Influence of Season and Leaf Development on Foliar Nutrient Elements Compositions of *Parkia biglobosa* (Jacq) R. Br. Ex G. Don in Sudano - Sahelian Ecosystem of Nigeria

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Abstract: Young, matured and mixed leaves samples randomly collected from the wild stands of *Parkia biglobosa* tree species at the Dundaye district area of Wamakko Local Government of Sokoto state were analyzed for mineral compositions as influenced by seasons and leaf development (age of leaf). Analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) were used at 5% to analyze the data and separate the means. Results showed that leaf developments (age), rainy and dry subseasons were found to influence mineral elements concentrations with few exceptions. Specifically, P (0.27 – 8.20ppm), K (138.73 – 6.01.10ppm), Ca (1.55-417.49ppm), Mg (1.29 – 145.02ppm), Mn (0.75-1.87ppm), Fe (1.64 – 7.68ppm), Zn (0.09 – 2.35ppm) and Cl_2 (0.47 – 0.50ppm) were influenced by season in the leaves of the tree; while young leaves significantly contained higher Cu (0.45-0.95ppm), Fe (3.35-6.48ppm) and Cl_2 (0.56-0.86ppm) mineral elements than both matured and mixed leaves samples of the tree. Therefore, for better supply of the mineral elements studied, young leaves of the tree were highly recommended than the other leaf samples studied during rainy subseasons or dry subseasons based on specific major findings of this research to the users.

Keywords: Season, Leaf Development, Foliar Nutrient, Element Composition, Sudano-Sahelian Ecosystem

INTRODUCTION

The North-Western Nigeria is ecologically recognized as Sudano-Sahelian ecosystem characteristically known to be rich in biological resources of flora and fauna, *Parkia biglobosa* inclusive. *Parkia biglobosa* (Jacq. Benth.) R. Br. Ex G. Don. Synonym: *Parkia clappertoniana* (used by Keay) is a tree that belongs to the family mimosaceae. The plant is known mostly by its Hausa vernacular name as Dorowa in the zone. It is a deciduous tree growing up to 20m in height with spreading branches and often a buttressed trunk. Pinnae 6 –11 pairs, leaflets glabrous, 14-30 pairs, oblong, the middle ones larger. The branches are cut for making pestle and mortar (Ghazanfar, 1989). This and other plants are known to be subjected for various uses ranging from medicinal to nutritional in nowadays. The seeds are used in preparing seasoning (Daddawa in Hausa) utilize in soup making. The leaves are cooked for medicinal uses and the concoction as well. They are also used as fodder consumed by animals and the stalks as firewood. The wood is equally used for making agricultural and kitchen utensils for man's use. Also, the leaves, and the stalks or wood are used as litter for enriching poor soils with nutrients and the thorny branches for fencing agricultural lands and stalks. Umar (2007) had reported that almost every part of any plant (root, stem, leaves, bark, flower, fruits and seeds) is known to have some uses.

The savanna or sudano-sahelian areas of Nigeria are characterized by low but torrential rainfall, high evapotranspiration and strong winds. The region is further characterized by vegetation dominated by grasses with varying densities of scattered trees and annual herbs. This region is thus faced with extinction of the available indigenous trees whose leaves could supplement the nutritional requirements of both the poor soils and the animals in the region without their nutrient elements composition investigated (African Locust Bean Tree inclusive). Leaves of plants are known to support human and animals life in various ways. Green leaves are the major world largest source of food and principally protein (Umar, 2007). Hassan *et al*, (2002) have reported the following values with respect to mineral compositions of *C. occidentalis* leaves: Ca - 0.68mg, Fe – 0.15mg, Magnesium – 0.58mg, K – 2.25mg, P – 0.25mg, Na – 0.50mg and Zn – 0.05mg. They further stated that of all the fourteen (14) elements known as essential, the seven (7) determined elements in the study are the most important and the values obtained were within the ranges of their daily allowance and in conformity with findings of other similar plants of similar habitat in Sokoto and Northern Nigeria.

Umar (2007) and Gent (2002) had reported that differences in nutrient compositions found in plant species are due to changes in plants caused by some factors e.g. light ,temperature, season, time of day, climate, genetic factors, edaphic factors, type and level of utilization, management and stage of growth of the leaf or plant, crown of the tree, tree age, position of leaves in the crown, habitat of the plant, age of foliage, natural between tree or plant variation and effect of diseases. Gent (2002) had also noted that differences among plant species on leaf nutrient composition possibly suggest that some other environmentally sensitive processes within the plant were responsible for the differences in leaf nutrient concentration. Similarly, George *et al*, (2002) had reported that leaf concentrations of Ca, Mg, Mn and B generally increased and N, P, Cu, and Zn decreased with leaf age. They added that movement of the more mobile elements (i.e. N, P. K, Cu and Zn) from the older into the young leaves was more rapid when trees were flushing compared with trees that had completed flushing. Irrespective of the state of flushing, higher concentrations of the less mobile elements – Mg, Ca, B and Mn were recorded in the older (matured) leaves compared with the younger leaves, indicating that their movement in to younger leaves is relatively slow.

Umar (2007) has also remarked that, the nutrients value of forage plant is individually and collectively affected by various factors and varies from time to time and location to location. Similarly, Osonubi and Chukwuka (1999) have commented that analysis of plant parts have revealed the presence of a large number of mineral elements but the amount and number of elements present in many also differ from plant to plant and from place to place depending on the habitat and season. In the same vein, Sina and Traore (2002) had noted that browse plants are good sources of forage during the dry season and good enough for survival but despite their relatively good protein content their quality is usually not sufficient for optimum productivity.

Gent (2002) had reported that plant species differed in elemental composition due to seasonal variation. Seasonal nutrient variation is related to changes in light and temperature that affect metabolism in leaves and roots, and the rate of chemical transformations of nutrients in soil. Also variation of day to night temperature, may exaggerate seasonal variation in nutrient concentration in the leaves of plants. Similarly, Ajakaiye *et al*, (1995) working on the effect of leaf position /age on the foliar nutrient concentration of cabbage and lettuce, had reported that the plant species showed preference for certain ions over others, that a cat ion of higher preference could replace one of the lower preference in plant cells, and that many of the macro-elements are more directly involved in physiologically mature tissue than in younger ones. In such tissues they took part in chlorophyll synthesis (e.g. Mg and N), stomata opening and solute accumulation (e.g. K) and cell wall formation (e.g. Ca).

It is believed that the knowledge of the nutrient composition of plants helps to make choosy the different variety of foods or feeds to be consumed by an organism or to be utilizing as source of organic manure to the soil by farmers. Literature search revealed that there are lots to be done on the study of nutrient elements of the indigenous tree species of Savanna. Umar (2007) reported that there is little literature on the indigenous species despite their adaptability and multipurpose nature in the semi-arid environment of Sokoto State. Muhammad (2001) reported that much still need to be done especially on the establishment, management, biology, productivity and seasonal variation in the nutritive values of browses in Nigeria. However, the different variety of parts of plant contained varying amounts of food of different nutritional values. Therefore, research into the food value of plant parts not to talk up leaves of *Parkia biglobosa* need special emphasis to reveal the potentialities of those parts for economic development. The study was important as it provide the quantitative data on nutrient levels that are of most significant to the nutritional requirement of the humans, micro-livestock and other wildlife especially herbivores e.g. deer, grass cutters, elephant, etc. It was also significant to the dietary needs of carnivores which depend on herbivores for the supply of their nutritional needs. The results were relevant in the areas of animal production and savanna soils fertilization via fresh and dry leaves. The research became imperative for more meaningful quantification of its nutritional potentials in the area.

The general objective of the study is to determine the minerals composition of young, matured and mixed leaves of *P. biglobosa* as influenced by season and stage of leaf development in Sudano – Sahelian ecosystem of Nigeria. The study was limited to the determination of phosphorus, Potassium, Calcium, Magnesium, Manganese, Copper, Iron, Zinc and Chloride contents of the leaves of the tree species and hence the need for its conservation. The findings may serve as an insight to the realization of the nutritional values of the leaves of the plant under study and other related species from similar habitat and hence for their conservation. The research output may serve as a baseline data for all similar subsequent researches.

METHODOLOGY

The study area is Dundaye district of Wamakko Local Government area of Sokoto State, where samples were collected from the standing scattered stands of the study species. The Tree from which samples were collected for this study is *Parkia biglobosa* (African Locust Bean Tree in English and Dorowa in Hausa) with the following sample treatments: Young leaves of the tree during early and late dry and rainy subseasons; Matured leaves of the tree during early and late dry and rainy subseasons; Mixed leaves of the tree during early and late dry and rainy subseasons.

Parameters investigated in each of the above sample treatments are nine (9) and they include: Phosphorus By calorimetric measurement method as described by Thakur and Dwivedi (2015), Potassium By flame photometry method as described by Bagel

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(2015); Calcium and Magnesium By versenate titration method (EDTA Titration method) as described by Udo and Ogunwale (1986); Manganese, copper, iron, zinc; and Chloride by spectrophotometery method as described by Sharma (2015) and Association of Official Analytical Chemists (1990). Two days were used to collect sample for all treatments of the plant under study. The duration for this research is one year. The research was conducted according to the seasons as follows: Early Dry Season: November- January; Late Dry Season: February- April; Early Rainy Season: May- July; Late Rainy Season: August- October.

Data generated based on the information obtained in the laboratory work or chemical analysis was analysed statistically using SAS computer system using ANOVA and DMRT statistical tools.

RESULTS

The result of mineral compositions of *P. biglobosa* obtained in this study across the subseasons and stages of leaf development are as follows:

Table 1: Influence of Season and Leaf Development (Age) on Mineral Composition in the leaves of *P. biglobosa*

Treatment	Composition (PPM)			
	P	**K**	**Ca**	**Mg**
Subseasons:				
Early Dry	0.46^{b}	138.73^{b}	351.79^{a}	67.88^{b}
Late Dry	0.27^{b}	601.10^{a}	1.55^{c}	1.29^{c}
Early Rainy	8.20^{a}	223.96^{b}	191.09^{b}	145.02^{a}
Late Rainy	6.96^{a}	240.96^{b}	417.49^{a}	98.93^{b}
S.E	1.42	57.40	36.91	15.64
Significance	S	S	S	S
Age:				
Young	4.19	304.49	247.89	79.55
Matured	3.72	263.95	251.63	80.21
Mixed	4.01	335.13	221.91	75.08
S.E.	1.23	49.71	31.96	13.55
Significance	NS	NS	NS	NS

Within a treatment group, means in a column with the same letter(s) in superscript are not significantly different using Duncan's multiple range test (DMRT) at 5% level.
S = Significant; NS = Nonsignificant; S. E = Standard Error; PPM = Part per million

Table 2: Influence of Season and Leaf Development (Age) on Mineral Composition in the leaves of *P. biglobosa*

Treatment	Composition (PPM)				
	Mn	**Cu**	**Fe**	**Zn**	**Cl_2**
Subseasons:					
Early Dry	1.61^{b}	0.50	3.94^{b}	0.11^{b}	0.50
Late Dry	0.75^{c}	0.44	1.64^{c}	0.09^{b}	0.81^{b}
Early Rainy	1.79^{ab}	0.96	7.68^{a}	0.17^{b}	0.94^{a}
Late Rainy	1.87^{a}	0.64	5.24^{b}	2.35^{a}	0.47^{c}
S.E	0.08	0.08	0.56	0.33	0.04
Significance	S	NS	S	S	S
Age:					
Young	1.68	0.95^{a}	6.48^{a}	1.11	0.86^{a}
Matured	1.35	0.51^{b}	4.05^{b}	0.52	0.62^{b}
Mixed	1.44	0.45^{b}	3.35^{b}	0.42	0.56^{b}
S.E.	0.07	0.07	0.49	0.28	0.03
Significance	NS	S	S	NS	S

Within a treatment group, means in a column with the same letter(s) in superscript are not significantly different using Duncan's multiple range test (DMRT) at 5% level.

S = Significant; NS = Nonsignificant; S. E = Standard Error; PPM = Part per million

From the results of the foregoing Table 1 above, it was generally observed that season and leaf development (age of leaves) have influenced the concentrations of some nutrient elements studied in the tree leaves. Specifically, P, K, Ca, Mg, Mn, Fe, Zn and Cl_2 were influenced by season in the leaves of the tree. Young leaves significantly contained, Cu, Fe and Cl_2 elements than both matured and mixed leaves samples of the tree.

DISCUSSION

The phosphorus concentrations generally observed to be significant in the leaves of the tree (*P. biglobosa*) for the effect of season with the concentration of rainy sub-seasons being higher than in the dry sub-seasons but the rainy and dry sub-seasons concentrations were not statistically different (Table 1) had agreed with an observation of Gent (2002) that differences in leaf nutrient concentration due to season often occurred in early rainfall and it could be related to high availability of this nutrient in the root zone of the soil during the rainy season. This finding indicated that phosphorus concentration is more in the rainy than in the dry sub-seasons of the year in the leaves of *P. biglobosa.* Effect of leaf development (age of leaves) did not show any significant effect on the content of phosphorus in the leaves of the tree (Table 1).

The potassium concentrations between the seasons were only significant in dry sub-season than all the other sub-seasons which were statistically the same (Table 1). This result was observed to decrease steadily from the late dry through the rainy sub-seasons to early dry sub-season. This finding was in close agreement with the result of George *et al.* (2002), who reported that nutrient showed a general decline in concentration in leaves with time, notably potassium and phosphorus concentrations. . Effect of leaf development (age) did not show any significant effect on the concentration of potassium in the tree (Table 1).
The observation that calcium concentration between the seasons in the leaves of the tree were significantly higher during the late rainy and early dry sub-seasons than during the early rainy sub-season, and late dry sub-seasons (Table 1) had agreed with report of Gent (2002) that differences in leaf nutrient concentrations often occurred in a particular species and at a particular time of the year, such occurrences were true for concentrations of N and Ca. This observation is evidently in consonance with this finding from the pattern of the results. Similar observation was made by George *et al.* (2002) that seasonal patterns of leaf nutrient concentrations as influenced by season and leaf position showed an overall increase in concentration of Ca and Mg (Ca, 0.4 – 1.4% and Mg, 0.3 – 0.54%) in the leaves of *Annona spp.* with time. Also, Gent (2002) had reported that plant species differed in elemental composition due to seasonal variation and this could be related to changes in light and temperature that affect metabolism in leaves and roots, and the rate of chemical transformations of nutrients in the soil. Also, variation of day to night temperature, may exaggerate seasonal variation in nutrient concentration in the leaves of plants. Effect of leaf development (age of the leaves) showed non-significant effect in the content of calcium in the leaves of the tree (Table 1).

The concentrations of magnesium between the seasons in the leaves of the tree observed to be significantly higher in the early rainy sub-season than late rainy and early dry sub-seasons, but the latter were significantly higher than that of the late dry sub-season (Table 1) had agreed with the finding of Gent (2002) that differences in leaf nutrient concentrations due to season often occurred in early rainfall. Similar observation was made by Turner and Barkus (2002), who reported that season was important for magnesium than all the other less mobile nutrients. This observation indicated that the leaves of this tree contained more of magnesium during the early rainy sub-season than in the other sub-seasons during the period of study. Effect of leaf development (age) did not show any significant effect on the content of magnesium in the leaves of the tree studied (Table 1).

Manganese concentration was generally observed to be significant in *P. biglobosa* leaves for the effect of season and the concentrations were significantly higher during the rainy sub-seasons than in the dry sub-seasons but the concentrations of the former two sub-seasons were not statistically different (Table 2). This observation had agreed with the observation of Gent (2002) who reported that differences in leaf nutrient concentration due to season often occurred in early rainfall and it could be related to high availability of this element in the root zone of the soil during that time of year. Effect of leaf development (age of the leaves) did not show any significant effect on the content of manganese in the leaves of the tree (Table 2).

The concentration of Copper was generally not significant between the seasons in the leaves of the tree for the effect of season and the concentration was numerically higher during the early rainy sub-season than all the other sub-seasons (Table 2). This finding had agreed with report of Gent (2002) that differences in leaf nutrient concentration due to season often occurred in early rainfall. George *et al.* (2002) noted that in *Annona spp.* nutrients showed overall increase with time. In this case, there was an increase in the concentration of this element from early rainy to late rainy through the dry sub-seasons. This observation may be accounted for by the influence of rainfall, its absence during the dry sub-seasons or change in temperature and availability of this element at the root zone of the soil as also noted by Umar (2007), and Umar (2015). Effect of leaf development (age of the leaves) show significant effect on the content of copper in the leaves of *P. biglobosa* and the concentration was significantly higher in the young leaves than the matured and mixed leaves, which were statistically the same (Table 2). Similar observation was made by Ajakaiye *et al.* (1995). This finding could be attributed to the need of this nutrient to the younger tissues of the tree than in the other treatments due to its significance in many of the metabolic activities associated with younger actively growing tissues.

Iron concentration observed to be significantly different between the seasons in the leaves of the tree and the concentrations were significantly higher during the early rainy sub-season than all the other seasons (Table 2). This finding had agreed with the report of Gent (2002) that differences in leaf nutrient concentration due to season often occurred in early rainfall. This could also be related to a high availability of iron (Fe) in the root medium of the tree. This finding indicated that early rainy sub-season favours high concentration of iron in the leaves of this tree than all the other sub-seasons. Effect of leaf development (age of the leaves) show significant effect on the content of iron in *P. biglobosa* and the concentration was statistically higher in the young leaves than the matured and mixed leaves, but the later two were statistically not different (Table 2). Similar observation was noted by Ajakaiye *et al.* (1995) working on cabbage and lettuce, and this observation could be attributed to the need of this element in the younger tissues of the tree than in the other treatments due to its significance in many of the metabolic activities associated with younger actively growing tissues.

Zinc concentration was significantly different between the seasons in the leaves of the tree and the content was significantly higher during the late rainy sub-season than all the other sub-seasons (Table 2). This finding indicated that leaves of this tree were richer in zinc concentration during the late rainy sub-season than all the other sub-seasons. This observation had agreed with report of Umar (2007) that nutrient composition of forages varies from time to time and could be attributed to genetic factors, climatic, edaphic and stage of growth of the forages. Effect of leaf development (age of the leaves) did not show any significant effect on Zinc concentration for the leaves of the species (Table 2). This indicated that the leaves or treatments were richer in concentration of this element and the result may be attributed to the significance of this element to the metabolic processes going on within the leaves of the tree hence zinc is essential for the transformation of carbohydrates, regulates consumption of sugars and is part of enzyme systems which regulate plant growth. It deficiency leads to chlorosis, mottle leaf and little leaf production by trees.

The observation that chloride concentration was significant between the seasons in the leaves of the tree and the concentration was higher during the early rainy sub-season than in the late rainy and early dry sub-seasons (Table 2) had agreed with the finding of Gent (2002) that differences in leaf nutrient concentration due to season often occurred in early rainfall and the result could be related to the influence of other factor than season, that influence nutrient concentration. *P. biglobosa* had been reported that it is moisture requiring plant species (Sina and Traore, 2002). Effect of leaf development (age of the leaves) show significant effect on chloride content in the leaves of *P. biglobosa* and the concentration was statistically higher in the young leaves than in the matured and mixed leaves and the latter two were statistically the same (Table 2). Similar observation was noted by Ajakaiye *et al.* (1995) working on nutrient concentration in the leaves of *Brassica oleracea* and *Lactuca sativa,* and this observation could be attributed to the need of this element in the younger tissues of the tree than in the other leaves or treatments due to it's significance in many of the metabolic activities associated with younger actively growing tissues.

To augment the gains of this research on nutrients elements concentrations, the leaves of *P. biglobosa* were recommended for better supply of P, Mg, Mn, Fe, Zn and Cl_2 during rainy subseasons but K and Ca, during dry subseasons. Young leaves were similarly recommended for the supply of Cu, Fe and Cl_2 as well as matured and mixed leaves for the supply of them than all other elements investigated. For general recommendations, young leaves were recommended during rainy subseasons for the specified elements than matured and mixed leaves during dry subseasons to the users from the humans, livestock and wildlife. Similar research should be conducted on interaction effects of season and leaf development (age of leaves) on this tree as well as similar research on other indigenous trees to bring out their nutritional potentials and full utilization in the zone and hence for their conservation.

CONCLUSION

The nutritional values of the leaves of the tree examined in this study revealed that elements were variously influenced by rainy and dry subseasons with few exceptions. The concentrations were mostly and favourably higher during the early followed by late rainy, early dry and late dry subseasons. Young leaves samples of the tree studied stand to be the best particularly as they contained high concentration of these essential elements than the other leaf samples studied. Season and leaf development (age of leaves) were two independents factors affecting the process of tree growth and development that has affected the concentration of elements studied.

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References

[1] N. M, Abel, N. Hunter, Chandler, G. Maka *Cattle Keeping, Ecological Change and Communal Management in Ngwaketse,* Addis Abba. IICA; (1987). 200p.

[2] T. A Adegbola, "Browse Plants: Propagation, Management and Utilization" In: Adu, I. F., Osinowo, B., Taiwo, B. A. and W. S. Alhassan (eds): *Proceedings of National Conference on Small Ruminant Production in Nigeria, N.A.P.R.I* Shika, Zaria, Kaduna, 1985, Pp 95 – 99.

[3] C. O. Ajakaiye, S. P. Bako, and J. B. Abun "Concentrations of Macro and Micro-nutrients in the Leaves of Cabbage (*Brassia oleracea var. capitata)* and Lettuce (*Lactuca sativa)* in Relation to Leaf Age". In: *The Nigerian Journal of Botany,* 8(20), 1995, Pp 77 – 81.

[4] *Association of Official Analytical Chemists*; 15th Edition. A.O.A.C. Inc Publishers. 1990, Pp. 241 – 248.

[5] S. S. Bagel, (2015). "Flame Photometery Method" in; *Laboratory Manual on Soil and Plant Analysis*: Dwivedi, B. S., Sharma, G. D., Almule, F. C., Tagore, G. S., Dwivedi, A. K., and Mitra N. G. (eds) National Training on climate Resilient Soil Management Strategies for Sustainable Agriculture. Pp. 20-21.

[6] Crowder, L. V. and H. L, Chhleda, *Tropical Grassland Husbandary,* New York: Longman Inc., 1982, 562 p.

[7] P. N. De Leeuw, "A Review of the Ecology an Fodder Resources of the Sub-humid zone," NAPRI *Symposium on Livestock Production in Subhumid Zone of West Africa,* No. 32, Kaduna state, (1979).

[8] J. Evans, *Plantation Forestry in the Tropics.* New York: Oxford University Press, 1982, 350pp.

[9] M. P. N, Gent, "Nutrient Composition of Salad Greens as a Function of Season and Fertilization". In: *Plant Nutrition.* New Harven, CT. 25, 2002, Pp. 981 – 998.

[10] A. P. George, R. J. Nissen, and M. L. Carseldine "Effect of Season (Vegetable Flushing) and Leaf Position on the Leaf Nutrient Composition of *Annona spp.* Hybid C. V. Pink's Mommoh in South – Eastern Queensland", IN: *Plant Nutrition.* New Harven, C. T. 25, 2002, Pp. 780 – 785.

[11] Ghazanfar, *Savanna Plans: An Illustrated Guide,* 1st published. Hong Kong: Macmillan Publishers Limited. 1989, 227pp.

[12] L. G. Hassan, N. A. Sani, and Faruq, "Nutrient Composition of *Cassia occidentalis* (L) Leaves", *Journal of Agriculture and Environment.* 3(2), 2002, Pp. 399-403.

[13] K. Y. Muhammad, *Response of Adansonia digitata and Parkia biglobosa to Nitrogen and Phosphate Application in a Semi-Arid Environment.* An M.Sc. research proposal paper presented at Faculty of Agriculture conference room, Usmanu Danfodiyo University, Sokoto, 2001, Pp. 5.

[14] O. Osonubi, and K. S. Chukwuka, *Basic Principles of Botany.* 1st Edition. Nigeria: Nerves Inc. in Association with the Authors, 1999,Pp 36 – 51.

[15] V.N. Pandey, "Leaf Protein Content and Yield of Some Indian Legumes". In: *Plant Foods for Human Nutrition* 46C. Nether lands; Kluwer Academic publishers, 1994, Pp. 313-322.

[16] G. D. Sharma, "Atomic Absorption Spectrophotometery Method" in; *Laboratory Manual on Soil and Plant Analysis*: Dwivedi, B. S., Sharma, G. D., Almule, F. C., Tagore, G. S., Dwivedi, A. K., and Mitra N. G. (eds) National Training on climate Resilient Soil Management Strategies for Sustainable Agriculture, 2015, Pp. 22-24.

[17] S. Sina, and S. A. Traore *Parkia biglobosa* (jacq.) R. Br. Ex G. Don. In: Oyen, L. P. A., M. J. Lemmens, S. D. Davis, M. Chauvet, and J. S. Simonsma (eds). *Plant Resources of Tropical Africa; PROCURSOR.* Wageningen, the Netherlands: PROTA Programme, 2002, Pp. 111-115.

[18] R. K. Thakur, and B. S. Dwidevi, "Colorimetric Measurement Method" in; *Laboratory Manual on Soil and Plant Analysis*: Dwivedi, B. S., Sharma, G. D., Almule, F. C., Tagore, G. S., Dwivedi, A. K., and Mitra N. G. (eds) National Training on climate Resilient Soil Management Strategies for Sustainable Agriculture, 2015, Pp.18-19.

[19] D. W. Turner, and B. Barkus "The Effect of Season, Stage of Plant Growth and leaf Position on Nutrient Concentration in Banana Leaves on a Krasnozen in New South Wales". In: *Plant Nutrition,* New Harven, CT. 25, 2002, Pp.786 – 792.

[20] E. J.Udo, and J. A. Ogunwale, *Laboratory Manual for the Analysis of Soil, Plants and Water Samples.* 2nd Edition. London: Macmillan Publisher, 1986, Pp. 67-137.

[21] T. Umar, *Nutrient Levels in the Leaves of Four Indigenous Trees in Sudan Savanna of North– Western, Nigeria.* An M.Sc. Dissertation Submitted to the Department of Forestry and Fisheries, U.D. U.S. (Unpublished). 2007, 121Pp.

[22] T. Umar, *Variations in Growth, Yield and Nutrient Composition of Senna occidentalis (L) and S. obtusifolia (L) in Fadama and Upland Microhabitats in Sokoto, Nigeria*. Ph.D Thesis Report Submitted to Post-Graduate School, Biological Sciences Dept, UDU, Sokoto, Nigeria, 2015.

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