



DIVERSITY OF REGENERATING TREE SPECIES IN RESPONSE TO DIFFERENT SOIL CHEMICAL PROPERTIES IN PARKLAND AREA OF GWARZO LOCAL GOVERNMENT, KANO STATE

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ABSTRACT: This research covered the parkland of Gwarzo, along Kano road and was aimed at determining the composition and density of regenerating tree species and the diversity in terms of richness and evenness of the species. The chemical properties of the soil were also determined. The findings of the research showed that, within the 50 systematically sampled plots of 25x25m, a total of 920 regenerating stems were encountered and identified as belonging to 16 different species, distributed within 11 families. Family *Fabaceae* had the highest number of four (4) species, followed by *Anacardiaceae* and *Combretaceae* with two (2) species each. Families *Bombacaceae*, *Moraceae*, *Maliaceae*, *Ebanaceae*, *Vertenaceae*, *Rhamnaceae*, *Myrtaceae* and *Zygophyllaceae* had one (1) species each. Poor regeneration was reported as the number of Seedlings was very low compared to the Saplings and Trees. *Diospyros mespiliformis*, *Eucalyptus camaldulensis*, *Azadirachta indica*, and *Parkia biglobosa* showed a high regeneration potential as more Seedling and Saplings were recorded. *Terminalia macroptera*, *Ficus sycomorus* and *Anogeissus leiocarpus* are under threat of endangerment as fewer seedlings and saplings were recorded. The Shannon wiener diversity index value (H') is moderate for all the classes; Seedlings (2.0572), Saplings (2.4394) and Trees (2.6502). The soil was alkaline with Ph values of 8.03 – 8.25 and did not differ significantly. The organic matter content of (3.38 – 4.07) decrease with an increase in soil depth, total Nitrogen (0.059-0.073) had no significant difference and decrease with an increase in depth. Available phosphorous differ significantly (0.75-0.96mg/kg) with decrease in depth. Exchangeable K, Mg, and Na significant different ($p < 0.05$) with the exception of Ca and all decreased with increase in depth.

Key words: Parkland, Trees, Species regeneration, Diversity and richness

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1. INTRODUCTION

The pressure of growing populations in developing countries has forced landless farmers onto soils which cannot sustain crop production and slopes that cannot be cultivated safely Food and Agriculture Organization (1997). It is also compounded by consistent influx of migrant from neighboring countries, resulting in over grazing and continuous over exploitation of marginal lands. This has in turn aggravated the twin problem of drought and desertification. Increasing demand for land

has also intensified deforestation; the traditional system of Agriculture is largely characterized by clearance of vegetation (Okonkwo 2010). Tree regeneration is described as the act of renewing tree cover by establishing young trees naturally or artificially, after the previous stand or forest has been removed.

The method, species and density are chosen to meet the goal of the landowner. Regeneration of trees can be natural through coppicing, self-sown seeds and root suckers or artificial by (planting chosen species, (Sarkar

and Devi, 2014). According to Bonkougouet *et al.* (1994), farmed parklands “are land-use systems in which woody perennials are deliberately preserved in association with crops and/or animals in a spatially dispersed arrangement and where there is both ecological and economic interaction between the trees and other components of the system”. Nair (1985) stated that, In the ICRAF Agroforestry systems inventory; farmed parklands are included in the category of ‘multipurpose trees on farmlands. The term ‘farmed parkland’ also encompasses parklands being farmed as well as land lying fallow, and does not exclude a pastoralist component.

Farmed parklands are common types of Agroforestry systems in the tropics that were over looked for a long time (FAO, 1997). Studies by Gideon and Verunumbe (2013) observed that trees feature prominently in traditional farming system because of their contributions to famers’ livelihood. Woody species form a major component of the bush fallow system and are widely retained in permanent land. In farmed parkland, cereals are cultivated, and grazed after harvest by livestock to fertilize the land. Tree regeneration is a central component for tropical forest ecosystem dynamics and is essential for preservation and maintenance of biodiversity (Rahman *et al.*, 2011). The objective of the research was to assess the diversity of regenerating tree species in relation to some soil chemical properties in the area.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Gwarzo local government area of Kano state, Nigeria, located between latitude 11°23'26" and 11°58'11"N and longitude 7°15'0" and 8°11'59"E, with a population estimate of 216,570 people and a total area of 393km² (NPC, 2006). The area has a mean annual rainfall of about 696.4mm that last usually for three to five months, the mean temperature ranges from 26°C to 33°C. The area is characterized by four distinct seasons (KNSG, 2014).

2.2 Data Collection

Sampled plots were marked using plastic rope and four wooden pegs within the plots, all types of regenerated tree species encountered were identified, counted and measured. Individual trees having dbh of ≥ 30cm diameter (measured at breast height) was considered as Trees, saplings with ≥ 10cm to < 30cm diameter and seedlings with < 10cm diameter. The status of regeneration of species was determined based on

population size of seedlings, saplings and trees as modified by Shankar (2001) and Khumbongmayum *et al.* (2006). Soil samples were also collected for chemical analysis. Explain how the soil samples were collected.

2.2.1 Sampling procedure

A systematic sampling technique of parallel line transect with plots method was employed Getachew and Biruk (2014), Fifty (50) 25×25m plots were set up and spaced at interval of 100m along linear transects separated by 200m from one another, and all the tree species encountered within the plots were identified, and measured. All sample plots were located at least 100m from the road to avoid edge effect.

2.2.2 Vegetation analysis

The data obtained from the study were presented in tables; species richness, diversity and evenness of regenerating tree species were analyzed using biodiversity formulas and methods as follows:

Shannon’s diversity index:

$$H' = -\sum P_i \ln p_i \dots\dots (1)$$

Where H' = Shannon diversity and P_i = proportion of individual species, ln = natural logarithm.

Species richness is an index based on the number of species; it describes Variety of species or the number of different species (or genera, families, etc.).

Species richness R is given as

$$d = N \sqrt{S} \dots\dots (2)$$

Where; S is number of species; N is number of individuals. **Evenness** is a measure of the relative abundance of the different species making up the richness of an area.

Evenness is calculated using Shannon Evenness index (E')

$$E' = H'/H'max \text{ or } E' = H'/\ln S \dots (3)$$

Where, H' is observed diversity;

H'max is equal to natural logarithm of richness, ln S.

Density = total No of stems of the species/ sampled area (ha) ... (4)

2.2.3 Soil sampling and collection

Composite soil samples were collected from the plots sampled at a depth of 0-15cm and 15-30cm close to the seedlings, saplings and tree species using soil auger. The soil samples collected were air dried, crushed gently and sieved through 2mm mesh for laboratory analysis.

2.2.3.1 Determination of soil chemical properties

- Soil pH was determined using electrode pH meter in 1:1 soil-water solution.
- Following Walkey and Black (1934), soil organic carbon was obtained and then multiplied by 1.729 to estimate organic matter content.
- Determination of available P was achieved by electro-photometer method of Bray and Kurt, 1945, exchangeable K and Na by digital flame photometry, exchangeable Ca and Mg were

determined using EDTA, while total N was determined using macro-kjeldal method with selenium catalyst.

- Cation exchange capacity (CEC) was determined by saturating the soil samples with normal neutral ammonium acetate solution, washing excess with alcohol, distilled and titrated against standard hydrochloric acid following Lavkulich, (1981 method.

2.2.3.2 Soil analysis

Data from laboratory analysis of the soil were subjected to analysis of variance (ANOVA) using SPSS and where significant difference existed, Tukey's HSD Test was used to separate the mean.

3. RESULTS AND DISCUSSION

3.1 Species Diversity Index

Table 1: Checklist of tree species and Shannon diversity value (H^1) for seedlings

Species	Ni	Pi	lnPi	(Pi)*(lnPi)
<i>Adansonia digitata</i>	13	0.094	-2.3645	0.2223
<i>Azadirachta indica</i>	23	0.167	-1.7898	0.2989
<i>Terminalia macroptera</i>	0	0.000	0.0000	0.0000
<i>Ficus sycomorus</i>	0	0.000	0.0000	0.0000
<i>Parkia biglobosa</i>	11	0.080	-2.5257	0.2021
<i>Faidherbia albida</i>	0	0.000	0.0000	0.0000
<i>Diaspyros mespiliformis</i>	27	0.196	-1.6296	0.3194
<i>Tamarindus indica</i>	9	0.065	-2.7334	0.1777
<i>Balanites aegyptiaca</i>	0	0.000	0.0000	0.0000
<i>Mangifera indica</i>	16	0.116	-2.1545	0.2413
<i>Vitex doniana</i>	0	0.000	0.0000	0.0000
<i>Anogeissus leiocarpus</i>	0	0.000	0.0000	0.0000
<i>Sclerocarya birrea</i>	0	0.000	0.0000	0.0000
<i>Ziziphus spina-christi</i>	11	0.080	-2.5257	0.2021
<i>Eucalyptus camaldulensis</i>	25	0.181	-1.7073	0.3094
<i>Daniellia olivieri</i>	3	0.022	-3.8167	0.0840
				2.0572

Source: Field Survey, 2015

Table 2: Shannon's diversity value (H') for saplings

Species	Ni	Pi	lnPi	(Pi)*(lnPi)
<i>Adansonia digitata</i>	19	0.077	-2.5639	0.1974
<i>Azadirachta indica</i>	31	0.126	-2.0715	0.2610
<i>Terminalia macroptera</i>	0	0.000	0.0000	0.0000
<i>Ficus sycomorus</i>	0	0.000	0.0000	0.0000
<i>Parkia biglobosa</i>	27	0.110	-2.2073	0.2428
<i>Faidherbia albida</i>	9	0.037	-3.2968	0.1220
<i>Diaspyros mespiliformis</i>	33	0.134	-2.0099	0.2693
<i>Tamarindus indica</i>	21	0.085	-2.4665	0.2693
<i>Balanites aegyptiaca</i>	17	0.069	-2.6736	0.1845
<i>Mangifera indica</i>	20	0.081	-2.5133	0.2097
<i>Vitex doniana</i>	11	0.045	-3.5756	0.1395
<i>Anogeissus leiocarpus</i>	7	0.028	-3.5756	0.1001
<i>Sclerocarya birrea</i>	0	0.0000	0.0000	0.0000
<i>Ziziphus spina-christi</i>	18	0.073	-2.6173	0.1911
<i>Eucalyptus camaldulensis</i>	29	0.118	-2.1371	0.2522
<i>Daniellia oliveri</i>	4	0.016	-4.1352	0.0662
				2.4394

Source: Field Survey, 2015

Table 3: Species richness (R), evenness (E) and density values

Diversity indices	Seedlings	Saplings	Trees
Species richness	1.3620	1.0201	0.6912
Species evenness	0.7420	0.8798	0.9559
Density (per hectare)	44.16	78.72	171.52

Source: Field Survey, 2015

Table 4: Soil chemical properties

	Seedlings	Saplings	Tree	F	Sig
Ph	8.06±0.75	8.07±0.13	8.16±0.74	2.33	0.13
O.M (g/kg)	3.88±1.8 ^a	3.51±0.27 ^b	3.80±0.18 ^{ab}	4.95	0.02
CEC	31.16±0.89	24.78±0.79	30.34±0.62	1.58	0.24
N (g/kg)	0.06±0.05	0.06±0.04	0.17±0.24	1.21	0.33
P (mg/kg)	0.87±0.05 ^a	0.81±0.03 ^b	0.94±0.02 ^c	42.16	0.00
K (cmol/kg)	0.06±0.03 ^a	0.05±0.06 ^a	0.04±0.08 ^{ab}	9.27	0.02
Na (cmol/kg)	2.99±0.11 ^a	2.49±0.23 ^b	2.53±0.26 ^b	8.90	0.02
Ca (cmol/kg)	0.55±0.07	0.46±0.23	0.50±0.13	0.40	0.67
Mg (cmol/kg)	1.21±0.88 ^a	1.09±0.06	1.34±1.07 ^b	11.89	0.01

Values followed by different superscripts along the rows indicate significant difference Soil chemical properties.

3.2 Diversity Index

Depending on the available tree species in an ecological zone, the diversity indices varies with location, the parklands of Gwarzo, is blessed with moderate diversity of regenerating tree species, in which Trees had higher diversity of 2.6502, followed by saplings (2.4394) and seedlings had the least diversity with 2.0572, this falls within the general limits of 1.5-3.5 (Kent and Coker, 1992). In comparison, the result agreed with the findings of Bello *et al.* (2013) in which they recorded a diversity value of 2.626 for trees at Kogo forest reserve, but higher than what Dikko (2012) found at Dabagi,

who recorded H' value of 1.45 for trees which is very low. Other findings by Onyekwelu *et al.* (2007) recorded H' values of 3.12 and 3.31 at Oluwa and Queen's Forests, south-western Nigeria. The moderate diversity obtained at the parkland of Gwarzo showed that climate favors diversity and may be partly responsible for the diversity obtained in the area; this also confirmed that ecological factors dictate the distribution and abundance of species

Margurran (1988), described Evenness (E_H) as a measure of Equitability of spread of available species. The regenerating species had a calculated evenness of

0.742, 0.879 and 0.9559 for seedlings, saplings and trees respectively, which are higher than Kuwanka Banza Forest reserve (0.74) as recorded by Danjibo (2014), Dabagi (0.74) as recorded by Dikko (2012). This indicate that all the regeneration indicators are moderately distributed in the parklands, which may be due to less competition for space among the tree species considering the nature of the site. In a similar research conducted by Nuraddeen (2014) at the parklands of Katsina state, the species richness stood at 0.73 to 1.56. The differences may be as a result of the more favorable conditions of the tropical rainforest zone in comparison to the Sudan savanna zone, level of exploitation, adaptability of species, and preference by the exploiters.

3.3 Soil Chemical Properties

The pH of the soil indicated alkaline conditions (8.03 to 8.25) which were not different; this may be due to the homogeneity in the parent material of the parkland. Soil pH influences nutrient uptake, hence tree growth, Londo and Carta (2002) argued that a pH of 6.5-7.0 generally provide the best growing conditions and may partly be responsible for the ability of an area to fairly sustain a reasonable number of species, despite constrains of efficient management practices. The poor regeneration recorded in the parkland may therefore be linked to the alkaline nature of the soil.

Organic matter content of the soil is low compared to 7.38 %, 11.57% and 8.42% recorded respectively at Jimajimi, Yartagimba and Daji areas as reported by Muhammad (2010), this may be due to the lower microbial counts that could undertake litter decomposition, lower litter falls or low moisture content that will enhance microbial activities. The organic matter of the soil was also low compared to what Bishir (2012) found at Kogo Forest Reserve in North West Nigeria. Organic matter affects tree growth through its effect on the physical, chemical and biological properties of the soil (Iwara 2009), this may be responsible for the poor regeneration recorded in the area. Total available Nitrogen recorded in the area was very low compared to what Halil *et al.* (2010) recorded at the Oriental Beech Forests in Turkey, lower than what Bishir (2012) obtained at Kogo, and also less than that of Kumar *et al.* (2010), this shows that the result is not within the range for the agro ecological zone. Phosphorous, this occurred in phosphate form, decreased with increase in depth, were lower than that reported by of Bhat and Kareriappa (2009), Bishir (2012) and Muhammad (2010) who recorded 1.26, 18-2.27, and 2.41-6.35 respectively.

The influence of soil properties on the distribution of flora have been documented by scholars in the past.

Aweto and Dikinya (2003) identified organic matter and clay proportion as soil variables that exerted marked influence on the distribution and abundance of tree species.; Ukpong (1994) identified nutrient and salinity as factors explaining species variation in mangrove swamps; John *et al.* (2007) identified soil pH as the strongest soil factor that influenced the distribution of species in three tropical forest; Udoh *et al.* (2007) identified Mn, clay content and TN as soil factors that influenced species distribution ; Zare *et al.* (2011) identified soil texture, salinity, effective soil depth, available nitrogen, potassium, organic matter, lime and soil moisture as major soil factors responsible for variations in the pattern of vegetation; Aparajita (2008) observed that vegetation was related to the chemistry of the surface-soil layer, including nitrate, organic carbon, C/N ratio and water content, and also the active-layer depth, while Medinski (2007) identified clay and silt, Soil EC and pH to influence the distribution and life form abundance. These results perhaps implied that tree/shrub species were selective of nutrients as well as depended entirely on the spatial heterogeneity of soil in nutrient distribution.

In consideration of the study area (Sudan savanna) in which the trees are scattered, coupled with human disturbances in terms of overexploitation of the tree species which had already exposed the soil and of course changed the soils in terms of structure, moisture content, and possibly micro fauna and flora. Regeneration can be negatively affected by the soil in one way or the other in terms of nutrient cycling and fertility.

4 CONCLUSION

The following conclusion was arrived at:

1. The parkland was moderate in terms of tree species composition.
2. Regeneration was poor as some species were endangered which may be due to over exploitation, climatic and or edaphic factors.
3. The low nutrient status of the soil in the area leads to the poor regeneration reported.
4. It is therefore recommended that an all-inclusive integrated management approach that will bring back the diminishing tree resources in the area shall be drawn

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AUTHORS' CONTRIBUTIONS

The First author designed and conducted the study and wrote the first draft of the manuscript. The Second Author managed the literature searches and proof read the manuscript and the Third Author managed the analyses of the study. All authors read and approved the final manuscript

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