

PERCEPTION OF HORTICULTURISTS ON NEMATODE PESTS OF ORNAMENTAL PLANTS AND THE LIKELIHOOD OF SOIL AS PRIMARY SOURCE OF INFECTION

*¹Tanimola A. A., ¹Nwokogba S. O. and ²Oladele A. T.

¹Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt, Choba, Rivers State, Nigeria

²Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt, Choba, Rivers State, Nigeria

*Corresponding Author's Email: tanimoladebo@yahoo.com.

ABSTRACT

Nematode pests contribute significantly to poor growth and losses in ornamental plants. However, majority of ornamental garden operators have little or no knowledge of these nematode pests. This study assesses the perception of horticulturists on plant-parasitic nematodes (PPNs) of ornamental plants in Port Harcourt metropolis. A total of 23 ornamental gardens were randomly chosen and visited. Structured questionnaire was randomly administered directly to all operators in collection of data and options were given in code to rank the results. A total of fifty-three soil samples were collected from all the gardens visited. Nematode pests were extracted from the samples using standard procedures. Data were processed using descriptive statistics, diversity indices, relative importance value (RIV) and analysis of variance. The results showed that 95.7% of the horticulturists were male, 78.2% were youth, while 100.0% of the ornamental garden owners had no knowledge of nematode pests attacking ornamental plants. Four nematode pest genera, *Meloidogyne*, *Pratylenchus*, *Tylenchulus* and *Helicotylenchus* were found in the soil being used for propagation by these horticulturists. However, *Meloidogyne* species with the RIV of 40.45% were the most important genus and the most frequently encountered nematode pest (relative frequency of occurrence of 19.35%). Hilltop horticultural garden had the highest mean population of PPNs, but not significantly more than PPNs in other gardens. The study revealed that nematode pests are one of the major bio constraints to ornamental plants and that soil if not treated could be a primary source of nematode infection.

Keywords: *Meloidogyne* species, Nematode pests, Ornamental gardens, Ornamental plants, Relative importance value.

INTRODUCTION

Beautification values of ornamental plants are one of the reasons facilitating their cultivation and they also enhance human health and provide other environmental benefits (Burchett *et al.*, 2008; Altmann, 2015). These ornamental plants beside physical benefits do confer other advantages on mankind such as mental and physiological facilitating relaxation, stress relieve, air purifying agents and higher productivity level (Bourlakis *et al.*, 2010). Globally, the significant and profitable contribution of ornamental plants industry to economy of nations has been acknowledged in which they encourage economic opportunities such as employment and revenue generation (Technavio, 2017). It has been projected that a revenue of approximately ninety-six billion dollars (\$US 96.4 billion) will be generated from the commercial and private uses of ornamental plants in the year 2021 (Technavio, 2017). Globally, The Netherlands, Kenya, Columbia, Malaysia, Ethiopia have been reported as major producers of ornamental plants (Rabobank, 2015). Nigerians are gradually becoming aware of the need for a beautiful, manageable and sustainable environment. The high intensity of a flourishing horticultural business in metropolitan centres attests to this fact. Kenya and Cote d' Ivoire are major exporters of cut flowers into the French market, yet Nigeria shows great promise in this trade. The great potentials identified in the production of ornamentals are being threatened during cultivation of these plants by bio-constraints like pests and diseases such as nematode pests.

Worldwide, nematode pests of plants contribute to the banes in the production of ornamental plants, but few of them cause significant problems (Sasser and Freckman, 1987; Deimi *et al.*, 2008). They are implicated in chlorotic and stunted growth, smaller and fewer leaves and flowers, galling formation, root proliferation, poor response to fertilizers due to root damage, reduction in yield of ornamental plants, and ultimately death (Ibrahim and Al-Yahya, 2002; Rathour *et al.*, 2003 and Tariq *et al.*, 2007). Throughout the world, ornamental plants production suffers 11.1% losses attributed to plant-parasitic nematodes (Sasser and Freckman, 1987). Among the plant-parasitic nematodes, *Meloidogyne* species are responsible for the root-knot diseases and they cause serious damage to ornamental and foliage plants (Sasser and Freckman, 1987).

The root-knot nematodes, *Meloidogyne* species are the most cosmopolitan nematode pest and have been reported as key pests on ornamental plants in many regions of the world (Deimi *et al.*, 2008; Brito *et al.*, 2010; El-Sherbiny, 2011 and Meressa *et al.*, 2014). *Celosia argentea* is being grown as an ornamental plant, but it is also consumed as a vegetable and pot-herb in many western African countries. *Meloidogyne incognita* and *M. javanica* readily attacked *Celosia argentea* and significantly reduced its growth (Caveness and Wilson, 1977). The reniform nematode, *Rotylenchulus reniformis*, the stunt nematode, *Tylenchorhynchus* spp., the lesion nematodes, *Pratylenchus* spp., the leaf nematode, *Aphelenchoides* spp. and the spiral nematode, *Helicotylenchus* spp. have been associated

with the decline of some ornamental plants (Rashid and Azad, 2013; Al-Sayed *et al.*, 2014).

The stem and bulb nematodes (*Ditylenchus dipsaci* and *D. destructor*), leaf and bud nematodes (*Aphelenchoides ritzemabosi* and *A. fragariae*) and root-lesion nematodes, *Pratylenchus penetrans* are also considered as key nematode pests infecting ornamental plants (Southey, 1993). Also, bulb and stem lesions caused by nematodes of the genus *Ditylenchus* (*D. dipsaci* Kuhn and *D. destructor* Thorne) have been reported in ornamental bulb plant species such Crocus, Hyacinth, Iris, Narcissus and Tulip grown in the Netherlands (Westeiijn and De Rooy, 1974). Plant-parasitic nematodes form important groups of organisms found in the soil, roots and leaves of plants with a major effect on plant growth and production (Decraemer and Hunt, 2013). Most ornamental plants are grown by most horticulturists using the soil as the major medium. Several studies have examined roots and soils of ornamental plants after cultivation for nematode pests (Brito *et al.*, 2010; Mahdavian and Jahanshahi, 2017). However, there is dearth of information on nematode pests in collected soils being used as one of the growing media for ornamental plants prior to cultivation. There is need to evaluate the knowledge-status of horticulturists or ornamental garden operators on nematode pests of ornamental plants in Nigeria and to determine if the soil medium for cultivation is one of the major sources of nematode infection.

Floriculture is an input intensive agriculture and there has been less information provided on the distribution of nematode pests on ornamentals in Nigeria. This study was carried out to assess the knowledge-status of horticulturists or ornamental garden operators on nematode pests as one of the biotic threats to ornamental plants and to ascertain if soil as one of the growing media serves as a source of primary infection to ornamental plants.

MATERIALS AND METHODS

Study Area

A total of 23 ornamental gardens within Port Harcourt metropolis, Rivers State were randomly visited in the study. Rivers State occupies latitudes range 5 20' 0"N and 5 45' 0"N, and longitudes range of 6 20' 0"E and 7 35' 0"E. The State is characterised with tropical hot monsoon climate owing to its latitudinal position. Heavy rainfall from April to October ranging from 2000 mm to 2500 mm and high temperature throughout the year with relatively constant high humidity are associated features with this climate (Asimiea *et al.*, 2015).

Instrument for Data Collection

A structured pre-tested and validated questionnaire by professionals in the Faculty of Agriculture, University of Port Harcourt (UNIPORT) was used in the collection of data from the commercial horticulturists, while interview was also used

to collect data from illiterate respondents. The questionnaire centered on soil-borne disease challenges in commercial ornamental gardens and the demographic characteristic of the respondents.

Survey Design, Sample Size and Sampling Technique

Structured questionnaires were purposively administered among twenty-three different ornamental gardens. Options were given in code and used to rank the results provided by the respondents. Copies of the questionnaire were administered directly to all respondents by the researcher. The copies of the questionnaire were collected back from the respondents upon completion while oral interviews were conducted and responses recorded appropriately for illiterate respondents.

Collection of Soil Samples

Soil samples were collected from soil heaped for propagation of ornamental plants in the nursery section of each ornamental garden visited. Three (3) soil samples of 250 ml each were collected using hand trowel, from the pool of each ornamental garden visited into polythene bags and well labelled. Soil samples collected were promptly moved in insulator boxes to the laboratory for further processing.

Extraction of Plant-parasitic Nematodes from Soil Samples

The nematodes were extracted using pie-pan method of nematode extraction (Whitehead and Hemming, 1965). Soil was thoroughly mixed together after collection for removal of stones and other debris. Two hundred ml of sieved soil sample was taken and poured on a facial tissue in a plastic sieve followed by the addition of water to the extraction plates by the side. The set-up was left for 24 hours and the sieves were later removed. The nematode suspension in the plates was then transferred into a beaker and allowed to settle down and after settling, the water was poured into a sample bottle for identification.

Identification of Plant-parasitic Nematodes: The extracted plant-parasitic nematodes were identified as described by Dropkin (1980). The nematode-water suspension from soil was preserved by 4% of formaldehyde prior to identification and enumeration of the plant-parasitic nematodes. Aliquot of 2 ml suspension was pipette into Doncaster counting dish (Doncaster, 1962). The counting dish was placed under a dissecting microscope and compound microscope synchronously for identification and counting using Bell's key (Bell, 2004). Multiple tally counters were used in the counting of the nematodes.

Data Analysis

Descriptive statistics were used to process data on frequency of occurrence of nematodes with these formulas (Norton, 1978);

$$\text{Absolute Frequency of Occurrence (F)} = \frac{\text{No. of occurrence of species}}{\text{Number of samples collected}}$$

$$\text{Relative Frequency of Occurrence} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times \frac{100\%}{1}$$

Nematode Abundance and Relative Importance Value

Nematode abundance and relative importance value of plant-

parasitic nematode species were determined using the methods of Shukla and Chandel (2014) and Kent and Coker (1996) with

modifications.

$$\text{Relative Density} = \frac{\text{Density of individual of species X}}{\text{Total density of all species}} \times \frac{100\%}{1}$$

$$\text{Relative Importance Value (\%)} = \frac{\text{Relative Density} + \text{Relative Frequency}}{2}$$

Determination of Community Structure and Diversity of Nematode Communities

The Paleontological Statistical Tool (PAST) of Hammer *et al.* (2001) was used to determine the diversity of nematode communities. Some indices calculated were:

- i. Genera (G) or Species Richness (S);
- ii. Shannon-Wiener index (H'): $(H') = -\sum (pi)(\ln pi)$
- iii. Evenness index (J) = $H'/\ln S$

Where, S = Number of species enumerated in the community.

- iv. Dominance index: $\text{Dominance index} = \sum (n_i/n)^2$

Data from nematode counts were transformed using Log₁₀(x+1), then analyzed with analysis of variance (ANOVA) and Fisher's Least Significant Difference was used to separate means at probability of 5% with Statistical Analysis System (SAS, 2007) package

RESULTS

Demographic characteristics of horticulturists within Port Harcourt metropolis on knowledge of nematode pests of ornamental plants

The demographic characteristics found in the questionnaire administered to the ornamental plant garden owners within Port Harcourt metropolis showed that 30.4% of the horticultural gardens are located along Nigerian Television Authority (NTA) road and 21.7% on Ikwerre road and University of Port Harcourt (UNIPORT) gate (Table 1). 17.4% of the ornamental gardens are

located at Peter Odili road, while Ozuoba area had 4.3% of these gardens. In terms of the state of origin of the horticulturists/garden owners, 52.2% of them hail from Akwa Ibom State, 17.4% are natives of Cross River and also 17.4% are Rivers State indigenes. Delta and Imo States have equal percentage of 4.3% each in terms of ornamental garden owners in Port Harcourt metropolis. The ornamental garden business in Port Harcourt is dominated by the indigenes of Akwa Ibom. Majority of the operators are youth (78.2%) with age range of the horticulturists from 26 to 45 years. There are more male horticulturists (95.7%) in the business than females (4.3%) (Table 1).

In terms of the educational qualifications, 69.6% of the ornamental garden owners had secondary school education, 17.3% had primary school education while few (13%) had tertiary level education (Table 1). Most of the ornamental garden owners (87 %) acquired their ornamental plant production training through apprenticeship; only 8.7% acquired theirs in a University or College of Agriculture, while 4.3% did not undergo any form of training (Table 1).

Information on the garden size and average income of the horticulturists within Port Harcourt metropolis

Table 2 showed the garden size and average income of horticulturists within Port Harcourt metropolis. 65.2 of the ornamental garden operators own a garden size of less than one plot (17 x 33 m²) of land and 21.7% has ornamental garden size ranging from 1-5 plots. Also, 73.9% of the horticulturists have between 1-2 gardens, whereas 21.7% own about 3-4 gardens (Table 2).

The average monthly income of the ornamental garden operators showed that majority (43.5%) of them earn between ₦10,000 - 20,000 per month and 13% of them earn average monthly income between ₦20,000 - 50,000. For other sources of income, 73.9% of the horticulturists have no other source of income, but 4.7% are contractors, traders and artisans.

Knowledge of the horticulturists on nematode pests, other diseases and methods of pest management

Knowledge of the horticulturists on nematode pests, other diseases and methods of pest management is presented in Table 3. Majority of the horticulturists or garden owners (60.9%) have no knowledge of pathogens causing diseases on their plants. Most of them (82.6%) learnt about diseases of ornamental plants through experience. 95.7% of the garden owners uses agrochemicals in managing diseases, whereas only 4.3% uses natural products. None of the ornamental garden owners (100%) had knowledge of plant-parasitic nematodes. Some of the horticulturists (65.2%) indicated that they have training on pest management and 56.5% of them were trained in similar private gardens, while 4.3% indicated that they had their training from universities and research institutes and 39.1% indicated other sources of training (Table 3). Most of the ornamental garden owners or horticulturists (91.3) rely mainly on the use of Agrochemicals in the management of diseases and other pests in their gardens (Table 3).

Growing media being used by horticulturists/garden owners and other practices influencing infection by nematode pests

Most horticulturists (91.3%) make use of topsoil in the propagation of ornamental plants and 8.7% of them make use of sawdust as the growing medium (Table 4). Table 4 also highlights that:

Table 1: Demographic characteristics of horticulturists within Port Harcourt metropolis

Variable	Frequency	Respondents (%)
Location of Garden		
Ikwerre Road	5	21.7
NTA Road	7	30.4
Uniport Gate	5	21.7
Ozuoba	1	4.3
Peter Odili Road	4	17.4
Others	1	4.3
Total	23	100.0
State of Origin of Operators		
Akwa Ibom	12	52.2
Cross-River	4	17.4
Delta	1	4.3
Rivers	4	17.4
Imo	1	4.3
Others	1	4.3
Total	23	100.0
Age of Garden Owners		
Below 25	1	4.3
26-35	9	39.1
36-45	9	39.1
46-55	4	17.4
Gender of Operators		
Male	22	95.7
Female	1	4.3
Total	23	100.0

Table 1 Cont'd: Demographic characteristics of horticulturists within Port Harcourt metropolis

Variable	Frequency	Respondents (%)
Educational Qualification		
Primary	4	17.4
Secondary	16	69.6
Tertiary	3	13.0
Total	23	100.0
Specialization		
Other biological/sciences	2	8.2
No response	21	91.3
Total	23	100.0
Where The Training Took Place		
Apprenticeship	20	87.0
University/Polytechnic/College Agriculture	of 2	8.7
No response	1	4.3
Total	23	100.0

Table 2. Information on the garden size and average income of the horticulturists within Port Harcourt metropolis

Items	Frequency	Respondents (%)
Garden Size		
Less than 1 plot	15	65.2
1-2plots	5	21.7
3-5 plots	3	21.7
Total	23	100
Number of Garden(s)		
1-2	17	73.9
3-4	5	21.7
Above 4	1	4.3
Total	23	100
Source of Income		
Artisan	2	8.7
Trading	1	4.3
Contractor/Supply	2	8.7
Others	1	4.3
None	17	73.9
Total	23	100.0
Average monthly income		
Below 10,000	3	13.0
10,000-20,000	10	43.5
20,000-30,000	3	13.0
40,000-50,000	3	13.0
Above 50,000	4	17.4
Total	23	100.0

Table 3: Knowledge of the horticulturists on nematode pests, diseases and methods of pest management

Items	Frequency	Respondents (%)
Organism causing Diseases?		
Yes	9	39.1
No	14	60.9
Total	23	100
Knowledge		
Experience	19	82.6
Common Organisms	2	8.7
Asking others	2	8.7
Total	23	100
Treatment of Diseases		
Use of agrochemicals	22	95.7
Use of naturals/Plant extracts	1	4.3
Total	23	100
Knowledge of Nematode Pests		
No	23	100.0
Training on Pest Management		
Yes	15	65.2
No	8	34.8
Total	23	100.0
Where Training was Done		
Private Garden	13	56.5
University/Research Institute	1	4.3
Others	9	39.1
Total	23	100.1
Type of Treatment		
Agrochemical	21	91.3
Cultural method	2	8.7
Total	23	100.0

78.3% of soil being used by the horticulturists are bought from suppliers and 21.7% dug from the surrounding. Most of these ornamental garden operators (65.2%) indicated that they do not treat their soil against pests and pathogens before being used,

while 34.8% treat their soil.

Entries in Table 4 shows that 21.7% of the horticulturists treat their soils through heat sterilization, but others (17.4%) make use of chemical treatments. Physical appearance of the soil is

being used by 87% of the horticulturists in the choice of soil propagation, while 4.3% make use of soil nutrient test and 8.7% make use of other method for choice of soil propagation method. All the ornamental garden owners acknowledged that they do not carry out any laboratory test before using their soils (Table 4).

Occurrence and relative importance value of plant parasitic nematodes in the soil of ornamental gardens

Figure 1 shows the occurrence and relative importance value of plant-parasitic nematodes in ornamental garden soils within Port Harcourt metropolis. *Meloidogyne* species with relative frequency of occurrence (RFOC 19.35%) was the most frequently encountered nematode pests and the most important (according to relative importance value (RIV of 40.45%) in the soils of ornamental gardens in Port Harcourt metropolis. This was followed by *Tylenchulus* species and then *Helicotylenchus* species (Fig. 1).

Diversity of Plant-Parasitic Nematodes found in the Soils of Ornamental Gardens in Port Harcourt Metropolis

Table 5 shows the diversity of plant-parasitic nematodes found in the soils of ornamental gardens in Port Harcourt metropolis.

The mean plant-parasitic nematode individuals encountered in the soils was 12.63, with a Dominance index of 0.42 while the Shannon Weiner index was 1.13. The Evenness index of 0.62 was obtained for the plant-parasitic nematodes associated with ornamental garden soils.

Population of Plant-Parasitic Nematodes found in the Soils of the Ornamental Gardens within Port Harcourt Metropolis

Table 6 shows the mean population of plant-parasitic nematodes in the soils of ornamental gardens in Port Harcourt metropolis. Hiltop horticultural gardens had the highest mean plant-parasitic nematodes in the soils of their garden, but this was not significantly higher than population of plant-parasitic nematodes in soils of most of the horticultural gardens. Isinimi, Oguta and Prince horticultural gardens had no plant-parasitic nematodes in their soils (Table 6).

Table 4: Growing media being used by horticulturists and other practices influencing infection by nematode pests

Variable	Frequency	Respondent (%)
Growing Media		
Topsoil	21	91.3
Sawdust	2	8.7
Total	23	100.0
Source of Soil		
Buy from suppliers	18	78.3
Dig from surroundings	5	21.7
Total	23	100.0
Treatment of Soil		
Yes	8	34.8
No	15	65.2
Total	23	100.0
Method of Treatment		
Sterilized by heating	5	21.7
Chemical Treatment	4	17.4
Total	23	100.0
Choice of Soil for Propagation		
Physical appearance of soil	20	87.0
Soil Nutrient test	1	4.3
Others	2	8.7
Total	23	100.0
Soil Test		
No	23	100.0
Yes	0	0

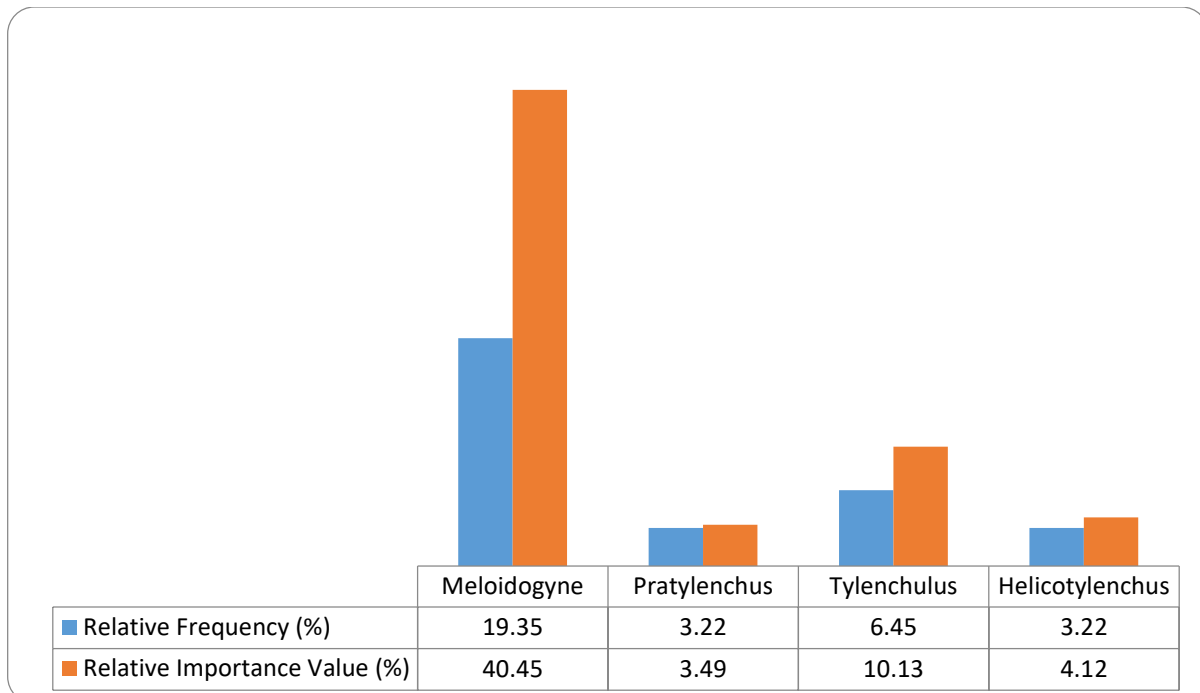


Figure 1: Occurrence and relative importance value of plant-parasitic nematodes in the soil of ornamental gardens in Port Harcourt metropolis

Table 5: Diversity of plant-parasitic nematodes found in the soil of ornamental gardens in Port Harcourt metropolis

Diversity Indices	Values
Individual	12.63
Dominance	0.42
Simpson	0.57
Shannon	1.13
Evenness	0.62

Table 6: Population plant-parasitic nematodes in nursery soils of ornamental gardens in Port Harcourt Metropolis

Ornamental gardens	Mean population of nematode pests
Hilltop horticultural garden	50(1.64)
I.k horticultural garden	26.67(0.63)
Bliss horticultural garden	20(1.32)
Godwin horticultural	16.67(0.56)
Kaades horticultural garden	13.33(0.84)
Ben Green horticultural garden	20(0.99)
Goodland horticultural garden	10(0.78)
God's favour horticultural garden	6.67(0.9)
Fruitful horticultural garden	3.33(0.34)
Land of beauty horticultural garden	0.00(0.00)
Dominion horticultural garden	6.67(0.44)
Isinimi horticultural garden	0.00(0.00)
Edduko parks and gardens	3.33(0.34)
Laritex horticultural garden	13.33(0.84)
Blessed horticultural garden	13.33(0.88)
Oguta horticultural garden	0.00(0.00)
Prince horticultural garden	0.00(0.00)
Solution horticultural garden	10(0.78)
Sunny royal horticultural garden	10(0.49)
LSD(P≤0.05)	26.66(1.024)

() = logarithm transformed

DISCUSSION

According to the survey in the study area (Port Harcourt metropolis), it was observed that there are more males in the ornamental garden business than females and this observation has been attributed to the arduous nature of ornamental plant business. This finding is in line with the reports of Adeduntan (2015) and Akintoye *et al.* (2018) that males dominate the ornamental industry in southwestern Nigeria because of the labour intensiveness of the business. In the assessment of ornamental nursery operation in Akwa Ibom State, Nigeria, Nelson *et al.* (2018) also reported that males dominate the ornamental garden business compared to female little or no presence.

From the demographic characteristics data entries, majority of the garden operators were predominantly youth and this contributes to their agility and capability to make good production decisions which brings about high productivity. The labour-intensive nature of the ornamental industry is one of the reasons for youth dominance of the industry. Akintoye *et al.* (2018) also reported the dominance of the youth in the ornamental industry in the Southwest Nigeria in support of the outcome in this study.

None of the ornamental garden operator has any knowledge on

nematode pests attacking their stocks and this is because nematode pests are not visible to the naked eyes for easy diagnosis. They are microscopic which makes it difficult for horticulturists to see these nematodes thereby limiting their knowledge. Also, the symptoms nematode pests produce might be non specific and hidden, thus limiting right diagnosis that would have facilitated effective management (Lopes-Caitar *et al.*, 2019). Poor training among the operators on pest management owing to lack of formal education support the poor identification of nematode pests as one of the major constraints to production of ornamental plants. Many workers have reported poor knowledge of nematode pests as one of the major pests of ornamental plants (Lopes-Caitar *et al.*, 2019)

This study reveals that *Meloidogyne* is the most frequent nematode genus found in the soils of most ornamental gardens in Port Harcourt metropolis. Several other workers have reported *Meloidogyne* species with over 100 species as one of the key nematode pests of ornamental plants (Elling, 2013; Lopes-Caitar *et al.*, 2019). Stunted growth and loss of aesthetic values due to chlorosis, wilting and leaf margin necrosis have been reported in landscape plants infected with plant-parasitic nematodes particularly root-knot nematodes (Sharma and Rich, 2005). Root-knot nematodes limit productivity by damaging

numerous nursery crops directly and by forming disease complexes with certain soil-borne fungal pathogens (Walker *et al.*, 1994; Zarina and Abid, 1995). Also other nematode pests such as *Pratylenchus*, *Tylenchulus* and *Helicotylenchus* reported in this study have been identified as damaging on ornamental plants (Lopes-Caitar *et al.*, 2019).

CONCLUSION

Commercial production of ornamental plants provides family income for many in Port Harcourt metropolis. However, most horticulturists or ornamental garden owners have no knowledge of nematode pests damaging these plant species. The study showed that soil as one of the growing media if not treated is a major source of infection of ornamental plants by nematode pests. Horticulturists or ornamental garden operators should be adequately trained on nematode pests of ornamental plants and proper treatments of soils being used in cultivation should be carried out to manage them so as not to be source of infection for nematodes and other pathogens.

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