PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 24 (11) 1969-1978 November 2020

Identification and Abundance of Plant-parasitic Nematodes Associated with Amenity Trees in the University of Port Harcourt, Rivers State, Nigeria

[1]OSENI, L; *[1]TANIMOLA, AA; [1]WOKOMA, EC; [2]OLADELE, AT

[1]Department of Crop and Soil Science, [2]Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt, Choba, Rivers State, Nigeria

*Corresponding Author Email: tanimoladebo@yahoo.com; Other Authors Email: qlatifatoseni@gmail.com; ekanem.wokoma@uniport.edu.ng; adekunle.oladele@uniport.edu.ng

ABSTRACT: Plant-parasitic nematodes contribute to unnoticeable damages which lead to gradual decline in the values and eventually death of amenity trees. Identification of these nematode pests is vital for their effective management. Reconnaissance survey was carried out to identify amenity tree species present in the University of Port Harcourt (UNIPORT). Composite bulked soil and root samples (126) were collected from amenity trees in UNIPORT and nematode pests were extracted from samples using modified Baerman method. The nematode pests were identified and their populations determined using standard procedures. Relative importance value (RIV) and diversity indices were calculated with appropriate software. Data were processed using descriptive statistics and with analysis of variance. 38 tree species were identified in UNIPORT belonging to 20 families. *Terminalia mantaly, Cocos nucifera* and *Terminalia catappa* with RIVs of 15.1, 9.35, and 9.12 respectively were the three most important amenity trees in UNIPORT. Fifteen nematode pest genera; *Helicotylenchus, Aporcelaimus, Tylenchulus, Meloidogyne, Scutelonema, Pratylenchus, Tylenchus, Rotylenchoides, Criconema, Hemicyliophora, Trichodorus, Mesodorylaimus, Heterodera, Paratylenchus* and *Longidorus* were associated with 21 of the amenity trees. The three most important nematode pest genera were *Helicotylenchus, Tylenchulus* and *Aporcelaimus* with RIVs of 42%, 16% and 5.34%, respectively. *Helicotylenchus* (RIV 45.41%) and *Tylenchulus* (RIV 30%) were the most important plant-parasitic nematode genera in the soil and roots of amenity trees, respectively. *Helicotylenchus, Tylenchulus* and *Aporcelaimus* were the three most important plant-parasitic nematode genera associated with amenity trees in UNIPORT.

DOI: https://dx.doi.org/10.4314/jasem.v24i11.18

Dates: Received: 25 January 2020; Revised: 05 November 2020; Accepted: 14 November 2020

Keywords: Amenity trees, Diversity indices, Identification, Nematode pests, Survey

Trees that are not grown or managed for their value as timber, but they also provide other benefits or values are amenity trees (Kraxner *et al*., 2003; Haysom and Murphy, 2003; Cullen, 2007). Some examples of amenity trees include urban trees found in parks and other open space, or lining the sides of streets, railways, rivers and canals, and in gardens (Olujobi, 2016). Amenity value of trees means how highly the trees are regarded by the community as part of the local landscape. Agbelade *et al*. (2016) reported the environmental benefits derived from amenity trees to include; purification of air, wind break, provision of shade, beautification, income generation from sales of firewood, provision of relaxation parks and gardens. A tree provides many benefits for the urban dwellers, such as environmental, economical and socio-cultural (Kraxner *et al.,* 2003; Jim and Chen, 2009; Onyekwelu and Olaniyi, 2012). The presence of tree is considered essential in improving the quality of life and well-being of city dwellers. In cities, trees have been considered to fulfil a primarily ornamental purpose; however, they also perform other important functions, such as their use for recreation (Gunderson *et al.,* 2006), their role as a link between man and nature (Aldous, 2007), and their contribution to the general well-being of residents in the cities (Dwyer *et al*., 2000). In West Africa, parks and recreation centres planted with various amenity trees serve as small business centres, community meeting place, religious worship centres and shades for groves in some urban and peri-urban centres (Fuwape and Onyekwelu, 2011). Trees have the potential to create different kinds of social spaces (William, 2008). Trees are culturally and spiritually important in many societies (Omura, 2004; Hall *et al*., 2011). Individuals and organizations maintain large tree registries (Van Pelt, 2001) and government agencies maintain parks and reserves dedicated to the sustainability of exceptionally large trees (James *et al.,* 2012). There are several pests affecting the growth and development

*Corresponding Author Email: tanimoladebo@yahoo.com

of trees, it varies from fungal, bacterial, nematode pest infections and at times severe insect damages (Khan, 2012). Some tree species are more susceptible to infestation than others. *Gmelina* is an example of a tree species susceptible to insect attack and diseases from different pathogens which might limit expansion (Dvorak, 2004). However, least consideration has been given to nematode pests of trees because the damage cause by them seems indistinctive and not easily recognised (Khan, 2012). Globally, plant-parasitic nematodes (PPNs) have been reported as one of the major biotic banes to the growth and development of trees (Hagan, 2005; El-Sherbiny, 2011; Manju and Subramanians, 2015). They are commonly associated with rhizospheres of many species of plants. Plant-parasitic nematodes have caused severe damages on plants where they attack the plants and alter the whole functioning of the plants. The symptoms observe varies with tree species and these symptoms include loss of vigour, small and distorted root systems, root galls and decay of feeder roots and sometimes death (Khan, 2012). One difficulty in assessing nematode impact is that damage resulting from nematode infection is often less obvious than that caused by many other pests or diseases. Losses that result from nematode attack may not necessarily be as a consequence of direct cell death, necrosis or 'diseased' tissue. However, they may be derived from other more insidious aspects, such as interference with the root system, reducing their efficiency in terms of access and uptake of nutrients and water. To the unaware, nematode-affected plants present typical drought and nutrient stress symptoms, which are easily and often misdiagnosed (Nicol *et al*., 2011). Detection of pathogens such as nematodes is often difficult because, pathogens often have lag times of several years between infection and the trees developing external or visible symptoms (Brasier, 2008). As a result of this, nematode identification and population determination is important for the healthy growth of trees. The identification of new or potentially harmful species of nematodes is important to their effective management (Zafar, 1998). This study was to identify and determine the abundance of plant-parasitic nematodes associated with amenity trees in University of Port Harcourt, Rivers State, Nigeria

MATERIALS AND METHODS

Research Site: The survey for plant-parasitic nematodes of amenity trees was carried out within the three parks (Choba, Delta and University) of the University of Port Harcourt (UNIPORT), Rivers State, Nigeria. The survey was carried out in July to August 2019. University of Port Harcourt is located at coordinates 4˚ 52' 30" and 4˚ 55'40" N, 6˚ 54'40"and 6˚ 55'49" E with an elevation of 18 m above sea level, temperature of 28-33˚C and with rainfall ranging from 2000-2680 mm per annum (Eludoyin *et al*., 2015). The sampling location cut across all the major roads, pathways and buildings in the university.

Research Design and Reconnaissance of Amenity Trees: Identification of amenity trees and their population in UNIPORT was carried out in a reconnaissance survey under the supervision of a plant taxonomist in June, 2019. The three parks of UNIPORT were surveyed using random sampling design method for the collection of roots and soil samples of amenity trees (Adesoye, 2011). Coordinates of locations where trees were found were taken using E-trex Garmin Geo Positioning System (GPS).

Collection of Soil and Root Samples: Twenty-one (21) tree species were selected base on their relative importance values for collection of soil and root samples from the outcome of the reconnaissance survey. The trees were randomly selected and samples were collected from five stands of each tree species. Soil and root samples were collected from both the soil and roots of the selected amenity trees to facilitate the extraction and identification of plant-parasitic nematodes present using standard procedures. Soil of 500 cm^3 were collected from the rhizospheres of each tree using hand trowel to a depth of 30 cm and bagged into a well labelled polythene bag. The roots were also collected from the same tree species using knife and added to the polythene bag. The bulked soil samples were taken to the laboratory for extraction. Soil and root samples were collected from all the selected 21 amenity trees. A total of 126 composite root and soil samples were collected across the University.

Extraction Procedure for Plant-parasitic Nematodes: The extraction of the plant-parasitic nematodes from the soil samples was done using the extraction tray method (Whitehead and Hemming, 1965; Coyne et *al*., 2007) at the Crop Protection Laboratory, Department of Crop and Soil Science, University of Port Harcourt. Each bulked soil sample was placed in a dish and sieved to remove debris from it and then it was evenly mixed. 200 cm^3 soil sample was poured on a facial tissue in a plastic sieve on an extraction tray and water was added by the side. The extraction set-up was allowed for 48 hours after which the sieve was removed and the water was poured into a beaker. The suspension was kept for a day and allowed to settle. The suspension was later decanted and the suspension containing nematodes were poured into a sample bottle and preserved in the refrigerator prior to identification and counting. The bottles containing nematode suspension were later sent to the Nematology Research

Laboratory, International Institutes for Tropical Agriculture (IITA), Ibadan, Oyo State for identification and counting.

The extraction of the plant-parasitic nematodes from the roots samples was done with the extraction tray method (Whitehead Hemming, 1965; Coyne *et al.,* 2007). Roots collected from each sample were properly rinsed with water to get rid of debris. The roots were chopped into small parts of 1-2 cm and from each bulked sample, 10 grams of the chopped roots of each sample was weighed out using an electronic weighing scale. The chopped roots were poured on the facial tissue inside the sieve and water was added by the side. The extraction set-up was allowed for 48 hours after which the sieve was removed and the water was poured into a beaker.

The suspension was allowed to settle for one to two hours, after which it was decanted and the suspension containing the nematodes was poured into a sample bottle and preserved in the refrigerator prior to identification and counting. Identification and population count of plant-parasitic nematodes were done at IITA Nematology Research Laboratory, Ibadan, Oyo State, Nigeria. Eppendorf pipette was used to take one millilitre of nematode suspension from 10 ml sample bottle and this was subsequently released into a counting slide.

The counting slide was placed under a Wild Leitz GMBH compound microscope and identification keys of Mai *et al.,* (1996), Mekete *et al.,* (2012) and Nematode Diagnostic Compendium at the IITA Nematology Research Laboratory were used to identify nematode pests to genera level. The identified nematodes were counted with the aid of a multiple tally counter. Each count for each nematode species was extrapolated to the volume of the sample bottle to determine the population count.

Data Processing and Analyses: Descriptive statistics were used to process data on frequency of occurrence of amenity trees and nematodes with these formulas (Norton, 1978);

$$AFO = \frac{No\ of\ occurence\ of\ species}{Number\ of\ samples\ collected}$$

$$RFO = \frac{Frequency\ of\ a\ species}{Frequency\ of\ all\ species}$$

Nematode Abundance and Relative Importance Value: Nematode abundance and relative importance value of plant-parasitic nematode species were determined using the methods of Kent and Coker (1996) and Shukla and Chandel (2014) with modifications.

$$AB = \frac{T_i}{T_s}$$

$$RD = \frac{Density\ of\ individual\ species}{Total\ density\ of\ all\ species}\ x\frac{100}{1}$$

$$RIV\ (\%) = \frac{RD + RF}{2}$$

Where AFO = absolute frequency of occurrence; RFO = relative frequency of occurrence; AB = Abundance, Ti = total number of individual species in all samples, Ts = total number of samples in which the species occurred; RD = relative density, RF = relative frequency, RIV = relative importance value

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:

(a) Genera (G) or Species Richness (S): This is the simple count of different species per organism.

(b) Shannon − Wiener index (H'): $(H') = -\sum(pi)(Inpi)$

(c) Evenness index $(J) = \frac{H'}{InS}$; Where, S Number of species enumerated in the community.

(d) Dominance index $= \sum(ni/n)^2$

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

RESULTS AND DISCUSSION

Relative Importance Values of Amenity Tree Species in the University of Port Harcourt: Thirty-eight (38) amenity tree species were identified belonging to 20 families from the reconnaissance survey (Table 1). The major families of trees encountered were *Moraceae, Fabaceae,* and *Arecaceae.*

The five most important tree species in UNIPORT were *Terminalia mantaly*, *Cocos nucifera*, *Terminalia catappa Azadirachta indica* and *Polyathia longifolia* with the relative importance values (RIV) of 15.1%, 9.35%, 9.12%, 8.18%, and 4.57%, respectively. The least prominent amenity trees encountered in UNIPORT were *Ficus exasperata* and S*yziguim malaccense* with the same RIV of 0.42% (Table 1).

Table 1: Occurrence and relative importance values of amenity tree species in the University of Port Harcourt

Tree Species	Family	Frequency of occurrence	Relative frequency of occurrence (%)	RIV (%)
Delonix regia	Fabaceae	7	5.22	4.23
Peltophorum pterocarpum	Fabaceae	5	3.73	3.18
Hura crepitans	Euphorbiaceae	5	3.73	2.88
Persia Americana	Lauraceae	1	0.75	0.53
Polyathia longifolia	Annonaceae	6	4.48	4.57
Gmelina arborea	Lamiaceae	3	2.24	1.68
Terminalia mantaly	Combretaceae	11	8.21	15.1
Azadiracha indica	Meliaceae	4	2.99	8.18
Terminalia catappa	Combretaceae	14	10.45	9.12
Ficus exasperate	Moraceae	1	0.75	0.42
Ficus benjamina	Moraceae	3	2.24	1.73
Ficus elastic	Moraceae	3	2.24	1.47
Syzigium malaccense	Myrtaceae	1	0.75	0.42
Arenga pinnata	Palmae	3	2.24	2.84
Roystonea regia	Arecaceae	2	1.49	1.51
Syagrus romanzoffiana	Arecaceae	2	1.49	0.90
Casuarina equisetifolia	Casuarinaceae	1	0.75	0.47
Pterocarpus santalinoides	Fabaceae	2	1.49	0.80
Cocos nucifera	Palmae	7	5.22	9.35
Mangifera indica	Anacardiaceae	6	4.48	3.91
Tectona grandis	Lamiaceae	2	1.49	0.80
Lagerstroemia indica	Lythraceae	3	2.24	1.68
Anacardium occidentalis	Anacardiaceae	2	1.49	1.10
Dacryodes edulis	Burseraceae	2	1.49	0.90
Elaeis guineensis	Arecaceae	2	1.49	4.09

RIV= Relative importance value

Table 1 Cont'd.: Occurrence and relative importance values of amenity tree species in the University of Port Harcourt

Tree species	Family	Frequency of occurrence	Relative frequency of occurrence (%)	RIV (%)
Ambodia gadis		2	1.49	0.80
Alstonia boonei	Apocynaceae	2	1.49	0.85
Musanga cecropioides	Urticaceae	2	1.49	0.80
Milicia excels	Moraceae	2	1.49	0.90
Treculia Africana	Moraceae	2	1.49	0.80
Spondias cytherea	Anacardiaceae	1	0.75	0.47
Chrysophyllum albidum	Sapotaceae	4	2.99	1.95
Terminalia ivorensis	Combretaceae	2	1.49	0.80
Senna fistula	Fabaceae	3	2.24	1.63
Pinus caribaea	Pinaceae	6	4.48	4.21
Eucalyptus camadulensis	Myrtaceae	4	2.99	2.10
Samanea saman	Fabaceae	2	1.49	0.80
Citrus sinensis	Rutaceae	4	2.99	2.05
Total		*134*	*100.0*	*100.0*

RIV= Relative importance value

Diversity of Amenity Tree Species in the University of Port Harcourt: The results for diversity of amenity trees species in UNIPORT is presented in Figure 1. The diversity indices such as Dominance, Shannon Wiener and Evenness were calculated. Dominance value for amenity tree species for taxa of 38 tree species is 8.51, Shannon Wiener index was 2.69 and the value for Evenness was 0.39.

Relative importance values of plant-parasitic and diversity of plant-parasitic nematodes associated with soil of amenity trees at the University of Port Harcourt: Helicotylenchus multicinctus with the RIV of 45.41% was the most important nematode pest genus associated with the soil of the amenity trees (Table 2). This was followed by *Tylenchulus* spp. with RIV of 14.67%. The least important nematode pest genera were *Trichodorus* spp, *Mesodorylaimus* spp. and *Paratylenchus* spp, all having the same RIV of 1.37%. Figure 2 shows results for the diversity of plant-parasitic nematodes associated with the soil of amenity trees. Fifteen nematode pest genera were encountered in the soil. The Dominance index for the nematode pests was 0.33, Shannon Wiener index of 1.73 and Evenness value of 0.38.

Relative importance values and diversity indices of plant-parasitic nematodes found in the roots of amenity trees at the University of Port Harcourt: Tylenchulus spp. had the highest RIV of 30%, then *Helicotylenchus multicinctus* with RIV of 18.33%, followed by *Aporcelaimus* species (RIV 12.22%)

(Table 3). The least prominent nematode pests were *Rotylenchoides* spp., *Criconema* spp., *Hemicyliophora* spp., *Trichodorus* spp. and *Longidorus* spp. with equal RIV of 6.11%.Figure 3 shows results for the diversity of nematode pests associated with roots of amenity trees. Dominance value for nematode pests was 0.22, Shannon Wiener of 1.80 and the value for Evenness was 0.76.

Mean relative importance values and diversity indices of plant-parasitic nematodes associated with amenity trees at University of Port Harcourt: Table 4 shows the results for occurrence and relative importance values of plant-parasitic nematodes found in roots of amenity trees. *Helicotylenchus multicinctus* had the highest RIV of 42% and *Tylenchulus* spp. with the RIV of 16%. Mean diversity indices of plant-parasitic nematodes associated with amenity tree species at the University of Port Harcourt is presented in Figure 4. The average Dominance index for nematode pests of amenity trees in UNIPORT was 0.29, whereas the Shannon Wiener index was 1.83 and the Evenness index was 0.41.

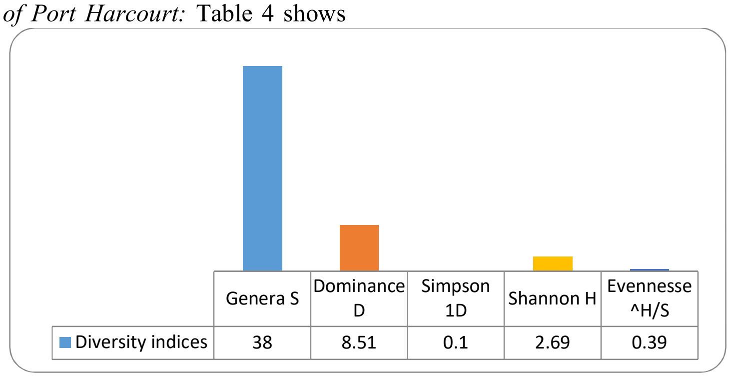

Fig 1: Diversity indices of amenity tree Species in the University of Port Harcourt

Table 2: Relative importance values of plant-parasitic nematodes found in the soil of amenity trees at the University of Port Harcourt

Plant-parasitic Nematodes	Frequency	Relative frequency (%)	*RIV (%)
Helicotylenchus spp.	18	36	45.41
Aporcelaimus spp.	3	6	4.48
Tylenchulus spp.	8	16	14.67
Meloidogyne spp.	3	6	5.22
Scutelonema spp.	2	4	3.85
Pratylenchus spp.	1	2	1.74
Tylenchus spp.	2	4	3.11
Rotylenchoides spp.	2	4	3.11
Criconema spp.	3	6	5.22
Hemicyliophora spp.	2	4	4.22
Trichodorus spp.	1	2	1.37
Mesodorylaimus spp.	1	2	1.37
Heterodera spp.	1	2	2.11
Paratylenchus spp.	1	2	1.37
Longidorus spp.	2	4	2.74
Total	**50**	**100**	**100**

**RIV = Relative Importance Value*

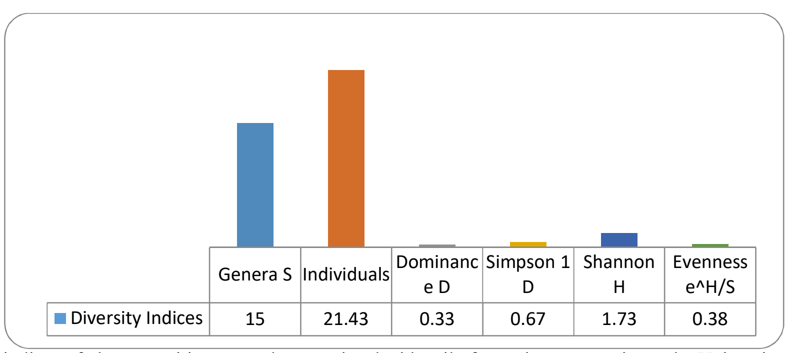

Fig 2: Diversity indices of plant-parasitic nematodes associated with soil of amenity tree species at the University of Port Harcourt

Table 3: Occurrence and relative importance values of plant-parasitic nematodes found in the roots of amenity trees at the University of Port Harcourt

Plant-Parasitic Nematode Genera	Frequency	Relative frequency (%)	*RIV (%)
Helicotylenchus spp.	3	20	18.33
Aporcelaimus spp.	2	13.33	12.22
Tylenchulus spp.	4	26.67	30
Pratylenchus spp.	1	6.67	8.89
Rotylenchoides spp.	1	6.67	6.11
Criconema spp.	1	6.67	6.11
Hemicyliophora spp.	1	6.67	6.11
Trichodorus spp.	1	6.67	6.11
Longidorus spp.	1	6.67	6.11
Total	15	100	100

**RIV = Relative Importance Value*

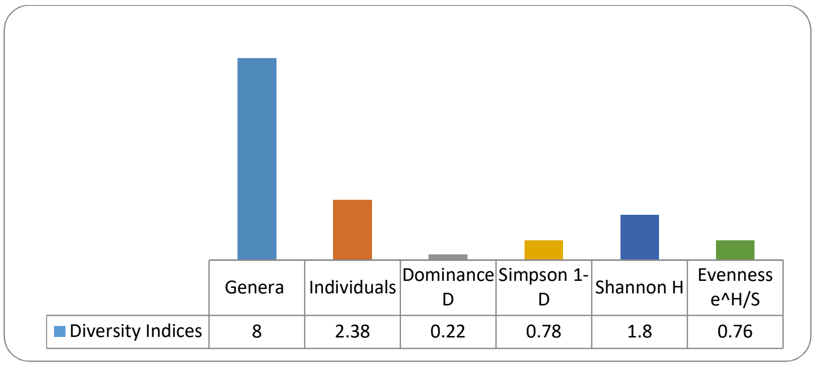

Fig 3: Diversity indices of plant-parasitic nematodes associated with roots of amenity tree species at the University of Port Harcourt

*Mean population of plant-parasitic nematodes associated with amenity trees in the University of Port Harcourt***:** *Terminalia catappa* had the highest mean population of *Helicotylenchus* species, Arenga pinnata had the highest mean of population of *Aporcelaimus*, whereas the highest population of *Tylenchulus* was found on *Terminalia catappa* (Table 5). The highest population of *Meloidogyne* was found on *Anacardium occidentalis*, *Roystonea regia* had the highest population of *Scutellonema*, *Polyathia longifolia* and *Persia americana* were the only amenity trees with the same population of *Pratylenchus*.

The highest mean populations of *Tylenchus*, *Rotylenchus*, *Criconemella*, *Hemiclyclophora*, *Trichodorus*, *Mesodorylaimus*, *Heterodera*, *Paratylenchus* and *Longidorus* were found in *Cocos nucifera*, *Mangifera indica*, *Anacardium occidentalis*, *Terminalia mantaly*, *Ficus elastica*, *Delonix regia*, *Delonix regia*, *Hura crepitans* and *Elaeis guineensis*, respectively (Table 5). The highest mean population of plant-parasitic nematodes of 106.67 was obtained from *Terminalia catappa,* but was not significantly higher than mean population of nematode pests of other amenity trees in UNIPORT (Table 5).The tree species identified in UNIPORT as amenity trees are 38 and classified into twenty families viz; *Fabaceae, Euphorbiaceae, Lauraceae, Annonanceae, Combretaceae, Meliaceae, Moraceae, Myrtaceae, Palmae, Arecaceae, Casuarinaceae, Anacardiaceae, Lambiaceae, Lythraceae, Burseraceae, Apocynaceae, Urticaceae, Sapotaceae, Rutaceae* and *Pinaceae*. Most of the trees belong to the *Moraceae* family. These prominent trees encountered in this study were in conformity with the reports of other workers as being effective as amenity trees (Babalola and Raji, 2016; Ugbaja, 2018). The cultivation of these encountered trees in UNIPORT could be due to their ability to provide shade, fruits, aesthetic values, increase property values (Hedonic) and their ease of growth (Schroeder, 1989; Panduro and Veie, 2013; Rosato *et al*., 2017).

Plant-parasitic nematodes found associated with amenity trees across UNIPORT varied in population densities and they are of different genera. The nematodes found affecting amenity trees in UNIPORT are of 15 genera; *Helicotylenchus* spp*, Aporcelaimus* spp. *Meloidogyne* spp.*, Scutelonema* spp.*, Pratylenchus* spp.*, Tylenchus* spp.*, Rotylenchoides* spp.*, Criconema* spp.*, Hemicyliophora* spp.*, Trichodorus* spp.*, Mesodorylaimus* spp.*, Heterodera* spp.*, Paratylenchus* spp.*, Longidorus* spp. and *Tylenchulus* spp. However, the three major genera are: *Helicotylenchus* spp., *Aporcelaimus* spp. and *Tylenchulus* spp.

Table 4: Relative importance values of plant-parasitic nematodes associate with amenity trees at the University of Port Harcourt

Plant-parasitic Nematodes Genera	Frequency of Occurrence	Relative frequency of Occurrence (%)	RIV (%)
Helicotylenchus spp.	20	33.33	42
Aporcelaimus spp.	4	6.67	5.34
Tylenchulus spp.	10	16.67	16
Meloidogyne spp.	3	5	4.5
Scutelonema spp	2	3.33	3.34
Pratylenchus spp.	2	3.33	3
Tylenchus spp.	2	3.33	2.67
Rotylenchoides spp.	3	5	3.83
Criconema spp.	3	5	4.5
Hemicyliophora spp.	3	5	4.83
Trichodorus spp.	2	3.33	2.33
Mesodorylaimus spp.	1	1.67	1.17
Heterodera spp.	1	1.67	1.83
Paratylenchus spp.	1	1.67	1.17
Longidorus spp.	3	5	3.5
Total	60	100	100

**RIV = Relative Importance Value*

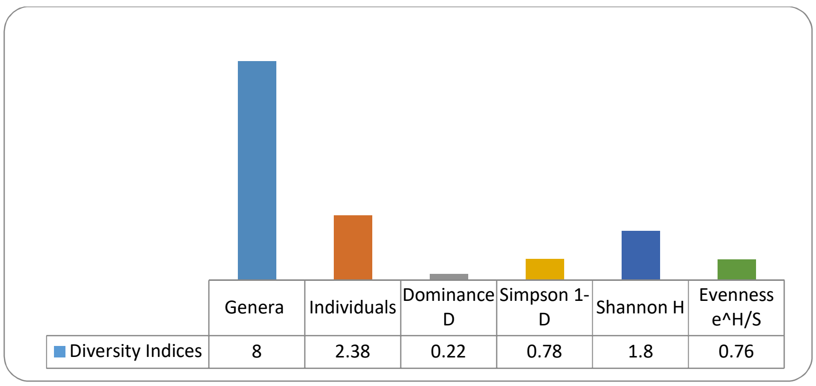

Fig 4: Diversity indices of plant-parasitic nematodes associated with Amenity tree species at UNIPORT

These nematodes found on amenity trees are in conformity with nematode pests that have been reported on trees due to their wide host range and mode of feeding (Ruehle, 1967; Ruehle, 1973; Gbadegesin *et al*., 1992; Gbadegesin *et al*., 1993; Nyczepir and Becker, 1998). The economically most important nematode pest species belong to the genera *Criconemella, Meloidogyne, Pratylenchus, Longidorus, Xiphinema, Trichodorus* and *Paratrichodorus*, and are widely distributed on tree crops throughout the world (Nyczepir and Halbrendt, 1993; Nyczepir and Becker, 1998). The traditional nematode genera associated with trees globally such as *Trichodorus*, *Paratrichodorus*, *Longidorus*, *Xiphinema* were found in significant abundance in this survey (Nyczepir and Becker, 1998; Lišková et al., 2007). These nematodes have been implicated in damage to forest trees with slow decline of growth and eventual tree death in 5 to 10 years, especially in young forest plantations (Khan, 2012). Wilting, drying, defoliation of branch or entire tree has been attributed to attack of nematode pests on trees (Khan, 2012). This shows the importance of plant-parasitic nematodes as one of the major constraints to growth of amenity trees. Also, *Aporcelaimus* species of the family Aporcelaimidae and *Mesodorylaimus* species (Dorylaimidae) classified as omnivores and predators (Andrassy, 2000; McSorley, 2012) are just being reported first in the rhizospheres of trees in Nigeria. The presence of these two nematode species has been linked to ecosystems in nearly all stages of succession, but they have their highest population at the later stages of succession especially in soils of old-growth forests (McSorley, 2012). They have strong adaptation to extreme environment, but are limited by soil with low PH, use of inorganic fertilizers and other agrochemicals. The report of these two nematode pest genera is an indication that their host range have increased either due to climate change or favourable environmental conditions. Recently, change in pest status has been linked to climate change in which potential pests of some plants are now becoming key pests (Asimiea *et al*., 2015).

Table 5: Mean population of plant-parasitic nematodes associated with amenity trees at the University of Port Harcourt

Tree Species	Heli	Apo	Tyle	Melo	Scut	Praty	Tylchus	Roty	Crico	Hemi	Trich	Meso	Hetero	Parat	Longi	Mean PPNs
Delonix regia	0	0	0	0	0	0	3.33	0	0	0	0	3.33	10	0	0	16.66 (0.57)
Peltphorum pterocarpum	23. 33	10	0	0	0	0	0	0	0	0	0	0	0	0	0	33.3 (1.23)
Hura crepitans	10	0	0	0	0	0	0	3.33	0	0	0	0	0	3.33	0	16.66 (1.23)
Polyathia longifolia	0	0	0	0	0	6.67	0	0	0	3. 33	0	0	0	0	0	10.00 (0.79)
Persia americana	0	0	0	0	0	6.67	0	0	0	0	0	0	0	0	0	16.67 (0.88)
Gmelina arborea	0	0	0	0	0	0	0	0	3.33	0	0	0	0	0	0	3.33 (0.35)
Terminalia mantaly	0	0	0	0	0	0	0	0	0	0	3.33	0	0	0	0	0.00 (0)
Azadiracha indica	10	0	3.33	0	0	0	0	0	0	0	0	0	0	0	0	13.33 (0.88)
Terminalia catappa	76.67	0	26.67	0	0	0	0	0	0	0	0	0	0	0	0	106.67 (1.27)
Ficus elastica	6.67	0	0	0	0	0	0	0	0	3.33	3.33	0	0	0	0	13.33 (0.84)
Arenga pinnata	36.67	6.67	13.33	6.67	0	0	0	0	0	0	0	0	0	0	0	63.33 (1.31)
Roystonea regia	10	0	6.67	0	10	0	0	0	0	0	0	0	0	0	0	26.67 (0.64)
Cocos nucifera	0	3.33	0	0	0	0	6.67	0	0	0	0	0	0	0	0	10.00 (0.79)
Mangifera indica	3.33	0	0	0	0	0	0	10	0	0	0	0	0	0	0	3.33 (0.35)
Lagerstroemia indica	3.33	0	3.33	0	0	0	0	0	0	0	0	0	0	0	0	6.67 (0.69)
Anacardium occidentalis	16.67	0	0	10	6.67	0	0	0	13.33	16.67	0	0	0	0	0	63.33 (1.31)
Elaeis guinensis	50	0	6.67	3.33	0	0	0	0	3.33	0	0	0	0	0	6.67	70.00 (1.84)
Chrysophyllum albidum	0	0	3.33	0	0	0	0	0	0	0	0	0	0	0	0	3.33 (0.35)
Senna fistula	0	0	3.33	0	0	0	0	0	0	0	0	0	0	0	0	3.33 (0.35)
Pinus caribaea	3.33	0	10	0	0	0	0	0	0	0	0	0	0	0	0	13.33 (0.54)
Eucalyptus camadulensis	3.33	0	0	0	0	0	0	0	0	0	0	0	0	0	3.33	6.67 (0.44)
LSD ($P \leq 0.05$)	52.85	7.77	16.74	7.76	7.49	5.87	4.64	4.15	8.81	10.79	2.94	2.08	6.23	2.08	2.93	74.71 (1.33)

Heli=*Helicotylenchus*; Apo=*Apocelaimus*; Tyle=*Tylenchulus*; Melo=*Meloidogyne*; Scut=*Scutellonema*; Praty=*Pratylenchus*; Tylchus=*Tylenchus*; Roty=*Rotylenchulus*; Crico=*Criconemella*; Hemi=*Hemicyclophora*; Tric=*Trichodorus*; Meso=*Mesodorylaimus*; Hetero= *Heterodera*; Parat=*Paratylenchus*; Longi= *Longidorus*; PPNs=Plant-parasitic nematodes; ( ) = logarithm transformed value

Conclusion: Thirty-eight (38) amenity tree species belonging to 20 families were identified in UNIPORT, one of which *Moraceae* constitutes the major family. The nematode pests of amenity trees in UNIPORT belong to 15 genera, with three predominant genera are *Helicotylenchus*, *Tylenchulus* and *Aporcelaimus*. Further research should be carried out on the effects of these nematodes on the amenity trees and how they could be well managed sustainably.

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