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Soil fertility dynamics and nutrient concentration of cassava leaves in Ethiope Region, Delta State, Nigeria

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ABSTRACT: *Evaluation of soil fertility dynamics and leaves nutrient concentration changes in cassava, Ethiope Region, Delta State. The region is made of two Local Government Area (Ethiope East and Ethiope West). Six cassava farming communities were randomly selected from the Local Government: Ethiope East (Oviorie, Urhuoka and Igun), Ethiope West (Otefe, Akpobome and Oghara). A representative soil and plant samples were taken at different growth stages: 3 months after planting (3MAP), 5MAP, 7MAP and 9MAP while parameter analyzed were: pH, organic carbon, total nitrogen, available phosphorus, exchangeable bases. Soil fertility index and soil evaluation factor were computed to evaluate the quality of soil. The soils were slightly acidic with values ranging from 5.8 to 6.8 and less variable. Organic carbon and total nitrogen ranged from low to moderate (1.16-2.64%) and (0.12-0.29%), respectively. Available phosphorus ranged from (12.7-33.8mg/kg) exchangeable calcium, magnesium and potassium ranged from 5.20-7.73cmol/kg, 0.99-3.26cmol/kg and 0.09-3.34cmol/kg, respectively. Cassava leaf pH concentration ranged from 6.0-7.6 and also less variable. The organic carbon and nitrogen ranged from 41.5-71.3% and 3.32-5.99% respectively. Phosphorus concentration ranged from 0.19-0.37% while calcium, magnesium and potassium ranged from 1.18-3.83%, 0.055-0.059% and 0.61-1.47% and varied between less and moderate, respectively. Soil fertility index and soil evaluation factor showed higher soil quality at 7MAP in Igun, Otefe, Akpobome and Oghara and at 9MAP in Oviorie and Urhuoka. The soil fertility and leaf nutrient changes of the farms followed similar pattern in some parameters analyzed and a negative relationship in others. The nutrient concentration was relatively higher at 7MAP similar to soil fertility although K concentration was higher at 9MAP. Therefore, site specific nutrient amendment with seasons is recommended for enhanced productivity.*

Key words: Investigation, Delta State, Ethiope region, Soil Fertility, Nutrient Changes.

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 (1). A staple food crop in Nigeria (2). It is extensively cultivated in tropical and subtropical regions as cash crop for many farmers who sell to processors (3). Low yield experienced by farmers caused by poor soil fertility could be address through proper evaluation to identify the limiting nutrients (4). The crop has gain prominence as one of the fastest expanding staple foods in Nigeria due to its rising demand (5), making stakeholders to look continually on how the cassava sub-sector can be shapened (5).

Cassava productivity in the region is greatly influence by poor soil poor management as a result the yield is far below the world potential 90t ha^{-1} (6). Expensive and scarce fertilizers to applications without soil fertility assessment compounded the problems (7,8). Yield reduction has been traced to lack of scientific information that can used for effective soil management (9). Nutrient removed by plant can only be supplied through soil amendment but this in most cases is beyond the means of the rural farmers (10). Studies have showed wide gap between potential and actual yield at the farms (11), pressing for huge need for soil managements. Meaningful results can only be achieved through fertility and nutrient uptake assessment. An essential component of cultivation is soil amendment because nutrients are perquisite for optimum crop yield (12). 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 (12).

Food insecurity has been a major challenging problem facing many developing countries for instance, Nigerians spend over 70% of their monthly income on food importation due to inability to grow enough food for the increasing population (13). This is traceable to soil infertility and land degradation (14). Nutrients are constantly removed from the soil through plant uptake, leaching and erosion. In some cases, elements are tied up by soil particles making them unavailable to plants. Some soil types may be naturally high in one element but low in another. In this kind of condition, optimum productivity cannot be sustained without adequate knowledge of the fertility. Therefore, increasing cassava productivity can be achieved by enhancing soil fertility and this can be done by investigating the variability of nutrients and determine the controlling factors so that proper measures can be taken for site specific management. On this premise optimum yield can be realized through proper fertilization by ensuring the right amount, right time, right place and right source (4R nutrient stewardship) required for improved production of crop (15). With the increasing demands for food, more effective utilization of degraded soils will be needed. This is where fertilization with adequate knowledge of soil fertility comes to play by minimizing losses and attendant environmental effects of excess application.

The minimum nutrient concentration required by a crop is referred to as critical value which is necessary to determine Nutrition Indices (NI), as a ratio between actual and critical nutrient concentration of a plant at different growth stages. Critical

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nutrient concentration and nutrition index have also been used as a diagnostic tool to determine crop demand for nutrients (16,17). Understanding soil fertility as well as the nutrient uptake during the growth cycle can help to conceive nutritional needs and identify management practices. Studies of such on soils use for cassava production in Delta State is relatively scarce hence, the objective of this study are to: 1) evaluate soil fertility changes and assess the nutrient concentration changes of cassava leaves; 3) establish soil fertility index and soil evaluation factors.

MATERIALS AND METHODS

Study Area

Observation, sample collection and evaluation were conducted from October, 2021 to August, 2022 in Ethiope Region, Delta State of Nigeria. The region covers two Local Government Areas (Ethiope East and West) and three known farming communities were randomly selected in each Local Government area. In Ethiope East, Oviorie-Ovu (5°40'0"N and 5°55'0"E), Urhuoka (5°48'26"N and 6°06'32"E) and Igun (5°44'48"N and 5°57'27"E). Whereas in Ethiope West, 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) were taken. The locations fall within the Niger Delta, which contains deep deposits of relatively young material 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 climate with mean annual temperature of 32.80 C$^{\circ}$ and annual rainfall of 2673.8mm.

Soil and cassava leaves sample collection

Reconnaissance visit was conducted in the region to identify farms where soil and plants samples would be collected. Ten (10) soil samples were taken at equal distances from each farm at 0-30cm depth with soil auger and bulked together to form a composite sample. Plant samples were collected from cassava leaf tissue by cutting cassava leaves along with its petioles using a knife. Thirty cassava leaves were collected from each sampling area (a leaf per stand taken at random). The plant samples were collected along with soil samples in all the farms at four different times that is, at three months after planting (3MAP), 5MAP, 7MAP and 9MAP.

Soil and cassava leaves Sample Preparation

The soil samples that were collected were air-dried at room temperature taken immediately to the laboratory and later sieved with a 2mm mesh sieve. After which the soil samples were properly packaged and labeled for analysis. Cassava leaves samples were cleaned to remove dust and residues and oven dried for 5days to obtain a constant weight. After drying, the samples were grinded, packaged and labeled for analysis.

Parameters and Laboratory procedures

Soil pH, organic carbon, total nitrogen, available phosphorus, exchangeable acidity, exchangeable bases (Calcium, Magnesium, Potassium, and Sodium), heavy metals (Iron, copper, manganese, and zinc), Ammonium, nitrate, Cation exchange capacity. Effective cation exchange capacity and base saturation were computed. Whereas in cassava leaves samples, plant pH, organic carbon, total nitrogen, phosphorus, potassium, calcium, magnesium, sodium and micronutrients (iron, copper, manganese and zinc). All the samples were analysed to according IITA (18).

Nutrient index availability

The nutrient availability index was calculated with reference to fertility rating chart in Table 1 in page 5 (19) and soil fertility was compared according to Parker *et al*. (20) nutrient index that was modified by Kumar et al. (2013) in the farms.

Nutrient index = {(1x A) + (2 x B) + (3 x C)}/NS

Where A = number of samples in low category,

B = number of samples in medium category and

C = number of samples in high category,

NS = total number of samples.

Soil pH, organic carbon, total nitrogen, available phosphorus, potassium, calcium and magnesium were used to calculate nutrient index values based on specific rating chart on Table 1

Table 1 Showing Soil rating chart and their nutrients indices

	Range		
Soil properties	Low	Medium	High
Soil pH	5.5-6.0	6.1-6.9	7.1-8.5
	Moderately acidic	Slightly acidic	Slightly alkaline
Organic carbon (%)	< 2.0	2.0-3.0	> 3.0
Total nitrogen (%)	< 0.15	0.15-0.20	> 0.20
Available phosphorus (mg/kg)	< 15	15-25	>25
Exchangeable potassium (cmol/kg)	< 0.2	0.2-0.4	>0.4
Exchangeable calcium (coml./kg)	< 1.5	1.5-4.5	>4.5
Exchangeable magnesium (cmol/kg)	< 1.5	1.5-4.5	>4.5

Source: FMARD (2012)

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

This was calculated using the following equations below according to Lu et al. (2002).

SFI = pH + organic matter (%, dry soil basis) + available P (mg kg−1, dry soil) + exch. K (ceq kg−1, dry soil) + exch. Ca (ceq kg−1, dry soil) + exch. Mg (ceq kg−1, dry soil) − exch. Al (ceq kg−1, dry soil) **SEF** = [exch. K (ceq kg−1, dry soil) + exch. Ca (ceq kg−1, dry soil) + exch. Mg (ceq kg−1, dry soil) − log (1 + exch. Al (ceq kg−1, dry soil))] × organic matter (%, dry soil) + 5

Data Analysis

Data were subjected to descriptive statistics such as range, means standard deviation and coefficient of variation

RESULTS AND DISCUSSION

pH changes in soil and cassava leaves

Soil pH values at Oviorie, ranged 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 at Igun, the values ranged from 6.1-6.8±.30 with a CV of 4.68%. 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%. Hydrogen ion concentration in cassava leaf tissue ranged from 6.0-6.6±.27 with a CV of 4.4% at Oviorie, 6.0-6.9±.39 with a CV of 6.1% at 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% at 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 was similar in Oviorie, Urhuoka and Otefe whereas, Igun, Akpobome and Oghara followed same trend. Highest peak of soil pH was observed in Igun while the least peak was recorded in Oviorie and Akpobome. Higher pH values in the farms could be due to releases exchangeable bases after decomposition which reduced accumulation of H+ and Al+++ ions on soil exchange complex (22). The pH of cassava leaves of Akobome had the highest peak while Igun had the least. Changes were observed in pH of cassava leaves 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

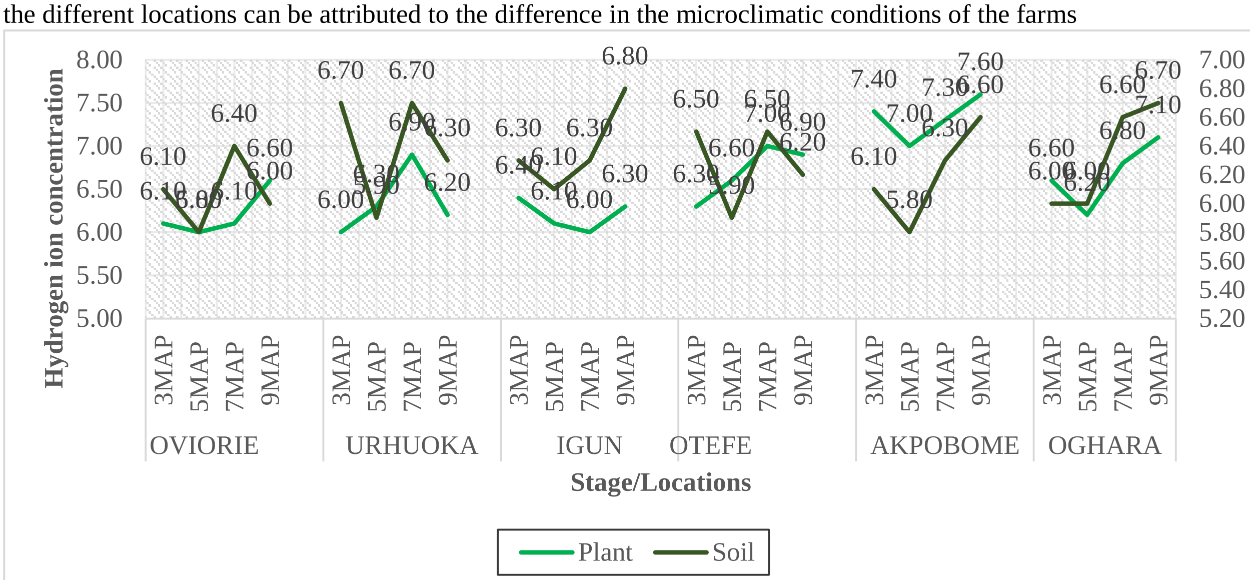

Fig 1. Successive pH changes in soil and cassava leaves in the study area

Organic carbon changes in soil and cassava leaves

The organic carbon at Oviorie soil ranged from 1.16-1.58±.21 with CV of 15.44%, the content varied 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% The content of organic carbon ranged between 2.15-2.51±.17 with CV of 7.58% in Otefe soils 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 organic carbon content ranged from 41.5-64.9±9.97 with a CV of 18.2% at Oviorie, 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 in these soils and the low to moderate values of soil organic carbon could be attributed to intensive cultivation coupled with crop removal which reduces organic carbon over time as well as burning which is a common practice destroying the organic residue that could have added to the organic matter content to the soil (23). Changes in Soil Organic carbon content was similar at Oviorie, 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 Oviorie where its highest was at 3MAP. Uptake of CO2 and allocation of carbon to respiration and biomass components (above-ground net primary production (ANPP) and below-ground net primary production (BNPP) is affected by water availability, nitrogen levels, temperature, stand age, and levels of atmospheric gases (24).

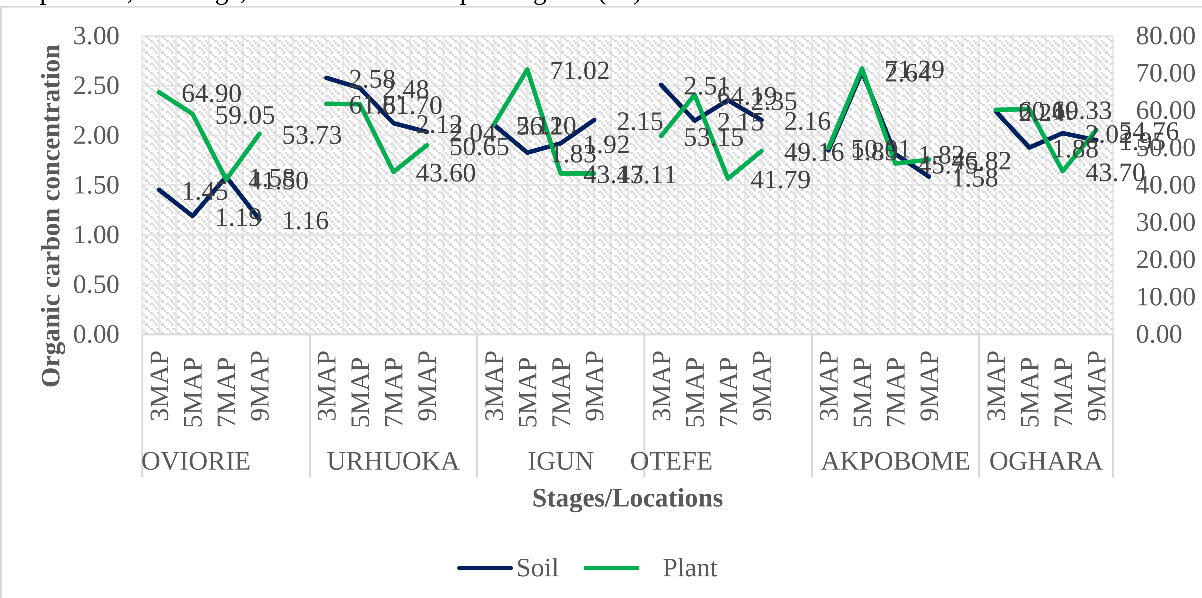

Fig 2. Successive Organic Carbon in soil and cassava leaves in the study area

Nitrogen changes in soil and cassava leaves

Total nitrogen at Oviorie, ranged from 0.13-0.17±.02 with CV of 14.67%, 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. The nitrogen content at Otefe ranged between 0.13-0.20 ±.03 with CV of 23.07%, ranged 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. Nitrogen concentration 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%. Total nitrogen found in soils was mostly in moderate levels with variations in time which can be due to physical, chemical or biological factors. According to Onwudike et al. (26), increased microbial population in soil helps in the organic material decomposition. The decomposition process help release nutrients into the soil. Changes in Total nitrogen varied with location with only Akpobome following similar trend as leaf concentration. The changes in concentration of nitrogen in cassava leaf also differed with locations. There was an increased between 3MAP and 5MAP which was followed by a decreased between 5MAP and 7MAP and increased again at 9MAP except in Oviorie which showed a steady decrease u to 7MAP and increased afterwards. The concentration levels can be attributed to the quantity of nitrogen released from the soil, quantity of nitrogen released from decomposition of previous crops and previous application of organic wastes.

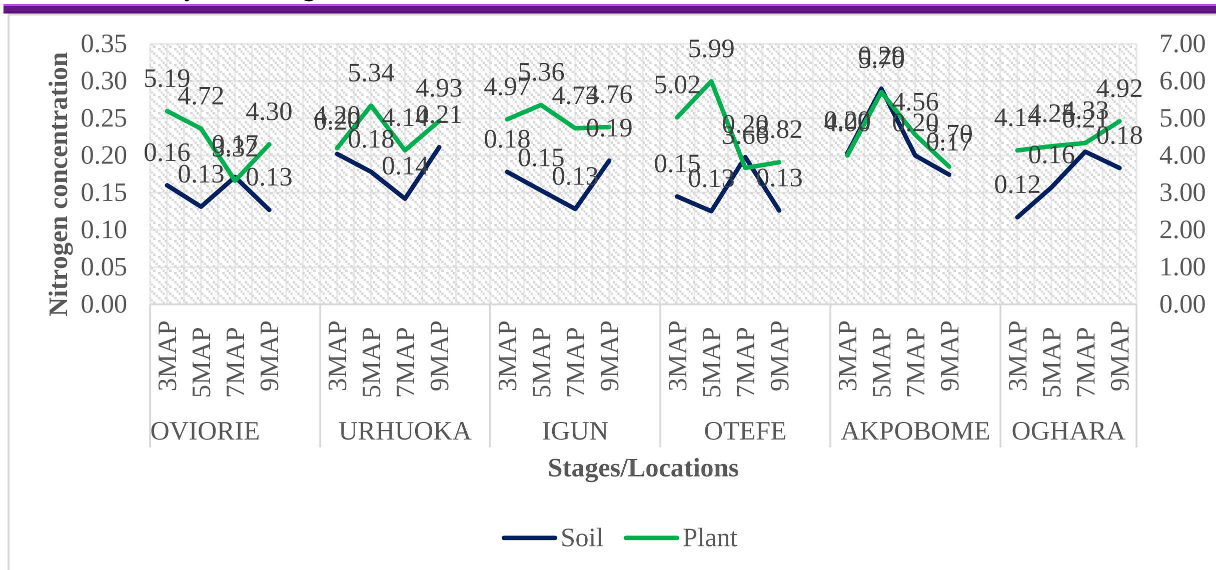

Fig 3. Successive total nitrogen changes in soil and cassava leaves in the study area

Phosphorus changes in soil and cassava leaves

The values of available phosphorus of soils at Oviorie ranged from 12.72-26.60±6.48 with a CV of 38.20% and varies from 15.20-28.42±6.31 with a CV of 33.07% in Urhuoka while at Igun, it ranged from 20.38-31.67±5.09 with a CV of 25.71%. It also ranged from 14.78-17.60±1.20 with a CV of 7.38% in Otefe soils, it 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%. Phosphorus concentration in cassava leaves 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 values were low at Oviorie and Otefe, moderate at Urhuoka and high at other locations. Decomposition of organic materials can produce humus which reduce phosphorus fixation in the soil (27). The phosphorus concentration in cassava leaves increased with time and decreased between 7MAP and 9MAP in the locations. Pistolis (28) supports that there is a P increase when soil temperature and humidity also augment.

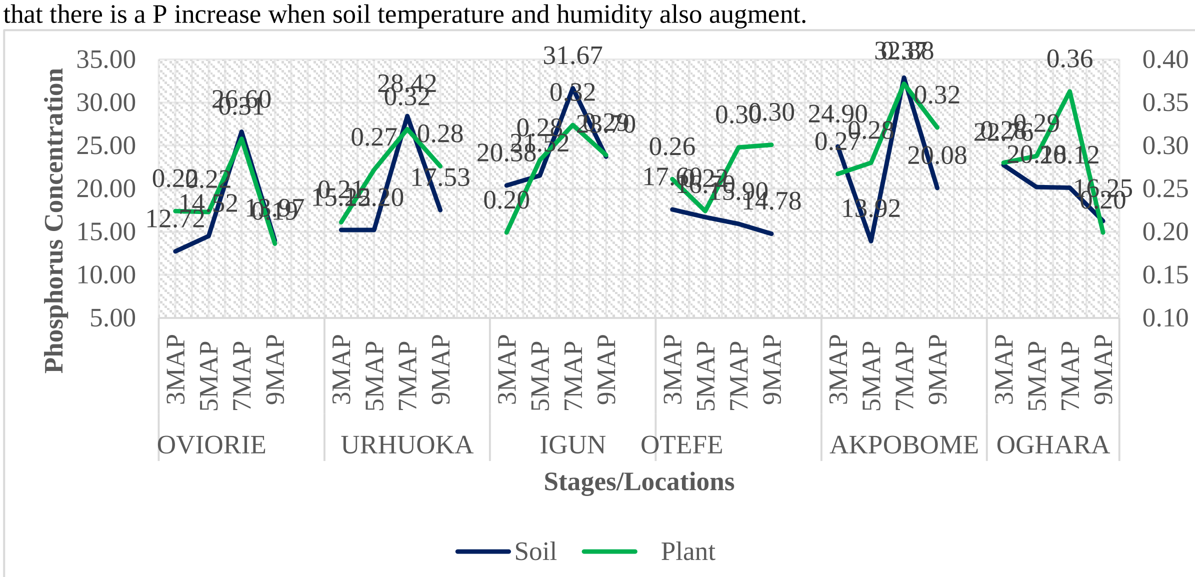

Fig 4. Successive phosphorus changes in soil and cassava leaves in the study area

Potassium changes in soil and cassava leaves

At Oviorie, exchangeable potassium contents varied from 0.10-1.41±.62cmol/kg with a CV of 128.78% and 0.11-0.39±.14cmol/kg with a CV of 58.48% at Urhuoka and it ranged from 0.09-1.54±.68cmol/kg with a CV of 121.75% in Igun. Also, the values ranged 0.11-0.57±.24cmol/kg with a CV of 75.14% in Otefe, and ranged from 0.13-3.34±1.54cmol/kg with a CV of 148.31% in Akpobome and 0.21-1.25±.54cmol/kg with a CV of 75.52% at Oghara. The percentage potassium concentration in cassava leaves varied from

0.63-1.20±.26 with a CV of 32.49% at Oviorie and 0.71-1.05±.15 with a CV of 17.32% at Urhuoka. At Igun, it varied from 0.61-1.17±.28 with a CV of 32.43% and 0.81-1.19±.19 with a CV of 19.19% at Otefe. It varied from 0.73-1.43±.32 with a CV of 27.39% at Akpobome and 1.04-1.47±.20 with a CV of 17.54% at 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. Soil Exchangeable Potassium showed an upward trend in all locations with a decrease at 9MAP at Igun, Otefe, Akpobome and oghara. Potassium concentration in cassava leaves maintained an upward trend although there was a decrease between 3MAP and 5MAP which was followed an increase up to 9MAP at Igun, Otefe, Akpobome and Oghara. Other locations showed an upward trend with Oviorie showing a decrease at 5MAP and Urhuoka showing increase at every successive stage. The decline could be due to the consumption of the available quantities and the mobility of K from leaves to stem. Low temperature during growth season might have lower the values because of the reduced availability and mobility of K.

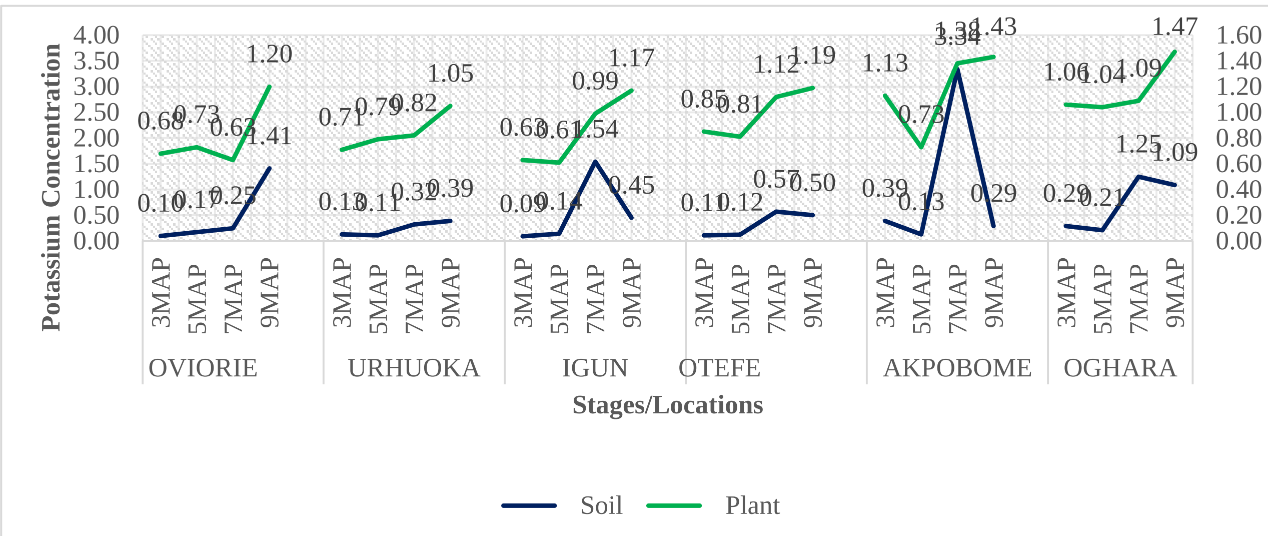

Fig 5.

Successive exchangeable potassium changes in soil and cassava leaves in the study area

Calcium changes in soil and cassava leaves

In Oviorie soils, the exchangeable calcium varied from 5.20-7.24±.87cmol/kg with a CV of 13.66% 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, it 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 percentage calcium content found in cassava leaf tissue varied from 1.64-2.06±.17 with a CV of 9.23% at Oviorie and 1.76-3.20±.64 with a CV of 27.90% at Urhuoka. At Igun, the variation ranges between 1.58-2.98±.58 with a CV of 26.47% and 1.42-2.53±.46 with a CV of 22.78% at Otefe. It varied 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% at Oghara. Calcium concentration in the leaves during growth cycle increased with time through the period of investigation although values were similar between 5MAP and 7MAP. The maximum value was observed at 9MAP and the minimum at 3MAP. The maximum value at 9MAP might have occurred because of the hot and dry weather that forces Ca ions to the leaves via transpiration stream. Fernandez-Escobar *et al* (29) reported results similar to the previously mentioned ones. The soils were high in calcium. The varying values in the farms could be due to changes in climatic conditions during growing season such as rainfall that accelerates runoff and leaching (30). Soil calcium showed increase in levels between 3MAP and 9MAP at Igun and Oghara. At Otefe and Akpobome there was an increase 7MAP followed by a decrease at 9MAP. At Oviorie and Urhuoka where there was a decrease between 3MAP and 5MAP followed by an increase with till 9MAP.

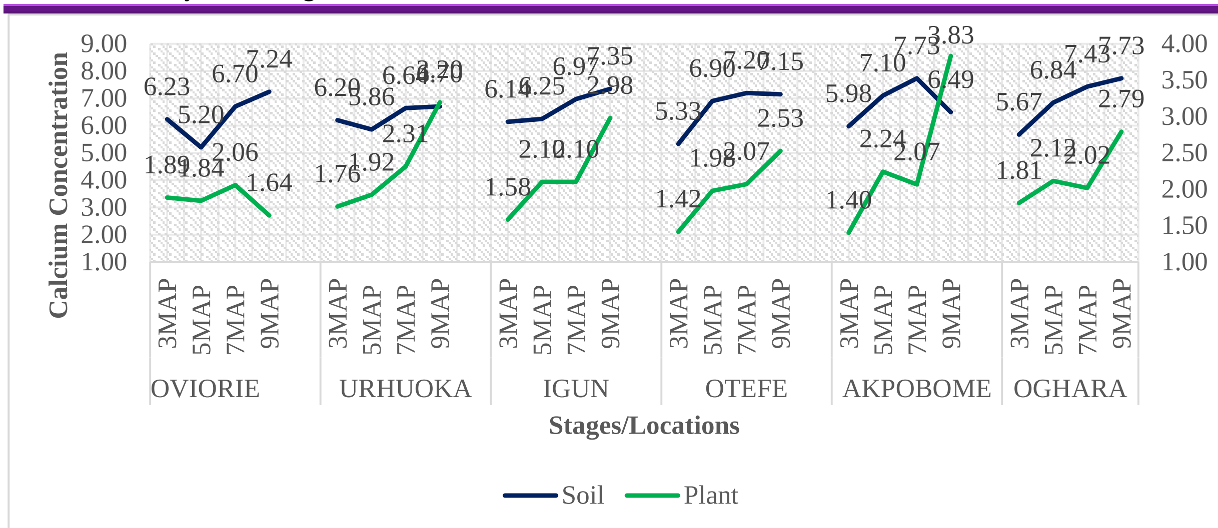

Fig 6. Successive calcium changes in soil and cassava leaves in the study area

Magnesium changes in soil and cassava leaves

The exchangeable magnesium contents of Oviorie soils varied from 0.99-2.63±.79cmol/kg with a CV of 52.2% and 1.21-2.35±.54cmol/kg with a CV of 32.92% in Urhuoka while 1.09 to2.07±.57cmol/kg with a CV of 35.48% at Igun. The values varied from 1.05-1.50±.19cmol/kg with a CV of 14.72% in Otefe, it ranged from 0.99-3.26±1.04cmol/kg with a CV of 60.35% in Akpobome and 1.17-1.96±.38cmol/kg with a CV of 25.15% at Oghara**.** The percentage Magnesium content varied from 0.056-0.057±.0005 with a CV of 0.88% at Oviorie and 0.055-0.058±.0013 with a CV of 2.22% at Urhuoka. At Igun, it varied from 0.056-0.059±.0015 with a CV of 2.58% and 0.057-0.058±.0005 with a CV of 0.87% at Otefe. 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% at Oghara. A similar concentration (0.06% Dry Matter) of magnesium in plant leaf tissue was maintained through assessment period. Easy leaching and increased mobility of Mg (31) might have caused the low concentration observed during periods of high and intense rainfall. Soil Magnesium showed an upward trend in all locations with increase in successive stage except at ethiope west which showed a decrease at 9MAP

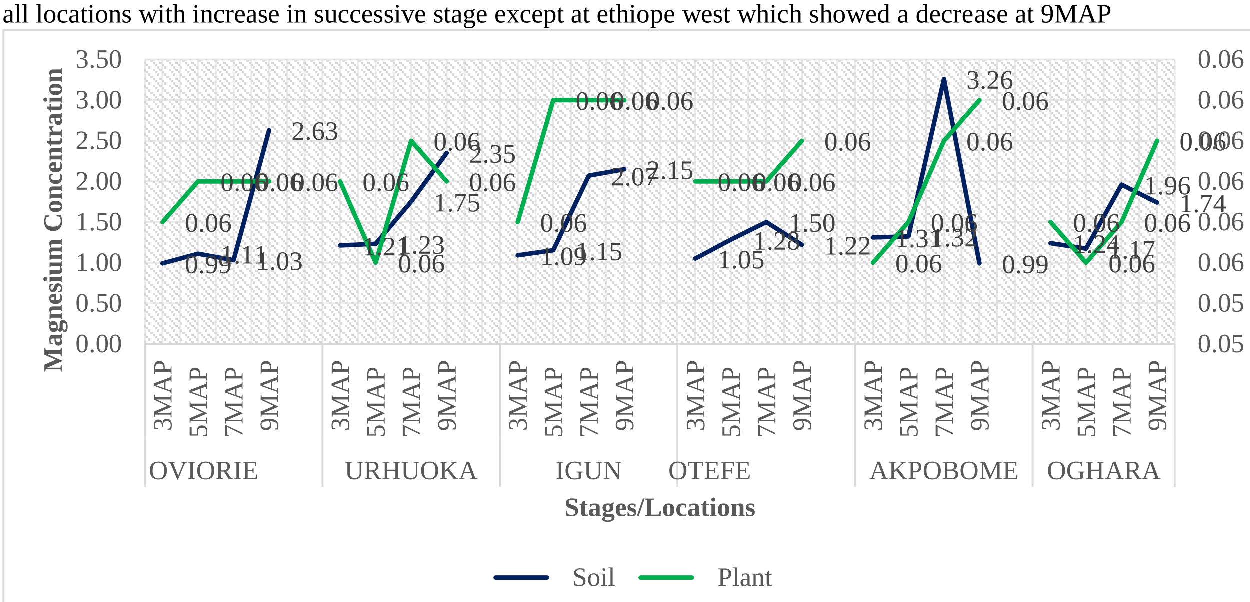

Fig 7. Successive exchangeable magnesium changes in soil and cassava leaves in the study area

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

The values of SFI and SEF with respect to time of assessment at each location is shown in Table 2. There was a decrease in Soil fertility index values between 3MAP and 5MAP except at Oviorie and Igun which showed a slight increase. However, between 5MAP and 7MAP, SFI values increased followed by a decrease at 9MAP. At 7MAP, SFI value was highest in all locations. This reveals that at 7MAP, more nutrients were released through mineralization of organic matter in the soil during the period. Soil

Evaluation Factor was also high at 7MAP confirming the highest SFI values observed at 7MAP. As regards soil fertility changes, the SEF values increased between 3MAP and 7MAP before decreasing at 9MAP except at Oviorie and Urhuoka where the decreased occur between 3MAP and 5MAP. The SFI and SEF values of the cassava farms at different growth stages shows the dynamic nature of the soils. In the farms, the lower fertility status as revealed by its low SFI and SEF values can be a function of its minimal soil cover which boosts the activities of running water, erosion and leaching. Foth and Ellis (32) noted that losses of soil nutrients by leaching appear to be more serious on soils whose surface is almost devoid of undergrowth. Plants and residue cover protects the soil from raindrop influence. This tends slow down the movement of surface runoff, leaching and allows excess surface water to infiltrate. The values of SFI and SEF reveals the availability of nutrients to plant which is higher during rainfall. Another major cause of low values of SFI and SEF could be traceable to poor soil amendment in the location, there was no record of fertilizer usage.

Table 2 Soil fertility index (SFI) and soil evaluation factor (SEF) at different growth stages

LOCATIONS	STAGE	PH	OC	P	Ca	Mg	K	Al	SFI	SEF
		(H2O)	%	MgKg	-------Cmol/kg------		MgKg			
OVIORIE	3MAP	6.10	1.45	12.72	6.23	0.99	0.10	0.00	27.59	12.32
	5MAP	5.80	1.19	14.52	5.20	1.11	0.17	0.00	27.99	11.48
	7MAP	6.40	1.58	26.60	6.70	1.03	0.25	0.00	42.56	12.98
	9MAP	6.00	1.16	13.97	7.24	2.63	1.41	0.00	32.41	16.28
URHUOKA	3MAP	6.70	2.58	15.22	6.20	1.21	0.13	0.00	32.04	12.54
	5MAP	5.90	2.48	15.20	5.86	1.23	0.11	0.00	30.78	12.20
	7MAP	6.70	2.12	28.42	6.64	1.75	0.32	0.00	45.95	13.71
	9MAP	6.30	2.04	17.53	6.70	2.35	0.39	0.00	35.31	14.44
IGUN	3MAP	6.30	2.11	20.38	6.14	1.09	0.09	0.00	36.11	12.32
	5MAP	6.10	1.83	21.52	6.25	1.15	0.14	0.00	36.99	12.54
	7MAP	6.30	1.92	31.67	6.97	2.07	1.54	0.00	50.47	15.58
	9MAP	6.80	2.15	23.70	7.35	2.15	0.45	0.00	42.60	14.95
OTEFE	3MAP	6.50	2.51	17.60	5.33	1.05	0.11	0.00	33.10	11.49
	5MAP	5.90	2.15	16.70	6.90	1.28	0.12	0.00	33.05	13.30
	7MAP	6.50	2.35	15.90	7.20	1.50	0.57	0.00	34.02	14.27
	9MAP	6.20	2.16	14.78	7.15	1.22	0.50	0.00	32.01	13.87
AKPOBOME	3MAP	6.10	1.85	24.90	5.98	1.31	0.39	0.00	40.53	12.68
	5MAP	5.80	2.64	13.92	7.10	1.32	0.13	0.00	30.91	13.55
	7MAP	6.30	1.82	32.88	7.73	3.26	3.34	0.00	55.33	19.33
	9MAP	6.60	1.58	20.08	6.49	0.99	0.29	0.00	36.03	12.77
OGHARA	3MAP	6.00	2.24	22.76	5.67	1.24	0.29	0.00	38.20	12.20
	5MAP	6.00	1.88	20.18	6.84	1.17	0.21	0.00	36.28	13.22
	7MAP	6.60	2.02	20.12	7.43	1.96	1.25	0.00	39.38	15.64
	9MAP	6.70	1.95	16.25	7.73	1.74	1.09	0.00	35.46	15.56

Summary

The study investigate soil fertility dynamic and nutrients concentration of cassava leaves in Ethiope region, Delta State. Six major cassava farming communities were randomly selected and representative soil and plant samples were taken at four successive growth stages. Parameters investigated were: pH, organic carbon, total nitrogen, available phosphorus, exchangeable bases and acidity, effective cation exchange capacity, base saturation, micronutrient elements and particle size distribution. Soil Fertility Index and Soil Evaluation Factor were calculated. The data obtained were subjected to descriptive statistics. The soils were slightly acidic, exchangeable cations ranged from low to high,. The soil fertility and leaf nutrient changes of the farms follows similar pattern. Leaf nutrient concentration was relatively higher at 7MAP as soil fertility although K concentration in leaf was higher at 9MAP. Therefore, site specific nutrient amendment with seasons is recommended for enhanced productivity.

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