Journal of Forests
2017 Vol. 4, No. 2, pp. 27-34
ISSN(e): 2409-3807
ISSN(p): 2413-8398
DOI: 10.18488/journal.101.2017.42.27.34

DIVERSITY AND GROWTH CHARACTERISTICS OF TREE SPECIES IN THE BOTANICAL GARDENS, UNIVERSITY OF IBADAN, NIGERIA

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Article History
Received: 18 October 2017
Revised: 19 December 2017
Accepted: 22 December 2017
Published: 29 December 2017

Keywords
Growth parameters
Diversity
Slenderness coefficient
Stability
Botanical gardens
Improved management
Nigeria.

ABSTRACT

This study assessed the diversity and growth characteristics of tree species in University of Ibadan Botanical Gardens with a view to provide data for improved management of the garden. Ten plots (25m x 25m) were sampled randomly in the garden. Growth parameters evaluated included: total and merchantable height, diameter at breast height, diameters at middle, base and top. Descriptive statistics of the growth characteristics of the tree species revealed a mean volume of 20.03+ 2.91m3/ha and 0.45+0.79m2/ha for basal area. *Afzelia africana* had the highest tree volume (72.42m3) followed by *Vitex doniana* (50.10m3) while the least volume was observed in *Terminalia cattapa* (5.57m3). *Cedrela odorata* (15.3%) had highest frequency of individual trees followed by *Delonix regia* (4.2%) while 12 species had single tree each (1.4%). Low Slenderness coefficient (SLC) of < 70 showed that most tree species in the garden are not susceptible to wind induced damage. Only *Enterolobium cyclocarpum* possessed moderate SLC which could be vulnerable to wind velocity despite some form of resistance. Further research centered on tree form and growth parameters need be encouraged for improved management of the botanical garden.

Contribution/Originality: This study documents the unique characteristics of tropical trees that are important in sustainable management of Botanical gardens for: tree diversity conservation, ecological restoration and maintenance in developing tropical countries.

1. INTRODUCTION

Globally, the removal or destruction of significant areas of forest cover is moving apace, where every year an integral part of the nation's forest is destroyed through industrialization, indiscriminate logging, urbanization, commercial agriculture amongst others [1]. These cumulative anthropogenic activities have resulted in a degraded environment with reduced biodiversity. The effects of these impacts are mostly evident in the developing countries, with highest rate of notoriety in Nigeria, where almost all the ancestral forests are lost in an alarming rate of disappearance [2-5].

Ihenyen, et al. [6] lamented that out of about 565 species of trees existing in Nigeria; over 60 species are faced with extinction and various forms of risk. However, as a result of massive loss of valuable plant species and adverse impact on environmental and socio-economic values, policies have been formulated for proper conservation and management of these tree species through establishment of several nature reserves and botanical gardens.

Botanical gardens are uniquely positioned to help address the issues relevant to restoring ecosystems. They provide knowledge and expertise in plant taxonomy, horticulture, biodiversity inventory, conservation biology, restoration ecology and ethno-botany which are key elements for achieving successful restoration. Botanical gardens also collectively serve as a global repository for documented plant materials, with few genetic individuals of plants maintained in living collections or seed banks Corlett [7]. BGCI [8] opined that Botanical gardens bring the understanding necessary to ensure that restoration leads to adequate taxonomic diversity and incorporates appropriate genetic provenance by utilizing knowledge gained from these collections and combined with landscape knowledge from field surveys and ecological research.

Botanical gardens can therefore restore diverse and ecologically resilient places, avoiding the dangers and pitfalls associated with growing inappropriate plants in the wrong environment. Botanical gardens are also well-placed to raise awareness amongst the general public of the need for, and benefits that can be derived from successful ecological restoration projects. They contribute to the conservation of living resources, maintaining ecological processes and vital systems, preserving genetic diversity and ensuring sustainable use of species and ecosystems [9].

Several botanical gardens are located within university premises in Nigeria for teaching, research and recreation. University of Ibadan botanical gardens play an essential role in the study and preservation of flora, through research and environmental education. Sustainable management of tree species in botanical gardens can only be ensured if reliable information on diversity and growth conditions of the trees are available which can be used in managing the garden to provide accurate and timely information on current growing stock. Therefore, there is need to understand species diversity, growth and ecology of trees in such gardens. This paper focused on tree species composition, their growth parameters and implications for management in the University of Ibadan botanical gardens.

2. METHODOLOGY

2.1. Study Area

The study was carried out in the Botanical Gardens, University of Ibadan (UI), Oyo State, Nigeria located on latitude 7°26"N and longitude 3°54" E and a mean altitude of 227m above sea level. The Botanical Gardens was primarily established to provide botanical teachings, research and recreation for all users. It is being developed to act as *ex situ* repositories of wild plant germplasms and centre for biodiversity conservation studies through research in Forestry, botany, ecology, horticulture, habitat study, management and restoration, species reintroduction, environmental education and sustainability [10]. The gardens have demonstrated a high sense of commitments to recreation education, conservation and sustainable environmental needs of the country [11].

2.2. Data Collection

Prior to tree enumeration, a reconnaissance survey was carried out to assess the trees distribution in the garden. Ten plots of 25m by 25m were randomly laid on two transects across different compartments of the garden. Plots laid were systemically numbered for easy identification and enumeration. The population of the trees in each of the plots was determined by numbering all the trees in each plot accordingly excluding trees below 20cm dbh. Tree heights and dbhs data was collected with the aid of Spiegel relascope and a girthing tape. Tree volume and basal area were determined viz;

2.3. Stem Volume

$$V = h/6\ (A_b + 4A_M + A_t)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where V = Volume of the tree (m^3), h = Total height of the tree (m), A_b = Cross sectional area of the tree at the base (m^2), A_m = Cross sectional area of the tree at the middle (m^2), A_t= Cross sectional area of the tree at top (m^2).

2.4. Basal Area

The Basal Area for individual trees within each plot was estimated using:

$$\text{Basal Area} = \pi D^2/4 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where: BA = Basal Area (m^2), π = 3.142 (constant), D = diameter at breast height (m).

2.5. Slenderness Coefficient (SLC)

$$SLC = \underline{THt/}Dbh \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Tree Slenderness coefficient values (TSC) were classified into three categories;

TSC values > 99…………… High slenderness coefficient

70 < TSC values < 99………Moderate slenderness coefficient

TSC values < 70 …………….Low slenderness coefficient

3. RESULTS AND DISCUSSION

A total of 72 trees comprising 30 species were encountered and measured in the ten (10) sample plots (25m x 25m) from the botanical garden. The mean growth variables were presented in Table 1. The minimum and maximum dbh ranged from 37cm to 175cm while total heights ranged from 18.0 to 34.5m.

Table-1. Growth variables of tree species in UI Botanical gardens

Growth Variables/statistics	Mean ± S.E	Minimum	Maximum
Dbh (cm)	70.4 ± 5.21	37.00	175.00
MHt (m)	15.57 ± 1.10	8.00	26.00
THt (m)	25.17± 0.99	18.00	34.50
SLC	41.70 ± 2.43	18.29	71.11
BA (m^2/ha)	0.45 ± 0.79	0.11	2.41
Vol (m^3/ha)	20.03 ± 2.91	5.57	72.42

Dbh = Diameter at breast height, MHt = Merchantable Height, THt = Total height;
SLC= Slenderness coefficient; BA= Basal Area; Vol= volume

Most of the trees were in diameter class 40 - 60cm (30 trees) and 60-80cm (25 trees) as shown in Fig.1. The least diameter class was 20 - 40cm. Limited tropical rain forest tree species have been observed to grow above 80cm in dbh [12] this is in tandem with the few trees above 80cm dbh class in the garden, however, this is contrary to expectation in a conservation area where no logging activity is allowed. Tropical natural forest ecosystems are usually characterized by high population density of plants, complex plant diversity, nutrients competition, soil water, space and solar insolation which results in lower Dbh and tall trees [13, 14]. In addition, some trees in the botanical gardens attained total heights above 34.5m because the garden enjoys adequate protection by law for conservation purposes.

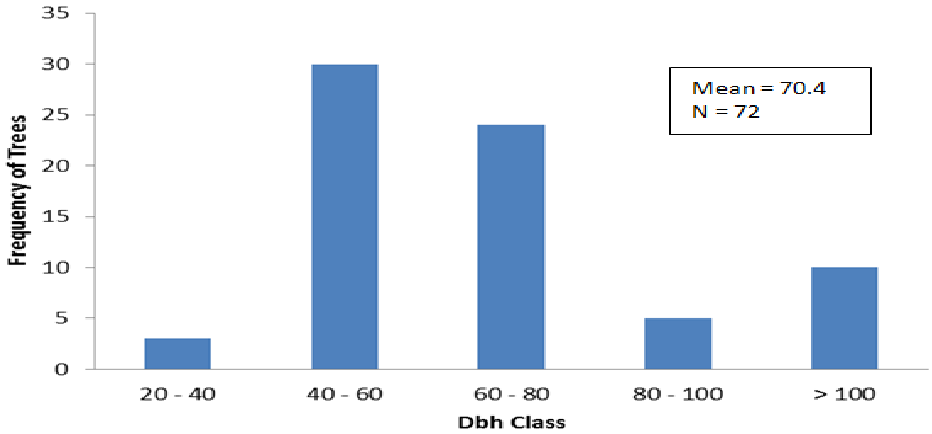

Fig-1. Tree dbh distribution pattern in UI Botanical gardens

Source: Field measurements

3.1. Tree Species Composition and Diversity in UI Botanical Gardens

The botanical gardens composed of both indigenous and exotic tree species of various economic and medicinal values. Some threatened and endangered tree species in Nigeria such as *Khaya grandifoliola* and *Albizia lebbeck* were also observed in the garden. The survey encountered 30 tree species distributed across 13 families, the trees were properly identified and growth parameters measured (Table 2). Common tree species in the botanical garden include: *Cederala odorata, Delonix regia, Gmelina arborea, Pterygota macrocarpa, Blighia sapida, Morus mesozygia and Bombax buonopozense.*

Table-2. Trees species composition in UI botanical garden

S/No	Botanical name	Family	Common/local name	Nativity
1	*Alstonia boonei*	Apocynaceae	Ahun	Indigenous
2	*Ceiba pentandra*	Bombacaceae	Araba	Indigenous
3	*Bombax buonopozense*	Bombacaceae	Ponpola	Indigenous
4	*Pterygota macrocarpa*	Combretaceae	Oporoporo	Indigenous
5	*Terminalia superba*	Combretaceae	Afara	Indigenous
6	*Anogeissus leiocarpa*	Combretaceae	Ayin	Indigenous
7	*Terminalia catappa*	Combretaceae	Almond fruit	Exotic
8	*Hura crepitans*	Euphorbiaceae	Sand box, Kerebuje	Indigenous
9	*Adenanthera pavonina*	Leguminosae	Red bread tree	Exotic
10	*Peltophorum pterocarpum*	Leguminosae	Yellow flame tree	Exotic
11	*Enterolobium cyclocarpum*	Leguminosae	Ear tree	Exotic
12	*Delonix regia*	Leguminosae	Flamboyant tree	Exotic
13	*Senna siamea*	Leguminosae	Cassia	Exotic
14	*Tetrapleura tetraptera*	Leguminosae	Aidan	Indigenous
15	*Afzelia africana*	Leguminosae	Apa	Indigenous
16	*Albizia lebbeck*	Leguminosae	Igbagbo	Indigenous
17	*Khaya senegalensis*	Meliaceae	Mahogany	Indigenous
18	*Cedrela odorata*	Meliaceae	Red cedar	Indigenous
19	*Khaya spp*	Meliaceae	Mahogany, Oganwo	Indigenous
20	*Khaya grandifoliola*	Meliaceae	Mahogany	Indigenous
21	*Milicia excelsa*	Moraceae	Iroko	Indigenous
22	*Morus mesozygia*	Moraceae	Aye	Indigenous
23	*Antiaris toxicaria*	Moraceae	Ooro, Oriro	Indigenous
24	*Pinus caribea*	Pinnaceae	Pine	Exotic
25	*Nauclea diderrichii*	Rubiaceae	Opepe	Indigenous
26	*Blighia sapida*	Sapindaceae	Ishin	Indigenous
27	*Triplochiton scleroxylon*	Sterculiaceae	Obeche, Arere	Indigenous
28	*Celtis brownie*	Ulmaceae	Ita	Indigenous
29	*Gmelina arborea*	Verbanaceae	Gmelina	Exotic
30	*Vitex doniana*	Verbanaceae	Oori	Indigenous

Source: Field survey

The relatively low population of trees observed in the study area, may be linked to anthropogenic factor and management option for recreation in the gardens. Level of natural disturbance and human impacts have been stated to influence plant populations in tropical ecosystems [13, 15]. Characteristic tree species with large branches are nurtured and given preferences by the management to create picnic/play spaces for tourist. Routine weeding of the gardens ensured only desired trees are allowed to thrive while naturally regenerated seedlings are removed for easy human movement and excellent scenic view. This is in line with the report of Agarwala, et al. [16] who asserted that tree species populations and regeneration is impacted by purpose and level of human use in India.

Most frequent family diversity of trees in the garden were Leguminosae (8 species), Combretaceae, Meliaceae (4 species each) and Moraceae (3 species) in the survey as reflected in Figure 2. This is congruent with findings in a Brazilian and Myanmar protected tropical forest where Combretaceae and Leguminosae families form part of the dominant species [17, 18]. Leguminosae and Combretaceae families probably possess broad spectrum of species, mostly easily adapted and usually produce large quantities of seed usually with long shelf life. For example, regeneration of *Afzelia africana* (Leguminosae) can be abundant in sites protected against fire [19].

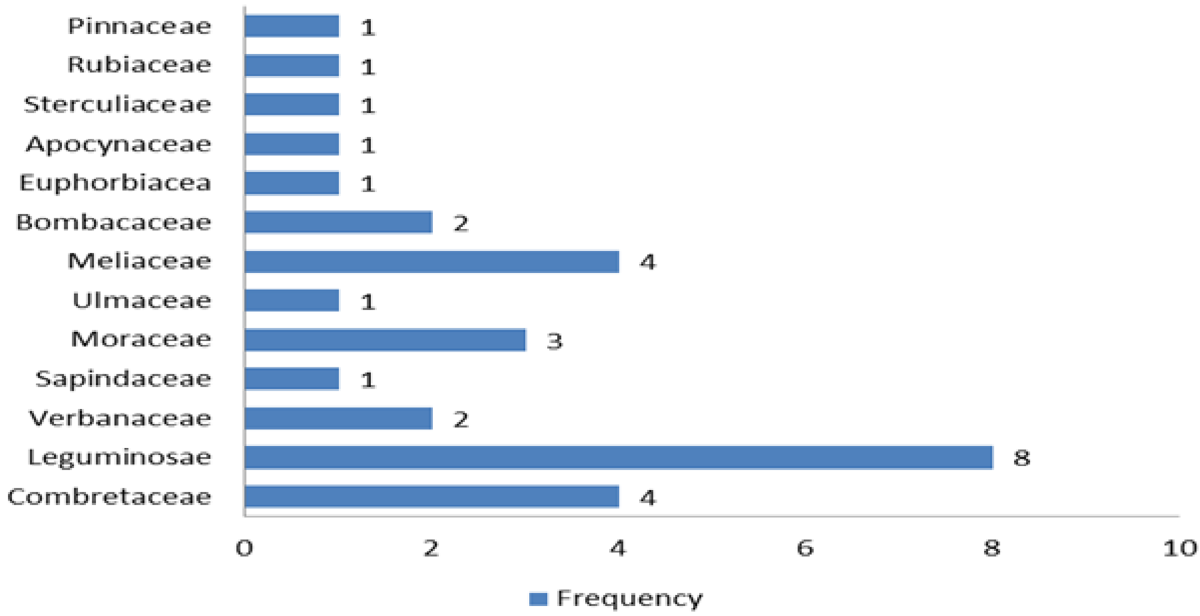

Fig-2. Diversity of Trees in UI Botanical Gardens

Source: Field survey

3.2. Population and Growth Parameters of tree species in UI Botanical gardens

Table 3 showed population distribution and growth parameters of sampled tree species in the botanical gardens. The enumerated plots had a total population of seventy two (72) trees. *Cedrela odorata* and *Delonix regia* had the largest populations of eleven (15.3%) and seven (9.7%) trees in the garden, while 13 species had single stand each representing 1.4% each of the enumerated trees. Trees of *C. odorata and D. regia* form massive spreading branches, usually evergreen that hinders regeneration of other species under the trees thereby making the environment suitable for picnic activities. Although, *D. regia* is an exotic species, it produces large quantum of flamboyant red flowers which attracts tourists to the garden in its season, these inherent factors could be responsible for their prevalence in the study site. Similar report in neighbouring Ghana showed that trees species with spreading branches such as *Hevea brasiliensis and Parkia biglobosa* were dominant in floristic composition of KNUST botanical gardens, Ghana [20].

Table-3. Species Population Distribution and Growth parameters of Trees in UI Botanical Gardens

S/No	Species	Freq	Percentage (%)	Dbh (cm)	Mht (m)	Tht (m)	BA (m^2)	Vol (m^3)	SLC
1	*Adenanthera pavonina*	1	1.4	54	9	18	0.23	13.08	33.3
2	*Afzelia africana*	2	2.8	50	26	32	0.2	72.42	64.0
3	*Albizia lebbeck*	2	2.7	56	17	26	0.25	11.25	46.4
4	*Alstonia boonei*	2	2.7	57	15	25	0.26	11.14	43.9
5	*Anogeissus leiocarpa*	1	1.4	105	25	30	0.87	34.05	28.6
6	*Antiaris toxicaria*	1	1.4	76	12	20	0.45	11.78	26.3
7	*Blighia sapida*	3	4.2	68	22	32	0.36	19.93	47.1
8	*Bombax buonopozense*	2	27	59	13	23	0.27	7.96	39.0
9	*Cedrela odorata*	11	15.3	70	13	20	0.38	12.05	28.6
10	*Ceiba pentandra*	1	1.4	58	10	20	0.26	11.52	34.5
11	*Celtis brownii*	1	1.4	49	8	18	0.19	11.88	36.7
12	*Delonix regia*	7	9.7	79	20	28	0.49	27.16	35.4
13	*Enterolobium cyclocarpum*	5	6.9	45	25	32	0.16	48.50	71.1
14	*Gmelina arborea*	1	1.4	70	18	31.5	0.38	21.00	45.0
15	*Hura crepitans*	3	4.2	62	13	20	0.3	8.45	32.3
16	*Khaya grandifoliola*	3	4.2	75	13	26	0.44	18.96	34.7
17	*Khaya senegalensis*	1	1.4	70	15	26	0.38	9.69	37.1
18	*Khaya senegalensis*	1	1.4	56	13	20	0.25	8.32	35.7
19	*Milicia excelsa*	2	2.8	127	15	30	1.27	38.4	23.6
20	*Morus mesozygia*	1	1.4	54	20	26	0.23	17.32	48.1
21	*Nauclea diderrichii*	1	1.4	70	18	25	0.38	14.14	35.7
22	*Peltophorum pterocarpum*	2	2.8	67	8	18	0.35	8.07	26.9
23	*Pinus caribea*	4	5.6	49	14	24	0.19	11.08	49.0
24	*Pterygota macrocarpa*	1	1.4	118	25	34.5	1.09	37.33	29.2
25	*Senna siamea*	5	6.9	80	10	22	0.5	19.83	27.5
26	*Terminalia catappa*	2	2.7	37	15	25	0.11	5.57	67.6
27	*Terminalia superba*	2	2.8	81	15	28	0.52	21.48	34.6
28	*Tetrapleura tetraptera*	1	1.4	54	12	25	0.23	11.06	46.3
29	*Triplochiton scleroxylon*	2	2.7	41	8	18	0.13	7.35	43.9
30	*Vitex doniana*	1	1.4	175	20	32	2.41	50.1	18.3
	Total	**72**	**100**						

Dbh = Av. Diameter at breast height, MHt = Av. Merchantable Height, THt = Av. Total height; SLC = Av. Slenderness coefficient value; BA = Av. Basal Area (m^2), Vol = Av. Volume (m^3)
Source: Field measurements

3.3. Slenderness Coefficient (SC)

SC is the ratio of total height to Dbh of a tree and can be used in measuring stability against wind-throw [21]. Low slenderness coefficient value indicates high resistance to wind damage (good stand stability) while high slenderness coefficient show low resistance to wind induced damage [22]. Most trees (96.67%) in the botanical gardens, were within low slenderness coefficient (< 70), this indicates good stability during high wind velocity, only *Enterolobium cyclocarpum* (3.3%) had moderate slenderness category (70 - 90). Although trees with moderate slenderness such as *Enterolobium cyclocarpum* usually show resistance to high wind velocity, however, it may be thrown off by excessive wind velocity. The tree species in the botanical are relatively stable and not readily susceptible to wind damage hence possess the ability to protect the site from soil erosion.

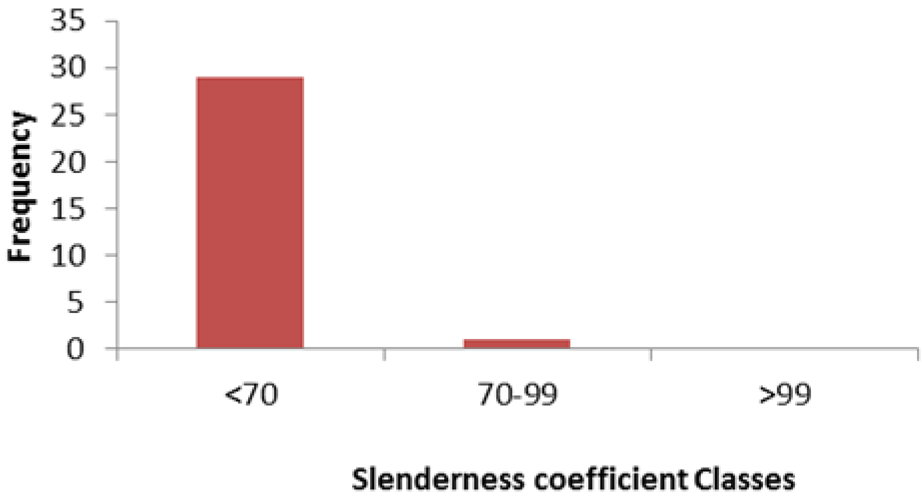

Fig-3. Distribution (%) of slenderness coefficient values for tree species in UI botanical garden
Source: Field measurements

4. CONCLUSION

The study revealed tree composition in UI botanical garden to comprise of indigenous and exotic species belonging to 13 families. Measured growth parameters showed average Dbh of 40 – 80cm and height of 24 – 30m. Slenderness coefficient for most trees in the botanical garden was generally low (< 70) indicating stability against strong wind. Knowledge obtained from the study could be useful in the sustainable management of the garden and similar protected areas in tropical regions.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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