Journal of Forestry Research and Management. Vol. 16(1). 57-69; 2019, ISSN 0189-8418

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Macro-nutrient composition and distribution in Teak trees from selected plantations in Ogun state, Southwest Nigeria

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ABSTRACT

Nutrient concentration of growing plants in most cases provides reliable information on their nutritional status, and it also can reflect the current state of nutrient supply and permit conclusion on whether a supplementary nutrient application of fertilizer is required. Since plant rely on nutrients from soil which also developed from different parent materials. This research therefore examined nutrient distribution pattern in different parts of teak stands grown in plantations established under different parent materials. Systematic line transect was employed to establish 36 sample plots of 900m^2 across Ilaro and Olokemeji plantations underlain by sedimentary and basement complex rocks respectively. In each plot, soil samples (topsoil and subsoil) and teak plant parts were collected. Given the destructive nature of total harvesting method, samples of different parts (such as leaf, bark, stem, twig and branch) of the teak trees were randomly harvested from 18 plots. The collected plant parts were used to assess the nutrient content in the plant parts. Also, effects of plantation ages on nutrient contents were determined using years of establishment of the plantations. Descriptive statistics, Analysis of Variance at 0.05 level of probability and correlation analyses were conducted for detecting statistically significant differences in nutrient distribution among the plant parts. The result revealed that at Ilaro there were significant variations in the concentration of sodium and nitrogen in the plant parts, while at Olokemeji all the plant nutrients investigated showed significant variations in concentration and distribution in plant parts. At both Olokemeji and Ilaro plantations, the concentration of plant nutrients was high in leaves and low in the twigs. However, at Ilaro, the distribution of plant nutrients across plant parts was only significant in sodium and nitrogen. Age of teak plant is observed in the present study to have significant effects on the distribution of essential nutrients (such as N, P and K).There is the need for proper management of teak mostly the matured ones.

Keywords: Nutrient content, Teak, plant parts, Teak plantation, Parent material

Introduction

Nutrient concentration in different parts of growing plants provides reliable information on their nutritional status as well as the current state of nutrient supply (Nambiar and Brown, 1997). Plant nutrient analysis generally provides more current plant-based information than soil testing which is very important for the understanding of ecosystem functioning and ecological status as more uptakes and less return to the soil lead to deterioration of land and ultimately lowering of productivity (*Zianis et al., (2005*). According to Maldacho (2016), fast-growing trees have the ability to accumulate high amounts of nutrients in their biomass but may cause nutrient depletion in the soil. The nutrient accumulation in the plant body also varies between different tree parts in space and time. Some plant species shed their foliage in the dry season and release nutrients

Journal of Forestry Research and Management. Vol. 16(1). 57-69; 2019, ISSN 0189-8418
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to the soil surface through mineralization, while some evergreen species keep it in the leaf biomass for a longer period. The nutrient content for various tree species has been quantified by a number of authors (Tiarks *et al.,* 2004; Pretzsch, 2010). It has been reported that nutrient concentrations can be two to three times greater in branches than in stem wood (Alriksson and Eriksson, 1998). Pretzsch (2010) has also calculated that out of 0.9 t/ha N stored within European beech; of this total, 63% are stored in leaves, bark and branch wood (equating to 25 % of total stand biomass). He noted that a further 37 % of stand biomass is held within the merchantable timber fraction (diameter over 7 cm). Furthermore, Pretzsch (2010) estimates that the harvest of the merchantable timber results in the removal of one third of N, P, K, Ca and Mg from the site.

The study conducted on *E. grandis* by Tiarks *et al.,* (2004), showed that the fraction of macronutrients in utilizable stem wood is small as compared to total reserves at the site. The crown and bark are observed to account for the highest proportion of the nutrients that is, about 54% to 82% of the aboveground biomass macronutrient pools. Studies describing nutrient accumulation in tree biomass of tropical plantations, especially those providing information on the amount of nutrient in different plant parts of the above biomass of tree are not easy to come by. Such issues, pertinent to sustainability of forest production, are of particular significance in the humid tropics because the rates of production are high and many tropical soils are of very low fertility (Folster and Khanna 1997). Among nutrient cycling processes, nutrient retranslocation becomes an important component of the cycle as the tree biomass increases over time (Bowen and Nambiar 1984). In order to understand nutrient cycling processes and evaluate site quality changes in a forest ecosystem, it is very important to understand nutrient distribution among different parts of plant biomass. Therefore, this research examined nutrient distribution pattern in different parts of teak tree grown in plantations established under different parent materials.

Materials and methods

Study area

The Olokemeji teak plantation is located in the heart of the Olokemeji Forest Reserve, between latitudes 7°05' and 7°40'N, and longitudes 3°15' and 3°46'E (Figure 1). It occupies a total land area of 58.88 km^2 (approximately 5,000 hectares) (Aminu-Kano and Marguba, 1968). The Ilaro Forest Reserve is defined roughly by latitude 06°38', 51°36N and 06°57', 24°40N and longitude 02°49', 06°12'E and 03°10', 43°60E (Figure 2). Ilaro reserve covers an area of about 34.2km by 39.9km (Kogbe, 1976). The area is located in the humid tropical region of high rainfall and high temperatures, where the wind system divides the year into two seasons: the rains and harmattan seasons. The study area is situated within a region that has long been known for its agricultural activities. This means that the original vegetation typical of the area must have been destroyed to make room for farming activities in the past. Thus, the vegetation type in this area is mainly secondary. But there are remnants of the original vegetation in some places, particularly in the forest plantations in Olokemeji developed to aid conservation. In some parts of the study area, the vegetation is an anthropogenic forest, found only along river courses.

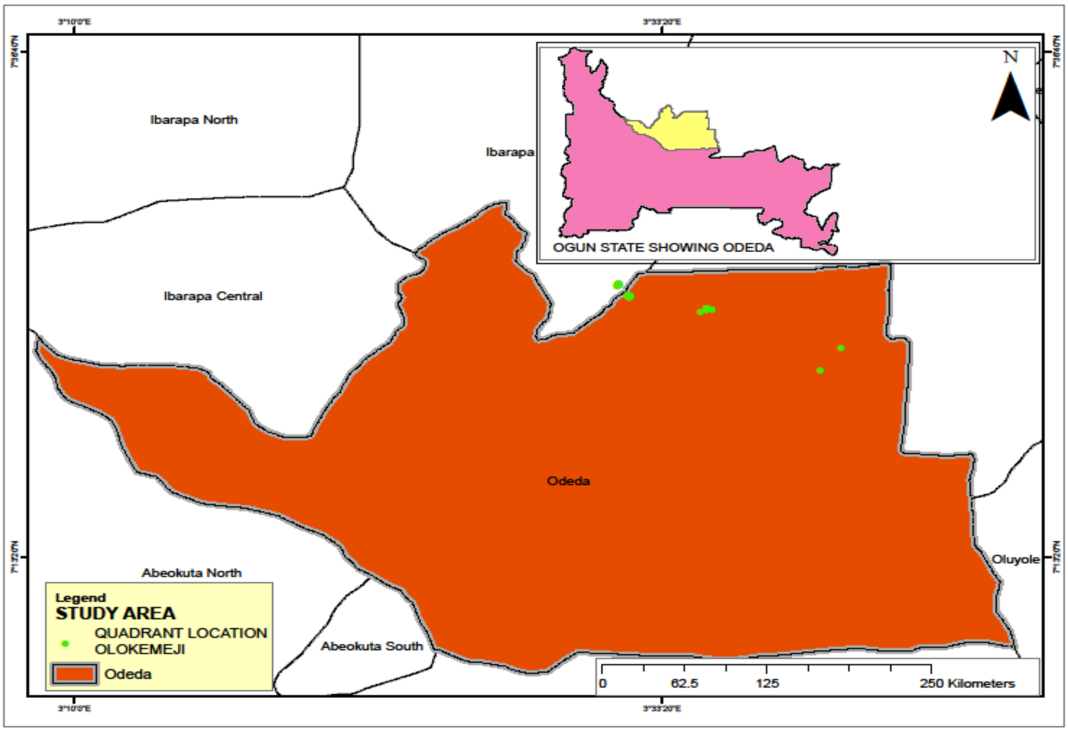

Fig. 1 Odeda LGA showing the study area (Olokemeji).

Journal of Forestry Research and Management. Vol. 16(1). 57-69; 2019, ISSN 0189-8418

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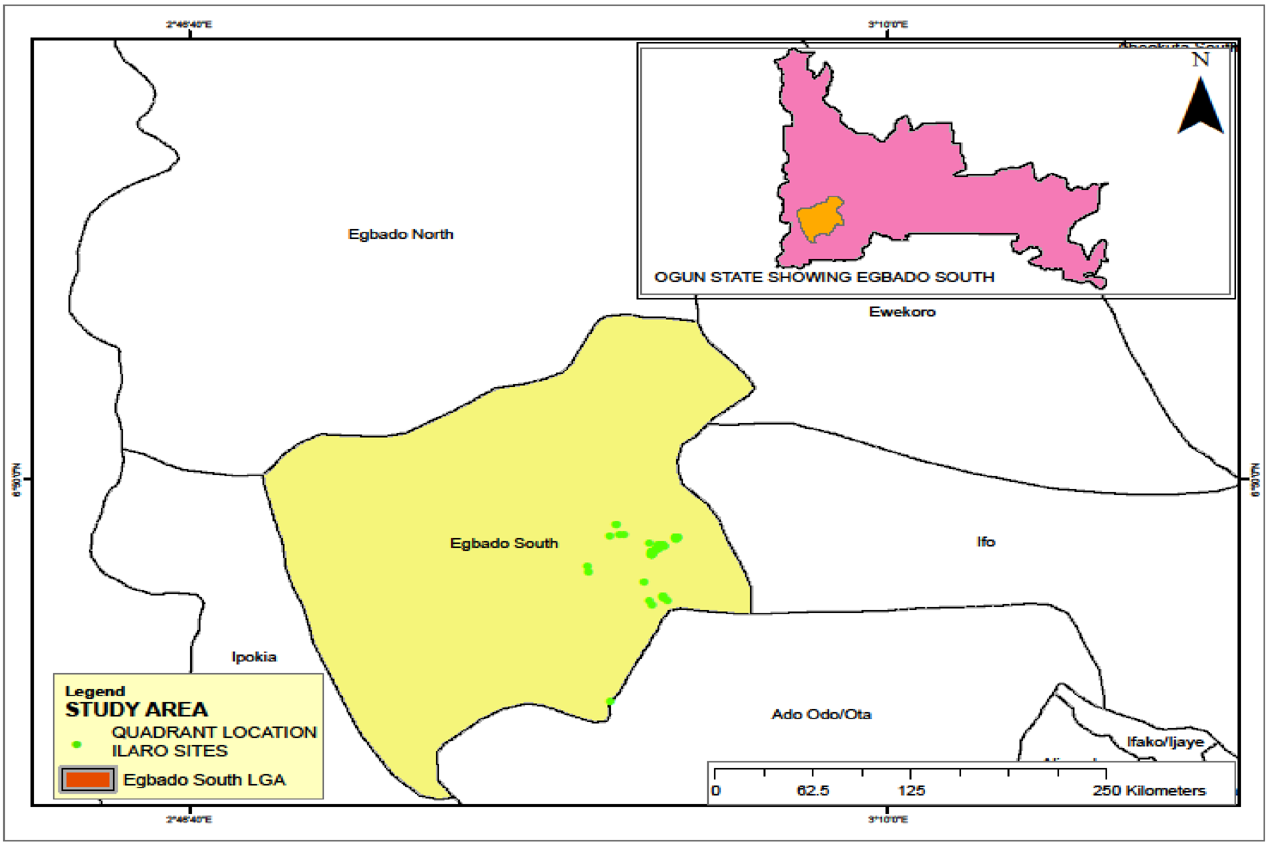

Fig. 2. Yewa South LGA showing the study area (Ilaro).

Data collection procedure

Data on the physical and chemical properties of soils and above-ground teak plant biomass were collected across different ages of teak plantation underlain by different parent materials. According to the forest resources study carried out by Federal Government in 1999, Ilaro forest has eleven (11) teak plantations with a total of 550 hectares. The teak plantations were established in 1970, 1972 and 1975, representing 48, 46 and 43 years. The study employed systematic (line transect) and simple random sampling techniques. Systematic sampling design (systematic line transect) was employed to determine sample plots by establishing plots across the sampled plantations. Three transects of 150m with a distance of 50 meters between them were laid, from which, four sample plots of 30m x 30m in size were laid in alternate directions along each transect at 10m intervals.

Laboratory analysis of nutrients in plant parts

Given the destructive nature of total harvesting method, samples of different parts (such as leaf, bark, stem, twig and branch) of the teak trees were randomly harvested from 18 plots. To examine the storage of nutrients in plant parts under different parent materials, plant component of sampled teak stand such as bark, stem, branch, leave and twig were collected. The collected plant parts were taken to Moor plantation, Ibadan for analysis to assess the nutrient content in the plant parts.

After the required parts had been collected, each part parameter was weighed in the field and sub-samples transported to the laboratory in plastic bags and oven-dried at 70°C to a constant weight. The total oven-dry weight of each component was obtained by applying dry matter content of the sub-samples. Total N was determined by a micro-Kjeldahl procedure. Calcium (C), magnesium (Mg) and potassium (K) were determined by digesting samples in H_2SO_4 and H_2O_2, and analyzing them by atomic absorption spectrophotometer

Statistical analysis

Data collected on various parameters and their elements were organized and subjected to different analyses, based on the objectives of the research and the structure of data collected. Descriptive statistics, such as arithmetic mean, the standard deviation, as well as standard error of mean of each of the indices were applied in order to determine the general characteristics of all parameters and indices. To examine the pattern of nutrient concentration and distribution in the above-ground tree components in teak plantations, the general linear model was applied. This was executed using the GLM of SAS version 9. Under this GLM, different sources of variation, such as the multiple comparison tests, were investigated. The general linear model is often used when the sample groups are not of the same size and when the main aim is to determine if the samples are from the same population or not. It is also used in studying interaction between subject-effects which include such parameters as location, year and soil depth. Levene's test of equality of error variances was employed to check if the samples were coming from the same population or not.

Results

Distribution of plant parts nutrients between in the study area

The result in Table 1 showed that sodium content (Na) was higher at Olokemeji plantation than in Ilaro plantation with mean values of 0.38% and 0.33%, respectively. The mean concentration of potassium (K) on the other hand was higher at Ilaro than in Olokemeji with mean values of 0.87% and 0.76% respectively (Table 1). For calcium (Ca), the mean concentration was higher at Olokemeji than in Ilaro with mean values of 1.03% and 0.91% respectively. The mean concentration of magnesium (Mg) was higher at Ilaro than in Olokemeji, with mean values of 0.44% and 0.14%, respectively. For phosphorous (P), the mean concentration was higher at Olokemeji than in Ilaro, with mean values of 0.88% and 0.34% respectively while for nitrogen (N), the mean concentration of 0.61% was recorded at Olokemeji, as against 0.54% mean value for Ilaro (Table 1).

Journal of Forestry Research and Management. Vol. 16(1). 57-69; 2019, ISSN 0189-8418

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Table 1: Descriptive Statistics of plant Part nutrients in the study area

Nutrient	Location	Mean	Std. Error
Na (%)	Ilaro		
	Olokemeji	0.38	0.015
K (%)	Ilaro	0.87	0.022
	Olokemeji	0.76	0.022
Ca (%)	Ilaro	0.91	0.015
	Olokemeji	1.03	0.015
Mg (%)	Ilaro	0.44	0.047
	Olokemeji	0.14	0.047
P (%)	Ilaro	0.34	0.030
	Olokemeji	0.88	0.030
N (%)	Ilaro	0.54	0.011
	Olokemeji	0.61	0.011

N= Nitrogen; P= Phosphorous K=Potassium; Na=Sodium; Ca=Calcium; Mg= Magnesium

Pattern of plant parts nutrient distributions in teak plantations in the study area

The concentrations of nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) in different plant parts of teak tree are shown in Tables 2. The results revealed the order of magnitude of nutrients in teak parts as follows: twig < branch < bark < stem < leaves. This nutrient pattern cuts across Ilaro and Olokemeji plantations. Results indicated that the mean concentrations of sodium in twigs, leaves, stems, barks and branches at Olokemeji plantation were comparatively higher with mean values of 0.26%, 0.48%, 0.42%, 0.37% and 0.33% than in Ilaro plantation, which has mean values of 0.21%, 0.45%, 0.39%, 0.35% and 0.29% respectively. The proportions of potassium in twigs, leaves, stems, barks and branches were higher in Ilaro plantation with mean values of 0.73%, 0.87%, 0.89%, 0.94% and 0.87% than in Olokemeji plantation with mean values of 0.66%, 0.84%, 0.81%, 0.76% and 0.73% for twigs, leaves, stem, barks and branches respectively (Table 2).

The results also indicated that the mean concentrations of calcium in twigs, leaves, stems and barks with exception of branches were higher at Olokemeji plantation with the mean values of 0.94%, 1.12%, 1.07%, 1.05% and 0.10% compare with that of Ilaro plantation, which had mean values of 0.87%, 1.02%, 0.93%, 0.89% and 0.85% respectively. Also, the concentration of magnesium in twigs, leaves, stems, barks and branches were higher in Ilaro plantation with mean values of 0.53%, 0.66%, 0.37%, 0.34% and 0.31%, than in Olokemeji plantation with mean values of 0.09%, 0.19%, 0.16%, 0.13% and 0.11% respectively (Table 2). The reverse was the case as the proportion of phosphorous in stem parts was higher in Olokemeji than in Ilaro plantation. In addition, for phosphorus the mean concentration of 0.80%, 0.97%, 0.92% 0.87% and 0.84% in twigs, leaves, stems, barks and branches was higher in Olokemeji than in Ilaro, with mean values of 0.19%, 0.30%, 0.43%, 0.40% and 0.36%

(Tables 2). The phosphorous content indicated that barks and stems contained more phosphorus in the Olokemeji plantation, whereas in Ilaro plantation branches, leaves and twigs had high phosphorus content.

Furthermore, for nitrogen, the mean concentration in twigs, leaves, stems, barks and branches at Olokemeji were rather higher than the mean concentration in Ilaro with values of 0.53%, 0.69%, 0.65%, 0.62%, 0.56% and 0.46%, 0.61% 0.58%, 0.53% and 0.49% respectively (Table 2). The pattern for nitrogen as an element revealed that its content was high in teak branches in Olokemeji, while in Ilaro, nitrogen contents were more in teak twigs, leaves, stems and barks. The iron distribution pattern among the plant parts also differed between the two plantations. For instance, barks and stems had more iron content in Olokemeji than in Ilaro. Branches and leaves had higher iron content in Ilaro plantation than in Olokemeji, while twigs had the same iron content in the two locations. The concentration of zinc in barks, branches, stems and twigs were higher in Ilaro plantation compared to those from Olokemeji plantation, with the exception of leaves which zinc content was higher in Olokemeji than Ilaro (Tables 2). The results presented above therefore identify leaves and stems as parts that yield highest nutrients in the two plantations while twigs yields the lowest concentration of nutrients. This implies that nutrient returned to the soil is substantially influenced by the amount of leaves and stems in the soils.

Table 2: Plant nutrients distribution of plant parts in the study area

Nutrients	Parameters	Olokemeji plantation		Ilaro plantation	
		Average	Std Dev	Average	Std Dev
N(%)	Twig	0.46	0.02	0.53	0.01
	Leave	0.61	0.01	0.70	0.02
	Stem	0.58	0.03	0.65	0.03
	Bark	0.53	0.02	0.62	0.02
	Branch	0.49	0.01	0.56	0.03
	Total	0.54	0.06	0.61	0.06
P (%)	Twig	0.19	0.21	0.80	0.01
	Leave	0.31	0.23	0.97	0.03
	Stem	0.43	0.24	0.92	0.04
	Bark	0.40	0.24	0.87	0.02
	Branch	0.36	0.21	0.84	0.01
	Total	0.34	0.23	0.88	0.06
K%	Twig	0.73	0.14	0.66	0.03
	Leave	0.90	0.15	0.84	0.02
	Stem	0.94	0.15	0.81	0.03
	Bark	0.91	0.14	0.77	0.02
	Branch	0.87	0.15	0.74	0.02
	Total	0.87	0.15	0.76	0.07
Na (%)	Twig	0.21	0.01	0.26	0.02
	Leave	0.45	0.01	0.48	0.03
	Stem	0.39	0.02	0.42	0.02
	Bark	0.35	0.01	0.37	0.01

	Branch	0.29	0.01	0.33	0.01
	Total	0.34	0.08	0.38	0.08
Ca (%)	Twig	0.87	0.08	0.94	0.03
	Leave	1.02	0.09	1.12	0.01
	Stem	0.93	0.06	1.07	0.03
	Bark	0.89	0.06	1.05	0.04
	Branch	0.85	0.07	0.10	0.02
	Total	0.91	0.09	1.03	0.07
Mg%	Twig	0.53	0.36	0.10	0.01
	Leave	0.66	0.40	0.19	0.02
	Stem	0.37	0.36	0.16	0.02
	Bark	0.34	0.36	0.14	0.01
	Branch	0.31	0.35	0.11	0.01
	Total	0.44	0.37	0.14	0.04

Nutrients concentration in teak parts among the plantation ages in the study area

The study made attempt to know if the significant variation in nutrient concentration in plant parts among the plantation ages in the two plantations studied. The result revealed that at Ilaro there were significant variations in the concentration of sodium and nitrogen ($p<0.05$) in the plant parts, while at Olokemeji all the plant nutrients investigated showed significant variations in concentration and distribution in plant parts ($p<0.05$) (Table 3). However, at both Olokemeji and Ilaro plantations, the concentration of plant nutrients was high in leaves and low in the twigs. However, at Ilaro, the distribution of plant nutrients across plant parts was only significant in sodium and nitrogen (Table 3). Consequently, the paired-samples test results showed that there were significant differences in the distributional pattern of plant nutrients in plant parts between Ilaro and Olokemeji plantations.

Table 3: ANOVA result of variation in plant nutrients in the study area

Plantations	Plant Nutrients	Sum of Squares	Df	Mean Square	F	Sig.
Ilaro	NA (%)	0.102	4	0.025	90.869	0.000
	K (%)	0.079	4	0.020	0.754	0.578
	CA (%)	0.054	4	0.013	2.005	0.170
	Mg (%)	0.257	4	0.064	0.381	0.817
	P (%)	0.110	4	0.027	0.429	0.785
	N (%)	0.046	4	0.011	24.275	0.000
Olokemeji	NA (%)	0.083	4	0.021	37.823	0.000
	K (%)	0.056	4	0.014	19.032	0.000
	CA (%)	0.063	4	0.016	16.829	0.000
	Mg (%)	0.017	4	0.004	18.676	0.000
	P (%)	0.052	4	0.013	19.400	0.000
	N (%)	0.053	4	0.013	21.570	0.000

Pairwise comparison of mean concentration of nutrients in plant nutrients

The pairwise comparison of mean concentration of plant nutrients between Ilaro and Olokemeji was carried out to show the location with the highest significant concentration of plant nutrients. The result shows that the mean concentration of calcium, phosphorous and nitrogen in different plant parts were higher at Olokemeji than in Ilaro (Table 4). On the contrary, the mean concentration of potassium (K) and magnesium were higher at Ilaro than at Olokemeji. This implies that location and plant parts have significant effect on plant nutrient distribution in the soil. Based on the above results, most of the nutrients are concentrated in the leaves. Similar results were reported by *Bargali et al. (1992)* in a eucalyptus plantation, and *Lodhiyal et al. (2002)* in a Shisham forest in India. Also, *Oladoye et al. (2006)* reported nutrient concentration which followed the trend: N > P > Mg > Ca > K > Na for leaf litter and seed components. They note that among all the litter components, leaf litter contributed more nutrients, especially nitrogen, than other litter components. High N-flux reflected the quantity and quality of nitrogen in the soil. Variation in the concentration of nutrients in the reproductive parts and leaves of teak reflect the litter quality or concentration of elements stored in the litter (*Muoghalu et al., 1993*). The elevated nutrient concentration in the leaves (especially N, K, and Ca) makes this tree component an important reserve of bio-elements, although it represents only a small percentage of the whole tree biomass. The highest concentration of P and K are found in the leaves, whereas the lowest are in the bark.

Table 4: Analysis of pairwise comparison of mean concentration of plant nutrients

Dependent Variables	(I) Location	(J) Location	Mean Diff. (I-J)	Std. Error	T-value	Sig.
NA (%)	Ilaro	Olokemeji	-.036	.021	-1.71	.093
	Olokemeji	Ilaro	.036	.021	1.71	.093
K (%)	Ilaro	Olokemeji	.108*	.031	3.48	.001
	Olokemeji	Ilaro	-.108*	.031	-3.48	.001
CA (%)	Ilaro	Olokemeji	-.123*	.021	-5.85	.000
	Olokemeji	Ilaro	.123*	.021	5.85	.000
Mg (%)	Ilaro	Olokemeji	.303*	.067	4.52	.000
	Olokemeji	Ilaro	-.303*	.067	-4.52	.000
P (%)	Ilaro	Olokemeji	-.542*	.043	-12.60	.000
	Olokemeji	Ilaro	.542*	.043	12.60	.000
N (%)	Ilaro	Olokemeji	-.075*	.016	-4.68	.000
	Olokemeji	Ilaro	.075*	.016	4.68	.000

*The mean difference is significant at the .05 level

Plantation age and nutrient distribution in plant parts

The results on age and nutrient distribution in the plant parts of teak trees at both Olokemeji and the Ilaro plantations show that sodium (Na) in the 43-years-old plantation had mean values of 0.33% and 0.33% respectively, the 40-years-old plantation had mean values of 0.39% and 0.35%, respectively and the 48 years-old plantation had mean values of 0.38% and 0.33%, respectively. Also, potassium (k%) at both Olokemeji and the Ilaro plantations show that, the 43 years-old plantations had mean values of 0.99% and 0.71%, respectively, while at the 46 years-old plantation, the reverse is the case with Ilaro and Olokemeji recording mean values of 0.91% and 0.78%, respectively, while, the 48 years-old plantations also, had mean values of 0.99%, 0.77%) at both Ilaro and Olokemeji, respectively (Table 5). The results of calcium (Ca) showed that the 43 years-old plantation had mean values of 0.98% and 0.84% at Ilaro and Olokemeji, respectively, the 46 years-old plantation had mean values of 1.06%, 0.92% at Olokemeji and Ilaro, respectively and the 48 years-old plantation also recorded mean values of 1.04% and 0.84% at Olokemeji and Ilaro plantations, respectively. Magnesium (Mg) also had mean values of 0.10% and 0.81%, for 43 years-old plantation; 0.14% and 0.42% for 46-years-old plantations and 0.13% and 0.10% for the 48 years-old plantation at both Olokemeji and the Ilaro plantations, respectively (Table 5). For phosphorous content, the results shows mean values of 0.53% and 0.10% for 43 years-old plantations; 0.90% and 0.38% for 40 years-old plantations and 0.88% and 0.53% for 48 years-old plantations at both Olokemeji and the Ilaro, respectively. Lastly, the results show that nitrogen (N%) had mean values of 0.54% and 0.52% for 43 years-old plantation; 0.63% and 0.56% for 46 years-old plantations and 0.61% and 0.54% for the 48 years-old plantations at both Olokemeji and the Ilaro plantations, respectively (Table 6). A cursory look at the values depicts discernible pattern and trend in nutrient concentration in teak biomass across the plantation ages. At Olokemeji, the proportion of nutrients in teak biomass shows a decreasing or downward trend mostly in the contents of Na, K, Ca, P and N, while an upward trend in nutrient content in teak biomass was observed in Mg. On the other hand, downward trend was observed in the contents of K, P and N, while upward trends in nutrient available in teak biomass were observed in Na, Ca and P.

Table 5: Plantation age and nutrient distribution in plant parts

Plant nutrients	43 Yrs old. Olokemeji plantation		43 Yrs old. Ilaro plantation	
	Ave.	**Std.Dev.**	**Ave.**	**Std.Dev.**
Sodium (Na %)	0.33	0.09	0.33	0.09
Potassium (K %)	0.99	0.06	0.71	0.06
Calcium (Ca %)	0.84	0.06	0.98	0.05
Magnesium (Mg %)	0.10	0.03	0.81	0.06
Phosphorous (P %)	0.53	0.06	0.10	0.04
Nitrogen (N %)	0.54	0.056	0.52	0.06
	46-Yr.-old Olokemeji plantation		**46-Yr.-old Ilaro plantation**	
Sodium (Na %)	0.39	0.09	0.35	0.09

Potassium (K %)	0.78	0.06	0.91	0.15
Calcium (Ca %)	1.06	0.07	0.92	0.10
Magnesium (Mg %)	0.14	0.03	0.42	0.39
Phosphorous (P %)	0.90	0.07	0.38	0.23
Nitrogen (N %)	0.63	0.07	0.56	0.06
	48 Yrs old. Olokemeji plantation		**48 Yrs old. Ilaro plantation**	
Sodium (Na %)	0.38	0.08	0.33	0.09
Potassium (K %)	0.77	0.07	0.99	0.06
Calcium (Ca %)	1.04	0.06	0.84	0.06
Magnesium (Mg %)	0.13	0.03	0.10	0.03
Phosphorous (P %)	0.88	0.07	0.53	0.06
Nitrogen (N %)	0.61	0.06	0.54	0.06

Discussion

The result on nutrient concentration and distribution pattern of plant parts in teak plantations reveals that the leaves have the most nutrient, while the plant part with the lowest nutrient is the twig. Akpokodje and Aweto (2007) note that the accumulating leaf and twig litter leads to the accretion of organic matter in the soil, which in situ decomposes to add nutrients to the soil. The nutrient pattern in plant parts differs between Ilaro and Olokemeji plantations. The study reveals that the concentration of nutrients in plant parts of a teak tree is substantially higher in the Olokemeji plantation than in Ilaro plantation. This may be presumably attributed to the differences in soils, relief, and geological and climatic conditions. The concentration of essential nutrients (N, P, K, Zn, and Fe) also varies with the plant parts. The phosphorous content in the Olokemeji plantation indicates that barks and stems contained more phosphorus, whereas in Ilaro plantation phosphorus contents were found more in the branches, leaves and the twigs. Nitrogen content in Olokemeji is high in the teak branches, but in Ilaro nitrogen contents are more in the teak twigs, leaves, stems and barks. In addition, the analysis reveals that Fe and Zn are concentrated in different plant parts. For instance, high iron (Fe) proportion was observed in the barks and stems in Olokemeji plantation, while in Ilaro Fe content are more in the branches and leaves. For zinc (Zn), the barks, branches, stems and twigs have high zinc content in Ilaro plantation, but in Olokemeji plantation, only the leaves have zinc content.

The study further shows that nutrient contents in plant parts differ between the study sites, with Olokemeji having a greater proportion of the measured nutrients. The study indicates that location has a significant effect on plant nutrient distribution. Also, plants have significant effect on plant nutrient distribution in the soil. Based on the above result, it is evident that most of the nutrients are concentrated in teak leaves. Similar results were reported by *Bargali et al. (1992)* in a eucalyptus plantation and *Lodhiyal et al. (2002) in a Shisham forest. Also, Oladoye et al. (2006)* report nutrient concentration which followed the trend of N > P > Mg > Ca > K > Na for leaf litter and seed components. They noted that among all the litter components, leaf litter contributed more nutrients, especially nitrogen, than other litter components. Thus, high N-flux reflects the quantity and quality of nitrogen in the soil.

Variation in the concentration of nutrients in the leaves and other parts of the teak plant reflects the litter quality or concentration of elements stored in the litter (*Muoghalu et al., 1993).* The elevated nutrient concentration in the leaves (especially N, K, and Ca) makes this tree component an important reserve of bio-elements, although it represents only a small percentage of the whole tree biomass. The highest concentrations of P and K are found in the leaves, whereas the lowest are in the bole wood and bole bark. The high concentration of phosphorous (P) and potassium (K) in parts of the forest tree studied could be attributed to the rapid loss of water-soluble compounds. Potassium (K) and phosphorus (P) are usually constituents of metabolite enzymes system of the plant sap. Calcium (Ca) and magnesium (Mg) are constituents of the structural makeup, such as the cell wall. The high accumulation for P and K in the plant parts particularly leaves and reproductive parts can be attributed to the effect of environmental factors (*Oladoye et al., 2006).* The decomposition of litter and release of N, P, K and other essential elements is due to the influence of micro-arthropods and earthworms (*Adejuyigbe, 2000; Cox et al., 2001*). Decomposition is important because plant production depends on the recycling of nutrients within the system; recycling depends on the decomposition of organic matter and release of the nutrient it contains. In a related study, Tian *et al.* (1998) note that soil fauna affects decomposition mainly through the combination of substrates, and influences microbial activity.

Conclusion

The study has shown that leaves have the most nutrients, while twig has the least concentration of nutrient. This suggests that a substantial amount of nutrient returned to the soil is derived from plant leaves. Age of teak plant is observed in the present study to have significant effects on the distribution of essential nutrients (such as N, P and K). This is because plant parts in young plantations have more nutrients than those from matured or older ones. This suggests the need for proper management of teak mostly the matured ones. The mature teak trees should be felled and replaced immediately with younger ones. Alternatively, the teak plantation should be sprayed with chemical fertilizers at regular intervals to help improve soil fertility status. Since teak parts are rich in nutrients, the litter droppings should not be completely raked or packed away during site management as it strips the soil of natural nutrient recycling. Less amount of money will be spent on the purchase of chemicals if these plant parts are allowed to decompose with time.

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