

## Influences of seasonal variation on soil chemical contents in selected housing estates within Ogun state

<sup>1</sup>Amujo, B. T. \*, <sup>2</sup>Towolawi, A. T, <sup>2</sup>Adeofun, C. O, <sup>2</sup>Oguntoke, O, <sup>3</sup>Babalola, O. A, <sup>2</sup>Ojekunle, Z. O.

<sup>1</sup>Department of Biological Science, Faculty of Natural and Applied Science, Chrisland University, Abeokuta;

<sup>2</sup>Department of Environmental Management and Toxicology, Federal University of Agriculture, Abeokuta, Ogun State;

<sup>3</sup>Department of Soil Science and Land Management, Federal University of Agriculture, Abeokuta, Ogun State.

\*Corresponding author: (Email: bamujo@chrislanduniversity.edu.ng; Phone: +234 (0)703 716 2284)

### ABSTRACT

Chemical compositions of soil have influences on its fertility. The research was carried out in dry and wet seasons to observe soil chemical parameters and fertility in six different housing estates across Ogun State, Nigeria. Soil samples were collected at the depth of 0-15 cm in a polythene bag; three samples from three points per site, three times in each of the four sampling periods. The samples were analysed for various parameters: EC, CEC, TOC, exchangeable Ca, Mg, Na and K, available N and P using standard methods. Obtained data were subjected to descriptive and inferential statistics, and Linear regression analysis. The EC ( $\mu\text{S}/\text{cm}$ ) ranged from  $105.86 \pm 3.62$  (2<sup>nd</sup> dry season) to  $788.29 \pm 29.00$  (2<sup>nd</sup> wet season); CEC ( $\text{Cmol}/\text{kg}$ ) ranged from  $1.50 \pm 0.25$  (2<sup>nd</sup> dry season) to  $12.49 \pm 1.58$  (1<sup>st</sup> rainy season). Both Ca and Mg were observed to be very low unlike Na which was moderately available ( $R^2 = 0.5159$  in the 2<sup>nd</sup> dry season,  $R^2 = 0.4411$  in the 2<sup>nd</sup> wet season). All the assessed housing estates were observed to have low total organic carbon ( $\text{TOC} < 11.63 \text{ g}/\text{kg}$ ), low nitrogen ( $\text{TN} < 1.5 \text{ g}/\text{kg}$ ) and low phosphorus ( $\text{AvP} < 8.00 \text{ g}/\text{kg}$ ) except 1<sup>st</sup> wet season when compared with soil nutrient ratings in Nigeria. Level of N and P were low while K was high. Soil fertility of the assessed housing estates was lower and needed to be augmented more in the dry seasons than in the rainy seasons.

**Keywords:** Soil fertility, Linear regression analysis, Dry and wet seasons, Nigeria

### INTRODUCTION

Soil quality is a value-based phenomenon affiliated to the objectives of ecosystem management, and hence will be management and ecosystem dependent. Soil quality may include capacity for water retention, carbon sequestration, plant productivity, waste remediation and other functions (Schoenholtz, et al., 2000). Assessment of soil quality and resource was prompted by increasing awareness that soil serves multiple functions

in maintaining worldwide environmental quality (Doran and Parkin, 1994). Soil quality and properties (soil texture, CEC, organic carbon, clay amount, plants species and their nutritional requirements) regulate plant availability to soil macro and microelements (McBride et al., 2003). Soils are being degraded worldwide through processes of erosion, anaerobiosis, salinization, compaction and hard-setting, organic matter

depletion and nutrient imbalance (Papendick and Parr, 1992).

Quality of soil with respect to texture to retain nutrients for plant growth could be classified to range from coarse texture with low TOC (2.91 – 8.72 g/ kg), medium texture with moderate TOC (8.72 – 11.63 g/ kg) to fine texture with high TOC (11.63 – 17.44 g/ kg) (Gelderman, 2013). Benefits of TOC include but not limited to improve physical condition; increase water infiltration and holding capacity; improve soil tilt and structure; decrease erosion losses; reduce compaction; supply plant nutrients; and increase soil CEC. Soil quality, if properly characterised, should serve as an indicator of the soil's capacity to produce safe and nutritious food, enhance human and animal health and overcome degradation processes (Ololade et al., 2010), not only for the large scale farming but also for subsistent because good health and well-being (Sustainable Development Goal 3) for all at all stage ought to be ensured and zero hunger (Sustainable Development Goal 2) should be campaigned and encouraged. Thus, the study selected housing estates for soil quality assessment to secure viability of farm produce from possible subsistent farming.

## MATERIALS AND METHOD

### Study area

Ogun State is located in south-west geopolitical zone of Nigeria and created in 1976 out of old Western state under the military regime with Abeokuta as the state capital. The state has 20 Local Government. The state is situated on Latitude 6.2°N and 7.8°N while on Longitude 3.0°E and 5.0°E sharing boundary with Benin Republic internationally at West while Oyo, Lagos and Ondo states at North, South and East respectively. Weather conditions the state are a tropical pattern with raining season (April-October) and dry season (November-March);

average yearly rainfall ranging from 128 cm southward parts, which are mangrove swamp to 105 cm northward areas which are typically derived Savannah vegetation while the Central part dwells in the rain forest belt. Monthly mean temperature of the state is 23 °C in July and 32 °C in February (CMTN, 2019). The state geology indicated a combination of sedimentary and crystalline rock of the basement complex rocks principally the granite gneisses (Fasina et al., 2015). The landmass of the state is nearly 16, 369.40 km<sup>2</sup> (Ogun State Central Department of Statistics, 2008).

### Data collection and preservation

Soil samples were collected at the depth of 0-15 cm in a polythene bag; three samples from three points per site (Towolawi et al., 2017). The sites were Shagamu, Ijebu-Ode, Laderin, Arigbajo, Obada-Okoko and Ilaro housing estates. Each site was sampled three times in each of the four sampling periods: two rainy seasons and two dry seasons. The samples were air-dried under the shade in the screen house of the Federal University of Agriculture, Abeokuta.

### Laboratory analysis

The air-dried soil samples were sieved through 2 mm sieve. Electrical Conductivity (EC) and Total Organic Carbon (TOC) of the soil were determined according to Ekeke and Okonwu (2013). Determination of Cation Exchange Capacity (CEC) at pH 7 was through ammonium acetate as exchanger (Abebayehu et al., 2011) and available P was extracted by Bray method (Bray and Kurtz, 1945) and P in the extract was determined colorimetrically by spectrophotometer. Total N was determined by Kjeldahl method (Houba et al., 1989). The exchangeable Ca, Mg, Na and K were extracted with Ammonium acetate method (1N NH<sub>4</sub>OAC pH

7.0) (Vaca et al., 2011): Na and K were determined with Flame Emission Photometer (Model PFP7, Jenway Ltd, UK) while Ca and Mg were determined with gravimetric titration (Bada et al., 2014).

### Statistical analyses

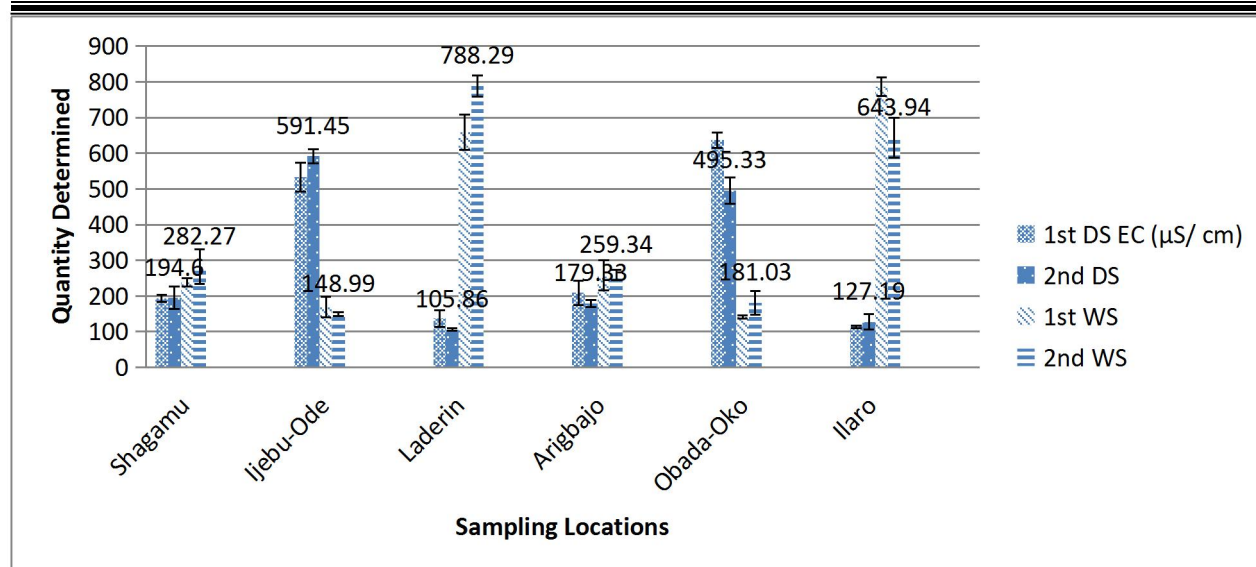
The data collected were subjected to descriptive (mean and standard deviation), inferential (ANOVA and Duncan's Multiple Range Test) statistics using IBM SPSS Statistics 22.

### RESULTS

The results of the soil chemicals and macro-elements across the sampling locations and seasons are represented in Figures 1-9 while comparison of soil fertility indicators across the sampling seasons was depicted in Figure 10. Comparison of some parameters with nutrient ratings for soil fertility in Nigeria is shown on Table 1. Tables 2-5 were presented for inferential statistics to know levels of significances among the mean values across the sampling seasons. Electrical conductivity was observed to range from 105.86 in Laderin in 2<sup>nd</sup> dry season to 788.29  $\mu\text{S}/\text{cm}$  in Laderin in 2<sup>nd</sup> wet season with significant ( $p < 0.05$ ). Highest influence from the sampling locations could be traced to the 1<sup>st</sup> wet season (20.491) with very non-considerable impact (6.00 %) from the Linear regression equation (Figure 1). Levels of the CEC (Cmol/ kg) of the soil samples were determined to be highest: 12.49

in Laderin in the 1<sup>st</sup> wet season and lowest: 1.5 in Ilaro in the 2<sup>nd</sup> dry season. The Linear regression equation showed that the highest influence from the sampling location was observed in the 1<sup>st</sup> wet season (0.083) with possible impact (3.46 %) was in the 1<sup>st</sup> dry season (Figure 2).

Lowest: 0.36 and highest: 9.11 level of Ca was detected ( $p < 0.05$ ) in Laderin in the 1<sup>st</sup> dry season and 1<sup>st</sup> wet season significantly ( $p < 0.05$ ) respectively. Soil samples in the wet were noticed to highly constitute (0.2077) Ca contents in the sampling locations while the readily available contents were minute (8.50 %) (Figure 3). Values of Mg (Cmol/ kg) in the soil of all the studied areas were observed to be lowest: 0.46 in Ilaro in the 1<sup>st</sup> dry season and highest: 2.43 in Ilaro in the 2<sup>nd</sup> wet season. Contents of Mg were observed to be highest (0.029) in the 1<sup>st</sup> wet season, when 3.47 % could be available as possible tapped micronutrient from the Linear regression equation (Figure 4). The Na (Cmol/ kg) level of the soil was measured to range ( $p < 0.05$ ) from 0.08 in Obada-Okole in the 1<sup>st</sup> dry season to 1.05 in Ilaro in the 2<sup>nd</sup> wet season. Though the determined values were generally low, 2<sup>nd</sup> wet season across the sampling locations was observed to have highest (0.0649) level of Na with significant (51.59 %) contents available for uptake (Figure 5). Level of total organic carbon (TOC in g/ kg) was determined to range significantly ( $p < 0.05$ ) from 1.76 in Laderin in the 2<sup>nd</sup> dry season to 8.80 in Arigbajo in the 1<sup>st</sup> wet season.



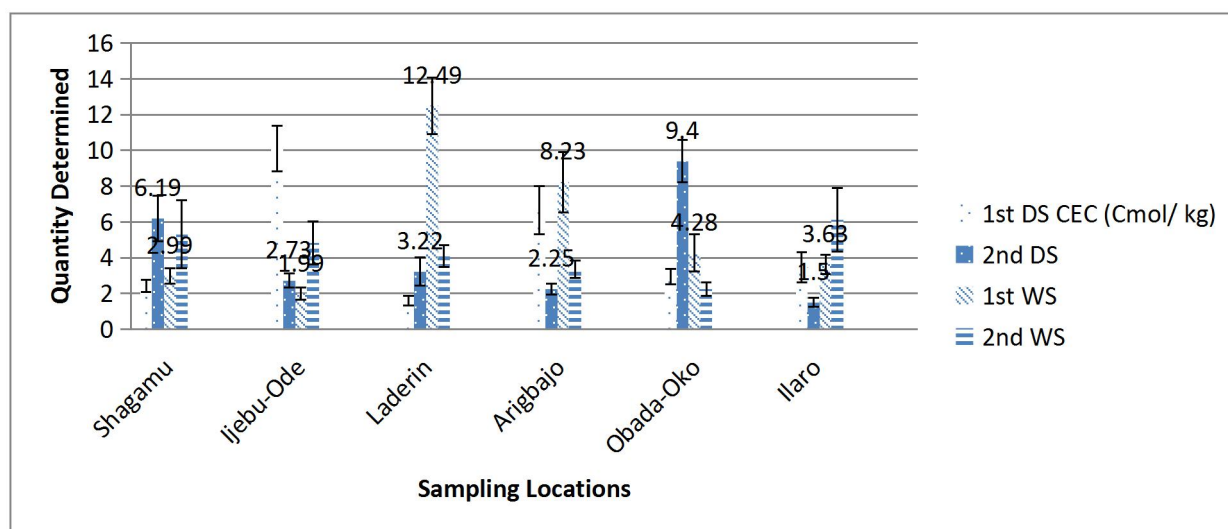
**Fig. 1.** Levels of EC (µS/ cm) across the Sampling Seasons and Locations

$$Y(1^{\text{st}}\text{-WS}) = 20.491x + 81.709 \quad (R^2 = 0.0606, 6.00 \%)$$

$$Y(2^{\text{nd}}\text{-WS}) = 12.505x + 134.41 \quad (R^2 = 0.0228, 2.28 \%)$$

$$Y(1^{\text{st}}\text{-DS}) = -0.1133x + 166.35 \quad (R^2 = 3\text{E-}06)$$

$$Y(2^{\text{nd}}\text{-DS}) = -5.0176x + 184.08 \quad (R^2 = 0.0064, 0.60 \%)$$



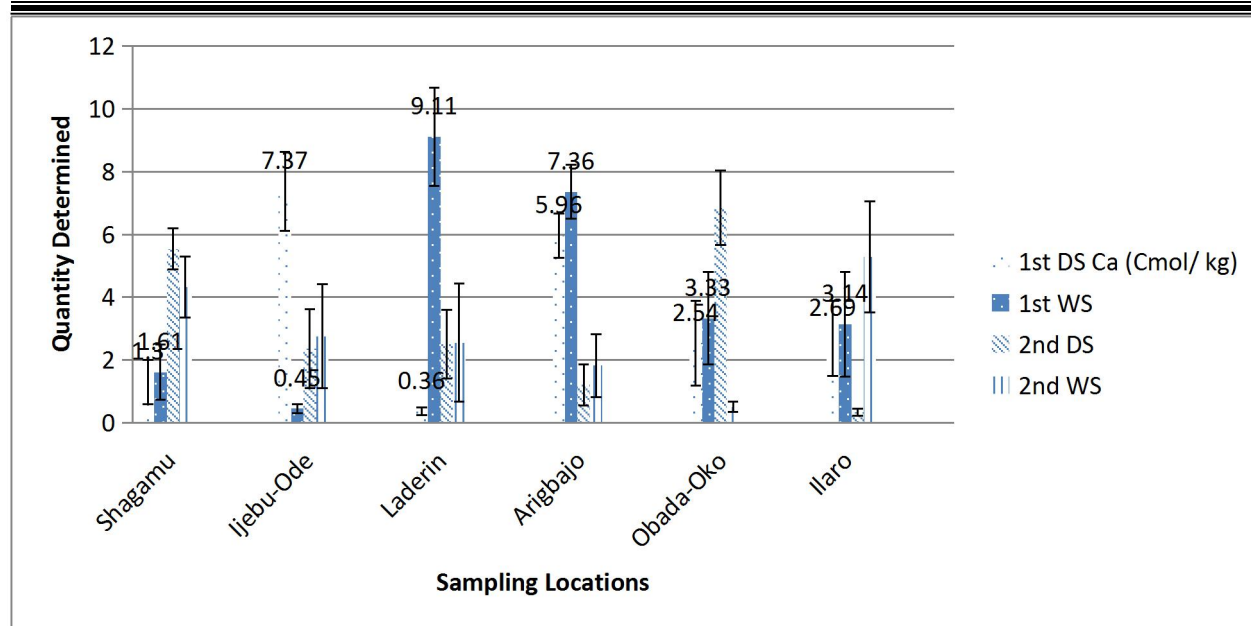
**Fig. 2.** Levels of CEC (Cmol/ kg) across the Sampling Seasons and Locations

$$Y(1^{\text{st}}\text{-DS}) = -0.1609x + 5.4985 \quad (R^2 = 0.0346, 3.46 \%)$$

$$Y(2^{\text{nd}}\text{-DS}) = -0.063x + 4.593 \quad (R^2 = 0.0061, 0.60 \%)$$

$$Y(1^{\text{st}}\text{-SW}) = 0.083x + 5.1037 \quad (R^2 = 0.006, 0.60 \%)$$

$$Y(2^{\text{nd}}\text{-SW}) = -0.0624x + 4.7029 \quad (R^2 = 0.0281, 2.81 \%)$$



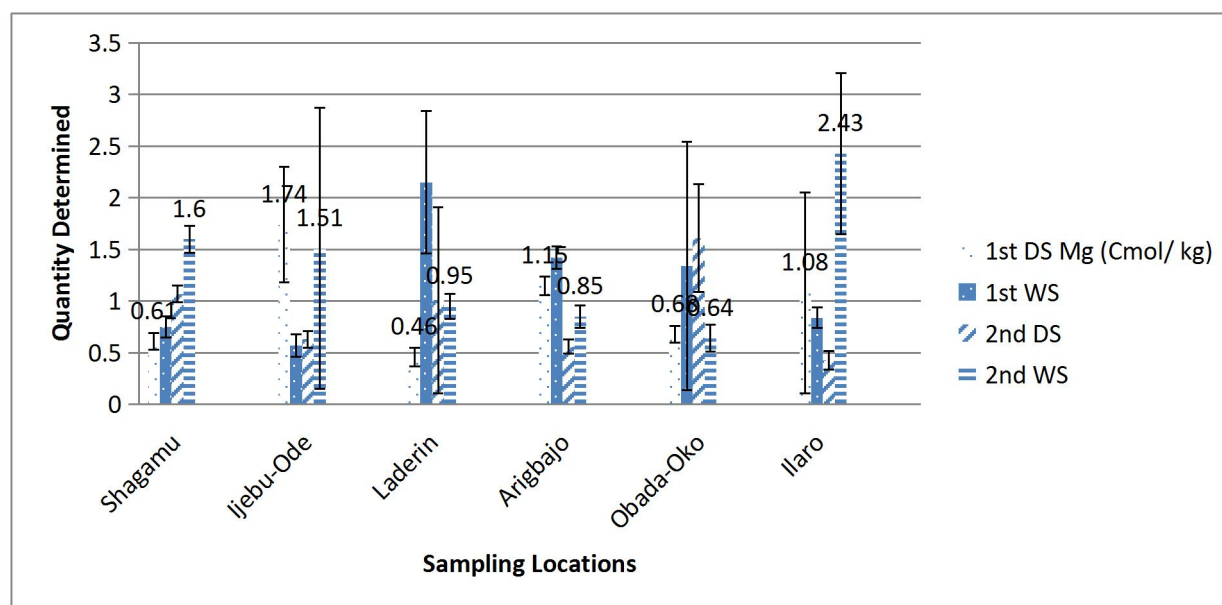
**Fig. 3.** Levels of Ca (Cmol/ kg) across the Sampling Seasons and Locations

$$Y (1^{\text{st}}\text{-DS}) = -0.0277x + 3.5363 (R^2 = 0.0014, 0.14 \%)$$

$$Y (2^{\text{nd}}\text{-DS}) = -0.1974x + 4.3179 (R^2 = 0.085, 8.50 \%)$$

$$Y (1^{\text{st}}\text{-WS}) = 0.2077x + 2.9204 (R^2 = 0.0532, 5.32 \%)$$

$$Y (2^{\text{nd}}\text{-WS}) = -0.0376x + 3.1004 (R^2 = 0.0067, 0.67 \%)$$



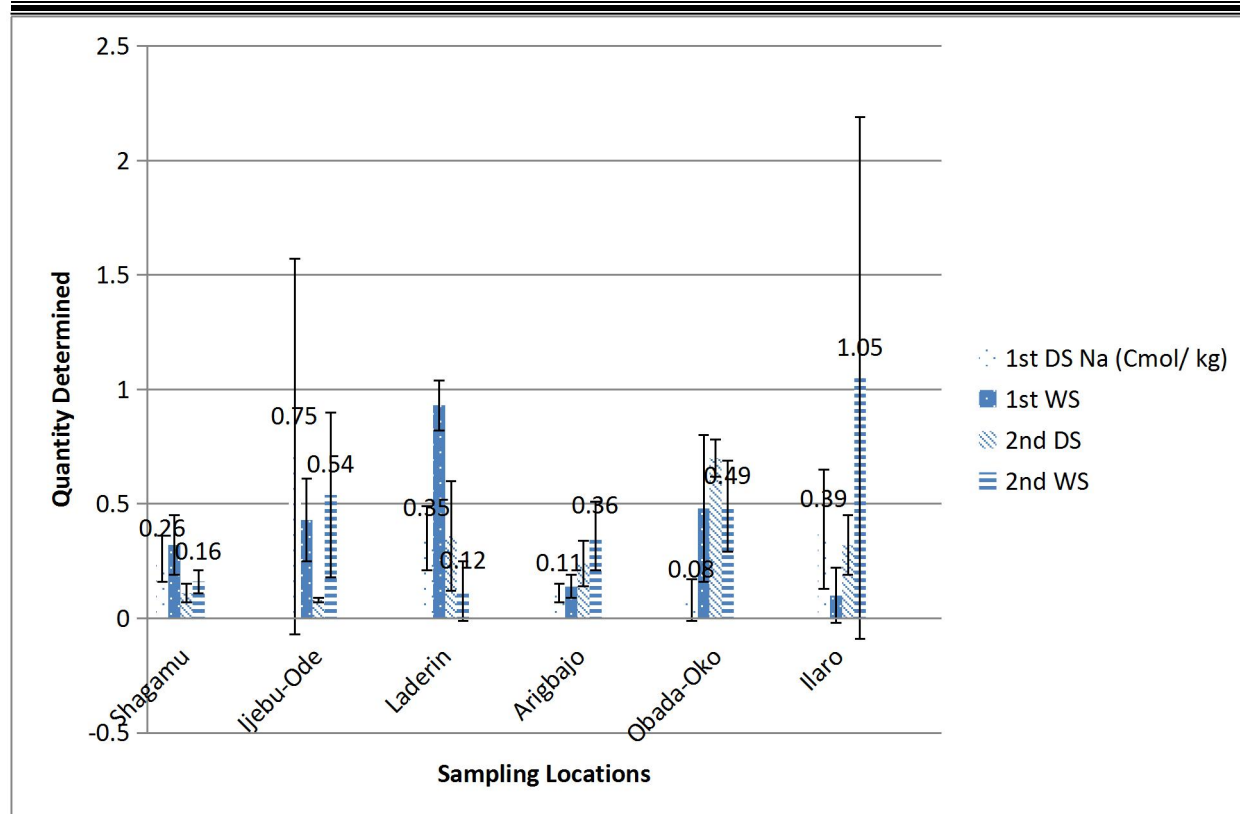
**Fig. 4.** Levels of Mg (Cmol/ kg) across the Sampling Seasons and Locations

$$Y (1^{\text{st}}\text{-DS}) = -0.002x + 0.9653 (R^2 = 0.0003, 0.03 \%)$$

$$Y (2^{\text{nd}}\text{-DS}) = -0.0101x + 0.9459 (R^2 = 0.0076, 0.76 \%)$$

$$Y (1^{\text{st}}\text{-WS}) = 0.029x + 1.0043 (R^2 = 0.0347, 3.47 \%)$$

$$Y (2^{\text{nd}}\text{-WS}) = 0.0206x + 1.2066 (R^2 = 0.0137, 1.37 \%)$$



**Fig. 5.** Levels of Na (Cmol/ kg) across the Sampling Seasons and Locations

$$Y (1^{\text{st}}\text{-DS}) = -0.0229x + 0.4605 (R^2 = 0.1236, 12.36 \%)$$

$$Y (2^{\text{nd}}\text{-DS}) = 0.0399x + 0.0625 (R^2 = 0.4411, 44.11 \%)$$

$$Y (1^{\text{st}}\text{-WS}) = -0.0249x + 0.5491 (R^2 = 0.0956, 9.56 \%)$$

$$Y (2^{\text{nd}}\text{-WS}) = 0.0649x + 0.0642 (R^2 = 0.5159, 51.59 \%)$$

Highest TOC in the soil samples in various locations was indicated to be in the 2<sup>nd</sup> wet season while the highest (27.33 %) available TOC contents for soil fertility were in the 1<sup>st</sup> dry season (Figure 6). Highest soil total nutrient (TN) contents occurred in Ilaro in the 2<sup>nd</sup> wet season with the least in Obada-Okò in the 1<sup>st</sup> wet season. Sampling locations were observed to contain high contents of TN in the wet season (0.1891), with moderately significant available contents (62.04 %) as shown by the Linear regression equation (Figure 7). Available phosphorus (AvP) (g/ kg) was determined to be least: 1.89 in Ilaro in the 1<sup>st</sup> dry season and highest: 27.95 in Laderin in the 1<sup>st</sup> wet season. Highest (0.4814) influence

of AvP could be traced to the 2<sup>nd</sup> dry season, but the readily soil available contents (20.75 %) were traced to the 2<sup>nd</sup> wet season as the Linear regression equation showed. Comparing the seasonal average values of the soil fertility indicators (TOC, TN, AvP and K) in this study with the soil nutrient ratings in Nigeria (FPDD, 1990) in Figure 10 and Table 1, soil of all the assessed housing estates was observed to have low total organic carbon ( $\text{TOC} < 11.63 \text{ g/ kg}$ ), low nitrogen ( $\text{TN} < 1.5 \text{ g/ kg}$ ) and low phosphorus ( $\text{AvP} < 8.00 \text{ g/ kg}$ ) except 1<sup>st</sup> rainy season. However, levels of K were within minimum soil nutrient rating (0.20 and 0.40 Cmol/ kg).

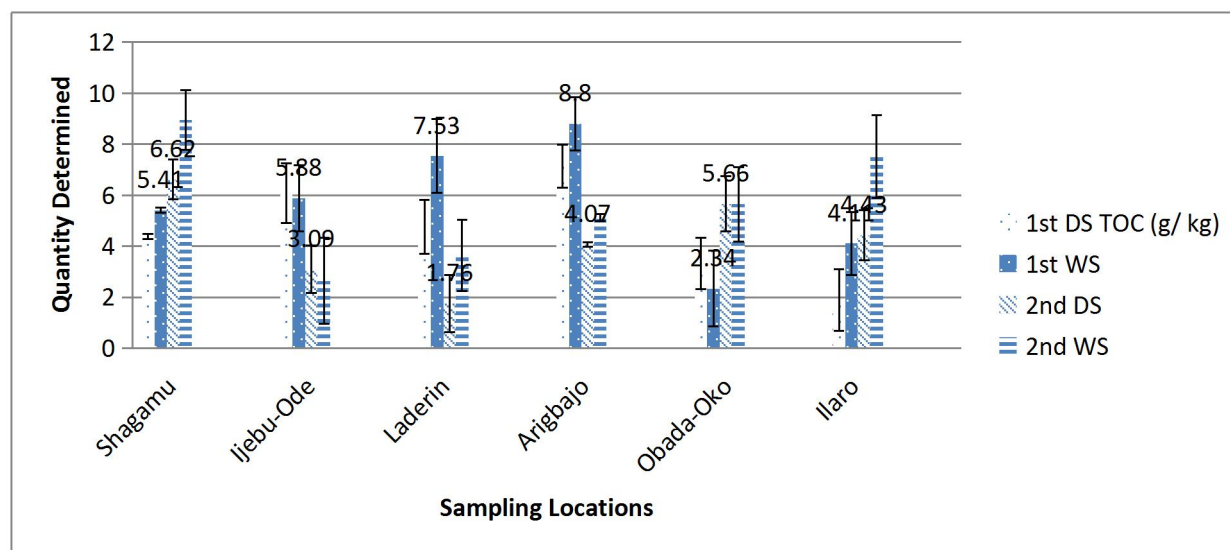


Fig 6. Levels of TOC (g/ kg) across the Sampling Seasons and Locations

$$Y (1^{st}\text{-DS}) = -0.2627x + 6.1713 (R^2 = 0.2733, 27.33 \%)$$

$$Y (2^{nd}\text{-DS}) = -0.0133x + 4.3514 (R^2 = 0.0008, 0.08 \%)$$

$$Y (1^{st}\text{-WS}) = -0.2264x + 7.0369 (R^2 = 0.1335, 13.35 \%)$$

$$Y (2^{nd}\text{-WS}) = 0.0469x + 5.3022 (R^2 = 0.0055, 0.55 \%)$$

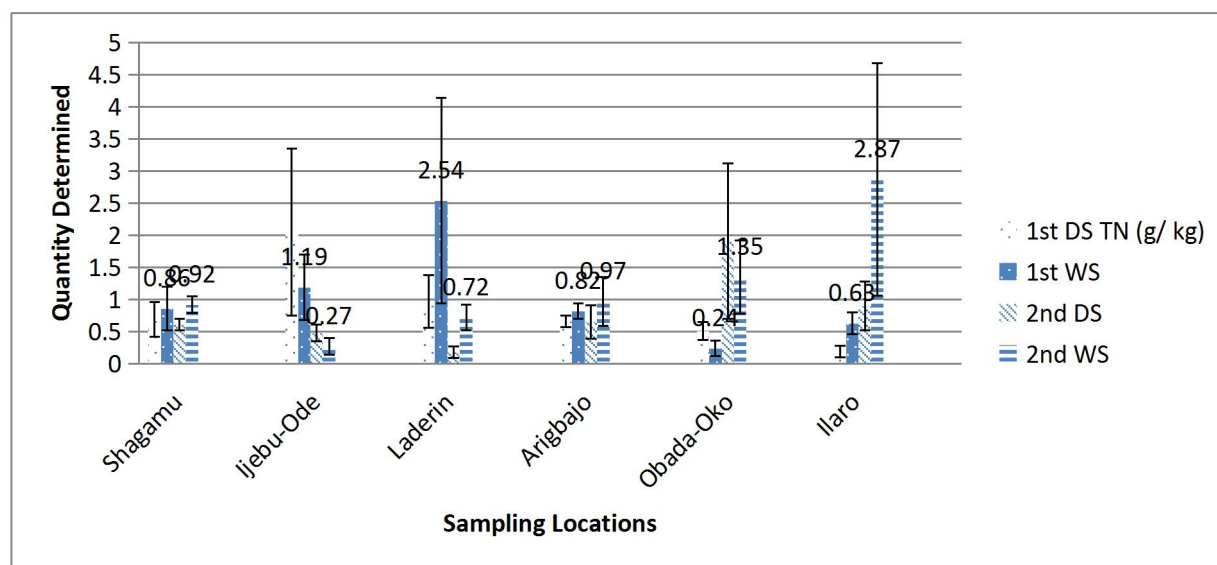


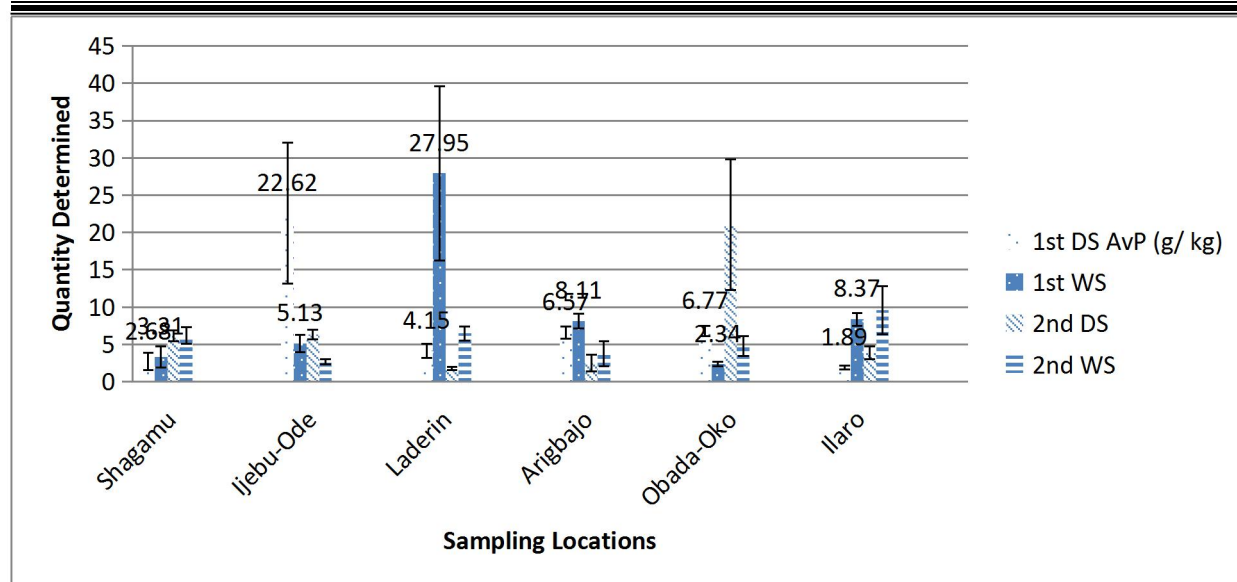
Fig. 7. Levels of TN (g/ kg) across the Sampling Seasons and Locations

$$Y (1^{st}\text{-DS}) = -0.1061x + 1.4819 (R^2 = 0.3815, 35.15 \%)$$

$$Y (2^{nd}\text{-DS}) = 0.0887x + 0.256 (R^2 = 0.3083, 30.83 \%)$$

$$Y (1^{st}\text{-WS}) = -0.0817x + 1.537 (R^2 = 0.1479, 14.79 \%)$$

$$Y (2^{nd}\text{-WS}) = 0.1891x + 0.0485 (R^2 = 0.6204, 62.04 \%)$$



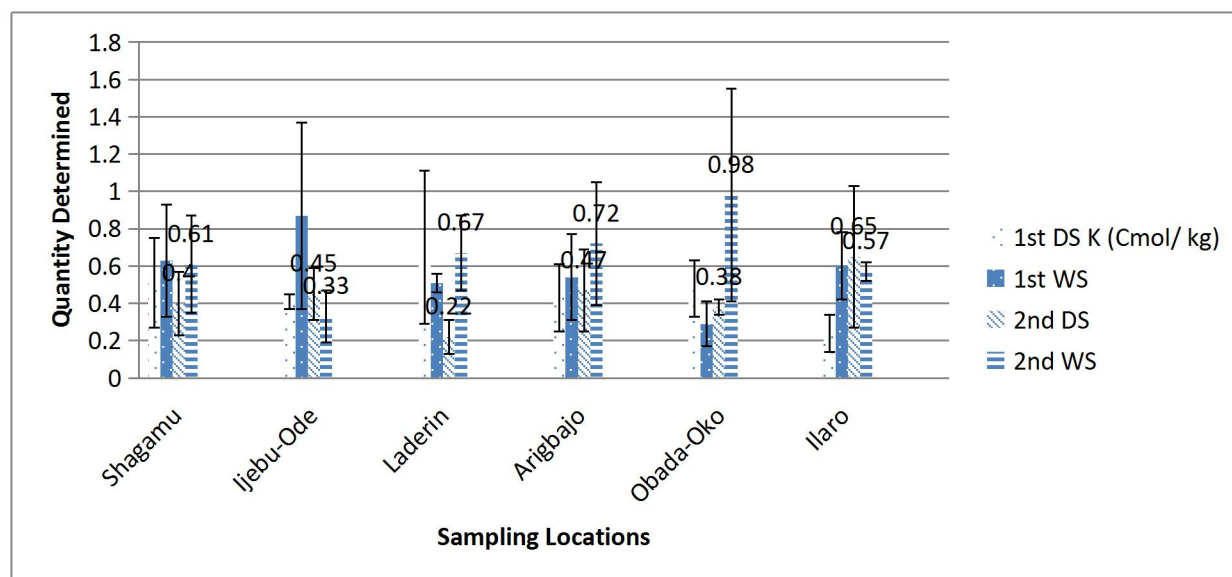
**Fig. 8.** Levels of AvP (g/ kg) across the Sampling Seasons and Locations

$$Y (1^{\text{st}}\text{-DS}) = -0.7011x + 11.654 (R^2 = 0.1163, 11.63 \%)$$

$$Y (2^{\text{nd}}\text{-DS}) = 0.4814x + 4.0348 (R^2 = 0.0634, 6.34 \%)$$

$$Y (1^{\text{st}}\text{-WS}) = -0.0416x + 9.4511 (R^2 = 0.0003, 0.03 \%)$$

$$Y (2^{\text{nd}}\text{-WS}) = 0.297x + 3.7797 (R^2 = 0.2075, 20.75 \%)$$



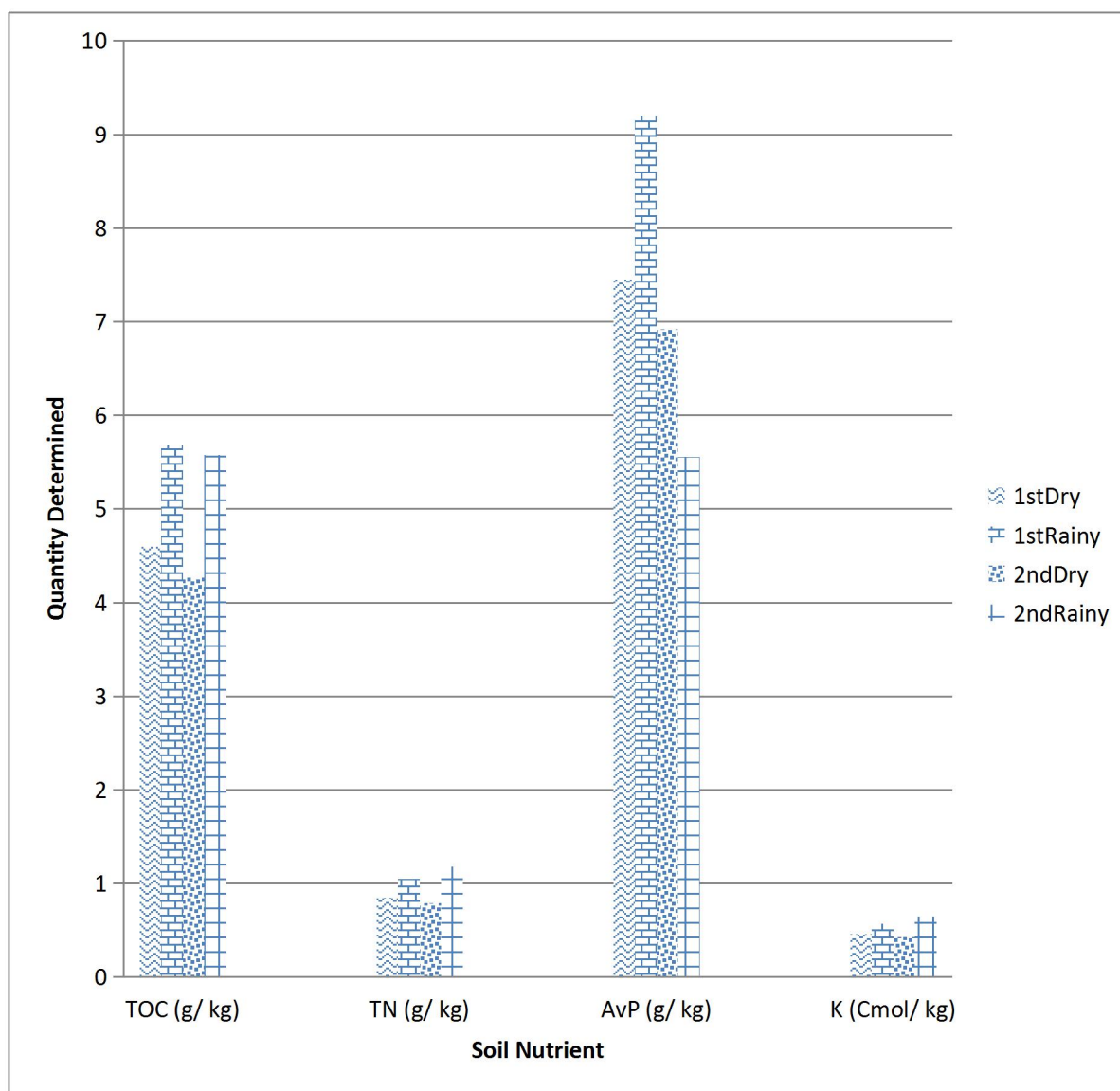
**Fig. 9.** Levels of K (Cmol/ kg) across the Sampling Seasons and Locations

$$Y (1^{\text{st}}\text{-DS}) = -0.0201x + 0.5825 (R^2 = 0.2529, 25.29 \%)$$

$$Y (2^{\text{nd}}\text{-DS}) = 0.0184x + 0.3178 (R^2 = 0.2429, 24.29 \%)$$

$$Y (1^{\text{st}}\text{-WS}) = -0.0266x + 0.7328 (R^2 = 0.2787, 27.87 \%)$$

$$Y (2^{\text{nd}}\text{-WS}) = 0.0257x + 0.4924 (R^2 = 0.2061, 20.61 \%)$$



**Fig. 9.** Comparison of soil fertility indicators across the sampling seasons

**Table 1:** Nutrient ratings for soil fertility classes in Nigeria

Ratings	TOC (g/ kg)	TN (g/ kg)	AvP (g/ kg)	K (Cmol/ kg)
Low	< 11.63	<1.5	<8	<0.20
Medium	11.63-17.44	1.5-2.0	8-20	0.20 - 0.40
High	<17.44	>2.0	>20	>0.40

Source: FPDD, 1990

TOC = Organic Matter/ 1.72 (Bada et al., 2014)

**Table 2:** Soil Chemical and Macro-element Parameters in the 1st Dry Season

Location	EC ( $\mu$ S/ cm)	CEC (Cmol/ kg)	TOC (g/ kg)	Ca (Cmol/ kg)	Mg (Cmol/ kg)	Na (Cmol/ kg)	TN (g/ kg)	AvP (g/ kg)	K (Cmol/ kg)
Shagamu	192.95 $\pm$ 10.02 <sup>b</sup>	2.42 $\pm$ 0.34 <sup>ab</sup>	4.38 $\pm$ 0.09 <sup>bc</sup>	1.30 $\pm$ 0.71 <sup>ab</sup>	0.61 $\pm$ 0.08 <sup>a</sup>	0.26 $\pm$ 0.10 <sup>a</sup>	0.69 $\pm$ 0.27 <sup>a</sup>	2.68 $\pm$ 1.17 <sup>a</sup>	0.51 $\pm$ 0.24 <sup>ab</sup>
Ijebu-Ode	532.95 $\pm$ 39.79 <sup>c</sup>	10.11 $\pm$ 1.28 <sup>d</sup>	6.09 $\pm$ 1.17 <sup>cd</sup>	7.37 $\pm$ 1.26 <sup>c</sup>	1.74 $\pm$ 0.56 <sup>b</sup>	0.75 $\pm$ 0.82 <sup>a</sup>	2.05 $\pm$ 1.30 <sup>b</sup>	22.62 $\pm$ 9.45 <sup>b</sup>	0.41 $\pm$ 0.04 <sup>ab</sup>
Laderin	136.85 $\pm$ 23.48 <sup>a</sup>	1.61 $\pm$ 0.27 <sup>a</sup>	4.76 $\pm$ 1.05 <sup>bc</sup>	0.36 $\pm$ 0.12 <sup>a</sup>	0.46 $\pm$ 0.09 <sup>a</sup>	0.35 $\pm$ 0.14 <sup>a</sup>	0.97 $\pm$ 0.41 <sup>a</sup>	4.15 $\pm$ 0.94 <sup>a</sup>	0.70 $\pm$ 0.41 <sup>b</sup>
Arigbajo	209.38 $\pm$ 34.17 <sup>b</sup>	6.66 $\pm$ 1.36 <sup>c</sup>	7.13 $\pm$ 0.84 <sup>d</sup>	5.96 $\pm$ 0.70 <sup>c</sup>	1.15 $\pm$ 0.09 <sup>ab</sup>	0.11 $\pm$ 0.04 <sup>a</sup>	0.66 $\pm$ 0.09 <sup>a</sup>	6.57 $\pm$ 0.79 <sup>a</sup>	0.43 $\pm$ 0.18 <sup>ab</sup>
Obada-Oko	636.37 $\pm$ 20.77 <sup>d</sup>	2.94 $\pm$ 0.43 <sup>ab</sup>	3.32 $\pm$ 1.00 <sup>ab</sup>	2.54 $\pm$ 1.35 <sup>b</sup>	0.68 $\pm$ 0.08 <sup>a</sup>	0.08 $\pm$ 0.09 <sup>a</sup>	0.51 $\pm$ 0.14 <sup>a</sup>	6.77 $\pm$ 0.68 <sup>a</sup>	0.48 $\pm$ 0.15 <sup>ab</sup>
Ilaro	113.90 $\pm$ 3.90 <sup>a</sup>	3.46 $\pm$ 0.85 <sup>b</sup>	1.89 $\pm$ 1.20 <sup>a</sup>	2.69 $\pm$ 1.19 <sup>b</sup>	1.08 $\pm$ 0.97 <sup>ab</sup>	0.39 $\pm$ 0.26 <sup>a</sup>	0.19 $\pm$ 0.09 <sup>a</sup>	1.89 $\pm$ 0.25 <sup>a</sup>	0.24 $\pm$ 0.10 <sup>a</sup>

Superscripts with same letter down the column were not significantly different ( $p > 0.05$ )

**Table 3:** Soil Chemical and Macro-element Parameters in the 1st Rainy Season

Location	EC ( $\mu\text{S}/\text{cm}$ )	CEC (Cmol/kg)	TOC (g/kg)	Ca (Cmol/kg)	Mg (Cmol/kg)	Na (Cmol/kg)	TN (g/kg)	AvP (g/kg)	K (Cmol/kg)
Shagamu	238.35 $\pm$ 12.38 <sup>b</sup>	2.99 $\pm$ 0.42 <sup>ab</sup>	5.41 $\pm$ 0.1 <sup>bc</sup>	1.61 $\pm$ 0.88 <sup>ab</sup>	0.75 $\pm$ 0.10 <sup>a</sup>	0.32 $\pm$ 0.13 <sup>a</sup>	0.86 $\pm$ 0.34 <sup>a</sup>	3.31 $\pm$ 1.45 <sup>a</sup>	0.63 $\pm$ 0.30 <sup>ab</sup>
Ijebu-Ode	169.05 $\pm$ 29.00 <sup>a</sup>	1.99 $\pm$ 0.34 <sup>a</sup>	5.88 $\pm$ 1.30 <sup>bc</sup>	0.45 $\pm$ 0.15 <sup>a</sup>	0.57 $\pm$ 0.11 <sup>a</sup>	0.43 $\pm$ 0.18 <sup>a</sup>	1.19 $\pm$ 0.51 <sup>a</sup>	5.13 $\pm$ 1.17 <sup>a</sup>	0.87 $\pm$ 0.50 <sup>b</sup>
Laderin	658.35 $\pm$ 49.15 <sup>c</sup>	12.49 $\pm$ 1.58 <sup>d</sup>	7.53 $\pm$ 1.45 <sup>cd</sup>	9.11 $\pm$ 1.56 <sup>c</sup>	2.15 $\pm$ 0.69 <sup>b</sup>	0.93 $\pm$ 0.11 <sup>a</sup>	2.54 $\pm$ 1.60 <sup>b</sup>	27.95 $\pm$ 11.67 <sup>b</sup>	0.51 $\pm$ 0.05 <sup>ab</sup>
Arigbajo	258.65 $\pm$ 42.21 <sup>b</sup>	8.23 $\pm$ 1.68 <sup>c</sup>	8.80 $\pm$ 1.04 <sup>d</sup>	7.36 $\pm$ 0.86 <sup>c</sup>	1.42 $\pm$ 0.11 <sup>ab</sup>	0.14 $\pm$ 0.05 <sup>a</sup>	0.82 $\pm$ 0.12 <sup>a</sup>	8.11 $\pm$ 0.97 <sup>a</sup>	0.54 $\pm$ 0.23 <sup>ab</sup>
Obada-Oko	140.70 $\pm$ 4.81 <sup>a</sup>	4.28 $\pm$ 1.05 <sup>b</sup>	2.34 $\pm$ 1.48 <sup>a</sup>	3.33 $\pm$ 1.47 <sup>b</sup>	1.34 $\pm$ 1.20 <sup>ab</sup>	0.48 $\pm$ 0.32 <sup>a</sup>	0.24 $\pm$ 0.12 <sup>a</sup>	2.34 $\pm$ 0.31 <sup>a</sup>	0.29 $\pm$ 0.12 <sup>a</sup>
Ilaro	786.10 $\pm$ 25.66 <sup>d</sup>	3.63 $\pm$ 0.53 <sup>ab</sup>	4.11 $\pm$ 1.24 <sup>ab</sup>	3.14 $\pm$ 1.66 <sup>b</sup>	0.84 $\pm$ 0.10 <sup>a</sup>	0.10 $\pm$ 0.12 <sup>a</sup>	0.63 $\pm$ 0.17 <sup>a</sup>	8.37 $\pm$ 0.85 <sup>a</sup>	0.60 $\pm$ 0.18 <sup>ab</sup>

Superscripts with same letter down the column were not significantly different ( $p > 0.05$ )

**Table 4:** Soil Chemical and Macro-element Parameters in the 2nd Dry Season

Location	EC ( $\mu\text{S}/\text{cm}$ )	CEC (Cmol/kg)	TOC (g/kg)	Ca (Cmol/kg)	Mg (Cmol/kg)	Na (Cmol/kg)	TN (g/kg)	AvP (g/kg)	K (Cmol/kg)
Shagamu	194.60 $\pm$ 31.76 <sup>b</sup>	6.19 $\pm$ 1.26 <sup>c</sup>	6.62 $\pm$ 0.78 <sup>d</sup>	5.54 $\pm$ 0.65 <sup>c</sup>	1.07 $\pm$ 0.08 <sup>ab</sup>	0.11 $\pm$ 0.04 <sup>a</sup>	0.61 $\pm$ 0.09 <sup>a</sup>	6.11 $\pm$ 0.73 <sup>a</sup>	0.40 $\pm$ 0.17 <sup>ab</sup>
Ijebu-Ode	591.45 $\pm$ 19.31 <sup>d</sup>	2.73 $\pm$ 0.40 <sup>ab</sup>	3.09 $\pm$ 0.93 <sup>ab</sup>	2.36 $\pm$ 1.25 <sup>b</sup>	0.63 $\pm$ 0.08 <sup>a</sup>	0.08 $\pm$ 0.01 <sup>a</sup>	0.48 $\pm$ 0.13 <sup>a</sup>	6.29 $\pm$ 0.64 <sup>a</sup>	0.45 $\pm$ 0.14 <sup>ab</sup>
Laderin	105.86 $\pm$ 3.62 <sup>a</sup>	3.22 $\pm$ 0.79 <sup>b</sup>	1.76 $\pm$ 1.12 <sup>a</sup>	2.50 $\pm$ 1.10 <sup>b</sup>	1.01 $\pm$ 0.90 <sup>ab</sup>	0.36 $\pm$ 0.24 <sup>a</sup>	0.18 $\pm$ 0.09 <sup>a</sup>	1.76 $\pm$ 0.24 <sup>a</sup>	0.22 $\pm$ 0.09 <sup>a</sup>
Arigbajo	179.33 $\pm$ 9.32 <sup>b</sup>	2.25 $\pm$ 0.32 <sup>ab</sup>	4.07 $\pm$ 0.08 <sup>bc</sup>	1.21 $\pm$ 0.66 <sup>ab</sup>	0.56 $\pm$ 0.07 <sup>a</sup>	0.24 $\pm$ 0.10 <sup>a</sup>	0.65 $\pm$ 0.26 <sup>a</sup>	2.49 $\pm$ 1.09 <sup>a</sup>	0.47 $\pm$ 0.22 <sup>ab</sup>
Obada-Oko	495.33 $\pm$ 36.98 <sup>c</sup>	9.40 $\pm$ 1.19 <sup>c</sup>	5.66 $\pm$ 1.08 <sup>cd</sup>	6.85 $\pm$ 1.18 <sup>c</sup>	1.61 $\pm$ 0.52 <sup>b</sup>	0.70 $\pm$ 0.08 <sup>a</sup>	1.91 $\pm$ 1.21 <sup>b</sup>	21.03 $\pm$ 8.78 <sup>b</sup>	0.38 $\pm$ 0.04 <sup>ab</sup>
Ilaro	127.19 $\pm$ 21.82 <sup>a</sup>	1.50 $\pm$ 0.25 <sup>a</sup>	4.43 $\pm$ 0.98 <sup>bc</sup>	0.34 $\pm$ 0.11 <sup>a</sup>	0.43 $\pm$ 0.09 <sup>a</sup>	0.32 $\pm$ 0.13 <sup>a</sup>	0.90 $\pm$ 0.38 <sup>a</sup>	3.86 $\pm$ 0.88 <sup>a</sup>	0.65 $\pm$ 0.38 <sup>b</sup>

Superscripts with same letter down the column were not significantly different ( $p > 0.05$ )**Table 5:** Soil Chemical and Macro-element Parameters in the 2nd Rainy Season

Location	EC ( $\mu\text{S}/\text{cm}$ )	CEC (Cmol/kg)	TOC (g/kg)	Ca (Cmol/kg)	Mg (Cmol/kg)	Na (Cmol/kg)	TN (g/kg)	AvP (g/kg)	K (Cmol/kg)
Shagamu	282.27 $\pm$ 47.70 <sup>b</sup>	5.30 $\pm$ 1.90 <sup>c</sup>	8.95 $\pm$ 1.18 <sup>d</sup>	4.32 $\pm$ 0.97 <sup>c</sup>	1.60 $\pm$ 0.13 <sup>ab</sup>	0.16 $\pm$ 0.05 <sup>a</sup>	0.92 $\pm$ 0.13 <sup>a</sup>	6.17 $\pm$ 1.10 <sup>a</sup>	0.61 $\pm$ 0.26 <sup>ab</sup>
Ijebu-Ode	148.99 $\pm$ 5.44 <sup>a</sup>	4.83 $\pm$ 1.19 <sup>b</sup>	2.64 $\pm$ 1.68 <sup>a</sup>	2.76 $\pm$ 1.66 <sup>b</sup>	1.51 $\pm$ 1.36 <sup>ab</sup>	0.54 $\pm$ 0.36 <sup>a</sup>	0.27 $\pm$ 0.13 <sup>a</sup>	2.64 $\pm$ 0.35 <sup>a</sup>	0.33 $\pm$ 0.14 <sup>a</sup>
Laderin	788.29 $\pm$ 29.00 <sup>d</sup>	4.10 $\pm$ 0.61 <sup>ab</sup>	3.64 $\pm$ 1.40 <sup>ab</sup>	2.55 $\pm$ 1.88 <sup>b</sup>	0.95 $\pm$ 0.12 <sup>a</sup>	0.12 $\pm$ 0.13 <sup>a</sup>	0.72 $\pm$ 0.20 <sup>a</sup>	6.45 $\pm$ 0.96 <sup>a</sup>	0.67 $\pm$ 0.20 <sup>ab</sup>
Arigbajo	259.34 $\pm$ 13.99 <sup>b</sup>	3.37 $\pm$ 0.48 <sup>ab</sup>	5.12 $\pm$ 0.13 <sup>bc</sup>	1.82 $\pm$ 1.00 <sup>ab</sup>	0.85 $\pm$ 0.11 <sup>a</sup>	0.36 $\pm$ 0.15 <sup>a</sup>	0.97 $\pm$ 0.38 <sup>a</sup>	3.74 $\pm$ 1.64 <sup>a</sup>	0.72 $\pm$ 0.33 <sup>ab</sup>
Obada-Oko	181.03 $\pm$ 32.78 <sup>a</sup>	2.25 $\pm$ 0.38 <sup>a</sup>	5.64 $\pm$ 1.47 <sup>bc</sup>	0.51 $\pm$ 0.17 <sup>a</sup>	0.64 $\pm$ 0.13 <sup>a</sup>	0.49 $\pm$ 0.20 <sup>a</sup>	1.35 $\pm$ 0.57 <sup>a</sup>	4.79 $\pm$ 1.32 <sup>a</sup>	0.98 $\pm$ 0.57 <sup>b</sup>
Ilaro	643.94 $\pm$ 55.54 <sup>c</sup>	6.12 $\pm$ 1.78 <sup>d</sup>	7.51 $\pm$ 1.63 <sup>cd</sup>	5.29 $\pm$ 1.77 <sup>c</sup>	2.43 $\pm$ 0.78 <sup>b</sup>	1.05 $\pm$ 1.14 <sup>a</sup>	2.87 $\pm$ 1.81 <sup>b</sup>	9.58 $\pm$ 3.19 <sup>b</sup>	0.57 $\pm$ 0.05 <sup>ab</sup>

Superscripts with same letter down the column were not significantly different ( $p > 0.05$ )

## DISCUSSION

The non-considerable impacts of the electrical conductivity (EC) depicted that low there was possibility of low dissolved solid which might adsorbed pollutants on its surface. Application of EC, as a measure of ion concentration and potentially negative effect of salinity on the osmotic potential and nutrient imbalances, is usually limited to where highly concentrated soil solutions are suspected to inhibit growth and productivity of farm produce (Burger et al., 1994). The presence of low values of CEC indicated presence of less clay and organic matter. The low values of CEC generally were depicting the soil low potential to provide plant with the required nutrients and thereby requiring sufficient soil management. The soil low CEC may be ascribed to clay minerals (Kaolinite) nature (Hassan et al., 2011; Yakubu et al., 2011). The soil could be observed to have low Ca and Mg levels with insignificant readily available contents unlike Na contents which were readily available in the soil samples to boost soil fertility. Though soil fertility is generally not influenced by the ratios of Ca, Mg, and K (Kopittke and Menzies, 2006), the levels of TOC in soil matrix influence a number of soil chemical and macro-element properties (Bada et al., 2014). The implication of this according to Soil Survey Laboratory Staff (1992) is that the ions, such as K, can easily be replaced by contaminants such as heavy metals because the sorption capacities for such ions in the soil matrix are very low (Bada et al., 2014).

Both CEC and TOC were observed low, the exchangeable Ca, Mg and Na were also low but could still support any practiced household subsistent farming. The sand texture of the assessed housing estates varied from coarse texture to fine texture to conform to the classification of Gelderman (2013), which might influence the low levels of TOC in this study with possible lack of soil

nutrients and low yield if the residents decide to practice subsistence farming for their small households' sustenance. Possible adverse condition on the environment from the low TOC (Shaaban et al., 2008) may be loosely availability of heavy metals which could have been adsorbed by soil matrix/ ligands of organic matter. Organic matter of the soil when compared with soil nutrient rating was very low, and may not provide adequate nutrients for plant uptake. Low soil TOC may regulate soil nutrients availability to plant roots (Ghehsareh and Samadi, 2011). The higher the TOC contents of the soil the more ligands to adsorb pollutants; high levels of TOC thus reduce negative environmental effects by adsorbing and binding soil microelements such as heavy metals from additives, amendments and pesticides (Cooperband, 2002). Levels of the soil chemical parameters and fertility were observed to vary across the estates. Availability of the TN contents in the wet season could influence its integration into soil organic matter to increase soil fertility.

## REFERENCES

- Abebayehu, A.E., Eyas, U. and Jan, D., 2011. Comparative analysis of soil nutrient balance at farm level: A case study in Jimma zone, Ethiopia. *International Journal of Soil Science*, 6, 259-266.
- Bada, B.S., Arowolo, T.A. and Ozoike, P. N., 2014. Assessment of heavy metal content of soil and kenaf (*Hibiscus cannabinus* Linn.) in a nutrient degraded soil amended with dairy sludge. *Journal of Applied Phytotechnology in Environmental Sanitation*, 3(4), 137-145.
- Bray, R.H. and Kurtz, H.T., 1945. Determination of total, organic and available forms of phosphorus in soils. *Soil Sci.*, 59, 39-46.
- Burger, J.A., Johnson, J.E., Andrews, J.A. and Torbert, J.L., 1994. Measuring mine soil productivity for forests. : International

- Land Reclamation and Mine Drainage Conference on Reclamation and Revegetation, Vol. 3. USDOJ Bureau of Mines, Special Publication SP 06C-94, 48-56.
- Cooperband, L., 2002. *Building soil organic matter with organic amendments: A resource for urban and rural gardeners, small farmers, turfgrass managers and large-scale producers*. University of Wisconsin-Madison. Published by the Center for Integrated Agricultural Systems (CIAS), College of Agricultural and Life Sciences, University of Wisconsin- Madison. 16pp.
- CMTN (cometonigeria), 2019. <https://www.cometonigeria.com/region/south-west/ogun-state/> [Accessed on 25 March 2019].
- Doran, J.W. and Parkin, T.B., 1994. Defining and assessing soil quality. In: Doran, J.W., Coleman, D.C., Bezdick, D.F. and Stewart, B.A. (Eds.), *Defining soil quality for a sustainable environment. Soil Science Society of America, Special Publication*, 35, 3-21.
- Ekeke, C. and Okonwu, K., 2013. Comparative study on fertility status of soils of University of Port Harcourt, Nigeria. *Research Journal of Botany*, 8, 24-30.
- Fasina, A.S., Raji, A., Oluwatosin, G.A., Omoju, O.J. and Oluwadare, D.A., 2015. Properties, genesis, classification, capability and sustainable management of soils from South- Western Nigeria. *International Journal of Soil Science*, 10(3), 142-152.
- FPDD (Fertilizer Procurement and Distribution Division), 1990. Literature review on soil fertility investigations in Nigeria. *Food Chemistry*, 78, 63-68.
- Gelderman, R., 2013. Basics of soil fertility: soil pH, soil CEC and root traffic. Nutrient, soil, and water management conference Fergus Falls, MN. Plant Science Dept. South Dakota State University. 72pp.
- Ghehsareh, A.M. and Samadi, N., 2011. Effect of soil acidification on growth indices and microelements uptake by greenhouse cucumber. *African Journal of Agricultural Research*, 7(11), 1659-1665.
- Hassan, A.M., Raji, D.A., Malgwi, W.B. and Agbanin, J.O., 2011. The basaltic soils of Plateau State, Nigeria: Properties classification and management practices. Proceedings of the 35<sup>th</sup> Annual Conference of the Soil Science Society of Nigeria, March 7-11, 2011, Minna, Nigeria.
- Houba, V.J.G., van der Lee, J.J., Navozomsky, I. and Walinga, I., 1989. Soil and plant analysis. Netherland Wageningen Agricultural University, Netherland. pp. 4-10.
- Kopittke and Menzies,, 2006. Review of BCSR in SSSAJ In: Gelderman, R., 2013. Basics of soil fertility: Soil pH, soil CEC and root traffic. Nutrient, Soil, and Water Management Conference Fergus Falls, MN. Plant Science Dept. South Dakota State University. 72pp.
- McBride, M.B., Nibarger, E.A., Richards, B.K. and Steenhuis, T., 2003. Trace metal accumulation by red clover grown on sewage sludge-amended soils and correlation to Mehlich 3 and calcium chloride-extractable Metals.
- Ogun State Central Department of Statistics (Ogun State CDS), 2008. Ogun State Statistics. Abeokuta: Ogun State Central Department of Statistics, Nigeria, 2pp.
- Ololade, I.A., Ajayi, I.R., Gbadamosi, A.E., Mohammed, O.Z. and Sunday, A.G., 2010. A study on effects of soil physico-chemical properties on cocoa production in Ondo State. *Modern Applied Science*, 4(5), 35-43.

Papendick, R.J. and Parr, J.F., 1992. Soil quality -- The key to sustainable agriculture. *Am. J. Alt. Agric.*, 7, 2-3.

Shaaban, M.M., Hussein, M.M. and El Saady, A.M., 2008. Nutritional status in shoots of barley genotypes as affected by salinity of irrigation water. *American Journal of Plant Physiology*, 3(2), 89-95.

Schoenholtz, S.H., Van Miegroet, H. and Burger, J.A., 2000. A review of chemical and physical properties as indicators of forest soil quality: challenges and opportunities. Elsevier Science BV. *Forest Ecology and Management*, 138, 335-356.

Soil Survey Laboratory Staff, 1992. *Soil survey laboratory methods manual*. Soil Survey Investigation Report No. 41. Version 1.0. USDA, Washington DC.

Towolawi, A.T., Arowolo, T.A., Bada, B.S., Badejo, A.A. and Taiwo, A.M., 2017. Phytoextraction assessment of green amaranth (*Amaranthus viridis* linn.) grown on soil amended with sewage sludge. *Ife Journal of Science*, 19(1), 133-140.

Vaca, R., Lugo, J., Martínez, R., Esteller, M.V. and Zavaleta, H., 2001. Effects of sewage sludge and sewage sludge compost amendment on soil properties and *Zea mays* L. Plants (heavy metals, quality and productivity). *Rev. Int. Contam. Ambie.*, 27(4), 303-311.

Yakubu, M., Baraya, S. and Noma, S.S., 2011. Assessment of soil and water quality along river Kadanko in Sanyinna district, Sokoto State. Proceedings of the 45<sup>th</sup> Annual Conference of the Agricultural Society of Nigeria, October 24-28, 2010, Nigeria.