Direct Research Journal of Agriculture and Food Science

Vol. 13(2), Pp. 73-81, July 2025,

https://journals.directresearchpublisher.org/index.php/drjafs; https://www.ajol.info/index.php/drjafs/issue/archive

Research Article
ISSN: 2354-4147

Potassium Fixation on Soils Formed from Diverse Parent Materials in Akwa Ibom State

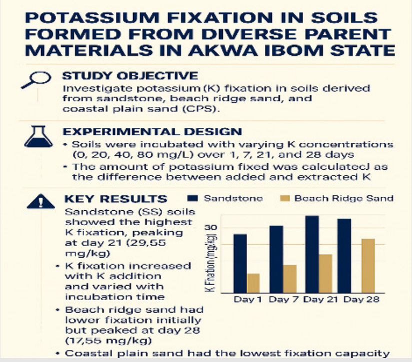
Ijah, C. J.*, Ekpo, H. J. and Ekwere, P. A.

Department of Soil Science, Faculty of Agriculture, Akwa Ibom State University, Akwa Ibom State, Nigeria.
Corresponding Author's Email: christianaijah01@gmail.com.Tel:+2348023854805

ABSTRACT

The study was conducted to determine the fixation capacity of potassium from soils formed from diverse parent materials (coastal plain sand, beach ridge sand and sandstone) in Akwa Ibom State. Composite surface soil samples were collected from three representative locations. A treatment solution containing 0, 20, 40 and 80mg/l of K prepared from Potassium Chloride (KCL) were added to 20g of soil in cups and the cups were carefully covered and allowed to incubate for 1,7,14 and 21 days respectively. The design was 3x4 factorial experiment fitted into a completely randomized design (CRD). Each of the treatments was replicated three (3) times. At a set day, the exchangeable and water soluble K were extracted with KCL and K not extracted was considered fixed in the soils. The results indicated that, the soils were dominated with sand fractions, acidic to slightly acidic with low nitrogen and electrical conductivity. Organic matter varied from low to moderate. The amount of K fixed in SS soil was higher in day 21 (29.55) > day 7 (22.55) > day 1 (15.65) > day 28 (7.89) and gradually decrease with length of incubation. The amount of K fixed in the soil increased with increased in the rate of K added. The BRS had the highest fixing capacity at day 28 (17.55mg/kg^{-1}) while the coastal plain sand had the least K (4.49mg/kg^{-1}). To reduce the risk of K fixed in these soils, the use of organic manure and periodic evaluation of soil K is recommended.

Keywords: *Potassium fixation, parent materials, coastal plain sand, beach ridge sand, sandstone*



POTASSIUM FIXATION IN SOILS FORMED FROM DIVERSE PARENT MATERIALS IN AKWA IBOM STATE

STUDY OBJECTIVE

Investigate potassium (K) fixation in soils derived from sandstone, beach ridge sand, and coastal plain sand (CPS).

EXPERIMENTAL DESIGN

- Soils were incubated with varying K concentrations (0, 20, 40, 80 mg/L) over 1, 7, 21, and 28 days
- The amount of potassium fixed was calculatecJ as the difference between added and extracted K

KEY RESULTS

Sandstone (SS) soils showed the highest K fixation, peaking at day 21 (29,55 mg/kg)

- K fixation increased with K addition and varied with incubation time
- Beach ridge sand had lower fixation initially but peaked at day 28 (17,55 mg/kg)
- Coastal plain sand had the lowest fixation capacity

Article Information
Received 11 May 2025
Accepted 3 June 2025
Published 5 July 2025
https://doi.org/10.26765/DRJAFS77482862

Citation: Ijah, C. J., Ekpo, H. J and Ekwere, P. A. (2025). Potassium Fixation on Soils Formed from Diverse Parent Materials in Akwa Ibom State. *Direct Research Journal of Agriculture and Food Science*. Vol. 13(2), Pp. 73-81

INTRODUCTION

Potassium (K) is one of the three primary macronutrients essential for plant growth and development, playing crucial physiological roles in enzyme activation, osmoregulation, protein synthesis, stomatal regulation, and photosynthesis (Yang et al., 2025; Wang et al., 2025). Its adequate supply is critical to plant productivity, and its deficiency can significantly constrain crop yields. Despite being the seventh most abundant element in the Earth's crust, potassium's availability in soils is often limited due to its complex forms and interactions within the soil matrix (Tisdale et al., 1995; Nayak et al., 2025; Essien et al., 2025). In the soil, potassium exists in four principal forms: mineral-bound, non-exchangeable (fixed), exchangeable, and solution K with only the latter two forms readily accessible to plants (Ijah et al., 2024a; Umoh et al., 2021). In many Nigerian soils, particularly those in tropical agroecosystems like Akwa Ibom State, a paradox exists whereby soils may contain high total potassium concentrations yet exhibit low levels of plant-available potassium. This phenomenon is largely attributed to potassium fixation a process where exchangeable or solution potassium is converted into non-exchangeable forms by clay minerals and becomes temporarily or permanently unavailable for plant uptake (Ikiriko et al., 2022; Pholkern et al., 2025). Factors influencing potassium fixation include the type of clay minerals present, the quantity of potassium added to the soil, the nature of parent materials, soil moisture content, organic matter, soil pH, and the soil's buffering capacity (Ano et al., 2003; Adeoye, 1986; Ogunremi, 1977).

Soils formed from different parent materials vary in their capacity to fix potassium. In Akwa Ibom State, soils are predominantly derived from sandstone, shale, and alluvium, each imparting distinct physical and chemical characteristics to the resulting soil (Umoh et al., 2021; Sam, 2025). Sandstone-derived soils are generally coarse-textured with low cation exchange capacity (CEC) and low potassium retention, resulting in a higher susceptibility to leaching (Bouasria et al., 2025; Sam, 2025). In contrast, shale-derived soils often contain higher clay content and minerals such as illite and vermiculite, which possess high potassium fixation potential due to their 2:1 lattice structure (Essien et al., 2025; Attah, 2025). Alluvial soils are more heterogeneous and their fixation potential depends largely on mineralogical composition and organic matter content (Umoh et al., 2021).

Several studies conducted in Nigeria underscore the complexity of potassium dynamics in tropical soils. Ataga (1974) evaluated potassium fixation in soils supporting oil palm in southern Nigeria and found that 35–65% of added potassium was fixed in both acid sands and basement complex-derived soils, with approximately 46% of the fixed K being released within two weeks. Similarly, Udo (1982) reported that Bende soils fixed the highest amount of potassium among nine studied southern Nigerian soils due to the prevalence of 2:1 clay minerals, while Abakaliki soils showed the lowest fixation capacity. His study also established a strong correlation between clay content, buffering capacity, and fixation (r = 0.77**).

Ano et al. (1991) demonstrated that soils under dry conditions fixed more potassium than those under wet conditions, with subsoils exhibiting greater fixation capacity. Potassium deficiency in Nigerian soils has been consistently reported across agroecological zones, including studies by Amao (1990), Osemwota et al. (1999) identified significant quantities of fixed K in southern Nigerian soils, with fixed K comprising up to 11.03% of total K in some areas. Further studies by Osemwuta et al. (1999) indicated that the average fixed K in surface and subsurface soils of Bendel State was 5.8% and 7.2% respectively, reinforcing the need to understand local fixation dynamics for effective nutrient management.

The amount of potassium added to soils significantly affects fixation capacity. Ogunremi (1977) observed that increased K application led to higher fixation, while Adeoye (1986) highlighted that prolonged incubation periods increased K fixation in sedimentary soils, with organic matter, pH, and aluminum oxide (Al_2O_3) being key fixation agents. These findings imply that both intrinsic soil properties and external management practices influence potassium retention and release.

In recent years, the influence of biological and landscape factors on potassium fixation has gained attention. Soil microbial communities, particularly those in the rhizosphere, mediate potassium cycling through mineralization and immobilization processes (Wang et al., 2025; Yang et al., 2025). In mining-impacted or organically enriched soils, microbial shifts can alter elemental dynamics, affecting potassium availability. Endophytic and rhizosphere-associated bacteria such as *Serratia fonticola* have been shown to enhance potassium uptake in deficient soils (Yang et al., 2025). Additionally, topographic features such as slope and curvature influence water movement, erosion, and nutrient redistribution, which in turn affect potassium fixation patterns (Fullen, Gambo, & Baldwin, 2025; Essien et al., 2025).

The acidic nature of most soils in southeastern Nigeria further complicates potassium availability. High levels of iron and aluminum oxides prevalent in acidic soils may indirectly reduce potassium mobility by enhancing fixation (Gambo et al., 2025; Nayak et al., 2025). Furthermore, anthropogenic activities like deforestation, bush burning, and indiscriminate application of agro-industrial waste alter the chemical and biological balance of soils, thereby modifying their potassium retention properties (Attah, 2025; Agboola, 2024).

Modern tools such as remote sensing and GIS mapping offer new ways to correlate lithological features with soil nutrient behavior and spatial distribution, aiding precision agriculture and land-use planning (Triomphe et al., 2024; Bouasria et al., 2025). These technologies can help predict areas with high or low fixation potential, enabling site-specific fertilizer application.

While phosphorus fixation in Akwa Ibom soils has been documented (Umoh et al., 2021), potassium fixation remains underexplored, despite its direct impact on crop productivity, particularly in rain-fed and low-input agricultural systems. This knowledge gap underscores the importance of site-specific studies that consider the interplay between lithology, climate, biological activity, and land use in determining soil fertility and sustainability (Mokhtar & Thomas, 2025; Triomphe et al., 2024).

Moreover, integrating indigenous knowledge systems and farmer experiences with scientific findings can lead to more adaptive and inclusive soil fertility management strategies (Fullen et al., 2025; Gambo et al., 2025). Socioeconomic variables such as access to agricultural inputs, education, and extension services also shape how farmers perceive and respond to soil nutrient deficiencies (Mugisa et al., 2025).

Given the above, this study aims to systematically evaluate potassium fixation in soils formed from diverse parent materials: namely sandstone, shale, and alluvium in Akwa Ibom State, Nigeria. It seeks to (1) assess the fixation potential of these soils, (2) link potassium retention to mineralogical and physicochemical properties, and (3) explore the influence of topography and anthropogenic activities.

By adopting a multidisciplinary approach, this research will contribute to improved potassium management strategies, sustainable agricultural productivity, and long-term soil health in the region.

MATERIALS AND METHODS

Description of the study area

The study was carried out on soils formed from diverse parent materials; sandstone (SS) from Odoro Ikpe in Ini local government area (L.G.A), beach ridge sand (BRS) from Uta-Ewa in Ikot Abasi L.G.A., and coastal plain sand (CPS) in Obio Akpa in OrukAnam L.G.A. in Akwa Ibom State. The State is located within the humid tropical region, characterized by heavy rainfall ranging from 2500 mm to 3000 mm along the coast. Mean annual temperature range between 24- 30°C with relative humidity of 75-80% within a year (Petters *et al.,* 1989).

Soil sampling and preparation

Surface soil samples (0 – 20cm depth) were taken from various locations with soil auger and bulked to form a composite soil sample. The bulked soil samples were air-dried, sieved using 2 mm sieve to remove materials greater than 2mm in diameter in stored in labelled polythene bags for laboratory analysis. The sieved samples were subjected to particle size analysis which was determined by the Bouyoucous hydrometer method using sodium hexametaphosphate (Calgon) as a dispersing agent. Soil pH was determined potentiometrically using a glass electrode pH meter in a 1:2.5 soil-water ratio. Electrical conductivity was determined in a 1:2.5 soil: water ratio using Conductivity Bridge. Total nitrogen was determined by the micro kjeldahl digestion method**.** Organic carbon was determined using the Walkley- Black wet dichromate oxidation method. The value was multiplied by 1.724 (conventional van Bemmelen factor) to obtain organic matter content. Exchangeable bases (Ca, Mg**,** K and Na**)** were extracted with 1N ammonium acetate (NH_4OAc) at pH 7.0 using 1:10 soil-liquid ratio. Calcium and Mg in the extract were determined by EDTA (Ethylene Diaminetetra Acetate Acid) titration method while Na and K in the extract were determined using a flame photometer. Exchangeable acidity was extracted with 1M KCl solution and the acidity from the extract was titrated with 0.01M Na0H. Effective cation exchange capacity (ECEC) was obtained from the summation of exchangeable bases and exchangeable acidity. Base saturation was calculated by dividing the total exchangeable bases by the effective cation exchange capacity and multiplied by 100. The analysis were conducted following procedures as described by Udo *et al.,* 2009)

Potassium fixation experiment

The Method of Ukpong *et al.,* (2014) was used for K fixation experiments. Twenty grams (20g) of the sieved soil was weighed into duplicated cups that the button were perforated to make it easy for solution to leach thoroughly and to dry up. A treatment solute containing 0, 20, 40 and 80 mgl of K prepared from Potassium Chloride (KCL) were added to the 20g of soil in specified cups and the cups were carefully covered and allowed to Incubate for 1,7,14 and 21 days respectively. The design was 3x4 factorial experiment fitted into a completely randomized design (CRD), a two (2) factor experiment with three (3) parent materials and four (4) rates of K application. Each of the treatments was replicated three (3) times at four (4) incubation days giving a total of 144 samples. Distilled water was added to the mixture at weekly intervals to keep the soil moist throughout the duration of incubation. At the set days, 20ml of potassium chloride was used to extract available K in the soil samples. The fraction of K not recovered as extractable K after each incubation time was calculated as the difference between the quantities of K in solution (recovered).

Statistical analysis

Data collected were subjected to analysis of Variance (ANOVA). Mean separation was done using Fishers Least significant difference (F- LSD) at 5% level of probability. Pearsons correlation coefficient was used to determine the relationship between the amount of K fixed with some soil properties.

RESULTS AND DISCUSSION

Physicochemical properties of the studied soils

The soils of the study area varied in texture from loamy sand for sandstone, sand for beach ridge sand and sandy loam for coastal plain sand (Table 1). The beach ridge sand had the highest sand content (90.94%), followed by sandstone (82.76%) and the least was in the coastal plan sand (71.70%). The clay fraction was higher in coastal plain sand (26.30%), followed by sandstone (12.70%) while the beach ridge sand had the least clay fraction (5.40%). The silt fraction was higher in the sandstone (4.45%), followed by the beach ridge sand (3.66%) and was low in the coastal plain sand (2.00%). The soil pH was acidic to slightly acidic in all the soils which is satisfactory for most crops (Aduayi *et al*., 2002). Total nitrogen ranged from 0.06% in beach ridge sand to 0.08% in sandstone soil. Available P ranged from 10.10mg/kg in CPS, 13.10mg/kg in SS and 18.01mg/kg in BRS. Available P exceeded the critical value of 12.5mg /kg in beach ridge sand and SS except soils formed from CPS as suggested by Adeoye and Agboola (1984) in critical P fertility class base on the soil text criteria and fertility map developed for Nigeria. (FMANR, 1990). Generally, the order of exchangeable bases was Ca > Mg > K > Na indicating low fertility status and may be due to high rainfall which causes erosion and leaching away of the basic cations (Ijah, *et al.,* 2024b). The electrical conductivity which measured the level of salt in soil (EC) was low in all the soil. Soil organic matter was high in soils derived from sandstone (2.31%) and low in beach ridge sand (1.28%).

Table1: Physicochemical properties of the studied soil.

Tested Parameters	Units	Depths	Sand stone (SS)	Beach Ridge Sand (BRS)	Coastal Plain Sand (CPS)
Particle size analysis		**0-20cm**			
Sand	%		82.76	90.94	71.70
Silt	%		4.45	3.66	2.00
Clay	%		12.79	5.40	26.30
Textural Class			loamy Sand	Sand	Sandy loam
PH			6.09	5.29	5.46
EC	dS/m		0.01	0.04	0.02
Organic matter	%		2.31	1.28	14.3
TN	%		0.08	0.06	0.07
Av.P	Mgkg		13.10	18.01	10.10
			Exch. bases		
Ca	cmolkg		3.01	3.08	2.02
Mg	cmol/kg		0.80	2.06	0.89
K	cmol/kg		0.23	0.16	0.11
Na	cmol/kg		0.01	0.08	0.02
EA	cmol/kg		2.44	2.84	2.54
ECEC	cmol/kg		6.49	8.22	5.61
BS	%		62.40	65.45	54.20

TN = Total Nitrogen EC = Electrical conductivity Av. P = Available phosphorus Ca = Exchangeable calcium Mg = Exchangeable Magnesium K = Exchangeable Potassium Na = Exchangeable Sodium EA =Exchangeable Acidity ECEC = Effective cation exchange capacity B.S = Base saturation

Table 2: Effect of parent materials and K rates on the amount of K fixed in soil at day 1.

Parent material	0	20	40	80	PM Total	PM means
CPS	5.42	6.12	13.40	22.08	47.02	11.75
BRS	4.71	5.06	8.08	10.10	27.95	6.98
SS	6.65	7.95	18.11	29.92	62.63	15.65
Rate Total	16.78	19.13	39.59	62.10		
Rate Mean	5.59	6.37	13.19	20.70		

The exchangeable Na was higher in BRS (0.08cmol/kg^{-1}) while the SS had the lowest (0.01cmolkg^{-1}). The exchangeable acidity was within the critical values of 2cmol/kg for these soils (Aduayi *et al.*, 2002). ECEC was high in BRS (6.49cmolkg^{-1}) while the CPS had the lowest (5.61cmol/kg^{-1}). The differences obtained from the study could be due to the different location the samples were taken. The base saturation values were high ranging from (62.40%) in SS, 54.20% in CPS and 65.45%) for BRS

Effect of parent materials and K rates on the amount of K fixed in soil at day 1

The effect of parent materials and K rates on the amount of K fixed in soil at day 1 is presented in (Table 2). SS had the highest fixing capacity of K (15.65mgkg^{-1}) while BRS had the least ability to fixed K (6.98mgkg^{-1}). The highest K fixing capacity of SS could be attributed to the nature of the clay mineral (Kaolinitic) and the presence of some specific adsorption sites for potassium in the soils. Similar observation was reported by Osemwota *et al.* (1999).

Effect of parent materials and K rates on the amount of K fixed in soil at day 7

The effect of parent materials and K rates on the amount of K fixed in soil at day 7 is presented in (Table 3). The SS fixed more of K (22.55mgkg^{-1}), followed by the CPS (16.58mgkg^{-1}) while the BRS had the least (12.13mgkg^{-1}) K fixed. The order of K fixation was SS > CPS > BRS. Potassium fixation increased with increased in concentration of K added during the incubation periods. This findings is in line with that of Ogunremi (1977) who reported that K fixation increases with increase of added K.

Effect of Parent Materials and K Rates on the amount of K Fixed in Soil at Day 21

The sandstone soils had the highest capacity to fixed K while the beach ridge sand had the lowest. The trend were as follows: SS (29.55mgkg^{-1}) > CPS (18.88mgkg^{-1}) > BRS (14.26mgkg^{-1}) as shown in (Table 4). The highest amount of K fixed in SS increased with days of incubation,

Table 3: Effect of parent materials and K rates on the amount of K fixed in soil at day 7**.**

Parent material	0	20	40	80	PM Total	PM means
CPS	7.03	9.08	20.17	30.04	66.32	16.58
BRS	6.05	6.70	16.06	19.72	48.53	12.13
SS	11.47	13.22	24.32	41.17	90.18	22.55
Rate Total	24.55	29.00	60.55	90.93		
Rate Mean	8.18	9.67	20.18	30.31		

Table 4: Effect of parent materials and K rates on the amount of K fixed in soil at day 21.

Parent material	0	20	40	80	PM Total	PM means
CPS	3.05	2.08	28.05	42.36	75.54	18.88
BRS	11.04	1.88	18.06	26.06	57.04	14.26
SS	12.79	17.59	36.06	51.79	118.23	29.55
Rate Total	26.88	21.55	82.17	120.21		
Rate Mean	8.96	7.18	27.39	40.07		

Table 5: Effect of parent materials and K rates on the amount of K fixed in soil at day 28.

Parent material	0	20	40	80	PM Total	PM means
CPS	1.18	1.32	6.20	9.26	17.96	4.49
BRS	20.06	15.05	17.03	18.06	70.20	17.55
SS	1.52	2.35	11.69	16.02	31.58	7.89
Rate Total	22.76	18.72	34.92	43.34		
Rate Mean	7.58	6.24	11.64	14.45		

Table 6: Interactive effect of parent materials and K rates on the amount of K fixed in soil at day 1, 7, 21 and 28.

Parent materials	Day 1	Day 7	Day 21	Day 28	Mean
CPS	11.76	16.58	18.89	4.49	12.93
BRS	6.99	12.13	14.26	17.55	12.73
SS	15.66	22.54	29.56	7.89	18.91
LSD (p<0.05)	0.06	0.35	0.44	0.14	
K Rates					
0	5.60	8.19	8.96	7.58	7.58
20	6.38	9.67	7.19	6.24	7.37
40	13.20	20.18	27.39	11.64	18.10
80	20.70	30.31	40.07	14.45	26.38
LSD (p<0.05)	0.07	0.41	0.51	0.16	
Parent Material x K Rate Interaction					
LSD (p<0.05)	0.13	0.70	0.87	0.27	

indicating that more K was entrapped into the inter- layer site of clay while the amount fixed in BRS soils decreased with days indicating the release of K into the soil. The findings obtained from this study agrees with the report of Udo *et al.,* (1982) and Osemwota *et al*., (1999).

Effect of parent materials and K rates on the amount of K fixed in soil at Day 28

The amount of K fixed at day 28 is shown in (Table 5). There was a gradual reduction in K fixing capacity at day 28 except in soils developed from the beach ridge sand. The beach ridge sand had the highest fixing capacity (17.55mgkg^{-1}) while the coastal plain sand had the least (4.49mg/kg^{-1}). The trend was as follows: BRS (17.55mgkg^{-1})>SS (7.89mgkg^{-1}) > CPS (4.49mgkg^{-1}). The less K fixed in SS and CPS indicate that more K was released into the soil system.

Interaction effects of Parent Materials and K rates on the amount of K fixed in soil at day 1, 7, 21 and 28

The amount of K fixed as affected by the different parent materials and K rate at different incubation days is shown in (Table 6). The amount of K fixed decreased at (P< 0.05) probability levels with length of incubation except in day 1, 7 and 21. The trend was in the order: Day 21 (0.87mgkg^{-1}) > Day 7 (0.70mgkg^{-1}) > Day28 (0.27mgkg^{-1}) > Day 1 (0.13mgkg^{-1}). Generally, in all the parent materials studied, soils formed from sandstone had the highest capacity to fixed K while the beach ridge sand and c0astal plain sand had the least. This findings could be attributed to the acidic condition of the soils which permit the release of K with no new chemical form in the process. The interaction effects is fully presented in (Figure 1, 2, 3 and 4). The graph shows plots of concentration of K fixed and the rate of K added in the soil. SS had the highest concentration of K fixed than other soils.

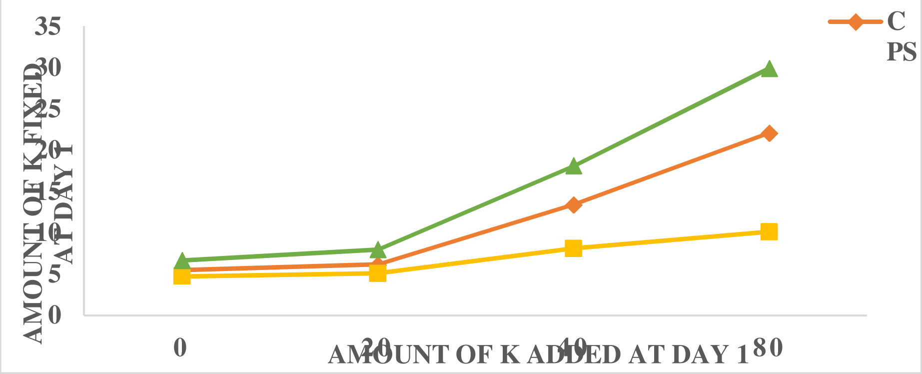


Figure 1: Amount of K fixed At Day 1

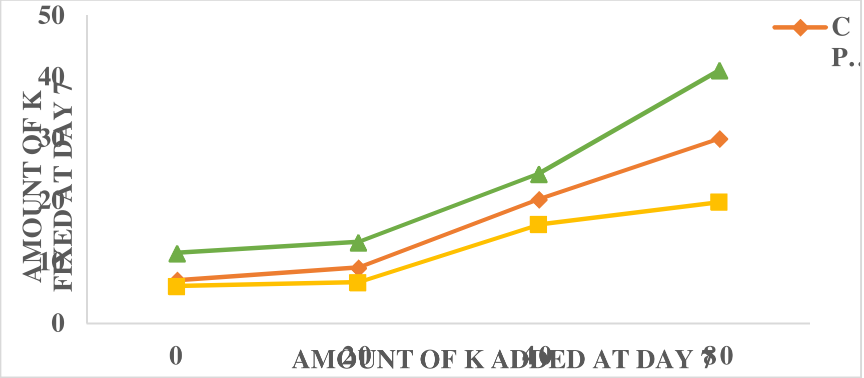


Figure 2: Amount of K fixed At Day 7

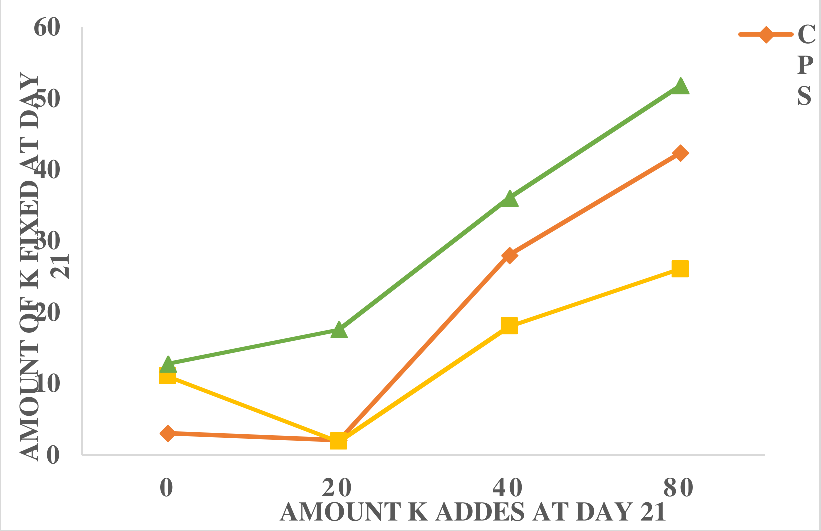


Figure 3: Amount of K fixed At Day 21

This could be attributed to the inherent fertility of the soil, the type of the parent material and soil pH. This results are in agreement with the report of Osemwuta *et al.,* 1999 and Adeoye, (1986).

Correlation matrix between the amount of K fixed and some soil properties

The correlation analysis in (Table 7) shows the level of

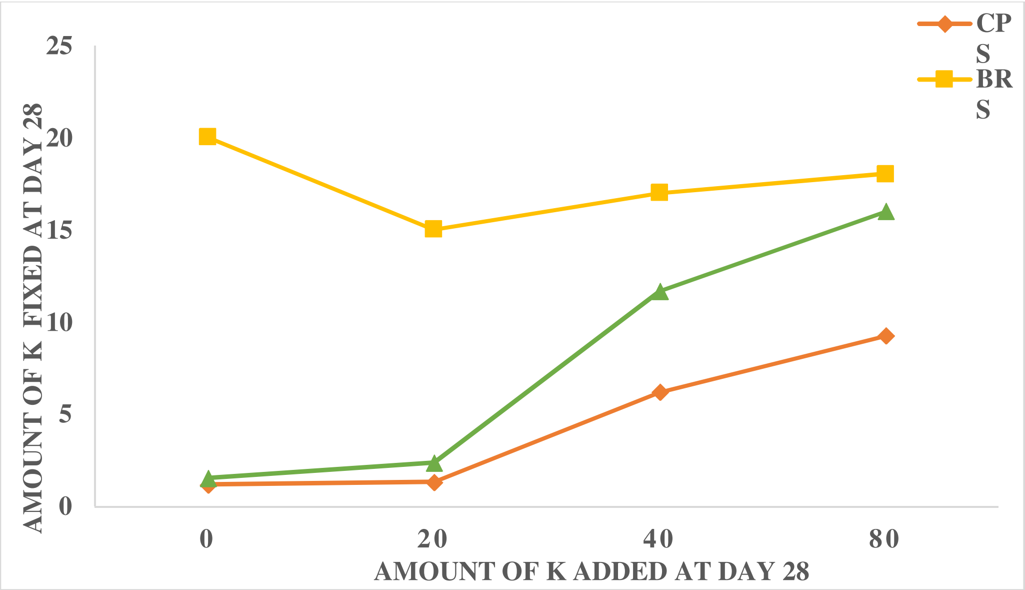


Figure 4: Amount of K fixed At Day 28

Table 7: Correlation relationship of K leaching potential and soil physico-chemical properties

	Day 1	Day 7	Day 21	Day 28	Sand	Silt	Clay	pH	EC	OM	TN	Av. K	Av. P	Ca	Mg	Na	EA	ECEC	BS
Day 1	1																		
Day 7	0.990	1																	
Day 21	0.961	0.990	1																
Day 28	-0.752	-0.652	-0.539	1															
Sand	-0.475	-0.347	-0.212	0.937	1														
Silt	0.260	0.394	0.519	0.440	0.726	1													
Clay	0.402	0.269	0.132	-0.906	-0.997	-0.779	1												
pH	0.929	0.972	0.995	-0.456	-0.117	0.599	0.036	1											
EC	-0.991	-0.963	-0.915	0.833	0.587	-0.131	-0.519	-0.872	1										
OM	0.902	0.954	0.987	-0.394	-0.049	0.652	-0.032	0.998*	-0.837	1									
TN	0.998*	0.997	0.975	-0.713	-0.424	0.316	0.349	0.949	-0.982	0.926	1								
Av. K	0.533	0.647	0.747	0.157	0.492	0.956	-0.561	0.808	-0.416	0.846	0.581	1							
Av. P	0.985	0.951	0.898	-0.855	-0.621	0.089	0.555	0.851	-0.999*	0.814	0.973	0.378	1						
Ca	-0.117	0.024	0.164	0.742	0.929	0.982	-0.956	0.258	0.247	0.323	-0.059	0.778	-0.287	1					
Mg	-0.920	-0.856	-0.775	0.950	0.781	0.138	-0.728	-0.711	0.964	-0.662	-0.896	-0.159	-0.974	0.496	1				
Na	-0.945	-0.889	-0.817	0.926	0.737	0.070	-0.680	-0.757	0.980	-0.711	-0.924	-0.226	-0.987	0.435	0.998*	1			
EA	-0.990	-0.960	-0.912	0.838	0.595	-0.122	-0.527	-0.868	1.000*	-0.832	-0.980	-0.408	-0.999*	0.256	0.996	0.982	1		
ECEC	-0.694	-0.586	-0.467	0.996	0.963	0.514	-0.938	-0.379	0.783	-0.316	-0.651	0.239	-0.809	0.796	0.920	0.891	0.789	1	
Bs	-0.328	-0.191	-0.052	0.869	0.987	0.827	-0.997	0.044	0.449	0.112	-0.273	0.625	-0.487	0.977	0.671	0.619	0.458	0.908	1

TN = Total Nitrogen Ec = Electrical conductivity AV. P = Available phosphorus Ca = Exchangeable calcium Mg = Exchangeable Magnesium K = Exchangeable Potassium Na = Exchangeable Sodium Ea =Exchangeable Acidity ECEC = Effective cation exchange capacity B.S =Base saturation

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed) association between the amount of K fixed and some soil properties. The amount of K fixed correlated positively with pH (r = 0.998), EC (r = 1.000), exch. Mg (r = 0.998) and negatively with other soil properties. The positive correlation implies that, it contributed to K fixation in the soil while the negative correlation shows that there was no relationship in K fixing ability.

Conclusion

The soils investigated varied with respect to their properties but showed dominance of the sand fractions, acidic to slightly acidic with low nitrogen and electrical conductivity. Some of the soil chemical properties were above the critical limit (available P) except in soils formed CPS. Organic matter varied from low to moderate. K fixed in SS soil decrease with length of incubation days and was significantly higher in day 21 (29.55mgkg$^{-1)}$ > day 7 (22.55mgkg^{-1}) > day 1 (15.65mgkg^{-1}) > day 28 (7.89 mgkg^{-1}). The amount of K fixed in the soil increased with increased in the rate of K added. There was a gradual reduction in K fixing capacity at day 28 except in soils formed from BRS. The BRS had the highest fixing capacity of (17.55mgkg^{-1}) while the coastal plain sand had the least K (4.49mgkg^{-1}). The trend was as follows: BRS (17.55mgkg^{-1}) > SS (7.89mgkg^{-1}) > CPS (4.49mg/kg^{-1}). Generally, in all the different parent materials studied, soils formed from SS had the highest capacity to fixed K. The amount of K fixed correlated positively with pH (r = 0.998*), EC (r = 1.000*), exch. Mg (r = 0.998*) and negatively with other soil properties. To reduce the risk of K fixed in these soils, potassium fertilizer recommendation program should take into consideration the amount of the applied K fertilizer that is initially fixed and periodic testing of soil K is vital for rational K fertilizer management.

REFERENCES

Adeoye, G. O. (1986). *PhD Thesis*, Department of Agronomy, University of Ibadan, Nigeria.

Adeoye, G. O. and Agbola, A. A. (1984) Critical Level for Soil pH, Available P, K, Zn and Mn and Maize Content of P, Cu and Mn in the Sedimentary Soils of South Western Nigeria. *Fertilizer Research*, 6, 65 – 71. http://dx.doi.org/10.1007/BFo1058165

Aduayi, E A, Chude, V.O, Adebuyi, B A and Olagiwolo S.O. (2002). *Fertilizer use management practices for crops in Nigeria*. 3rd Ed. Produced by Federal fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja Nigeria pp 23-73.

Agboola, O. E. (2024). *Assessment of Physicochemical Properties and Heavy Metals Concentration of Abbatoir Effluent on Oko Oba River in Agege, Lagos Nigeria* (Master's thesis, Kwara State University (Nigeria)).

Amao, A. O. (1990). *PhD Thesis*, University of Ibadan, Nigeria.

Ano, A. O (2003). Effect of Amendment with termite mound on K fixation of some soils of South Eastern Nigeria, Derived from Coastal Plain Soils. Proceeding of 28th *Annual Conference of the Soil Science Society of Nigeria*. Pp. 180–184.

Ano, A. O. (1991). Potassium Fixation characteristics of Eastern Nigeria Soils developed from diverse parent material. Journal of Potassium Research 8: 177 – 186.

Ataga, D. O. (1974). Release and fixation of Potassium in some soils supporting the oil palm *(Elaeis guineensis*) in Nigeria. *Proc.* 10th Coll. Int. Potash Inst., Bern, pp. 131.

Attah, I. C. (2025). Implementation of agro-industrial by-products in expansive soil amelioration: design of experiment approach. *AI in Civil Engineering*, *4*(1), 8.

Bouasria, A., Fekkak, A., Haissen, F., Jouhari, A., & Berrada, I. (2025). Using long-term bare earth composite image and machine learning in lithological mapping of Adrar Souttouf mafic complex (Oulad Dlim massif, Southern Morocco). *Remote Sensing Applications: Society and Environment*, *38*, 101516.

Bouasria, A., Fekkak, A., Haissen, F., Jouhari, A., & Berrada, I. (2025). Using long-term bare earth composite image and machine learning in lithological mapping of Adrar Souttouf mafic complex (Oulad Dlim massif, Southern Morocco). *Remote Sensing Applications: Society and Environment*, *38*, 101516.

Essien, O. A., Hogan, E. D., Akata, O. R., Enyong, J. K., & Ben, F. E. (2025). Assessing Spatial Variability of Soil Physical and Chemical Quality as Affected by Slope Curvature and Aspect of Acid Soils in Akwa Ibom State, Nigeria. *Asian Journal of Agriculture and Allied Sciences*, *8*(1), 197-210.

Federal Ministry of Agriculture and Natural Resources (FMANR, 1990). Literature Review on Soil Fertility Investigation in Nigeria (in five volumes). Federal Ministry of Agriculture and Natural Resources, Lagos, pp: 32 – 45.

Fullen, M., Gambo, A., & Baldwin, T. (2025). Indigenous farmer's knowledge and perception of desertification and soil erosion in Jigawa state, Nigeria.

Gambo, A., Fullen, M. A., & Baldwin, T. C. (2025). Indigenous farmers' knowledge and perception of desertification and soil erosion in Jigawa State, Nigeria. *Discover Soil*, *2*(1), 1-18.

Ijah, C. J., Iyanam, M. V., Essien, G. E., Robson, M. S and Effiong, I. B. (2024b). Forms and Status of Potassium in Soils Supporting Rubber (*Havea Brasiliensis*) Plantations in three Locations in Akwa Ibom State. *Direct Research Journal of Agriculture and Food Science.* 12 (3): 18 – 24.

Ijah, C. J., Udoh, A. B., Iyanam, M. V., Udounang, P. I and Effiong, I. B.(2024a). Assessment of Potassium Leaching Potentials in Soils Formed on Diverse Parent Materials in Akwa Ibom State*. In: Proceedings of the 48th Annual Conference of Soil Science Society of Nigeria*, Abuja. Pp160 – 171.

Ikiriko, M.E., Kamalu, O. J., Joseph. I. E (2022). Potassium fixation of some soils derived from different parent materials in Cross River State. *Greener Journal of Agricultural Sciences* 12 (1): 01- 15.

Mokhtar, S. M., & Thomas, A. (2025). Stimulating Agricultural Production through Technical Assistance. In *Islamic Finance and Sustainable Development* (pp. 64-76). Routledge.

Mugisa, A., Bigirinama, R., Kisembo, C., Mulume, A., Lurhangire, E., Bisimwa, G., & Mwene-batu, P. (2025). Trends in socio-economic level and accessibility to healthcare of households in Eastern Democratic Republic of Congo from 2011 to 2023: Documentary review of South Kivu. Mokhtar, S. M., & Thomas, A. (2025). Stimulating Agricultural Production through Technical Assistance. In *Islamic Finance and Sustainable Development* (pp. 64-76). Routledge.

Nayak, S., Kumar, M., & Dhal, N. K. (2025). Impact of post-anthropogenic forest fire on soil carbon dynamics and physicochemical properties in tropical dry deciduous Sulia Reserve Forest, Odisha. *Environmental Monitoring and Assessment*, *197*(5), 537.

Ndzana, G. M., Meersmans, J., Xue, B., Temgoua, E., Bekoa, E., Akam, B. M. & Bitondo, D. (2024). Assessing the morphological and physico-chemical properties of vertisols and black soils for optimal land management in Garoua, Northern Cameroon, sub-Saharan Africa. *Moscow University Soil Science Bulletin*, *79*(5), 664-673.

Ndzana, G. M., Meersmans, J., Xue, B., Temgoua, E., Bekoa, E., Akam, B. M., & Bitondo, D. (2024). Assessing the morphological and physico-chemical properties of vertisols and black soils for optimal land management in Garoua, Northern Cameroon, sub-Saharan Africa. *Moscow University Soil Science Bulletin*, *79*(5), 664-673.

Ogunremi, L. T. (1977). *B.Sc. Project*, Agronomy Department, University of Ibadan, Nigeria.

Osemwota, I. O., Okpefa, G. O., Ogboghodo, A and Aisagbokhai, H. I. (1999). Quantities of Potassium Fertilizer Required to raise the soil test value in soils of Edo State of Nigeria. Niger Agric. J. 30: 132 – 139.

Petters, S. W, Usoro, E. J, Udo, E. J, Obot, U. W and Okpon, S. N. (1989).

Akwa Ibom State Physical Background, Soils and Land use Ecological Problems. Technical Report of the Task Force on Soils and Land Use. Government Printer, Uyo. 602.

Pholkern, K., Srisuk, K., & Saraphirom, P. (2025). Soil salinization risk assessments under future climate conditions: The case of central Huai Luang River Basin, Northeast, Thailand. *Agricultural and Biological Engineering*, *2*(2), 32-43.

Pholkern, K., Srisuk, K., & Saraphirom, P. (2025). Soil salinization risk assessments under future climate conditions: The case of central Huai Luang River Basin, Northeast, Thailand. *Agricultural and Biological Engineering*, *2*(2), 32-43.

Sam, I. J. (2025). Soil Physical Variability: A Field Assessment to Identify the Major Factors of Soil Component Variation in Akwa Ibom State, Southeastern Nigeria. *Geography, Earth Science and Environment: Research Highlights Vol. 6*, 114-140.

Tisdale, S. L., Nelson, W. L., Beaton, J. D and Havlin, J. L (1995). Soil Fertility and Fertilizers. 5th Ed. Prentice - -Hall of India, New Delhi. 684p.

Triomphe, B., Ouattara, S. D., Kumar, G., Fuchs, L., Sanchez-Choy, J., Piraux, M., & Baudron, F. (2024). Co-designing technical innovations in the context of agroecological living landscapes. A cross-country analysis of the codesign process, results, and learnings over the 2023-2024 period.

Udo, E. J (1982): Potassium quantity intensity relations and fixation capacity of Southeastern Nigerian Surface Soils. *Nigerian Journal of Soil Science*. 3: 120 – 134.

Udo, E.J., Ibia, T. O., Ogunwale, J. A., Ano, A. O. & Esu, I. E. (2009). Manual of Soil, Plan and Water Analyses. Sibon Books Limited, Lagos, Nigeria, pp. 183

Ukpong, I. M., Osodeke, V. E., and Akpan, U. S. (2014). Determination of phosphorous fixing capacities and residual values of soils of Akwa Ibom State, Nigeria. *Merit Research Journals*, 2(8), 096 – 103.

Umoh, F. O., Essien, O. A., Ijah, C. J., & Sunday, A. E. (2021). Determination of Phosphorous Fixation Capacity on Alluvium, Sandstone and Shale Soils of Akwa Ibom State, Nigeria. *International Journal of Sustainable Agricultural Research*, *8*(2), 105-113.

Wang, C., Zhang, R., Xia, J., Liu, H. C., Sand, W., Etim, I. I. N., ... & Zhou, Y. H. (2025). Microbial Community Dynamics and Elemental Speciation in Antimony-Contaminated Mining Areas. *Journal of Sustainable Metallurgy*, 1-16.

Yang, J., He, J., Wang, S., & Gu, H. (2025). Evaluating Soil Quality in Mollisols: A Comparative Study of Tree Species in the Northeast Plain under Long-Term Silviculture. *Journal of Soil Science and Plant Nutrition*, 1-15.

Yang, M., Fu, Y., Hu, S., Leng, F., Zhuang, Y., Sun, W., & Wang, Y. (2025). Potential function of plant-growth-promoting endophytic Serratia fonticola CPSE11 from Codonopsis pilosula in phytoremediation of Cadmium ion (Cd2+). *Journal of Environmental Management*, *380*, 124994.