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Influence of different soil types and mineral fertilizer on maize (*Zea mays* L.) growth for effective production, soil fertility improvement and food security

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ABSTRACT

The study was conducted to determine the influence of different soil types and mineral fertilizer on maize (*Zea mays* L.) growth for effective production, soil fertility improvement and food security, at the Teaching and Research Green house, Obubra, Faculty of Agriculture and Forestry, Cross River University of Technology, Nigeria. Ikom Local White, maize variety were treated to one level of NPK (15:15:15) mineral fertilizer (0.06 kg ha^{-1}) and four different soil types (sandy, clay, sandy loam and loamy soils). Soil samples were analyzed before and after maize cultivation to determine the influence of the mineral fertilizer on soil/plant performance. Ring method of fertilizer application was employed to apply fertilizer at the same rate to all the soil types. The experiment was laid out in a Completely Randomized Design (CRD). The treatments were replicated four times to give a total of twenty polybags. The result obtained indicates that soil type-fertilizer treatment (STFT) increased ($p = 0.05$) the growth of maize and further increased (N, P, K, Ca, Na, Mg, Organic Matter, Cation Exchange Capacity including pH) over the control, with loamy soil - 0.06 kg ha^{-1} NPK (15:15:15) mineral fertilizer treatment significantly ($p< 0.05$) increased the growth parameters (plant height and number of leaves of maize) over all other treatments, and closely followed by sandy loam-0.06 kg ha^{-1} NPK (15:15:15) mineral fertilizer treatment (T_3(SL)). Loamy soil-mineral fertilizer treatment seems responsive and effective for productive maize cultivation, for soil fertility improvement and food security.

Keywords: Food security; soil type; mineral fertilizer; *Zea mays*; corn; soil-fertilizer effect; maize growth

1. INTRODUCTION

Soil is the naturally occurring material that covers the earth crust. It is the basis for human development and survival, providing nutrients which feeds and nourish crops, for food/fiber production. Soil is a natural resource, it gives plant roots anchorage, in addition to been home for billions of micro and macro organisms. Soil Science Society of America (SSSA, 2012) presents soil as a complex mixtures of minerals, water, air, organic matter, and countless organisms, that are the decaying remains of once-living things. The importance of soil has been stressed over the years, playing a crucial role in Agriculture, Engineering, Meteorology, Geology including Mining. SSSA (2012) identify soil as an unconsolidated mineral matter which plays a crucial role in the environment; ranging from been media for plant growth; modifying atmosphere by emitting and absorbing gases/dust; provision of habitat for soil organisms/Man; absorbs, hold, purify and release water which is the basic liquid for Human survival and production. As important as soil is, it mismanagement, deterioration and degradation is high, especially in the humid tropics, where soil acidity is on the increase. Declining soil fertility has been reported by Sanchez *et al.* (1997) as the fundamental cause of declining crop yields in Africa, as the pH declines, supply of essential plant nutrients decreases while Aluminum and a few micro-nutrients become more soluble and toxic to plants. According to Harter (2007) these problem are more acute in humid tropical regions with highly weathered soils. A report by Sanchez and Logan (1992) indicates that one-third of the tropics (1.7 billion) hectares of tropical soil are vulnerable to soluble aluminum to be form which stands too toxic for crop plants, thereby limiting food/fibre production and degrading the soil fertility status. This is because the soil quickly looses its fertility and erodes in the heavy rain when the forest is removed.

A large number of soil types have been described and mapped in Sub-Saharan Africa and most are highly weathered and inherently infertile in terms of their productivity for arable farming (Bronick and Ial, 2005). Erosion is the most common form of land degradation affecting soil productivity in Nigeria (Phillip *et al.*, 2008; Titilola and Jeje, 2008), it main effect is loss of soil nutrient and actual soil loss. Soil loss due to erosion prompted by poor land use practices could be as much as 15 tons per hectare per year on bare ploughed soil in Western Nigeria (Titilola and Jeje, 2008). Apart from soil loss, erosion drastically affects the physic-chemical properties of the soil. Hanson (1992) reported that out of the three billion hectares of arable land in tropical Africa, only 1.47% is considered to be free of physical or chemical constraint, 13.2% has limited nutrient retention capacity, 16.9% has high soil acidity, and 6.8% has high phosphorus (P) fixation. Nitrogen (N) and Phosphorus (P) are the most serious limiting factors for cereals and food legumes, respectively (Takow *et al*., 1999). Deficiencies of Potassium (K) in root crops, Sulfur (S) and Zinc in maize have been reported in continuously cultivated fields which have few or no inputs of fertilizer (Jones and Wild, 1975; Hanson, 1992).

Soil erosion, surface sealing and crusting have been reported to be high in tropics (Van de Watt and Valentin, 1992). Deterioration in Cation Exchange Capacity (CEC), Water Holding Capacity (WHC) and low pH is a constraint to tropical soils. Findings by Juo *et al*. (1994) indicates that soil of the tropics are poorly buffered, Kaolinitic, low in organic matter and cannot sustain crop production. Deforestation, Salinization, Alkalization and water logging are also constraints of tropical soils (Karshenas, 1994).

In Nigeria, soil degradation affects about 50 million people and leads to the greatest loss of GNP (Gross Net Profit) worth US $ 3000 million per year relative to other environmental problems (World Bank, 1990). Hole *et al*. (2005) reported that each year about 5 – 10 million hectares of crop land are taken out of production because of soil erosion, nutrient depletion, salinization and water logging. Obi and Ebo (1995) reported that Nigerian soils are inherently infertile, acidic and low in organic matter content. Hence, the application of mineral fertilizer becomes very important in tropical cropping systems for soil fertility improvement and increase crop production.

Soil texture has been described as the relative amounts or proportions of coarse and fine materials present in a soil sample (Ibanga, 2006). Soil texture takes into account the relative proportions of sand, silt and clay content in a given soil sample, giving the different sizes of individual particles. Twelve (12) textural classes are employed in classifying and identifying soil types (clay; sandy clay; sandy clay loam; sandy loam, loamy sand; sand; clay loam; loam; silty; silty clay loam; silt loam, and silt), with percentage sand, clay and silt used as a determinate factor. Different methods have been developed over the years and used to identify a particular soil textural class: Pipette method of particle analysis; hydrometer method and finger feeling method, which is a field texture determination of the textural class of a given soil sample. Determination of soil textural class enhance productivity of the researcher/farmer, suggesting the soil type and giving guidelines on the type of crops suitable for the soil.

Nitrogen (N) is an essential plant nutrient, its functions in plant-soil nutrition ranges from; been a constituent of all proteins, chlorophyll/enzymes reactions, to been yield-determining factor for maize production (Adediran and Banjoko, 1995; Subedo and Ma, 2005). Phosphorus (P) is also one of the essential nutrients for proper soil functioning/crop nutrition, the mineral element functions in some enzymes/protein synthesis and in Deoxyribonucleic acid (DNA) and Adenosin triphosphate (ATP) metabolism. P aids seed/fruit formation, crop maturity and helps in strengthens the skeletal structure of the plant preventing lodging. Potassium (K) is essential for normal growth of plant. FFD/NSPFS (2011) reported K been an activator of enzymes involving in photosynthesis, protein and carbohydrate (CHO) metabolism. K assist carbohydrate translocation; synthesis of protein and maintenance of its stability; membrane permeability and pH control; water utilization by stomatal regulation. K also improves utilization of light during cool and cloudy weather, enhancing plant to resist cold and adverse conditions (FFD/NSPFS, 2011). Several fertilizer trails/programmes carried out over the years indicated a positive outcome. Recent findings by Onasanya *et al*. (2009) indicated increased plant growth and grain yield when mineral fertilizer was applied on maize. Okonwu and Menash (2012) findings also confirmed the potential of fertilizer on increasing plant growth.

Wheat, Rice and Maize have always been in the mind of Man, owning to the fact that these crops has endless uses/utilization. Exploration of these three (3) most important food crops is huge with maize been the most explored. Maize is the most important cereal crop. The crop belongs to the grass family *Poaceae*. Botanically the crop is called (*Zea mays* L.), the crop is also called corn with its origin traced back to Central American tropics and Mexico (Brewbaker, 2003). Maize is a multipurpose crop, its uses/utilization ranges from Herbal: where the silk is used to treat urinary tract infections and kidney stones (Abdulrahaman, 1997;Dilip and Aditya, 2013). Medically: the crop silk have been used to improve blood pressure and support liver functioning (Dilip and Aditya, 2013). Pharmaceutically: the crop decocte/extract are used in drug production and other related pharmaceutical products. Nutritional value of maize include 80% carbohydrate, 10% protein, 3.5% fiber, 2% mineral (IITA, 2001), including iron and vitamin B. Industrial utilization of maize include wet milling, production of ethanol and other maize-related products (Watson, 1988). With it economic importance ranging from production of edible oil, cooking oil which can be used as an anti-freeing material (Oladejo and Adetunji, 2012) to provision of income, improvement of standard of living, supply basic nutrients in animal feed/feed formulation, serves as indicator-crop for soil fertility assessment and as a mandate crop for food security for the ever increasing human population.

Maize is cultivated in all Agro-ecological zones of the world, with the United States recording a world production at 177.3 million tons and 3.6 yield in tons/acre (Brewbaker, 2003). China, Brazil, Mexico, France, Russia, South Africa, India including Yugoslavia are the leading world producers of maize. Nigeria as at 2003 produced 1.8 million tons and yield 0.6 tons/hectare (Brewbaker, 2003), which increased to 8 million tons as at 2014 (IITA, 2014) presenting Nigeria as the largest African producer of maize. With areas like Adamawa, Bauchi, Borno, Yobe including Obubra (Cross River State) being her main production belt.

Against the problems of tropical humid soils, rapid misuse/mismanagement of soils, resulting in soil-nutrient deterioration and to effectively produce maize in low-nutrient tropical humid soils, then the need to conduct this research findings arises, with the following objectives:

1. Seeking the best soil type for maize (*Zea mays* L.) production in the study area and its environs through greenhouse trials
2. To determine the influence of mineral fertilizer on maize (*Zea mays* L.) growth for increase production and for food security
3. To evaluate the effect of mineral fertilizer on soil properties, for effective and sustainable crop production in the tropics

2. MATERIALS AND METHODS

2. 1. Experimental site (Study Area)

The experiment was conducted at the Teaching and Research Greenhouse, Faculty of Agriculture and Forestry, Cross River University of Technology (CRUTECH), Obubra campus, Nigeria. The study area lies between Latitude 6°06' North and Longitude 8°18' East in the rainforest zone of Nigeria. Obubra has an annual mean rainfall of 2250 mm – 2500mm per annum (CRADP, 1992) with a temperature of 25 °C to 27 °C. The area is described as Derived Savanna vegetation, with anthropagenic activities including farming, lumbering and deforestation which adversely deplete vegetation, causing soil erosion, land degradation and fertilizer spilt, thereby polluting/degrading the environment. Subsistent farming at a peasant level is the major socio-economic activities of the local people. The experiment was conducted between March and August 2015 and 2016 respectively.

2. 2. Plant material selection (Source of material)

Local maize variety: Ikom Local White, was obtained from Agricultural Extension Office, Ikom, Cross River State (CRS), Nigeria. Apron plus, a widely used seed dressing chemical in the area was procured from Crop protection unit of the Department of Agronomy, Faculty of Agriculture and Forestry, CRUTECH. Mineral fertilizer (NPK 15:15:15) was also obtained from Agric Extension office, Ikom CRS.

River sand soil sample was obtained from Ovonum river, Obubra. The sample was obtained from the river to ensure it was a pure sandy soil. Pure clay soil ample was obtained from a reserved clay heap at the experimental location. Field soil sample was obtained by soil sampling collection at the Teaching and Research experimental farm.

2. 3. Soil sampling and processing

Soil sample were collected from the Teaching and Research Farm, Faculty of Agriculture and Forestry, CRUTECH, Obubra. The samples were collected at a depth of (0-30cm) with the aid of soil auger. The samples were collected at two points: Point A; where the soil was visually observed to be sandy loan soil, and point B; where the soil was observed to be loamy soil. The samples were transferred to the laboratory for analysis.

The samples were air-dried at room temperature (22-23 °C). The samples were ground into fine particles with the aid of a laboratory mortar and pestle, the particle was sieved using 2mm sieve.

2. 4. Soil analysis

All soil samples collected from the various sources were subjected to standard laboratory analysis.

2. 5. Laboratory Analysis

Soil Physical Properties

- Particle size distribution:

The particle size distribution was determined by hydrometer method as described by Gee and Bauder (1986). Individual sample textural class was further determined using soil triangle.

Soil Chemical Properties

- Soil pH: Soil pH was determined in water 1:2 soil: water ratio using pH meter with glass electrode (Thomas, 1996).
- Organic Carbon (OC): Organic Carbon was determined by the dichromate wet-oxidation method as described by Nelson and Sommers (1996).
- Organic Matter (OM): The value of organic carbon (OC) was multiplied by 1.732 to obtained Organic Matter content.
- Total Nitrogen (TN): Total Nitrogen was determined by the micro-kjeldahl digestion and distillation method as described by Bremmer (1996).
- Exchangeable Cations (EC): The bases were extracted with neutral NH_4OA_c. Calcium and Magnesium were determined in the extract by EDTA titration, Potassium and Sodium by the use for flame photometer (Udo *et al.*, 2009) .
- Available Phosphorus: Available Phosphorus was determined by the Bray-1 method as described by method described by Kuo (1996)

- Cation Exchange Capacity (CEC): Cation Exchange Capacity was determined by method described by Summer and Miller (1996).

2. 6. Plant Media preparation

After determining from laboratory analysis and soil triangle guide, different textural soil class obtained were:

River sand sample = Sandy Soil (SS)
Clay material sample = Clay Soil (CS)
Experimental site soil sample; point A = Sandy loam (SL)
Experimental site soil sample; point B = Loamy Soil (LS)

Extra-large polybags were labeled according to treatments, and then the different soils were filled into designated polybags.

2. 7. Treatment

- *Soil treatment*

The soil treatments used in this experiment were:

Treatment one (T_1) Sandy Soil (SS)
Treatment two (T_2) Clay Soil (CS)
Treatment three (T_3) Sandy loam Soil (SS)
Treatment four (T_4) Loamy Soil (LS)
Treatment five (T_5) Control (CR)

Fives soil treatments were used and replicated four (4) times.

- *Fertilizer treatment*

One level (0.06 kg ha^{-1}) of mineral fertilizer (NPK 15:15:15) was applied to all the soil treatments except the control.
Although the treatment labeled as the control (CR) was texturally identified as sandy-loam soil, but no fertilizer was applied to it during fertilizer application.

2. 8. Planting / Greenhouse techniques

Ikom Local White, maize variety was subjected to germination test, viable seeds were selected. Healthy and clean seeds were treated with Apron plus seed dressing chemical, this was done to get a disease/insect-free seeds and to control soil borne pathogens before sowing. Healthy and viable seeds were sown on 3rd March, 2015. Two seeds were planted per polybag.

Maize seedlings were later thinned to one plant per polybag at 14 days after planting (DAP).

2. 9. Fertilizer application

Mineral fertilizer (NPK 15:15:15) was applied to the plant in polybags at 5 Weeks after Planting (5WAP). 0.06 kg ha^{-1} of NPK (15:15:15) fertilizer was applied by ring method to Sandy soil (T_1(SS)). 0.06 kg ha^{-1} of NPK (15:15:15) fertilizer was also applied to clay soil

(T_2(CS)), Sandy loam (T_3(SL)) and Loamy soil (T_4(LS)) respectively. Fertilizer application for CS, SL and LS was achieved using the ring method of application, were a ring of 3 radius was open at 3cm depth round each of the plant in all replicates, fertilizer was applied, the ring was then covered back with the media soil. No fertilizer was applied in the control polybags across the four replications.

3. RESULTS AND DISCUSSION

3. 1. Physical Properties

Results of the physical properties of the media soil used for growing the maize crop before NPK (15:15:15) fertilizer application is presented in Table 1. Texturally, river sand sample was analyzed and classified using the soil triangle to be sandy soil with sand value of 99% (0.5% silt and 0.5% clay), clay material sample was analyzed to be clay soil with clay content of 99.5% (0.25 sand and 0.25 silt), while the experimental soil sample analyzed for point A was sandy-loam soil with values of (70.0% sand, 24.0% silt and 6.0% clay) at Point B (23% sand, 50% silt and 27% clay) was analyzed putting the textural class as loamy soil.

3. 2. Nutrient Composition

The physic-chemical properties of the composite sample (mixture of all soil samples used in the experiment) is presented in Table 2. Texturally, the soil was analyzed to be a sandy loam soil dominated by sand content of 830 g/kg, clay and silt content of (80 g/kg and 69 g/kg). The soil was acidic with pH of (5.91) in H_2O and 5.07 in KCl. The Organic matter content and Total Nitrogen were low with values of 1.18 g/kg and 0.071 g/kg. The available phosphorus was low with value of 3.56 mg/kg. The exchangeable cations (Ca, Mg, Na and K) were equally low in status with values of 3.42 cmol/kg for Ca^{2+} and 1.48 cmol/kg for Mg^{2+}. The value obtained for Na^+ was 0.55 cmol/kg which was also low. The CEC was 6.27cmol/kg.

The low N, P, Organic matter (OM), pH and other nutrients are characteristics of tropical soils as described by Chude (1998); Ojeniyi (2010). The low nutrient status of the soil showed that there is need to improve the fertility status of the soil in the area for increase production and improve crop performance. In accordance with the findings of FAO (2006) which recommends that when nutrients are far below or below their critical levels, then the need for nutrient amendment is crucial, hence, the need for the NPK (15:15:15) fertilizer applied to the crop arises for enhance crop performance, for food security and overall soil improvement.

Fertilizer rate and selected application method used in the study are presented in Table 3. NPK (15:15:15) fertilizer supplies three essential nutrients to the plant; Nitrogen (N), Phosphorus (P) and Potassium (K) which increases the growth of plants. Hence, application of mineral fertilizer will help to produce the expected crop growth and in addition to increasing the fertility status of the soil.

Table1. Textural class of soil samples used for maize (*Zea mays* L.) cultivation
2015 Experiment soil textural analysis for individual sample.

Source of soil sample	Soil Property	Soil Triangle unit (%)	Value obtained (%)	Soil Textural Class (STC)
River sand soil sample	Sand	(%)	99.0	Sandy soil
	Silt	(%)	0.5	
	Clay	(%)	0.5	
Clay material sample	Sand	(%)	0.25	Clay soil
	Silt	(%)	0.25	
	Clay	(%)	99.5	
Experimental site soil sample Sample Point A	Sand	(%)	70.00	Sandy loam soil
	Silt	(%)	24.0	
	Clay	(%)	6.0	
Experimental site soil sample Sample Point B	Sand	(%)	23.0	Loamy soil
	Silt	(%)	50.0	
	Clay	(%)	27.0	

Soil samples were first analyzed in the laboratory and further confirmation of the textural class was done using soil triangle in percentage (%)

Table 2. Physicochemical Properties of media soil before cropping
2015 Experiment soil sample analysis for composite sample.

Soil Property Analyzed	Unit	Value obtained
Sand	(g/kg)	830
Silt	(g/kg)	69
Clay	(g/kg)	80
Textural class		Sandy loam
pH (H_2O)		5.91

pH (KCl)		5.07
Organic Matter	(g/kg)	1.18
Total N	(g/kg)	0.071
Available P	(mg/kg)	3.56
Exchangeable K	(cmol/kg)	0.21
Exchangeable Mg	(cmol/kg)	1.48
Exchangeable Ca	(cmol/kg)	3.42
Exchangeable Na	(cmol/kg)	0.55
CEC	(cmol/kg)	6.27

Composite sample was obtained by bucking (mixing) all soil samples together, and analyzed in the laboratory

Table 3. Details of treatment, fertilizer rate and method of fertilizer application used for the study in 2015 and 2016 Experiments

Treatment S/N	**Treatment**	**Treatment Code**	**Fertilizer Rate (kg ha^{-1})**	**Method of fertilizer Application**
Treatment 1 (T_1)	Sandy soil	SS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer	Ring Application Method
Treatment 2 (T_2)	Clay soil	CS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer	Ring Application Method
Treatment 3 (T_4)	Sandy loam soil	SL	0.06 kg ha^{-1} NPK (15:15:15) fertilizer	Ring Application Method
Treatment 4 (T_4)	Loamy soil	LS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer	Ring Application Method
Treatment 5 (T_5)	Control	CR	No fertilizer	No Application

$T_{1;}$ $T_{2;}$ $T_{3;}$ T_4; T_5 Numbers of treatment used. SS; CS; SL;LS;CR: Different treatment used

Soil samples were also collected in 2016 from the same locations studied in 2015. Textural class of the different soil samples were analyzed and further determined, confirmed and concluded using soil triangle, as presented in Table 4.

Table 4. Textural class of soil samples used for maize (*Zea mays* L.) cultivation
2016 Experiment soil textural analysis for individual sample.

Source of soil sample	Soil Property	Soil Triangle unit (%)	Value obtained (%)	Soil Textural Class (STC)
River sand soil sample	Sand	(%)	98.0	Sandy soil
	Silt	(%)	1.0	
	Clay	(%)	1.0	
Clay material sample	Sand	(%)	0.5	Clay soil
	Silt	(%)	0.5	
	Clay	(%)	99.0	
Experimental site soil sample Sample Point A	Sand	(%)	70.0	Sandy loam soil
	Silt	(%)	20.0	
	Clay	(%)	10.0	
Experimental site soil sample Sample Point B	Sand	(%)	24.0	Loamy soil
	Silt	(%)	50.0	
	Clay	(%)	26.0	

Soil samples were first analyzed in the laboratory and further confirmation of the textural class was done using soil triangle in percentage (%)

After textural determination and confirmation Table 4. All soil samples analyzed texturally were buck together to form a composite sample which was subjected to standard experimental laboratory analysis for physic-chemical soil analysis as presented in Table 5.

Table 5. Physicochemical Properties of media soil before cropping
2016 Experiment soil sample analysis for composite sample.

Soil Property Analyzed	Unit	Value obtained
Sand	(g/kg)	820

Silt	(g/kg)	64
Clay	(g/kg)	78
Textural class		Sandy loam
pH (H_2O)		5.87
pH (KCl)		5.02
Organic Matter	(g/kg)	1.12
Total N	(g/kg)	0.067
Available P	(mg/kg)	3.53
Exchangeable K	(cmol/kg)	0.18
Exchangeable Mg	(cmol/kg)	1.44
Exchangeable Ca	(cmol/kg)	3.40
Exchangeable Na	(cmol/kg)	0.55
CEC	(cmol/kg)	6.24

Composite sample was obtained by bucking (mixing) all soil samples together, and analyzed in the laboratory

Result of the physical and chemical properties of the media soil sample before cropping and mineral fertilizer application (Table 5) showed that texturally, the soil was sandy loam soil dominated by sand fraction of 820 g/kg, clay and silt particle of (78 g/kg and 64 g/kg). The pH of the soil was acidic with a value of (5.87) in H_2O and (5.02) in KCl. The organic matter (OM) was low (1.12 g/kg). The Total Nitrogen, available Phosphorus was also low as well as the exchangeable cations of Calcium, Magnesium, Potassium and Sodium. The CEC was 6.24 cmol/kg. These properties showed that there is need to improve the soil fertility level for high productivity. Result trend observed indicated a decrease in the soil properties value, further, pointing to the problem of humid tropical soils which include rapid deterioration of soil nutrients as described by Hole *et al*. (2005).

3. 3. Plant Data collection

Data was collected first at one (1) Week after Fertilizer Application (WAFA) (6 Weeks after Planting (6WAP), subsequent measurement of plant height were taken at one Week interval until 10 Weeks after planting (10 WAP). Growth parameters recorded at different stages of crop growth and development were: Plant height and Number of leaves.

These parameters were determined in the following ways:

- *Plant Height*: This was taken from a sample of randomly selected maize plants, tag within each replicate. Standard measuring tape was used for measuring the height from the soil level to the top-most leaf. The mean was then determined and recorded.
- *Number of Leaves*: Counting of leaves on the randomly selected tag maize plant was done, and the value was recorded for each treatment in all the replicates. The mean values were then calculated for each treatment. Number of leaves were counted and recorded for each treatment throughout all the replication, first at one week after fertilizer application (6WAP(1 WAFA)), then subsequent counting was done at one (1) Week Intervals (WI).

3. 4. Statistical Analysis

Data generated for plant growth parameters were analyzed using the procedure for Analysis of Variance (ANOVA) for Completely Randomized design (CRD). Separation of means was done using Fishers Least Significant Difference (f-LSD) at 0.05% probability level.

3. 5. Plant Height

The trend observed in plant height at all levels of the plant growth and development shows an increase in plant height across all the treatments, with the least height recorded in the control (T_5(CR)) as presented in Table 6.

Table 6. Influence of soil types and mineral fertilizer (NPK 15:15:15) on maize (*Zea mays* L.) height (cm) 2015 Experiment

Treatment S/N	Treatment Code	Treatment	Maize mean height at 1WAFA	Maize mean height at 5WAFA
Treatment 1 (T_1)	SS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy soil	1.80	2.53
Treatment 2 (T_2)	CS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Clay soil	3.28	5.50
Treatment 3 (T_4)	SL	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy loam soil	3.51	5.52
Treatment 4 (T_4)	LS	0.06 kg ha^{-1} NPK (15:15:15)	3.62	5.99

		fertilizer in Loamy soil		
Treatment 5 (T_5)	CR	Control	1.59	2.43
LSD ($p < 0.05$)			0.26	0.59

SS; CS; SL; LS: Different soil types. CR: Control.
Mean with the least value produce minimum plant height.
All means were separated using (f-LSD) Fisher Least Significant Difference at 0.05%

Result obtained from ANOVA analysis of plant height at one Week after fertilizer application, showed that plant height increased across all the treatments, with Loamy soil (LS(T_4)) producing the tallest ($P = 0.05$) plant (3.62 cm). Loamy soil significantly ($p < 0.05$) increased the height of maize plant over the control. Sandy-loam soil recorded a mean plant height value of (3.51 cm), indicating increase in maize height compared to CS, SS and the control. Clay soil-fertilizer treatment produced plants with a mean height of (3.28 cm) which significantly ($p < 0.05$) increased the height of plant over the control, presenting Clay soil (CS) to be more advantageous than Sandy soil and the control. However, Sandy soil recorded a mean maize plant height at 1.80cm, indicating a positive influence of the fertilizer to boost the nutrient level of the soil, thereby enhancing the crop growth increase over the control. Minimum plant height was recorded in the control with a mean value of 1.59 cm.

At 5 Weeks after Fertilizer Application (5 WAFA (10 Weeks after Planting)), Loamy soil recorded a mean plant height of (5.99 cm), which was significantly ($p < 0.05$) difference over the control, this was followed by Sandy-loam soil which produced a mean value of (5.52 cm), which present Sandy-loam-fertilizer treatment to be preferable compared to CS, SS and the control. Clay soil (CS) produced plants with a mean height of 5.50 cm, indicating a positive influence of the soil-fertilizer impact on the plant, and further placing clay soil as advantageous compared to Sandy soil and the control. Sandy soil (SS) recorded a plant height with mean value of (2.53 cm) placing Sandy soil above the control and further indicating the ability of Sandy soil to increase crop growth and development, if properly managed. The least (minimum) plant height (2.43 cm) at 5WAFA was produced in the control, presenting all other treatments above the control.

However, it can be presented that the influence soil type-NPK (15:15:15) mineral fertilizer on maize height in Loamy soil (5.99cm) < Sandy-loam soil (5.53 cm) < Clay soil (5.50 cm) < Sandy soil (2.53 cm) < Control (2.43 cm). Presenting a guide for farmers and Agricultural Researcher/Practitioner who wish to effectively manage soil/nutrient use efficiency for profit maximization, protection of the environment and for food security.

Treatment effect (influence) observed in this experiment agrees with the research findings of Kogbe and Adediran (2003) whose report indicated an increased in maize (*Zea mays* L.) growth/yield after NPK fertilizer application in both Guinea and Derived savanna soils of Nigeria. Findings of Onasanya *et al.* (2009) also agrees with this experiment, where they reported increased in growth parameters and subsequent yield in maize after mineral fertilizer application in humid tropical soils of southwest Nigeria.

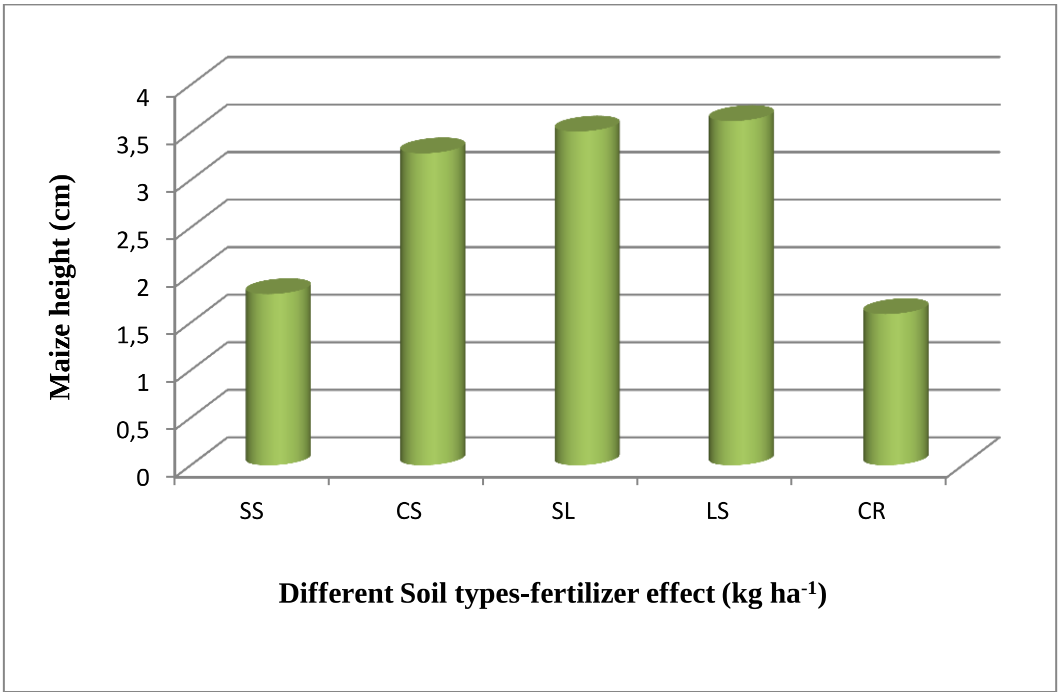

Fig.1. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn height at 1WAFA

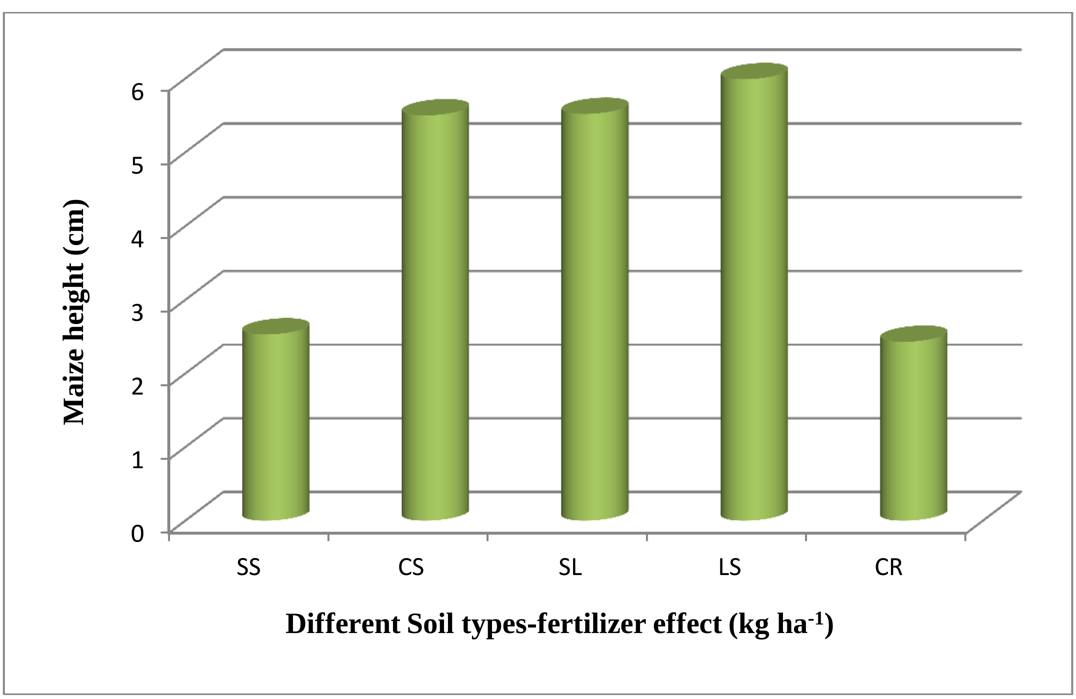

Fig. 2. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn height at 5WAFA

Table 7. Influence of soil types and mineral fertilizer (NPK 15:15:15) on maize (*Zea mays* L.) height (cm) 2016 Experiment

Treatment S/N	Treatment Code	Treatment	Maize mean height at 1WAFA	Maize mean height at 5WAFA
Treatment 1 (T_1)	SS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy soil	1.78	2.50
Treatment 2 (T_2)	CS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Clay soil	3.20	5.48
Treatment 3 (T_4)	SL	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy loam soil	3.48	5.50
Treatment 4 (T_4)	LS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Loamy soil	3.60	5.97
Treatment 5 (T_5)	CR	Control	1.52	2.40
LSD ($p < 0.05$)			0.77	1.40

SS; CS; SL; LS: Different soil types. CR: Control.
Mean with the least value produce minimum plant height.
All means were separated using (f-LSD) Fisher Least Significant Difference at 0.05%

ANOVA analysis obtained in the 2016 experiment indicated an increased across the various treatments, with Loamy soil producing maximum ($p = 0.05$) plant height with a mean value of (3.60 cm), presenting LS to be significantly ($p < 0.05$) different over all other treatments. Soil-fertilizer influence on maize plant in Sandy-loam soil was at a value of (3.48 cm) presenting (T_3(SL)) as preferred over (CS and SS). 3.20 cm was recorded in treatment two (T_2(CS)) Clay soil, placing the plant mean value as preferred when compared with the value recorded in SS (T_1). However, Sandy soil produced plants with a mean height of (1.78 cm) indicating the good management practice (mineral fertilizer application) adopted to cultivate maize using Sandy soil. Minimum mean plant height of (1.52 cm) was observed and recorded in the control.

The increased recorded in maize plant growth to soil type-fertilizer treatments can also be attributed to fact that the soil, even the plant is grown out of the field where adverse (unfavorable) climatic/weather conditions like incessant rainfall that wash away crop nutrients in the area is controlled.

Influence of Soil type-fertilizer impact at 5WAFA was observed to be high, with Loamy soil producing the maximum ($p = 0.05$) plants height (5.97 cm), which stands significantly ($p < 0.05$) higher than all other treatments in 5 Weeks after Fertilizer Application (WAFA). However, Sandy loam soil recorded a mean plant height at 5.50 cm, placing SL as preferred when compared to SS and the control. Clay soil-fertilizer influence on maize was recorded by it mean value, which was recorded at the tune of (5.48 cm), presenting clay soil as better when compare to treatment one (T_1(SS)). Sandy soil produced plant with mean height of (2.50 cm), presenting sandy soil as the second to the least (control) in terms of increase in plant height. The least plants height was recorded in the control with a mean value of (2.40 cm).

The trend observed, analyzed and recorded in 2016 experiment is similar to the findings in 2015 experiment, and therefore agrees further with the findings of Kogbe and Adediran (2003); Onasanya *et al*. (2009).

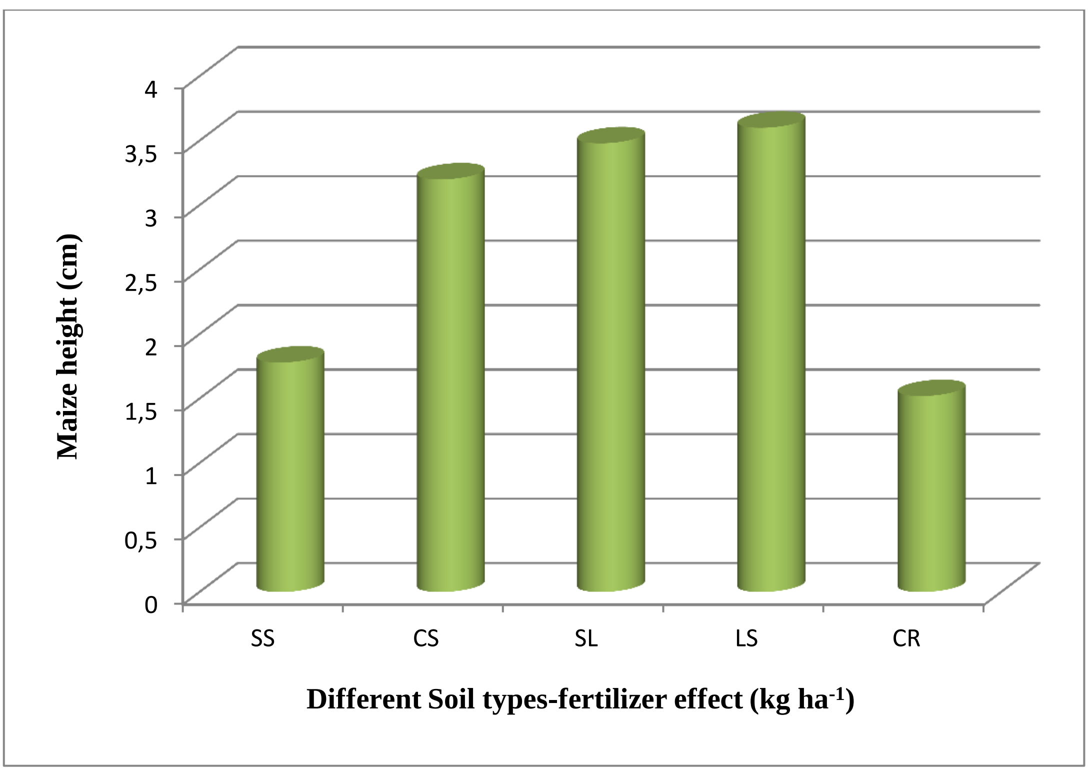

Fig. 3. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn height at 1WAFA

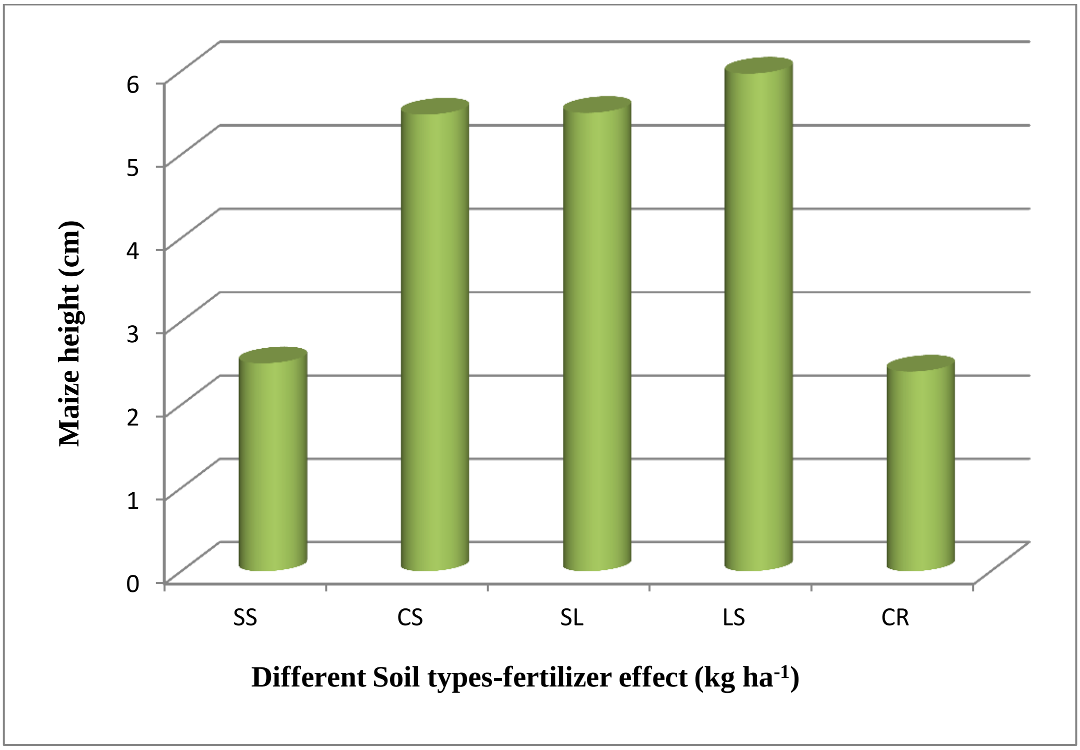

Fig. 4. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn height at 5WAFA

3. 6. Number of Leaves

ANOVA analysis for number of leaves as presented in Table 8, shows the trend in the influence of soil-fertilizer responds of maize plant to the treatment, with the highest production of leaves in Loamy soil-fertilizer treatment.

Table 8. Influence of soil types and mineral fertilizer (NPK 15:15:15) on maize (*Zea mays* L.) Number of Leaves 2015 Experiment.

Treatment S/N	Treatment Code	Treatment	Maize mean height at 1WAFA	Maize mean height at 5WAFA
Treatment 1 (T_1)	SS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy soil	7.50	11.00
Treatment 2 (T_2)	CS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Clay soil	11.50	17.50

Treatment 3 (T_4)	SL	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy loam soil	12.00	18.00
Treatment 4 (T_4)	LS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Loamy soil	13.10	19.50
Treatment 5 (T_5)	CR	Control	6.50	10.50
LSD ($p < 0.05$)			0.68	0.99

SS; CS; SL; LS: Different soil types. CR: Control.
Mean with the least value produce minimum plant height.
All means were separated using (f-LSD) Fisher Least Significant Difference at 0.05%

Statistical analysis using ANOVA procedures indicates significant ($p < 0.05$) increase in the number of leaves produced at 1WAFA (6 Weeks after planting). Placing Loamy soil as the best treatment, where the maximum ($p = 0.05$) number of leaves was produced over all other treatments, with a mean number of leaves at (13.10). A positive influence exist between sandy-loam soil and mineral fertilizer on maize number of leaves, this was shown in treatment three (SL) where it produced a mean value recorded at (12.00) which immediately followed LS(T_4), indicating the potential of this treatment to be adopted in areas where loamy soils are limited. Increase in number of leaves at 0.05% probability level ($p = 0.05$) was recorded for Clay soil, the soil, the soil-fertilizer influence on maize number of leaves was observed and recorded to a tune of (11.50), indicating the potential of this treatment over sandy soil and the control, and further indicating the ability of this soil to be used wisely and professionally for maize production, especially if well managed. ANOVA analysis presented the soil-fertilizer influence on maize number of leaves produced in sandy soil to be the second to the least with a mean value recoded at (7.50), further indicating a positive influence, placing sandy soil as preferred when compared to the control (CR). However, the minimum number of leaves was produced in the control, with a mean value at (6.50). Although it must be understand that the control textural class is sandy-loam, but since no mineral fertilizer (NPK 15:15:15) was applied, hence, there is reduction in the nutrient status, thereby depleting the soil-nutrient level, and placing the soil as a weak treatment (control) over all other treatments. Hence, in an increasing order, it can be presented that LS < SL < CS < SS < CR.

Analysis of variance result obtained at 5 Weeks after fertilizer application (10 Weeks after planting) indicated a significant ($p < 0.05$) increased for all treatment, with the maximum ($p = 0.05$) number of leaves produced in loamy soil and minimum number of leaves produced in the control. Mean value of (19.50) was recorded in Loamy soil-fertilizer treatment, placing the treatment as the best, hence, revealing the efficiency of the treatment to be high on maize number of leaves over all other treatments. Significant ($p < 0.05$) difference was observed in the ANOVA analysis in sandy-loam-nutrient influence on maize number of leaves when compared to the control. The maize plant responds to the treatment (18.00) indicated that sandy-loam soil can be used effectively and efficiently to cultivate maize in humid tropics, but must be properly managed to ensure quality/high productivity. Increase ($p = 0.05$) to the tune of (17.50) was observed after ANOVA analysis in CS(Clay soil), indicating the soil-fertilizer effect on maize number of leaves, which was positive and further indicating that for maize to be successfully cultivated and recorded as profitable in clay soil, mineral fertilizer should be supplied to the soil/plant, and at the appropriate time to enhance the soil-crop performance.

ANOVA result for sandy soil (11.00) indicates increased ($p = 0.05$) in the number of leaves produced when compared to the control, although it must be known that the control is texturally sandy-loam soil, clearly presenting the impact of fertilizer to enhance high performance of crop growth on all types of soil , if properly managed. (10.50) was recorded as the mean value for the number of leaves produced in the control, probably because no fertilizer was supplied to this treatment, placing the treatment (control) as weak when compared to other treatments used in this experiment. However, the control recorded the least number of leaves. The trend observed in the soil-fertilizer effect on maize plant number of leaves can be presented as: Loamy Soil-fertilizer impact < Sandy loam soil-fertilizer impact < Clay soil-fertilizer impact < Sandy soil-fertilizer impact < Control (No fertilizer). Hence, this experiment agrees with the research findings of Enujeke (2013) whose report indicates increased in growth parameters and further increased in maize yield when NPK mineral fertilizer was applied to the crop/soil. The experimenter's findings further indicated fertilizer to be the life-wire of improved crop (maize) production, contributing 50% to 60% in the productivity of food grains in many parts of the globe. Findings of Kogbe and Adediran (2003) are also in-line with this experiment.

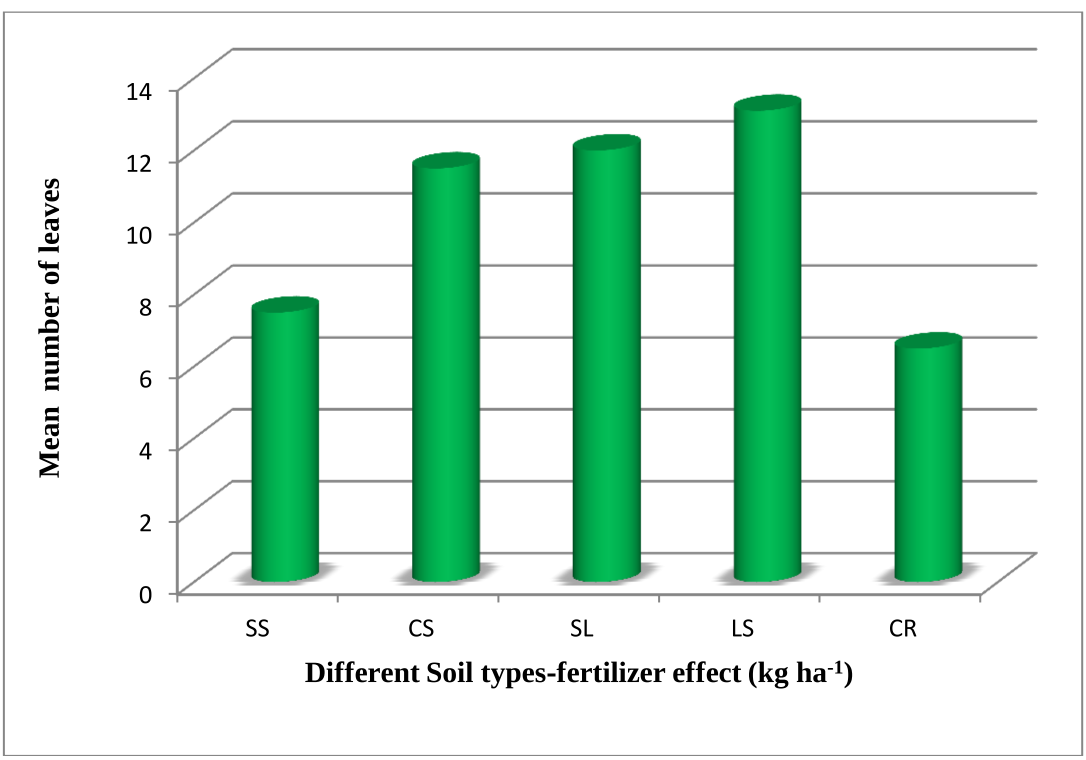

Fig.5. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn number of leaves at 1WAFA

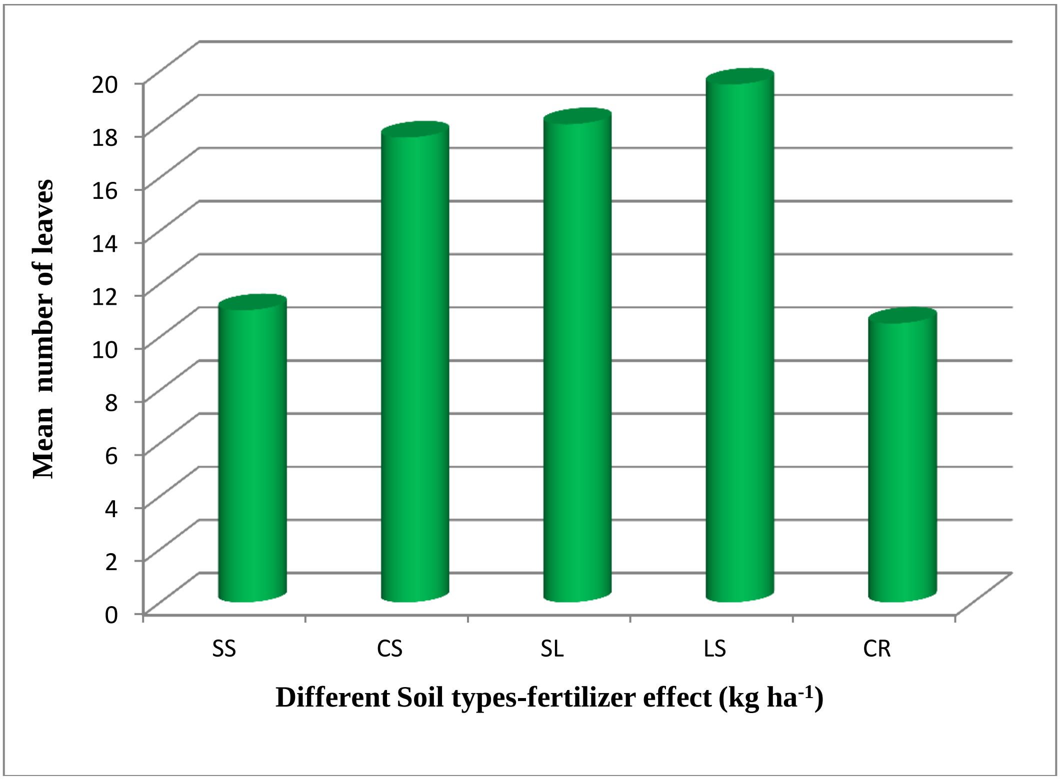

Fig. 6. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn number of leaves 5WAFA

Table 9. Influence of soil types and mineral fertilizer (NPK 15:15:15) on maize (*Zea mays* L.) Number of Leaves 2016 Experiment.

Treatment S/N	Treatment Code	Treatment	Maize mean height at 1WAFA	Maize mean height at 5WAFA
Treatment 1 (T_1)	SS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy soil	6.10	11.01
Treatment 2 (T_2)	CS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Clay soil	11.20	17.00
Treatment 3 (T_4)	SL	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Sandy loam soil	12.00	17.99

Treatment 4 (T_4)	LS	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in Loamy soil	13.05	19.48
Treatment 5 (T_5)	CR	Control	6.10	10.40
LSD ($p < 0.05$)			0.84	0.91

SS; CS; SL; LS: Different soil types. CR: Control.
Mean with the least value produce minimum plant height.
All means were separated using (f-LSD) Fisher Least Significant Difference at 0.05%

2016 trend observed from ANOVA analysis indicates positive impact (effect) in soil-fertilizer influence on the number of leaves recorded across all the treatments. Analysis result showed a significant ($p < 0.05$) difference in the number of leaves over the control. With Loamy soil (LS(T_4)) producing the highest ($p = 0.05$) mean number of leaves (13.05) at one Week after fertilizer application (6 Weeks after planting), indicating the high potential of loamy soil-fertilizer influence on the plant growth, thereby presenting a guide, that loamy soil influence (responds) to nutrient fertilizer uptake and further release to plant is high and more efficient over all other soil types studied. Significant ($p < 0.05$) difference was shown in sandy loam soil-fertilizer influence on the number of leaves produced, mean value of (12.00) was recorded in this treatment, further stressing the point that if properly managed, sandy loam soil can be used for effective and effective and efficient maize production. (11.20) was recorded as the mean value in treatment two (CS), Clay soil fertilizer influence indicate an increase ($p = 0.05$) over the control, thereby placing clay soil as preferred over sandy soil and unfertilized sandy-loam (Control (CR)).

Analysis of variance further presented Clay soil as 3rd best treatment, indicating that Farmers and Researchers who do not get access to loamy or sandy-loam soils can alternative utilized clay soil with proper management guide for maximum and productive cultivation/production. Sandy soil-fertilizer influence (increased) on maize number of leaves was also significant ($p < 0.05$), placing SS over the control, hence, presenting a guide, that in areas where loamy soil, sandy-loam an clay soil are limited, then sandy soil can be effectively manage and used for effective maize (crops) production.

The mean value (6.10) recorded for sandy soil present Sandy soil and unfertilized sandy-loam soil as been of the same production strength at one (1) Week after fertilizer application, in this experiment. Hence, it can be said that, Sandy soil = unfertilized sandy-loam soil in terms of production capacity at 1 WAFA in this experiment. The Control and Sandy soil produced mean number of leaves at (6.10 and 6.10) respectively.

Statistical analysis from ANOVA present treatments across 5 WAFA to be significantly ($p < 0.05$) different in 2016 experiment, with the maximum ($p = 0.05$) number of leaves (19.48) been produced with Loamy-NPK (15:15:15) fertilizer soil, further indicating the ability of the treatment (LS (T_4)) to consistently producing plants with higher growth parameter across the experiments, hence, grading Loamy soil-fertilizer effect (impact) as the best for successful and sustainable production.

Increase in number of leaves to the tune of (17.99) was recorded for Sandy-loam-NPK (15:15:15) fertilizer soil, presenting the treatment as effective when compared with CS, SS at 10WAP in 2016 experiment. Clay soil produced (17.00) mean number of leaves, indicating the impact of soil-fertilizer influence on the maize number of leaves in the treatment, and further presenting a guide, that for clay soil to be used for successful cultivation, certain management practices like mineral fertilizer application can be adopted especially in the infertile humid tropics. Mean value of (11.01) was recorded for Sandy soil, presenting sandy soil-fertilizer impact on maize number of leaves as positive, hence, increasing the growth of the crop. Minimum number of leaves (10.40) was produced in the control, hence, placing all other treatments over the control.

From the various trend of results obtained from ANOVA analysis it could be said that: Loamy soil-fertilizer impact significantly ($p < 0.05$) influenced the number of leaves across all treatments at one (1) and (5) Weeks after fertilizer application (WAFA). Report of this experiment is in-line the 2015 experiment, and agrees with the submission of Enujeke (2013); Onasanya *et al*. (2009), where their various reports indicates increase in maize plant growth and yield after application of mineral fertilizer. Experiment of Kogbe and Adediran (2003) further agrees with the findings of this experiment, where they reported an increase in maize plant growth/yield in Derived and Guinea savanna soils after application of NPK mineral fertilizer for maize cultivation.

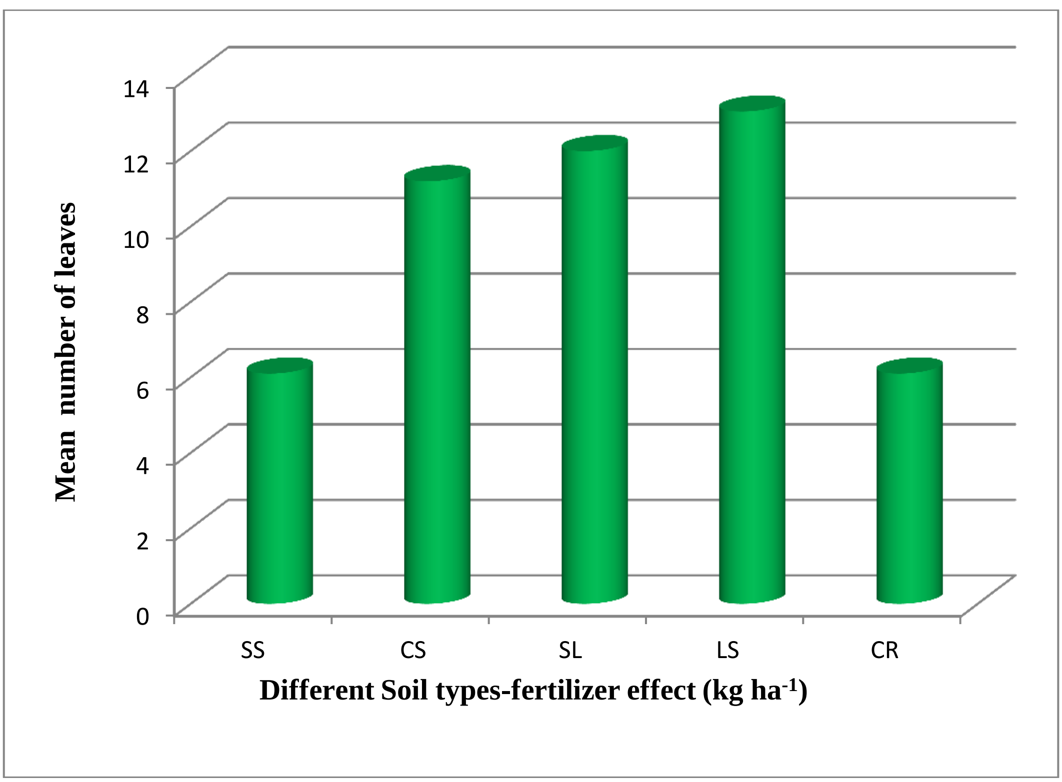

Fig. 7. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn number of leaves 1WAFA

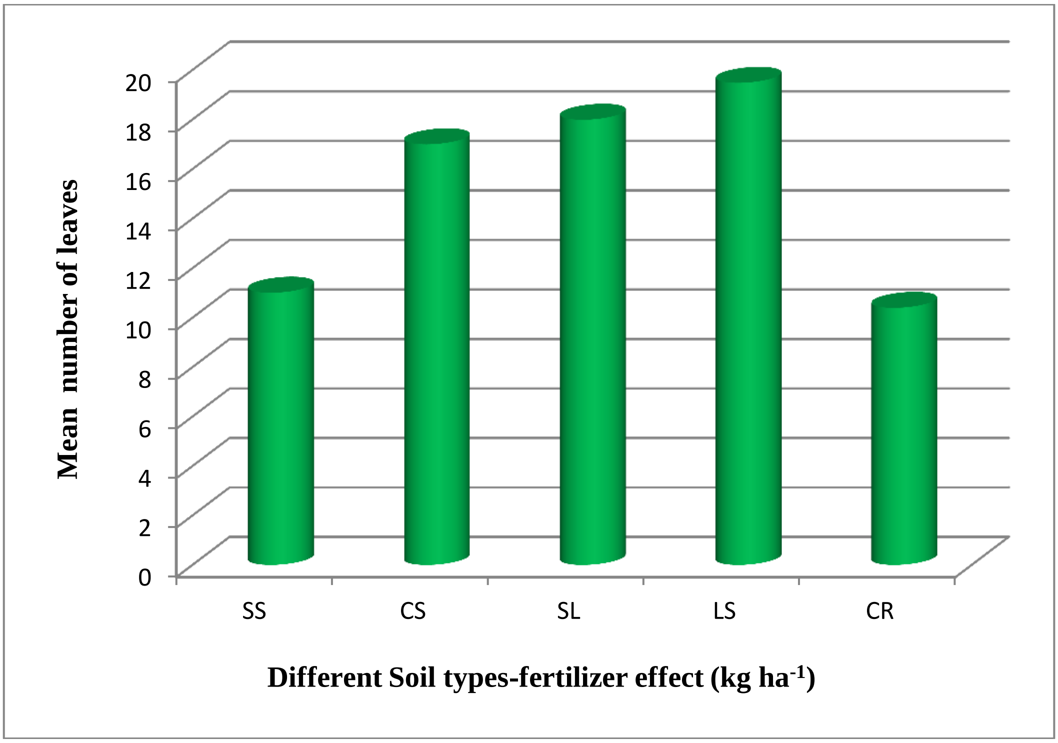

Fig. 8. Influence of Different soil types- NPK (15:15:15) mineral fertilizer on corn number of leaves 5WAFA

3. 7. Soil-fertilizer influence on nutrient Composition of soil

Soil samples were collected from the media soil across all the treatments at the end of the cultivation. Samples from the various treatments were analyzed separately to obtain the influence on a particular soil type-fertilizer treatment. Soil samples were subjected to standard laboratory analysis procedure used in analyzing the sample before planting.The physic-chemical properties of the soil as presented in Table 10, indicates that texturally, the soil class remains Sandy-loam, presenting the fact that the fertilizer had no effect on the soil textural class, this fact was also observed and confirmed by Adaikwu *et al*. (2012); Onwudike *et al*. (2016) whose report indicated no change in textural class of soil after soil amendments.

Table 10. Effect of NPK (15:15:15) fertilizer on soil fertility (chemical properties of media soil after cropping) 2015 Experiment

Treatment S/N	**Treatment/*Textural class***	**Soil Property Analyzed**	**Unit**	**Value obtained**
Treatment 1 (T_1)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Sandy soil*	Total Nitrogen	g/kg	0.085
		Available P	Mg/kg	3.60
		pH (H_2O)		6.10

		pH (KCl)		5.20
		Organic Carbon	g/kg	0.89
		Organic Matter	g/kg	1.55
		Exchangeable Ca	Cmol/kg	3.58
		Exchangeable Mg	Cmol/kg	1.52
		Exchangeable Na	Cmol/kg	0.59
		Exchangeable K	Cmol/kg	0.25
		CEC	Cmol/kg	6.32
Treatment 2 (T_2)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Clay soil*	Total Nitrogen	g/kg	0.090
		Available P	Mg/kg	3.70
		pH (H_2O)		6.11
		pH (KCl)		5.30
		Organic Carbon	g/kg	0.90
		Organic Matter	g/kg	1.56
		Exchangeable Ca	Cmol/kg	3.70
		Exchangeable Mg	Cmol/kg	1.54
		Exchangeable Na	Cmol/kg	0.60
		Exchangeable K	Cmol/kg	0.27
		CEC	Cmol/kg	6.39
Treatment 3 (T_3)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Sandy loam* soil	Total Nitrogen	g/kg	0.091
		Available P	Mg/kg	3.62
		pH (H_2O)		6.20
		pH (KCl)		5.63
		Organic Carbon	g/kg	0.92
		Organic Matter	g/kg	1.60
		Exchangeable Ca	Cmol/kg	3.80

		Exchangeable Mg	Cmol/kg	1.61
		Exchangeable Na	Cmol/kg	0.64
		Exchangeable K	Cmol/kg	0.27
		CEC	Cmol/kg	6.40
Treatment 4 (T_4)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Loamy soil*	Total Nitrogen	g/kg	0.098
		Available P	Mg/kg	3.80
		pH (H_2O)		6.25
		pH (KCl)		5.64
		Organic Carbon	g/kg	0.98
		Organic Matter	g/kg	1.70
		Exchangeable Ca	Cmol/kg	3.89
		Exchangeable Mg	Cmol/kg	1.66
		Exchangeable Na	Cmol/kg	0.65
		Exchangeable K	Cmol/kg	0.27
		CEC	Cmol/kg	6.52
Treatment 5 (T_5)	Control *Sandy-loam*	Total Nitrogen	g/kg	0.060
		Available P	Mg/kg	3.00
		pH (H_2O)		5.10
		pH (KCl)		5.00
		Organic Carbon	g/kg	0.60
		Organic Matter	g/kg	1.04
		Exchangeable Ca	Cmol/kg	3.30
		Exchangeable Mg	Cmol/kg	1.20
		Exchangeable Na	Cmol/kg	0.41
		Exchangeable K	Cmol/kg	0.81
		CEC	Cmol/kg	6.10

T_1; T_2; T_3; T_4; T_5 : Number of treatments used in the experiment

Result obtained from laboratory soil analysis showed that the treatment increased soil pH when compared to the control. With treatment four (T_4(LS)) recording the highest pH value of (6.25) in H_2O and (5.64) in KCl. This was followed by Sandy loam-fertilizer treatment (T_3 (SL)) at (6.20) in H_2O and 5.63 in KCl. Clay soil-fertilizer treatment recorded a pH value at (6.11 in H_2O and 5.30 in KCl). Treatment one (Sandy soil-fertilizer treatment) pH was recorded at (6.10 and 5.20) in H_2O and KCl respectively. The least pH in H_2O (5.10) and KCl (5.00) was recorded in the control. Mineral fertilizer treatment at one level (0.06 kg ha^{-1} NPK (15:15:15) fertilizer application also increased the soil Total Nitrogen, available Phosphorus, exchangeable Calcium, and soil Organic Matter in all treatments, except in the control, where nutrient values were reduced. There was a reduction in the CEC in the control.

The soil properties improvement due to the application of mineral fertilizer indicates the impact of mineral fertilizer on soil chemical properties. The report of this finding agrees with the submission of Okonwu and Mensah (2012) which stated increase in N, P, K, Ca, Na including Mg, Organic Carbon (OC), and Organic Matter (OM) content in soil properties after application of NPK mineral fertilizer.

Increase recorded in soil chemical properties also agrees with report of Abdu El-Aziz (2007) whose finding presents fertilizer to be the source of plant nutrients that can supply the soil with its natural nutrients (fertility).

Table 11. Effect of NPK (15:15:15) fertilizer on soil fertility (chemical properties of media soil after cropping) 2016 Experiment

Treatment S/N	**Treatment/*Textural class***	**Soil Property Analyzed**	**Unit**	**Value obtained**
Treatment 1 (T_1)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Sandy soil*	Total Nitrogen	g/kg	0.081
		Available P	Mg/kg	3.57
		pH (H_2O)		6.06
		pH (KCl)		5.15
		Organic Carbon	g/kg	0.86
		Organic Matter	g/kg	1.49
		Exchangeable Ca	Cmol/kg	3.56
		Exchangeable Mg	Cmol/kg	1.48
		Exchangeable Na	Cmol/kg	0.59
		Exchangeable K	Cmol/kg	0.22
		CEC	Cmol/kg	6.29

Treatment 2 (T_2)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Clay soil*	Total Nitrogen	g/kg	0.086
		Available P	Mg/kg	3.67
		pH (H_2O)		6.07
		pH (KCl)		5.25
		Organic Carbon	g/kg	0.87
		Organic Matter	g/kg	1.51
		Exchangeable Ca	Cmol/kg	3.68
		Exchangeable Mg	Cmol/kg	1.50
		Exchangeable Na	Cmol/kg	0.60
		Exchangeable K	Cmol/kg	0.24
		CEC	Cmol/kg	6.36
Treatment 3 (T_3)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Sandy loam* soil	Total Nitrogen	g/kg	0.087
		Available P	Mg/kg	3.59
		pH (H_2O)		6.16
		pH (KCl)		5.58
		Organic Carbon	g/kg	0.89
		Organic Matter	g/kg	1.55
		Exchangeable Ca	Cmol/kg	3.78
		Exchangeable Mg	Cmol/kg	1.57
		Exchangeable Na	Cmol/kg	0.64
		Exchangeable K	Cmol/kg	0.24
		CEC	Cmol/kg	6.37
Treatment 4 (T_4)	0.06 kg ha^{-1} NPK (15:15:15) fertilizer in *Loamy soil*	Total Nitrogen	g/kg	0.094
		Available P	Mg/kg	3.77
		pH (H_2O)		6.21
		pH (KCl)		5.59
		Organic Carbon	g/kg	0.95

		Organic Matter	g/kg	1.65
		Exchangeable Ca	Cmol/kg	3.87
		Exchangeable Mg	Cmol/kg	1.62
		Exchangeable Na	Cmol/kg	0.65
		Exchangeable K	Cmol/kg	0.25
		CEC	Cmol/kg	6.49
Treatment 5 (T_5)	Control *Sandy-loam soil*	Total Nitrogen	g/kg	0.056
		Available P	Mg/kg	3.00
		pH (H_2O)		5.06
		pH (KCl)		4.99
		Organic Carbon	g/kg	0.56
		Organic Matter	g/kg	0.97
		Exchangeable Ca	Cmol/kg	3.28
		Exchangeable Mg	Cmol/kg	1.16
		Exchangeable Na	Cmol/kg	0.41
		Exchangeable K	Cmol/kg	0.15
		CEC	Cmol/kg	6.07

T_1; T_2; T_3; T_4; T_5 : Number of treatments used in the experiment

Soil type-fertilizer influence on soil chemical properties as presented in Table 11, indicates that the application of NPK (15:15:15) mineral fertilizer produced an increase in soil pH. Soil pH was increased from 5.87 in H_2O to (6.21) and 5.02 to (5.59) in KCl, in treatment four (T_4 (LS)). Soil type-fertilizer treatment (STFT) in treatment three (T_3 (SL)) recorded an increased in pH of (6.16 in H_2O and 5.58 in KCl), indicating an increased over the control. Treatment two (T_2 (CS)) recorded an increased pH to the tune of (6.07) in H_2O and (5.25) in KCl. Sandy soil-fertilizer treatment pH was recorded at (6.06) in H_2O and (5.15) in KCl. Laboratory analysis observation (inference) revealed a reduction (from 5.87 in H_2O and 5.02 in KCl in analyzed composite sample to 5.06 in H_2O and 4.99 in KCl) of soil pH in the control, and further proofing the importance of mineral fertilizer in soil fertility management.

However, it can be said: increased in soil pH in LS < SL < CS < SS < CR. Soil type-fertilizer treatment also increased the soil total Nitrogen, available Phosphorus, exchangeable Calcium, Organic Carbon and soil Organic Matter across all treatments except in the control, where reduction of the soil nutrients was observed, which may be attributed to nutrient uptake and further utilization for growth. Reduction in CEC value was observed in the control, the reduction may be attributed to crop nutrient uptake/utilization.

Findings of this experiment agrees with the submission of John *et al*. (2004) whose report indicate mineral fertilizer as an important source of Nitrogen (N) which is associated with vigorous vegetative growth and increase soil nutrients. Laboratory soil analysis observation of soil chemical properties obtained in 2016 experiment is similar to the 2015 experiment, although variations in soil properties data was observed, this may be attributed to inconsistency in the soil system due to regular fall in pH, Total Nitrogen (TN), Organic Carbon (OC), Organic Matter (OM), Exchangeable Cations including CEC of the soil, caused by rapid deterioration of humid tropical soil as a result of human and nature actions on this soils.

Experiment of Okonwu and Mensah (2012) is in accordance with this experiment, where their report findings indicates increased in (N, P, K, Ca, Na, and Mg including OC, OM) after mineral fertilizer application.

4. CONCLUSION

Result of this investigation further confirms the influence of mineral fertilizer in increasing growth performance of maize and increasing soil fertility. 0.06 kg ha^{-1} NPK (15:15:15) fertilizer application on (Loamy, Sandy-loam, Clay and Sandy soils) improved maize growth and increase the soil (N, P, K, Ca, Na, Mg, OM, CEC and pH). Loamy soil-fertilizer treatment (T_4 (LS)) significantly ($p < 0.05$) influenced the overall growth of maize over the control. Studying the various soil types, their responds to NPK mineral fertilizer and their influence on maize growth, it is concluded that mineral fertilizer is responsive and effective on maize when applied on Loamy soil for high growth performance, soil fertility improvement and for food security.

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