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OCCURRENCE AND PREVALENCE OF PLANT PARASITIC NEMATODES ASSOCIATED WITH OKRA (*Abelmoschus esculentus*) IN ADAMAWA STATE, NIGERIA

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ABSTRACT

Okra is known to be attacked by many pest, the status of plant parasitic Nematodes and its management on okra is not known in Adamawa state hence a study was conducted between July 2023 and October 2023 to examine the occurrence of plant-parasitic nematodes associated with Okra (Abelmoschus esculentus L. Moench) in adamawa state North Eastern

Introduction

Okra (*Abelmoschus esculentus L. Moench*) is one of the useful vegetables in the world most importantly in the tropical and subtropical regions and it is an important vegetable crop consumed worldwide (Olaniyi et al., 2009; Omotoso et al., 2018). Okra is a member of the Malvaceae family and is an indigenous crop of Africa cultivated widely in West and Central Africa for its immature fruits (Varmudy, 2011; Komolafe et al., 2021).

The total production of Okra (*Abelmoschus esculentus L. Moench*) varies from country to country. The world's total okra production was estimated at 11.2 million Tons. India is the top country by okra production in the world. As of 2022, the okra production in India was 6.87 million

Nigeria. Six (6), (Fufore, Mubi South, Song, Mubi North, Mayobelwa and Ganye) out of 21 local government areas (LGAs) were purposefully selected for the survey of plant parasitic nematodes (PPN) on okra roots and soil based on okra production and geographical spread in the state. Composite soils and okra root samples were collected from three farms in each of the 6 Local government areas, and nematodes were extracted identified, and counted using the modified Baermann tray method. The results revealed eight genera of plant parasitic nematodes in okra-cultivated fields: Meloidogyne, Helicotylenchus, Tylenchus, Hoplolaimus, Rotylenchus, Pratylenchus, Scutellonema, and Aphelenchus. Among these, Meloidogyne (81.45%), *Pratylenchus* (65.48%), *Scutellonema* (61.59%), *Tylenchus* (45.85%), *Hoplolaimus* (36.90%), and *Rotylenchus* (35.90%) were the most occurred in both okra cultivated soil and roots. *The study indicated higher nematode populations in soil compared to plant roots, with variations in density across locations influenced by soil type and cultivation practices. The occurrence of nematodes was consistently linked to intercropping practices and soil properties. It is recommended that Farmers need to adopt the management practices of plant parasitic nematode on okra cultivated field to increase yield.*

Keywords: *Occurrence, Abelmoschus esculentus, Associated, plant parasitic nematodes, Adamawa*

tons this accounts for 61.19% of the world's okra production while the okra production in Nigeria increased from 315,000 t in 1.81 in 2020 to 1.91 million ton in 2022 growing at an average annual rate of 5.47% (knoema, 2024; FAOSTAT, 2022). Okra yield per hectare in Nigeria differs ranging from 3.36-7.43 t/ha and 6-5.7 t/ha (Komolafe et al2021). However the total area under cultivation has increased over the years. India has been known to be the highest producer of okra in the world, followed by Nigeria and Sudan (Komolafe et al., 2021). Okra thrives well in different soils, but it is best grown in well- drained sandy and clay loam soils, especially with rich organic matter (Sreenivasa et al., 2010). It can tolerate slightly acidic soil. The crop can be grown in soils with pH range from

4.5 to 7. According to Iyagba et al. (2012), okra grows best on loams and sandy loams, but will produce good yields on heavier soils. It is a crop of tropical and sub-tropical climates requiring a long warm and humid growing season (Komolafe et al., 2021). It is susceptible to frost and cannot thrive well in cold. It may be grown at elevations from sea level up to 30 m (Omotoso et al., 2018) but can tolerate a wide range of rainfall (Omotoso et al., 2015). Seeds fail to germinate below 20 ° C. Optimum temperature for seed germination is 29 ° C. Okra is a stout, erect annual herb that grows to about 4 m tall with spirally arranged leaves with leaf blades up to 50 cm in diameter (Olaniyi et al., 2009). The fruit is a capsule and grows quickly after flowering. Fruits or pods are green, 5-35cm long and 1-5 cm in diameter (Adetuyi et al., 2011).

Plant parasitic nematodes are considered among the top 5 major plant pathogens and the first among the 10 most important genera of plant parasitic nematodes in the world (Mukhtar et al. 2013a). The most damaging factors to an okra crop are diseases and pests. Among these, root-knot nematodes (*Meloidogyne spp.*) are the most harmful to okra production (Hussain et al., 2011).

In Nigeria Two species of root- knot nematodes, *M. incognita and M. javanica* very frequently attack *A. esculentus* (Caveness, 1976). (Jada et al., 2021,) reported that 4 genera *meloidogyne, scutellonema, athelenchode and hophlaimid* are associated with moringa and they dominate 4 local government area of Adamawa state northeastern Nigeria. It was also reported that *meloidogyne javanica* is mostly found in the northern Nigeria (hunt et al., 2018). (Sikora and Fernandez, 2005) reported that severe attach of root-knot disease caused by *meloidogyne Spp* on okra and yield losses up to 27%. Incidence and severity of wilt disease caused by fungi and bacteria have been reported to increase in many crops by root-knot infection (Shahbaz et al., 2015; Tranq-khan et al, 2016). The yield losses caused by root- knot nematodes are due to buildup of inoculums of this pathogens (kayani et al,. 2013). Because of the damage that plant parasitic nematodes causes on the field, several ways has been employed to minimize them such approach are the use of natural enemies (Khan et al., 2008). Use of resistant variety (William and Kumar, 2006) enhancing cultural practices (okada and harada, 2007). Grafting is an effective

approach to deal with soil borne pathogens, increasing yields in stressful environments (Bie et al., 2017). The management of plant parasitic nematodes with synthetic nematicides is the predominant strategy for many years (Siji et al., 2010), but studies have shown that high cost of synthetic nematicide and their hazardous effects on the environment, non-target organisms are banes to their use by most peasant farmers in Africa (Adekunle and Fawole, 2003; Fawole, 2009). Many measures are being explored in the management of root-knot nematodes such as crop rotation, planting of resistant varieties, use of botanicals, amongst others (Siji et al., 2010). Most nematicide have been linked to various healthy and environmental problems leading to their withdrawal from market (Lilley *et al*., 2007). Hence the objective of the study is to Establish the occurrence and abundance of PPN associated with Okra cultivated field in Adamawa state Nigeria.

MATERIALS AND METHODS

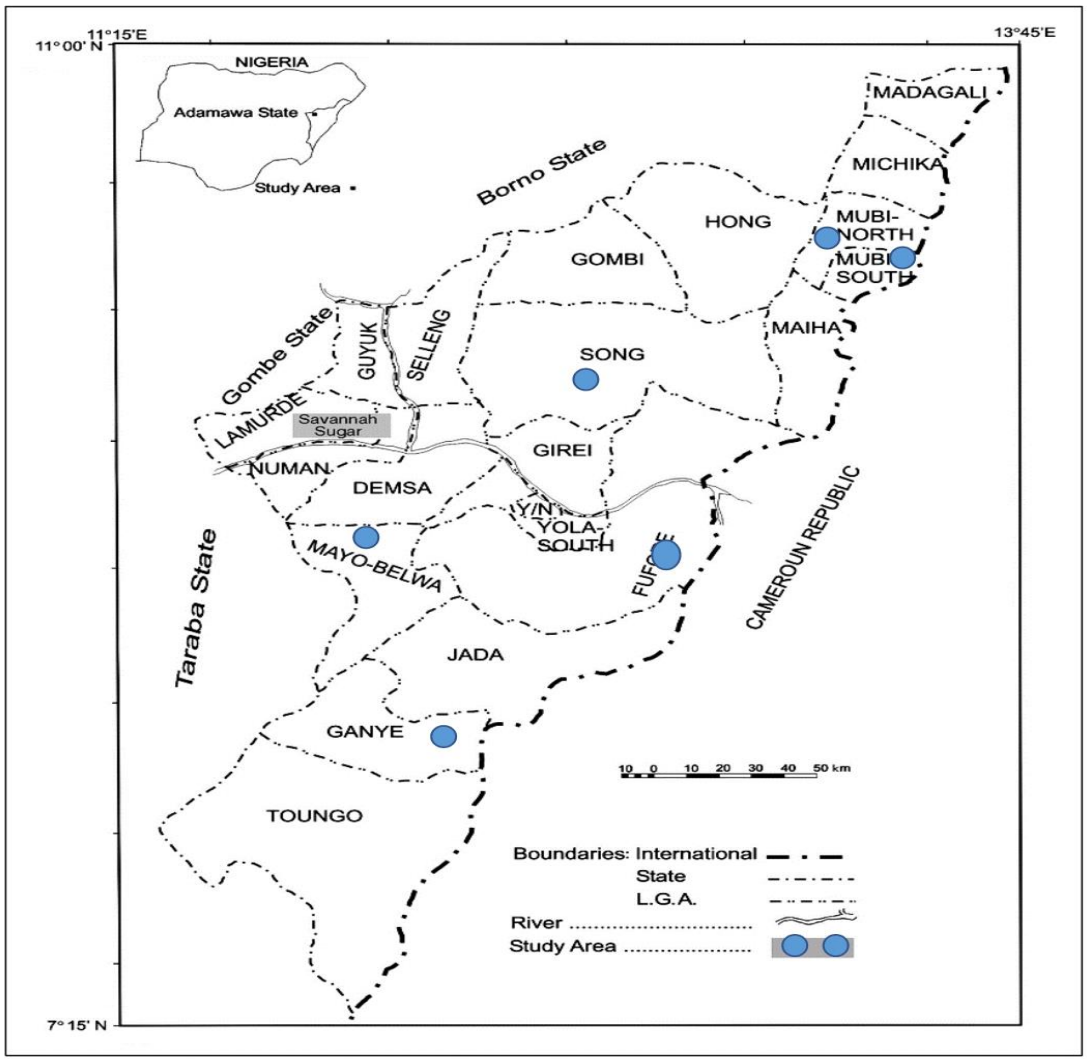
Sampling site

The survey was carried out between July to October, 2023 rainy season in Adamawa State. Six (6), (fufore, Mubi South, Song, Mubi North, Mayobelwa and Ganye) out of the 21 local government areas (LGAs) were purposefully selected for the survey of plant parasitic nematodes (PPN) on okra roots and rhizosphere based on okra production and geographical spread in the state.(Fig:1)

Sampling Procedure for Soil and Roots Collection

For sampling purpose, 10 different farmers' farms was selected from three villages. In each farmer's field, soil samples were collected at random from 5 points and were bulked and mixed in a bucket. two (2) kg of soil sample from each farm was taken and placed in a plastic bag then labeled appropriately giving a total of 10 kg soil sample from each Local government making a total of 60 soil sample. While collecting the soil samples 3 okra plant were uprooted gently from each of the farmers' fields and the soil surrounding the roots were collected to about the depth of 10-15 cm and then labelled according to the villages and their respective L.G.A. The root samples were taken simultaneously

with soil sample to the laboratory for nematode extraction in the Nematology laboratory of the Department of Crop Protection laboratory, Modibbo Adama University, Yola. For extraction each of the bag was carefully opened and mixed thoroughly stones and roots were removed from the soil and then stored at room temperature in the laboratory. Then about 250 ml of each sample were measured for extraction. During the survey the cropping were recorded indicating either sole okra or mixed okra with other plant crops such as cereals, legumes, and tree crops.



Source: https://www.researchgate.net/figure/Map-of-Adamawa-State

Fig: 1. Map of Adamawa state showing the study area.

Extraction of surveyed Nematodes in soil and plant roots

Nematodes from the soil samples were extracted using the Baermann tray method as described by Coyne *et al.,* (2018). Each composite sample was thoroughly mixed and nematodes were extracted from a 250 ml sub-sample. Each extraction set up were left undisturbed for 24-48 hours after which the nematode suspension was decanted into a beaker. Ten 10 g of roots sample collected were cut into pieces and were blended using a blender then nematodes were extracted using Baermann tray method as described by Coyne *et al.,* (2018). From the nematode suspension extracted in each case, 2 ml was drawn and 2 ml of boiling water plus 2 ml of 4% formaldehyde was added to kill and fix the nematodes (Baimey et al., 2009). These nematodes were counted and identified to genera level as described by Coyne *et al.,* (2018). This were repeated 10 times to estimate the nematodes specimen associated for each sample.

Estimation of number of galls

Total number of galls in three plants roots in each treatment were counted visually and the average number was taken as number of galls per plant. And the galling index was calculated using Taylor and Sasser (1978).

Data analysis for the surveyed nematodes

The plant-parasitic nematode genera associated with okra were analyzed by determining their mean density per local government, the relative density, the frequency of occurrence in the samples, and the prominent value. The mean density in this work refers to the average number of individual nematode specimens per 250 ml of soil or 10 g roots in each local government. The population density (PD, %) of each nematode genus was calculated using the formula below as described by (Haougui et al., 2017).

$$\mathrm{PD} = \frac{\text{number ofnematodes in a genus}}{\text{total number of nematodes}} \mathrm{X}100$$

PD (%) = (No. of Nematode specimen in a genus/Total No. of Nematodes).100.
The frequency of occurrence (FO, %) for each nematode is the percentage of samples where the nematode is found and will be calculated using the formula (Agaba and Fayode, 2012):

$$\text{FO (\%)} = \frac{\text{number of samples containing nematodes}}{\text{total number of samples}} \text{X100}$$

FO (%) = (No. of samples containing a nematode / Total sample size).100
Prominent value (PV, %) is calculated using Jada et al (2021) formula in De Waele et al. (1998)

$$\text{PV (\%)} = \text{Density x } \frac{\sqrt{\text{Frequency Of Occurance}}}{10}$$

In addition, before cutting roots from each sample into bits (pieces) they were observed for presence of root galls caused by nematodes in the Meloidogyne genus. The root galls were counted and galling index ranked on a scale of 1-5 as described by Tayler and Sasser (1978).

RESULTS

Surveyed Locations of plant parasitic nematode of okra in Adamawa state. The different okra locations surveyed for plant parasitic nematode from the six local government area (Mubi south, Mubi North, Song, Fufore, Mayobelwa and Ganye) are presented in table 1. Song, Fufore, Mayobelwa and Ganye are located in the guinea savanna while Mubi south, and Mubi North are Sudan savanna. In all the local government area, some cultivated okra as sole crop, covering an area of 0.2- 0.5 ha. Some location are mixed crop covering 1-2 ha with some having maize, sorrel, jute, and sorghum. In some location, farmers use okra as border crops covering 1-2 m to help them cultivate for household use and for easy access to farms.

Presence of Plant Parasitic Nematode Genera in okra roots and soil of Adamawa state

Table 2 shows the presence of Plant Parasitic Nematode Genera by Local Government in Okra cultivated Soil. The result shows all the six 6 LGA are associated with plant parasitic nematode. Seven genera *Meloidogyne* spp, *Hoplolaimus* spp, *Pratylenchus, Helicotyleanchus, Scutelellonema, Tylenchus, And Rotylenchus species,* were found in all the local government area. Also 3 genera, *Helicotyleanchus, Tylenchus* and *Rotylenchus* were found to be in small quantity in all the local government area. This indicates that the total of seven nematode genera are found in sampled okra area. Among the seven genera *Meloidogyne* is the most dangerous. Similarly Table 3 shows the presence of Plant Parasitic Nematode Genera in Okra roots of some Local Government in Adamawa state. The result shows all the six 6 LGA are dominated by *Meloidogyne* spp and *Pratylenchus.* Also, *Hoplolainus* were found in Four LGA (Mubi South, song, Fufore, and Ganye). Similarly, *Tylenchus* was present in Mubi north, Mubi south, Mayobelwa, and Ganye while it was absent in Fufore. In the same vein *Secutellonema*, was present only in Fofure, Mayobelwa, and Ganye while it was absent in Mubi south, Mubi North and song. However, *Aphelinchid* was absent in five 5 local government areas where it appears only in Ganye LGA. It could be observed that one of the genera found in the okra soil are not here. It indicate that they are either migratory endo parasite or exo parasite. The genera *Meloidogyne* is found in okra roots from all the sampled area of the study.

Table 1: Surveyed okra Locations in 2023 raining season in Adamawa state

Local Government Area	Location	Geographical coordinate	Other crops intercropped with okra
Mubi south	Gidan Madara Barama	10^0 25 N La, $13^0$30 E Lo 10'27 N La, $13^0$29 E Lo	Maize, sorrel and jute Sole okra

Mubi north	Lokowa Sabon gari	10^0 26 N La, 13^{0}28 E Lo 10^0 16 N La, 13^{0}17 E Lo	Jute, maize sorrel Maize
Song	Loko Barkin Tudu song	9^0 37 N La, 12^{0}33 E Lo 9^0 63 N La, 12^{0}55 E Lo	Onion, maize, Maize pepper and tomato
Fufore	Chi gari Ribado	9^0 13 N La, 12^{0}36 E Lo 9^0 28 N La, 12^{0}39 E Lo	Maize, rice, pepper Sole okra
Mayobelwa	Mayobelwa Sebore	9^0 06 N La, 12^{0}05 E L$_0$ 9^{0}14 N La, 12^{0}08 E L$_0$	Tomato, maize, garden egg, sorrel
Ganye	Sangasumi Babbaray	8^{0}26 N La, 12^{0}2'58 E L$_0$ 8^{0}43 N La, 12^{0}07 E L$_0$	Banana, groundnut, maize, rice and mango

Source: Field survey 2023, La= latitude; Lo= longitude, E= East; N=north

Table 2: presence of plant parasitic Nematode Genera in Okra Soil of Adamawa State

Plant parasitic Nematode Genera							
Local Government Area	**MDG**	**HOP**	**PRAT**	**HEL**	**SCUT**	**TYL**	**ROTY**
Mubi south	++	++	+	+	++	+	+
Mubi north	+	++	+	+	+	+	+
Song	++	++	++	+	++	+	+
Fufore	+	+	++	+	++	+	+
Mayobelwa	++	+	+	+	++	+	+
Ganye	++	+	+	+	+	+	+

Key: MGD= Meloidogyne spp; HOP= Hoplolaimus; PRAT= Pratylenchus; HEL= Helicotyleachus; SCUT=Scutellonema; TYL= Tylenchus; ROTY= Rotylenchus += Nematode specimen 100; ++= Nematode specimen more than 100

Table 3: presence of Plant Parasitic Nematode Genera by Local Government in Okra roots of Adamawa state.

Plant parasitic Nematode Genera						
Local Government Area	**MDG**	**HOP**	**PRAT**	**SCUT**	**TYL**	**APHE**
Mubi south	++	++	++	-	+	-
Mubi north	++	-	+	-	++	-
Song	++	++	++	-	++	-
Fufore	++	+	++	++	-	-
Mayobelwa	++	-	++	++	++	-
Ganye	+	+	+	+	+	+

Key: MGD= Meloidogyne spp; HOP= Hoplolaimus; PRAT= Pratylenchus; SCUT= Scutellonema; TYL= Tylenchus; APHE= Aphelenchus += Nematode specimen 100; ++= Nematode specimen more than 100. -= No nematode specimen

Plant parasitic Nematode found in okra cultivated soil of some Local Government Area of Adamawa state

The result in Table 4 shows shows in terms of the presence of the plant parasitic nematodes in terms of population density, frequency of occurrence and prominent value. The result of nematode extracted from soil sample showed the presence of seven genera (*Meloidogyne* spp, *Helicotylenchus,Tylechus, Hoplolaimus, Rotytenchus, Pratylenchus* and *Scutellonema* spp of plant parasitic nematode was detected in Mubi South, Mubi North, Song, Ganye, Mayobelwa and Fofure L.G.A with *Meloidogyne* the most occurred followed by *Hoplolaimus* and pra*tylenchus*. In Mubi south highest nematode mean population density (PD) was recorded for *Meloidogyne* spp (215.53) and frequency of occurrence (FO %) of 40.50 and prominent value (PV) of 137.16. in 250g of soil. Followed by *Hoploliamus* which

recorded 204.2 PD, 36% frequency of occurrence and 124.04 (PV) while *Helicotylenchus* recorded the least (PD) of 21, FO% of 7.1 and PV of 5.59. Similarly, Mubi north recorded 5% of PV 162.50 FO%, PV of 75.17 for *Hoplolaimus* followed by *scutellonema* with 93.75 PD, 11.50 FO%, 21.23PV, and *pratylenchus* with 80.5 Pd, 15.60 FO% 31.79 PV respectively while *Tylenchus* recorded the least PD 15.50, FO% 8.2 and PV 5.41 in 250g of soil. Also, in song L.G.A *Scutellonema* recorded the highest PD of 236.75, FO% 27.9, and PV 125.05 followed by Pra*tylenchus* with 21.2 FO %, 50.30 PV and *Meloidogyne* spp with 16.80 FO%, 44.10 PV while *Tylenchus* recorded the least PD 21.75 FO%, 17.00, and PV 17.10 respectively.

Furthermore, in Fufore L.G.A *Pratylenchus* recorded the highest frequency of occurrence of 22.80% and PV of 55.98 followed by *Helicotylenchus* with 18.20 FO%, 23.03 PV and *Rotylenchus* with 16.10 FO%, 17.96 PV, while *Tylenchus* recorded the least PD 19.75, 14.50 FO %, and 7.78 PV. In the same vein in Mayobelwa L.G.A *Meloidogyne* spp recorded the highest PD 218.00, FO 31.50% and 122.35 PV followed by S*cutellonema* with 148.25 PD, 27.50% FO, 62.02 PV and *Helicotylenchus* with 99.25 PD, 30.10 FO, 48.97 PV while *Tylenchus* recorded the least PD 21.50, 10.90% FO, 8.84 PV respectively. Also, the result in table one 1 showed that in Ganye L.G.A *Meloidogyne* spp recorded the highest frequency of occurrence 17.50%, PV 50.62 followed P*ratylenchus* with 16.20 % FO, 33.61 PV while *Rotylenchus* recorded the least FO 5.90 % and 4.01 PV respectively. It could be seen that the genera *Meloidogyne* spp spp recorded the highest relative density I all the local government area. This genera still leading in terms of frequency of abundance in okra field of all the local government with the exception of what is obtained from Fufore. This indicate that this Genera is highly distributed in the okra field in respective of the cropping system which might affect their distribution.

Table 4: Important plant parasitic nematode genera from soil samples of okra in 6 six Local government of Adamawa state northeast Nigeria.

Local government Area	Nematode identified	Mean Nematode density	Frequency % of occurrence	Prominent Value
Mubi south	Meloidogyne	215.53	40.5	137.16
	Hoplolaimus	204.25	36.9	124.07
	Pratylenchus	62.75	12.2	29.92
	Helicotyleachus	21	7.1	5.59
	Scutellonema	142.5	16.8	58.41
	Tylenchus	18.75	14.7	7.19
	Rotylenchus	72.25	35.9	43.29
Mubi north	Meloidogyne	79.25	11.5	26.87
	Hoplolaimus	162.5	21.4	75.17
	Pratylenchus	80.5	15.6	31.79
	Helicotyleachus	37.25	12.6	13.22
	Scutellonema	93.75	11.1	21.23
	Tylenchus	15.5	12.2	5.41
	Rotylenchus	53	19.0	23.10
Song	Meloidogyne	110.25	16	44.1
	Hoplolaimus	112.75	14.9	43.52
	Pratylenchus	109.25	21.2	50.30
	Helicotyleachus	49.75	16.8	20.39
	Scutellonema	236.75	27.9	125.05
	Tylenchus	21.75	17.1	8.99
	Rotylenchus	63.5	22.8	30.32
Fufore	Meloidogyne spp	96.75	14	36.20

	Hoplolaimus	90.25	11.9	31.13
	Pratylenchus	117.25	22.8	55.98
	Helicotyleachus	54	18.2	23.03
	Scutellonema	130.5	15.4	51.21
	Tylenchus	19.75	15.5	7.78
	Rotylenchus	44.75	16.1	17.96
Mayobelwa	Meloidogyne	218	31.5	122.35
	Hoplolaimus	95	12.5	33.59
	Pratylenchus	62	12	21.48
	Helicotyleachus	89.25	30.1	48.97
	Scutellonema	148.25	17.5	62.02
	Tylenchus	21.5	16.9	8.84
	Rotylenchus	28.5	10.2	9.10
Ganye	Meloidogyne	121	17.5	50.62
	Hoplolaimus	94.25	12.4	33.19
	Pratylenchus	83.5	16.2	33.61
	Helicotyleachus	45.25	15.3	17.69
	Scutellonema	96.25	11.4	32.49
	Tylenchus	30.25	23.7	14.75
	Rotylenchus	16.5	5.9	4.01

Source: Field survey 2023 Adamwa state

Plant parasitic Nematode found in okra roots of some Local Government Area of Adamawa state

Table 5 showed that six plant parasitic nematode genera were found in okra roots from 6 L.G.A. From the result, three genera *Meloidogyne* spp, *Tylenchus, Pratytlenchus* were common in four L.G.A (Mubi South Mubi North Song and Mayobelwa) with exception of two L.G.A Ganye, and Fofure which is dominated by *scutellonema* and *hoplolaimus*. However, one genus *Aphelenchus* was found only in okra roots of Ganye LGA. From the result also, it showed

Meloidogyne spp has the highest frequency occurrence (F 0 %) of 70.61, 81.45, 55.48, 65.49, 45.55 and 78.45% respectively. In Mubi South, Mubi North, Song, Fofure, Mayobelwa and Ganye. Local Government area respectively. Also, in all the 6 L.G.A *Meloidogyne* spp recorded the highest mean nematode populating dentisity of 187.50, 117.75, 245.0, 154, 150.25, and 87.75 in Mubi South, Mubi North Song, Fufore, Mayobelwa and Ganye respectively. Similarly, in Mubi South, *Meloidogyne* spp recorded the highest prominent value of 157.56 followed by *pratylenchus* with 1 10.15 (PV) while Tyenchus recorded the least PV of 54.12. However, *Hoplolainus* recorded 65.55 FO % and 19.37 PV. In Mubi North *Meloidogyne* spp constituted 81.45% frequence of occurrence with highest PV of 106.27 while *Pratylenchus* and *Tylenhus* constituted 65.48 and 45.88 % FO and 69.32 PV and 69.06 PV respectively. However, only 3 genera were found in okra plant root in Mubi North *Meloidogyne* spp*, pratylenchus, and Tylenchus.* Also in song L.G.A highest PV was recorded from *Meloidogyne* spp (189.19) and FO % of 55.48. Followed by *pratylenchus* and *Hoplolaimus* 138.33 and 112.99 PV, 43.15 and 28.91 FO%. In the same view in fofure, highest PV was recorded from *Meloidogyne* spp (124.63) followed by *scutellonema* (100.58), and *pratylenchus* (87.93) while *Hoplolaimus* recorded the least PV of 49.51. Furthermore, in Mayobelwa highest PV was recorded from *Meloidogyne* spp (101.41) PV followed by *pratylenchus* with PV 74.95 and FO% of 38.15% while the least PV and FO % was recorded from Ty*tenchus* PV of 46.05 and 15.85 % FO and *secutellonema* with 61.65 PV, 28.65% FO. Finally, in Ganye, *Meloidogyne* spp recorded the highest PV of 77.72, 78.45% FO followed by *scutellonema* with PV 63.13, FO % 61.59. Least PV and FO % was recorded from *Tylenchus* 20.37 PV, 15.55% FO%. However, *Aphelenchus* was found only in Ganye okra roots with 41.23% FO and 45.94 PV, and PD of 71.55 respectively. it could be seen that *Meloidogyne* was the most occurred species in the okra roots in all the six LGA. the frequent occurance of the genera *Meloidogyne* was due to the fact that okra being the favourabel host for *Meloidogyne* and hence the uniques nature of aphlenchus could be the facts that some of the okra farms in ganye are

either mixed with rice or rice was irrigated previously in the dry season or being intercropped with groundnut.

Table 5: Frequency of occurrence (FO%), Population density (PD), and prominent (PV) of plant parasitic nematode associated with okra plant roots grown in 6 L.G.A of Adamawa state.

Local Government Area	Nematode Genera	Mean Population Density of Nematode (PD)	Frequency of Occurrence (FO %)	Prominent Value
Mubi south	Meloidogyne	187.50	70.61	151.56
	Pratylenchus	141.60	60.50	110.15
	Tylenchus	98.60	30.50	54.12
	Hoplolaimus	112.86	65.55	91.37
Mubi north				
	Meloidogyne	117.75	81.45	106.27
	Pratylenchus	85.67	65.48	69.32
	Tylenchus	101.96	45.88	69.06
Song				
	Meloidogyne	245.00	55.48	189.19
	Hoplolaimus	210.14	28.91	112.99
	Tylenchus	150.40	10.51	48.76
	Pratylenchus	198.40	43.15	138.33
Fufore				
	Meloidogyne	154.00	65.49	124.63
	Hoplolaimus	89.67	30.48	49.51
	Pratylenchus	130.14	45.65	87.93
	Secutellonema	135.44	55.15	100.58
Mayobelwa				
	Meloidogyne	150.25	45.55	101.41

	Secutellonema	103.26	28.65	61.65
	Pratylenchus	141.26	38.15	74.95
	Tylenchus	115.67	15.85	46.05
Ganye				
	Meloidogyne	87.75	78.45	77.72
	Tylenchus	51.65	15.55	20.37
	Hoplolaimus	68.54	50.48	48.69
	Secutellonema	80.44	61.59	63.13
	Aphelenchid	71.55	41.23	45.94

Source: Field survey 2023

Table 6: Total mean of Meloidogyne spp in soil and roots, Number of galls and galling index

Local Government Area	Meloidogyne spp in 250 g of soil + 10 g of roots	Number of Galls	Galling index
Mubi south	403.03	16	3
Mubi north	197	8	2
Song	355.25	25	3
Fufore	250.75	19	3
Mayobelwa	368.25	34	4
Ganye	208.75	5	2
Mean	297.17	17.83	2.83
P<f	0.0560 *	0.0250 **	0.0890 *

Key:0=0; 1-2 galls =1; 3-10 galls=2 ;11-30 galls =3; 31-100 galls=4; > 100 galls=5. (Taylor and Sasser, (1978

Table 6 showed the total mean, number of galls and galling index of Meloidogyne spp specimen in soil and roots of okra plant. The result showed that the roots of okra from the 6 L.G.A has galls. The roots of okra from Mubi south and Ganye showed a light galling (galling index=2). Also, the highest total

mean of Meloidogyne spp from both soil and roots was recorded from Mubi South (403.03), followed by Mayobelwa with (368.25). While the least total mean was recorded from Mubi north (197). However, Fufore and Ganye did not differ from each other and is less than what was obtained from song and Mayobelwa but greater than what was obtained from Mubi north. Similarly, highest number of galls was recorded from Mayobelwa 34 (galling index=4) meanwhile Mubi south, Song and Fufore recorded the same (galling index =3).

Discussion:

A survey of okra-cultivated farms across six local government areas (LGAs) in Adamawa State revealed the presence of 13 genera of plant-parasitic nematodes, occurring at varying frequencies and population densities. The nematode genera identified include seven (7) genera of plant parasitic nematodes *Meloidogyne* spp., *Helicotylenchus, Tylenchus, Hoplolaimus, Rotylenchus, Pratylenchus, and Scutellonema,* detected in the okra cultivated soil. *While six (6) genera of plant parasitic nematode Meloidogyne* spp., *Tylenchus, Hoplolaimus, Rotylenchus, Pratylenchus, Scutellonema, and Aphelenchus* was identified in the plant roots With *Meloidogyne* spp the most occurred and abundant in okra roots. This indicates that the most dangerous plant parasitic nematode like *Meloidogyne* are found in all the fields in the study area. This findings, is in line with Ogunsola *et al* (2018) who reported that 4 genera of plant parasitic nematode (*Meloidogyne* Spp*, Helicotylenchus* Spp*, Rotylenchus* Spp*, and Tylenchus* Spp) were found in association with roots and rhizospheres of Roselle plant with *Meloidogyne* being most prominent. These findings also aligned with the study by Jada et al. (2021), who reported the presence of 14 genera of plant-parasitic nematodes, with species of *Meloidogyne*, *Scutellonema*, *Aphelenchides*, and *Hoplolaimus* being more abundant and frequent in *moringa oleifera.* The occurance of these genera may be attributed to the favorable conditions provided by okra, which is a susceptible host to these nematodes this result Is in agreement with Danso and

Abugri (2021), who reported that okra plants are highly susceptible to plant-parasitic nematodes. Similarly the suveyey revealed that *Meloidogyne* spp. (root-knot nematodes), *Pratylenchus* spp. (lesion nematodes), *Helicotylenchus* spp. (spiral nematodes), *Hoplolaimus* spp. (lance nematodes), and *Rotylenchulus* spp. (reniform nematodes) were particularly prominent in the okra fields, indicating their frequent occurrence in the rhizosphere soil and roots of okra plant. This findings is in line with Seid *et al* (2015). Who reported that *pratylenchus, meloidogyne, Helicolylenchus, and longidorus* where most frequently encountered and abundant plant parasitic nematode genera from the soil. The high susceptibility of okra to these nematodes, especially root-knot and sting nematodes to vegetable crop, makes it prone to severe infestations. This multiplicity could be ascribed to the cropping pattern which is mostly intercropped with vegetables and cereals such as maize and sorghum, cover crop such as groundnut. Also Continuous cropping of okra without proper rotation practices further intensifies nematode population buildup in the soil. This finding is consistent with the studies by Noling (2019) and Danso and Abugri (2021), who reported that okra plants are highly susceptible to plant-parasitic nematodes due to degraded soil conditions, low organic matter, and nutrient imbalances, which increase plant vulnerability to nematode attacks.

The result revealed that there was a high galling indesx across the location and the variation in galling index across the LGAs was significant, with Mubi South recording the highest galling index of 4, indicating heavy infestation with *Meloidogyne* spp. The total mean nematode population in this region was also the highest at 403.03, suggesting that environmental conditions and soil health in Mubi South may be particularly conducive to nematode proliferation. Mayobelwa followed with a galling index of 3 and a total mean nematode count of 368.25, indicating a strong nematode population that can lead to significant plant damage. In contrast, Mubi North exhibited a lighter galling index of 2, with a total mean of 197, suggesting either less favorable conditions

for nematode reproduction or the presence of more resistant okra varieties. The factors influencing the variation in nematode distribution among the LGAs maybe temperature, moisture, and overall climatic conditions, which affect nematode life cycles and host plant health. For example, the higher galling indices observed in Mubi LGA may be due to consistent rainfall, which provides favorable conditions for nematode movement and plant susceptibility. These findings align with Singh et al. (2020), who reported that drought conditions can stress plants, making them more vulnerable to nematode infestations.

The study also found that nematode populations were higher in soil than in plant roots. The highest populations of *Hoplolaimus*, *Scutellonema*, *Pratylenchus*, and *Helicotylenchus* spp. were observed in the soil across the six LGAs, while *Meloidogyne* spp., *Pratylenchus* spp., and *Tylenchus* spp. were more abundant in the roots of okra plants. This is in agreement with Jada *et al.,* (2021) and Adegbite *et al.,* (2014), who reported that *Meloidogyne* spp. are the main parasitic nematodes in the rhizosphere of vegetable crops.

Furthermore, the study revealed that the highest population densities of *Hoplolaimus*, *Scutellonema*, *Pratylenchus*, and *Helicotylenchus* spp. were observed in the soil across the six LGAs, particularly in Mubi North, Song, and Fufore. This could be attributed to the cultivation of sorghum in these areas during the rainy season, which favors nematode proliferation. The consistent detection of *Meloidogyne* spp., *Pratylenchus* spp., and *Tylenchus* spp. in the roots of okra plants suggests that these genera are the most significant nematode threats to okra cultivation in the region. The study also revealed that there was a significant variation in nematode population density across the LGAs, which may be influenced by factors such as cropping patterns, climatic conditions, soil type, and cultural practices. For instance, intercropping okra with other suitable crops as hosts may contribute to the buildup of nematode populations, as continuous cropping without interruption can lead to an increase in nematode population density. These findings align with the study

by Eche *et al.,* (2013), who reported that continuous intercropping without interruption leads to an increase in nematode populations.

CONCLUSION

A survey of okra-cultivated farms in six local government areas of Adamawa State identified seven (7) genera of plant parasitic nematodes *Meloidogyne spp., Helicotylenchus, Tylenchus, Hoplolaimus, Rotylenchus, Pratylenchus, and Scutellonema,* were detected in the okra cultivated soil. *While six (6) genera of plant parasitic nematode Meloidogyne spp., Tylenchus, Hoplolaimus, Rotylenchus, Pratylenchus, Scutellonema, and Aphelenchus was identified in the plant roots With Meloidogyne spp.,* the most abundant in okra roots. The study indicated higher nematode populations in soil compared to plant roots, with variations in density across locations influenced by soil type and cultivation practices. The occurrence of nematodes was consistently linked to intercropping practices and soil properties. It is recommended that Farmers need to adopt the management practices of plant parasitic nematode on okra cultivated field to increase yield.

Recommendation

1. Farmers need to adopt the management practices of plant parasitic nematode on okra cultivated field in the study area.
2. Continues cropping of a single crop on the field year after year need to be stopped to reduce nematode build up.

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