



## SURVEY ON EXOTIC PLANT SPECIES IN AHMADU BELLO UNIVERSITY ZARIA BOTANICAL GARDEN



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**Abstract:** Exotic plant species can replace native species by becoming invasive and causing change in habitat structure, affect ecosystem processes and threaten biodiversity if not detected and managed early. In some cases it might even lead to local extinction of native species. Botanical garden of Ahmadu Bello University Zaria (ABU) is an insitu conservation site where the composition and rate of invasion by exotic species is yet unknown. As such for proper management and control, this survey was designed to document the number of indigenous and exotic plants species in the garden. The garden was divided into 19 plots based on existing concrete walk-ways and map. Plants were collected from each plot using modified "Whittaker technique" and identified at the Herbarium Department of Botany ABU, Zaria. The plants were further grouped into indigenous and exotic species using the savanna keys as well as other literature sources. A total of two hundred and twenty two (122) species belonging to forty eight (48) families, including eighty three (83) exotics and thirty nine (39) indigenous were recorded. Members of the family Fabaceae were dominant with fifteen (15) species of which eleven (11) were exotic plants. Evaluation of the data revealed that exotic plant species were significantly ( $p < 0.01$ ) overrepresented over the indigenous plant in the garden. *Albizialebbeck*, *Bauhinia monandra* and *Gmelinaarborea* which are exotics were the most dominant plant species. It was concluded that, the exotic plant species have higher representatives in almost all the plots and needs to be managed to prevent local extinction of natives in the garden.

**Keywords:** Botanical garden, conservation, extinction, indigenous plants, invasive species, biodiversity

### Introduction

Exotic plants (non-native species) are those transported intentionally or unintentionally by human activities to new areas very far from their long-term evolutionary habitat (Schulz and Gray, 2013). Indigenous plants (sometimes also called native plants) are plants that have evolved over thousands of years in a particular region without human introduction. These plants are adapted to the geography, hydrology, and climate of that region where they evolved with other plants to constitute a community. A community of indigenous plants provides habitat for a variety of native wildlife species such as birds and butterflies (Douglas, 2007). Invasion of natural habitat by exotic species threaten ecological processes and biodiversity worldwide (Mooney, 1999). Exotic species become invasive when they occur outside their natural range into new areas where they establish themselves and quickly invade and out-compete native plant species for available resources (Randall, 1996; Williamson and Fitter, 1996; Akter and Zuberi, 2009). These are likely in habitat disturbed by human activity (Burke and Grime, 1996; Davis *et al.*, 2000). Exotic plant species compete aggressively (Sumners and Archibold, 2007) due to high population growth rates, reproductive capacities, short life cycles, dispersal effectiveness and efficient utilization of water and nutrients (Orians, 1986; Kolar *et al.*, 2001). The introduction of exotic plant species by humans increased significantly during the last five centuries, especially due to rapid increase in global trade and travel (Dogra *et al.*, 2010). Some exotic plant species were introduced deliberately by human due to its economic value (Dogra *et al.*, 2010) while others were introduced to new areas through animal, water and wind dispersal. It is evident that continued spread of harmful non-native species (Thuller *et al.*, 2005) is affecting natural areas including botanical gardens and wildlife parks (Allen *et al.*, 2009). The invasion by alien or exotic plant species represents an ecological risk to indigenous plants world-wide (Kil *et al.*, 2004) and has the potential to alter structure and dynamics of native plant communities and functioning of ecosystem.

Ahmadu Bello University Zaria Botanical Garden was established in 1962 as an in-situ conservation site that is rich in plant species. Thus exotic plant species in the garden are not native to Nigeria or West Africa but were introduced into the garden.

Some exotic plant species if not regulated can multiply and take over the habitat at the expense of indigenous once which might lead to local extinction. Identifying exotic species and their distribution in a given locality is ideally the first step towards managing biological invasion (Barnett *et al.*, 2007). Thus, the present survey was conducted to document the number of exotic and native plant species and their distribution in the Ahmadu Bello University Zaria Botanical Garden for proper and efficient management and control.

### Materials and Method

#### Study area

The study was conducted in the Botanical Garden of Ahmadu Bello University Zaria (Fig. 1). The garden lies at latitude 11° 11' N, longitude 7° 38' E. Zaria is located in the Northern sub-humid Guinea savannah ecological belt with distinct rainy and dry seasons with variation in temperature and relative humidity. The dry season is between middle of October on the average (Jahake, 1982). Zaria has an annual rainfall of 100-114 mm with relative humidity that ranges from 70-80% in August and about 15-20% in December. Daily temperature averages about 23.6°C in the month of April and about 23.3°C in August approximately (Tanko, 2005). The garden covers an area of about 41,886.04 m<sup>2</sup> (Tanko, 2005). The entire garden is divided into three sections for management purposes and further divided into 19 plots (Ahmed *et al.*, 2014). Concrete walkways in the garden divide the vegetation into subsections. The flora of the garden comprises of both indigenous and naturalized exotic plant species. The garden was formerly relatively unexploited area, but today parts of the garden are cultivated for experimental purposes by the Department of Botany and Biology ABU Zaria. Nonetheless, no hunting and grazing activities are allowed.

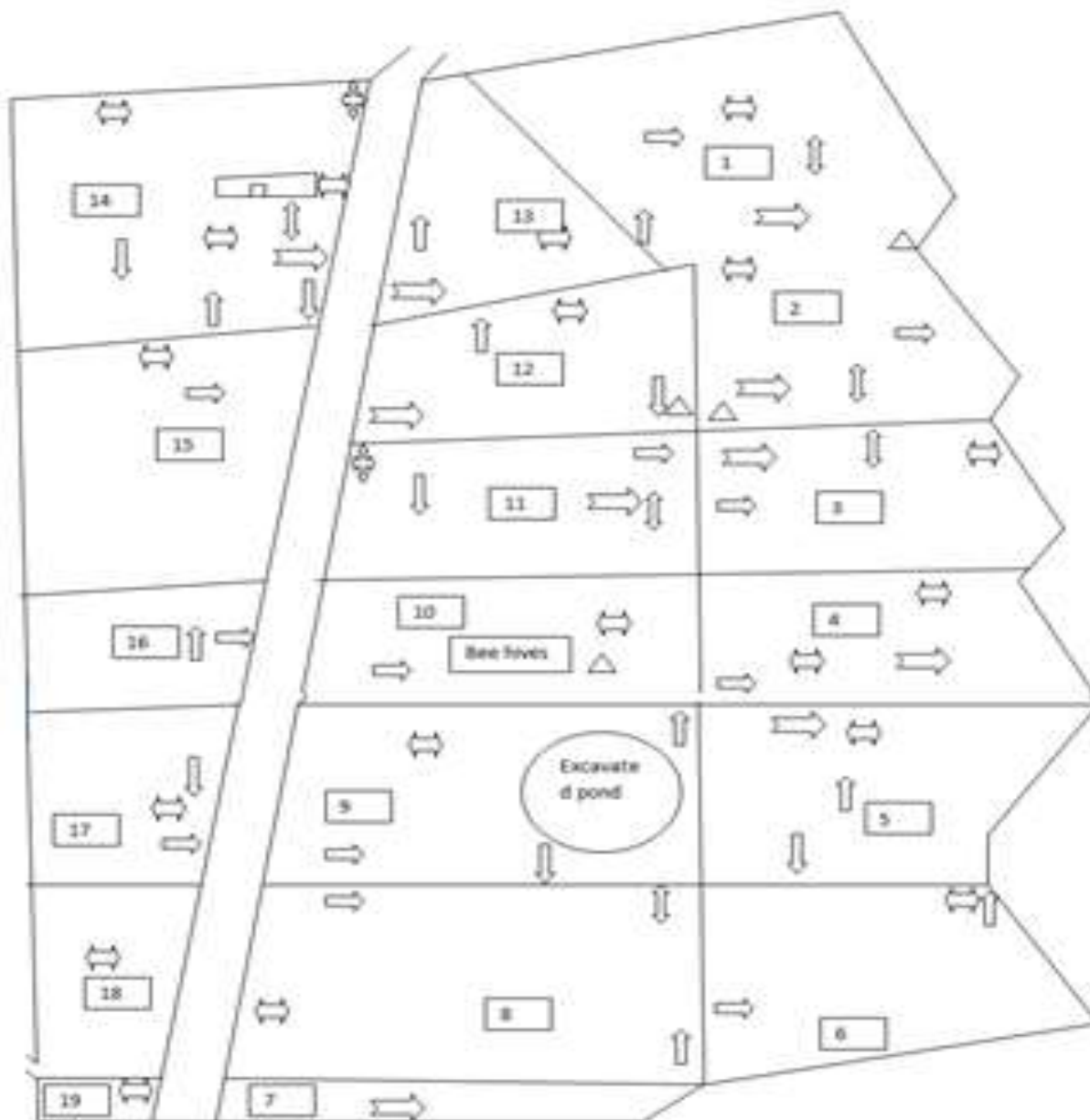


Fig. 1: Map of Ahmadu Bello University Zaria Botanical garden (Ahmed *et al.*, 2014)

**Plant collection**

The study covered a period of three months. Plants were collected twice in a week using "Whittaker technique" which is a standard sampling technique for measuring plant diversity to assist in resource inventories and for monitoring long-term trends in vascular plants species richness. Plant species were collected at multiple scales using 1, 10 and 100 m<sup>2</sup> subplots within a 20 x 50 m (1000 m<sup>2</sup>). Plants collected were taken to the Department of Botany Herbarium for identification.

**Identification of plant species**

Identification was accomplished with the aid of flora of West Tropical Africa (Hutchinson *et al.*, 2014) and by comparison with Herbarium collection. The artificial key method, which is a chat designed using vegetative characters to determine any specimen after series of questions that match the specimen, was also implemented to aid in identification. Plants identified were then grouped into exotic and native species using the

savanna plants identification key. Student T-test was compare the two groups.

**Results and Discussion**

A total of 122 plants species belonging to forty eight families were observed in the Botanical Garden (Table 1). Exotic plants (83) have significantly higher species and representation than the indigenous plant (39) with calculated p-value= 0.00098 (Table 3). The garden was observed to hold a good collection of plant species indicating its effectiveness as a center for research and educational purpose. However, high species richness is not always an advantage as a habitat may have high number of distinct species, because many common and wide spread species are invading it at the expense of species restricted to the habitat (Tanko, 2012).

Table 1: Check list of native and exotic plant species in Ahmadu Bello University, Botanical Garden Zaria

Family	Exotic plants	Common name	Indigenous plants	Common name
Acanthaceae	<i>Thunbergiaalata</i>	Black eyed susan vine		
Agavaceae	<i>Agave sisalana</i>	Sisal hemp	<i>Sansevieriatrifaciata</i>	Good luck plant
	<i>Agave lechuguilla</i>	Shindagger	<i>Sansevierialiberica</i>	Bowstring hemp
	<i>Agave Americana</i>	Century plant		
Aloaceae	<i>Aloe vera</i>	Lily of desert	<i>Aloe buettneri</i>	African aloe
Amaranthaceae	<i>Cyathulavariiegata</i>	Tuhodmanok		
Anacardiaceae	<i>Mangiferaindica</i>	Mango	<i>Anacardiumoccidentale</i> <i>Lanneaacida</i>	Cashew Common smoke tree
Annonaceae			<i>Annonasenegalensis</i>	Wild custard apple
Apocynaceae	<i>Rouvolftiacumissii</i>		<i>Holarrhena floribunda</i>	False rubber tree
	<i>Thevetianeriifolia</i>	Yellow oleander	<i>Carissa edulis</i>	Egyptian Carissa
	<i>Plumeriarubra</i>	Temple tree	<i>Strophanthussarmentosus</i>	Strophanthus
	<i>Saba florida</i>	Paste rubber		
	<i>Allamandacathartica</i>	Yellow allamanda		
	<i>Adeniumobesum</i>	Desert rose		
Aquifoliaceae	<i>Ilex aquifolium</i>	English holly		
Araceae	<i>Hyphaenethebaica</i>	Doum palm	<i>Borassusaethiopum</i>	African Fan palm
	<i>Caladium bicolor</i>	Caladium	<i>Elaeisguineensis</i>	Oil palm
Asparagaceae	<i>Asparagus africanus</i>	African asparagus		
Asteraceae			<i>Vernoniakotschyana</i>	Iron weed
Balsaminaceae	<i>Impatiens irvingii</i>			
Bignonaceae	<i>Jacaranda mimosifolia</i>	Jacaranda tree	<i>Newbouldialaevis</i>	Tree of life
	<i>Tecomastans</i>	Yellow elder		
	<i>Crescentiacujete</i>	Calabash tree		
Burseraceae	<i>Commiphorapedunculata</i>			
Cannaceae	<i>Canna indica</i>	Indian shot		
Capparaceae	<i>Maeruaangolensis</i>	Bead bean		
Caricaceae	<i>Carica papaya</i>	Pawpaw		
Casuarinaceae	<i>Casuarinaequisetifolia</i>	Australian pine		
Combretaceae	<i>Terminaliaavicennioides</i>	Lead wood tree	<i>Guierasenegalensis</i> <i>Anogeissusleiocarpus</i>	Moshi medicine Alex tree
Commelinaceae	<i>Tradescantiapendula</i>	Inch plant		
	<i>Rhoeo discolor</i>	Oyster plant		
	<i>Setcreaseapurpurea</i>	Wandering jew		
Crassulaceae	<i>Bryophyllumpinnatum</i>	Leaf of life		
Dioscoreaceae	<i>Dioscoreabulbifera</i>	Air yam	<i>Taccaleontopetaloides</i> <i>Dioscoreaprehensilis</i> <i>Dioscoreadumetorum</i>	India arrow root Turtle back Bitter yam
Ebeneceae	<i>Diospyrosmespiliformis</i>	African ebony		
Euphorbiaceae	<i>Jatrophacurcas</i>	Barbados nut		
	<i>Securinegavivrosa</i>	Common bush weed		
	<i>Euphorbia milii</i>	Crown of thorns		
	<i>Euphorbia cotinifolia</i>	Caracasana		
	<i>Pedillantustithymaloides</i>	Red bird flower		
	<i>Acalyphawilkesiana</i>	Leaf copper		
	<i>Acalyphas</i>			

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Fabaceae	<i>Albizialebeck</i>	Fry wood	<i>Tamarindusindica</i>	Tamarind
	<i>Bauhinia monandra</i>	Pink orchid tree	<i>Erythrasenegalensis</i>	Coral tree
	<i>Acacia ataxacantha</i>	Flame turn	<i>Lonchocarpussericeus</i>	Cube tree
	<i>Sennasiamea</i>	Cassod tree	<i>Parkiabiglobosa</i>	African locust bean
	<i>Dalbergiasissoo</i>	Shisham		
	<i>Sennasiberiana</i>	Pea tree		
	<i>Delonixregia</i>	Flamboyant		
	<i>Cynometramegalophylla</i>	Muhimbi		
	<i>Calliandrahaematocephala</i>	Powder puff		
	<i>Gliricidiasepium</i>	Metaraton		
	<i>Sennasingueana</i>	Indian senna		
Lamiaceae	<i>Gmelinaarborea</i>	Gmelina		
	<i>Hoslundiaopposita</i>	Orange bird berry		
	<i>Tectonagrandis</i>	Teak		
	<i>Coleus blumei</i>	Buntblatt		
Liliaceae	<i>Haemanthuscinnabarinus</i>	Blood flower		
Lorantaceae	<i>Tapinanthusdoneifolius</i>	African mistletoe		
Lythraceae	<i>Lagerstroemia speciosa</i>	Queen's flower		
Malvaceae	<i>Ceibapentandra</i>	Kapok tree	<i>Bombaxcostatum</i>	Silk cotton tree
	<i>Hibiscus rosasinensis</i>	China rose		
	<i>Pterygotasp</i>			
Meliaceae	<i>Azadirachtaindica</i>	Neem tree	<i>Khayasenegalensis</i>	African mahogany
Moraceae	<i>Ficusiteophylla</i>	Climbing stream	<i>Ficussp</i>	
	<i>Ficusplatyphylla</i>	Broad leaves		
Musaceae	<i>Musa sapientum</i>	Banana		
Myrtaceae	<i>Psidiumguajava</i>	Guava		
	<i>Eucalyptus citriodora</i>	Citron scented gum		
	<i>Eugenia jambolana</i>	Jambul		
Nyctaginaceae	<i>Bougainvillea glabra</i>	Paper flower		
Oxalidaceae	<i>Oxalis corymbosa</i>	Wood sorrel		
Phyllanthaceae	<i>Phyllanthusmeullerianus</i>	Kuntze	<i>Brideliaferrugenia</i>	Savanna bride
	<i>Phyllanthussp</i>			
Polagalaceae			<i>Securidacalongepedunculata</i>	Violet tree
Rhamnaceae	<i>Ziziphusmucronata</i>	Buffalo thorn		
Rubiaceae	<i>Ixoracoccinea</i>	Flame of the woods	<i>Nauclealatifolia</i>	African peach
Rutaceae	<i>Citrus sinensis</i>	Sweet orange		
	<i>Citrus reticulata</i>	Tangerine		
	<i>Citrus lemon</i>	Lemon		
Salicaceae	<i>Oncobaspinosa</i>	Snuffbox tree		
Sapindaceae			<i>Blighiasapida</i>	Shea butter
Sapotaceae			<i>Vitellariaparadoxa</i>	Abakunini
			<i>Omphalocarpumelatum</i>	Black plum
Verbanaceae	<i>Lantana camara</i>	Lantana weed	<i>Vitexdoniana</i>	
	<i>Durantarepens</i>	Golden dew drop		
			<i>Clerodendrumcapitatum</i>	Gung
			<i>Clerodendrumthomsoniae</i>	Heart vine
Vitaceae	<i>Cissusaralioides</i>	Wheel tree	<i>Cissusibuensis</i>	Makoni
			<i>Cissuscymosa</i>	Basari
			<i>Cissuspopulnae</i>	Osielle des pygmees
Zamiaceae	<i>Encephalartosbarteri</i>	West African cycad		
Zygophyllaceae			<i>Balanitesaegyptiaca</i>	Desert palm

The most dominant family in terms of species richness and abundance was Fabaceae having fifteen species of which eleven were exotics. *Bauhinia monandra*, *Albizialebeck* and *Gmelinaarborea* which are exotic were the most dominant plants occurring in almost all the plots surveyed (Table 2). This could be attributed to balistichory mode of seed dispersal as observed with *Albizialebeck* and *Bauhinia monandra*. *Gmelinaarborea* fruit smell attracts birds and bats which feed on the fruits thereby enhancing the dispersal of the seeds. Similar findings have been reported by Rahman and Roy (2014). Other reproductive strategies such as reproducing early and producing large number of seeds might also be responsible for the relative abundance of some of the tree species. Apart from reproductive strategies, exotic plants can also affect pollinators visitation to indigenous species (Brown *et al.*, 2002; Totland *et al.*, 2006) thereby spreading faster than the indigenous plant. Two of the exotic species that were observed in the garden namely, *Lantana camara* and *Psidiumguajava*, have been reported as invaders from 135 protected areas around the world (Foxcroft *et al.*, 2013). Even though these plants have significant economic important and were not highly represented in the garden, their dispersal should be checked and manage to prevent invasion in the future.

**Table 2: Check list of dominant and trivial species on each plot in the garden**

Plot No.	Dominant species	Trivial species
1	<i>Bryophyllumpinnatum</i>	<i>Diospyrosmespiliformis</i>
2	<i>Sansieverialiberica</i>	<i>Borassusaethiopum</i>
3	<i>Bauhinia monandra</i>	<i>Tamarindusindica</i>
4	<i>Bauhinia monandra</i>	<i>Nauclealatifolia</i>
5	<i>Albizialebeck</i>	<i>Vitellariaparadoxa</i>
6	<i>Albizialebeck</i>	<i>Newbouldialaervis</i>
7	<i>Albizialebeck</i>	<i>Acacia ataxacantha</i>
8	<i>Khayasenegalensis</i>	<i>Vitexdoniana</i>
9	<i>Mangiferaindica</i>	<i>Securidacalongepedunculata</i>
10	<i>Bauhinia monandra</i>	<i>Vitexdoniana</i>
11	<i>Bauhinia monandra</i>	<i>Elaeiguinensis</i>
12	<i>Bryophyllumpinnatum</i>	<i>Ficusplatyphylla</i>
13	<i>Bryophyllumpinnatum</i>	<i>Hibiscus rosasinensis</i>
14	<i>Newbouldialaervis</i>	<i>Omphalocarpumelatum</i>
15	<i>Gmelinaarborea</i>	<i>Tecomastans</i>
16	<i>Albizialebeck</i>	<i>Lantana camara</i>
17	<i>Albizialebeck</i>	<i>Parkiabiglobosa</i>
18	<i>Sennasiberiana</i>	<i>Diospyrosmespiliformis</i>
19	<i>Carissa edulis</i>	<i>Albizialebeck</i>

**Table 3: Number of exotic and indigenous plant species on each plot in the garden**

Plot Number	Exotic plants	Indigenous plants	Total
1	13	9	22
2	14	7	21
3	11	7	18
4	8	9	17
5	7	6	13
6	9	2	11
7	7	2	9
8	9	7	16
9	7	6	13
10	10	5	15
11	11	6	17
12	15	7	22
13	22	6	28
14	12	8	20
15	8	3	11
16	6	3	9
17	6	3	9
18	4	6	10
19	3	2	5
<b>Total</b>	<b>182</b>	<b>104</b>	<b>286</b>
Mean	9.58	5.47	15.05
P-value			0.00098

Conversely, some of the indigenous species such as *Elaeiguinensis*, *Omphalocarpumelatum* and *Securidacalongepedunculata* have only one representative each (Table 2) despite their economic importance. Their relatively low abundance in the garden might be attributed to their propagation requirements. There was also evidence of debarking on some of the indigenous plants including *Securidacalongepedunculata* due to their purported medicinal use. Debarking of stems and roots had been identified as one of the highest destructive extractive technique commonly observed in Nigeria (Fasola and Egunyomi, 2002). Other studies (Cunningham, 1988; Johns 1988; Peters, 1996) revealed that debarking often kill medicinal plants. Most of such perennials, required prolonged period of growth with considerable number of years required to reach flowering and fruiting stage, thus minimizing their regenerating possibilities in their natural habitat (Shinwari and Khan, 2000). Activities such as debarking need to be curtailed to prevent local extirpation of species from the garden as observed in the surrounding localities.

While some species were highly represented, some like *Borassusaethiopum*, *Tamarindusindica* and *Vitellariaparadoxa* had few representatives. This type of collection is regarded as imbalance collection according to Simmons (1976) which is not a quality of a good botanical garden. Such trivial species could be regenerated in the garden in the form of tree planting campaign so as to ameliorate the indigenous from going into the worst cases of conservation status.

**Conclusion**

In conclusion, there are significantly higher numbers of exotic species as compared with indigenous species with *Bauhinia monandra*, *Albizialebeck* and *Gmelinaarborea* being the most dominant species in the garden. The native plants need to be under high conservation watch to prevent higher incidence of extirpation in the garden, as they prove medicinal importance and as such poorly represented compared to the exotic plants in the botanical garden.

**Conflict of Interest**

Authors have declared that there is no conflict of interest in this study.

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