



Soil Fertility Dynamics and Nutrient Concentration of Cassava Leaves in Ethiope Region, Delta State, Nigeria

Ojobor, S. A., Okogu, O. G. and Onoriasakpovwa, R. A.

Department of Agronomy, Delta State University, Abraka

Corresponding Author: smartojobor@gmail.com, 08065938821

ARTICLE HISTORY

Received: 09/03/2025

Accepted: 28/05/2025

Article Type:

Research Paper

Volume: 13

Issue: 1

Pp: 23 –35

ABSTRACT

Low cassava yield experience due to poor fertility could be address through soil quality evaluation for cassava production hence the objective to monitor soil fertility dynamics and cassava leaves nutrient concentration in Ethiope Region, Delta State. Soil and leaves samples were collected at 3 months after planting (3MAP), 5MAP, 7MAP and 9MAP in six farming communities (Oviorie, Urhuoka. Igun, Otefe, Akpobome and Oghara). Particle size distribution, pH, organic carbon, total nitrogen, phosphorus, potassium, calcium, magnesium and aluminium were measured. Soil evaluation factor (SEF) and soil fertility index (SFI) were used to evaluate the quality of the soil. Data obtained were subjected to descriptive analysis. Soils were sandy loam in texture suitable for cassava production and slightly acidic. Organic carbon was adequate while nitrogen and K were moderate but P and Ca were high generally while Mg insufficient. The SFI and SEF values showed the dynamic nature of soil. The peak was observed at 7 MAP in Otefe, Akpobome and Oghara while Oviorie, Urhuoka and Igun followed similar trend. The soil fertility and leaf nutrient changes of the farms followed similar pattern in most parameters. The nutrient concentration was relatively higher at 7MAP similar to soil fertility although K concentration was higher at 9MAP. Indicating nutrient imbalance and variation at different sampling months and these negatively affect cassava growth and yield. These call for site specific nutrient amendment for cassava productivity in the zone.

Keywords: Cassava production, Nutrient concentration, Soil fertility assessment and Soil quality index.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is an important food crop in West Africa with high yield potential of over 90 t/ha of fresh storage roots (32 t/ha dry matter) per year (Adiele *et al.*, 2020). A staple food crop in Nigeria (Otekunrin and Sawicka, 2019), extensively cultivated in tropical and subtropical regions as cash crop by many farmers who sell to processors (FAO, 2018). Increasing demand for cassava can offer farmers great opportunity to intensify its production and make more money but soil fertility decline is a limiting factor causing

low yield. The low yield experienced could be addressed through proper evaluation of soil quality to identify the limiting nutrients (Roy *et al.*, 2006). The crop has gained prominence as one of the fastest expanding staple foods in Nigeria due to its rising demand, making stakeholders to look continually on how the cassava sub-sector can be shaped (Ikueomonisan *et al.*, 2020).

Cassava productivity in the region is greatly influence by poor soil management leading to the yield far below world potential of 90t ha⁻¹ (El-Sharkawy, 2004). Expensive and uncertain fertilizer applications without

soil fertility assessment compounded the problems (Ojobor *et al.*, 2020, Ojobor and Aimufia 2022). Major cause of the challenges can be traced to lack of scientific soil fertility information that will aid effective soil management (Chikere-Njoku, 2017). Nutrient removed by plant can only be supplied through soil amendment but this can be achieved through soil quality information (Mugo *et al.*, 2020). Studies have showed wide gap between potential and actual yield at the farms (Chianu *et al.*, 2012), pressing for much need for soil managements. Meaningful results can only be obtained by studying the fertility and leaves nutrient concentration in an area. An essential component of cultivation is soil amendment because nutrients are pre-requisite for optimum crop yield (Wang *et al.*, 2021). Fertilizer applications based on initial level of soil fertility, amount of nutrient removed by crop and efficiency of nutrient uptake guarantee soil fertility maintenance and optimum yield. This provides scientific approach for balanced fertilization between added nutrient and available nutrients (Wang *et al.*, 2021).

Food insecurity has been a major challenge facing many developing countries. For instance, Nigerians spend over 70% of their monthly income on food importation due to inability to grow enough crops (Senjobi, 2007). This is traceable to soil infertility and land degradation (Agbede and Adekiya, 2012). Nutrients are constantly removed from the soil through uptake, leaching and erosion. In some cases, elements are tied up by soil particles making them unavailable to plants. Some soils may be naturally high in one element but low in another. In this condition, optimum productivity cannot be attained therefore, cassava productivity can be achieved by enhancing soil fertility through investigating the viability of soil quality and determine the controlling factors for proper measures to be taken. On this premises, optimum yield can be realized with proper fertilization (Oliveira *et al.*, 2017). Understanding soil fertility as well as plant leaves nutrient concentration during the growth cycle can help to realize nutritional needs and identify management option. Such

studies on soils used for cassava production in Delta State is relatively scarce or not documented hence, this study monitored soil fertility and cassava leave nutrient concentration changes in six farming communities in Delta State, Nigeria.

MATERIALS AND METHODS

Study Area

Observation, sample collection and evaluation were conducted from October, 2022 to August, 2023 in six communities, Delta State, Nigeria. The six communities {Oviorie (5°40'0"N and 5°55'0"E), Urhuoka (5°48'26"N and 6°06'32"E), Igun (5°44'48"N and 5°57'27"E) Otefe (5°59'10"N and 5°45'37"E), Akpobome (5°52'36"N and 5°43'45"E) and Oghara (5°58'54"N and 5°37'05"E)} in Ethiope region that covers two Local Government Areas (Ethiope East and West). The locations fall within the Niger Delta, which contains deep deposits of relatively young materials and it is situated in the rain forest zone. The dry season lasts from November to April and is marked by cool (harmattan) dusty haze from the north-east winds. The rainy season is from May to October. The area is characterized by moderate climate with mean annual temperature of 32.80 C° and annual rainfall of 2673.8mm (NIMET, 2022).

Soil and Cassava Leave Samples Collection

Reconnaissance visit was conducted and six cassava farming communities identified where soil and plant samples were collected. Ten (10) soil samples were taken at equal distances of 0-20cm depth with soil auger and bulked together to obtained composite sample and thirty cassava leaves were collected with its petioles using a knife (leaf per stand taken at random). Both samples were taken in all the farms at four different growth stages that is, at three months after planting (3MAP), 5MAP, 7MAP and 9MAP, respectively.

Samples Preparation

Soil samples were air-dried at room temperature, sieved with a 2mm mesh sieve after which were properly packaged and labeled. While cassava leaves samples were cleaned to remove dust and residues before oven drying to obtain a constant weight.

Thereafter, the samples were pulverized, packaged and labeled for analysis.

Parameters Considered in Soil and Cassava Leaves

In soil samples, particle size distribution, pH, organic carbon, total nitrogen, available phosphorus, calcium, magnesium, potassium, aluminum while in cassava leaves samples, all the parameters measured in soil were considered except particle size distribution and aluminum in Analytical laboratory, University of Ibadan following laid than procedures.

Soil Fertility Index (SFI) and Soil Evaluation Factor (SEF)

The two-soil quality index were calculated using the following equations (Lu et al., 2002).

$SEF = [\text{exch. K (cmol kg}^{-1}, \text{ dry soil)} + \text{exch. Ca (cmol kg}^{-1}, \text{ dry soil)} + \text{exch. Mg (cmol kg}^{-1}, \text{ dry soil)} - \log (1 + \text{exch. Al (cmol kg}^{-1}, \text{ dry soil)})] \times \text{organic matter (\%, dry soil)} + 5$

$SFI = \text{pH} + \text{organic matter (\%, dry soil basis)} + \text{available P (mg kg}^{-1}, \text{ dry soil)} + \text{exch. K (cmol kg}^{-1}, \text{ dry soil)} + \text{exch. Ca (cmol kg}^{-1}, \text{ dry soil)} + \text{exch. Mg (cmol kg}^{-1}, \text{ dry soil)} - \text{exch. Al (cmol kg}^{-1}, \text{ dry soil)}$

Data Analysis

Data obtained from laboratory analysis were subjected to descriptive statistics such as range, means standard deviation and coefficient of variation.

RESULTS AND DISCUSSION

Soil Particle Size Distribution

Table 1 showed the particle size distribution of the six communities. Sand fractions values varied from 79-81±.85% with CV of 1.07 % at Ovorie and 79-82±1.26% with CV of 1.57% in Urhuoka and the ranged was between 80-83±1.26% with a CV of 1.55% in Igun. It ranged from 78-81±1.26% with a CV of 1.58% at Otefe. Akpobome was 78-81±1.29% with CV of 1.62% while in Oghara, the values ranged from 79-80±.50% with CV of 0.63%

Silt varied from 9-13±1.83% with CV of 16.6% at Ovorie and 10-12±.96% with CV of 8.91% in Urhuoka while in Igun, it varied from 9-12±1.29% with a CV of 12.30%. The values ranged from 11-12±.58% with a CV of

5.02% at Otefe, in Akpobome, it varied from 10-13±1.26% with CV of 11.18% while Oghara values ranged from 11-13±1.00% with CV of 8%.

Clay fraction values varied from 7-10±1.31% with CV of 14.82% at Ovorie and 8-10±1.15% with CV of 12.83% at Urhuoka and 7-10±1.26% with a CV of 15.25% in Igun. It ranged from 8-10±.96% with a CV of 10.94% at Otefe while Akpobome values varied from 9-10±.50% with CV of 5.41% and in Oghara, it ranged from 7-10±1.26% with CV of 15.25%. The textural class of the locations (loamy sand) were good for cultivation of cassava. This indicates that soil texture is not a problem in the zone (Ojobor et al., 2021)

pH Changes in Soil and Cassava Leaves

There were pH changes with MAP, highest soil pH value was measured at 9MAP in Igun whereas the least was recorded at 5MAP in Akpobome farm (Figure 1). It ranged at Ovorie from 5.8-6.4 ±.25 with CV of 4.12% and between 5.9-6.7±.12 with CV of 5.98% in Urhuoka while the values ranged from 6.1-6.8±.30 with a CV of 4.68% at Igun. It ranged between 5.9-6.5 ±.29 with CV of 4.58% in Otefe, between 5.8-6.6±.34 with a CV of 5.43% in Akpobome while at Oghara, the values ranged between 6.0-6.7 ±.38 with CV of 5.97%.

In cassava leaves the value ranged from 6.0-6.6±.27 with a CV of 4.4% at Ovorie, 6.0-6.9±.39 with a CV of 6.1% in Urhuoka, 6.1-6.4±.18 with a CV of 2.94% at Igun, 6.3-7.0±.32 with a CV of 4.72% in Otefe, 7.0-7.6±.25 with a CV of 3.41% at Akpobome and 6.2-7.1±.38 with a CV of 5.66% at Oghara. There were successive pH changes in soil and cassava leaves in the region (Fig 1). Soil pH changes were similar in Ovorie, Urhuoka and Otefe whereas, Igun, Akpobome and Oghara followed same trend. Highest peak of soil pH was observed in Igun while the least was recorded in Ovorie and Akpobome. Higher pH values in the farms could be due to exchangeable base released decomposition that cause the reduction of H⁺ and Al ions on exchange complex (Ibrahim & Idoga, 2015). pH changes of cassava leave at different growth stages following a trend

slightly similar to changes in soil pH. The variation at the different locations can be attributed to the difference in the microclimatic conditions of the farms (Löbs *et al.*, 2020). The slight acidic nature of the areas under investigation indicated that metals will not be a threat as their available in the soils may not reach toxic levels to cultivated cassava because mobility and availability of metals are not affected by pH increase in soil as a result of decreased metal solubility (Lake, 2000, Umeri *et al.*, 2017 and Onwuka *et al.*, 2022).

Organic Carbon Changes in Soil and Cassava Leaves

Organic carbon changes at different stages of sampling and was highest in Akpobome at 5MAP and lowest in Ovorie at 9MAP (Figure 2). At Ovorie, it ranged from 1.16-1.58±.21 with CV of 15.44%, between 2.04-2.58±.26 with CV of 11.43% in Urhuoka while at Igun, it ranged from 1.83-2.15±.15 with a CV of 7.71%. In the same vein it ranged between 2.15-2.51±.17 with CV of 7.58% in Otefe and ranged from 1.58-2.64±.46 with a CV of 23.37% in Akpobome while at Oghara, it ranged between 1.88-

2.24±.16 with CV of 7.74%. The leaves organic carbon content was highest in Akpobome at 5MAP and lowest at 7MAP in Ovorie. Though, it ranged from 41.5-64.9±9.97 with a CV of 18.2% at Ovorie, 43.6-61.8±8.92 with a CV of 16.4% at Urhuoka, 43.1-71.0±13.3 with a CV of 24.9% at Igun, 41.8-64.2±9.35 with a CV of 17.9% at Otefe, 45.8-71.3±12.0 with a CV of 22.5% at Akpobome and 43.7-60.3±.7.81 with a CV of 14.3% at Oghara. Soil organic carbon was mostly low and could be attributed to crop removal (Onwudike *et al.*, 2016). Changes in soil organic carbon content was similar at Ovorie, Otefe and Oghara. At Akpobome and Urhuoka, it followed same trend as cassava leaf organic carbon concentration which showed a downward trend in all locations having its highest concentration at 5MAP except at Ovorie where it's highest at 3MAP. The investigated regions have high OC content as the values are within 1.5 – 2.0 % and even in higher range in most cases according to the rating of (FMARD, 2012) attributed to decomposition organic waste (Umeri *et al.*, 2017 and Onwuka *et al.*, 2022).

Table 1. Soil Particle Size Distribution (%)

Location		Sand	Silt	Clay	Textural Name
Ovorie	Mean	80.13	11.00	8.88	Loamy Sand
	SD	0.85	1.83	1.31	
Urhuoka	Mean	80.25	10.75	9.00	Loamy Sand
	SD	1.26	0.96	1.15	
Igun	Mean	81.25	10.50	8.25	Loamy Sand
	SD	1.26	1.29	1.26	
Otefe	Mean	79.75	11.50	8.75	Loamy Sand
	SD	1.26	0.58	0.96	
Akpobome	Mean	79.50	11.25	9.25	Loamy Sand
	SD	1.29	1.26	0.50	
Oghara	Mean	79.25	12.50	8.25	Loamy Sand
	SD	0.50	1.00	1.26	

Key: SD = Standard Deviation

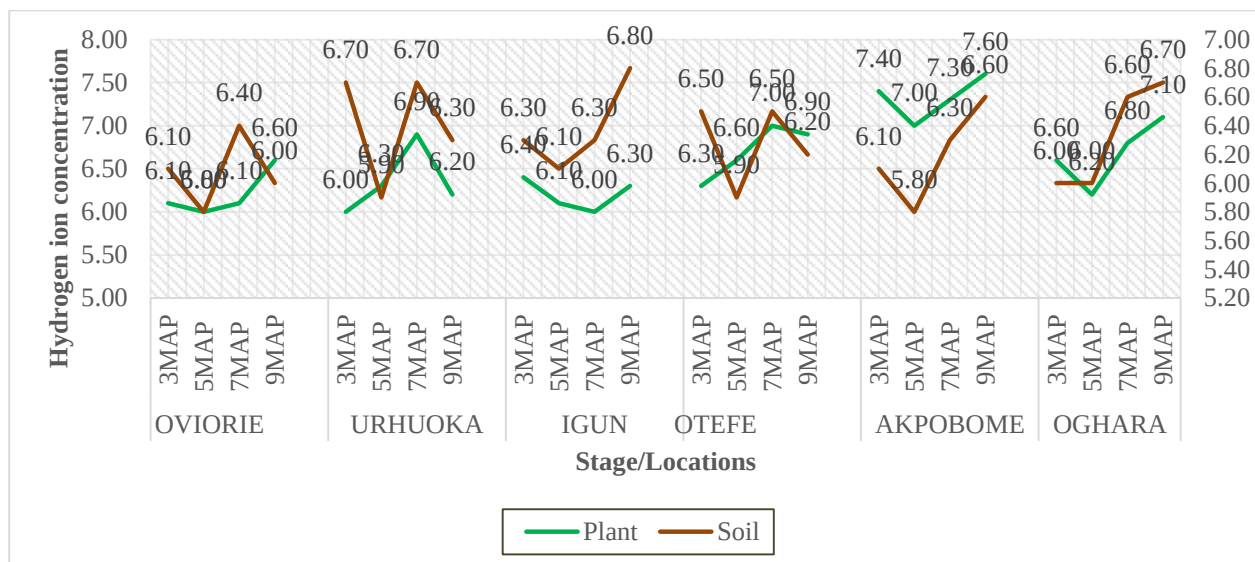


Figure 1: Successive pH changes in Soil and Cassava Leaves

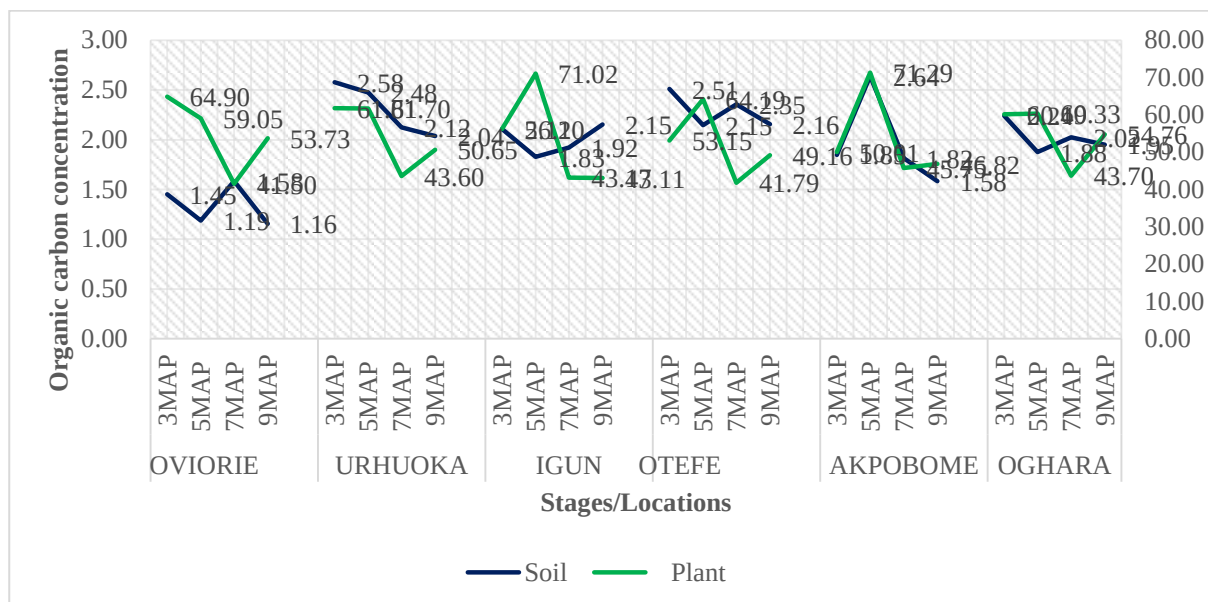


Figure 2: Successive Organic Carbon in soil and cassava leaves

Nitrogen changes in soil and cassava leaves

The highest total nitrogen at 7MAP was found in Akpobome and the lowest at 3MAP in Oghara (Figure 3). The value at Oviorie, ranged from 0.13-0.17±.02 with CV of 14.67%, it varied between 0.14-0.20±.03 with CV of 16.82% in Urhuoka and ranged from 0.13-0.19±.03 with a CV of 17.53% in Igun. At Otefe, it ranged between 0.13-0.20 ±.03 with CV of 23.07%, from 0.17-0.29±.05 with a CV of 23.32% in Akpobome and 0.12-0.21±.04 with CV of 22.85% at Oghara.

Cassava leaves in Otefe had the highest nitrogen concentration at 7MAP while the least was reported at 5MAP in Oviorie. It ranged from 3.32-5.19±.80 with a CV of 18.2% at Oviorie, 4.14-5.34±.58 with a CV of 12.51% at Urhuoka, 4.73-4-5.36±.29 with a CV of 5.86% at Igun, 3.66-5.99±1.10 with a CV of 23.69% at Otefe, 3.70-5.70±.88 with a CV of 19.64% at Akpobome and 4.14-4.92±.35 with a CV of 7.91% at Oghara. Total nitrogen found in soils were mostly at moderate levels with variations in time which

can be due to physical, chemical or biological factors. Suggesting moderate level of adequacy of total nitrogen in the soils of the studied region are available for plant growth. According to Onwudike *et al.* (2016), increased microbial population in soil helps in the organic material decomposition that help release nutrients into the soil. Changes in total nitrogen varied with location with only Akpobome following similar trend. There was an increased between 3MAP and 5MAP which was followed by a decreased at 7MAP and increased again at 9MAP but Oviorie showed steady decrease at 7MAP. The nutrient concentration in the leaves could be attributed to the quantity of soil nitrogen released (Morgan and Connolly, 2013)

Phosphorus Changes in Soil and Cassava Leaves

There were successive changes of available phosphorus with MAP and was highest at 7MAP in Igun and lowest at 3MAP

in Oviorie. Also, it ranged from 12.72-26.60±6.48 with a CV of 38.20% in Oviorie and 15.20-28.42±6.31 with a CV of 33.07% in Urhuoka while at Igun, it was between 20.38-31.67±5.09 with a CV of 25.71%. It ranged from 14.78-17.60±1.20 with a CV of 7.38% in Otefe soils and ranged from 13.92-33.88±8.00 with a CV of 34.88% in Akpobome while at Oghara, the values ranged from 16.25-22.76±2.68 with a CV of 13.54%. The concentration in cassava leaves was highest in Akpobome at 7MAP and lowest in Oviotie at 9MAP. The value ranged from 0.19-0.31±.05 with a CV of 21.9% at Oviorie, 0.21-0.32±.04 with a CV of 16.48% at Urhuoka, 0.20-0.32±.05 with a CV of 19.37% at Igun, 0.22-0.30±.04 with a CV of 13.37% at Otefe, 0.27-0.37±.05 with a CV of 15.26% at Akpobome and 0.20-0.36±.07 with a CV of 23.74%. Available phosphorus was low at Oviorie and Otefe, moderate at Urhuoka and high in other locations.

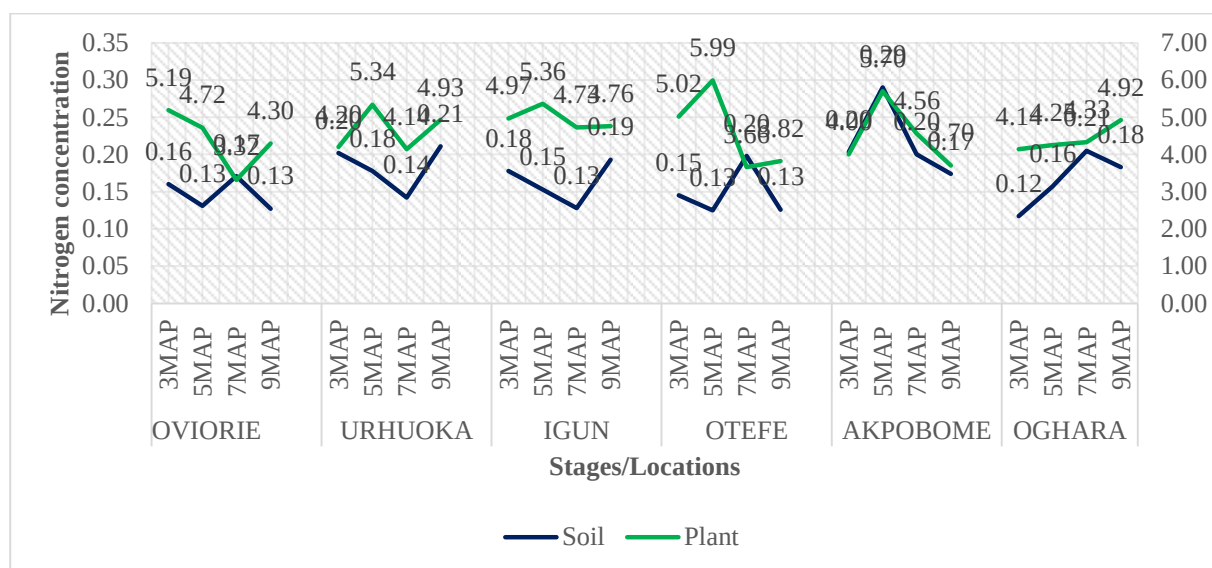


Figure 3: Successive Total Nitrogen Changes in Soil and Cassava Leaves

Organic materials decomposition can produce humus which reduce phosphorus fixation in the soil (Kavitha & Sujatha, 2015). The phosphorus concentration in cassava leaves increased with time and decreased between 7MAP and 9MAP in the locations. High levels of available phosphorus in the studied areas could be as result of fertilizer application and probably other amendments (Kamalu *et al.*, 2022). Furthermore, the slight

soil acidity could probably not have inhibited micro-organisms preventing P fixation resulting in the higher critical level considered suitable for crop production. Therefore, cassava growth is not vulnerable to P deficiency (Bouain *et al.*, 2014, Mongon *et al.*, 2017 and Onwuka *et al.*, 2020).

Potassium Changes in Soil and Cassava Leaves

Akpobome recorded the highest value of potassium at 7MAP while had the least at 3MAP in Igun (Figure 5). The contents varied from $0.10\text{-}1.41\pm.62\text{cmol/kg}$ with a CV of 128.78% in Ovorie, $0.11\text{-}0.39\pm.14\text{cmol/kg}$ with a CV of 58.48% at Urhuoka and it ranged from $0.09\text{-}1.54\pm.68\text{cmol/kg}$ with a CV of 121.75% in Igun. Also, the values ranged $0.11\text{-}0.57\pm.24\text{cmol/kg}$ with a CV of 75.14% in Otefe, and ranged from $0.13\text{-}3.34\pm.154\text{cmol/kg}$ with a CV of 148.31% in Akpobome and $0.21\text{-}1.25\pm.54\text{cmol/kg}$ with a CV of 75.52% at Oghara. Potassium in cassava leaves was highest at 9MAP in Oghara and the least was found in Igun at 3MAP. It varied from $0.63\text{-}1.20\pm.26$ with a CV of 32.49% at Ovorie and $0.71\text{-}1.05\pm.15$ with a CV of 17.32% in Urhuoka. At Igun, the value varied from $0.61\text{-}1.17\pm.28$ with a CV of 32.43% and $0.81\text{-}1.19\pm.19$ with a CV of 19.19% in Otefe. It varied from $0.73\text{-}1.43\pm.32$ with a CV of 27.39% at Akpobome

and $1.04\text{-}1.47\pm.20$ with a CV of 17.54% in Oghara. The soils were mostly moderate in potassium. The varying values in the farms could be due to changes in climatic conditions during growing season. It showed an upward trend in all locations with a decrease at 9MAP at Igun, Otefe, Akpobome and Oghara. The leaves concentration maintained an upward trend although there was a decrease between 3MAP and 5MAP and increase up to 9MAP in Igun, Otefe, Akpobome and Oghara. Other studied locations showed an upward trend with Ovorie showing a decrease at 5MAP. Urhuoka showed an increased at every successive stage. The decline could be due to the consumption of the available quantities and the mobility of potassium from leaves to stem (Xu *et al.*, 2020). The result revealed that K was sufficient for plant growth when compared to critical level (0.24 cmol/kg) indicating that K deficiency is not possible in the studied region (Umeri *et al.*, 2017 and Onwuka *et al.*, 2020)

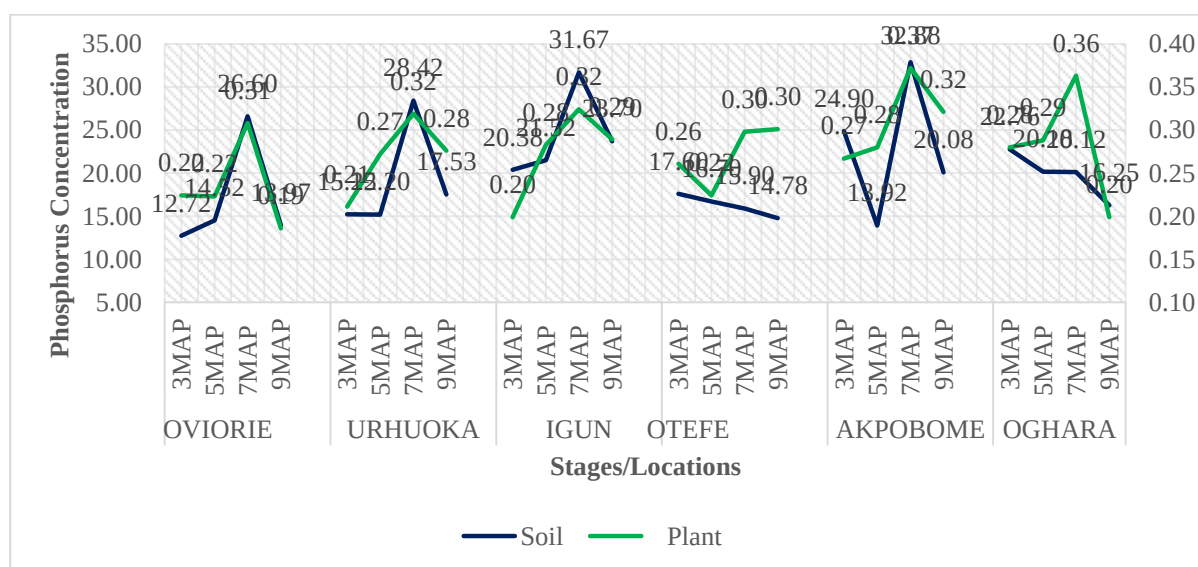


Figure 4: Successive Phosphorus Changes in Soil and Cassava Leaves

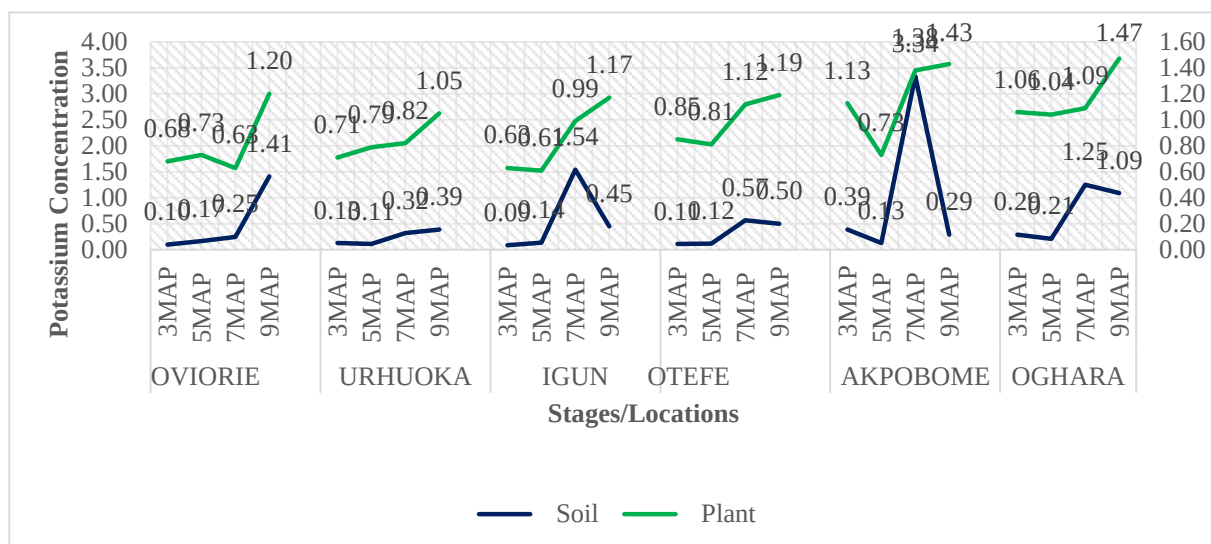


Figure 5: Successive Exchangeable Potassium Changes in Soil and Cassava Leaves

Calcium Changes in Soil and Cassava Leaves

Highest value of calcium was measured in Akpobome and Oghara at 7 and 9MAP, respectively while the least was recorded in Oviorie at 3MAP (Figure 6). It varied from 5.20-7.24±.87cmol/kg with a CV of 13.66% at Oviorie and 5.86-6.70±.40cmol/kg with a CV of 6.23% in Urhuoka while the ranged was 6.14-7.35±.58cmol/kg with a CV of 8.96% in Igun. At Otefe, the values ranged from 5.33-7.70±.89cmol/kg with a CV of 13.34%, it ranged from 5.98-7.73±.76cmol/kg with a CV of 11.10% in Akpobome and 5.67-7.73 ±.91cmol/kg with a CV of 13.16% Oghara. The cassava leaf content was highest at 9MAP in Oghara and lowest in Akpobome at 3MAP. It varied from 1.64-2.06±.17 with a

CV of 9.23% at Oviorie, 1.76-3.20±.64 with a CV of 27.90% at Urhuoka and ranges between 1.58-2.98±.58 with a CV of 26.47% at Igun. The values ranged from 1.42-2.53±.46 with a CV of 22.78% in Otefe. It varies from 1.40-3.83±1.03 with a CV of 43.17% at Akpobome and 1.18-2.78±.42 with a CV of 19.45% in Oghara. Calcium concentration in the leaves during growth cycle increased with MAP although values were similar and 5MAP and 7MAP. The maximum value at 9MAP might have occurred because of the hot and dry weather that forces Cations to the leaves via transpiration stream. The varying values in the farms could be due to changes in climatic conditions such as rainfall that accelerates runoff and leaching (Adamu *et al.*, 2015).

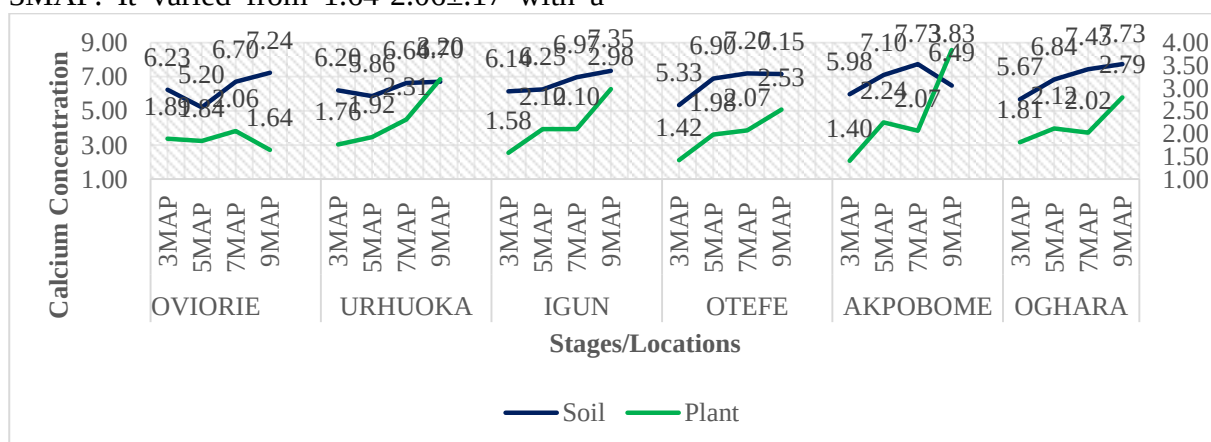


Figure 6: Successive Calcium Changes in Soil and Cassava Leaves

Magnesium Changes in Soil and Cassava Leaves

Akpobome had the highest value of magnesium at 7MAP while the lowest was recorded in Ovorie at 3MAP (Figure 7). The value varied from 0.99-2.63±.79cmol/kg with a CV of 52.2% in Ovorie and 1.21-2.35±.54cmol/kg with a CV of 32.92% in Urhuoka while 1.09 to 2.07±.57cmol/kg with a CV of 35.48% at Igun. It varies from 1.05-1.50±.19cmol/kg with a CV of 14.72% in Otefe, ranges from 0.99-3.26±1.04cmol/kg with a CV of 60.35% in Akpobome 1.96±.38cmol/kg with a CV of 2 Oghara. The percentage magnesium in the studied area were similar and varied from 0.056-0.057±.0005 with a CV of 0.88% at Ovorie and 0.055-0.058±.0013 with a CV of 2.22% at Urhuoka. It varied at Igun from

0.056-0.059±.0015 with a CV of 2.58% and 0.057-0.058±.0005 with a CV of 0.87% in Otefe. Whereas, it varied from 0.055-0.059±.0018 with a CV of 3.2% at Akpobome and 0.055-0.058±.0013 with a CV of 2.24% in Oghara. Leaching and increased mobility of Mg might have caused the low concentration observed during periods of high and intense rainfall ((White & Broadley 2008, Ojobor et al., 2013). According to the critical level of 1.90 cmol/kg recommended by Agboola & Ayodele (1987), most of the studied farms investigated had insufficient exchangeable mg required for proper growth of plant suggesting poor photosynthesis and inhibition of the plant growth and vitality (Unanaonwi and Chinevu, 2013).

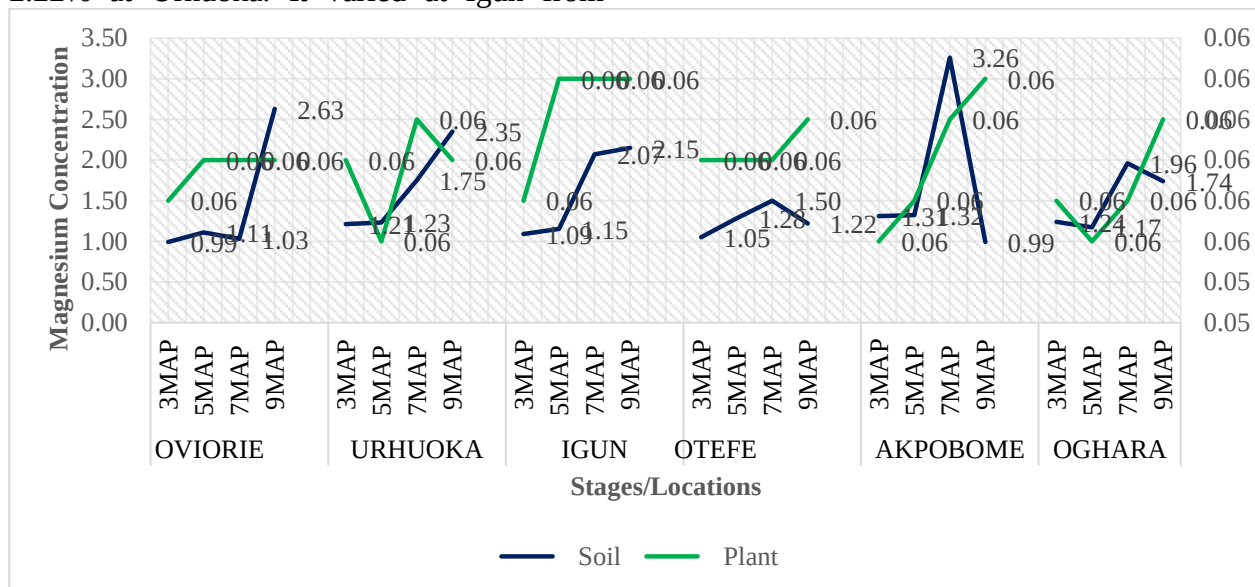


Figure 7: Successive Exchangeable Magnesium Changes in Soil and Cassava Leaves

Soil Fertility Index (SFI) and Soil Evaluation Factor (SEF)

Figure 8 showed that at 3 and 5MAP in Igun, SFI was highest while at 7 and 9 MAP, it was highest in Akpobome followed by Otefe at 3 and 5MAP, Igun and Oghara at 7 and 9MAP, respectively. The SEF value in Otefe was highest at 3 and 5MAP while Akpobome and Igun follows, respectively. It has been observed that continuous cultivation of cassava causes soil loss probably through erosion due to deep plowing, the spacing that are wider and low crop growth initial consequently bringing deeper non-desirable conditions higher sand content closer to the

surface horizon (Howeler, 2017 and Adjei et al., 2023). Soil fertility index and soil evaluation factor provide information on how the soil nutrient levels changed and how they are changing if in predictable ways in relation to how much fertilizer has been applied and how much the grass has grown (Orobator, 2017).

Evaluation Factor (SEF) at Different Growth

Soil organic carbon was adequate while total nitrogen was moderate, P was high generally but K was moderate. Calcium was high whereas most of the farm had

insufficient Mg. The SFI and SEF values at different growth stages shows the dynamic nature of the soils. The values revealed the availability of nutrients to plant and it was higher during period of rainfall. There were variations with peak at 7 MAP in Otefe,

Akpobome and Oghara while Oviorie, Urhuoka and Igun followed same trend. Therefore, this study provides information on the nutrient changes and how fertilizer should be applied.

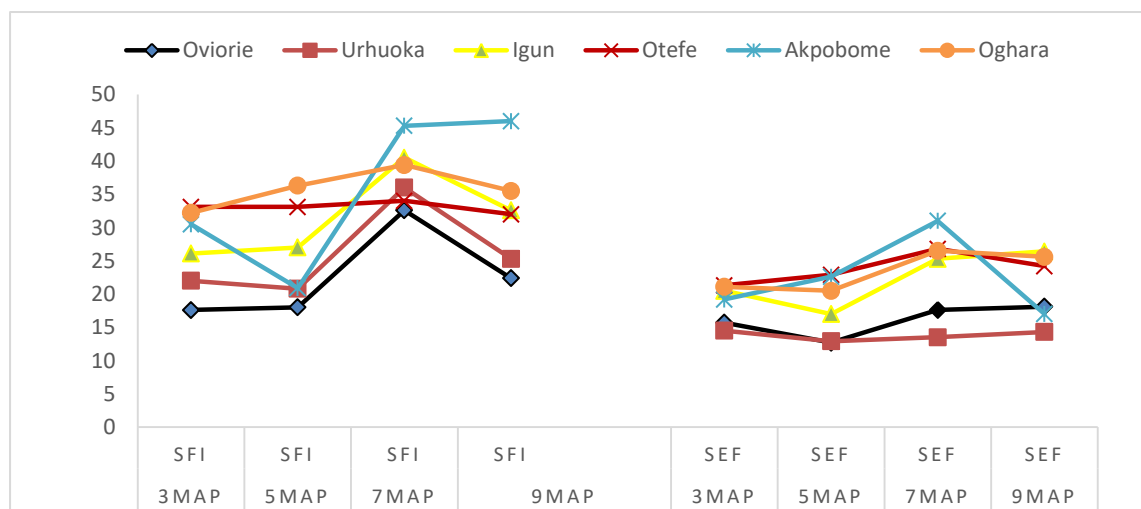


Figure 8: Soil fertility Index (SFI) and Soil

CONCLUSION

The study investigated soil fertility dynamic and leaf nutrient concentrations of six cassava farming communities (Oviorie, Urhuoka, Igun, Otefe, Akpobome and Oghara) in Delta State. The communities were randomly selected from Ethiope Region and representative soil and plant samples were taken at four successive growth stages. Parameters measured were: particle size distribution, pH, organic carbon, total nitrogen, available phosphorus, potassium, calcium, magnesium and aluminum. Data obtained were subjected to descriptive statistics. The soil and cassava leaf nutrient changes of the farms follow similar pattern and relatively higher at 7MAP as soil fertility although K concentration in leaf was higher at 9MAP. Results showed sandy loam texture suitable for cassava production and slightly acidic

REFERENCES

Adamu, U. K., Mrema, J. P. and Page 32 J. (2015). Fertility Status and Sustainability Assessment of Soils for the Production of Maize at Solomon Mahlangu Campus Farm,

Morogoro, Tanzania *Advances in Research*, 5(2). pp. 1-12

Adiele, J. G., Schut, A. G., Van Den Beuken, R. P. M., Ezui, K. S., Pypers, P., Ano, A. O. and Giller, K. E. (2020). Towards closing cassava yield gap in West Africa: agronomic efficiency and storage root yield responses to NPK fertilizers. *Field Crops Research*, 253. pp. 107820.

Adjei, E. O., Ayamba, B. E., Buri, M. M., Biney, N. and Appiah, K. (2023). Soil quality and fertility dynamics under a continuous cassava-maize rotation in the semi-deciduous forest agro-ecological zone of Ghana. *Front. Sustain. Food Syst.* 7:1095207. doi: 10.3389/fsufs.2023.1095207

Agbede, T. M., Adekiya, A. O. (2012). Effect of wood ash, poultry manure and NPK-15-15 15 fertilizer on soil and leaf nutrient composition, growth and yield of okra (*Abelmoschus esculentum*) on a degraded Alfisol of south west

- Nigeria. *Emir. J. Food Agric.*, 24(4). pp. 314–321
- Agboola, A. A. and Ayodele, O. (1987). Soil test for upland rice in southwestern Nigeria. *Fertilizer Research*, 14. pp. 227-234.
- Bouain, N., Shahzad, Z., Rouached, A., Khan, G. A., Berthomieu, P., Abdelly, C., Poirier, Y. and Rouached, H. (2014). Phosphate and zinc transport and signal in plants: Toward a better understanding of their homeostasis interaction. *J. Exp. Bot.* 65. pp. 5725–5741.
- Chianu, J. N., Chianu, J. N. and Mairura, F. (2012). "Mineral fertilizers in the farming systems of sub-Saharan Africa. A review." *Agronomy for sustainable development*. 32(2). pp. 545-566.
- Chikere-Njoku, C. (2017). "Assessment of fertility status of soils used for cassava production in Owerri, Area of Imo State, Nigeria." *Journal of Agriculture and Food Sciences* 15(2). pp. 1-10.
- El-Sharkawy, M. A. (2004). Cassava biology and physiology. *Plant Mol. Biol.* 53. pp. 621-641. doi:10.1007/s11103-005-2270-7
- FAO (2018). Food Outlook - Biannual Report on Global Food Markets – November 2018. Rome, pp.104. Available at <http://www.fao.org/3/CA2320EN/ca2320en.pdf>.
- FMARD (2012). Literature Review on the Soil Fertility Investigation in Southern Nigeria. Federal Ministry of Agriculture and Rural Development. Edited by Chude V.O., 2nd Edition. 250p
- Howeler, R. H. (2017). "Does cassava cultivation degrade or improve the soil. A new future for cassava in Asia: its use as food, feed and fuel to benefit the poor," in *Proceedings 8th Regional Workshop held in Vientiane, Laos*.
- Ibrahim, M. M. and Idoga, S. (2015). Soil Fertility Status of the Research Farm of the University of Agriculture, Makurdi, Benue State, Nigeria. *Donnish Journal of Agricultural Research*. 2(4). pp. 033-036.
- Ikuemonisan, E. S., Taiwo, E. M., Igbekele, A. and Kemisola, A. (2020). "Cassava production in Nigeria: trends, instability and decomposition analysis (1970–2018)." *Heliyon* 6(10). pp. e05089.
- Kamalu, O. J., Ogio, V. and Ikiriko, M. E. (2022). Evaluation of soil quality under different land use types in the coastal plain sands of Niger Delta. *Journal of Global Ecology and Environment*. 15(4). pp. 37-44
- Kavitha, C. and Sujatha, M. P. (2015). Evaluation of soil fertility status in various agro ecosystems of Thrissur District, Kerala, India. *International Journal of Agriculture and Crop Sciences*. 8. pp. 328- 338.
- Lake, B. (2000). Understanding Soil pH Leaflet No. 2. NSW Agriculture publication Agfact AC.
- Löbs, N., Walter, D., Barbosa, C. G. G., Brill, S., Alves, R. P., Cerqueira, G. R., de Oliveira, S. M., de Araújo, A. C., de Oliveira, L. R., Ditas, F., Moran-Zuloaga, D., Pires Florentino, A. P., Wolff, S., Godoi, R. H. M., Kesselmeier, J., Mota de Oliveira, S., Andreae, M. O.,
- Pöhlker, C. and Weber, B. (2020). Microclimatic conditions and water content fluctuations experienced by epiphytic bryophytes in an Amazonian rain forest, *Biogeosciences*, 17. pp. 5399–5416,

- <https://doi.org/10.5194/bg-17-5399-2020>
- Lu, H., Liu, Z., Wu, N., Berne, S., Saito, Y., Liu, B., and Wang, L. U. O. (2002). Rice domestication and climatic change: phytolith evidence from East China. *Boreas*, 31(4): 378-385.
- Mongon, J., Chaiwong, N., Bouain, N., Prom-u-Thai, C., Secco, D. and Rouached H. (2017). Phosphorus and Iron Deficiencies Influences Rice Shoot Growth in an Oxygen Dependent Manner: Insight from Upland and Lowland Rice. *Int. J. Mol. Sci.*, 18. pp. 607.
- Morgan, J. B. and Connolly, E. L. (2013). Plant-Soil Interactions: Nutrient Uptake. *Nature Education Knowledge* 4(8). pp. 2
- Mugo, J., Karanja, N. N., Gachene, C. K., Dittert, K., Nyawade, S. O. and Schulte-Geldermann, E. (2020). Assessment of soil fertility and potato crop nutrient status in central and eastern highlands of Kenya. *Scientific reports*, 10(1). pp. 1-11.
- NIMET (2022). Nigeria Meteorological Center, Abuja, Official Bulletin
- Ojobor, S. A. and Aimufia, P. N. (2022). Fertility status of fadama soils in Asaba, Delta State, Nigeria: *Nigeria Journal of Soil Science*. 32 (1). pp. 72-76
- Ojobor, S. A., Egbuchua, C. N. and Onoriasakpovwa, R. A. (2021). Assessment of soil fertility status using nutrient index approach of Ovu Sub-Clan, Delta State, Nigeria: *Agricultural Science Digest* 41(2). pp. 282-288
- Ojobor, S. A., Okonmah, L. U. and Egbuchua, C. N. (2013). Soil Fertility Status of Oil Palm Plantations in Delta North Agro-ecological Zone, Delta State: *Nigerian Journal of Science and Environment*. 12(1). pp. 20-24
- Oliveira, N. T., Uchôa, S. C. P., Alves, J. M. A., Albuquerque, J. A. A. and Rodrigues, G. S. (2017). Effects of harvest time and nitrogen doses on cassava root yield and quality. *Rev Bras Ciênc Solo* 41: e0150204. <https://doi.org/10.1590/18069657rbcs20150204>
- Onwudike, S. U., Uzoho, B. U., Ihem, E. E., Ahukaemere, C. M., Nkwopara, U., Irokwe, I. F. and Echeanyanwu, G. I. (2016). Evaluation of the fertility status of selected soils in Mbaise, Imo State Southeastern Nigeria using nutrient index method. *Agrosearch* 16(1). pp. 75-86.
- Onwuka, I. J. C., Nwaedozie, J. M., Kwon – Dung, E. H. and Terna, P.T. (2020). Fertility Status of Selected Agricultural Soils Along Major Roads in Nasarawa Eggon and Doma Areas of Nasarawa State, North Central, Nigeria. *J. Chem. Soc. Nigeria*. 45(4). pp. 587 -608
- Orobator, P. O. (2017). Soil Fertility Index and Soil Evaluation Factor as Determinants of Soil Quality Assessment under Different Land Uses in Edo State, Nigeria. *Journal of Nigerian Environmental Society*. 11(2). pp. 21-30.
- Otekunrin, O. A. and Sawicka, B. (2019). Cassava, a 21st century staple crop: How can Nigeria harness its enormous trade potentials? *Acta Scientific Agriculture* 3(8): 194-202.
- Roy, R. N., Finck, A., Blair, G. J. and Tandon, H. L. S. (2006). Plant nutrition for food security. *A guide for integrated nutrient management*.

FAO Fertilizer and Plant Nutrition
Bulletin. 16. pp. 368.

seedlings. *Front. Plant Sci.* 11. pp.
904.doi10.3389/fpls.2020.00904.

Senjobi, B. A. (2007). Comparative Assessment of the Effect of Land Use and Land Type on Soil Degradation and Productivity in Ogun State, Nigeria. 161. pp. *Unpublished Ph. D. Thesis submitted to the Department of Agronomy, University of Ibadan, Nigeria.*

Page 35

Umeri, Y., Onyemekonwu, R. Moseri, H. (2017). Evaluation of physical and chemical properties of some selected soils in mangrove swamp zones of Delta State, Nigeria. *Archives of Agriculture and Environmental Science.* 2(2). pp. 92-97.

Unanaonwi, O. E. and Chinevu, C. N. (2013). Physical and Chemical Characteristics of Forest Soil in Southern Guinea Savanna of Nigeria. *Global Journal of Science Frontier Research.* 13(10). pp. 24-30

Wang, J. L., Liu, K. L., Zhao, X. Q., Zhang, H. Q., Li, D., Li, J. and Shen, F. R. (2021). Balanced fertilization over four decades has sustained soil microbial communities and improved soil fertility and rice productivity in red paddy soil. *Science of the total environment.* pp. 793 1November 148664

White, J. P. and Broadley, M. R. (2008). Biofortification of crops with seven mineral elements often lacking in human diets—iron, zinc, copper, calcium, magnesium, selenium and iodine. *New Phytol.* 182. pp. 49–84

Xu, X., Wang, F., Sha, J., Chen, Q., Tian, G., Zhu, Z., Ge, S. and Jiang, Y. (2020). Effects of potassium levels on plant growth, accumulation and distribution of carbon and nitrate metabolism in apple dwarf rootstock