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Evaluation of Soil Quality Status under Different Forest Tree Species in Nigeria

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ABSTRACT

A study was carried out at Forestry Research Institute of Nigeria, Ibadan, South -western, Nigeria in the second quarters of 2018 to evaluate the current status and the distribution of some soil quality factors of study area. The study also aimed at suggesting strategies for efficient management of the soil quality factors in the study areas. Soil samples were collected under six (6) different forest trees species plantations. The samples were subjected to routine laboratory analytical protocol for the determination of both physical and chemical properties of the samples. Results implicated that the soil organic matter (SOM) of the study area varied from one forest plantation to the other. However, SOM was found to be highest under natural forest (NF) with a mean value of 3.90% while open field had the least with a mean value of 1.62%. Similar results were observed for soil total nitrogen (N). There was a significant ($p<0.05$)difference in the amount of exchangeable K contents (0.008cmol/kg) in soils under open field with less ground cover and forest tree species relative to soils under NF, Nauclea dideirichi (ND) and Mangifera indica (MI) respectively. Soils under NF significantly recorded the highest exchangeable Ca compared to open field and others. It can therefore be concluded that good agricultural management practises that will enhance soil quality factors and multi forest species cultivation be encouraged for effective and efficient nutrient management systems in the forest ecosystems for enhancement of bio diversities of both micro and macro organisms. However, due to population pressure on the available land for other non-agricultural purposes coupled with annual bush burning, inadequate rainfall, lack of good agricultural practices and non-availability of natural forest for farming, it has become imperative that agroforestry system of farming in which trees or shrubs are grown in association with crops is advocated.

Keywords: Ecosystems, Forest, Nutrient, Soil quality factors.

1 Introduction

Soil according to FAO portal is defined as the natural medium for the growth of plants, a natural body consisting of layers that are composed of weathered mineral materials, organic material, air and water: an end product of the combined influence of climate, topography, organisms (Flora, Fauna and humans) on parent materials (original rocks and materials) over time. Soil quality however, is the ability of soil to provide, supply the required materials to planting and its ability to maintain and improve moisture and air within the soil and support human being needs (Doran, Coleman, Bezdicek, and Stewart 1994).

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A major problem facing tropical agriculture is the inherently low fertility status of moist of the soils because of the predominantly low activity kaolinitic clay type and soil organic matter. Soil fertility according to young (1997) is the capacity of the soil to support plant growth under given climatic conditions. Soil fertility maintenance therefore has been as concern in tropical Africa particularly with the rapid population increase occurring in the past few decades with its associated continuous land use soil organic matter status has been identified as one of the most important indicator of soil quality factor. However, due to population pressure on the available land for other non-agricultural purposes coupled with annual bush burning, inadequate rainfall, lack of good agricultural practices and non-availability of natural forest for farming, it has become imperative that agroforestry system of farming in which trees or shrubs are grown in association with crops is advocated.

The contribution of soil organic matter to overall performance of agricultural production and is positive influence on the fertility of soil cannot be over emphasised. The word organic matter generally refers to naturally occurring compound found in the atmosphere, aquatic and soil environmental. This therefore, implies that organic matter occurs in virtually all naturally systems, SOM usually occurs as about 1-5% or more of the top soil depending on the location and type of soil.

Objectives:

1: To evaluate the current status and the distribution of some soil quality factors of study area.

2: The study also aimed at suggesting strategies for efficient management of the soil quality factors in the study area.

2 Materials and methods

The study which was conducted at Forestry Research Institute of Nigeria (FRIN) Idi-Ishin, Ibadan aimed at evaluating soil quality status under different forest tree species in Nigeria. Idi - Ishin. Ibadan lies between latitude of 07^0 10^1 N and longitude 03^0 52^1 E. It lies at an altitude of about 122 meters above the sea level. It is in tropical rain forest zone. The total annual rainfall of about 1600mm was distributed over a period between nine to ten months in a bimodal rainfall pattern. Early rain occurs between March to late July and late rain occurs between August to October with five months dry season and a short day spell in August (August break). The day season runs from early November to March with characteristic cool dry northern wind and harsh scorching sun. The temperature of Ibadan is fairly high throughout the year with minimum temperature usually ranges from 25.1^{o}C to 28^{o}C. Ibadan has a moderate high to very high relative humidity throughout the year with a range of 46% to 89%. The soil temperature at Ibadan is considered fairly high and ranges between 26^{o}C and 36^{o}C (Akanbi, 2016).

2.1 Soil sample collection techniques

Five different plantations contain each of tree species were selected for the study. The sites were demarcated into two blocks depending on the shape, soil samples were collected on the demarcated blocks in a stratified manner. Three soil samples were collected per augering points at nine different locations per block in each of the plantation under study and adjacent plot (control) using bucket auger at depths of 0 -15, 15 - 30 and 30 - 45cm at 25m apart. The sample were tagged, and dried, crushed and allowed to pass through a 2.0mm mesh sieve. Sample collected from the adjacent open plot were equally prepared same way and were subjected to both physical and chemical analysis. Mechanical analysis was done using hydrometers method as describe by Bouyoucos (1957). P^H was determined in water (1:2 soil:

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water ratio) using a P^H meter with glass electrode as described AOAC (1990). Organic carbon content was determined using the Wakley - Black (Nelson and Somers, 1982) available Phosphorus determination was done by Bray method described by Bray and Kurtz (1945). Total nitrogen (N) was determined by the Kjedahl digestion procedure (Jackson 1962). Exchangeable bases were determined by extraction with neutral ammonium acetate and the amount of K, Ca, Na in the filtrate were determined using Perkin Elema Atomic Absorption Spectro - photometer (AAS). Exchangeable acidity was determined by soil extraction with 1 neutral and titration with 0.05N N_aOH using Phenolphthalein indicator as outlined by IITA (1979).

2.2 Statistical analysis

The obtained data were subjected to analysis using Microsoft Office Excel for means and results presented in charts with their error bars showing the differences in the treatments

3 Results and Discussions

The results of soil physical properties under the different plantations selected for the study indicated that the %Sand contents ranged between 79.17 and 90.17 while the % clay and silt fractions ranged from 8.67 to 19.00% and from 1.17 to 6.50% respectively. The soil separates in the study area varied widely indicating spatial differences in their parent materials. However, the textural classification was predominantly sandy clay loam. The soils under MI; ND; GS and TS recorded the highest bulk densities in descending order although the differences were not significant ($p > 0.05$). There were no significant ($p < 0.05$) differences in soil bulk densities found under OF; NF and IS but were significantly lower ($p<0.05$) than the MI; ND; GS and TS. The relatively lowest bulk densities found under NF (0.38g/cm^3) and IS (0.37g/cm^3) is an indication that NF and IS are able to loosen the soil under thereby creating more pore spaces within the root rhizosphere thus creating more avenue for easy infiltration and aeration. This observation agreed with Ziblim *et al.,* (2012) who reported a lower bulk density under *Teak grandis* relative to the other tree species and control.

3.1 Nitrogen (N)

Figure 1 presents the result of soil Nitrogen (N) under different forest tree species. The result indicated that soil total N contents were highest under *NF* compared with other tree species and adjacent open field. However, this was distantly followed by *IS* (0.89%) and *ND* (0.82%) respectively. Open forest and *TS* recorded least N value of (0.53%) and (0.56%) respectively.

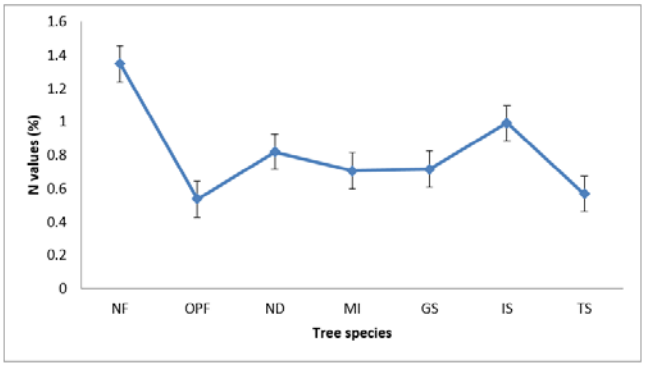


Figure 1: Soil Nitrogen under different forest tree species

3.2 Phosphorus (P)

Similar trend was observed for phosphorus (P). However, the differences in the amount of P found under NF was significantly ($p > 0.05$) higher compared to other tree species in the study area. The open field (OP) recorded the least amount of available P (3.16mg/kg). The OPF, MI and IS were not statistically ($p > 0.05$) different from each other

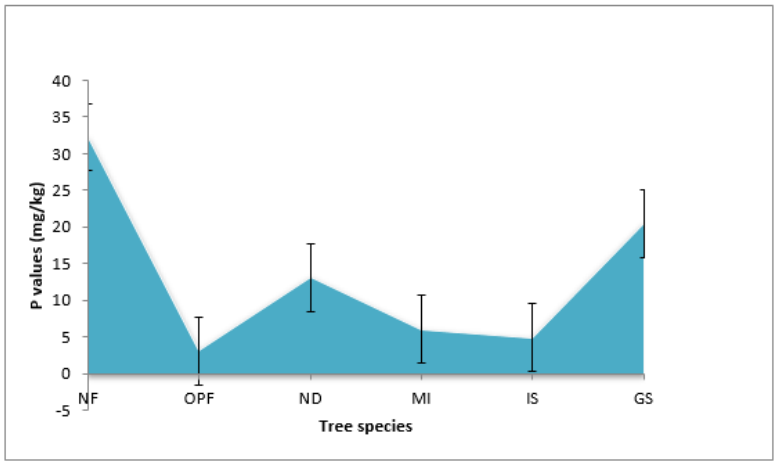
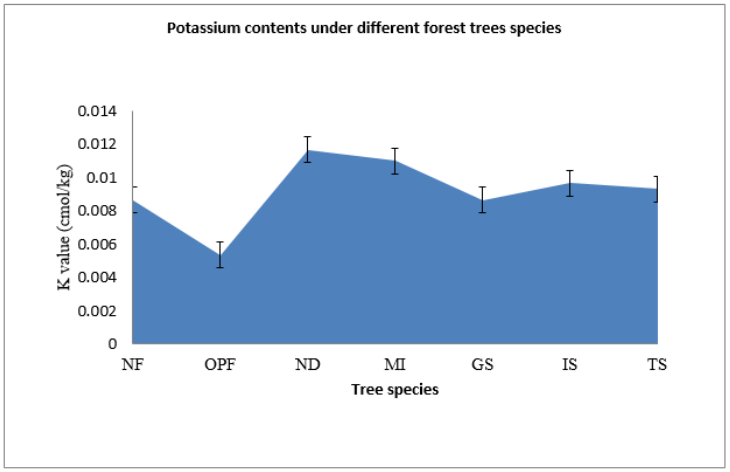


Figure 2: Soil Phosphorus contents under different forest tree species

3.3 Potassium (K)

The potassium (K) contents of the study area varied from 0.008 to 0.09cmol/kg. There was also a significant ($p < 0.05$) difference in the exchangeable K contents (0.08cmol/kg) in soils under open field with less ground cover and forest trees relative to soils under natural forest. *Nauclea dideirichi and Mangifera indica* respectively. Soils under *Irvingia spp; Gmelina spp* and *Terminalia superb* recorded similar K (0.009cmol/kg) contents and were significantly ($p<0.05$) different from each other.



Potassium contents under different forest trees species

Figure 3: Soil Potassium contents as found under different forest tree species.

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3.4 Calcium (Ca)

There were no significant ($p > 0.05$) difference in the status of exchangeable Ca among soils under *Nauclea didereichi, Gmelina spp* and *Terminalia superb* (Fig 4). The results further indicated that soils under natural forest and *Mangifera indica* had the highest Ca contents of 0.79 and 0.76cmol/kg respectively. This could be attributable to leaf litters falls from different forest trees species found under the natural forest.

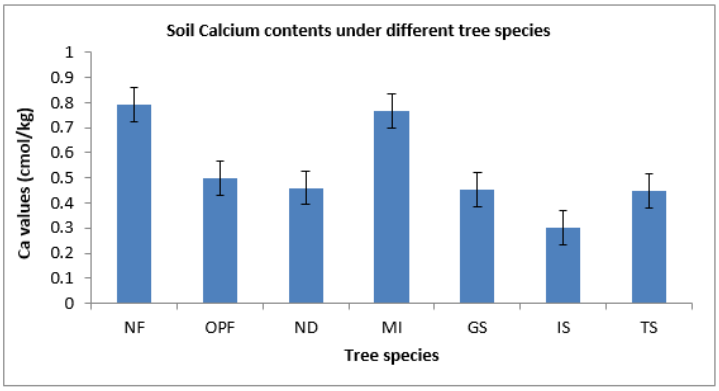


Figure 4: Soil calcium contents under different tree species

3.5 Soil organic matter (SOM)

All the plantations selected had moderately high organic matter contents. The moderately high rates of SOM could be attributed to high leaf litters fall and its consequent decomposition and mineralization of the organic materials due to high activities of both micro and macro fauna under the various forest tree species. Relative to the *TS* which recorded the least SOM value of 1.62%, soils collected under the *NF* recorded the highest SOM contents of 3.90% and are significantly ($p<0.05$) higher than all other soils under study except *IS*. This observation agreed with the results of Dinakaran and Krishnayya (2010) who opined that there was a significant increase in the levels of soil organic matter in the afforested areas under Teak, Bamboo and mixed vegetation. This was distantly followed by soils collected under *MI, GS and TS* respectively. The mean values of SOM under *GS* and *TS* had similar SOM contents of 2.66 and are not significantly ($p < 0.05$) different from one another.

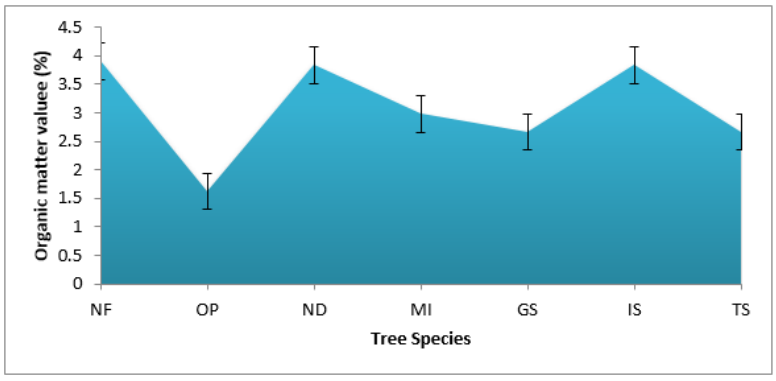


Figure 5: Soil organic carbon contents under different tree species

3.6 Soil reaction (pH)

The pH values of soil suspension (1:2) of all the representative soils in the study area were mostly slightly acidic in reaction. The soil pH values ranged between 5.91 and 6.24. The small variations observed in soil pH values could be due to possible variability in calcium carbonate equivalent, soil organic matter and leaching of bases (Deshmuku, 2012). There was no significant ($p<0.05$) difference in terms of pH distribution across the selected farm locations (Fig 6). However, the soil reaction (pH) has a significant influence on bioavailability of nutrients. Therefore efforts must be geared towards embarking on good soil agricultural practices that will maintain appropriate soil pH for sustainable forest conservation.

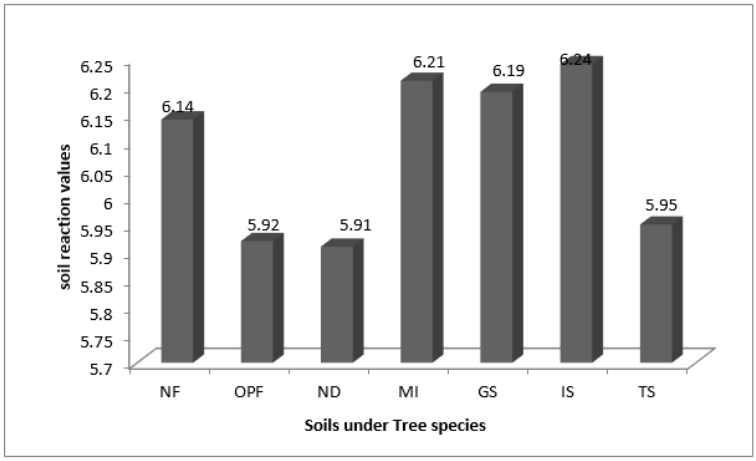


Figure 6: Soil reaction under different tree species

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