Variation in the Quantities of three Macro-Nutrients (N:P:K) in the Leaf Prunings of three Indigenous Agroforestry tree Species

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Abstract: A study was conducted at the University of Uyo, Forestry Arboretum to assess the quantities of three macro-nutrients (N, P, K) in the leaf prunings of three agroforestry tree species of Anthonata macrophylla, Dactyladenia barteri and Lonchocarpus griffonianus. The tree species were of two age series of three and six years. Results obtained revealed that nutrient elements' contents in the three year age series were: Anthonatha macrophylla (N: 1.61%, P: 0.20% and K: 0.90%), Dactyladenia barteri (N: 1.47%, P: 0.26% and K: 0.08%), and Lonchocarpus griffonianus (N: 4.69%, P: 0.22% and K: 0.80%), while in the six year age series it was: A. macrophylla (N: 1.12%, P: 0.22% and K: 0.70%), D. barteri (N: 1.75%, P: 0.24% and K: 0.05%) and L. griffonianus (N: 3.36%, P: 0.24% and K: 0.06%). This suggests that these agroforestry trees can be used intercropped with arable crops and the prunings used by farmers to improve soil fertility for sustainable soil fertility management.
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Key Words: Agroforestry Trees, Leaf Prunings, Nitrogen, Phosphorus and Potassium.

1.0 Introduction

Land is one of the limiting factors to increase food production in Nigeria. With a relatively high population of 140,000,000, a farming system which would ensure a corresponding increase in food, wood and livestock production is highly desirable. The limited land area has posed a threat to such orthodox farming methods as bush fallow and shifting cultivation, which could have been of some help in maintaining and enhancing the fertility and stability of soil. The adoption and intensification of agroforestry system of farming may be the only substitute in raising the agricultural production in the country, replenishing of soil nutrients and checking the desertification threats especially in the northern parts of the country (Glover, 1989).

In many developing countries, sustained and high population growth rates, combined with limited and rapidly diminishing land for food and forage production, have created a need to intensify agroforestry production in order to bridge the gap between requirement and supply of food and ensure proper human nutrition (Smith and Van Hourtet, 1997). Leguminous trees and shrubs have been identified to be multipurpose values (food, fibre, fodder, timber, wood, nitrogen fixation, nutrient cycling and live fences) across all of the agro-ecological zones of Africa (Smith and Van Hourtet, 1997).

Anthonotha macrophylla, Lonchocarpus griffonianus and Dactyladenia barteri are indigenous multipurpose leguminous tree species which are capable of fixing nitrogen to the soil through its prunings and nodulation process. Nitrogen fixation into the soil is a unique ability of these tree species (Etukudo, 2000). They act as the major sources of organic manure to farmers. This natural ability to fix nitrogen to the soil is due to the possession of root nodules which provide habitat for the nitrogen fixing bacteria. These bacteria, such as Azotobacter and Clostridium, are capable of fixing free nitrogen from the atmosphere into the root nodules of the leguminous species and eventually release into the soil for crop growth (Giller and Wilson, 1999).

Besides nodulation of these multipurpose tree species, the litter also supply diverse quantities of macro and micro-nutrients to the soil such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), molybdenum (Mo), zinc (Zn), and manganese (Mn). These nutrient elements are very essential for the metabolic processes in crops (Nwoboshi 2000). For instance, N is essential for protein synthesis, K is essential for cell membrane formation, while P plays a vital role in photosynthetic activities and the formation of high energy phosphate compounds.

2.0 Materials and Methods

2.1 The study area

This study was conducted in the University of Uyo's Forestry Arboretum, which lies within the tropical rainforest zone of Nigeria on latitude 5.00^0N and longitude 7.00^0E. The rainfall of the area ranges from 1800 to 3200mm per annum. The mean annual temperatures vary between 28.48^0C and 30.13^0C. The soil pH is 6.7. The soil characteristic is generally sandy loam. An area of 0.5ha of the arboretum is used for agroforestry practices, where arable crops like cassava (Manihot spp) are intercropped with leguminous tree species such as Leucaena leucocephala and Gliricidia sepium. The total area of the arboretum is about 2 ha.

2.2 Sample collection

The fresh leaf samples were collected from the two aged series of three and six years stands of Anthonata macrophylla, Dactyladenia barteri and Lonchocarpus griffonianus in the Arboretum. The samples were bagged and labeled separately and taken to the laboratory. They were washed with distilled water without mixing them and oven dried at 80^0C with Stuart-Scientific Oven 252 for 24 hours. After drying, they were ground with a grinder into powdery form and stored properly in glass bottles. The experiment was conducted three times on each of the species and the mean values were obtained.

2.3 Laboratory procedure

Phosphorus and potassium were determined by Flame photometry as outlined by Association of Official Analytical Chemists (1970). Nitrogen content was determined using Kieldahl Markham procedures (Viano et al., 1995).

3.0 Results and Discussion

The percentage nitrogen composition in D. barteri of three years was 1.47% while that of six years was 1.75%; L. griffonianus of three years had 4.69% of nitrogen while that of six years of age had 3.36%; the percentage N content in A. macrophylla was 1.61% at three years and 1.21% at six years of age (Table 1). The percentage phosphorus contents in the leaf prunings of D. bateri under three years and six years of age were 0.26% and 0.24% respectively, while those of L. griffonianus at three and six years of age were 0.22% and 0.24% respectively and Anthonotha macrophylla contained 0.20% at three years while that of six years of age contained 0.22% (Table1). Potassium composition in D. barteri of three years and six years of age were 0.08% and 0.05% respectively. Lonchocarpus griffonianus of three years contained 0.80% of K while that of six years of age contained 0.06% and the percentage content in A. macrophylla was 0.90% at 3 years while that of 6 years of age was 0.70% of K (Table 1).

There was a wide variation in composition of nutrients in the leaf prunings of these indigenous agroforestry tree species. L. griffonianus contained the highest quantity of N in both years while A. macrophylla had the least (1.12%). The highest percentage nitrogen (4.69%) was obtained from L. griffonianus, followed by A. macrophylla (1.61%) and the least (1.47%) was obtained from D. barteri. The three year old stands contained a higher quantity of nitrogen in their leaf prunings than those obtained from the six year old stands. This results confirmed the findings of (A.O.A.C. 1975) that plant samples, especially leguminous species always show a significant increase in N content at tender age than those from the older ages. This implies that nutrient components in plants decrease with age, and this means that leguminous plants release more nutrients to the soil when they are young than when they are old. This suggests that in agroforestry system, soil is greatly enriched when the hedge row prunings are incorporated before six years of age. Dactyladenia barteri contained the highest percentage of phosphorus (0.26%) followed by L. griffonianus with the value of (0.22%), and the least (0.20%) from A. macrophylla in their leaf litter. The results also revealed that the six year old stands contained almost equal percentage of P. Anthonotha macrophylla had the highest percentage of potassium (0.90%) while L. griffonianus contained 0.80%, and the least (0.08%) was obtained from D. barteri. The percentage quantity of potassium in the leaf prunings of three year old trees were higher than those of six years. This finding is in line with that of Viano et al (1995) that plants at tender age have higher nutrient composition than those from old age. This means that for maximum supply of nutrients to the soil for high yield of arable crops, the prunings from these species should be done far below 6 years of age. Anthonotha macrophylla had the highest percentage of potassium (0.70%) per kilogram weight. Those of three years of age contained more quantities of K than those of six years. This again suggests strongly that, prunings of these species should be carried out and incorporated into the soil at the age far below six years in order to ensure high fertility for high productivity of arable crops.

Table 1: Variation in moisture and dry matter contents of leaf prunings of three and six years old stand of Dactyladenia barteri, Lonchocarpus griffonianus and Anthonother macrophylla.

Species	Three years of age		Six years of age	
	Moisture Content (%)	Dry matter content (%)	Moisture content (%)	Dry matter content (%)
Dactyladenia barteri	52.38	47.62	47.63	52.37
Lonchocarpus griffonianus	66.38	33.61	46.78	53.22
Anthonotha macrophylla	52.94	43.06	43.18	56.82

N/B: Values are means for three replicates of six samples from laboratory experimentation.

Table 2: Variation in nutrients (NPK) contents of leaf prunings of three and six years old stands of Dactyladenia barteri, Lonchocarpus griffonianus and Anthonotha macrophylla.

Species	Three years of age			Six years of age		
	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Dactyladenia barteri	1.47	0.26	0.08	1.75	0.24	0.05
Lonchocarpus griffonianus	4.69	0.22	0.80	3.36	0.24	0.06
Anthonotha macrophylla	1.61	0.20	0.90	1.12	0.22	0.70

N/B: Values are means for three replicates of six samples from laboratory experimentation.

Table 3: Physico-Chemical Properties of soils in the immediate environment of three agroforestry plant species

Plot (species)	Soil depth (cm)	pH (ds/m)	EC (ds/m)	Org. matter (%)	Total N (%)	Avail. P (mg/kg)	Ca (cmol/ kg)	Mg (cmol/ kg)	Na (cmol/ kg)	K (cmol/ kg)
Dactyladenia barteri	0-15	5.20	0.03	3.00	0.10	70.99	2.80	1.40	0.06	0.11
Lonchocarpus griffonianus	0-15	5.30	0.06	2.90	0.08	73.99	2.40	1.20	0.05	0.10
Anthonotha macrophylla	0-15	5.20	0.04	3.10	0.11	71.99	2.60	1.30	0.06	0.12

Plot (species)	Soil depth (cm)	E.A. (cmol/ kg)	ECEC (cmol/ kg)	B. Sat. (%)	Sand (%)	Silt (%)	Clay (%)
Dactyladenia barteri	0-15	2.60	6.97	62.69	83.08	4.88	12.04
Lonchocarpus griffonianus	0-15	2.80	6.55	57.25	83.80	5.88	11.04
Anthonotha macrophylla	0-15	2.40	6.48	62.96	81.08	6.88	12.04

Table 4: Variation in Nutrient contents between Exotic and Indigenous species

Exotic leguminous tree specie				Indigenous leguminous tree species			
Species	Nitrogen Content(%)	Phosphorus content(%)	Potassium content(%)	Species	Nitrogen Content(%)	Phosphorus content(%)	Potassium content(%)
Leucaena leucocephala	1.78	0.12	0.55	Dactyladenia barteri	1.61	0.25	0.07
Gliricidia sepium	1.75	0.11	0.52	Lonchocarpus griffonianus	4.03	0.23	0.43
Acacia auriculiformis	1.71	0.09	0.49	Anthonotha macrophylla	1.14	0.21	0.80
N/B: Means are from literature				N/B: Values are means for three replicates of six samples from laboratory experimentation.			

4.0 Conclusion

The indigenous leguminous agroforestry tree species: Anthonotha macrophylla, Lonchocarpus griffonianus and Dactyladenia barteri have great potentials of adding N, P and K to the soil through their prunings. However, in order to achieve the maximum supply of these essential nutrients into the soil to engender high yield of arable crops intercropped with them, the tree species should be pruned far below six years and the prunings incorporated into the soil. It is therefore, recommended that, these leguminous species should be intercropped with arable crops for their prunings to be incorporated to the soil for nutrient availability.

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