

EFFECT OF NPK FERTILIZER AND INTERVAL MANAGEMENT ON THE CHEMICAL PROPERTIES OF COASTAL PLAIN SANDS OF AKPABUYO, NIGERIA

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ABSTRACT

Investigation of the chemical properties of the coastal plain soils treated with NPK 20:10:10 fertilizer (NPK) at the rate of 0,60, 90 and 120kg ha⁻¹ and observed at intervals of 3,6,9 and 12 months was carried out from March 2009 to 2010 at Akpabuyo, Cross River State, Nigeria. The experiment comprises of four fertilizer rates and four management intervals fitted into a Latin square design. The soils pH value increased consistently from 3 to 12months. Mean values of organic matter decreased with increase in profile depth from 2.12-1.34g kg⁻¹. The distribution of N from the top soil down the profile increased consistently from 3 to 12 months. The mean value of N from the top soil was 0.82%. Exceeding 0.2%, the critical value and was more than the mean values obtained in the sub-surface soil. The mean value of P (33 mgkg⁻¹) during the 9 months interval was significantly (P<0.05) higher than all other sampling periods. There was vertical and horizontal loading of P which lead to higher available P at the surface in soil depths of 0-15 and 15-30cm than 30-40cm and 40- 50cm. Levels of Ca increased slightly with sampling interval but decreased down the profile. The soils were also characterized as follows: strongly acid (pH 5.1 – 5.3), exchangeable Mg. (> 0.5 cmol kg⁻¹), low contents of K and Na as well as high exchangeable Al. levels (> 4.0 cmol kg⁻¹) and cation exchange capacity (22 – 36 cmol kg⁻¹) The application of 90 kg/ha⁻¹ NPK fertilizer during the 9 months interval gave highest values of N,P, Ca and Mg under the condition of the experiment, indicating that these elements will not be deficient in these soils. Equally, the CEC, organic matter and base saturation had their advantage in the 9 months interval where 90 kg” was applied. This is cost effective and could be used to improve crop production in Akpabuyo, Nigeria.

KEY WORD: Chemical Properties, NPK Fertilization, Management Intervals, Coastal Plain Sands.

INTRODUCTION

To increase crop performance, there is always need to establish relationships between soil chemical properties and soil capacity to produce food crops. The soils capacity and capability to produce crops is indeed the basis of yield predictions and could be considered as the most useful expression of soil productivity (Enwesor, 1981). Yield and crop performances are however closely correlated with soil condition.

FAO (1986) reported that coastal plain sands cover an area of 480km² in Cross River, 3,470.32km² in Bendel State, 42.20km² in Lagos State, 213.16km² in Akwa Ibom State, 12.18km² in Ogun State, 40.62km² in Ondo State; and 5.435.92km² in River State. In Cross River State, coastal plain soils are found mostly in Akpabuyo, Bakassi, Calabar and Odukpani Local Government Areas.

Coastal plain soils have high agricultural potentials because of their moderate inherent fertility and availability of water during the dry season. In crop production and land use, the evaluation of soils' chemical properties is important because properties such as pH, Organic matter, Nitrogen, Phosphorus

Exchangeable bases, Cation Exchange Capacity and Base saturation affect plant growth and development (Enwesor 1981).

Coastal plain soils are underlain by massive deposits of limestone, with kaolinite as dominant clay, pH of 5.0 C.E.C of 13.10 cmol (+) kg⁻¹ and based saturation of about 13% (Enwesor 1981). The soils are acidic due to the parent material from which they are formed; they are low in nutrient status (Ca, Mg, K) and high in soluble and exchangeable Al and Mn, which are toxic to the crop (Lekwa and Whitesid 1986).

Because the soil has been subjected to long period of intermittent cropping and bush fallow, it is very low in total available nutrients. In organic fertilizer such as NPK when applied to the soil, adds nutrients, improves the soil chemical properties and enhances crop growth, development and yield (Ubi et al 2005).

Capacity of the soils often exacerbate losses of nutrients considering the importance of soil plant relationships. The objective of this study was to evaluate the chemical composition of the soil and soil reaction following N:P:K fertilizer treatment on the coastal plain sands of Akpabuyo, Nigeria.

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MATERIALS AND METHODS

The study was conducted at Akpabuvo (9° 9' and 8° 12' E, 4° 37' – 41° N) in Cross River State, Nigeria. The climate of the area is typical of tropical humid region with a mean annual rainfall of 3500 – 4000 mm, a mean annual temperature of 26 – 27°C and mean relative humidity of 80 – 90% (Akpan-Idiok, 2012). The soils of the area are formed from the Tertiary Coastal Plain Sands and the landscape rises from gently to strongly undulating in most places. The original forest vegetation has disappeared due to high population density and over cultivation of the soils. The present vegetation is typical of secondary forest. Rotational bush fallow cropping system in the area constitutes the main cropping system in the area (Akpan-Idiok, 2012).

Soil sampling

Before the start of the experiment, composite soil samples were taken at depths of 0 – 15cm, 15 – 30cm, 30 – 40cm and 40 – 50cm. Random samples were collected with the help of a soil auger and bulked to form a composite sample. The samples were packed in a

Fertilizer Rates

The four rates of NPK 20:10:10 inorganic fertilizers were applied in the following rate:

0kg NPK ha⁻¹

60kg NPKha⁻¹

90kg NPK ha⁻¹

120kg NPKha⁻¹

Treatments were applied in the following order:

AP = At the beginning of the experiment

H₄ = 4 months

H₇ = 7 months

H₁₀ = 10 months
Soil sampling was done at the following intervals

Soil sampling was done at the following intervals:

3 months

6 months

9 months

12 months, all fitted into a Latin square design.

Statistical Analysis

Data collected were subjected to statistical analysis involving means separation, and comparing the means using standard deviation (SD), with coefficient of variability (CV%) as outlined Steel and Torrie (1960) were used in arriving at the deductions and conclusions.

RESULTS AND DISCUSSION

Soil Reaction

Soil reaction varied from mildly acid to medium with mean pH values of 5.1 at 3 months, 5.1 at 6 months, 5.7 at 9 months and 5.9 at 12 months. The acidity levels in these soils could be partly attributed to moderate rainfall and removal of bases during the process of eluviation. This acidity level rated to be moderate was earlier reported (Faji and Mohammed 2000). The soil pH of the area is within tolerable range for crop production. The application of N:P:K fertilizer tended to increase the pH values at the 12 month

polyethylene bags and labelled appropriately. There were air-dried, ground with a wooden roller and sifted through a 2mm mesh sieve for chemical analysis. Sampling was repeated at a three month-interval after application of fertilizer up to the twelfth month at the various depths mentioned above.

Chemical Analysis

Soil pH was determined potentiometrically in 1:2.5 soil/water ratio. Organic matter was determined by the Walkey and Black method (Allison 1965). Total N was determined by the micro-kjeldahl method (Bremer, 1965). Available P was determined by the molybdenum blue colour method of Murphy and Ridey (1902) after extracting soil with Bray P-1 extractant (Bray and Kurtz, 1945). Exchangeable bases (Ca, Mg K and Na) were extracted with 1M N1-14 OAC p^H7 and the amounts in the extracts measured with flame photometer for Na and K while Ca and Mg were determined with Atomic absorption spectrophotometer (Model 6-105 HV/Visible Spectropliotometer Jenway, UK). Exchangeable acidity was extracted with IN KCL (Mclean, 1964), while CEC was by summation of the exchangeable cations and exchangeable acidity. Base saturation was calculated as the sum of the bases (TEB) divided by CEC.

interval more than either 3,6, or 9 months.

Soil organic matter

The mean soil organic matter was 1.34g kg⁻¹ at 3 months, 1.53g kg⁻¹ at 6 months, 1.55g kg⁻¹ at 9 months and 1.68g kg⁻¹ at 12 months. The organic matter contents were moderate. The rating for organic matter (OM) contents of these soils were moderate to high having mean values of 1.34g/kg⁻¹ at 3 months, 1.53g/kg⁻¹ at 6 months and 1.20g kg⁻¹ at 9 months and 1.86g/kg⁻¹ at 12 months.

The low values of organic matter at 3 months could be due to high mineralization resulting to increased microbial activities, good soil aeration and low natural organic matter returns early in the season. The high organic matter in the 12 months interval later in the season is suggested to be as a result of low mineralization due to reduced microfloral activities and poor soil aeration and drainage. It might also be possible that there was organic matter accumulation from the 3

months to 12 months after the decomposition of dead leaves and this might have accounted for the high organic matter in the 12 months. Young (1997) elucidated that high soil organic matter status leads to improved structural stability, lower bulk density and balance between fine and coarse pores. These properties he noted to ease root penetration, resist erosion and provide the necessary nutrient for the plant.

Total Nitrogen

The total N ranged from 0.68 to 0.87% with a mean of 0.74%, at 3 months, 0.77 to 0.89% with a mean of 0.82% at 6 months 0.76 to 0.91% with a mean of 0.82% at 9 months and 0.70 to 0.88% with a mean of 0.77% at 12 months (Tables 1,2,3, and 4). The high levels of Total N in these soils could be attributed to the high natural organic matter returns and mineralization of plant residue and N fertilizer application. Similar results were obtained by Scholes et al (1994). We consider these coastal plain soils moderately suitable for crop production (FAO, 1976).

Available P

Available P values determined by Bray P-I method were moderate to high and ranged from 7.14 to 13.6mg kg⁻¹ with a mean of 9.75mg kg⁻¹ at 3 months, 12.02 to 18.78mg kg⁻¹ with a mean of 16.55mg kg⁻¹ at 6 months, 28.6 to 48.10mg kg⁻¹ with a mean of 35.58mg kg⁻¹ at 9 months and 11.14 to 15.12mg kg⁻¹ with a mean of 13.48mg kg⁻¹ at 12 months. Soils with P values below 10mg kg⁻¹ are generally considered marginally suitable (Scholes et al (1994). The available P consistently decreased with increase in profile depth and is suggested to be due to vertical and lateral movement of P in the subsurface soil which could be a characteristic of soils of sand stone parent materials. Nitrogen and P are organic matter dependent, as organic matter mineralizes, these elements are released into the soils.

The application of N:P:K at the interval of 9 months in November tended to increase the P content of the soil more than P values obtained from either 3,6 or 12 months intervals. This implies that applied P to this soil is abundantly available for plants use at the period close to the later part of the season (November) than early in the season. The available P values were highest in the 9 months which suggests that there was high rate of P mineralization together with high inorganic available P within the experimental condition. It could be suggested that the 9 months with 90 kg ha⁻¹ NPK fertilizer combination could lead to high P availability within the coastal acid sand ecosystem in Akpabuyo, Nigeria.

Exchangeable (Ca Mg K and Na)

The exchangeable bases ranged from 4.66 to 5.6 cmol (+) kg with a mean of 4.7 cmol (+) kg for Ca; 1.58 to 1.80 cmol (+) kg with a mean of 1.7 cmol (+) kg for Mg; 0.12 to 0.15 cmol (+) kg with a mean of 0.13 cmol (+) for K and 0.04 to 0.07 cmol (+) kg with a mean of 0.05 cmol (+) kg for Na for the 3 months interval. And between 4.08 to 5.18 cmol (+) kg with a mean of 4.9 cmol (+) kg for Ca, 0.85 to 2.98 cmol (+) kg with a mean of 1.89 cmol (+) for Mg, 0.08 to 0.09 cmol (+) kg with a mean of 0.09 cmol (+) kg for K, and 0.04 to 0.05 cmol (+) kg with a mean of 0.04 cmol (+) kg for Na during the

6 months interval. For the 9 months interval, the values were from 0.06 to 5.76 cmol (+) kg with a mean of 5.1 cmol (+) kg for Ca; 0.98 to 1.21 cmol (+) kg with a mean of 1.25 cmol (+) kg for Mg; 0.08 to 0.12 cmol (+) kg with a mean of 0.04 cmol (+) kg for K; and 0.02 to 0.04 cmol (+) kg with a mean of 0.04 cmol (+) kg for Na. values for 12 month interval ranged from 4.56 to 5.88 cmol (+) kg with a mean of 5.2 cmol (+) kg for Ca; 0.12 to 1.31 cmol (+) kg with a mean of 1.13 cmol (+) kg for Mg; 0.12 to 0.14 cmol (+) kg for a mean 0.11 cmol (+) for K; and 0.02 to 0.05 cmol (+) kg with a mean of 0.04 cmol (+) kg for Na. The mean values of Mg 1.25 cmol (+) kg obtained at 9 months interval tended to be higher than all other values obtained in either 3,6 or 12 months intervals. The nutrients elements (N:P:K, Ca, Mg) were generally higher at the surface soil, decreasing with depth below their critical levels. This is due to the effect of annual water table fluctuations causing leaching of the nutrients down the profile, a characteristic of coastal sands. Among the exchangeable cations (Ca, Mg, K, Na) high Mg and Ca contents were observed and agreed with the findings of Pitty (1979) who reported that Mg and Ca are the most predominant cation in tropical soils due to their strong absorption and rapid release into the soil through mineral weathering. The low value of K which is below critical level, 0.2 cmol (+) kg (Kyuma et al 1986) might be attributed to the high rainfall and leaching intensity normally often encountered in coastal plain soil. The low value of Na could be attribute to the selective ultra filtration of sodium chloride out of the soil solution through the roots of the plants in the study area (Chapman, 1976). The distribution of exchangeable bases did not show any definite pattern, with the profile depth during the 6 months. The surface and sub-10 surface horizons with higher pH values tended to have a corresponding higher exchangeable bases at 3 months intervals.

The coastal plain soil at Akpabuyo is therefore well supplied with organic matter phosphorus, nitrogen, calcium and magnesium for good crop performance in the area.

Cation Exchange Capacity (CEC)

The cation exchange capacity values were generally high, ranging from 20.25 to 34.52 cmol (+) kg with a mean of 24.30 cmol (+) kg⁻¹ at 3 months, 20.01 to 34.68 cmol (+) kg⁻¹; with a mean of 25.1 cmol (+) kg⁻¹ at 6 months, 20.14 to 35.16 cmol (+) kg⁻¹; with a mean of 25.40 cmol (+) kg⁻¹ at 9 months and 22.96 to 37.29 cmol (+) kg⁻¹; with a mean of 27.41 cmol (+) kg⁻¹ at 12 months, (Tables 1,2,3 and 4).

The CEC values for the 12 months interval, on the average, was 7.3% higher than those of either 3,6, or 9 months. The soils had CEC value above 20 cmol (+) kg⁻¹ regarded as suitable for crop production if other factors are favourable (FAO 1976).

Base Saturation (% BS)

- The % B.S ranged between 57.8 and 64.1% with a mean of 58.2%; 58.2 to 69.6% with a mean of 62.6%; 30.1 to 67.2% with a mean of 58.4% and 66.2 to 67.6% with a mean of 64.7% for the 3,6,9 and 12

- Months intervals respectively. The % B.S determined at 6 and 12 months intervals were close and higher than values of 3 and 9 months and exceeded the critical limit of 60% established for the ecological zone (Hollan *et al* 1989).

Exchange acidity (Al and H⁺)

Exchangeable Al ranged between 5.6 and 35.3 cmol (+) kg⁻¹ with a mean of 30.3 cmol (+) kg⁻¹ at 3 months, 19.6 to 27.4 cmol (+) kg⁻¹, with a mean of 23.3 cmol (+) kg⁻¹ at 6 months 10.3 to 21.3 cmol; (+) kg⁻¹, with a mean of 15.3 cmol (+) kg⁻¹ at 9 months and 8.6+ 18.6 cmol (+) kg⁻¹; with a mean of 13.2 cmol (+) kg⁻¹ at 12 months. There was a marked decrease in exchangeable acidity with increasing intervals from 9 to 12 months. This means that Al toxicity was very likely to occur later in the season (Raji and Mohammed 2000). The toxicity of soluble Al may be mitigated in part by an increase in

the soluble Ca concentration (Jackson 1969, Foy *et al*, 1978; Helyar, 1978).

The values of pH ranged from 12.4 to 13.0 cmol (+) kg⁻¹ with a mean of 12.3 cmol (+) kg⁻¹ at 3 months, 0.2 to 16.2 cmol (+) kg⁻¹; with a mean of 13.1 cmol (+) kg⁻¹ at 6 months 7.1 to 13.0 cmol (+) kg⁻¹; with a mean of 9.8 cmol (+) kg⁻¹ at 9 months and 5.1 to 9.1 cmol (+) kg⁻¹ with a mean of 6.6 cmol (+) kg⁻¹ at 12 months. There was a gradual drop in the values of H⁺ later in the season. However, the exchange complex for the 3 and 6 months were dominated by H⁺ and because of the preponderance of H⁺ ions in the exchange complex, the clays of this humid region appeared to have calcium-hydrogen complex. In this case, H⁺ ions may displace metallic ions giving rise to an acid (hydrogen saturated) clay. Acid clays are calcium aluminum clays. The indirect negative fertility effect of leaching Ca and Mg is the rise in the level of exchangeable Al + H which is a reflection of acidic soil (Lekwa and Whiteside 1986).

Table 1: Nutrient distribution within different soil depths at 3 months

Properties	Sd	0 – 15 \bar{x}	CV (%)	Sd	15 – 30 \bar{x}	CV (%)	Sd	30 – 40 \bar{x}	CV (%)	Sd	40 – 50 \bar{x}	CV (%)
pH (H ₂ O)	0.02	0.2	0.02	0.02	5.3	0.3	0.03	4.9	0.5	0.10	4.8	1.6
Na (cmol kg)	0.02	0.06	0.04	0.10	0.05	8.2	0.12	0.05	4.5	0.02	0.03	.8
K (cmol kg)	0.02	0.06	5.1	0.10	0.04	18.1	0.10	0.04	3.8	0.02	0.03	2.4
Ca (cmol kg)	0.07	>.16	8.9	0.04	5.03	15.4	0.05	4.01	17.2	0.02	4.66	0.6
Mg (cmol kg)	0.03	0.87	3.1	0.50	0.84	24.3	0.32	0.81	6.8	0.50	0.81	4.9
Exch. Al.	0.10	35.3	2.8	0.14	31.6	28.1	0.14	28.70	21.2	0.30	25.5	2.4
Acidity H ^t	0.10	13.0	2.1	0.32	12.4	15.6	0.10	1.10	7.2	0.02	1.0	3.0
Organic matter (%)	0.02	1.82	3.4	0.12	1.24	7.4	0.10	1.21	8.5	0.30	1.08	3.1
P. available	0.32	13.64	4.2	0.10	11.86	9.2	0.15	8.36	11.9	0.10	7.14	6.3
CEC (cmol kg)		34.52	10.5	0.32	22.24	0.4	0.32	20.15	10.4	0.30	20.25	5.8
Total N	0.03	0.87	06	0.12	0.81	16.7	0.10	0.73	18.1	0.30	0.68	2.7
B (%)	0.031	64.1	6.5	0.10	58.7	14.1	0.31	58.30	7.5	0.02	51.8	12.6

Sd = Standard deviation

\bar{X} = Mean

CV = Coefficient of variation

Table 2: Nutrient distribution within different soil depths at 6 months

Properties	Sd	0 – 15 \bar{x}	CV (%)	Sd	15 – 30 \bar{x}	CV (%)	Sd	30 – 40 \bar{x}	CV (%)	Sd	40 – 50 \bar{x}	CV (%)
pH (H ₂ O)	0.02	5.17	0.6	0.02	5.13	0.3	0.02	5.109	0.6	0.10	5.04	1.5
Na (cmol kg)	0.02	0.05	0.8	0.10	0.05	15.2	0.10	0.04	15.4	0.02	0.04	2.4
K (cmol kg)	0.10	0.09	6.5	0.04	0.12	21.0	0.10	0.08	24.1	0.02	0.08	15.7
Ca (cmol kg)	0.06	5.18	3.6	0.04	5.27	14.3	0.04	4.91	15.9	0.02	4.08	0.6
Mg (cmol kg)	0.07	2.90	21.2	0.02	1.95	16.1	0.02	1.77	12.6	0.10	0.85	4.8
Exch. Al.	0.10	22.4	12.9	0.02	25.0	22.6	0.50	21.4	31.0	0.10	19.6	25.6
Acidity H ⁺	0.10	16.0	2.5	0.14	13.8	14.2	0.17	12.6	0.4	0.30	10.2	3.0
Organic matter (%)	0.10	2.13	2.1	0.50	1.50	25.5	0.60	1.34	12.6	0.02	1.15	0.2
P. available	0.32	18.98	2.0	0.60	18.24	0.4	0.14	17.17	10.0	0.30	12.02	6.3
CEC (cmol kg)	0.04	34.68	2.5	0.17	23.35	12.5	0.02	22.13	8.5	0.10	20.1	5.1
Total N	0.02	0.89	2.6	0.18	0.56	1.7	0.04	0.81	6.2	0.10	0.77	0.4
B (%)	0.10	62.0	13.2	0.04	59.6	2.5	0.03	54.5	4.3	0.02	52.2	0.6

Sd = Standard deviation
 \bar{x} = Mean
 CV(%) = Coefficient of variation

Table 3: Nutrient distribution within different soil depths at 9 months

Properties	Sd	0 – 15 \bar{x}	CV (%)	Sd	15 – 30 \bar{x}	CV (%)	Sd	30 – 40 \bar{x}	CV (%)	Sd	40 – 50 \bar{x}	CV (%)
pH (H ₂ O)	0.02	5.79	0.04	0.10	5.66	0.5	0.02	5.64	0.6	0.10	5.52	0.4
Na (cmol kg)	0.02	0.04	0.06	0.10	0.04	0.8	0.02	0.03	2.8	0.10	0.02	0.6
K (cmol kg)	0.10	0.12	6.4	0.02	0.10	5.8	0.02	0.08	10.5	0.02	0.08	6.5
Ca (cmol kg)	0.02	5.76	3.8	0.10	5.68	2.9	0.02	4.97	8.1	0.10	4.06	3.9
Mg (cmol kg)	0.02	1.21	4.5	0.10	1.35	5.1	0.10	1.62	6.2	0.10	0.98	2.6
Exch. Al.	0.30	21.3	22.8	0.30	18.0	24.2	0.32	12.1	20.9	0.30	10.3	30.2
Acidity H ⁺	0.31	13.0	28.2	0.30	10.8	21.8	0.30	0.6	24.3	0.32	0.3	24.2
Organic matter (%)	0.10	2.14	4.5	0.10	1.54	6.2	0.10	1.33	5.4	0.02	1.20	8.0
P. available	0.32	43.10	2.6	0.02	36.31	3.0	0.02	34.32	3.8	0.10	28.60	5.6
CEC (cmol kg)	0.10	35.16	2.1	0.02	24.12	2.5	0.32	22.00	2.9	0.02	20.14	3.9
Total N	0.10	36.4	2.5	0.02	30.5	2.6	0.02	30.0	3.6	0.02	20.3	2.7
B (%)	0.02	0.91	3.0	0.10	0.86	2.8	0.10	0.80	2.4	0.02	0.76	2.4

Sd = Standard deviation
 \bar{x} = Mean
 CV(%) = Coefficient of variation

Table 4: Nutrient distribution within different soil depths at 12 months

Properties	Sd	0 – 15 \bar{x}	CV (%)	Sd	15 – 30 \bar{x}	CV (%)	Sd	30 – 40 \bar{x}	CV (%)	Sd	40 – 50 \bar{x}	CV (%)
pH (H ₂ O)	0.02	5.89	0.4	0.2	5.87	0.3	0.02	5.84	0.3	0.10	5.82	1.6
Na (cmol kg)	0.02	0.05	0.8	0.2	0.4	0.6	0.10	0.04	15.3	0.02	0.02	2.8
K (cmol kg)	0.02	0.14	6.2	0.2	0.13	6.2	0.04	0.12	26.7	0.02	0.12	16.7
Ca (cmol kg)	0.10	5.88	5.8	0.10	5.76	3.1	0.02	4.71	0.67	0.02	4.56	0.8
Mg (cmol kg)	0.10	1.34	5.27	0.10	0.96	2.6	0.02	1.32	16.5	0.02	0.92	4.9
Exch. Al.	0.14	2.24	2.6	0.02	2.12	24.5	0.02	1.65	34.6	0.30	1.36	38.2
Acidity H ⁺	0.10	18.0	24.1	0.10	14.1	31.4	0.10	12.0	36.4	0.10	8.6	3.0
Organic matter (%)	0.10	9.1	28.2	0.14	7.6	36.2	0.14	5.4	0.4	0.10	5.1	0.2
P. available	0.50	15.12	2.4	0.10	13.10	4.2	0.50	14.32	12.5	0.02	11.14	6.3
CEC (cmol kg)	0.60	37.29	2.5	0.2	25.36	2.0	0.04	23.84	1.7	0.30	22.96	4.8
Total N	0.15	0.88	2.3	0.2	0.86	2.0	0.60	0.71	2.8	0.02	0.70	5.1
B (%)	0.18	63.0	2.8	0.2	62.5	2.0	0.17	60.2	3.4	0.10	56.6	3.2

Sd = Standard deviation

\bar{X} = Mean

CV (%) = Coefficient of variation

CONCLUSION

The study x-rayed soils fertility indices such as pH, Organic matter, Cation Exchange Capacity, Total Nitrogen, Exchangeable bases, Available P, Exchangeable Acidity and percent Base saturation as influenced by treatment combination in the soil. Though characterized by low K and high percentage aluminum saturation, their agricultural utilization is potentially high if proper soil management practices are adopted.

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