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Original Article

Occurrence of parasitic nematodes infecting cucumber in Kwara State, Nigeria

OPEN ACCESS

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ABSTRACT

Management of nematodes required identification and quantification of the plant parasitic nematode species causing infection so as to develop control strategies. The experiment was carried out to determine the abundance of plant parasitic nematodes associated with cucumber in Kwara State. Two hundred and fifty grams (250g) of rhizospheric soil were collected from 18 cm depth, and ten grams of root samples were collected from each of 20 farms across the four Agricultural Development Programme (ADP) delineated agricultural zones of Kwara State following the zigzag sampling technique for nematode extraction and identification. Nematodes were extracted using the Baermann technique and were counted using the standard nematode counting dish; also, soil samples collected from each zone were also exposed to soil tests. Data were analyzed using descriptive statistics. Ten plant parasitic nematode genera were identified, and the most prevalent was *Meloidogyne* spp. with a 7143.00/250 ml mean population density, followed by *Pratylenchus* spp, while the least was *Rotylenchus* spp. having a mean population density of 48.00/250 ml suspension. The study concluded that root-knot nematodes (*Meloidogyne* species) were the most abundant in cucumber-growing fields of Kwara State. Therefore, subsequent build-up of these plant-parasitic nematodes should be periodically monitored by plant nematologists because cucumbers are good hosts of plant-parasitic nematodes, and early observation of population increase will be checked before it gets out of hand.

KEYWORDS: *Abundance, Coordinates, Delineated, Prevalent, Survey*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most cultivated crops in the Cucurbitaceae family. Although, originally a native of Southern Asia, cucumber is now grown across different continents in the tropical, subtropical and warm temperate climates **(**Sharma *et al*., 2016). Globally, it is grown and relished nutritionally as good source of essential elements required by the body and roughage (Mukhtar *et al*., 2013).Cucumber helps in body hydration, regulation of blood pressure and prevention of cardiovascular diseases. They contain magnesium, potassium, dietary fibre and vitamin A, C and K (Mukhtar *et al*.,2013). It also a source of phenolic compounds that promotes antioxidant and anti-

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inflammatory activities. The seeds are also source of oil used for cooking (GBIF,2013).

China is the largest producer of cucumber in the world with annual production of 75,597,659 tons annually. In Africa, Egypt (433,440) leads in cucumber production, followed by Sudan (331,402) and Cameroon (258,773). Nigeria is not presently ranked (Umeh and Ojiako,2018) probably because of low production or paucity of official records. However, average production in Africa still falls short of that of Asia.

In Nigeria, the highest production of cucumber comes from Plateau State, located in the north-central part of the country, while Osun State in South-western part of the country is the second ranked producer (Ambrose,2013). The production of cucumber is threatened by tremendous yield losses from diseases and pests such as anthracnose, damping-off, *Fusarium* wilt, Angular leaf spot, Cucumber mosaic, aphids and nematodes. Of these, nematodes are one of the major factors responsible for huge quantitative and qualitative losses (Palomares-Rius *et al*.,2017). Although, more than twenty parasitic nematode genera have been reported to be associated with vegetables worldwide, however, the most occurring and destructive are the root- knot nematodes which serve as natural host to many vegetables in Nigeria (Izuogu and Abiri, 2014). Approximately 50% of screenhouse-grown vegetable are infected by root-knot nematodes with an annual loss of more than $400 million reported by Osunlola and Fawole (2015). Even at low levels, the nematode remains one of the most destructive pathogens of vegetables (Mukhtar *et al*.,2013). Effective management of nematode required proper identification and quantification of the nematode population to determine the best management practices. Therefore, the aim of this experiment was to determine different nematodes species associated with cucumber field in different locations of Kwara State, Nigeria.

MATERIALS AND METHODS

Survey Area

Kwara state has a total land size of 36,825,020 hectares (FOS, 1995). It is located between Longitude 2° 30' E and 6° 25' E and Latitude 7° 45' N and 9° 30' N (KWADP, 1998). The State has a forest area of about 1000km^2 situated in the transitional zone between forest woodland of the South and the Savanna of the North (Anwar et al. 2013) which is characterized by a long rainy season (Kwara State Atlas, 1981).The mean annual rainfall is 1,200mm. The temperature is uniformly high throughout the year varying between 28°C and 29.5°C (Abiodun *et al*., 2014). The soil ranges from sandy loam to sandy clay loam (Oyedunmade and Izuogu, 2011). Kwara State consists of sixteen (16) Local Governments Areas, which was divided into four zones by the (KWADP,1998) in consonance with ecological characteristics and cultural practices of the zone (KWADP, 1981). Each zone comprises the following blocks; Zone A : Kaiama, Gwanara, Okuta and Yashia Blocks; Zone B: Kpada, Lade, Lafiagi, Shonga and Bacita Blocks; Zone C : Ganmo, Temidire, Aboto – Oja, Paiye, Oloru and Bode-Saadu Blocks and Zone D: Oke-Odo, Obbo-Ile, Olla, Iponrin, Igbaja Offa and Oro Blocks (Ayinde *et al*., 2008).

The criteria for farm selection and sampling were based on accessibility, availability of farmer and the willingness of the farmer to allow sample collection from his farm. A total of 20 farms were sampled from the four agroecological zones and 3 to 8 farms were visited in each zone of 2 .0 ha of farm size. Soil and root samples were collected for nematode analysis from the farms during 2019 and 2020 growing seasons (September to November).

Soil samples for the survey were collected from the rhizosphere of the cucumber with the aid of soil auger at depth of 18 cm close to the base of the plant. Twenty soil core samples per farm were taken in a zigzag pattern from each of the cucumber farms and bulked together to form a composite sample, which gave a representation of the nematode sample on each farm.

Root samples were obtained by uprooting five cucumber in each of the farms at 28 cm depth using hand fork from each of the four corners. Numbers of infested sampled Farms during survey were 5, 8, 3 and 4 for Zone A, Zone B, Zone C and Zone D respectively. All samples were properly labeled, packed and kept in a refrigerator in the Department of Crop Protection laboratory, University of Ilorin, Ilorin. Samples collected were processed for extraction within 24 hours after collection and further identification of extracted nematodes was carried out. All sampled farms were geo-referenced using Geographical Positioning System (GPS). Figure 3.1 is a map of surveyed locations and soil types below.

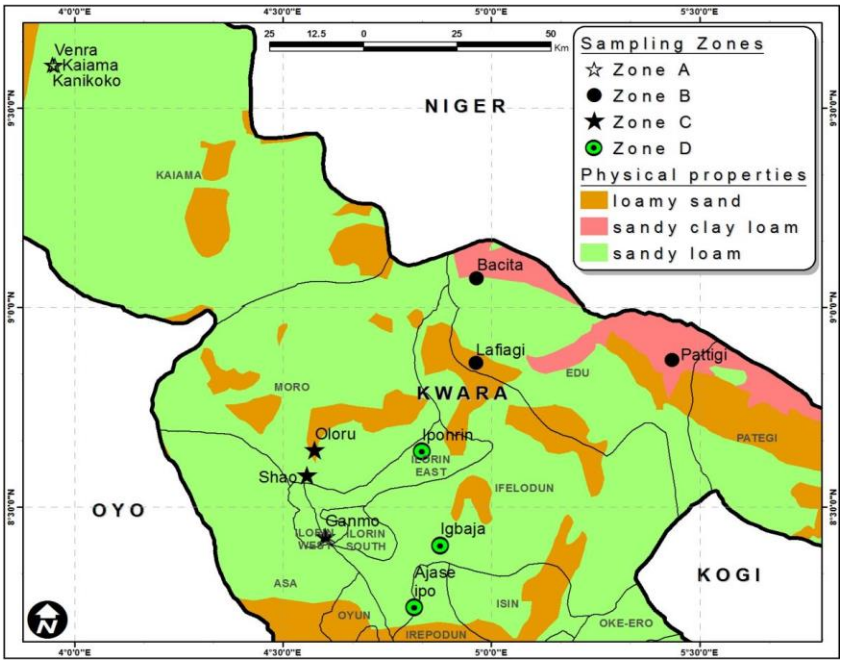

Figure 1: Map showing surveyed locations and their soil properties

Extraction of Nematodes from Soil and Root Samples

According to the location of the farms, the soils and roots were separated. Juveniles from the soil and root samples were extracted using the Modified Baermans extraction Tray method as described by (Whitehead and Hemmings,1965). A double ply facial tissue was laid in a sieve and the sieve was placed in a tray. Two hundred grams of the composite soil were poured into the sieve and water was gently poured at the base of each of the tray for easy migration of nematodes into water. The extraction was left undisturbed for 48 hours.

The resulting nematode suspension in the bowl was poured into a 500 ml beaker and left undisturbed for 3 hours. For root samples, roots uprooted were carefully washed under running tap, a subsample of 200 g roots were chopped into 1-2 cm pieces and macerated for 1 to 2 minutes using blender (Orisajo and Fademi,2012) and nematodes were extracted using the Modified Baermans extraction technique as in soil extraction.

The nematode suspension was concentrated to about 250 ml by removing excess water (supernatant) using the settling and decanting method (Caveness, 1975). The different nematode genera recovered were identified under a compound microscope using the pictorial key for plant-parasitic nematodes identification to generic level by (Mekete *et al.*, 2012).

Counting of identified nematode species was done under a compound microscope using (Doncaster, 1962). Counting dish. Subsamples (20 ml) were counted four times and the average was used to estimate the nematode population occurrence and mean densities of nematode. Nematodes recorded from soil and root samples in each zone were calculated following modified methods of (Araya *et al*., 2002).

$$\text{Percentage of occurrence} = \frac{\text{Number of infested farms}}{\text{Total number of farms in zone}} \times 100 \quad (1)$$

Percentage relative abundance of nematode population in soil or roo

$$\frac{\text{In}}{\text{Tn}} 100 \quad (2)$$

Where: In = Individual nematode population per 250 ml soil suspension or 10 g root per suspension,

Tn= Total nematode population extracted

Soil samples collected from each zone were also exposed to soil properties analysis using Dawis and Freitas, (1970) and Singh, (1999).

RESULTS AND DISCUSSION

Table 1 showed the plant parasitic nematode recovered from the soil and root in the area sampled. Ten nematode genera were identified in association with cucumber from

the four agroecological zones in Kwara State, Nigeria. The plant-parasitic nematodes recorded from soil and roots of cucumber farm include; *Heterodera*, *Tylenchus*, *Helicotylenchus*. *Pratylenchus*, *Meloidogyne*, *Xiphinema*, *Scutellonema, Longidorous, Criconema,* and *Rotylenchus.* These nematodes recorded widespread of occurrence and distribution on cucumber farm in the four agro-ecological zones surveyed. However, *Meloidogyne* was the most prominent plant-parasitic nematode found in soil around cucumber plants. It showed the highest mean population density distribution of 7143 and a relative abundance of 42.12. *Xiphinema* was the least occurring nematode genus with a population density and relative abundance of 122 and 0.71 respectively.

The nematodes detected in the root are *Heterodera*, *Pratylenchus*, *Meloidogyne*, *Scutellonema*, *Rotylenchulus* and *Helicotylenchus*. However, *Tylenchus*, *Longidorous*, *Criconema* and *Xiphinema* were not found in the root. In similarity to the soil nematodes, *Meloidogyne* had the highest population (3322.2) and relative abundance of 70.8.

Table 1: Nematode genera recovered from 250 ml soil and 10 g root suspension of cucumber farms surveyed

Nematode Genus	MSNP	R SN P (%)	MRNP	RRNP (%)
Heterodera	50.00^{a}	2.39^{ab}	0.00^{a}	0.00^{a}
Pratylenchus	3620.00^{e}	21.34^{d}	1257.33^{d}	26.800.02^{c}
Meloidogyne	7143.00^{f}	42.12^{e}	3322.20^{e}	70.80^{d}
Tylenchus	735.00^{c}	4.32^{ab}	0.00^{a}	0.00^{a}
Scutellonema	2957.00^{d}	17.45^{c}	33.00^{a}	0.810^{bc}
Longidorous	265.00^{bc}	1.55^{ab}	0.00^{a}	0.00^{a}
Criconema	143.00^{b}	0.84^{a}	0.00^{a}	0.00^{a}
Xiphinema	122.00^{b}	0.71^{a}	0.00^{c}	0.00^{bc}
Rotylenchus	48.00^{a}	0.29^{a}	0.00^{c}	0.00^{a}
Helicotylenchus	336.00^{bc}	1.99^{ab}	41.00^{b}	0.90^{b}

Values in the same column followed by the same letter superscript (s) have no significant differences at p<0.05 according to Duncan Multiple Range Test (DMRT). MSNP=Mean soil nematode population; RSNP= Relative abundance of soil nematode population; MRNP=Mean root nematode population; RRNP= Relative abundance of root nematode population

Table 2 showed the nematode population recovered from the cucumber roots in each of the zones in Kwara State, Nigeria. The five nematode genera recovered were *Pratylenchus*, *Meloidogyne*, *Scutellonema*, *Rotylenchus*, and *Helicotylenchus*. Zone B had the highest nematode occurrence with four nematodes recovered from the roots which include *Pratylenchus*, *Meloidogyne*, *Xiphinema* and *Rotylenchus* with 322.70, 1002.00, 33.00 and 38.33 respectively. This was followed by Zone C with three nematode genera (*Pratylenchus*, *Meloidogyne* and *Helicotylenchus*). However, Zones A and B had the least occurrence with two nematode genera detected in each of the zones.

Table 2: Population of nematodes found in cucumber (10 g root) in all zones of Kwara State, Nigeria

Zones	*Pratylenchus*	*Meloidogyne*	*Scutellonema*	*Rotylenchus*	*Helicotylenchus*
Zone A	42.33^{b}	867.30^{b}	0.00^{a}	0.00^{a}	0.00^{a}
Zone B	322.70^{c}	1002.00^{c}	33.00^{b}	38.33^{b}	0.00^{a}
Zone C	892.30^{d}	896.60^{bc}	0.00^{a}	0.00^{a}	30.00^{c}
Zone D	0.00^{a}	556.30^{a}	0.00^{a}	0.00^{a}	11.00^{b}

Values in the same column followed by the same letter superscript (s) have no significant differences at p<0.05 according to Duncan Multiple Range Test (DMRT).

Table 3 showed the population of nematodes in each of the zones where cucumber was cultivated in Kwara State, Nigeria. Result revealed that all the nematodes were detected in Zone B area of the state, making them the zone with highest nematode occurrence. This was followed by Zone A where seven nematodes were detected with the exception of *Tylenchus, Criconema* and *Longidorous.* However, Zone C had the lowest nematode occurrence where *Pratylenchus, Meloidogyne* and *Criconema* were detected.

Table 3: Population of nematodes found in cucumber (250 ml of Soil) across all the zones in Kwara State, Nigeria

Nematode genera	Zone A	Zone A	Zone A	Zone A
Heterodera	37.90[b]	68.40[b]	0.00[a]	0.00[a]
Pratylenchus	2600.30[c]	4267.9[d]	920.10[b]	460.20[a]
Meloidogyne	7940.10[d]	8920.70[d]	3710.80[a]	7770b0[c]
Tylenchus	0.00[a]	920.70[c]	0.00[a]	25.80[b]
Scutellonema	1050.20[b]	3225.60[c]	0.00[a]	0.00[a]
Longidorous	0.00[a]	440.10[b]	0.00[a]	0.00[a]
Criconema	0.00[a]	302.30[c]	195.70[bc]	0.00[a]
Xiphinema	243.20[c]	205.80[c]	0.00[a]	53.80[b]

Percentage occurrence of nematodes recovered in all the zones is shown in Figure 2. Zone B recorded the most occurrence of nematode population as well as the highest percentage occurrence of 40%. This was followed by Zones A and D with percentage nematode occurrence of 25% and 20% respectively. Finally, Zone C recorded the lowest (15%) percentage occurrence of nematode population.

Percentage occurrence of nematodes recovered in all the zones

The study revealed the presence of plant-parasitic nematodes within the rhizosphere of cucumber plants grown in an open field of the four agroecological zones of Kwara State. The investigation showed that both endoparasitic and ectoparasitic nematodes were both prevalent in across the state. The experiment also revealed root-knot nematode (*Meloidogyne* spp.) to be the most prevalent nematode infecting cucumber in the area; this was followed by lesion nematode (*Pratylenchus* spp.). This finding is in agreement with (AminuTaiwo & Fawole, 2012), who reported occurrence, abundance and distribution of plant-parasitic nematodes associated with cucumber in Southwest Nigeria. Previous studies also indicated that root-knot nematodes had the highest frequency of occurrence and population density in the rhizosphere of vegetable crops globally (Anwar & Khan, 1973; Mokbel, 2014; Olajide *et al*.,2018). Root-knot nematodes are polyphagus in nature, with the widest host range, while also distributed worldwide (Rich *et al*.,2008). *Meloidogyne* spp. is also a menace in the root of cucumber, because apart from the extensive galling it induces in the root systems, its presence is often associated with increased incidence and severity of *Fusarium* wilts and *Verticullum* wilt of vegetables (Anwar & Khan, 1973).

In this study area, the mixed infection of root-knot nematodes and other root-feeding nematodes is worrisome because of their damaging economic effects. For instance, lesion nematodes (*Pratylenchus* spp.) are known to form disease complexes with different soil-borne fungi causing root rot, which increases damage in root (Sikora and Fernadez,1990). Also, *Longidorous*, *Criconemoides*, *Xiphinema*, and *Tylenchus* are ectoparasites that feed on epidermal root tissues and parasitic to vegetables (Anwar *et al*.,2013).

Most of the areas within the zone B were heavily infested with nematodes compared to the other areas (tables 1and 2). This indicated that that the conditions of zone B are more favorable for multiplication of nematodes and hence the high density observed the in zone B as compared to other zones. It could also be noted that the zone had the highest percentage of sandy soil. This could imply that soil texture is a factor that influences abundance and distribution of plant-parasitic nematodes. Studies carried out with soils differing in texture composition have demonstrated the influence of soil physical properties on nematode population density and distribution. This is also similar to the observation of Kandji *et al*.(2001) which stated the potential of nematodes as bio-indicator organisms to soil status. The higher number of plant-parasitic nematodes associated with sandy soils could be attributed to high porosity and aeration that favors nematodes mobility.

CONCLUSION AND RECOMMENDATIONS

Generally, the presences of different genera of plant parasitic nematodes in all the zones have been investigated and *Meloidogyne* species are the most abundant in all the zones. The presence of high population of *Meloidogyne* spp. and their attendant economic importance in cucumber growing zones of Kwara State is noteworthy. Attention should therefore be focused on the management of this nematode in order to increase productivity in the State and the Kwara State extension officers should create awareness to farmers on the adverse effect of plant-parasitic nematodes in cucumber production.

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Authors Contributions

Conceptualization, methodology, and writing were perfected by HSB, data creation was done by KYB, data analysis by OAA and review was done by NBI. The authors declare that they have read and approved the publication of the manuscript in this present form.

Ethical Statement

Not applicable

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