ASSESSMENT OF MACRO AND MICRO MINERAL COMPOSITIONS AT DIFFERENT DEPTHS OF FOREST NURSERY SOILS INFEDERAL UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA

ABSTRACT

Forest soil is characteristically fundamental in the establishment of healthy seedlings for eventual planting out on the field. It is composed of mineral particles, organic matter, water, air, and numerous microorganisms.Two forest nursery soils at different depths were investigated at the Federal University of Agriculture Abeokuta (FUNAAB) for their mineral compositions. With the aid of a soil auger, twenty soil samples were randomly collected from different points in two sites at different depths (0-15cm and 15-30cm, air dried and taken to the laboratory for further analysis. Site 1 and site 2 (frequently cultivated portion for agroforestry bare-root seedlings and intermittently used portion). The obtained data were subjected to descriptive statistics. The composition of mineral elements varied with sites and depths. The level of Potassium was higher at depths 0 – 15 cm and 15 – 30 cm in site 2 than other macro-minerals (Sodium, Calcium and Magnesium)when compared between sites. The order of concentration includesK>Mg>Na>Ca. Micro-minerals were significantly higher at soil depth 0 – 15 cm in site 2 than site 1(Fe>Zn>Mn>Cu). At soil depth 15 – 30 cm, levels of copper, zinc and manganese were significantly higher ($p < 0.05$) in site 1 with the following trend Cu>Fe>Zn>Mn. The study showed that forest nursery soils varied in their mineral composition along with depth in the studied sites. Site 2 had better physicochemical properties and higher level of some essential minerals needed for good performance of seedling growth at nursery stage.

Keywords: Forest nursery soil; macro-minerals; micro-minerals; soil depth

INTRODUCTION

A nursery is an area where plants are raised for subsequent planting. It consists of transplant beds, paths, irrigation channels and so on. Forests are significant to life on earth. They purify the air we breathe, filter the water we drink, prevent erosion, and act as an important buffer against climate change. Cultural and spiritual values, biodiversity conservation, nutrient recycling and carbon dioxide sequestration are among other services functions of the forest (Ajewole and Popoola, 2001). Despite the key roles forest play in the world´s environmental and economic health, forests continue to be lost, along with the endangered animals that live in them (Oliveira and Lacerola, 1993; Epstein *et al*., 1998).

A forest soil is a natural or only slightly distributed materials that took centuries to develop under permanent forest cover. Forest soils are influenced by forest vegetation. A succession of genetic soils layers is present, ranging from the very important surface organic layers down to the mineral parent materials. The persistent depositing of tree litter upon the ground for many years has developed the features surface layers of organic matter found in forest areas. When forests are removed and the land is used for agriculture, the soil structure generally deteriorates and this is evident by reduced pore space, increased bulk density, increased compaction, reduced content of water stable aggregates, and reduced rates of infiltration, has marked effects on surface water runoff, stream flow and sedimentation. Forest soils are important globally for many reasons which includes the relatively large amount of carbon stored in forest soil organic matter (Lowe *et. al*., 2016)

The structure of the forest soil directly influences the growth of the forest biodiversity. Organic matter in the forest soil helps improve and maintain soil structure. In addition to microorganisms of a forest soil has a relatively high population of macro-organisms that favours soil structure and produces many large burrows and channels. Soil structure is defined as the manner in which the primary soil particles (sand, silt and clay) are combined and arranged with other solid soil components to form clumps or aggregates. It is also the arrangement and organization of the particles and substances that constitute soil. The quality of soil structure is measured by the capacity of the soil particles to clump together or aggregate (Lutz and Chandler, 1947).

Most forest soils have acidic soil reaction, with pH values lying within 3.0-7.0 though some forest soils have pH values greater than 7.0. The forest soils are generally more acidic (have less pH) than grassland and agricultural soils due to the continuous production of organic acids and $C0_2$ from decomposing litters. Chemical properties of soils include Cation exchange capacity which is the maximum quantity of total cation that a soil is capable of holding. Soil pH, soil nutrients, soil organic carbon, soil salinity among others (Wilson and Sellers, 1985). The aim of this study is to assess the structural characteristic and chemical properties of forest nursery soil in Federal University of Agriculture Abeokuta (FUNAAB) for optimum productivity at the nursery stage.

MATERIALS AND METHODS

Description of the study area

The study was carried out at the nursery site of the Department of Forestry and Wildlife Management, Federal University of Agriculture Abeokuta (FUNAAB), Ogun State. This area falls within Latitudes 7°N and 7°58' and Longitudes ranges from 3°20'E to3°37'E. The area has a tropical climate with a bimodal distribution of rainfall; it lies within the humid lowland tropical rainfall with two distinct seasons (the wet season from March to October and the dry season from November to February). The mean annual rainfall is about 1113 mm which peaks in July and September. The relative humidity of the area is 82.4% and the average monthly temperature of 35.8°C (Aiboni, 2001). The forest nursery is divided into two main parts on the basis of planting stocks (bare-root & container nursery) as well as seedling size (transplant &seedling nursery). The bare root plant section is the study area for this research. This site is divided into two; site 1 (plants grow directly in the nursery soil and the roots are separated from the soil at the time of lifting such as tomatoes. The lifted planting stock is further handled and planted without soil surrounding the roots. Also, it has only seedling beds in which seedlings only are raised, no transplanting is done. We use this bed for some agroforestry practical for growing crops e.gSolanum spp., amaranthus, celosia etc) and site 2 (planting activities are not carried out here; the land is untilled).

Soil sample collection and laboratory analysis

Soil samples were collected randomly from ten points at two different depths 0-15 cm and 15-30 cm in each site (site 1 and site 2) at the FUNAAB forest Nursery with soil auger. Site 1 and site 2 represent frequently cultivated for agroforestry bare-root seedling and intermittently used parts respectively. The samples were poured into individual sample bags, appropriately labelled and taken to the laboratory for analysis.

The collected samples were air dried, crushed and sieved through a 0.5 m mesh size sieve and analyzed. Soil particle size was determined the pipet method (Gee and Bauder, 1986), soil pH was determined in 0.01M $Cacl_2$ by using a soil collection solution ratio for 1:2.5 by means of a Phillip analogue pH meter. The soil was determined using the pH meter (Black, 1965). The organic carbon content of the soil was determined by the wet oxidation method of Walkley-Black as described by Allison (1965). The total nitrogen content of the soil was determined by Micro Kjeldahl procedure Bremner (1965). C:N was computed as ratio of N:C. Available phosphorus (P) was extracted by the Bray 1 method. The P concentration in the extract was determined colorimetrically by using the Spetronic 20 and absorption was read-off as described by Bray and Kurts (1945) and modified by Murphy and Riley (1962). Exchangeable K, Ca and Mg were extracted using ammonium acetate, K was determined on flame photometer and Ca and Mg by Atomic Absorption Spectrophotometer (AAS). The trace nutrients are copper (cu), iron (Fe), manganese (Mn) and Zinc (Zn).

The Soil textural class were identified following the ISSS soil texture classification system. The proportion of clay, silt and sand were used to characterize particles size distribution while the soil physiochemical properties such as bulk density, porosity, soil organic matter, pH, CEC, moisture content, and soil organic carbon (SOC) which were considered as indicators of soil quality were determined.

Statistical Analysis

The data obtained were analysed using analysis of variance (ANOVA) with the Statistical Analysis System (SAS, 2015) computer package at 5% level of significance to determine difference in the treatments effect, while, the means of differences among the treatments were separated using Fisher's Least Significant Difference (F-LSD; $P \leq 0.05$).

RESULTSAND DISCUSSIONS

Macro-mineral composition at differentdepths and sites

Mineral composition of some macro minerals in site 1 and site 2 at different depths. Varied. At 0 – 15 cm and 15 – 30 cm soil depths, level of Potassium was higher in site 2 than other essential minerals (Sodium, Calcium and Magnesium) when compared between sites. Their order of concentration include K> Mg> Na> Ca (Figure 1).

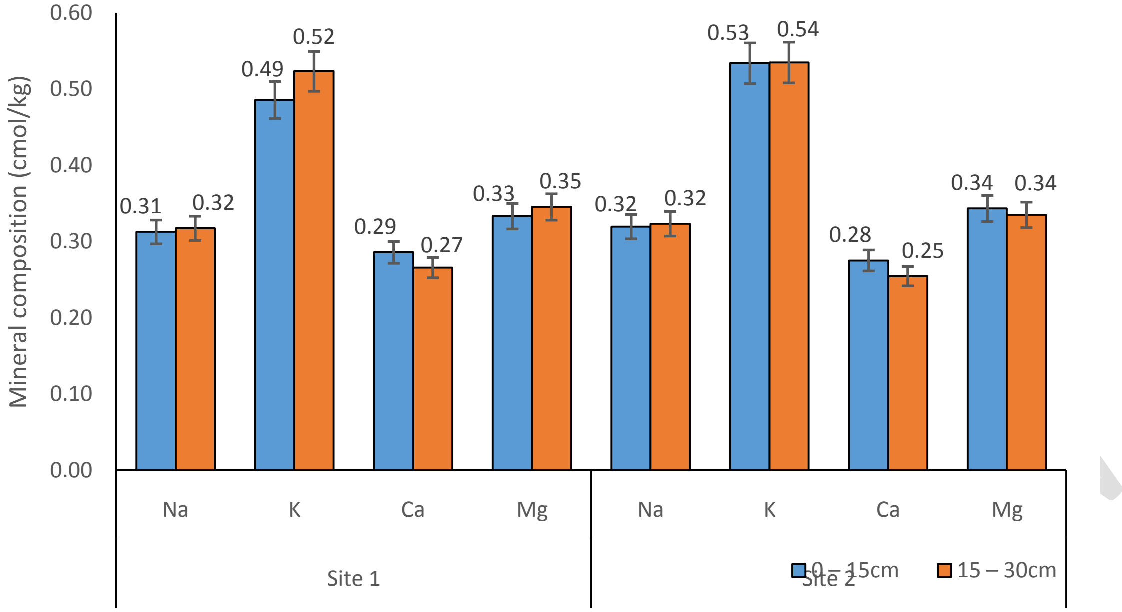

Figure 1: Mineral composition of the two studied depths and sites

Composition of Trace minerals at different depths and sites

The levels of some trace minerals recorded in the soils of the two sites are shown in Table 1. At 0 – 15 cm soil depth, results showed significantly higher ($p < 0.05$) levels of copper, iron and zinc in the site 2 than the site 1. On the other hand, manganese level was significantly higher ($p < 0.05$) in site 1 than site 2 (Table 1). At soil depth 15 – 30 cm, levels of copper, zinc and manganese were significantly higher ($p < 0.05$) in site 1 than site 2. However, level of iron was significantly higher ($p < 0.05$) in the site 1 than site 2 (Table 1).

Table 1: Trace minerals at different depths and sites

Micro-minerals	**0 – 15cm**		**15 – 30cm**	
	Site 1	**Site 2**	**Site 1**	**Site 2**
Cu	0.10 ± 0.00^{b}	0.10 ± 0.00^{b}	0.11 ± 0.01^{a}	0.09 ± 0.00^{c}
Fe	6.21 ± 0.01^{b}	6.02 ± 0.03^{d}	6.48 ± 0.09^{a}	6.09 ± 0.02^{c}
Zn	0.21 ± 0.01^{b}	0.20 ± 0.01^{c}	0.22 ± 0.01^{a}	0.19 ± 0.00^{d}
Mn	1.25 ± 0.01^{b}	1.35 ± 0.31^{a}	1.20 ± 0.01^{c}	1.15 ± 0.02^{d}

Means in the same row having similar superscripts are not significantly different ($p < 0.05$)

There were variations in the physicochemical parameters of the forest nursery soils assessed at the two different sites and depths. The particle size distribution (proportion of clay, silt and sand) also varied among soil depths. Generally, the soils in both sites and depths have a good balance of particle sizes which will have the best stability of pore space size and thus the best soil properties for maximum plant growth and productivity.Muoghalu and Awokunle (1994) reported a similar trend in the particle size distribution in the

Nigerian rainforest region, Omo biosphere reserve, Nigeria. While the texture is a basic soil property, vegetation disparity could have contributed to the variations in particle size distribution. The pH of the soils was slightly acidic. Consequently,availability of nutrients such as Nitrogen and Phosphorus needed by plants will be supported within this soils. This is corroborated by Alloway and Aryes (1997) who stated that high value of pH is predictable as most soils in the tropics range from acidic to slightly neutral. The value may also be as a result of buffering effect of soil organic matter against pH change in addition to the release of basic cations during organic matter decomposition. The percentage of organic matter in the two sites varied but was higher at 0-15 cm depth in site 1. The substantial difference is probably due to the accumulation and decay of leaf litter and root in the soil. Thus, improves soil physical properties by providing organic binding agents, increasing water holding capacity of soils, provides better aeration, lowering soil bulk density, and improving the elasticity and resilience of the whole soil. The decrease in organic matter with depth could be due to the decrease in the abundance of the fine roots with depth; at greater depth, larger diameter roots predominate, and this agrees with the work of Oyedele*et al.* (2008) who stated that organic matter plays a significant role in adsorption reaction in the soil. It is widely known that 90% of soil nitrogen is in organic combination. High total nitrogen value observed in site 1 could be ascribed to the dominance of nitrogen fixing tree species composition such as*Leucaenaleucocephala*, *Albizialebbeck*and *Gliricidiasepium*around the forest nursery and their rate of decomposition. This agrees with the report of Vanlauwe*et al.* (1997) and Deng, *et al.*(2020) that species with high nitrogen content decompose more rapidly. Available phosphorus levels were higher at 15-30 cm depth in both sites. Higher phosphorus content in the soil may be an indication of excessive use of inorganic fertilizer or routine application of compost manure high in phosphorus in the area. According to Etabo*et al.* (2018) and Fageria*et al.* (2002) phosphorus availability or unavailability in the soil to plants critically affects the uptake of nitrogen and other nutrients.

In addition, variations in essential mineral composition between and within sites were observed. In site 1 and 2, the trend of micronutrients includes K>Mg>Na>Ca at both 0 – 15 cm and 15-30 cm soil depths. Level of Potassium was higher than other essential elements Sodium, Calcium and Magnesium in site 2 at both 0 – 15 cm and 15 – 30 cm soil depths when compared between sites. The result of Oladoye (2021) in a related study agrees with this study, where Calcium and Magnesium decreased significantly with soil depth in all the study site with 0 - 15cm depth varying significantly from 15- 30cm depth. Higher level of trace mineral was recorded in site 2 at 0 – 15 and the trend is as follows; Fe>Zn>Mn>Cu. At soil depth 15 – 30 cm, the order of concentration includes Cu>Fe>Zn>Mn. As reported by Kirchmamm and Eriksson(2011); and Combatt*et al.* (2021), trace minerals which are required for the normal growth of plants vary in their composition in the soil. All the macronutrients assessed in this study varied with depth in each site.

CONCLUSION

The study on the assessment of physicochemical properties and mineral compositions of forest nursery soils indicated variations in these parameters at different depths and sites within the same locations. Physiochemical properties such as Bulk Density, Porosity, and Soil Organic Carbon are considered as indicators of soil quality which ensures optimum productivity at forest nursery stage. The proportion of Clay, Silt and sand were used to characterize particle size distribution also varied. There were disparities in mineral composition both micro and macro minerals between the two sites. Site 2 had better physicochemical properties and higher level of some essential minerals needed for good performance of seedling growth at nursery stage. Future studies should investigate other likely factors which can affect the productivity of soils at nursery stage.

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