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DETERMINATION OF AVAILABLE PHOSPHORUS (P) AND CATION EXCHANGE CAPACITY (CEC) IN THE SOIL OF FEDERAL COLLEGE OF EDUCATION FARM, ZARIA, NIGERIA.

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ABSTRACT
Soil is a form of medium containing mineral nutrients needed for plant growth. Any soil that contains ample amount of nutrient supports plant growth and such soil is said to be fertile. It is within the purview of this study to determine the availability of phosphorus and the exchangeable metals such as calcium, magnesium, potassium and sodium respectively in the soil of Federal College of Education, Zaria. These nutrients were determined in the soil sample by using Spectroscopic techniques. The results obtained showed that the phosphorus content of the soil to be 10.88mol/kg and the effective cation exchange capacity in the soil samples determined to be 2.85 which is lower than the critical value reported to be 3.12. The mean values of magnesium, Potassium and sodium were obtained to be 0.93, 0.49 and 0.92 mol/kg respectively. In conclusion, from the research work, available phosphorus, exchangeable cation exchange capacity in the soil of Federal College of Education is not adequate for the growth and up take of the crops.

Keywords: Soil; Nutrients; Cation; Phosphorus; minerals; Exchange

1.0 Introduction:

Since mankind discovered agriculture, soil has become the most indispensable aspect of natural medium that supports plant growth. It has continuously supported life different domain of human endeavours providing food, shelter and employment.

Soils are products of evolution and have a unique organization consisting of genetically developed layers or horizons. Organic matter is subject to translocation from place to place in the soil by means of water and animal activities (Schaetz *et al.*, 2015). (Marian *et al.*, 2017) observed that in humid regions, water migrates down through the soil and remove soluble materials. He also said many soils absorb addition of the earth crust, volcanic ash or sediments eroded from higher lands. Plants growing on land depend on soil for water and nutrients. Soil provides an environment in which roots can function. This requires pore spaces for root, Oxygen must be available for root respiration and the carbon dioxide that is provided must diffuse from the soil instead of accumulating in it.

Study Area

Samples 1,2,3 and 4 soils were collected from different sites of the Federal college of Education farm located in Zaria (Figure 1). The town lies between latitude $11.07.0^{II}$ and 12^{0} North longitude 07.44^{II} and 8^{0} East in Kaduna state.

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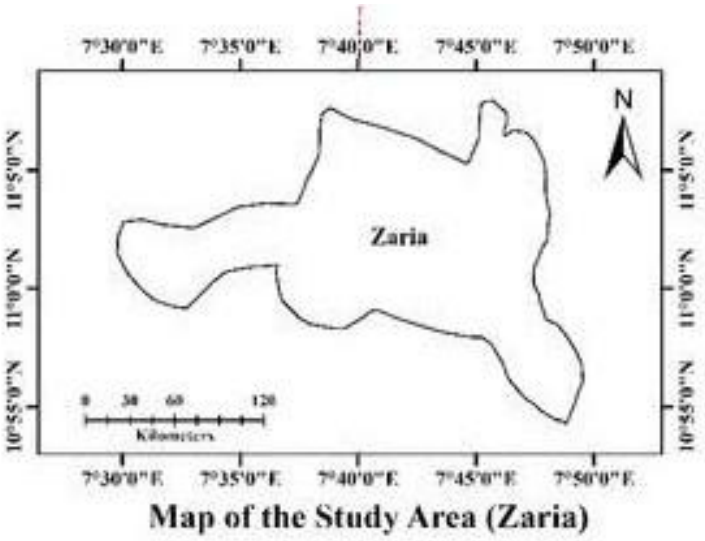

Fig. 1. Map of the study Area (Zaria)

Federal College of Education is located at an elevation of none meters (0 feet) above sea level, Zaria has a tropical wet and dry or savannah climate (Classification: AW). The district's yearly temperature is 27.65^0C. Zaria typically receives about 89.92 mm of precipitation and has 128.23 rainy days (35.13% of the time) annually. (Brady *et al.*,2008) opined that at least 16 elements of the soil are currently considered necessary for the growth of vascular plants. Carbon(C).

Hydrogen (H), and Oxygen (O) combined in photosynthetic reactions, is obtained from air and water. They compose 90% or more of dry matter. The remaining 13 elements are obtained largely from soil. They went further to explain that Nitrogen (N) Phosphorus (P). Potassium (K), Calcium (Ca), Magnesium (Mg) and Sulphur (S) are required in large quantities and are referred to as the macro elements or macro nutrients. Elements required in considerably smaller quantities are called micro elements or micro nutrients.

The micro elements include manganese (Mn) Iron (Fe), Boron (B), Zinc (Zn). Copper (Cu), Molybdenum (Mo) and Chlorine (Cl According to Arnon (1984), more than 40 additional elements have been found in plants.He reported that same plants accumulate elements that are not essential but increase plant growth or quality. Sodium can also be a substitute for potassium (K) in some plants if potassium is in low supply. Cobalt and Vanadium increase plant growth.(Schaetz *et al.*,2015) observed that most nutrients in soil exist in mineral and organic matter and as such are insoluble and unavailable to plants. Nutrients become available through weathering and organic matter decomposition. He observed that it's rare for soil to supply all the essential elements for long period of time in the quantities needed to produce high crop yields.

He went further in his report, that nutrients are absorbed mostly from soil solution to form colloid surfaces as cations and anions. Cations are positively charged while anions are negatively charged.

3.0 MATERIALS AND METHODS

MATERIALS: The materials used include; sample bags, sterile containers, shovels, diggers, pestle, mortar etc

EQUIPMENT: Atomic Absorption Spectrometer, Flame photometer and Spectrophotometer

SAMPLE COLLECTION: samples 1,2,3 and 4 soils were collected from different sites of the Federal college of Education farm located in Zaria. The town lies between latitude $11.07.0^{,11}$ and 12°North longitude 07.44^{11} 44 and 8°east in Kaduna state.Federal college of education is located at an elevation of none meters (0 feet) above sea level, Zaria has a tropical wet and dry or savannah climate (classification: AW). The district's yearly temperature is 27.65^0. Zaria typically receives about 89.92 millimeters of precipitation and has 128.23 rainy days (35.13% of the time) annually.

The field from which the samples were taken was under continuous cultivation, therefore there is heterogeneity among the different parts of

field. The samples were collected before any application of fertilizer.

In the farm where the samples were collected, four different portions were marked to be dug to a depth of 1-15 cm for each pit. The four pits were dug using a digger and shovel. Pit samples were taken from each pit and put in a well labelled sterile sample bottle, which were further taken to the laboratory. The different samples of soil were air-dried at room temperature. Lump soils were rolled in the mortar using pestle. After air–drying the soil, the soil was sieved with 2mm mesh sieve. The fine samples were further subjected to soil analyses.

3.1 Soil Analysis Procedure

3.1.2 Determination of Exchangeable Base

The soil samples were digested using normal saline; this is used in order to maintain the chemical and physical conditions of the soil samples. Saturation method described by Chapman (1966) and determined by atomic absorption spectrometer and flame photometer for calcium, magnesium, potassium and sodium.

During the atomic absorption spectroscopy process, the soil samples will absorb electromagnetic radiation at a specific wavelength. This produces a measurable signal. By looking at these signals, it is then possible to determine the parts per million levels of the specified metals in the samples that are been tested.

3.2 Effective Cation Exchange Capacity (CEC)

Effective cation exchange capacity was measured by the summation of the amounts of exchangeable cations including exchangeable Hydrogen (H) and Aluminium (Al.)

Exchangeable acidity was determined by extracting soil with in Kcl and titrating with 0.5N NaOH using phenolphthalein (Juo, 1979).

3.3 Determination of Available Phosphorus

Available phosphorus was determined by Bray method (Bray and Kurtz 1945). The concentration of phosphorus in the extract was determined calorimetrically in the spectrophotometer.

4.0 Results and Discussion

The results of the study are seen in tables 1 and 2 and Figures 2 - 4. The exchangeable Calcium (Ca) content in the four Samples collected include 1.80 molkg^{-1}, 1.40molkg^{-1}, 5.00 molkg^{-1}, 3.20 molkg^{-1} respectively having the mean of 2.85 molkg^{-1} as shown in fig. 3. This mean is lower than the critical value of 3.12 molkg^{-1} required by crops reported by (Balassubramanian *et al.*, 1984). This also indicates that there is low availability of calcium in the soil of Federal College of Education farm for plant uptake.

The exchangeable magnesium (Mg) contents are 0.43, 0.60, 1.67, 1.00 (mollkg^{-1}) for the four soil samples respectively with the mean being 0.93 molkg^{-1} this is slightly higher than the critical value of 0.20 0.42 molkg^{-1} as reported by (Arnon, 1984). This implies that there is high amount of magnesium in the soil of Federal College of Education Farm Zaria and therefore magnesium may not be added to the soil through fertilizer. The exchangeable potassium content in the four samples collected include 0.23 (molkg^{-1}), 0.17 (molkg^{-1}), 1.23 (molkg^{-1}), 0.33 (molkg^{-1}), respectively, having a mean of 0.49 (molkg^{-1}).

The mean is in the range of 0.1 to 0.5 (molkg^{-1}) predicted by (Balasubramanian*et al*, 1984) The exchangeable sodium Content in the four samples collected include 0.36, 0.38, 2.26, 0.68 (molkg^{-1}) respectively, having a mean of 0.92 (molkg^{-1}). This is high compare to the range of 0.08 - 0.20 (molkg^{-1}) as predicted by the (Balasubramanion*et al.*, 1984). This implies that the sodium content of Federal College of Education Farm Zaria is readily available for crop uptake. The cation exchange capacity content in the four samples collected includes 3.02, 2.75, 10.26. 5.31 (molkg^{-1}) respectively,

having the mean of 5.34 ($molkg^{-1}$). The cation exchange capacity is lower than that stated by (Lombin and Singh, 1986). The cation exchange capacity of the savannah is generally low, which is kaolinitic status of organic matter and clay (Lombin and Singh 1986). The low cation exchange capacity also may be as a result of low pH values since cation exchange Capacity has been reported to be a continuous function of pH (Tisdale, *et al.*, 1985).

From Fig. 2, available phosphorus for the four samples varies from 5.25 $mgkg^{-1}$ to 15.50 $mgkg^{-1}$ respectively with a mean of 10.88 - 15.50 $mgkg^{-1}$.This is low when compared with values reported by (Jones and Wild, 1976); and falls within the range as reported by (Gurbir*etal*., 2015) to be 3.8 - 30.6$mgkg^{-1}$(Gurbir*etal.,* 2015). Plants grown on soils with low available phosphorus develop symptoms which indicate phosphorus deficiency, the high phosphorus Content in the surface of the soil may be due to the presence of organic carbon that accumulated from nutrient recycling.

Table 1: Results of Available Phosphorus In the Soil of Federal College of Education Zaria Farm.

SOIL SAMPLES	*AVAILABLE PHOSPHORUS*
Pit depth (1– 15cm)	$mgkg^{-1}$
1	*12.25*
2	*5.25*
3	*15.50*
4	*10.50*

Table 2: Results of the Exchangeable Bases in The Soil of Federal College of Education Zaria Farm

Soil samples	*($mollkg^{-1}$)* *EXCHANGEABLE BASES*					
Pit dept (1-15cm)	*Ca*	*Mg*	*K*	*Na*	*H+Al*	*ECEC*
1	*1.80*	*0.43*	*0.23*	*0.36*	*0.20*	*3.02*
2	*1.40*	*0.60*	*0.17*	*0.38*	*0.20*	*2.75*
3	*5.00*	*1.67*	*1.23*	*2.26*	*0.10*	*10.26*
4	*3.20*	*1.00*	*0.33*	*0.68*	*0.10*	*5.31*

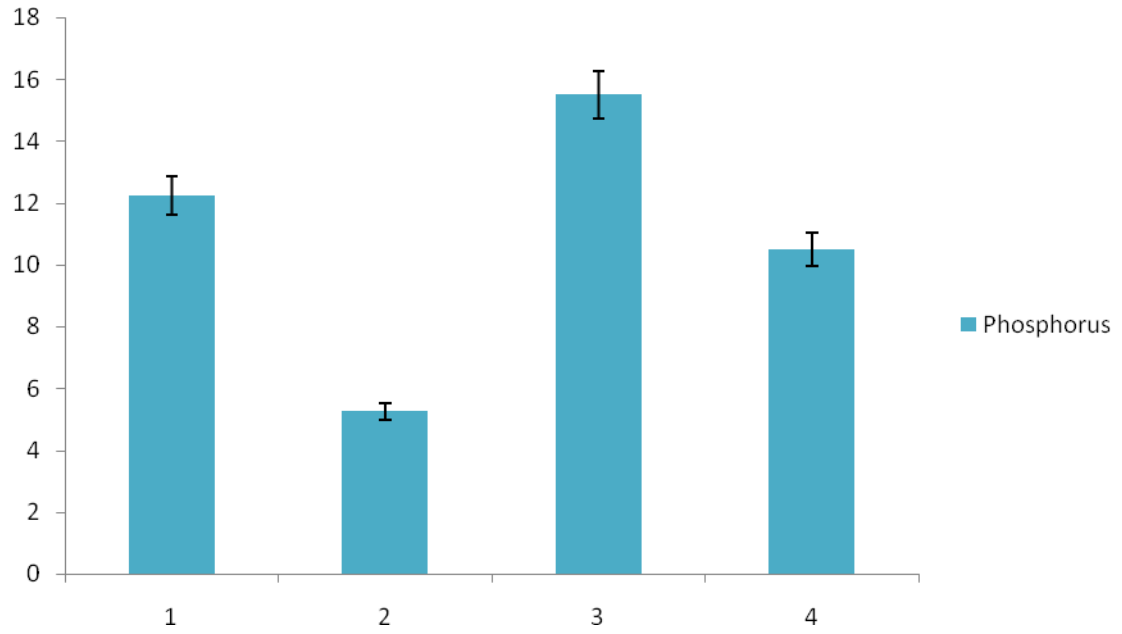

Figure 2: Bar Chart Showing the Availabilities of Phosphorus ($Mgkg^{-1}$) Against The Pit Depts (Cm)

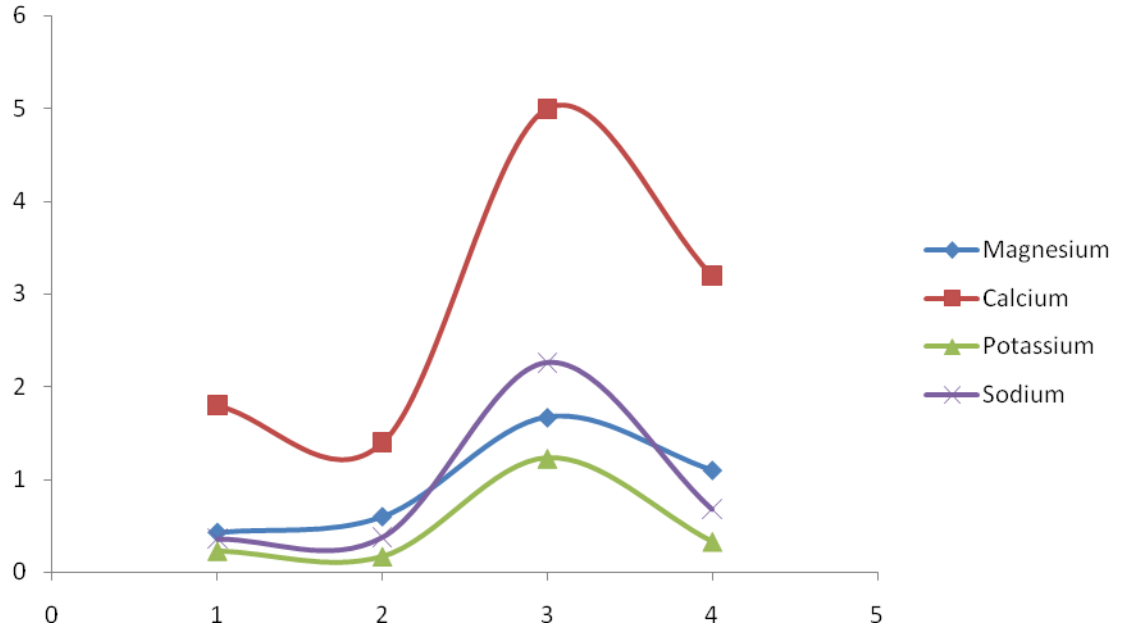

Figure 3: Graph of the exchangeable bases such as magnesium, calcium, potassium and sodium

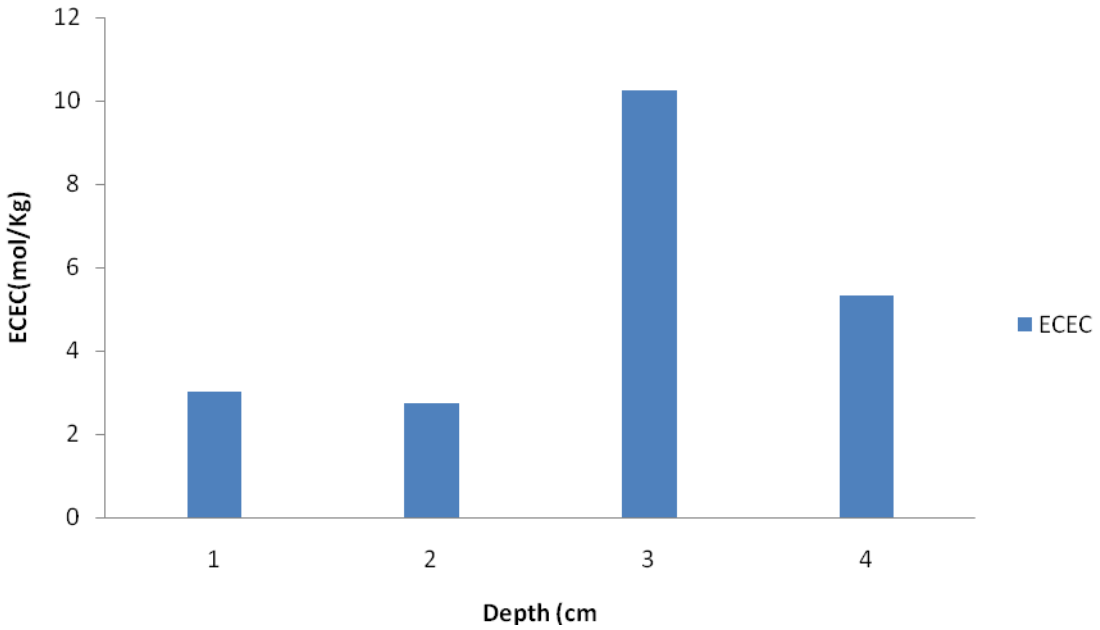

Figure 4: Bar Chart Showing The Availabilities Of Effective Cation Exchange Capacity (Ecec) (Mg/Kg) Against The Pit Depts (Cm)

5.0 Conclusions and Recommendations

It is concluded from the forgoing findings that the available phosphorus in the soil of Federal College of Education farm is not adequate for the growth of crops. The exchangeable cation exchange capacity is also not adequate for the uptake of the crops, though some of the mineral nutrients are adequate when compared to literature. The hydrogen and Aluminium in the same soil also shows that the soil is not acidic hence it is suitable for plant growth. The findings also entails that the available phosphorus and some of the exchangeable bases in the Farm land are not adequate for plant up take.

From the study it is recommended that: Two laboratories at least should be established in the Agricultural department of Federal College of Education Zaria for soil and crop analyses while the other for animal analysis. (Henry 2017) says that phosphorus level is affected by human activities like over grazing, tillage practices, continues farming, hence these activities should be minimized. Activities like throwing of animal dung and plant residues, kitchen waste etc. should be added to the soil in other to maintain the mineral nutrients of the soil

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