Nematodes Associated with *Citrullus lanatus* in Kwara State, Nigeria

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KEYWORDS

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ABSTRACT

The cultivation of watermelon is rapidly becoming popular in many areas of sub-Saharan Africa because of its economic and nutritional benefits. However, one of the factors limiting watermelon production is plant parasitic nematodes. This study was carried out to determine the abundance, occurrence, and distribution of nematodes infecting watermelon in some areas of Kwara State, Nigeria. A total of 96 root and soil samples were collected from 8 watermelon growing areas of the State, namely; Ajase-ipo 1, Ajase-ipo 2, Unilorin, Olomu, Eyenkorin, Onireke, Lafiaji 1, and Lafiagi 2. Extraction was done using a modified Baermann extraction tray method, while the nematodes were identified to genus level under a compound microscope. Five endoparasitic and ectoparasitic nematode genera were detected from the roots and soils; Meloidogyne, Pratylenchus, Scutellonema, Helicotylenchus, and Criconema. Results revealed that Meloidogyne spp. was the most prevalent nematode with 492.61 and 272.44 for the root and soil samples respectively. Meloidogyne spp. and Helicotylenchus spp. had the highest frequency of occurrence of 87.50% in the root, followed by Pratylenchus spp. with 62.50% and Scutellonema spp. with 50%. More nematodes were also recovered from the root than from the soil. This study provides fundamental information about the distribution of plant parasitic nematodes that infect watermelon in Kwara State.

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INTRODUCTION

Citrullus lanatus (Thumb.) Matsum and Nakai belong to the family Cucurbitaceae (Dantata, 2014). It is the most cultivated and consumed cucurbit in the world (Tunde, 2019; Anikwe *et al*., 2016). The fruit is greatly enjoyed because of its pleasurable taste and rich moisture, which can be used to assuage thirst (Mangila *et al*., 2007). It has a high level of lycopene which helps to lower cholesterol. The leaves are used as green vegetables in some areas while the juice of the roots can be used to stop hemorrhage after abortion. They contain antioxides which provide effective action against the free radicals in the body. Watermelon juice can be applied directly on the skin to minimize blemishes on the skin. The cultivation of watermelon is gradually becoming popular in Nigeria because of high demand thereby making it a good source of income for local farmers (Sabo *et al*., 2013). This also highlights the economic importance of the crop (Shehu *et al*., 2013). Some reports also show it is one of the most preferred fruits in Nigeria (Adeoye *et al.* 2011).

Despite the nutritional and economic benefits of watermelon, infection by pests and pathogens has been a major cause of poor growth and yield of the crop in Nigeria. The total watermelon production in Nigeria is estimated to be 139,223 tonnes (Abubakar *et al*., 2020). This is low when compared to production in other African countries like Algeria (2 million tonnes), Egypt (1.4 million tonnes), and their West African counterparts like Mali which produces about 396, 641 tonnes annually (World Atlas, 2023). A preliminary investigation showed that plant parasitic nematodes are one of the major pathogens limiting the production of the crop in Nigeria. Earlier studies showed that different nematode genera like *Meloidogyne, Helicotylenchus, Pratylenchus, Scutellonema, Criconema, Rotylenchulus, Longidorus,* and *Paratrichodorus* are associated with watermelon in Nigeria and other parts of the world (Bello *et al*., 2020). Of the entire nematode genera, root-knot nematode (RKN) appears to be the most prevalent economically important nematode

of the crop. Alone, this nematode cause an annual loss estimated at $157 billion across different crops globally (Abad *et al*., 2008). There are indications that this figure is grossly underestimated in Africa because of a lack of awareness and inadequate assessment of the economic impact of nematodes on the continent (Onkendi *et al*., 2014). Unfortunately, there is a dearth of information about nematodes associated with watermelon in the Northern regions of the country which are the main producers of the fruit in the country.

This experiment was therefore carried out in some watermelon growing areas of Kwara State to identify nematodes that infect watermelon in the State. Kwara State is located in the North Central part of Nigeria and its proximity to both the Northern and Southern states indicates its strategic importance to food security in Nigeria and African continent.

MATERIALS AND METHODS

Discription of study area

The study was conducted in Kwara State, Nigeria (figure 1). The State has two main climatic seasons, the dry and wet seasons. Annual rainfall ranges between 1000 to 1500 mm while the average temperature lies between 30^{o}C and 35^{o}C. Kwara State falls within the Woodland and tall grass agroecological zone in Nigeria. The State is further divided into four main ecological zones in consonance with the ecological characteristics, cultural practices, and administrative convenience by the Kwara State Agricultural Development Program (ADP) as given below as Zone A: Baruteen and Kaima; Zone B: Edu and Patigi; Zone C: Asa, Ilorin East, Ilorin South, Ilorin West, and Moro; Zone D: Ekiti, Ifelodun, Irepodun, Isin, Offa, Oke-Ero and Oyun (KWADP, 2006).

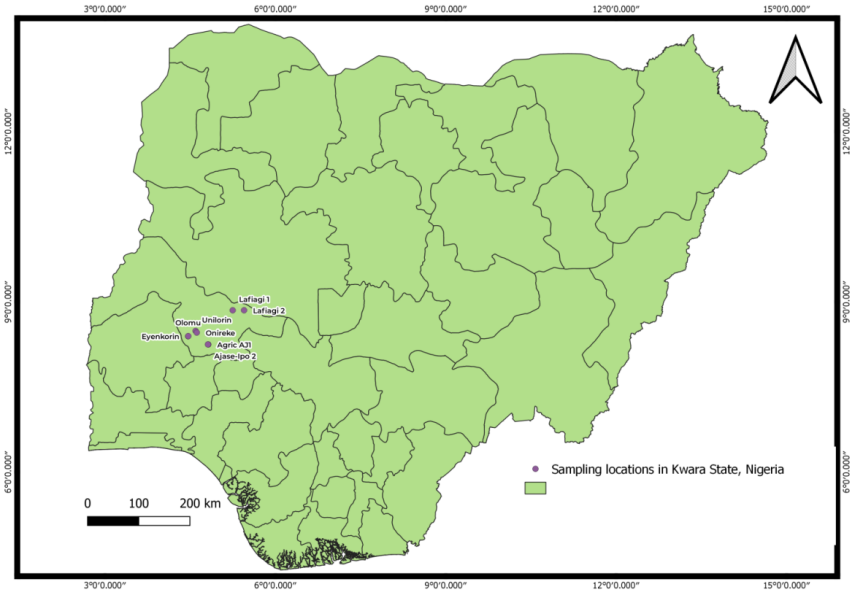

Figure 1: A map showing the locations where the watermelon survey was carried out in Kwara state, Nigeria

Sampling technique

The field sampling was carried out in three agroecological zones of the state which are the major watermelon-producing areas (Figure 1); Zone B, C, and D. The sampling was carried out between September to November 2017 cropping season. Criteria used for the selection of the survey area were availability of the farm, accessibility, and willingness of the farmer to allow sample collection on their farm. The average farm size in each location is not less than 2 hectares. All the farms visited intercrop watermelon with other crops; Ajase-Ipo (cucumber, tomato, pepper, cabbage, and maize), Eyenkorin (Palm tree and maize), Unilorin (cucumber), and Lafiagi (tomato). In each location, the Global positioning system (GPS) coordinate was recorded.

Collection of soil and root samples

Rhizospheric soil samples at a depth of 0 cm to 20 cm together with corresponding roots were collected from each location in a "W-shaped" pattern across each field. Soil samples from five plants spaced at an equal distance from each other were bulked together to ultimately obtain composite samples of six in each farm. These were collected in polyethylene sample bags, labeled accordingly, and transported for laboratory analyses (Bello *et al*., 2020). The soil and root samples were separated according to the location of each farm. The Global Positioning System (GPS) of the locations was also recorded

Extraction and morphological identification of nematode from soil and root samples

Soil samples were mixed thoroughly and a subsample of 250 ml was taken from each composite sample for nematode extraction and identification using the modified Baermann extraction tray method. Root samples were rinsed under a gentle stream of running water and blotted with tissue paper (Coyne *et al*., 2007). The cleaned root was chopped into 0.5 cm to 1 cm and macerated with a blender for 5 seconds. A subsample of 10 g was taken for nematode extraction and identification using the modified Baermann extraction tray method as described above. After 48 hours, the number of nematode populations in 2ml suspension was counted three times using Doncaster counting dish (Doncaster, 1962), and the average was used to estimate the nematode population. Each nematode genus was identified using the CABI Crop Protection Compendium (CABI, 2007) and diagnostic keys, under a compound microscope (Coyne *et al*., 2007).

Determination of Prominence Value (PV)

The Prominence value for the nematode genus identified was determined using the formula;
Prominence value = (mean population density ×√frequency of occurrence) ÷ 10
Where,
Mean population density (MPD) = total number of nematodes ÷ number of samples obtained.
Frequency of occurrence (FO) = (number of samples containing a nematode species ÷ number of samples collected) × 100.

RESULTS

Results showed that watermelon was planted as a mixed crop in the majority of the area visited. Some major crops planted along the crop include Cucumber, tomato, pepper, Maize, cabbage, and maize (table 1).

Table 1: Locations, GPS and farming system practiced in sampled watermelon growing areas of Kwara State, Nigeria

Location	GPS	Alternative crop	Farming system
Ajase-ipo_1	8º23’33’’N 4º35’55’’E	Cucumber, tomato, pepper	Mixed
Ajase-ipo_2	8º14’47’’N 4º49’19’’E	Cucumber, tomato, pepper, cabbage and maize	Mixed
Olomu	8º26’16’’N 4º26’1’’E	Palm tree and maize	Mixed
Eyenkorin	8º23’38’’N 4º27’55’’E	Cassava and maize	Mixed
Unilorin	8º26’57’’N 4º39’52’’E	Cucumber	Mixed
Onireke	8º26’52’’N 4º36’36’’E	Cucumber, Maize	Mixed
Lafiagi	8º50’56”N 5º24’58’’E	–	Sole
Lafiagi_2	8º51’10’’N 5º24’59’’ E	Tomato	Mixed

Five nematode genera were identified from the sampled root and soil; *Meloidogyne, Pratylenchus, Scutellonema, Helicotylenchus*, and *Criconema.* Results revealed that *Meloidogyne* was the most prevalent nematode with a PV of 492.61 and 272.44 for the root and soil samples respectively (table 2). This was followed by *Helicotylenchus, Pratylenchus*, and *Scutellonema*. Whereas *Criconema* was not detected inside the root, it recorded the lowest PV of 1.88 in the soil. Data also revealed variations in the frequency of occurence among different nematode genera from different locations. *Meloidogyne* and *Helicotylenchus* had the highest FO of 87.50% in the root, followed by *Pratylenchus* with 62.50% and *Scutellonema* with 50%. Similarly, *Meloiogyne* had the highest occurrence in the soil (87%) while *Pratylenchus* and *Helicotylenchus* occurred in 75% of the locations. *Criconema* had the least occurrence of 25%. The mean population density (MPD) analysis further established *Meloidogyne* as the most abundant nematode in both the root and soil samples.

Table 2: Prominence value (PV), Frequency of occurrence (FO), and Mean population density (MPD) of plant parasitic nematodes recovered from watermelon fields in 8 locations across Kwara state, Nigeria

	Root			Soil		
	MPD	FO (%)	PV	MPD	FO (%)	PV
Meloidogyne	526.88	87.50	492.61	291.25	87.50	272.44
Pratylenchus	30.63	62.50	24.21	18.75	75.00	16.24
Scutellonema	18.13	50.00	12.82	12.50	62.50	9.88
Helicotylencus	140.63	87.50	131.54	91.25	75.00	79.02
Criconema	0.00	0.00	0.00	3.75	25.00	1.88

Generally, the highest population of nematodes was recorded in Ajase-ipo_1 and followed by Unilorin in both root and soil samples. In contrast, the location with the least nematode abundance in both samples was Lafiagi_2.

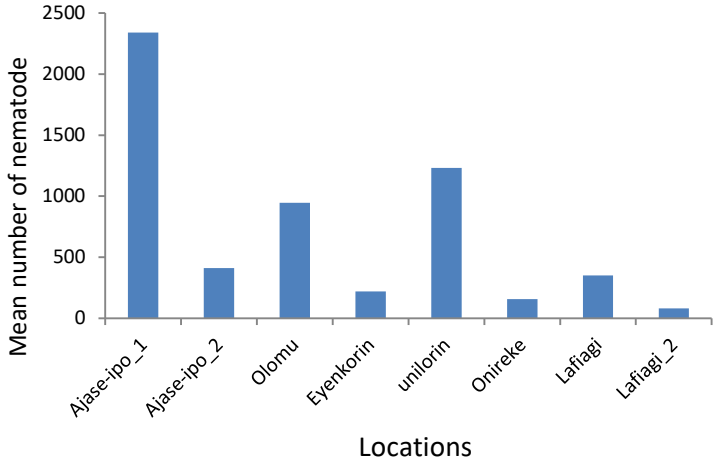

Figure 2: Mean population density of nematode recovered from the root of watermelon across different areas of Kwara State

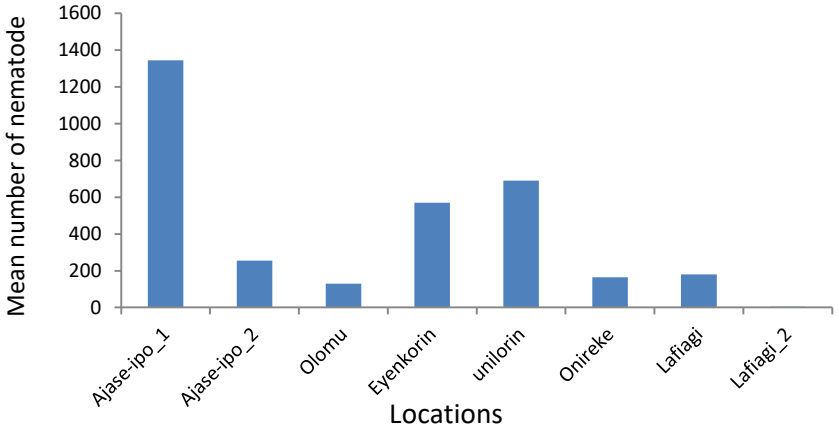

Figure 3: Mean population density recovered from the soil of watermelon across different areas of Kwara state during

On the whole, more nematodes were recovered from the root samples than soil samples (Fig 4 and 5).

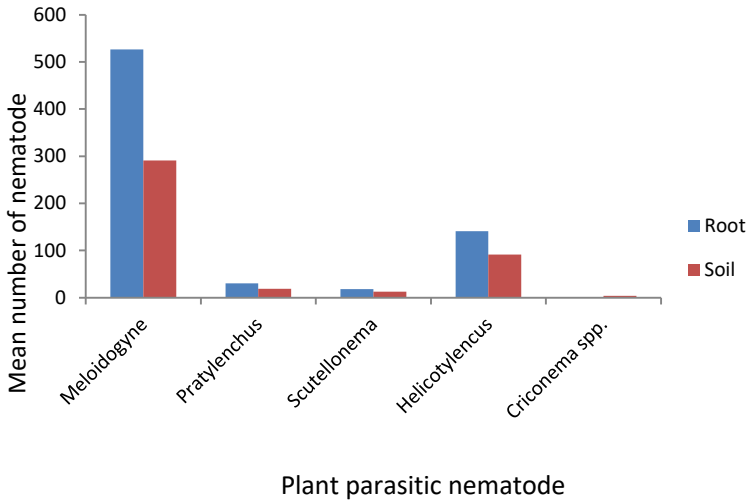

Figure 4: Mean population density of nematode recovered from the root and soil of watermelon planted in different locations of Kwara State

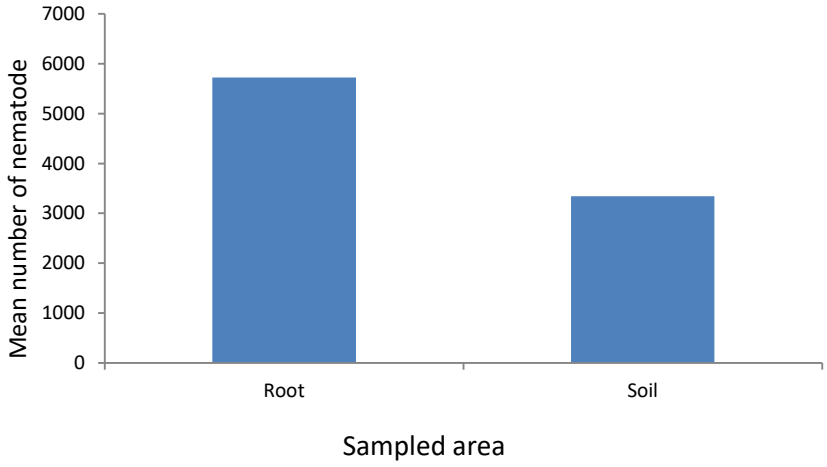

Figure 5: Mean nematode population recovered from the root and the soil from different watermelon growing areas of Kwara State

DISCUSSION

This study provides relevant information about the occurrence of parasitic nematodes on watermelon in Kwara State, Nigeria. The presence of both ectoparasitic and endoparasitic nematodes showed the susceptibility of watermelon to different nematode genera and the ability of the pathogen to cause a reduction in both the growth and yield of watermelon on the field. It is also worrisome that all the five nematode genera sampled in this study were found in mixed infection. Before this study, each of the nematode genera identified has also been found to be associated with other crops in Sub-Saharan Africa and other continents of the world (Kolombia *et al*., 2020; Marais, 2019), nevertheless, this work is providing relevant information on watermelon nematodes in a region where there is a paucity of information. *Meloidogyne* was detected as the most prevalent nematode genus across locations in this study. The findings of this experiment are similar to Bello *et al.* (2020), who also reported the presence of nematodes on the field of watermelon in the southwestern states of Nigeria. The nematode (*Meloidogyne* spp.) has been previously named as the most damaging nematode genera in plants with a wide range of hosts (Lunt *et al*., 2014). Across Africa, twenty-two (22) species of root-knot nematode have been reported on several plants including vegetables, fruits, and tree crops (Onkendi *et al*., 2014).

Previously, the high prevalence of *Meloidogyne* in the field is usually attributed to factors like cultural practices, cropping history, and soil type (Anwar and Mckenry, 2012; Eche *et al*., 2013). In most of the places sampled during this study, watermelon was planted alongside other crops which are also natural hosts of *Meloidogyne*. In this case, it could be inferred that planting alternate hosts besides the watermelon field could have led to a surge in the population density of the pathogen (Alabi *et al*., 2017). This is similar to

the observation of Seid *et al*. (2015), where they observed a higher population density of *Meloidogyne* in places where Khat was intercropped with tomato, pepper, potato, cabbage, and maize. Another factor that could have led to an increase in the population density of *Meloidogyne* is the cropping history of the field (Eche *et al*., 2013). Higher nematode population was observed in locations where there was continuous cultivation over the years and no interruption (Unilorin, Agric AJ1, Agric AJ1, Olomu, and Eyenkorin). The practice of continuous production allows a buildup of nematode over time and particularly, *Meloidogyne* which has an extensive range of hosts (McClure *et al*., 2012) and could have survived in the soil over time in those locations. This is also similar to the observation of Afolami *et al*. (2014), when they investigated the activities of some nematode genera on sugarcane. They reported a high population on the field as a result of using the field continuously. The life cycle of the nematode is also a factor that could have caused an increased prevalence of the nematode. Under favourable environmental conditions, an adult female of *Meloidogyne* can produce more than 50 to 1000 eggs which also gives them numerical strength that increase their chances of surviving (Hussain *et al*., 2016). The findings of this experiment is in congruence with earlier reports by Izuogu *et al*. (2016), who reported extensively on the effects of *Meloidogyne* on cucurbits in Kwara state, Nigeria. The recovery of endoparasitic *Pratylenchus* and *Scutellonema* in the root also showed the susceptibility of the varieties cultivated in the locations. The recovery of more nematodes from the root than soil across all locations showed the susceptibility of watermelon roots to endoparasitic nematodes.

CONCLUSION

The knowledge from this study has established the major nematode genera infecting watermelon in Kwara State Nigeria. It was also discovered that *Meloidogyne* is the most ubiquitous across the field in the State.

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Conflicts of Interest: We state that there is no conflict of interest whatsoever on this research work.

REFERENCES

Abad, P., J. Gouzy, M. J. Aury *et al*., 2008. Genome sequence of the metazoan plant-parasitic nematode Meloidogyne incognita. Nature Biotechnology 26: 909– 15.

Adeoye, I. B., F. B. Olayide-Tawo, O. A. Adebisi, J. M. Usman, and M. A. Badmus. 2011. Economic analysis of watermelon based production system in Oyo State. Nig J Agric Biol Sci. 6(7): 53-59

Afolami, S., S. Solomon, and F. Daramola. 2014. Biodiversity of plant-parasitic nematodes of Sugarcane in Bacita, Nigeria. Journal of Entomology and Nematology 6(6):71-79

Alabi, C., J. Atungwu, S. Sam-Wobo, and I. Odeyemi. 2017. Occurrence and prevalence of nematodes in yam fields from four community-based farming scheme locations in Ogun State, Nigeria. Nigerian Journal of Parasitology 38:307-312. DOI: 10.4314/njpar.v38i2.33

Anikwe, M. A. N., J. C. Agu, and E. E. Ikenganyia. 2016. Agronomic evaluation of four exotic tropical varieties of watermelon (*Citrullus lanatus* L.) in Two Agro-enviroments in Nigeria. International Journal of Plant and Soil Science. 10(2):1-10

Anwar, S.A. and M. McKenry. 2012. Incidence and population density of plant-parasitic nematodes infecting vegetable crops and associated yield losses in Punjab, Pakistan. Pakistan Journal of Zoology. 44:327-333

Atlas big, (2023). World watermelon production by country. https://www.atlasbig.com/en-gb/countries-by-watermelon-production

Bello, T. T., D. L. Coyne, M. Rashidifard, and H. Fourie. 2020. Abundance and diversity of plant-parasitic nematodes associated with watermelon in Nigeria, with focus on *Meloidogyne* spp. *Nematology*.0: 1-17

CABI (2007). Crop protection compendium. Wallingford, UK, CAB Publishing.

Coyne, D. L., J. M. Nicol, and B. Claudius-Cole. 2007. Practical plant nematology: a field and laboratory guide. SP-IPM Secetariat, Cotonou, Benin, International Institute of Tropical Agriculture (IITA).

Dantata, I.J. 2014. Assessing watermelon cultivars under different planting distances in Bauchi North, Nigeria. Asian Journal of Applied Sciences. 2: 381-386.

Doncaster, C. 1962. A counting dish for nematodes. Nematologica 7:334-336. DOI: 10.1163/187529262X00657

Eche, N. M., E. N. O. Iwuafor, S. Amapui, and M. A. V. Bruns. 2013. Effect of long-term soil management practices on nematode population in an Alfisol under continuous maize in Northern Guinea Savanna of Nigeria. International Journal of Agricultural Policy and Research 1(3): 80-86.

Hussain, M. and Mukhtar, T. and Kayani, M. (2016). Reproduction of Meloidogyne incognita on resistant and susceptible okra cultivars. Pakistan Journal of Agricultural Sciences. 53, 371-375

Izuogu, N.B., S. A. Abolusoro,. and L. B. Yakub. 2016. Nematicidal potential of aqueous extract of *Hyptissuaveolens*in the management of root-knot nematode, *Meloidogyne incognita* of some cowpea cultivars. Croat. J. Food Sci. Technol. 8(1): 15-19

Kolombia, Y. A., P. L. Kumar, O. Adewuyi, S. Korie, N. Viaene, W. Bert, and D. L. Coyne, 2020. Distribution, prevalence and severity of damages caused by nematodes on yam (Dioscorearotundata) in Nigeria. Nematropica 50:1–18.

Kwara State Agricultural Development Project, KWADP. 2006. Agronomic Survey Report

Lunt, D. H., S. Kumar, G. Koutsovoulos, and M. L. Blaxter. 2014. The complex hybrid origins of the root knot nematodes revealed through comparative genomics. Peerj 2:356 doi: 10.7717/peerj.356

Mangila, E., F. P. Tabiliran, M. R. A. Naguit, and R. Malate. 2007. Effects of organic fertilizer on the yield of Watermelon. Journal of Agriculture 2: 27-35

Marais, M. 2019. Service Report N04346: South African plant parasitic nematode survey (SAPPNS). Queenswood, South Africa, Agricultural Research Council.

McClure M.A., C. Nischwitz, A. M. Skantar, M. E. Schmitt, and S. A. Subbotin. 2012. Rootknot nematodes in golf course greens of the western United States. Plant Disease. 96: 635-647.

Onkendi, E. M., G. M. Kariuki, M. Marais, and L. M. Moleleki. 2014. The threat of root-knot nematodes (Meloidogyne spp.) in Africa: a review. British Society for Plant Pathology. 63 (4): 727-737

Sabo, M. U., M. A. Wailare, M. Aliyu, S. Jari, and Y. M. Shuaibu. 2013. Effect of NPK fertilizer and spacing on growth and yield of watermelon (*Citrilluslanatus L.*) in Kaltungo Local Government area of Gombe State, Nigeria. Scholarly Journal of Agricultural Science. 3(8): 325-330. Available online at http:// www.scholarly-journals.com/SJAS

Seid, A., M. Goftishu, L. Degebassa, and T. Mekete, T. 2015. Occurrence, distribution, and abundance of plant-parasitic nematodes associated with khat (Catha edulis forsk) in East Hararghe zone, Ethiopia. Nematropica 45 *(*2): 208-214

Shehu, F. G., S. Francois, and A. Idris. 2013. Profitability and adoption of watermelon technologies by farmers in Moro Local Government of Kwara State, Nigeria. Journal of Agricultural Science 5(5): 91-99

Tunde, A. 2019. Determinants of Watermelon Production and its impact on the farmers in Ifelodun L.G.A, Kwara State, Nigeria. Ruhuna Journal of Science 10:149. 10.4038/rjs.v10i2.80.