Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 77 (2014) 29037-29040

ISSN: 2229-712X

Properties of soils developed on charnockite in ekiti state, Nigeria

Shittu,O.S

Department of Crop, Soil and Environmental Sciences, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, Nigeria.

ARTICLE INFO

Article history:
Received: 16 October 2014;
Received in revised form:
25 November 2014;
Accepted: 4 December 2014;

Keywords
Properties,
Charnockite,
Ekiti.

ABSTRACT

Soil samples were collected from charnockitic soils of Ekiti state, Nigeria by random sampling using the soil map of Ekiti state as a guide. Surface samples and sub surface samples were dug covering about 100ha. The soils were sandy to loamy sand on the surface to sandy clay in the sub-soil. All the pedons, show consistently increasing clay with depth, pointing to argillic horizon development. Chemical analysis shows that the soil are characterized by high base saturation (>35% by NH_4 OAc). The CEC, organic carbon, available phosphorus (Bray1) and total nitrogen were generally low. Most of the nutrient elements decreased with increase in depth.

Introduction

Charnockites are found on every continent, Ekiti State may provide one of the world's best and accessible region for their study. Charnockite occur in Africa at locations which include Ekiti state of Nigeria. This rock is formed in the following local government areas (LGAs) of Ekiti state: Ado-Ekiti, Ekiti East comprising Omuo, Ilasa, Gboyin in areas around Ode, Ijan, Aisegba, Imesi Agbado,ilumoba, Egbe, Ikere, and Ikole comprising Ayedun, Ipao, Irele, Ijesa-isu, Ayebode Ekiti (Ekiti Investors Handbook, 2002). These charnockitic soils are of considerable value to the agricultural economy of the state in particular and Nigeria at large. Management of soils physical properties is usually of lower priority than the management of chemical properties in traditional agricultural systems. It is also highly soil specific (Sanchez, 1978).

Because of highly weathered minerals or sandy texture of soils derived from charnockite in Ekiti State, most of these soils commonly have effective cation exchange capacity (ECEC) of lower than 4. For such soils, increasing CEC is an important management goal. Organic matter contributes the bulk of the exchange sites in many highly weathered soils. The maintenance of organic matter in such soil is the principal way to keep CEC values within reasonable levels (Chapman, 1965).

The contents of nutrients in these charnockitic soils, however, need to be documented for proper planning of agricultural activities and land use. There is specifically, no quantitative data about the content and distribution of nutrients in soils developed over Charnockite in Ekiti state. Thus, the scope of this study is to provide the benchmark data on physical and chemical properties of Chemical properties of Charnockitic soils of Ekiti State.

Materials And Methods

The study was conducted in areas where Charnockite are found in Ekiti State.Six (6) of these areas chosen as study sites for this work include, Ado.Ikere, Ijesa-Isu, Ire and Itapa. The coordinates are as follows: Ado latitudes 7^o 31'N and 7^{o}49'N and longitudes 5^{o}7' and 5'27'E, Ikere latitudes 7^o 29 and 7^{o}47N and longitude 5^{0}13' and 5^{o}23'E, 1jan latitude 7^{o}38'N and longitude 5^{o}23E ijesa-iju latitude 7o45N and longitude 5^{o}35E and Osin-Itapa latitude 7^{o}5^{o}N and longitude 5^{o}26'E .

The soils used in this investigation were sampled from the 6 locations, with the aid of shovel, soil auger and hand trowel. Profile pit of in diameters each were dug at Ado, Ikere, Ijan, Osin-Itapa, Ijesa-Ilu and Ire Ekiti, the study areas, to depth ranging from 1.5-2.0m below ground surface. Each horizon was sampled with a hand trowel, described, using the criteria of the soil survey manual of soil survey staff (2003) and the guidelines for soil profile description (FAO, 1990). Sample from the diagnostic horizon in each profile were taken air dried, gently ground and sieved for laboratory analysis. Particle size distribution was done for textural class using hydrometer method while soil P^H was determined using electronic digital PH meter, organic carbon content was determined using dichromate procedure (Walkey and Black, 1934) and extractable cautions were extracted with one normal neutral ammonium acetate (Chapman, 1965). The calcium, magnesium and potassium on atomic absorption spectro photometer. Total nitrogen was determined using Kjedahl method and available phosphorous by vanadate molybdate method. Organic matter was obtained by multiplying the organic carbon by the factor 1· 72.

Results

The soils are all generally sandy in texture (Table 1), ranging from sand to loamy sand, the finer textures are in argillic horizons (Bt) of Ado and Ijesa-Isu pedons. The general particles are mainly hardened Fe/Mn nodules in all the sub-surface horizons of all profiles except Ijesa-Isu. Sand is the dominant fine earth fraction (less than 2mm portion) Table 2. the silt content in all the profiles increases down the profile having a range between 3 to 10%. The clay content increases down the profile with a range between 7 to 33.76%. sand is very high in all the soils and decreases with depth. The gravel content ranges from 9.00 to 65.80% but follows no regular pattern. The depth with highest gravel content varied among the profiles the gravely horizons appear not to constitute to root proliferation, since root are found beyond them.

Data on soil chemicals properties presented in (Tablel2) The soil P^H (in H_{20}) range from 5.10 to 7.30 and so indicating strongly acid to alkaline reaction with highest values associated with surface horizons. The values were irregular down this profile except at Ikere and Ijesa-Isu pedons where it decreased down the profile. Exchangeable acidity ranges from 0.04 to 1.00 Cmol/kg and generally increases with depth. It ranges from 0.04 Cmol/kg in the surface horizon to 1.00 Cmol/kg in the sub-surface in line with decreasing PH values.

Calcium is the most prevalent caution with values ranging from 1.40 to 9.40 Cmol/kg soil and so rated as moderately high (2-5 Cmol/kg Soil) in the Ire,Ijesa-Isu and Ijan soils, and moderate to very high (2- >5 Cmol/kg)in the Ikere, Itapa- Osin and Ado soils where it increases down the profile except at Ado.

Exchangeable Mg varies from 1.00 to 3.80 Cmol/kg soil. The values are rated as moderately high to very high in all the soils. The values are very low in the surficial horizon except at Ire.

Exchangeable K ranged from 0.04 to 0.74 Cmol/kg soil,in the soils. The values are rated (Hill, 1978) as low (<0.10 Cmol/kg) to high values (0.1-70.15 Cmol/kg).

Exchangeable Na values fall within the low range

The cation exchange capability (CEC) values are low (<8 Cmol/kg) in the surface horizons except at Ijapa-Osin the CEC values follows no definite trend down the profiles base saturation (By NH_4OAc method) is high, ranging from 73.38% to 93.03% in all the soils.

The organic carbon content decrease with profile depth from 3.91% in the surface horizon to 0.99% in the sub surface. Correspondingly, the percentage total N decreases from 0.21% to 0.04%.

The values of organic carbon (C), in the soils are very low, being below 5%in all the soils. The organic carbon content was highest in the surficial horizon and decreases down the profile. The organic matter content is high in Ire, Itapa-Osin, Ikere and Ado Soils (>5%) except at Ijesa-Isu and Ijan. The organic matter content was also high in the surficial horizon and decreases down the profile in all the locations.

The Nitrogen content (N) of the surface horizon of some of the soils are very low (<0.1%) except Itapa-Osin and Ado-Ekiti having 0.11% and 0.21% N respectively. The N content follows no particular trend in all profiles. The phosphorus (P) content of the soil are also critically low with values below 1.0 Mg/kg soil respectively except Ire and Isan surface soils having P content above1.0Mg/kg soil. In nearly all the soils the P-values decrease down the profiles.

Discussion

The high sand (an average of 70%) content of the soils is largely a reflection of the parent materials from which the soils are formed. Fe/Mn occurs in most of the profiles except Ijesa-Isu. This perhaps is an ion indication of alternating wet and dry cycles; this might infer that plinthization may be another pedogenic process responsible for soil development on chamockite.

The predominance of sand in the surface is attributed to preferential removal of clay and silt by erosion (Ojanuga, 1971) and the influence of the of the parent material (Greenland, 1971). The proportion of sand indicates that these soils are characterised by high in infiltration rate and low water holding capacity and the ground water supply may no longer be recharged especially in the dry season (Fagbami and Udo 1982, stop 1989).

The P^H of the soils fall between 5.60-7.50 and 5.60 and 7.0. (P^H H_20 and Kcl) and these values fluctuated irregularly down the profile in all the pedons. The soils are very strongly acidic profiles (Ado and Ijesa-Isu) and neutral or alkaline (Iyan, Itapa-Osin and Ikere). The high P^H (>7.0) observed on soils of profile Ijan, Itapa-Osin and Ikere might be due to the liming effect of bush burning. For example of Ire, Ado and Ijesa-Isu, the acidic P^H must be due to the affects of the cultivation, erosion and leaching of nutrients down the profile. The PH of most of the soils decreased irregularly with depth. These decreases PH values with profile depth could be due to the effect of nutrient bio cycling (Ogunwale et al., 2002) nearly all the locations.

The organic carbon content was highest in the sacrificial horizons and decreases down the profile. This is an indication of continuous deposition of organic materials. Generally organic carbon ranged between 1.15 and 3.91%in all the pedons. The low organic value may be as a result of faster rate of mineralization due to intense cultivation and seasonal burning that characterised the derived savannah belt. Cultivation is know to favour rapid mineralization (Agboola and Corey, 1973; Brady 1984).

The silt in all the soils ranged from 4.00 to 10.00%. this content agrees with those soils from most other sandy soils of the South Western Nigerian Characterised by low silt (<10%-15% content) Fasina 2001, 2003, Shittu and Fasina, 2004)

The depth of gravel content varied widely for all the profiles with values rsanging from 9.00 to65.80%. the general content observed is a common feature of those soils formed in the upland portion of landscape derived from granitic, metamorphic rocks of central South Western Nigeria (Okusami and Oyediran, 1985 Smyth and Montgomery, 1962).

The total N ranged from 0.04-0.21%. The total N values can be considered low to medium when composed to the critical value of plant nutrient for N (0.20%). The intense of cultivation of the soils can increase the rate of mineralization of organic matter and this affects the level of total N content in the soil and while burning which is a feature of slash and burn agriculture also leads to utilization and escape of N from the soil. The values obtained in chamockite soils is in agreement with values recorded for Nigerian soils (Ogunwale and Ashaye, 1975, Fashina 2005) The values are low and the inadequacy would need to be taken into consideration in managing these soils.

Available P is low and fluctuated irregularly with soil depth in all the pedons. Total N in the surface horizon is <0.1%, this is regarded as low as being recommended by Adepetu (1956) for south western Nigerian soils. The available P critical status for South Western Nigeria soils is between 8-20mg/kg. the N and P are low in all the pedons indicating serious deficiency problems especially at the surface horizons. N and P deficiencies have been established as characteristics of soils in the derived savannah and guinea savannah zones of Nigeria (FMANR, 1990).

The organic matter content for all the soils are generally high at the surface (top soil). This is expected as the main land use in the area usually involves bush fallowing.

Exchangeable Ca is the most prevalent cation on the exchange complex with values ranging from1.40 Cmol/kg-9.40 Cmol/kg soil. This is followed by Mg having between 0.20 Cmol/kg and 3.80 Cmol/kg soil. Similar findings were reported by Fagbami and Akamigbo (1986).in the soil of lower Benue valley.

Exchangeable K and Na contents are generally low to medium in all the profiles 0.04-0.74 Cmol/kg and 0.05 Cmol/kg-0.29 Cmol/kg respectively. Exchangeable Na content less than 0.03 Cmol/kg is rated low. The low Na and K content in the soil might be attribute to the nature of the parent material and intensity of leaching caused by heavy rainfall.

The low ECEC reflect the intensity weathered nature of the soils. The ECEC value obtained are similar to those obtained by Okusami (1990) and Fasina and Ogunkunle (1995).

Physical Properties of Soil Developed on Charnockite in Ekiti State

Depth (cm)	Gravel	Sand	Silt	Clay	Silt/Clay	Textural class
			Ado (Pedon A)			
0-11	62.40	83.24	9.00	7.78	1.16	Loamy Sand
12-21	62.80	78.24	6.00	15.76	0.38	Sandy Loam
22-61	37.20	64.24	6.00	29.76	0.20	Sandy clay loam
62-118	38.00	62.24	5.00	32.76	0.15	Sandy clay loam
119-150	65.80	62.24	4.00	33.76	0.17	Sandy clay loam
			Ijesa-Isu (Pedon B)			
0-20	9.00	87.24	5.00	7.78	0.60	Loamy sand
21-32	14.40	82.24	5.00	12.76	0.39	Loamy sand
33-110	22.00	77.24	4.00	18.76	0.21	Sandy loam
111-150	15.40	74.24	4.00	21.76	0.81	Sandy clay loam
			Ijan (Pedon C)			
0-20	15.40	89.24	5.00	5.76	0.87	Sand
21-35	35.60	86.24	4.00	6.76	0.59	Loamy sand
36-60	45.60	84.24	4.00	13.76	0.29	Sandy loam
61-90	63.40	76.24	3.00	17.76	0.17	Sandy loam
91-120	55.20	76.24	3.00	17.76	0.17	Sandy loam
			Itapa-Osin (Pedon D)			
0-23	44.60	84.24	5.00	6.76	0.74	Sand
24-50	26.60	81.24	5.00	13.76	0.36	Loamy Sand
51-80	48.00	72.21	7.00	20.76	0.34	Sandy loam
81-130	48.00	72.24	6.00	21.76	0.28	Sandy loam
			Ire (Pedon E)			
0-20	25.00	81.24	9.00	9.76	0.90	Loamy sand
21-43	60.20	76.24	7.00	16.76	0.42	Sandy loam
44-70	44.80	76.24	7.00	16.76	0.42	Sandy loam
71-120	52.80	72.24	6.00	21.76	0.28	Sandy loam
			Ikere (Pedon F)			
0-23	24.00	83.24	10.00	6.76	1.50	Sand
24-64	34.00	78.24	10.00	11.76	0.85	Loamy Sand
65-92	57.00	74.24	7.00	18.76	0.37	Sandy loam
93-140	38.00	71.24	8.00	22.76	0.35	Sandy loam

Chemical properties of soils developed from Charnockite in Ekiti state

Horizon	Depth (cm)	pH (H_2O)	pH (KCl)	OM (%)	Total N (%)	Avail. P	Organ C (%)	Base Sat.(%)	Ca	Mg	K	Na	Ex Acidity	CEC	ECEC
										cmol kg^{-1}					
							Ire								
Ap	0-20	5.60	5.40	5.86	0.05	1.11	3.39	99.03	2.20	1.60	0.14	0.13	0.04	6.53	4.11
Bt_1	21-43	5.60	5.20	5.04	0.04	0.92	2.91	97.77	3.80	1.20	0.12	0.15	0.12	8.80	5.39
Bt_2	44-70	5.70	5.00	3.59	0.06	0.09	2.07	94.09	3.00	3.80	0.08	0.13	0.44	9.30	7.45
C	71-120	5.70	5.00	2.89	0.06	0.03	1.66	89.66	2.80	2.20	0.04	0.16	0.60	6.28	5.80
							Itapa-Osin								
Ap	0-23	7.30	6.70	6.76	0.11	0.05	3.91	97.64	5.60	2.40	0.10	0.16	0.20	9.26	8.46
Bt_1	24-50	6.90	6.40	3.93	0.06	0.25	2.27	98.08	5.80	3.40	0.74	0.29	0.20	12.78	10.43
Bt_2	51-80	7.10	6.30	3.65	0.07	0.13	2.11	97.97	9.40	3.60	0.25	0.24	0.28	14.30	13.77
C	81-130	7.10	6.40	3.17	0.04	0.05	1.83	97.16	5.60	3.00	0.64	0.13	0.48	10.85	9.85
							Ikere								
Ap	0-23	7.00	5.60	5.04	0.04	0.27	2.91	90.41	2.60	0.20	0.23	0.12	0.44	6.42	4.59
Bt_1	24-64	6.80	5.40	2.89	0.05	0.20	1.67	93.69	3.20	3.60	0.10	0.23	0.48	8.85	7.61
Bt_2	65-92	6.40	5.20	2.06	0.04	0.18	1.19	91.56	3.60	2.60	0.18	0.13	0.60	7.84	7.11
C	93-140	6.10	5.20	2.00	0.05	0.15	1.15	92.47	5.80	2.20	0.20	0.15	0.68	10.32	9.03
							Ado								
Ap	0-11	6.30	5.60	6.48	0.21	0.06	3.75	98.39	3.60	1.00	0.14	0.14	0.08	6.21	4.96
Bt_1	12-21	5.90	5.30	5.17	0.07	0.10	2.99	94.98	3.40	1.00	0.05	0.09	0.24	8.75	4.78
Bt_2	22-61	6.10	5.20	2.88	0.04	0.11	1.67	86.33	6.40	3.60	0.21	0.11	0.48	12.10	10.80
Bt_3	2-118	5.70	5.20	2.54	0.04	0.15	1.47	86.33	3.60	2.00	0.11	0.10	0.92	7.32	6.73
C	119-150	5.70	5.00	1.72	0.06	0.31	0.99	79.38	2.20	1.00	0.55	0.10	1.00	5.38	4.85
							Ijesa-Isu								
Ap	0-20	6.30	6.00	4.48	0.07	0.58	2.59	95.62	1.40	1.00	0.14	0.08	0.12	6.11	2.74
Bt_1	21-32	6.20	6.00	3.93	0.06	0.30	2.27	96.60	3.60	1.80	0.19	0.10	0.20	6.55	5.89
Bt_2	33-110	6.00	5.80	3.79	0.04	0.50	2.19	94.49	3.20	2.80	0.09	0.08	0.36	6.98	6.53
C	111-150	6.00	5.70	2.69	0.04	0.11	1.55	94.23	3.80	1.80	0.12	0.08	0.44	7.28	6.24
							Ijan								
Ap	0-20	7.50	7.00	4.00	0.08	1.36	2.31	97.63	2.00	1.00	0.20	0.10	0.08	5.67	3.38
Bt_1	21-35	7.30	6.70	3.79	0.07	0.57	2.19	95.43	2.60	1.40	0.09	0.09	0.20	5.65	4.38
Bt_2	36-60	7.30	6.50	3.17	0.05	2.55	1.83	93.03	4.10	1.50	0.22	0.05	0.44	7.32	6.31
Bt_3	61-90	7.40	6.50	3.09	0.04	0.34	1.79	93.04	5.00	2.40	0.13	0.07	0.24	8.28	7.84
C	91-120	7.40	6.10	2.83	0.13	0.15	1.63	97.68	3.80	1.80	0.21	0.08	0.14	9.09	6.03

The low ECEC value indicate that the soils have low potentials for retaining plant nutrients, hence the necessity for adequate management. The ECEC indicate low activity clay characteristic of kaolinite (Lal and Stewart, 1990). The percentage base saturation values are high ranging from 86.33% to 99.03%. Those values generally decrease with depth. This could also be attributed to the effect of nutrient bicycling.

Conclusion and recommendation

The findings have shown that chamockitic soils of Ekiti state are very deep (at least 120cm). They are acid to alkaline, and are moderately high in exchangeable bases but low in CEC (<8 Cmol/kg) in the surface horizon and cannot sustain continuous cropping. It is therefore imperative to adopt an affective organic matter management practise. This is important for the low CEC soils which have the most of the negative charges in the poorly aggregated sandy soils.

Finally, the soil properties also indicate that a systematic N fertilizer management practise will be necessary for optimum crop production.

References

Adepetu, J.A. (1986) Soil Fertility requirement in Oyo, Ogun and Ondo State (FDALR). Federal Ministry of Agriculture and Water Resources (publication) Lagos, 1986.

Agboola A.A and Corey, R.B (1973): Influence of soil organic matter on cowpea response to N fertilizer. Agronomy journal 70 (1): 25- 28.

Brandy, N.C (1984): Nature and properties of soils 7th edition Pg 680- 686.

Chapman, M.D (1965): Certain exchange capacity. In : C.A. Black (ed). Methods of soils analysis. Agron. Monograph 9:1324- 1341. Am. Soc. Agron. Madison, Wisconsin.

Ekiti Investors Handbook (2002): Raw materials Resources of Ekiti State on Local Govt. Pg 1-2.

Fagbami, A. Akamigbo. F.O.R (1986): Soils of Benue State and their capabilities. Proceedings of Nigeria held in Makurdi Pg 6-23

Fagbami, A and Udo. E.J (1982): Nutrition distribution in the basement complex soils of the tropical dry rainforest of South Western Nigeria 2. Macronutrient – Zinc and Copper Soil Science: 139:531-537

FAO (1990) Guidelines for Soil Science profile description FAO, Rome Pg 23

Fasina, A.S (2001): Physical properties of soils of Lagos in Relation to Land use. Annals of Agricultural Science (2): Pg 1-8

Fasina, A.S (2002): An evaluation of the Predictive Power of a soil Map from Western Nigeria Journal of Sustainable Agriculture and the Enviroment 3 (2): 342-347

Fasina,A.S (2005): Influence of land use on the variability of Top Soil properties of an Alfisol in Southern Nigeria. Journal of Agriculture Research and Development 4:1-10

Greenland, D.J. (1975): Characterization of soil and relation to their Classification and Management Clarendon Press, Oxford

Hiller, R.M, Hale,J.B, and Hull R, (1978): Some causes of chlorosis and necrosis of sugar beet foliage. Annals of applied Biology 33: 13-28

Ogunwale, J.A, Olaniyan, J.O and Aduloju M.O. (2002): Morphological, Physico-Chemical and Clay Mineralogical properties of soils overlying basement complex rocks in Ilorin East, Nigeria. Moor Journal of Agricultural Research Vol 3: No2: 147- 154

Lalr, and Stewart B. A (1990) : Soil degradation: A global threat: Advances in Soil Science Vol 11:345pp.

Ogunwale, J. A and Ashaye, T.I (1975): Sandstone – derived soils of a Catena at Iperu, Nigeria. Journal of Soil Science 26(1): 22- 31

Okusami, T. A and Oyediran G. O. (1985): Slope- Soil. Relationships in an Aberrant Top sequences in Ife Area of South Western Nigeria Variabilities in soil properties. Ife Journal Agriculture 7: 1- 15

Sanchez, P. A. (1978): Properties and Management of soils in the Tropics, John and Sons New York 618 pp.

Shittu, O. S. and Fasina, A. S. (2004): Cassava Yield as affected by different Fertilizer Models at Ado- Ekiti. Nigerian Journal of Soil Science 14: 66- 73

Smuth, A. J and Montgomery, R. F. (1962): Soils and Land use in Central Western Nigeria Government printer, Ibadan 265pp

Soil Survey Staff (2003): Keys to Soil Taxonomy. USDA Soil Conservation Service, 6th Edition, 360 pp

Stoop B. (1989): Zinc absorption from composite meals. I the significance of wheat extraction rate, zinc, calcium and protein content nutrition 33: 739- 745

Walkey, A and C. A. Black (1934): An examination of degtjarell methods for determining soil organic matter and proposed modification of the chronic acid titration method soil science. 29: 38- 45.