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Potassium fixation of some soils derived from different parent materials in Cross River State, Nigeria.

Ikiriko, M.E[1]; Kamalu, O.J[1]; Joseph, I.E[1]

[1]Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt, Nigeria.

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****Corresponding Author***
Ikiriko M.E.
E-mail: *miebaka.ikiriko@ uniport.edu.ng*

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ABSTRACT

Potassium fixation of some soils derived from different parent materials in Cross River State was studied being a major problem that affects the efficiency of K fertilizers. A total of eighteen soil samples were collected from three parent materials: Basement complex, Coastal plain sand and Shales. Six levels of potassium chloride (0, 25, 50, 100, 200 and 400 mg) were added to 1kg soil and replicated three times. Potassium was extracted with 1 N NH4OAc after one day, ten- and forty-two-days incubation. The amount of K fixed was determined and correlation between applied and fixed K was carried out. The soil pH ranged from 5.29 to 5.60, organic carbon varied from 1.33% to 2.18 %, the exchangeable cations are in order of abundance; Ca2+ > Mg2+ > K+ > Na+ and the ECEC of the soils varied from 4.86 cmol/kg for basement complex to 19.38 com/kg for shales. The mean proportion of K fixed varied from 2.06 to 279.05 mg/kg for Shales, 5.95 to 288.44 mg/kg for basement complex and 8.06 to 292.23 mg/kg for soils derived from coastal plain. There was significant correlation (P<0.01) between added and fixed potassium during all the incubation days, the results of this study show that the studied soils irrespective of the parent materials has the ability to fix K and thus, fertilizer recommendation should take into consideration of the amount that is initially fixed.

INTRODUCTION

Potassium (K) is an essential element required by plants; it comes after nitrogen and phosphorus. It is one of the primary elements needed for metabolism, physiological and life cycle of developments. Potassium availability to plants depends on its intensity in the soil solution, capacity of the available pools as well as the buffering capacity of the solid phase (Bilias and Barbayiannis, 2017).

The intensity refers to the potassium concentration in the soil solution, and the buffering capacity is a measure of the total amount of potassium in the solid phase of the soil which can be available in the soil solution while the replenishment rate in the soil represents the transfer rate of potassium from the solid phase of the soil to soil solution (Aminul *et al.,* 2017).

Potassium influences the population of microorganisms in the rhizosphere and plays key role in the nutrition and health of man and livestock. Potassium exists in four forms in the soil: the solution form, exchangeable form, non-exchangeable form or fixed form and mineral or structural form (Romheld and Neumann 2006).

The equilibrium and kinetic reactions that exist between the various of form of potassium in the soil solution is usually influenced by the process of leaching and plant uptake, it is immediately replenished by other forms such as the exchangeable and non-exchangeable fractions. Potassium availability in the soil solution could therefore be predisposed by the solution-exchangeable potassium dynamics, rate of potassium exchange in soils, potassium fixation and release from soil minerals and leaching (Yawson *et al.,* 2011).

Fixation as applied to potassium in soils refers to the reversion of water-soluble potassium to less soluble and non-replaceable forms. The water soluble and replaceable soil potassium are the main source of potassium for the soil solution and to be more or less available for plant growth, and it constitute the form of which the nutrient is mostly readily utilized by plants. Hence, the problem of potassium fixation is of practical importance as regards to the management of potassium fertilizers application as well as the availability of essential nutrient to plants.

Potassium fixation is a direct significance of the existence of 2:1 Clay minerals. In assessing the potassium supplying capacity, the potassium that is readily released and the slow releasing potassium fractions must be appraised because of the dynamics of water and gas in the soil-plant system and rhizosphere processes (Romheld and Neumann, 2006). Potassium fixation is said to be a wide phenomenon in most soils and account significantly for the availability of applied potassium to plants. The amount of potassium fixed and that required to bring about fixation varies with different soils. There is little information on K fixation characteristic of the soils of Cross Rivers State. The main objective of this study was to: (1) characterize the proportion of fixed Potassium in soils in Cross River State based on Parent materials and (2) establish the relationship between Potassium fixed and potassium added in respect to days of incubation.

MATERIALS AND METHODS

Description of Study Site

The study was carried out within Cross Rivers State, Nigeria, located between latitude 05^0 32′ and 4^0 27′ North of the equator and longitude 7^0 15′ and 09^0 28′ South of the Greenwich meridian. It is a tropical climate of average annual temperature of 26.4^0C, the average precipitation of the area is 2708mm with about 70% annual total occurring between March- September. May and July have the highest amount of rainfall. The vegetation of the study area is mainly rainforest and the land-use are majorly agricultural purposes (cassava, plantain, melon, vegetable, maize, yam, cocoyam and banana).

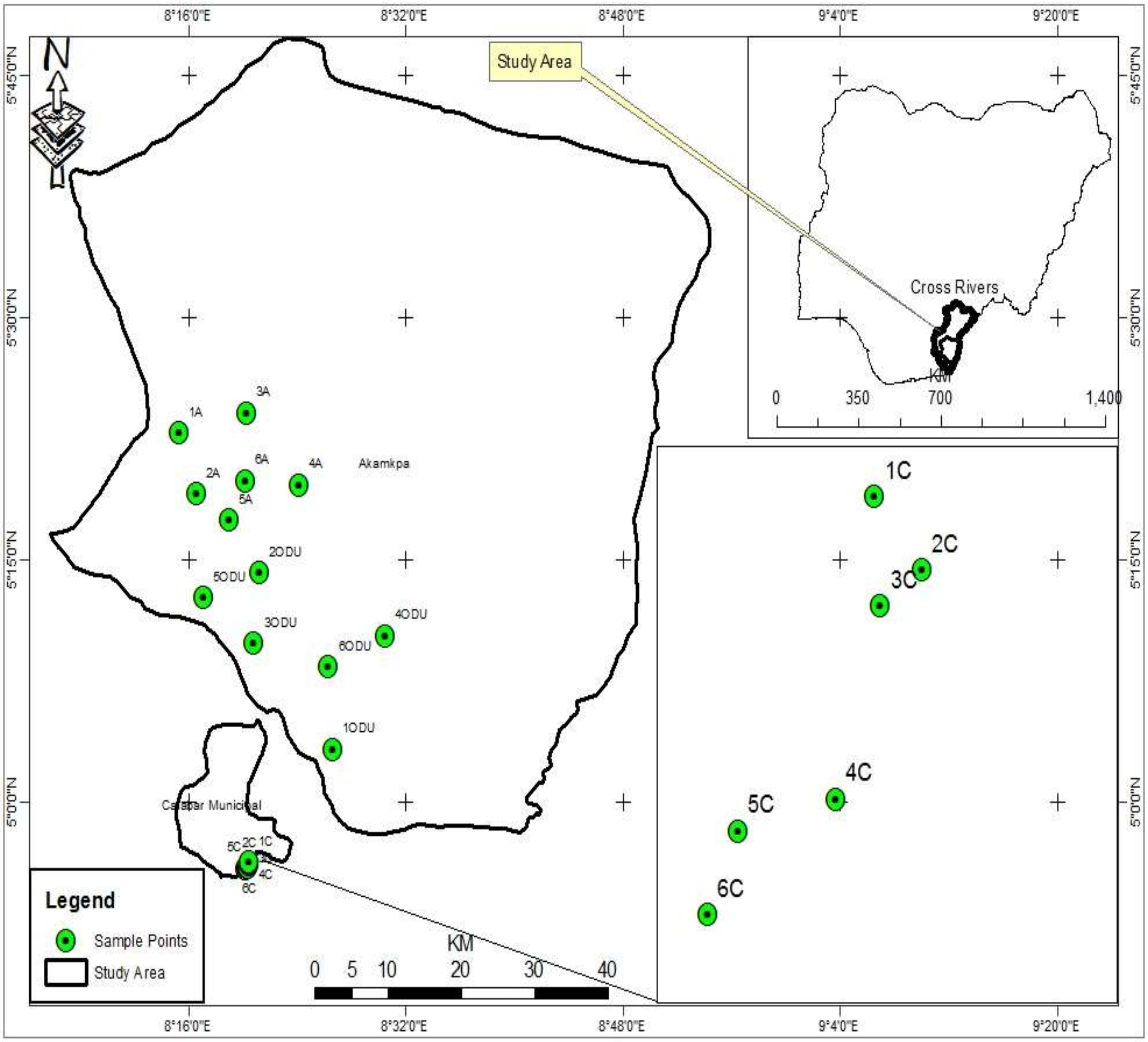

Figure 1: Map showing locations of the experimental soil samples

Soil Samples Collection and Preparation

The soil samples were randomly collected at 0 -30 cm based on parent material; basement complex, coastal plain sand and shales (Figure 1). Six soil samples were collected per location, giving a total of 18 samples. The collected soil samples were air- dried in a shade, gravel and plant roots removed and crushed with porcelain mortar and pestle and sieved through a 2mm mesh. Soil particles less than 2mm were stored in polyethene bags and appropriately labeled preceding to laboratory analysis. A ration of each soil sample was crushed and passed through a 0.5mm sieve for the determination of organic carbon and total nitrogen.

Laboratory Analysis

The soils were analysed for physical and chemical properties. The particle size distribution was determined by the modified bouyoucos hydrometer method (Anderson and Ingram 1993). The soil pH was measured in 1:1 soil-water ratio. Total organic carbon was determined by the dichromate wet oxidation method as described by Nelson and Sommer (1996). Exchangeable bases (Ca, Mg, Na and K) were extracted with 1N ammonium acetate (NH_4OA_C) buffered at pH 7.0 (Thomas 1996). Exchangeable K and Na in the extract were read through the Jenway flame photometer (model PEP7) while Ca and Mg were read on atomic absorption spectrophotometer. Effective cation exchange capacity

(ECEC) was obtained by summation method. Exchangeable Acidity (EA) was extracted with 1N KCl and determined by titration with 0.05 N NaOH using phenolphthalein indicator (McClean 1982). Total Nitrogen was determined using a modified Kjeldahl digestion procedure (Bremmer and Mulvaey, 1982) and available phosphorus was determined by Bray II method (Olsen and Sommers, 1982).

Potassium Fixation

Fixation studies was carried out according to the method as described by Portela *et al.* 2019. Different amount of potassium chloride (KCl) were added to 1 kg of each soil (oven dry basis); 0, 25, 50, 100, 200 and 400 mg in three replicates. The soils were incubated wet near field capacity at 22 º C for 1, 10 and 42 days respectively, and water content was maintained constant throughout the incubation period.

The amount of potassium fixed was obtained by difference, measuring the amounts of potassium remaining extractable by ammonium ions as follows;

Potassium Fixed = K applied + K before treatment - K extractable after treatment (Srinivasa and Takkar 2000)

Statistical Analysis

Data collected was subjected to statistical analysis, correlation analysis between potassium fixed and potassium added in respect to different days of incubations were analyzed using Genstat statistical package (Buysse *et al.,*2004).

RESULTS AND DISCUSSION

Physiochemical Properties of the Experimental Soils

Soil pH is a master variable of soil fertility and as well as indicator of soil nutrient dynamics. The pH varied from moderate to strongly acidic (5.29 to 5.60) as shown in Table 1. Soil pH value less than 5.50 indicates that the soils may suffer from aluminum toxicity. It has been reported that aluminum toxicity occurs in soils with pH values less than 5.50 and increases in intensity as the soil pH decreases below 5.0 (Opara-Nadi *et al*.,1988; White *et al*.,2006 and Ikiriko *et al*., 2016).

The nitrogen content ranged from 0.82 g/kg (low) at Akampka to 0.90 g/kg (high) at Calabar (Table 1). According to Chude *et al*., 2012, the total nitrogen content is below the critical limit (1.2 – 1.6 g/kg), which implies that there will be a response to nitrogen application.

Organic carbon improves soil chemical properties in three ways; as a net source of carbon and nutrients, increases cation exchange capacity and stimulates biological activities. Soil organic carbon is the major component of soil organic matter, it plays a vital role in plant nutrient supply, determines response to N and P fertilizers and improve soil physical structure and processes. The total organic carbon varied from 1.33 % (low) at Akampka to 2.18 % (high) at Calabar as shown in Table 1. Maria and Yost (2006) rated organic carbon content of < 1.5 %, 1.5 – 2.5 % and < 2.5 % as low, medium and high, respectively. The total organic carbon was low to moderate.

The exchangeable cations are in order of abundance; $Ca^{2+} > Mg^{2+} > K^{+} > Na^{+}$. This indicates that as weathering progresses, an enormous amount of potassium is being leached out of the soil colloid as compared with others exchangeable cation. The calcium content of the studied soils ranged from 2.40 cmol/kg at Akampka to 11.20 cmol/kg at odukpani (Table 1). The exchangeable magnesium ranged from 0.8 cmol/kg at Akampka to 3.80 cmol/kg at odukpani. The magnesium content of Calabar and Odukpani were above the critical limit (1.5-3.0 mg/kg) as reported by Obigbesan, 1981. While the sodium content of the soil varied from 0.59 to 0.66 cmol/kg to 1.09 cmol/kg for soils of Akampka and Odukpani respectively. The sodium content of the studied soils is above the critical limit reported by Obigbesan, 1981.

The ECEC of the soils varied from 4.86 cmol/kg (low) at Akampka to 19.38 mg/kg (high) at odukpani. The ECEC value for soils of Akampka and Calabar are below 16 cmol/kg which indicate that soils are dominated by low activity clay (Opara-Nadi, 1988 and Thomas *et al.,* 2019).

Table 1: Physiochemical properties of the experimental soils

Soil Parameters	Akamkpa (B.C)	Calabar (C. S)	Odukpani(S)
pH	5.29	5.40	5.60
Available Phosphorus mg/kg	15.79	70.18	17.54
Total Nitrogen (g/kg)	0.82	0.90	0.85
Organic Carbon %	1.33	2.18	1.78
Water soluble K cmol/kg	0.08	0.31	0.14
Exchangeable Cations (cmol/kg)			
Potassium (K)	0.21	9.15	0.33
Sodium (Na)	0.59	0.66	1.09
Calcium (Ca)	3.00	2.40	11.20
Magnesium (Mg)	0.80	2.00	3.80
EA cmol/kg	0.26	0.38	2.96
ECEC cmol/kg	4.86	5.59	19.38
$CaCO_3$ %	0.45	0.85	1.65
Sand %	80.60	86.60	62.60
Silt %	10.00	4.00	10.00
Clay %	9.40	9.40	27.40
Textural class	**Sandy loam**	**Loamy sand**	**Sandy Clay loam.**

*B.C: Basement Complex, C.S: Coastal Plain sands, S: Shale, EA: Exchangeable Acidity, *$CaCO_3$: Calcium Carbonate, ECEC: Effective Cation Exchange Capacity, OC: Organic Carbon, TN: Total Nitrogen

Fixation capacity

Akampka Soils (Basement Complex)

The proportion of mean value of potassium fixed for soil derived from basement complex at 25, 100, 200 and 400 mg/kg of K added ranged from 5.95 to 288.44 mg/kg. The soils (Soil No. 1A, 2A, 3A 4 A, 5A and 6A) showed releasing properties at 25, 50, and 100 mg/kg of potassium added (Table 2a and 2b). Potassium fixation increased with increase in concentration of potassium added during the incubation periods (Fig 1). There was a high correlation (n=6*,* $P< 0.01$) between K added and K fixed in all the incubation periods (Table 3).

Calabar Soils (Coastal Plain Sand)

The proportion of mean values of Potassium fixed for soils derived from coastal plain sand at 25, 100, 200 and 400 mg/kg of K added ranged from 8.06 to 292.23 mg/kg. The soils (Soil No. 1C, 2C, 3C 5C and 6C) showed releasing properties at 25, and 50 mg/kg of potassium added (Table 4a and 4b). Potassium fixation increased with increase in concentration of potassium added during the incubation periods (Fig 2). There was a high correlation (n=6*,* $P< 0.01$) between K added and K fixed in all the incubation periods (Table 5)

Odukpani Soils (Shales)

The proportion of mean value of potassium fixed for soil derived from shales at 25, 100, 200 and 400 mg/kg of K added ranged from 2.06 to 279.05 mg/kg. The soils (Soil No. 1ODU, 4ODU, 5ODU and 6ODU) showed releasing properties at 25, and 50 mg/kg of potassium added (Table 6a and 6b). Potassium fixation increased with increase in concentration of potassium added during the incubation periods (Fig 3). There was a high correlation (n=6*,* $P< 0.01$) between K added and K fixed in all the incubation periods (Table 7).

In general, the amount of potassium recovered increased with the amount of potassium added irrespective of the parent material of the studied soils. Also, higher level of potassium fixation was observed in one and ten days of incubation while the 42 days gave the lowest levels of potassium fixed.

The studied soils have the potential to fix applied potassium despite their different parent materials (Ayarza, 1988, Tening *et al.,* 1995 and Thomas *et al*., 2016). The ability of these soils to fix potassium could be attributed to their nature of clay mineral and low cation exchange capacity. Hence, there is an indication of the presence of specific adsorption sites for potassium in the soils. The adsorption sites may increase the fixation of potassium in the soil, improve nutrient cycling, and the residual effect of potassium fertilization (Ritchey *et al.,* 1980). The higher levels of potassium levels of potassium fixation observed in the one and seven days of incubation in some soils, and the low amount of potassium fixed at 42 days period of incubation, are not common as the fixation sites in the soil are first satisfied when a nutrient element is added before providing the excess for plant uptake. The efficacy of potassium fertilizer applications are usually influenced by previous application which is fixed by the soil sorption sites, this fixed fertilizer should be put into consideration for rational fertilizer management (Portela, 2019).

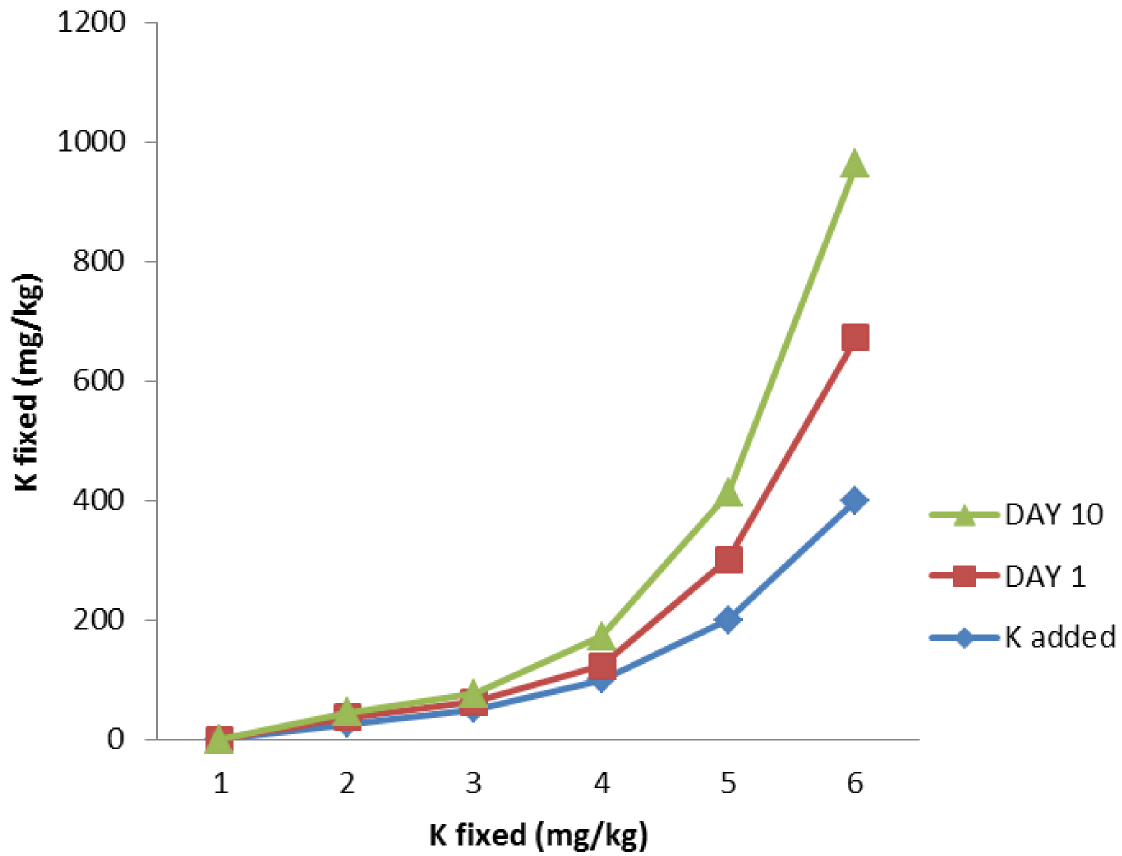

Figure 4.1 : Relationship between K added and the amount of K fixed with time of soils derived from basement complex

Table 3: Correlation between K added and different days of incubation of soils derived from basement complex.

	Day 1	Day 10	Day 42
K added	0.978**	0.984**	0.988**

** = Significant

Table 2a: Amounts of Potassium fixed by soils derived from Basement Complex (Akamkpa)

Soil No.		1A		2A		3A	
K added (mg/kg)	Incubation Time (days)	K Recovered	K Fixed	K Recovered	K Fixed	K Recovered	K Fixed
				mg/kg			
0.00	1	34.80	-	32.84	-	52.78	-
	10	28.15	-	22.29	-	18.38	-
	42	41.44	-	19.94	-	35.58	-
	Mean	**34.80**	**-**	**25.02**	-	35.58	-
25.00	1	49.65	10.15	65.68	-7.84	48.87	28.91
	10	40.66	12.49	57.08	-9.79	34.80	8.58
	42	52.78	13.66	69.59	-24.65	64.51	-3.95
	Mean	**47.70**	**12.10**	**61.12**		**49.39**	**11.19**
50.00	1	73.90	10.90	85.23	-3.25	93.05	9.73
	10	46.14	32.01	76.63	-4.34	71.94	-3.56
	42	116.51	-25.07	93.84	-23.90	50.83	34.75
	Mean	**78.85**	**5.95**	**85.23**		**71.94**	**13.64**
100.00	1	144.27	-9.47	82.50	50.34	87.58	65.20
	10	108.69	19.46	44.96	77.33	66.47	51.91
	42	69.59	71.85	46.53	73.41	56.69	78.89
	Mean	**107.52**	**27.28**	**58.00**	**67.03**	**70.25**	**65.33**
200.00	1	161.47	73.33	95.79	137.05	131.76	121.02
	10	89.53	138.62	82.11	140.18	90.71	127.67
	42	152.09	89.35	104.00	115.94	82.11	153.47
	Mean	**134.09**	**100.43**	**93.97**	**131.06**	**101.53**	**134.05**
400.00	1	128.63	306.17	139.58	293.26	161.87	290.91
	10	143.49	284.66	125.11	297.18	144.66	273.72
	42	139.19	302.25	137.62	282.32	134.89	300.69
	Mean	**137.10**	**298.93**	**134.10**	**290.92**	**147.14**	**288.44**

*A; Akampka

Table.2b: Amounts of Potassium fixed by soils derived from Basement Complex (Akamkpa)

Soil No.		4A		5A		6A	
K added (mg/kg)	Incubation Time (days)	K Recovered	K Fixed	K Recovered	K Fixed	K Recovered	K Fixed
		←		mg/kg			→
0.00	1	49.65	-	28.54	-	28.15	-
	10	14.47	-	18.38	-	22.29	-
	42	59.82	-	8.21	-	60.99	-
	Mean	**41.31**		**18.38**		**37.14**	
25.00	1	63.34	11.31	37.14	16.40	42.62	10.53
	10	33.23	6.24	30.10	13.28	29.71	17.58
	42	113.78	-28.96	23.07	10.14	102.83	-16.84
	Mean	**70.12**	**-3.80**	**30.10**	**13.27**	**58.39**	**3.76**
50.00	1	64.90	34.75	61.77	16.77	69.99	8.16
	10	41.83	22.64	61.77	6.61	44.18	28.11
	42	123.16	-13.34	54.74	3.47	62.56	48.43
	Mean	**76.63**	**14.68**	**59.43**	**8.95**	58.91	**28.23**
100.00	1	127.85	21.80	129.02	-0.48	122.38	5.77
	10	76.63	37.84	69.99	48.39	55.52	66.77
	42	127.07	32.75	114.95	-6.74	111.43	49.56
	Mean	**110.52**	**30.80**	**104.65**	**13.72**	**96.44**	**40.70**
200.00	1	199.79	49.86	138.80	89.74	96.57	131.58
	10	152.87	61.60	130.59	87.79	113.78	108.51
	42	89.14	170.68	126.29	81.92	129.02	131.97
	Mean	**147.27**	**94.05**	**131.89**	**86.48**	**113.12**	**124.02**
400.00	1	251.01	198.64	179.85	248.69	133.72	294.43
	10	96.18	318.29	121.59	296.79	150.92	271.37
	42	150.53	309.29	119.64	288.57	190.02	270.97
	Mean	**165.91**	**275.41**	**140.36**	**278.02**	**158.22**	**278.92**

*A; Akampka

Table 4a: Amounts of Potassium fixed by soils derived Coastal Plain Sand (Calabar)

Soil No.		1C		2C		3C	
K added	Incubation Time (days)	K Recovered	K Fixed	K Recovered	K Fixed	K Recovered	K Fixed
				mg/kg			
0.00	1	37.93	-	50.05	-	14.08	-
	10	42.23	-	43.01	-	20.72	-
	42	51.61	-	38.32	-	49.65	-
	Mean	**43.92**	-	**43.79**		**28.15**	-
25.00	1	45.35	17.58	85.63	-10.43	70.38	-31.30
	10	75.46	-8.23	68.03	-0.02	51.61	-5.89
	42	61.77	14.84	58.26	5.06	59.04	15.61
	Mean	**60.86**	**8.06**	**70.64**	**-1.85**	**60.34**	**-7.19**
50.00	1	64.12	23.81	93.84	6.21	61.38	2.70
	10	72.72	19.51	64.51	28.50	76.24	-5.52
	42	93.44	8.17	60.21	28.11	50.05	49.60
	Mean	**76.76**	**17.16**	**72.85**	**20.94**	**62.56**	**15.59**
100.00	1	71.16	66.77	132.93	17.12	77.02	37.06
	10	124.72	17.51	84.45	58.56	88.75	31.97
	42	114.56	37.05	82.11	56.21	91.88	57.77
	Mean	**103.48**	**40.44**	**99.83**	**43.96**	**85.88**	**42.27**
200.00	1	129.81	108.12	150.53	99.52	137.62	76.46
	10	152.09	90.14	126.68	116.33	169.69	51.03
	42	168.12	83.49	116.51	121.81	140.75	108.90
	Mean	**150.00**	**93.92**	**131.24**	**112.55**	**149.35**	**78.80**
400.00	1	176.72	261.21	164.21	285.84	168.12	245.96
	10	155.21	287.02	155.61	287.40	160.30	260.42
	42	159.91	291.70	134.89	303.43	151.31	298.34
	Mean	**163.95**	**279.98**	**151.57**	**292.23**	**159.91**	**268.24**

*C ; Calabar

Table 4b: Amounts of Potassium fixed by soils derived Coastal Plain Sand (Calabar)

Soil No.		4C		5C		6C	
K added	Incubation Time (days)	K Recovered	K Fixed	K Recovered	K Fixed	K Recovered	K Fixed
				mg/kg			
0.00	1	34.41	-	21.11	-	22.29	-
	10	24.63	-	21.50	-	25 02	-
	42	39.88	-	47.70	-	57.47	-
	Mean	**32.97**	**-**	**30.10**	-	**34.93**	**-**
25.00	1	43.79	15.62	68.03	-21.92	38.32	8.97
	10	46.92	2.71	69.59	-23.09	72.33	-22.31
	42	64.51	0.37	62.95	9.75	60.60	21.87
	Mean	**51.74**	**6.23**	**66.86**	-11.75	**57.08**	**2.84**
50.00	1	50.83	33.58	89.14	-18.03	76.63	-4.34
	10	64.51	10.12	58.65	12.85	67.64	7.38
	42	68.81	21.07	63.73	33.97	69.20	38.27
	Mean	**61.38**	**21.59**	**70.51**	**-3.68**	**71.16**	**13.77**
100.00	1	100.48	33.93	96.18	24.93	100.48	21.81
	10	100.87	23.76	59.43	62.07	88.75	36.27
	42	109.08	30.80	100.09	47.61	108.30	49.17
	Mean	**103.48**	**29.50**	**85.23**	**44.87**	**99.18**	**35.75**
200.00	1	154.44	79.97	96.57	124.54	141.53	80.76
	10	145.05	79.58	147.40	74.10	144.27	80.75
	42	134.11	105.77	84.84	162.86	142.71	114.76
	Mean	**144.53**	**88.44**	**109.60**	**120.50**	**142.84**	**92.09**
400.00	1	136.84	297.57	167.73	253.38	150.14	272.15
	10	131.76	292.91	198.62	222.88	162.26	262.76
	42	142.72	315.16	165.78	281.92	157.56	299.91
	Mean	**131.11**	**301.88**	**177.38**	**252.73**	**156.65**	**278.27**

*C ; Calabar

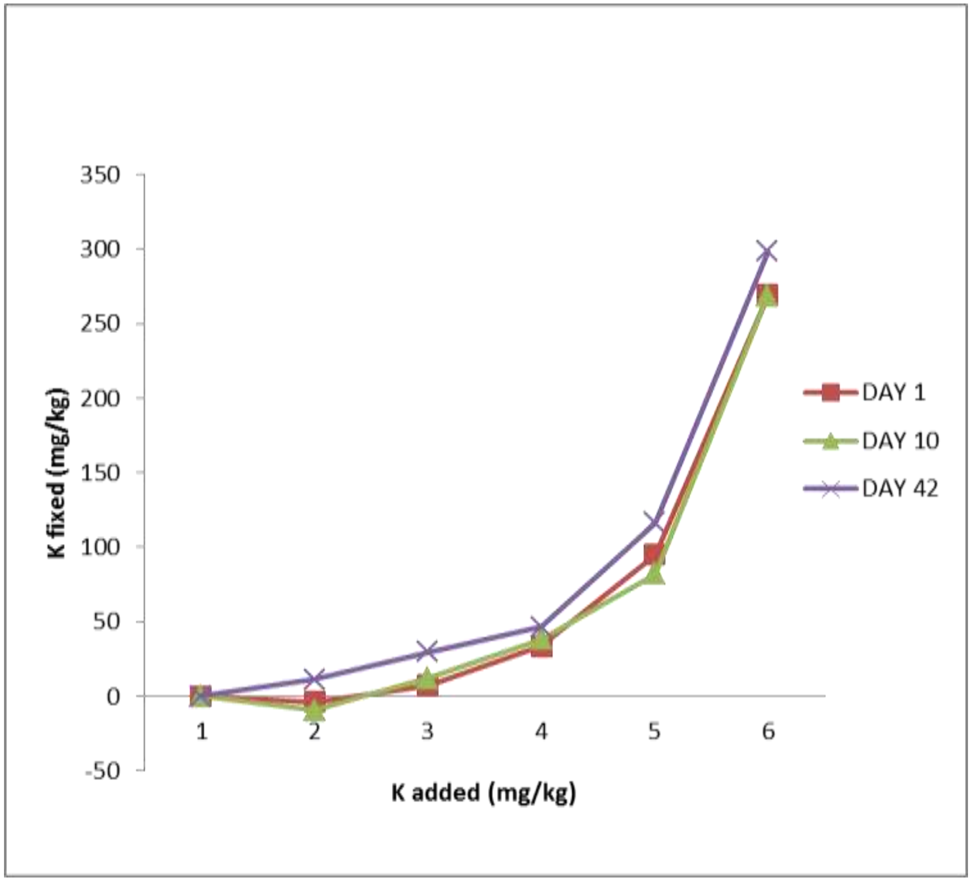

Figure 2: Relationship between K added and the amount of K fixed with time of soils derived from coastal plain sand

Table 5: Correlation between K added and different days of incubation of soils derived from coastal plain sand.

	Day 1	Day 10	Day 42
K added	0.975**	0.965**	0.992**

** = Significant *P < 0.01*

Table 6a: Amounts of Potassium fixed by soils derived Shales (Odukpani)

Soil No.		1ODU		2ODU		3ODU	
K added	Incubation Time (days)	K Recovered	K Fixed	K Recovered	K Fixed	K Recovered	K Fixed
				mg/kg			
0.00	1	30.49	-	62.17	-	32.84	-
	10	33.23	-	31.67	-	29.32	-
	42	31.27	-	38.71	-	25.02	-
	Mean	**31.66**	-	**44.18**	-	**29.06**	-
25.00	1	72.72	-17.23	40.66	46.51	52.78	5.06
	10	55.13	3.10	56.30	0.37	42.23	12.09
	42	53.96	2.31	62.56	1.15	37.14	12.88
	Mean	**60.60**	**-3.94**	**53.17**	**16.01**	**44.05**	**10.01**
50.00	1	86.02	-5.53	73.12	39.05	77.02	5.82
	10	65.68	17.55	51.61	30.06	73.11	6.21
	42	63.63	17.93	52.00	36.71	68.42	6.60
	Mean	**71.68**	**10.05**	**58.91**	**35.27**	**72.85**	**6.21**
100.00	1	87.97	42.52	129.81	32.36	82.11	50.73
	10	112.21	18.28	90.32	41.35	101.65	27.67
	42	59.43	71.84	61.77	76.94	80.15	44.87
	Mean	**86.54**	**44.21**	**93.97**	**50.22**	**87.97**	**41.09**
200.00	1	136.06	94.43	127.46	134.71	147.40	85.44
	10	134.50	98.73	143.88	87.74	117.29	112.03
	42	102.44	128.83	139.58	99.13	110.26	114.76
	Mean	**124.33**	**107.33**	**136.97**	**107.21**	**124.98**	**104.08**
400.00	1	151.31	297.18	215.43	246.74	240.84	192.00
	10	166.95	264.32	166.17	265.50	229.51	199.81
	42	140.75	290.52	148.57	290.14	222.08	202.94
	Mean	**153.00**	**278.01**	**176.72**	**267.46**	**230.81**	**198.25**

Table 6b: Amounts of Potassium fixed by soils derived Shales (Odukpani)

Soil No.		4ODU		5ODU		6ODU	
K added	Incubation Time (days)	K Recovered	K Fixed	K Recovered	K Fixed	K Recovered	K Fixed
				mg/kg			
0.00	1	25.02	-	61.38	-	45.35	-
	10	39.88	-	21.50	-	44.18	-
	42	30.87	-	36.36	-	20.33	-
	Mean	**31.93**	-	**39.75**	-	**36.62**	-
25.00	1	71.16	-21.14	84.06	2.32	82.89	-12.54
	10	44.96	19.94	45.74	0.76	43.01	26.17
	42	50.05	5.84	42.62	18.74	52.78	-7.45
	Mean	**55.39**	**1.55**	**57.47**	**7.27**	**59.56**	**2.06**
50.00	1	110.26	-35.24	78.59	32.79	84.06	11.29
	10	69.20	20.68	76.24	-4.24	55.52	38.66
	42	66.08	14.81	67.64	18.72	60.99	9.34
	Mean	**81.85**	**0.08**	**74.16**	**15.76**	**66.86**	**19.76**
100.00	1	95.79	29.23	94.62	66.76	84.06	61.29
	10	108.69	31.19	93.84	27.66	101.65	42.53
	42	92.27	38.62	89.14	47.22	92.27	28.06
	Mean	**98.92**	**33.01**	**92.53**	**47.21**	**92.66**	**43.96**
200.00	1	96.96	128.02	117.29	144.09	136.84	108.51
	10	125.11	114.77	113.78	107.72	10556	138.62
	42	117.29	113.60	106.74	129.62	135.67	84.66
	Mean	**112.73**	**118.81**	**112.60**	**127.14**	**126.02**	**110.60**
400.00	1	202.53	222.49	127.85	333.53	154.44	290.91
	10	186.89	252.99	121.59	299.91	170.08	274.10
	42	179.85	251.04	119.25	317.11	148.18	272.15
	Mean	**189.76**	**242.17**	**122.90**	**318.85**	**157.57**	**279.05**

* ODU ; **Odukpani**

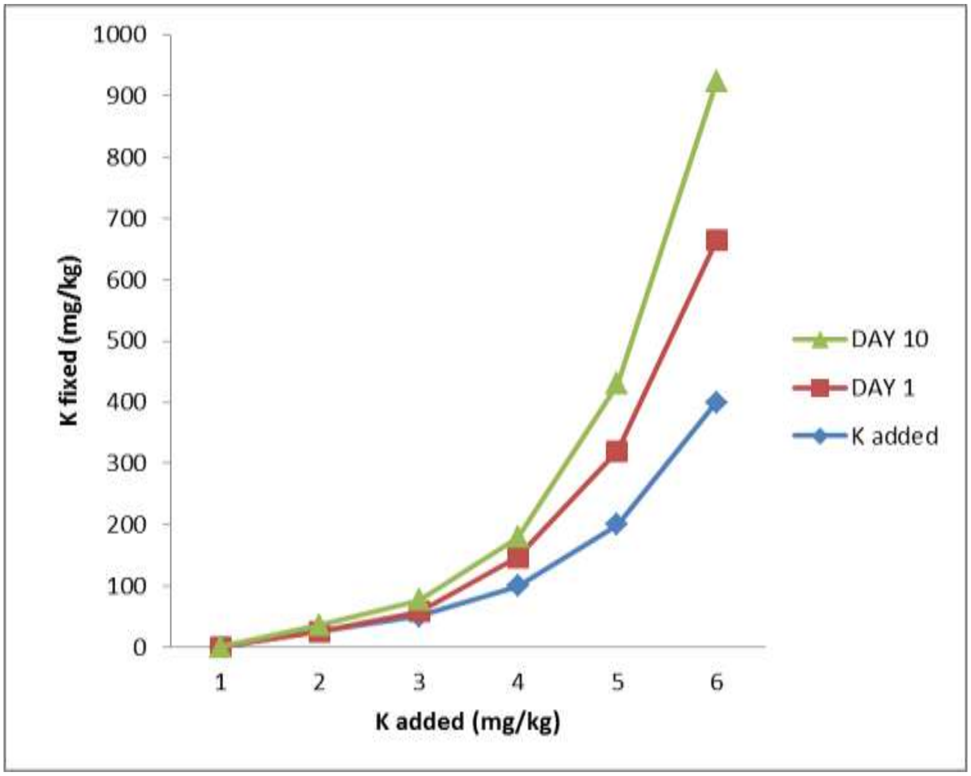

Figure 3: Relationship between K added and the amount of K fixed with time of soils derived from shales

Table 7: Correlation between K added and different days of incubation of soils derived from coastal plain sand

	Day 1	Day 10	Day 42
K added	0.992**	0.983**	0.991**

** = Significant *P < 0.01*

SUMMARY AND RECOMMENDATION

The soils investigated varied with respect to their properties but showed dominance of the sand fractions, moderate to strongly acidic and predominantly of low activity clay (ECEC < 15 cmol/kg) for soils derived from basement complex and coastal plain sand. Some of the soil chemical properties were above the critical limit (Mg, Na, Ca and P), available phosphorus was below the critical limit for soils derived from basement complex, organic carbon varied from low to moderate.

The mean proportion of potassium fixed varied from 2.06 to 279.05 mg/kg for shales, 5.95 to 288.44 mg/kg for basement complex and 8.06 to 292.23 mg/kg for soils derived from coastal plain sand. There was also a linear relationship between the proportion of potassium fixed and the amount added at higher incubation period, and best fixation was observed at 42 days of incubation for the different amount of potassium added. There was significant correlation (*P< 0.01*) between potassium added and potassium fixed during all the incubation days

Potassium fertilizer recommendation program should take into consideration the amount of the applied K fertilizer that is initially fixed. In general, periodic evaluation of soil potassium is vital for rational potassium fertilizer management.

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