International Journal of Scientific Research in Agricultural Sciences, 2(1), pp. 0016-021, 2015
Available online at http://www.ijsrpub.com/ijsras
ISSN: 2345-6795; ©2015; Author(s) retain the copyright of this article
http://dx.doi.org/10.12983/ijsras-2015-p0016-0021

Full Length Research Paper

Determination of Mineral Accumulation through Litter Fall of *Parkia Biglobosa Jacq Benth* and *Vitellaria Paradoxa Lahm* Trees in Abuja, Nigeria

Ibrahim Ndaginna Abdullahi*, Pam Zang Chuwang, Toba Samuel Anjorin, Hector Ikemefuna

Department of Crop Science, Faculty of Agriculture, University of Abuja, Abuja, Nigeria
*Corresponding Author: Email: Ndaginna1@yahoo.com

Received 27 November 2014; Accepted 09 January 2015

Abstract. The availability of the nutrients in the soil contributes to its accumulation in tree plants as it is examined in the study that contribution of leaf litter fall of *Parkia biglobosa* Jacq Benth and *Vitellaria paradoxa* Lahm on the University of Abuja Teaching and Research Farm. The aim of this research is to determine some of the basic nutrient elements present in the harvested leaf litter (biomass) of the two tree forest crops on the Farm for a period of one rainy season. The study was a field work of which leaf litter were collected from four selected trees each of the 2 sampled species, routinely over a 6 month period with the upper layer soil serving as control and analysed using the Randomized Complete Block Design. Findings using Analysis of Variance (ANOVA) revealed that soil fertility may be dependent upon the nutrient accumulation as it was discovered that *P. biglobosa* (2.75g/l) fixes more nitrogen into the soil compared to *V. paradoxa* (2.12g/l). Though both tree species added huge amounts of calcium especially in *P.biglobosa* (69.6 g/l) but all elements were significant (p=0.05) except Magnesium and Sodium. The study showed the need to have more trees planted on the farm to ensure constant nitrogen and other macro elements essential for plant growth and development to sustain crop production and sustainability

Keywords: Leaf, Nitrogen, Nutrient, *Vitellaria paradoxa*

1. INTRODUCTION

The distribution of nutrients in various plant parts and also in different life forms of vegetation depends on the functional balance within the system. Nutrient concentration in plants controls the biochemical as well as the biogeochemical cycles. The amount of nutrients taken up depends on the demand of the plant species also on the availability of the nutrients in the soil. Nutrient accumulation and the pattern of distribution in different components of plants are affected by climate and by the type and age of the species (Peterson, 2002). Llodhiyal et al. *(*1994) pointed out that major macro-nutrients limiting the production of a forest crop are Nitrogen (N), Phosphorus (P) and Potassium (K).

According to Chaplin and Kedrowski (1983), nutrient availability is a major factor influencing the distribution of plant species. It is seen that there are marked variations in the concentrations of different nutrients in each component of the tree species. The leaf component of the plant is metabolically the most active and accumulates maximum amount of nutrients therefore it seems that input to the soil nutrient pool will be maximum by the leaf litter in the forests. Climate variables, chemical composition of the litter and its palatability to soil fauna are most important determinants in the decomposition process. The dry matter mostly consists of carbon, oxygen, hydrogen and inorganic elements. The essential elements such as N, P, K, Ca and Mg are also of vital importance in meeting micro-organisms body requirements (Martinez and Gomes, 2005). Leaf litter decomposition is very important in agriculture because it leads to the addition of organic matter to the soil (enriching the soil with humus) (Hopkins, 2005).

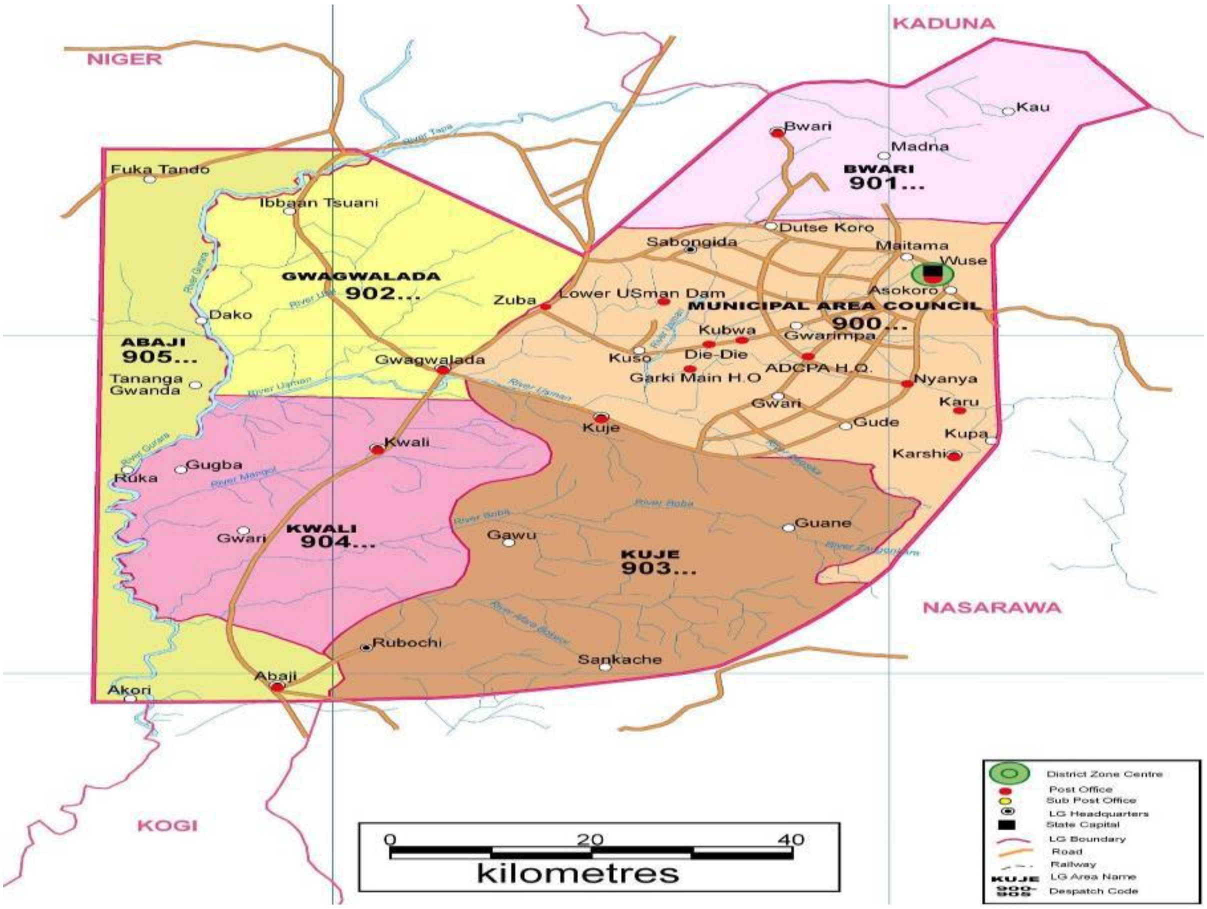
It is evident and can clearly be stated that without the decomposition of plant litter on the farm leading to nutrient accumulation overtime(as a result of climatic factors) that the soil will never be fertile. An infertile soil is bedevilled by many problems; the most prominent of these problems include the inability to support plant growth and agriculture in general. Nutrient accumulation as well as litter decomposition joined together to enrich the soil with needed nutrients (organic matter) to support the growth of plants, improve yield and resist disease attack. It is clear that the fertility of the soil either from organic or inorganic sources is the bedrock of agriculture and once this is affected, there is reduction in agricultural productivity as well as susceptibility to pest and diseases attack.

The aim of this research is to determine the basic nutrient elements present in the harvested leaf litter (biomass) of two forest crops- *Parkia biglobosa* Jacq (Locust bean tree) and *Vitellaria paradoxa* Lahm (Shea butter tree) trees on a Research Farm for the period of one rainy season (April-October, 2013). Other objectives are to evaluate the amount of mineral deposit through leaf biomass production of both tree species and to determine the amount of inorganic nutrient deposit through nutrient accumulation during precipitation of both tree species.

2. MATERIALS AND METHODS

2.1. Experimental Site

The experimental site for the research was located at the Teaching & Research Farm, Faculty of Agriculture, University of Abuja Main campus, Abuja, Nigeria. Abuja is located on latitude $6^0$45' and $7^0$39' East and longitude $8^0$25' and $9^0$20' North (Map 1). The average temperature was 33^0C, 14% humidity during rainy (planting) season and an annual rainfall between 1,100 mm to 1,600 mm. The farm covers an area of about 12 ha and the study plot of the research is about 1.5 ha and consists of various crops ranging from cassava, groundnut, cowpea, maize, yam, soybean etc. Two economic trees found on the site are *Parkia biglobosa* and *Vitellaria paradoxa* which constitute the plants understudy.



Map 1: Study Area

The vegetation of farm falls under the guinea savannah. It has an average annual rainfall of between 1000-1500mm which is spread over 6 months of the year with a relative humidity of 70% which reduces gradually during the day. Temperature ranges between 28-38 degrees. The area around the farm is occupied mostly by Fulani settlements and their major occupation is livestock husbandry and subsistent crop production.

2.1. Experimental Materials and Procedure

The materials used include wood baiting shaped into 1m by 1m quadrants, nylon, plastic bowls, rope (twine), axe/cutlass, and 15 1-litre plastic bottles

2.2. Field procedure

4 trees each were selected from both species using purposive random sampling. The trees were marked (L1-L4 where L= Locust bean tree and S1- S4 where S= Shea butter tree). 1m by 1m woody quadrants were constructed with the wood wrapped with polyethene (nylon) and placed at the bottom of each tree to harvest fallen leaves. The leaf litter was harvested and stored in a labelled nylon bags. Each date of collection was properly documented. The collection was done every week for 6 months (April-October, 2013).

2.3. Laboratory procedure

Mineral content was determined by the Association of Official Analytical Chemistry Methods (AOAC, 1990) using the flame system of the Atomic Absorption Spectrophotometry (AAS), (Unicam 969 solaar). The leaves were dissolved in concentrated nitric acid, heated and filtered, made up to the 100ml mark in a volumetric flask with de-ionized water. The absorbance of the samples was read directly on the Atomic Absorption Spectrophotometry (AAS). Working standard solutions for the metals were prepared from stock standard solution (1000ppm) and absorbance was noted for standard solution of each element and samples using Atomic Absorption Spectrophotometer (AAS).

The calibration curve is obtained for Concentration vs Absorbance. Data were statistically analyzed using fitting of a straight line by least square method. A blank reading was also taken and necessary corrections were made during the calculation of concentration of various elements including N, Na, Mg, P, Ca, K.

2.4. Data analysis

Analysis was done by randomly selecting four each of the established trees of Shea and Locust bean on the University farm after which litter samples were collected with soil serving as the control. Randomised complete block design (RCBD) was used with 3 treatments. Least Significant Difference at 0.05 was used to separate the means of the data collected. Genstat 7.0 (Discovery edition) was employed in running the data.

3. RESULTS AND DISCUSSIONS

It is a known fact that shoots and leaves are the most dynamic parts of a tree plant. Determining their nutrient accumulation patterns may lead us to understanding their differential requirement as nutrients through abscission for plant growth and development. From Table 1, it is observed generally that the nutritional component of the leaf of *P. biglobosa* is higher in nutrients elements sampled than that of *V. paradoxa* helping us to easily infer that the leaf litter of *P.biglobosa* is more nutritious than *V. paradoxa.*

Table 1: Leaf litter decomposition treatment means from the trees

Treatment	**Mean (g/l)**					
	N	**P**	**K**	**Mg**	**Ca**	**Na**
Vitelleria paradoxa	2.12	0.428	3.10	8.76	55.8	26.1
Parkia biglobosa	2.75	0.568	2.91	12.09	69.6	37.8
Control	0.29	2.659	0.24	11.79	64.8	31.2
LSD	0.90	0.196	1.39	3.99	7.47	17.02
Significance (0.05)	*	*	*	NS	*	NS

N/S = Non significant at 0.05 and * = Significant at 0.05.

The amount of nitrogen ranged between 2.75 (*P. biglobosa*) and 2.12 (*V. paradoxa*) while the control had very low amount (0.29). Also, the concentration of phosphorus was established more in the control (2.659) while the other treatments were much lower in their mean as shown in the table despite the significant effect at 0.05. Potassium level in the leaf litter showed a lower mean with *P. biglobosa* (2.91) recording the lowest and control (0.24) having the lowest as indicated in the table. Meanwhile, magnesium and sodium had no significant effect (P=0.05) on the effect of the leaf litter decomposition. *V. paradoxa* had the lowest value of Magnesium (8.76) and highest occurred in *P. biglobosa* (12.09) though the control had no significant difference with the other treatments as shown in table 2. The amount of sodium however indicated the treatment had no significant difference with the lowest mean found in the treatment *Vitelleria paradoxa* (26.1) though control had a higher mean (31.2) but *P. biglobosa* (37.8) treatment had the highest. On the contrary, Calcium had significant level of the mineral amount found as *V. Paradoxa* (55.8) recorded the lowest, the control (64.8) was slightly lower than *P. biglobosa* treatment (69.6) as shown in figure 2.

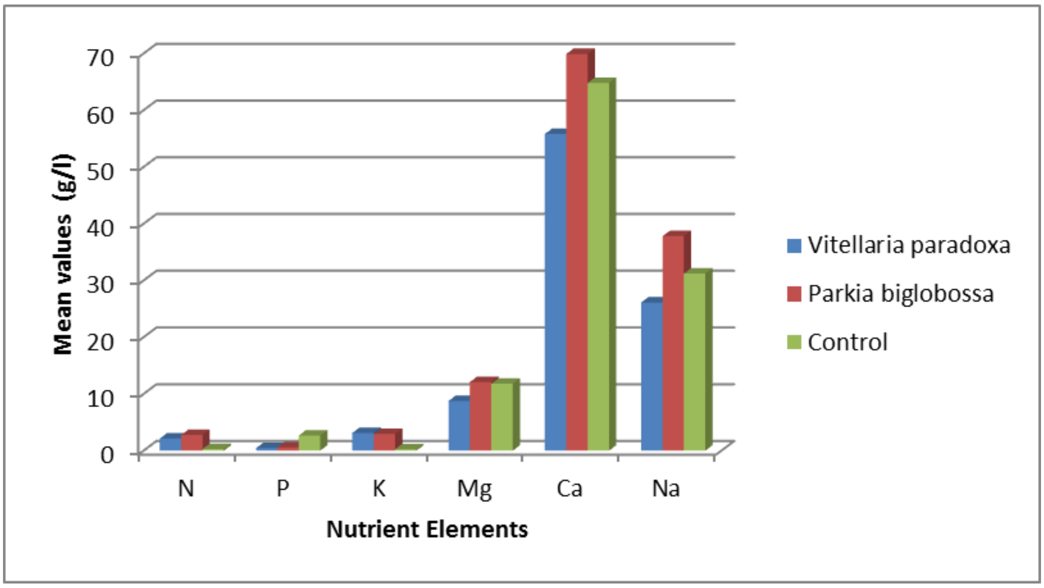


Fig. 1: Bar graph illustrating the treatments and mineral elements determined in the leaf litter decomposition

Also from figure 1, we observe that control is higher than the means of both trees in almost all the nutrient elements except nitrogen and potassium where the means are higher. The high amount of Ca in our study is most likely related to the fact that leaf Ca concentration as at the high end of the satisfactory range. It is interesting to note that the accumulation of nutrients in new leaf growth account for over 90% of the net gain for total N, P, K, Ca, Mg and Na in the entire tree from the analysis, it indicates that rapid accumulation of all nutrients in leaves took place during active shoot growth. In general, foliage is the tree tissue with the highest nutrient concentration and it is considered to contain 20-40% of total stand nutrients, while tree stems are assumed to have relatively low concentrations of nutrients (Jackson, 2003). Litter mass and N and P concentrations in the decomposing leaf litter changed greatly with time. N and P concentrations increase in the initial decomposition stages for many species of trees. Nutrient release or accumulation from the decomposing leaf litter is not correlated with the initial nutrient content of the leaf litter. Leaf litter is significantly correlated with initial leaf litter nitrogen content but not with phosphorus content and *P. biglobosa*, which has high nitrogen content exhibits a relatively faster decomposition rate. Sateesh et al. (2014) also confirmed the availability of N, P K, Ca, and Mg in the litter residue of wheat and soybean farm after burning. In addition, leaf area has little effect on decomposition, but there is a strong positive correlation between decomposition rates and specific leaf area. Dry weight loss of leaf litter increased with an increase of the number of species in the leaf litter mixture (Uyovbisere and Elemo, 2002; Chaplin and Kedrowski, 1983). Sharma and Sharma (2013) discussed that the concentration of nutrients in different tree components are in the order: foliage> seed> their branches and in root components in the order: fine roots> lateral root> stump roots. It is seen that foliage component of various trees have maximum nutrient concentrations and there are marked variations in the concentration of different nutrients in each components.

Xi- Hua et al. (2003) said that leaf litter decomposition is related to the initial quality of leaf litter which includes structure and nutrient content of leaf litter and the species and composition of the mixed leaf litter. As earlier stated the litter which is rich in more nutrients is more palatable to soil fauna and would be decomposed quicker than other litter. It is seen that in the field the leaves of *P. biglobosa* would decompose faster than that of *V. paradoxa* because it is rich in N, which all living bacteria thrive on and also rich in P, Mg, Ca and Na which are all essential nutrients as Kpotor et al. (2014) confirmed the intake of nitrogen at different levels in a different maize trials in Ghana.

4. CONCLUSION

Organic matter management is a key to sustainable fertility and productivity of tropical soil systems. The role *Parkia biglobosa* and *Vitelleria paradoxa* play in the soil fertility of the University of Abuja Research Farm is significant to the productivity of arable crops.

Results from Leaf litter decomposition observed generally that the nutritional component of the leaf of *P. biglobosa* is higher in nutrients elements sampled than that of *V. paradoxa* helping us to easily infer that the leaf litter of *P.biglobosa* is more nutritious and help in improving the soil than that of *V. paradoxa* except in phosphorus.

In conclusion, the importance of the presence of economic trees on the university research farm cannot be over emphasized. Aside providing a steady source of nitrogen and other essential nutrients for the farmland and aiding in soil nutrient recycling, they also help in militating against erosion, improving soil fertility and aiding agricultural productivity in general.

More research findings should be done on the other macro and micro nutrients contributed by the trees for the improvement of the soil for increased agricultural productivity and reduced environmental degradation.

REFERENCE

Abdullahi IN, Chuwang PZ, Isah AD (2012). Effect of biofertilizer on the growth of Vitellaria paradoxa seedlings. Journal of Research in Environmental Science and Toxicology, 1(11): 294-297

Bakker MA, Carreno-Rocabado G, Porter L (2010). Leaf economics traits. functional ecology, 25: 473-483.

Chaplin FS, Kedrowski RA (1983).Seasonal changes in nitrogen and phosphorus fractions in evergreen and deciduous trees. Ecology, 64: 376-391.

Fernandez J, Moya S (2012). Nutrient accumulation and export in teak plantations in central America. Longman publishers.

GenStat Release 10.3DE (Windows 7) VSN International Ltd. (Rothamsted Experimental Station). Hertfordshire, UK.

Hopkins HC (2005). The taxonomy, reproductive biology and economic potential of *Parkia biglobosa* in Africa and Madagascar. Botanical journal of the linnean society. 1: 135-167.

Jackson ML (2003). Soil chemical Analysis. Prentice Hall of India pvt, limited., New Delhi, Pg 498.

Pearl K, Akromah R, Ewool MB, Kena AW, Owusu-Adjei E, Tuffour HO (2014). Assessment of the Relative Yielding Abilities and Stability of Maize (Zea mays L) Genotypes under Different Levels of Nitrogen Fertilization across Two Agro-Ecological Zones in Ghana. International Journal of Scientific Research in Agricultural Sciences, 1(7): 128-141, 2014

Llodhiyal LS, Llodhiyal N (1994). Nutrient Cycling and nutrient use. Oxford press, London.

Martinez AJ, Gomes HE (2005). Tree protection in the Amazon. Chula printing press, Brazil.

Sharma B, Sharma K (2013). Nutrient accumulation in various Plant parts. Academic Journal of Biological Sciences, 2: 46-100.

Karwariya S, Singh RP, Prasad AR, Kumar DA (2014). Extraction of Crop Residue Burnt Field and its Impact on Soil Fertility. International Journal of Scientific Research in Agricultural Sciences, 1(8): 156-164.

Uyovbisere O, Elemo KO (2002). Effect of tree foliage on P*arkia biglobosa* and *Azadirachta indica* on soil fertility and productivity of maize in a savanna alfisol. Nutrient cycling in Agroecosystems, 62: 115-122.

Peterson M (2002). Nutrient accumulation in coniferous trees. Maple publishers, Alaska.

Xi-Hua H, Jian-Jun H, En-Rong Y (2003). Leaf litter decomposition of common trees in *Tiantongwang*. Shanghai press.

Zeigler A (2008). Seawater concentrate for abundant Agriculture. Iowa publishers.

ABDULLAHI, Ibrahim Ndaginna is a young Lecturer at the Crop Science Department, University of Abuja, Nigeria. He obtained his first degree in Forestry from Usmanu Danfodiyo University, Sokoto, Nigeria in 2006 and his Master's degree from Forest Resources Management Department, University of Ibadan, Nigeria in 2011 and currently a PhD candidate of the University. His recent research focuses on conventional and micro propagation of indigenous tropical tree species in Sub-Saharan Africa and Agroforestry practices in the region.

CHUWANG Pam (Ph.D) is a Senior Lecturer of Agronomy at the Department of Crop Science, University of Abuja, Nigeria. He attended Ahmadu Bello University, Zaria where he obtained all his postgraduate degrees. His research focuses on Agronomy and Farming systems especially of tropical tuber crops.

ANJORIN, Samuel Toba (Ph.D) is also a Senior Lecturer at Department of Crop Science, University of Abuja, Nigeria. He had his postgraduate training at the Federal University of Technology, Minna, Nigeria. His research focuses on Mycology, Plant pathology and Tree Crop protection.

IKEMEFUNA, Hector graduated recently from the Department of Crop Science, University of Abuja. He has worked on the propagation of tropical tree crops on farms in Abuja, Nigeria.