Thus, there is a need to factor in nematode suppressive strategies into the cultural practices utilized in the entire yam producing endemic area if optimum yield is to be realized.

Keywords

Varieties, PPNs, *Meloidogyne* Spp, *Pratylenchus* Spp, *Scutellonema* Spp, Rhizosphere

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1. Introduction

Yam is the second most important root and tuber crop in the World after Cassava in terms of production and contributes more than 200 dietary calories per day for 60 million people in the yam zone [9]. It has been a prominent food and cash crop for most farmers in the yam production areas of Nigeria, with the sales of yam in both domestic and international markets contributing significantly to the economy of the country [2]. Yams (*Dioscorea* spp.) are monocotyledonous plant which belongs to the family from Southeast Asia, South America, and West Africa. It is an important economic crop comprising more than 900 species which are particularly grown in tropical countries of West Africa countries. The highest producer of Yam production is concentrated in West Africa, with Nigeria producing the largest proportion followed by Ghana and Cote d'lvoire [4] Yams is an important subsistence food crop which is useful in the same manner as potatoes in the western world. These tubers provide a substantial intake of vitamins (thiamine and vitamin C), iron and potassium [8]. It is commonly used as a boiled, baked, fried, roasted or mashed to suit regional tastes and customs [12]. The Peels and matured yam tubers are used as feed to domestic animals such as pigs, goats, and chickens. More importantly, many of the *Dioscorea spp*. have high content of steroidal saponins which make them suitable for industrial applications as corticosteroids precursors and anti-cancer bioactive compounds [14]. The productivity and profitability of yam cultivation are increasingly compromised by various biotic stresses, among which the parasitic nematodes pose one of the most formidable challenges [10]. Yam is gradually being realized as an important non-traditional crop for export in Ghana [7]. Despite numerous the importance, yam production still falls behind other tuber and cereal crops [5]. Yam ranks second in tubers in terms of volume and value of non-traditional export crops in Ghana and the second highest producer in the world after Nigeria [11].

Plant parasitic nematodes (PPNs) are essential biotic stress factor in crop production. PPNs infection undermines resistance to other pests and diseases while predisposes plants to other pathogens that, in turn, magnify losses but also mask the nematode damage. Crop yield losses due to nematodes are difficult to calculate accurately, with global estimates varying considerably from $US 80 billion to $US 157 billion per year [13]. Nematode infection contributes to long term storage losses estimated as 50%, and in some instances, loss could be total [15]. *Pratylenchus* spp, *Meloidogyne* spp and *Scutellonema* spp (yam nematode) are the primary major lesion nematode and they cause dry rot disease of tubers. These PPNs causes dry rot symptoms to yam in West and East Africa. *Scutellonema* spp is considered the most important species of all species which constitute Low levels of infection on seed tubers, which may go undetected, provide inoculum to the next crop, and lead to heavy losses of infected tubers during storage. PPNs have traditionally been the species associated with yield loss in yam [6]. The intensive cultivation of yam (and other crops) on the same land leads to the buildup of Plant Parasitic Nematodes (PPNs) which can be responsible for heavy losses through reduced quality of tubers. The yield losses encountered due to the PPNs, pose severe threats to global agricultural crops, and yields of yam [1].

In the present study, five yam varieties in FCT, Nigeria were evaluated for their reaction to plant parasitic nematodes infection under stable field conditions at kwali and Kuje Area Council of Nigeria.

2. Materials and Methods

2.1. Study Sites

The trials were conducted during 2024 planting season in two Area Councils (ACs) locations in FCT of Nigeria. The sites were Yangoji, Wako, Kundu, Dafa, and Ashara (Kwali Location), Kuchiyako, Damwa, Aduga, Bamishi, and Kuje Urban (Kuje Location). Yam is extensively cultivated in these areas and initial parasitic nematode population densities were perceived to be very high. All the sites experience uniform rainfall pattern. The geo-ecological, climatic, and edaphic factors were determined.

2.2. Experimental Design

Land preparation was done manually by clearing weeds with a cutlass and debris was 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 and peel samples using the modified Baermann funnel method. After 24 hours of extraction, samples were fixed with Formalin - 49% and distilled water 110.4 ml and second, third and fourth stage nematodes were mounted on aluminium double cover glass slides and specimens were identified (CIH, 1978) by morphology. 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. Result and Discusions

The Percentage Frequency of Plant Parasitic Nematodes in Kwali Area Council of FCT in Figure 1 shows the percentage of plant parasitic nematodes at Kwali ACs of FCT. The percentage of *Pratylenchus* spp (51.3%) differ significantly from *Trichodorous* spp (0.5%). But there was no significant difference in the percentage of *Xiphinema* spp (2.1%) and *Helicotylenchus* spp (2.1%). However, Heterodera spp (1.1%) differs significantly from *Scutellonema* spp (10.1%). The least percentage was observed in *Longidorous* spp (0.9%). *Meloidogyne* spp (22.4%) and *Criconemoides* spp (1.0%) differ significantly from each other.

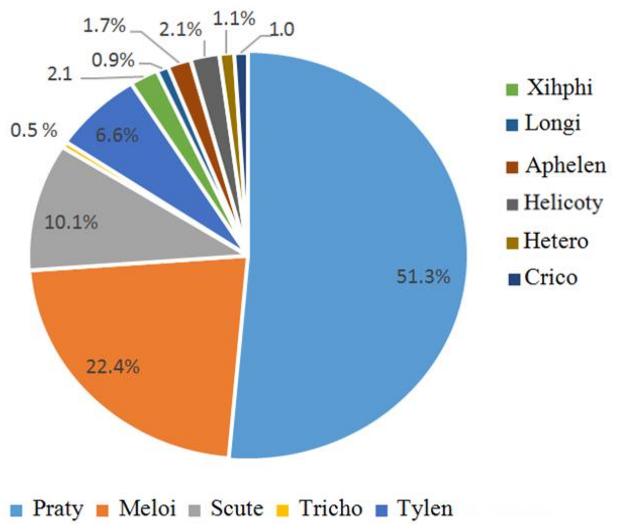

Figure 1. *The Percentage Frequency Presentation of Plant Parasitic Nematodes in Kwali ACs of FCT.*

In table 1, The mean population densities of plant parasitic nematodes associated with yam plants in the five selected villages of Kwali AC of FCT, the mean population density in Table 1 shows that there was no significant difference in Yangoji yam farms for *Pratylenchus* spp (121.08) and *Meloidogyne* spp (113.01). Also, no significant difference was observed for *Pratylenchus* spp, *Scutellonema* spp, *Meloidogyne* spp (97.24, 83.21, and 91.23) at Wako yam farm. However, at Dafa yam farm, there was significant difference in *Pratylenchus* spp (83.10), *Scutellonema* spp (36.13), and *Tylenchus* spp (25.55). *Aphelenchus* spp, *Longidorous* spp, *Heterodera* spp and *Criconemoides* spp show no significant difference in all the yam farms. Also, there was no significant difference in *Meloidogyne* spp at Kundu, Dafa, and Ashara yam farms (67.24, 77.13, and 62.62).

Table 1. *Mean Population Densities of Plant Parasitic Nematodes Associated with Yam Plants in Five Selected Villages of Kwali ACs of FCT.*

Villages	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6	SP 7	SP 8	SP 9	SP 10	SP 11
Yangoji	121.08±4.12a	76.14±3.71ab	113.01±4.01a	56.31±3.75b	36.77±1.87bc	7.05±0.08cd	23.22±1.87c	1.65±0.01d	0.00±0.00d	0.00±0.00d	0.10±0.20d
Wako	97.24±3.98a	83.21±3.31ab	91.23±3.91a	45.32±2.99b	15.16±1.12cd	6.35±0.05cd	0.00±0.11d	1.22±0.00d	0.00±0.00d	0.00±0.00d	0.00±0.31d
Kundu	93.97±4.72a	78.24±2.11ab	67.24±3.56ab	33.53±2.24bc	11.70±2.28cd	7.15±0.01cd	34.12±2.13bc	1.20±0.00d	0.01±0.00d	0.00±0.00d	0.30±0.00d
Dafa	83.10±4.11ab	36.13±3.00bc	77.13±3.48ab	25.55±2.89c	17.26±1.04cd	6.12±1.08cd	1.45±0.35d	1.83±1.64d	0.03±0.00d	0.00±0.00d	0.00±0.00d
Ashara	71.12±3.01ab	43.11±2.94b	62.62±3.10ab	21.34±1.25c	13.11±1.61cd	10.11±1.01cd	0.12±0.00d	2.01±1.11d	0.00±0.00d	0.00±0.00d	0.00±0.00d

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 - Tylenchus, SP 5 - Xiphinema, SP 6 - Helicotylenchus, SP 7 - Trichodorus, SP 8 - Aphelenchus, SP 9 - Longidorous, SP 10 - Heterodera, SP 11 - Criconemoides

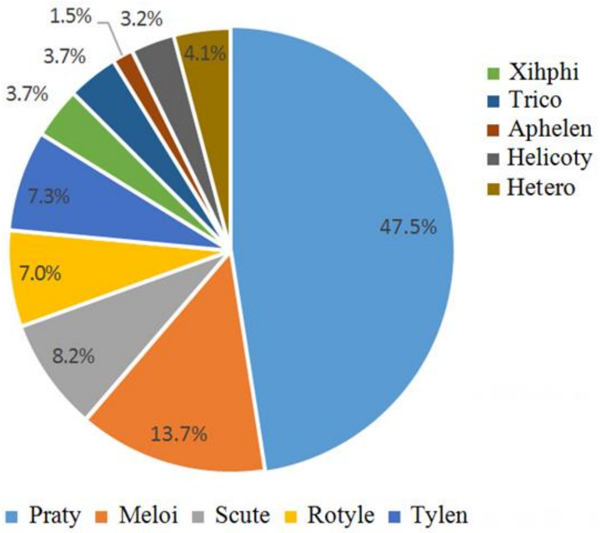

Figure 2. *The Percentage Frequency Presentation of Plant Parasitic Nematodes in Kuje AC of FCT.*

The percentage of plant parasitic nematodes (PPNs) at Kuje ACs is presented in Figure 2. The percentage of plant parasitic nematodes revealed that *Pratylenchus* spp (47.5%) was significantly differennt from *Heterodera* spp (4.1%). However, there was no significant difference in *Xiphinema* spp (3.7%), *Helicotylenchus* spp (3.2%) and *Trichodorous* spp (3.7%). Moreso, *Meloidogyne* spp (13.7%) differs significantly from *Scutellonema* spp (8.2%) in Kuje Acs. There was no significant difference in *Tylenchus* spp (7.3%) and *Rotylenchus* spp (7.0%) respectively.

The mean population densities of plant parasitic nematodes associated with yam plants in the five selected villages of Kuje AC of FCT in Table 2 shows that mean population densities in *Pratylenchus* spp (77.08) at Kuchiyako yam farm differs significantly from Damwa (54.11), Aduga (34.21), Bamishi (33.37), and Kuje Urban (12.12). however, there was no insignificant difference in *Scutellonema* spp in Aduga and Bamishi (28.23 and 26.13). There was no significant difference in *Helicotylenchus* spp in all yam farms at Kuje ACs (6.05, 4.11, 7.18, 5.34, and 8.11) but significant difference was observed in *Tylenchus* spp at Kuchiyako (36.92) Kuje Urban (15.14). Also, no significant difference was observed in *Rotylenchus* spp (11.65) at Bamishi and Kuje Urban. More so, there was no significant difference in *Scutellonema* spp, *Meloidogyne* spp, *Tylenchus* spp, and *Rotylenchus* spp at Aduga yam farm (28.23, 23.37, 23.92, 20.34). significant difference was observed in *Meloidogyne spp* (58.76) and *Rotylenchus* spp (23.35) at Kuchiyako yam farm.

Table 2. *Mean Population Densities of Plant Parasitic Nematodes Associated with Yam Plants in Five Selected Villages of Kuje ACs of FCT.*

Villages	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6	SP 7	SP 8	SP 9	SP 10	SP 11
Kuchiyako	77.08±5.10a	45.44±3.26ab	58.76±4.21b	36.92±2.56ab	23.35±2.48c	10.26±1.14cd	6.05±1.08d	3.82±0.30d	1.00±0.00d	0.11±0.00d	0.00±0.11d
Damwa	54.11±4.84b	37.45±3.01ab	43.11±3.96ab	31.52±1.21ab	19.52±1.73cd	25.16±3.12c	4.11±0.05d	0.31±0.61d	1.42±0.00d	0.00±0.00d	0.00±0.00d
Aduga	34.21±3.45ab	28.23±2.73c	23.37±4.56c	23.92±1.24c	20.34±1.56cd	32.16±2.28ab	7.18±1.01d	0.12±0.00d	1.10±0.00d	0.01±0.00d	0.00±0.00d
Bamishi	33.37±2.22ab	26.13±2.02c	36.11±2.66ab	19.45±3.89cd	11.65±3.49cd	17.16±1.14cd	5.34±1.08d	0.46±0.31d	1.00±1.60d	0.03±0.00d	1.06±0.00d
Kuje Urban	21.12±1.78c	13.11±2.19cd	41.31±1.94ab	15.14±1.48ab	11.34±1.15cd	13.41±1.41cd	8.11±1.01d	3.12±1.01d	2.01±0.11d	0.00±0.00d	1.00±0.00d

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 - Tylenchus, SP 5 - Rotylenchus, SP 6 - Xiphinema, SP 7 - Helicotylenchus, SP 8 - Trichodorus, SP 9 - Aphelenchus, SP 10 - Longidorous, SP 11 - Heterodera

4. Conclusion and Recommendation

This research has demonstrated that pathological reaction of the PPNs of the five yam varieties. The histopathology study also revealed that yam exhibited a typical *Pratylenchus* spp susceptible reaction. Plant parasitic nematodes have been reported to cause yield losses in yam production and which later caused cell disruption and disorganization in the cortex endodermis and vascular cells and formation of giant cells which is essential for a successful host/nematode relationship. However, adoption of early planting and rouging of infected yam fields will also serve as other management technique [3]. All the identified plant parasitic nematodes could be utilized for breeding resistant yam varieties. However, nematode association with yam brought about yield and quality reduction. A lot of research reporting nematode damage to crops has supported this claim [8]. These plant parasitic nematodes do not attack plant alone but generally constitute multi pathogenic population in which this component species interact continuously under field condition [8]. There is a need to factor in nematode suppressive strategies into the cultural practices utilized in the entire yam producing nematode endemic area if optimum yield is to be realized.

Abbreviations

Acs	Area Councils
PPNs	Plant Parasitic Nematodes

Conflicts of Interest

The authors declare no conflicts of interest.

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