INCIDENCE AND POPULATION OF PLANT PARASITIC NEMATODES OF PEPPER (*CAPSICUM FRUTESCENS* L.) FROM THREE SELECTED VILLAGES IN MOKWA LOCAL GOVERNMENT, NIGER STATE, NIGERIA

***Paiko A. S.[1], SaiduY[1], Bello L.Y[2], Wada, A.C. [3,4] Umar A.M[1], Emmanuel K[1], Rabba M.L [2] Kasim A[5] and Korokoa H.N.Z[1],**

[1]Department of Pest Management Tech., Niger State College of Agriculture, Nigeria
[2]Department of Crop Production, Niger State College of Agriculture, Mokwa. Nigeria
[3]Department of Crop Production, Federal University of Technology, Minna, Nigeria
[4]National Cereals Research Institute, Badeggi, Nigeria
[5]Department of Pre-ND Science, Niger State College of Agriculture, Mokwa, Nigeria
*Corresponding Author: e-mail address: saidua028@gmail.com
Phone numbers: (+234) 8135907442

ABSTRACT

A survey was carried out from three village areas around Mokwa to investigate and determine the incidence and population of plant parasitic nematodes of pepper. A total of nine soil samples from pepper rhizosphere were taken 10 cm around the plants. The samples were extracted using White head tray method. From the supernatant's residue, a total of five genera of plant parasitic nematodes (PPNs) were identified. Thespecies Scuttelonema. bradyswas found to be predominant in the soil samples as it accounted for up to 45.34% of the overall nematode population with the population density (PD) of 365. This was followed by Helicotylenchus multicinctus with 38.50% and PD 310, Meloidogyne sp with 8.07%, Criconemela sp with 6.8 3% and Aphelenchoides sp with 1.24% was the least in occurrence. Both soil textural class and properties influenced nematode population distribution. The presence of these parasitic nematodes even at low populations in the soil is significant, as population build up can eventually result inthe reduction of crop yield. Based on the importance of the damages caused by these nematodes to pepper in the surveyed areas, it is important to train farmers on techniques of growing healthy seedlings, as well as conducting periodic soil and pathogenicity tests. These will assist the farmers to continue to grow nematodes - free pepper to improve their household income.

Key words: Incidence, Mokwa, nematodes, pepper, population

INTRODUCTION

Pepper (*Capsicum* sp) is one of the five most important vegetable crops used in Nigeria as condiment and food flavour (Paiko *et al.*, 2019). The cultivation pepper has existed for several hundreds of years as a sustainable form of agriculture. Capsicum exists as an annual herbaceous vegetable or perennial shrub of the Solanaceae family (Amusa *et al.*, 2004). It is a spice grown in both tropical and sub-tropical regions (Than *et al.*, 2008). Pepper is also suitable for the diets of the obsessed and is useful in the control of cancer of the stomach and colon (Pamplona-Roger, 2007).

Peppers are low in sodium, cholesterol free, rich in vitamins A and C, and are a good source of potassium, folic acid and vitamin E (Than *et al.*, 2008). Fresh green peppers contain more vitamin C than citrus fruits and fresh red peppers have more vitamin A than carrots (Than *et al.*, 2008). Sauces, soups,, stews are generally made from Capsicum fruits and it is also used as flavouring agent (Amusa *et al.*,2004, Paiko *et al.*, 2019). Varieties of pepper provide income for farmers who cultivate it in substantial quantities (Amusa *et al.*, 2004).

The domestic demand for pepper has increased over time which has resulted in the decline in its quantity ... producing countries (Abubakar, 2015). This prompts the need to increase the supply of pepper at the farmer's level to beef up the quantity at the domestic level and to give room for export.

Nigeria is known to be one of the major producers of pepper in the world accounting for about 50% of the African production and the major area of production is Northern Nigeria (Paiko *et al.*, 2019).It is important to note that in spite of the production level of pepper in Nigeria, importation of Pepper still continues (Abubakar, 2015). General increase in pepper yield in Nigeria can be enhanced by the cultivation of improved cultivars, and intensification of cultural practices and disease management.

Parasitic nematodes alone or in combination with other factors reduce pepper crop productivity and they cause farmers and nurserymen thousands of naira losses due to poor quality crop annually (Pokharel *et al.*, 2009).

Despite the importance of pepper to the national economy, limited attention is paid to problems limiting its production. In general, plant health problems, particularly those caused by nematodes have been neglected. Nematodes are well known as one of the most important diseases limiting vegetable production (Pokharel *et al.*, 2009). There is dearth of reports on the plant parasitic nematodes of pepper in Niger State. Early identification and listing of plant pathogens in an area allows for timely development of management strategies for them. This goes a long way in avoiding epiphytotics and severe crop losses. It also checks the spread of many plant parasitic nematodes diseases and ensures the prevention of their spread to new areas.This work was, therefore, carried out to determine the incidence and population of plant parasitic nematodes in infested pepper (*Capsicum annum* L.) from three selected villages in Mokwa Local Government, Area of Niger State, Nigeria.

METHODOLOGY

Description of experimental location

The experiment was carryout at the Training and Research Plot of the Pest Management Technology Department, Niger State College of Agriculture, Mokwa located on Latitude 9.3044 °N and Longitude 5.06 6°E of the Equator. Mokwa lies in the Southern Guinea Savanna agro-ecological zone. The average temperature in Mokwa is 27.6 °C. Precipitation averages 1149 mm and is bimodal in nature with two rain peaks in a raining season in June and August. The least amount of rainfall occurs in September and the average in the month is 1 mm. In August, the precipitation reaches its peak, with an average of 242 mm. The temperatures are highest in April, at around 30.5 °C. On the average, August is the coldest month of the year, with average temperature of 25.5 °C.

Sampling site and soil samples collection

A survey of infested pepper plants was conducted in three selected villages namely: Mokwa, Bokani and Jagi. From each village, three farms were tagged; 1, 2 and 3 and sampled. Soil samples were taken from the rhizosphere of plants by digging a hole near the base of the roots,10 cm deep following the procedure of Duong *et al.* (2015). Soil samples were collected randomly from plants showing symptoms of retarded growth and 15 soil cores were collected in a "W" pattern using a hand Trowel. The samples from each farm were thoroughly mixed in a 10-liter bucket, after which 500 g was taken as composite sample and put in labeled polyethylene bags following Speijer and De Waele (1997) procedural guidelines. They were then sealed tightly and labeled with details of host, locality and date of collection. A total of nine composite soil samples were collected in all.

Nematode extraction

White head tray method as described by Whitehead and Hemming (1965)was used for recovering nematodes from the soil samples. From each bulk sample, 200 g of soil sub-sample was wrapped in two layers of facial tissue and placed in a tray on top of a mesh. Approximately 200 ml of water were added to the pan, until the mesh was slightly covered with water and the soil contacts the water for 24 hoursto allow the nematodes crawl out of the soil. To count the nematodes, the triplicate of 1 ml from 100 ml homogenised suspension was taken into Huxley nematode counting slide and observed under a compound light microscope with under 10x magnification on Nikon's Eclipse 50i microscope (Kent, WA) according toSpeijer and de Waele, (1997). Average of the three counts was expressed as the mean population of the nematodes per 200 g or 100 ml. Nematodes were identified based on morphology and different species occurrences were recorded.

Rizosphere soil properties

Each of the remaining soil samples was sieved with a mesh of 2 mm size and air-dried for texture analysis following the method of Bouyoucos hydrometer (Gee and Or, 2002) The pH was measured *in situ* using pH meter while organic matter was determined using ignition method.

Data analysis

Absolute frequency and absolute density of the nematodes were calculated using method of AbdulRahman *et al.* (2014):

$$\text{Absolute frequency} = \frac{e}{n} \times 100,$$

Where e = total number of samples containing a given nematode and

n = total number of samples at a given site and

$$\text{Absolute density} = \frac{\text{Number of nematodes in all samples}}{\text{Number of samples collected}} \times 100$$

RESULTS AND DISCUSSION

Table 1 shows the areas surveyed for plant parasitic nematodes associated with pepper plant in Mokwa. Five nematode species /genera namely *Helicotylenchus multinctus*, *Scutellonema bradys*, *Meloidogyne* sp. ,*Aphelenchoides sp*, and *Criconemela sp* were isolated from soils of pepper plants from nine sampling sites in Mokwa, Niger State, Nigeria.

Of the five species/genera obtained, *S. bradys* was found to be predominant in the soil samples as it accounted for up to 45.34% of the overall nematode population with population density

(PD)of 365. It was followed by *Helicotylenchus multicinctus* with 38.50% and PD of 310, *Meloidogyne sp* with 8.07%, *Criconemela sp* with 6.83 % and *Aphelenchoides sp* with 1.24% which was the least in occurrence (Fig. 1)

Estimated Gross margin analysis for melon production under sole cropping system: The estimated gross margin analysis for melon production under sole cropping system is shown in Table 8.

Estimated Gross margin analysis for melon production under mixed cropping per hecture: The estimated gross margin analysis for melon under mixed cropping system per hecture is shown in Table 2. The Table showed that cost of hired labor constituted 30.67 % of the total cost of production followed by seed cost, herbicides and fertilizers with 1.27, 20.54 and 10.54%, respectively. The net farm income accounted for ₦44,620.94. Also, the return on a Naira invested was ₦1.84 while gross and operating ratios were 0.57 and 0.35 respectively. All the ratios were less than 1 indicating profitability of melon production under mixed cropping system.

Table 1: Areas sampled for plant parasitic nematodes associated with pepper plants

VILLAGES	LOCATIONS	LAT.	LONG.	NEMATODES GENUS	POPULATION DENSITY
Makwa-	FARM-1	9.3027866°N	5.0468195 °E	*Helicotylenchusmulticinctus*	25
				Scutellonemabradys	45
	FARM-2	9.2955367°N	5.0468195° E	*Helicotylenchusmultinctus*	25
				Scutellonemabradys	35
				Meloidogyne sp.	10
				Aphelenchoidessp	5
	FARM-3	9.3044968°N	5.0758915°E	*Helicotylenchusmultinctus*	10
				ScutellonemaBradys	10
				Meloidogynes sp.	80
				Criconemellasp	25
BOKANI	FARM-1	9.2962536VN	5.05377244°E	*Helicotylenchusmultinctus*	60
				Scutellonemabradys	25
				Meloidogyne sp.	10
				Aphelenchoidessp	5
	FARM-2	9.21877933°N	5.0400533°E	*Helicotylenchusmultinctus*	5
				Scutellonemabradys	10
				Meloidogynessp	5
	FARM-3	9.2983686°N	5.072093338°E	*Helicotylenchusmultinctus*	20
				Scutellonemabradys	50
				Criconemellasp	30
JAGI	FARM-1	9.15941166°N	5.23994166°E	*Scutellonemabradys*	20
				Meloidogyne sp	20
	FARM-2	9.11581666°N	5.21554166°E	*Helicotylenchusmultinctus*	5
				Scutellonemabradys	15
	FARM-3	9.11175499°N	5.215418333°E	*Helicotylenchusmultinctus*	160
				Scutellonemabradys	86
				Meloidogyne sp	10

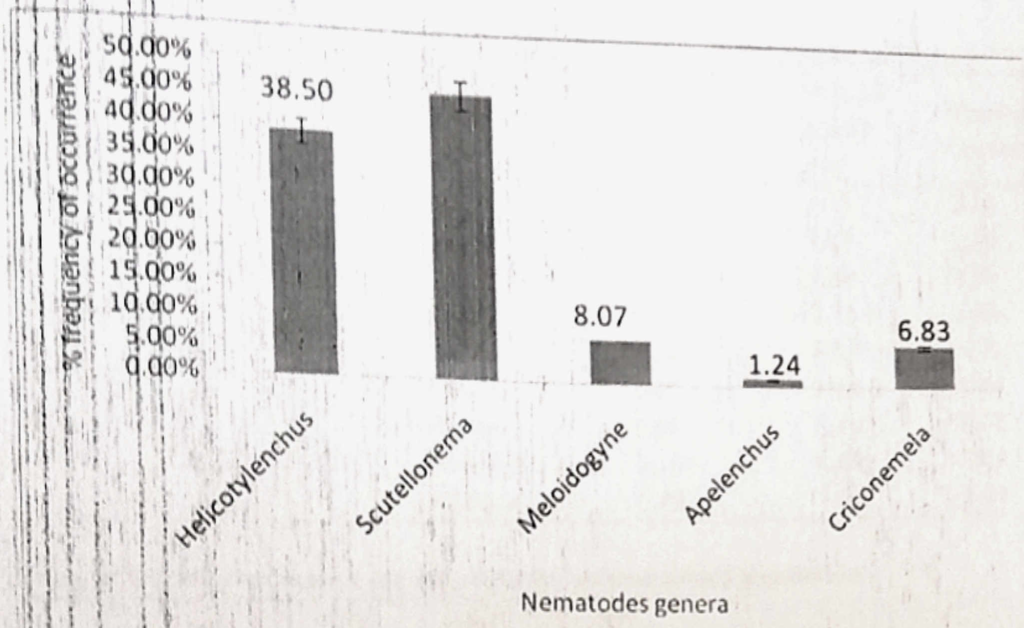

Fig.1:Frequency of occurrence of nematode genera isolated from soil rhizosphere of pepper plants from Mokwa.

Figure 2: shows that Jagi village recorded the highest population density of nematodes with 39.13% followed by Mokwa with 33.50% and Bokani with the least population density of 27.32%.

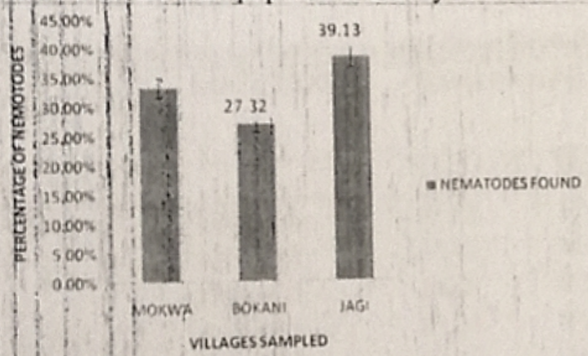

Fig.2.Percentage population of nematodes collected from three villages in Mokwa.

Soil properties influencing phytoparasitic nematode population on pepper

The relationship between nematode species and some soil properties is shown in Tables 2 and 3. The result shows that there was significant relationship between soil properties and nematodes population. Soil pH value between the ranges 6.49 to 7.2 greatly influenced nematodes abundance, while lower pH of 5.32 to 6.26 did not support nematode abundance. Soil organic matter (OM) content of 7.03% supported higher nematode population (NP) density of 255, while OM of 4.83 and 4.88% supported lower nematodes population density of 20 respectively. Generally, there was positive correlation between OM and NP (Table 3). Similarly, soil moisture content of 4.6% favoured higher nematode population and lower population was recorded from moisture content of 1.68% (Table 2). Among the soil textural classes, sandy clay loam soils supported higher nematodes population while clay and clay loam soils recorded low nematodes population (Table 4)

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Table 2: Soil properties influencing phytoparasitic nematode population on pepper

VILLAGE	LOCATIONS	pH	Organic matter (%)	Moisture Content (%)	Nematode pop
Mokwa	FARM-1	6.62	3.13	2.18	70
	FARM-2	6.92	1.82	1.10	75
	FARM-3	7.2	2.08	0.99	125
BOKANI	FARM-1	5.32	2.78	1.18	100
	FARM-2	6.26	4.83	3.04	20
	FARM-3	6.85	3.69	1.86	100
JAGI	FARM-1	5.65	3.49	1.27	40
	FARM-2	6.16	4.88	1.68	20
	FARM-3	6.49	7.03	4.60	255

Table 3: Correlation matrix for soil roperties on nematodes population

	pH	OM	MC	NP
pH	1	0.6522*	0.8944*	0.5141*
OM		1	0.0013	0.2898
MC			1	0.1159
NP				

* - Correlation values are significant at $p < 0.05$

The correlation coefficient (r) indicated the relationship between soil properties and nematodes population

Table 4: soil textural class from samples collected in three villages of Mokwa

VILLAGE	LOCATIONS	Total (microns)			Soil textural class	Nematode population
		Clay (<2)	Silt (2–50)	Sand (>50)	(USDA)	
Mokwa	FARM-1	37.18	19.05	43.76	Clay loam	70
	FARM-2	31.67	11.37	56.92	Sandy clay loam	75
	FARM-3	28.29	8.10	63.58	Sandy clay loam	125
BOKANI	FARM-1	31.31	9.21	59.44	Sandy clay loam	100
	FARM-2	41.69	31.78	26.48	Clay	20
	FARM-3	31.48	37.51	30.99	Clay loam	100
JAGI	FARM-1	34.12	25.32	40.54	Clay loam	40
	FARM-2	22.45	22.59	54.92	Sandy clay loam	20
	FARM-3	31.15	20.42	48.38	Sandy clay loam	255

The prevalence of the most economically important pepper nematode, *S. bradys* was documented in this study. The results of the present study contradict that reported by Adamou *et al.* (2013) where *Meloidogyne sp* population was found to be rather localised instead of being widespread in pepper farms as earlier reported by the workers. In our study, *Meloidogyne sp.* was found in only few locations and in lower quantity. The second most important parasitic genus was *Helicotylenchus*. The present report is in agreement with that by Mokbel *et al.* (2006) who found 9 phytoparasitic nematode genera to be associated with soil samples got from vegetable crops. The results show that the surveyed peppers were earnestly infected by nematodes in all the sites of the three villages. Five plant parasitic nematode genera were identified from our study.

The prevalence and wide distribution of nematodes across the study area may be due to an indiscriminate exchange of pepper seedlings among farmers from one locality to another. It was found that in the surveyed area, exchange of pepper and other vegetable seedlings is commonly practiced by the farmers.

The effects of soil physical and chemical properties on the nematode population were also investigated in the present study. Plant parasitic nematodes live their life cycles in the soil rhizosphere, which invariably impacts on their mobility dynamics, breeding, parasitism and soil-root interaction (Fajardo *et al.*, 2010, Myint *et al.*, 2017). Geographical locations influence the effect a community of PPN has on crop which usually is dependent on agro-climatic conditions, host susceptibility, pathogenicity and other climatic factors (Baimey, 2009). According to Asif *et al.*(2015), seasonal fluctuation determines nematode population in a given area. Thus, nematode populations increase with season and nematode movement through large soil pore diameter and soil particle size with ease will be dependent on moisture. Soil texture is among the factors generally believed to influence PPNs species distribution. Certain species of PPNs prefer soils with higher oxygen content or lighter sandy soil to heavy ones, which may be connected to nematodes preference (Jibia *et al.*, 2016). Studies carried out by (Baimey *et al.*, 2009) showed that soil with different textural classes and chemical composition had influence on how soil physical and chemical properties affect nematode population distribution, density, and community structure. The results of the present study on soil textural classes agree with the reports by the above workers as the sandy loam textural class harboured more nematodes than the clay and clay loam classes.

In the present study, the result also agrees with the report by Thoden *et al.* (2012) who found an increase of plant parasitic nematodes with the addition of soil organic matter. Other workers, Akhtar and Malik (2000) and Thoden *et al.* (2012) found rapid increase in populations of free-living nematodes when organic amendments were added to the soil. In contrast, reduction in populations of plant parasitic nematodes was found when organic matter in the form of green manures or compost was added to the soil (Walker, 2004).

Similarly, the results of this study on pH is in agreements with earlier studies by Koen (1967) who observed that soil pH values 5.0-7.3, was not harmful to *Pratylenchus brachyurus* but pH 1.0 was deadly. Also, according to Ardakani *et al.*, (2014), pH 1 7 supported abundance of *Tylenchulus semipentrans* on citrus.

However, results on soil texture in this study are in most cases contradictory. Cadet *et al.* (2004) and Jaraba *et al.* (2007) opined that *Meloidogyne* gave abundance and higher frequency in sandy soils than clayey soils. Yet, Avendaño *et al.* (2004) pointed out that the population density of the same nematode genus was related to higher clay percentages. The differences on results illustrated that, other likely factors, suchas air porosity and structure among others, may influence the population of nematodes in soil.Thus the results of the present study agree with the reports by earlier workers and stresses that the predominance of the nematodes species from the sandy soils of most of the farms may be a consequence of low yields of pepper from farmers in the surveyed area.

CONCLUSION AND RECOMMENDATION

Results from this study have stablished the abundant occurrence of plant parasitic nematodes, which may consequently cause severe yield reduction in pepper. The findings show a rather lower distribution of plant parasitic nematodes, as only five genera were found from the rhizosphere of the pepper plants. The presence of genus *Meloidogyne* in lower frequency and localised to few locations contradict the widespread believe that *Meloidogyne* is the major nematode of pepper. This is the first documented report on distribution of PPNs associated with pepper in the study area. The presence of these nematodes even at lower densities in the soils is noteworthy as population build up may possibly result to crop yield reduction. Thus, further investigation should focus on the extent of pepper damage by these nematodes in Mokwa LGA to assist pepper farmers in their choice of farm locations to avoid nematode damage and or yield reduction.

REFERENCES

AbdulRahman, S .A., Moh'd S.N., Zain. M.Z. Bilal Mat, A.K.Sidam, R.Y. Othman and Z. Mohamed (2014). Population Distribution of Plant-Parasitic Nematodes of Bananas in Peninsular Malaysia, Sains Malaysiana. 43(2): 175–183

Adamou, H. Mamame, N.K. Adamou, B. Ali, D., and Toudou, A (2013). Plant Parasitic Nematode Communities Associated with Pepper Crops in Aguie Region (Niger Republic). Botany Research International 6 (1): ISSN 2221-3635 © IDOSI Publications, DOI: 10.5829/idosi.bri

Amusa, N.A., Kehinde I.A. and A.A. Adegbite (2004). Pepper fruit anthracnose in the humid forest of southwestern Nigeria. Nutrition and Food Science 34(3):130-134

Asif, M. Rehman, B. Parihar, K. Ganai, M. A and Mansoor, A. S. (2015). Effect of Various Physico-Chemical Factors on the Incidence of Root Knot Nematode Meloidogyne spp. Infesting Tomato in District Aligarh (Uttar Pradesh) India. Journal of Plant Sciences 10 (6): 234-24

Abubakar.S. (2015). Nigeria imports vegetables. Accessed from (http://www.fepsannigeria.com/index.php?option=com_content&view=article&id=216:nigeria-imports-vegetables-&catid=57:frontpage) on 19th Jan 2015.

Akhtar M, Malik A. (2000). Roles of organic soil amendments and soil organisms in the biological control of plant-parasitic nematodes: are view. Bioresource Technology 74, 35-47.

Ardakani, A.S., Mafi, Z.T, Hesar, A.M and Goltappeh, E.M. (2014). Relationship between Soil Properties and Abundance of Tylenchulusse mipenetrans in Citrus Orchards, Kohgilouyehva Boyerahmad Province. J. Agr. Sci. Tech. (2014) Vol. 16: 1699-1710

Avendaño, F., F.J. Pierce, O. Schabenberger, and H. Melakeberhan (2004). Spatial variability. The spatial distribution of soybean cyst nematode in relation to soil texture and soil map unit. Agronomy Journal 96:181-194

Baimey, H., Coyne, D.L., Tchabi, A., Labushagne, N. and Rotifa, I. (2009). Distribution and prevalence of nematodes (Scutellonema bradys and Meloidogyne spp.) on marketed yam (Dioscorea spp.) in West Africa. Field Crops Research, 96: 142-150

Cadet, P., S.D. Berry, and V.W. Spaull (2004). Mapping of interactions between soil factors and nematodes. European Journal of SoilBiology40:77-86

De Waele D, Elsen A (2007). Challenges in tropical plant nematology. Ann. Rev. Phytopathol. 45:457-485

Duong, Duc Hieu, Bui Thi Thu Nga, Nguyen Huu Hung and Ngo Xuan Quang (2015). Vertical Distribution of Plant Parasitic Nematodes in Black Pepper Farm, Dong Nai Province. Academia Journal of Agricultural Research 3(10): 270-275.

Fajardo M.P., Erwin A.E and Manuel C.P (2010). Soil Properties Influencing Phyto parasitic Nematodes Population on Chilean Vineyards. Chilean Journal of Agricultural Research. 71 (2). Pp 240 – 248

Gee, G.W., and D. Or (2002). The solid phase, particle size analysis. p. 255-293. In Dane, J.H., and G.C. Topp (eds.). Methods of soil analysis, Part 4 physical methods. Book Series Nº 5. Soil Science Society of America, Madison, Wisconsin, USA

Jaraba, J., Z. Lozano, y M. Espinosa (2007). Nematodosa galladores asociados al cultivo de papaya (Caricapapaya L.) en el departamento de Córdoba, Colombia. Agronomia Colombiana 25:124-130

Jibia, A.B., Zurmi R. S., Iliya M., Sani G.M and Sanusi L., (2016). Incidence and population of plant parasitic nematodes in green amaranth (Amaranthus hybridus L.) (Caryophyllales: Amaranthaceae) from three selected areas in Dutsin-Ma Town, Katsina State, Nigeria. Brazilian Journal of Biological Sciences, 3, (6):319-330

Koen, H. (1967). Notes on the host range, ecology and population dynamics of Pratylenchus brachyurus. Nematologica13, 118-124

Myint, N.N., Aye, Y. Y., Aung, Y. Y. and Bawm, S. (2017). Detection of plant parasitic nematodes in the soil of crop field in Meiktila area, Myanmar. Journal of Scientific Agriculture 1: 258-263 doi: 10.25081/jsa.2017.v1.821

Mokbel, A.A. Ibrahim, I.K.A. EL-Saedy, M.A.M. and Hammad, S.E. (2006) . Plant Parasitic Nematodes Associated with some Fruit Trees and Vegetable Crops in Northern Egypt. Egypt. J. Phytopathol., Vol. 34, No. 2, pp. 43-51

Paiko, A. S., Bello, L.Y. Salaudeen, M.T. and Wada, A.C. (2019), Abundance of plant-parasitic nematodes from rhizosphere of pepper plants as influenced by soil physical and chemical properties in parts of Niger state, Nigeria, Journal of Agricultural and Rural Research, 3 (1): 1-9.

Pamplona-Roger G.D. (2007). Healthy Foods, Editorial Safeliz, Spain Pp375

Pokharel, R. R.; Larsen, H. J.; Hammon, B.; Gourd, /T.; Bartolo, M. (2009). Plant parasitic nematodes, soil and root health in Colorado onion fields. In: Godin, R. (Ed.). Western Colorado Research Center, Colorado State University. Annual report. Ft. Collins: Colorado State University.

Speijer P. R. and D. De Waele. (1997). Screening of Musa germplasm for resistance and tolerance to nematodes. INIBAP Technical Guidelines 1.INIBAP, Montpellier, France, 42pp.

Than, P;Prihastuti H; Phoulivong S; Paul W; Taylor J and Hyde K.D. (2008). Chilli anthracnose disease caused by Colletotrichum species. International symposium on fungal diversity Oct 16-19 Hangzhou China

Thoden TC, Korthals GW, Visser J, Van Gastel-Topper W. (2012). A field study on the host status of different crops for Meloidogyne minor and its damage potential on potatoes. Nematology 14, 277-284.

Walker GE. (2004). Effects of Meloidogyne javanica and organic amendments, inorganic fertilisers and nematicides on carrot growth and nematode abundance. NematologiaMediterranea32, 181-188.

Whitehead, A.G. and Hemming, J.R. (1965). A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Annals of Applied Biology, 55: 25-38