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Full Length Research Paper

Kola cultivation and its effect on soil fertility status of selected kolanut plantations in Ogun State, Nigeria

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Abstract

Kola nut is an economically important indigenous cash crop. Two species– cola nitida and *Cola acuminata* are the most prevalent in Nigeria. Soils of five Kola nut plantations in different Local Government Areas (LGAs) in Ogun State were evaluated for effects of previous farming practices as well as their suitability for continuous use for kola cultivation. The sites were selected based on production outputs from the 10 Kola nut producing LGAs in the state. The stratified random technique at depths of 0-15cm, 15 – 30cm and 30 – 45cm was employed for soil sampling. Analytical results showed the pH of the soils to be between 5.29 and 7.57, sand content between 49.95% (Mamu) and 73.57% (Agoro) and clay contents between 17.57% (Odogbolu LGA) to 35.81% (Ijebu-North LGA). The silt contents ranged from 2.64%. (Ikenne LGA) and 14.72% (Ijebu North LGA). The predominant soil texture in these areas is sandy loamy. Soil organic carbon contents were adequate in all LGAs except Odogbolu LGA which was found to be below critical levels. Odogbolu LGA was also found to have Nitrogen (N) content below the critical level for the cultivation of kola. Available Phosphorus, P in the all five LGAs was between 8.03mg/kb and 13.98mg/kg which are above the critical required value of 3.7mg/kg soil. Exchangeable Potassium ranged from 0.08cmol/kg in Ikenne LGA to 0.44cmol/kg in Sagamu LGA. The Magnesium, Mg contents of the soils in all five LGAs were found to be below the critical level. The results confirm the fact that Kola plantations thrive under different soil conditions in the state hence soil management practices have to be established specifically for each farm for maximum yields. There is no one-fits-all remedy for the farms. Coppicing of old and expired trees would also help in achieving better productivity.

Keywords: Ogun, Physico-chemical, Kola Plantation.

INTRODUCTION

Kolanut is one of the several tropical tree crops used in local and international trade. There are over forty species of Kolanut. Seven have edible nuts but the two most common and useful fruit producing species in Nigeria are cola nitida (Gbanja) and cola acuminata (Abata). The former is of more economic importance than the latter as C. acuminata is mostly used for traditional practices especially rituals and on social occasions in Nigeria. Kolanut is also used in the production of pharmaceutical drugs, wines (Beattie, 1970, Ogutuga, 1975), beverages, liquors and confectionaries because of its caffeine content. Kolanut pod husk is used for livestock feeds (Egbe and Sobamiwa 1989) and has also been utilized for the production of liquid soap (Yahaya et al., 2001) as well as the production of snail feed (Yahaya et al., 2001, Hamza and Babatunde 2001). At present, the demand for Kolanut exceeds its production hence there is a need to increase its total plantation acreage and nut yield per tree. This can be achieved through a detailed study of the existing conditions of the farms. Kolanut was a major export earner for Nigeria before dependence of the economy shifted to oil and its derivatives (Akinbode, 1982). Kolanut production in Nigeria ranges from 85,000 to 127,000 metric tonnes annually (Ologunagba, 2009) representing around 70% of world production1 (Famuyiwa, 1987, Quarcoo, 1973).

Ogun state produces the largest amount of Kolanut in the country devoting about 65,000 hectares of land and producing 80,000 MT of the crop in 2010/2011 (National survey on Agricultural Exportable commodities,2013).

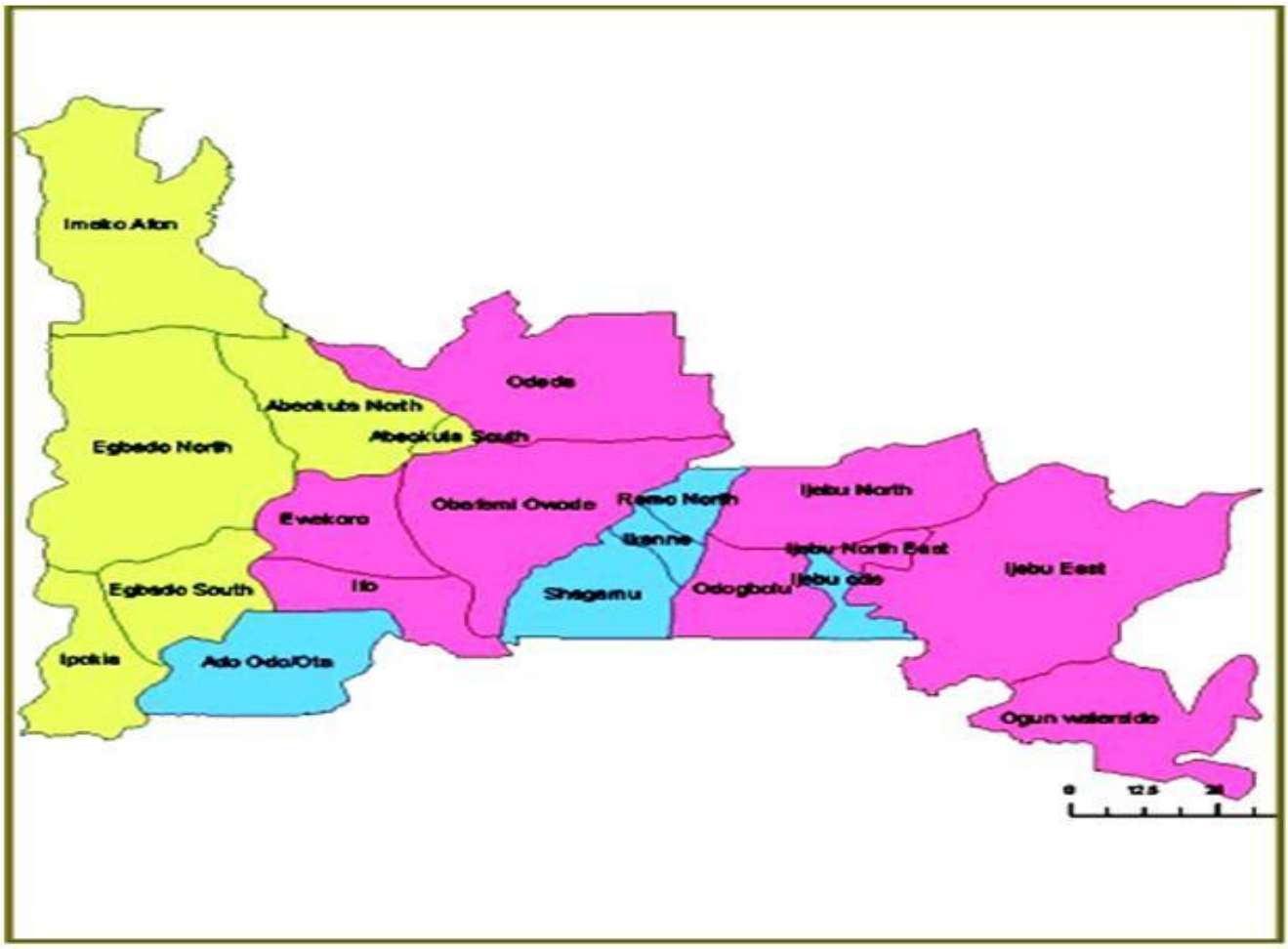

Figure 1: Map of Ogun State showing the selected LGAs for study (depicted by*)

The largest collection market within the state is located at Sagamu. Kolanut is produced in 10 out of the 20 LGAs in the state. This study was conducted by taking soil samples from 5 of these plantations from different zones based on the production output (figure 1). The production of Kolanut is influenced by soil fertility and the ability of any soil to replace nutrients absorbed by crops depend mainly on the clay type, mineral composition of the fine fraction and soil fraction in toposequence. Aiboni and Ogunkunle (1988) have shown that the presence of weatherable minerals in the fine sand fraction within 200cm of the profile is one of the conditions for high fertility of tropical soils.Most of the Kolanut plantations in Ogun state are old, inherited and run by farmers generally within the age bracket of 50 – 70 years. The farmers “mine” nutrients from the soil through kola pod harvests yearly but hardly employ practices to ensure nutrient replacement through processes like fertilizer applications. Ipinmoroti et. al. (2000) have reported falling kola yields due to old age and soil nutrient depletion.

This investigation sought to affirm this phenomenon and determine the effects of this continuous depletion of soil mineral resources on kola production through an assessment of soil fertility status of the plantations and recommend efficient land use practices to ameliorate it.

MATERIALS AND METHODS

Ogun State has a humid, tropical climate with high rainfall and temperature. 5 LGAs were chosen for this study out of the 10 LGAs producing kola economically in the state. The kola farms were found to be between 45 and 70 years old. The five plantations chosen are located at Mamu (Ijebu-North Local Government Area (LGA)), Agoro (Odogbolu LGA) - (Ijebu Ode zone). Sapala Makinde (Owode – Obafemi LGA) – (Egba/Yewa zone) and Igbepa (Sagamu LGA) and Ikenne (Ikenne LGA)-(Remo zone) covering the three geo-political zones of the state. Soil samples were collected using the auger sampler at 0-15, 15-30, and 30-45cm depths respectively 10 meters apart from each plantation. Several samples were collected and mixed for each soil depth level to obtain composite samples. 15 composite samples from the each farm were used. The samples were air-dried and passed through a 2mm mesh sieve before

Table 1: Physical and chemical properities of soil at kola plantation in Agoro (Odogbolu Iga)

SOIL DEPTHS	H	Sand	Clay	Silt	Textural Class	pH	Org C	Total N	Avail P	K	Ca	Mg	Na	Mn	Fe	
Cm		%	%	%			%	%	Mg/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	Mg/kg	Mg/kg	c
A																
0-15		78.24	13.76	8	Sandy Clay	4.95	1.08	0.09	10.49	0.09	1.05	0.05	0.25	72.6	17.18	
15-30		72.8	18.48	8.72	Sandy Clay	5.22	0.69	0.06	8.13	0.09	0.66	0.04	0.25	35	13.83	
30-45		68.8	20.48	10.72	Sandy Clay	5	0.65	0.06	11.03	0.09	0.65	0.05	0.32	30.3	11.38	
Mean		73.28	17.57	9.15	Sandy Clay	5.06	0.81	0.07	9.88	0.09	0.79	0.05	0.27	75.97	14.13	
B																
0-15		80.24	16.64	3.12	Sandy Clay	5.07	0.92	0.08	9.1	0.3	2.17	1.01	0.28	32.8	13.7	
15-30		70.24	20.64	9.12	Sandy Clay	5.4	0.5	0.04	10.52	0.13	0.72	0.05	0.25	25.5	11.19	
30-45		70.24	21.76	8	Sandy Clay	4.82	0.43	0.06	9.07	0.08	0.74	0.05	0.2	33.7	12.53	
Mean		73.57	19.68	6.75	Sandy Clay	5.9	0.62	0.06	9.53	0.17	1.21	0.37	0.24	30.67	12.43	
C Uncultivated Area																
0-15		78.8	13.2	8	Sandy Clay	5.58	1.30	0.12	21.97	0.11	1.97	0.05	0.35	74.2	12.97	
15-30		80.24	11.76	8	Sandy Clay	5.95	0.50	0.04	7.51	0.04	0.88	0.05	0.2	28.7	11.67	
30-45		70.8	22.48	6.72	Sandy Clay	5.97	0.36	0.03	17.46	0.11	1.26	0.05	0.35	19.9	11.33	
Mean		76.61	15.81	7.57	Sandy Clay	5.83	0.7	0.06	13.98	0.09	1.37	0.05	0.3	40.93	11.99	

mechanical and chemical analysis. The values obtained are average values.

The soil textural class was determined by the hydrometer method (Bouyoucos, 1951) using hexametaphosphate as the dispersing agent. Soil pH was determined in soil/water ratio of 1:2.5 using a glass electrode pH meter, total Nitrogen was determined by the kjeldahl method while available P, was determined using the Bray No. 1 method (Bray and Kultz, 1945). The exchangeable cations were extracted with neutral IN NH_4OAC and K, Mg and Ca contents were determined using atomic absorption spectrophotometry. The Walkley and Black method was used for the determination of carbon contents (Walkley and Black, 1934) while exchangeable acidity was determined by extraction with 0.05 IN KCl and titration with 0.05N NaOH using phenolphthalein as indicator (McClean, 1965). Effective cation exchange capacity (ECEC) was obtained by the base saturation

Exchangeable B
ECEC

RESULTS AND

The results are
B are duplicate

Table 2: Physical and chemical properities of soil at kola plantation in Mamu)Ijebu-North lga)

Soil depth S	H	Sand	Clay	Silt	Textural Class	pH	Org C	Total N	Avail P	K	Ca	Mg	Na	Mn	Fe
		%	%	%			%	%	Mg/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kG	Mg/kg	Mg/kg
A (cm)															
0-15		58.8	22.48	18.72	Sandy loamy	6.28	0.68	0.07	1.44	0.23	1.44	0.05	0.55	55.7	15.35
15-30		46.24	39.76	14	loamy Clay	5.61	0.44	0.04	9.32	0.13	0.97	0.05	0.3	18.2	11.16
30-45		44.8	45.2	10	loamy Clay	5.4	0.51	0.04	7.64	0.11	1.18	0.05	0.37	18.1	11.55
Mean		49.95	35.81	14.24		5.76	0.6	0.05	6.13	0.16	1.19	0.05	0.4	30.67	12.69
B (cm)															
0-15		66.8	18.48	14.72	Sandy Clay	5.45	1.29	0.11	7.45	0.15	1.65	0.05	0.37	50.3	17.83
15-30		54.8	30.48	14.72	Sandy loamy	5.56	0.58	0.05	7.18	0.15	1.13	0.05	0.37	10.8	13.79
30-45		50.8	34.48	14.72	Sandy loamy	4.92	0.51	0.04	6.15	0.15	0.96	0.05	0.37	4.6	12.33
Mean		57.47	27.81	14.72		5.31	0.79	0.07	6.93	0.15	1.25	0.05	0.37	21.9	14.64
C- Uncultivated Area (cm)															
0-15		62.8	19.2	18	Sandy Clay	6.4	3	0.26	6.79	0.25	8.42	0.05	0.75	8.47	17.25
15-30		56.8	25.2	18	Sandy loamy	5.78	1.65	0.14	7.53	0.44	4.32	0.05	0.72	6.63	16.31
30-45		44.8	34.88	16.72	Sandy loamy	5.97	0.39	0.08	8.84	0.42	2.87	0.05	0.82	4.25	11.78
Mean		58.13	26.43	17.57		6.03	1.68	0.16	7.72	0.37	2.51	0.05	0.76	6.49	15.11

while U represents composite samples from soils nearby not presently used for kola cultivation (control).

AGORO (ODOGBOLU LGA)

The results are presented in Table 1. The textural class is predominantly sandy clay. The soils where kola is cultivated are more acidic when compared to un-cultivated soils (control). There is also a decrease in available P, Ca, Na, AI and base saturation percentage which might imply usage by kola trees for fruit production while there is no significant difference in total N percent, K, Mg and exchangeable acidity (EA). There is also a significant in cultivated soils c

MAMU (IJEBU-

Results obtaine

Table 3: Physical and chemical properties soil at kola plantation in Sapala Makinde (Owode/Obafemi lga)

Soil depth S	H	Sand	Clay	Silt	Textural Class	pH	Org C	Total N	Avail P	K	Ca	Mg	Na	Mn	Fe
Cm		%	%	%			%	%	Mg/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	Mg/kg	Mg/kg
A															
0-15		54.8	30.48	14.72	Sandy loamy	5.4	1.15	0.1	9.86	0.21	1.61	0.05	0.35	102.9	19.02
15-30		52.8	34.48	12.77	Sandy loamy	5.2	1.01	0.09	7.16	0.2	1.32	0.05	0.3	90.5	16.67
30-45		70.24	18.64	11.12	loamy Clay	5.18	0.94	0.08	11.06	0.19	1.43	0.05	0.4	83.3	16.61
Mean		59.28	27.87	12.87		5.26	1.03	0.09	10.03	0.2	1.46	0.05	0.35	92.23	17.43
B															
0-15		64.24	21.26	14	Sandy loamy	5.37	1.59	0.34	11	0.36	2.38	0.05	0.3	98.2	18.11
15-30		56.8	31.2	10	Sandy loamy	5.2	0.86	0.07	19.64	0.22	3.4	0.05	0.5	78.6	14.85
30-45		52.24	42.66	5.12	Sandy loamy	5.03	0.72	0.06	11.93	0.09	1.47	0.05	0.2	66.9	14.88
Mean		57.76	32.53	9.71		5.2	1.06	0.09	13.88	0.16	1.42	0.05	0.33	81.23	15.95
C- Uncultivated Area															
0-15		60.24	21.26	18	Sandy loamy	7.3	2	0.15	10.6	0.39	12.26	0.05	0.87	107.4	21.71
15-30		58.24	29.76	12	Sandy loamy	7.4	1.01	0.09	8.51	0.22	4.44	0.05	0.57	69.4	20.8
30-45		56.24	29.76	14	Sandy loamy	6.38	0.86	0.1	7.27	0.28	3.83	0.05	0.57	77.4	20.98
Mean		54.24	27.09	14.67		7.03	1.22	0.11	8.79	9.30	0.84	0.05	0.67	84.73	21.16

The soil textural class is mainly sandy loamy and loam clay There appears to be a depletion of the amount of organic carbon, available P, Ca Na, Fe and ECEC which could imply their consumption during the production of kola. However, there is also an increase in the amounts of Mn and Al and a negligible difference in the values for pH, total N, K and EA when compared to virgin areas. The results indicate minimal utilization of these the essential minerals for growth of kola in Mamu.

SAPALA-MAKINDE (OWODE/OBAFEMI LGA)

The soil texturally is mainly sandy loamy. Cultivation of kola led to an increase in acidity (pH) and reduction in amounts of K, Ca, Na, Fe and ECEC. There are however, no significant differences in organic carbon, total N, Mg, EA and base saturation as well as an increase in available P. The results for this study are presented in Table 3.

IGBEPA (SAGA

Soil textural cla decrease in orga and ECEC indic production while and Al in soil production. The in acidity, mg, percent. The res

Table 4: Physical and chemical properties soil at kola plantation in Igbepa (Sagamu Iga)

Soil depth S	H	Sand	Clay	Silt	Textural Class	pH	Org C	Total N	Avail P	K	Ca	Mg	Na	Mn	Fe
Cm		%	%	%			%	%	Mg/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	Mg/kg	Mg/kg
A															
0-15		67.55	19.2	13.28	Sandy Clay	6.43	2.48	0.22	7.88	0.5	7.03	0.05	1	94.5	19.35
15-30		67.55	31.2	12.8	Sandy Loamy	6.45	2.06	0.19	12.54	0.47	6.46	0.05	1.04	61.7	25.21
30-45		67.52	28.2	9.28	Sandy Loamy	6.88	1.59	0.14	10.92	0.39	7.91	0.05	0.55	55.6	25.67
Mean		67.54	24.53	11.79		6.59	2.04	0.18	10.58	0.44	7.13	0.05	0.86	70.6	23.33
B															
0-15		69.52	23.24	7.28	Sandy Loamy	6.51	2.48	0.22	12.08	0.44	3.23	0.05	0.75	79.8	21.24
15-30		69.52	27.2	7028	Sandy Loamy	6.08	2.49	0.33	9.64	0.38	4.37	0.05	0.7	65.8	23.37
30-45		69.52	29.2	9.29	Sandy Loamy	6	2.06	0.19	10.74	0.37	4.53	0.05	0.62	33	25.55
Mean		61.52	26..55	6.61		6.2	2.34	0.21	10.92	0.4	4.81	0.05	0.69	59.4	23.53
C- Uncultivated Area															
0-15		65.52	22.2	18.28	Sandy Loamy	6.56	3.72	0.41	11.09	0.24	9.93	0.05	0.57	91.7	23.64
15-30		53.52	39.2	19.28	Sandy Loamy	6.16	6.35	0.72	8.76	0.24	12.67	0.05	0.67	81.6	34.95
30-45		37.52	49.2	13.28	Sandy Clay	6	2.78	0.23	8.68	0.28	7.3	0.05	0.8	36.7	32.35
Mean		50.19	33.53	16.95		6.24	4.28	0.46	9.51	0.25	9.96	0.05	0.68	70	30.13

IKENNE (IKENNE LGA)

The soil textural class is sandy loamy from the results as presented in Table 5. There is a decrease in available P and Fe indicating usage for kola production but no significant differences on total N percent, K, Mg, Na, EA and base saturation percent compared with uncultivated areas. The soil at this location was found to be most acidic.

It can be summarized from the findings that the prevalent textural soil for kola plantation in Ogun state is sandy loamy. It can also be seen that cultivation of kolanut takes place in acidic soils and leads to a further decrease in pH (increased acidity) with continuous cultivation although Ikenne could be considered an exception. The results indicate that for most plantations apart from Ikenne (the most acidic location), Potassium (K), Calcium (Ca), Sodium (Na), Aluminum (Al), Organic Carbon (Org. C), Phosphorus (P) and Iron (Fe) are utilized for the growth of kola. The critical value for soil organic content is 1.05% and the values obtained for the entire plantation apart from Agoro are above the critical level. This can be remedied by practices like surface mulching and/or application of organic fertilizers as required.The major source for soil organic carbon is leaf litter mineralization. Total nitrogen, (N) percent has a critical value of 0.1% and all the plantations have soils that have nitrogen contents above this value except for Agoro. However, most of the soils apart from those of Igbepa and Ikenne have values below the critical level post kola cultivation. There is thus a need to replenish the total N concentration between cycles of cultivation in the affected showed phosph of 3.7 mg/kg ev however, a red obtained in th reduction for k attributed to P-s their clay conten monitored for n not fall below th production. The Mamu, Sapara above the critic cultivated and plantations whil were found to h thus requiring f productivity.

Table 5: Physical and chemical properties of soil at kola plantation in (Ikenne I.G.A.)

SOIL DEPTHS	H	Sand	Clay	Silt	Textural Class	pH	Org C	Total N	Avail P	K	Ca	Mg	Na	Mn	Fe
Cm		%	%	%			%	%	Mg/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	Mg/kg	Mg/kg
A															
0-15		69.52	22.2	8.28	Sandy Loamy	5.68	1.94	0.21	11.47	0.008	2.25	0.04	0.25	43.8	12.05
15-30		57.52	33.2	9.28	Sandy Loamy	5.14	1.48	0.12	9.37	0.08	1.46	0.05	0.17	49.7	12.36
30-45		49.52	47.2	3.28	Sandy Clay	5	1.12	0.11	9.14	0.08	1.35	0.05	0.1	13.4	0.85
Mean		58.85	24.2	6.99		5.27	1.5	0.11	10.06	0.08	1.69	0.05	0.17	32.63	11.41
B															
0-15		74.1	22.54	3.36	Sandy Loamy	5.73	2.32	0.18	8.2	0.09	1.84	0.05	0.3	76.2	9.44
15-30		73.52	23.2	3.28	Sandy Loamy	5.51	1.35	0.14	10.43	0.07	2.04	0.05	0.17	65.5	12.54
30-45		61.52	37.2	1.28	Sandy Loamy	5.38	1.38	0.11	8.15	0.08	1.78	0.05	0.17	14.9	11.38
Mean		69.71	27.63	2.64		5.55	1.62	0.15	8.93	0.08	2.22	0.05	0.21	52.37	11.12
C- Uncultivated Area															
0-15		75.52	23.2	1.28	Sandy Loamy	5.54	1.56	0.14	8.07	0.08	1.43	0.05	0.25	59.3	12.99
15-30		75.52	25.2	1.28	Sandy Loamy	4.97	1.43	0.15	8.02	0.09	1.21	0.05	0.15	49.5	9.95
30-45		63.52	27.2	9.28	Sandy Loamy	5.37	1.22	0.11	15.14	0.09	1.39	0.05	0.15	35.5	12.47
Mean		70.19	25.2	4.61		5.29	1.4	0.13	10.47	0.09	1.48	0.05	0.18	48.1	11.83

The calcium contents of the soils in the five studied locations are above the critical level of 0.1cmol/kg hence there would be no need to supplement this mineral.The magnesium contents for the soils in all the plantations were below the critical value for growth of kola (0.08cmol/kg) except in Agoro where one of the cultivated portions had a value of 0.3cmol/kg.

This may be a direct consequence of the high sand content of the studied soils. While sodium in the kola plantation soils have average values of 0.27cmol/kg, 0.24cmol/kg in sections A and B under kola plantation, the sodium content of the uncultivated portion has a value of 0.30cmol/kg. This implied that there is not much depletion of Na due to cultivation of kola and might signify its non-essential nature for kola growth. This is consistent with the observation of Ayodele (1988) in kola production farms. The principles of crop rotation would help in enhancing better yields of the crop.

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Table 6: A summary of the effects of kola production on soils in the five locations are presented in

Location	Textural class	Acidity	Minerals reduced	Minerals with no significant effect	Minerals Increased by kola cultivation
Agoro	Sandy Clay	U=5. 83, A = 5.06, B= 5.09	P, Ca, Na, Al	N, K, Mg	Fe
Mamu	Sandy loamy/ loamy Clay	U= 5.63, A= 5.76, B= 5.31	Org. C, P, Ca, Na, Fe	N, K	Mn, Al
Sapala-Makinde	Sandy loamy	U=7.03, A= 5.26, B –=5.20	K, Ca, Na, Fe	Org, C, N, Mg,	P
Igbepa	Sandy loamy	U=6.24, A= 6.59, B= 5/29	Org. C. N, Ca, Fe	Mg, Na, Mn	Al
Ikenne	Sandy loamy	U= 5.5.29, A= 5/27, B=5.55	P, Fe	N,Mg, Ba	

This would help in achieving effective land conservation whose primary aim is the appropriate allocation of land to uses for which they are most suitable.

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