HYDRO-PHYSICAL PROPERTIES AND MICRONUTRIENT STATUS OF MAYO-GWOI FLOODPLAIN SOILS, IN TARABA STATE, NIGERIA

Abstract

The aim of this research was to study the hydro-physical characteristics and the status of micronutrients in floodplain soils of Mayo-Gwoi in Taraba state, Nigeria. A detailed soil survey was conducted at the Mayo-Gwoi floodplain using rigid grid approach. Observations were made at 100m regular intervals. Two profile pits were dug and sampled from each of the three soil mapping units identified. The samples were analyzed and characterized as follows; texture vary from loamy to sandy clay loam, bulk density (1.30 g/cm^3), particle density (2.63 g/cm^3), water holding capacity (37.5%), water content at field capacity (36 %) and wilting point (24 %), zinc (1.0 Mg/Kg), iron (6.3 Mg/Kg), copper (0.5 Mg/Kg) and manganese (6.3 Mg/Kg). These soils showed some evidence of degradation and could be productive if subjected to appropriate management and maintenance.

Key words: Micronutrients, physical characteristics, Mayo-Gwoi floodplain soils, rigid grid

Introduction

Knowledge of soil physical and chemical properties are key to making agronomic and environmental decisions. However, the heterogeneous nature of these soil properties mainly due to changes in structural and chemical composition of soil minerals from microscale to global scale (Brady, 2006), makes this decision difficult. The dynamics of soil moisture including the water retention capacity and soil nutrient status determine to a large extent the soil productivity. According to Havlin (2003), micronutrients are as important in plant nutrition as macronutrients; though they simply occur in plants and soils in much lower concentrations. It has been observed that plants grown in micronutrient-deficient soils exhibit similar reductions in productivity as those grown in macronutrient-deficient soils. Micronutrients in soils exist in the form of elements in primary and secondary minerals; adsorbed to mineral and organic matter surfaces; incorporated in organic matter and microorganisms; incorporated into solution, depending on the source of the micronutrients.

Understanding the relationships and dynamics among these forms is essential for optimizing plant productivity in micronutrients deficient soils. The availability of micronutrients to plants is determined by both the total amount of the nutrient in the soil and the soil's properties. Other factors such as crop species and variety can also influence the degree to which micronutrient levels affect crop production.

The hydro-physical properties of soil including the soil moisture dynamics and water retention capacity are influenced by land use. Land use is defined by Vink (1975) as any kind of permanent or cyclic human intervention to satisfy human needs from a complex of natural and artificial resources which together constitute land. Therefore, at any given time, land use is resultant of interplay of available land resources with cultural, social and economic conditions of the past and present developments. According to Odingo (1991), land use in Africa is excessively influenced by the patterns of use which have been set by previous generations and administrations depending on the kind and level of technology available to them at the time. Ojanuga (1991) writes that land use pattern is an expression of the agricultural system, representing the interaction between the ecological and economic factors in which the vital link is the decision maker, namely, the farmer.

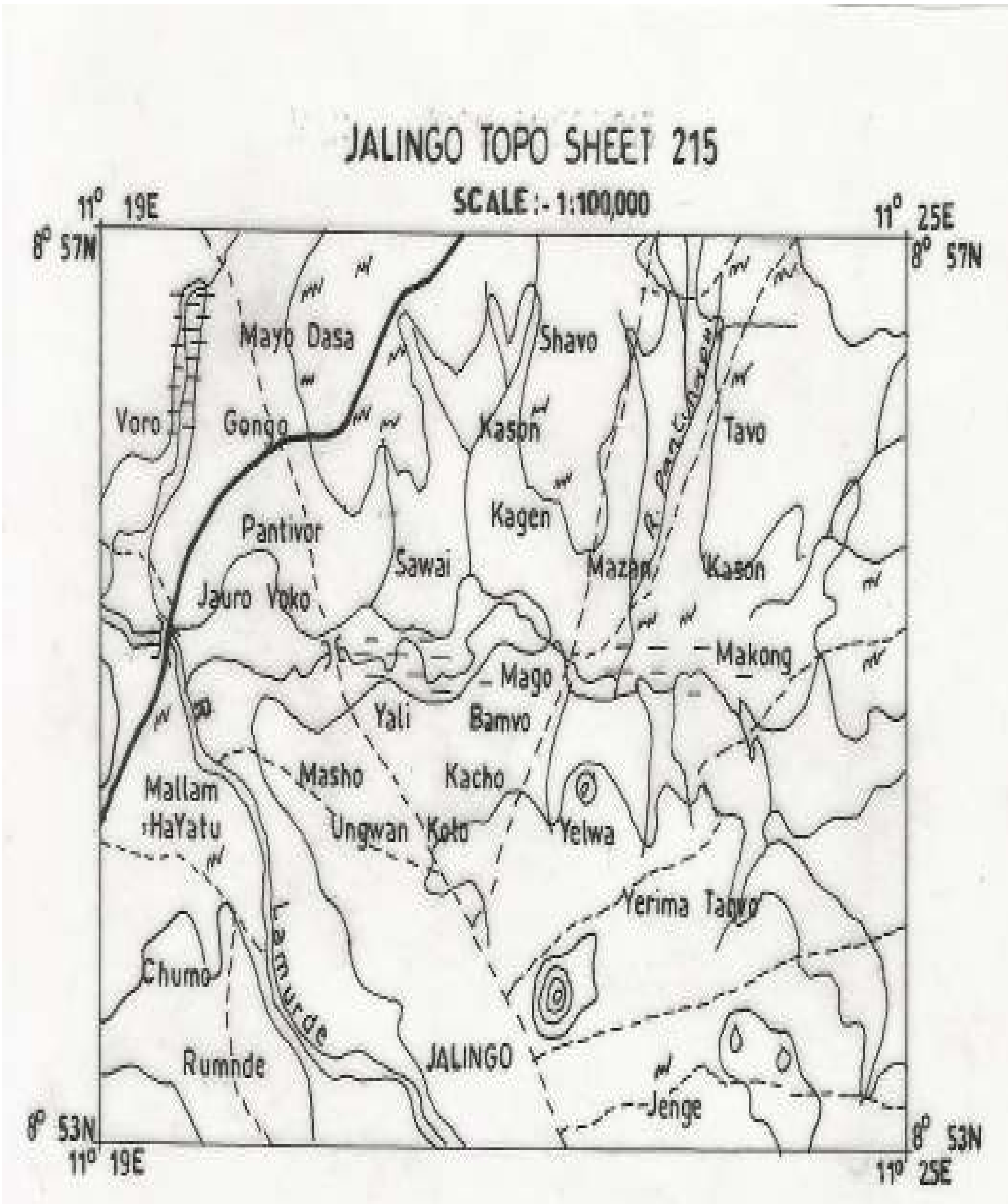
It is of concern that in spite of the increasing interest in fadama farming in Taraba State, there is no available literature on the hydro-physical properties and micronutrient levels of the floodplain soils. Thus, based on the realization that such information forms the background to an efficient and judicious use of the soil resources, the objective of this study was to study the hydro-physical properties and the status of micronutrients in the soils of Mayo-gwoi floodplain.

Materials and Methods

Description of the study area

The Mayo-Gwoi floodplain is located between latitudes 8^0 53' and 8^0 85' North and longitudes 11^0 23' and 11^0 75' East. It covers an area of about 120ha. It's located in Jalingo city, the capital of Taraba State. The geology of the area has been described by Bawden (1972) as a basement complex and the rocks are mainly pre-cambrian granitic and migmatite gneisses. Jalingo lies within the tropical hinterland climate region. The region is characterized by double maxima rainfall pattern which has about four months of dry season with relative humidity having generally over 80% in the morning and falls to between 50 and 79% in the afternoon. The dry and wet seasons are controlled by the annual migration of the intertropical zone of convergence (ITZC).The dry season is characterized by the dry dust, laden with harmattan winds coming across the Sahara desert and occurring between November and February of every year. The wet season sets in by April and lasts until October (Iloeje, 1981).

Fig. 1.



Sampling and Laboratory Analysis

Detailed soil survey was conducted at the Mayo-Gwoi floodplain soils which is the study site. A Rigid grid method was employed for surveying the area, baseline was drawn and traverses perpendicular to the baseline were cut and observations were made at 100m regular intervals. Based on the information obtained in the field, three (3) mapping units were identified viz mapping units 1, 2 and 3 respectively. In mapping units 1 and 3, two profile pits each were sunk while mapping unit two had three profile pits making seven profile pits. Profile pits were sampled according to the pedogenetic horizons. Soil colour was determined using Munsell soil colour chart. Particle size distribution was determined by Bouycous hydrometer method using sodium hexametaphosphate (Calgon) as the dispersant and the textural class determination adopted was the USDA textural triangle method Jaiswal (2003). The bulk density was by core method (Blake and Hartge, 1986). The particle density was determined as described by Jaiswal, (2003). Soil moisture content was determined using the gravimetric method as described by Jaiswal (2003) while the water holding capacity of the soil was determined by the method of Klute (1986).The porosity of the soil was determined according to the method described by (Blake and Hartge, 1986) in Jaiswal (2003).

Results and Discussions

Table 1: Physical properties of Mayo-Gwoi flood plain soils

Mapping Unit	Profile Depth	B.D g/cm^3	PD g/cm^3	Porosity (%)	F.C (%)	WP (%)	AV H_2O (mm)	WHC (%)	Sand (%)	Silt (%)	Clay (%)	Textural class
MU1	0-18	1.42	2.65	46	25	14	11	37.1	56	21.2	22.8	Scl
	18-61	1.44	2.64	46	23	14	9	37.2	66	11.2	22.8	Scl
	61-82	1.41	2.64	47	25	16	9	37.2	62	13.2	26.8	Scl
	82-99	1.26	2.63	52	40	29	11	38.1	52.8	38	22.8	S
	99-144	1.35	2.62	45	22	14	8	32.2	54	5.2	40.8	Scl
	144-158	1.33	2.64	50	31	16	15	38.2	28	43.2	28.8	Cl
	158-178	1.24	2.64	53	37	28	9	32.2	47.2	40	52.8	Sl
	178-200	1.22	2.65	54	43	27	16	33.3	52.0	43.2	46.8	Sl
	0-14	1.32	2.63	50	32	23	9	40.2	10	61.2	28.8	Scl
	14-41	1.34	2.64	49	30	21	9	40.3	58	3.2	38.8	Sc
	41-78	1.49	2.64	44	21	13	8	40.2	58	19.2	22.8	Scl
	78-122	1.33	2.65	50	31	19	12	40.1	78	3.2	18.8	Sl
	122-141	1.4	2.63	47	26	15	11	39.2	74	3.2	22.8	Scl
	141-180	1.34	2.59	49	30	21	9	34.6	58	3.2	38.8	SC
	180-200	1.42	2.62	46	24	14	10	35.7	52	5.2	42.8	Scl
MU2	0-30	1.23	2.64	54	42	26	16	38.2	42	31.2	26.8	L
	30-50	1.29	2.65	51	34	15	18	38.4	8.0	29.2	62.8	C
	50-85	1.35	2.65	49	29	15	14	38.5	58	19.2	22.8	Scl
	85-140	1.32	2.59	50	32	18	14	33.3	35.2	58.0	26.8	L
	140-175	1.18	2.64	56	51	38	14	34.2	10	45.2	44.8	SL
	0-38	1.24	2.64	53	41	24	16	39.6	32	35.2	32.8	Cl
	38-62	1.33	2.64	50	31	19	12	33.4	10	47.2	42.8	Sc
	62-120	1.24	2.65	53	40	23	17	40.6	42	23.2	34.8	Cl
MU3	0-18	1.24	2.64	53	41	24	16	39.6	32	35,2	32.8	Cl
	18-54	1.22	2.64	54	42	26	17	39.4	58	21.2	20.8	Scl
	54-105	1.29	2.64	51	36	24	12	39.7	2.0	53.2	44.8	Sl
	105-134	1.22	2.63	54	42	26	17	35.6	8.0	51.2	40.8	Sc
	134-184	1.44	2.64	46	24	13	10	34.7	4.0	19.2	22.8	Sc
	0-34	1.18	2.57	56	54	42	12	40.3	36	21.2	42.8	C
	34-52	1.22	2.61	54	46	34	12	40.5	22	5.2	72.8	C
	52-93	1.18	2.58	55	53	42	11	33.4	18	9.2	72.8	C
	93-130	1.25	2.63	53	41	31	10	35.4	40	3.2	56.8	C

	0-38	1.25	2.64	53	40	28	12	41.2	32	17.2	50.8	C
	38-60	1.24	2.61	53	43	32	11	40.6	34	9.2	56.8	C
	60-90	1.37	2.57	48	43	32	15	40.2	32	45.2	22.8	L
	90-120	1.25	2.64	53	41	29	12	40.4	32	16.8	51.2	C
	120-150	1.37	2.63	48	43	32	15	35.3	32	45.2	22.8	L
Range	-	1.18-1.49	2.57-2.65	44-56	21-54	13-42	8-18	32.2-41.2	2-78	3.2-61.2	18.8-72.8	
Mean	-	1.30	2.63	51	36	24	12	37.5	39	25.9	37.8	

BD= bulk density; PD =particle density; FC =field capacity; WP =wilting point; AV.$H_2$0 =available water; WHC= water holding capacity, C=Clay, SC=Sandy clay, Cl=Clay loam, Scl=Sandy clay loam, L=Loam, S=Sand

Table 2. Micronutrients in Soils of Mayo-Gwoi Floodplain

Pedon Number	Pedons Depth (cm)	Zn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Mn (Mg/kg)
P1	0-18	1.1	9.7	ND	6.4
	18-61	2.6	8.1	0.5	4.4
	61-82	2.7	7.4	0.6	20.8
	82-99	2.1	5.6	ND	0.8
	99-144	2.6	3.1	0.5	4.6
	144-158	0.4	2.7	0.5	4.9
	158-178	0.5	2.8	0.5	10.2
	178-200	0.7	2.2	0.4	7.8
P2	0-14	1.5	8.1	0.5	5.9
	14-41	1.6	8.8	0.5	5.6
	41-78	1.6	5.4	0.5	9.2
	78-127	2.6	8.9	0.3	11.7
	127-141	2.4	5.6	0.4	3.1
	141-180	0.5	3.9	0.3	6.9
	180-200	0.3	7.7	0.7	4.0
P3	0-30	1.1	8.7	0.4	15.1
	30-50	0.5	6.9	0.4	6.3
	50-85	0.5	5.1	0.7	3.9
	85-140	0.8	7.8	0.5	7.1
	140-175	0.6	5.0	0.4	8.7
P3	0-32	0.5	6.2	0.6	2.4
	32-62	0.8	5.7	ND	6.1
	62-120	0.8	5.7	0.5	6.1
P4	0-18	0.3	5.6	0.3	2.8
	18-54	0.3	7.7	0.4	3.6
	54-105	0.5	6.0	0.4	6.9
	105-134	0.2	5.1	0.5	1.1
	134-184	0.6	5.0	0.6	7.2
P5	0-38	0.8	9.7	0.5	8.0
	38-52	0.7	5.9	0.5	6.3

	52-93	0.8	4.0	0.7	8.9
	93-130	0.6	7.1	0.4	9.2
P6	0-38	0.5	9.0	0.5	5.3
	38-60	0.6	5.7	0.6	5.4
	60-90	0.7	8.0	0.5	7.0
	90-120	0.7	8.7	ND	5.9
	120-150	0.1	3.4	0.3	6.4
Range	-	0.1-2.7	2.2-9.7	0.3-0.7	0.8-20.8
Mean	-	1.0	6.3	0.5	6.7

Note: ND = No data

Soil textures were variable within the mapping units, surface texture ranged from loamy sand through sandy clay loam to clay. The sand contents of the profiles changed with depth, it has clay texture in both surface and subsurface horizons, these variations may be due to differences in parent materials and topography (Brady and Weil, 2002). The clay content of the soils was low while the sand content was high. Soil structures were also variable: being weakly developed in pedons that are moderately coarse-textured (pedons 1-5) and well developed in a pedon with high clay content. This lack of structural development in the horizons could be attributed to the effect of low water table (Udo, 2001). The bulk density of the soils ranged from 1.22 g/cm^3 to 1.44g/cm^3 (Table 1). These values are considered safe for root penetration since root penetration may be hindered in soils having bulk density above 1.75 g/cm^3 (Esu, 2005).

The water holding capacity in both the surface and subsurface horizons of the soils were low (Table 2) and this could be attributed to the low organic matter content. Organic matter has been known for its importance at improving water retention capacity of most surface soils (Brady and Weil, 2002). Consequently, water at field capacity, water at wilting point and available water in the soils are low but fall within the range that cannot cause any negative effect to most arable crops (Brady, 2002). The concentration or content of zinc in these soils were low (Table 2) and could be due to low organic matter content of the soils (Brady and Weil, 2002).The iron content of the soils were generally low to moderate (Table 2). The low iron content could be due to transformation and redox reactions (Brady, 2006). Similar result was reported by Mustapha *et al*, (2003) on the study of profile distribution of some Hydromorphic soils of Dass, Bauchi State. However, the level of available copper in the soils was deficient in all the pedons (Table 2) at both the surface and subsurface horizons which could be attributed to the low crystal concentration of copper in the soils dynamics (Havlin et *al*, 2003).The level of manganese was moderate at the surface and subsurface horizons in all the pedons (Table 2). This could also be attributed to the low organic matter content and the acidic nature of the soils shown by their pH values. Brady and Weil (2002) and Havlin *et al*, (2003) opined that the availability of most of the micronutrients in soils depend on the soil pH and organic carbon contents. Consequently, improving the organic carbon contents of the soil which serves as the mainstay of most extractable soil micronutrients (Brady and Weil, 2006), could help to improve the productivity of Mayo-Gwoi flood plain soils

CONCLUSION

The study highlights the hydro-physical characteristics and the micronutrient status of soils from Mayo-Gwoi floodplain in Taraba state, Nigeria. The soils are characterized to have varying textures ranging from loam through loamy sand to sandy clay loam, low to moderate bulk density values as well as water holding capacity. The soils also showed low to moderate levels of the micronutrients (zinc, iron, copper and manganese). Good productivity of these soils would be ensured by adequate soil management strategies such as addition of organic matter in the form of poultry manure to improve the soil since organic matter is a major source of micronutrients in soils as well as improving soil physical health.

REFERENCE

Bawden, M. G. (1972). *The Land Systems, Land Resources Study No. 9, LRD.,* Tolworth Towers Subritan Surrey, England. pp. 205-209

Blake, G. R. and K. H. Hartge(1986). Bulk Density. In: *methods of soil analysis, part 1. Physical and Mineralogical methods*. A. Klute (ed) American Society of Agronomy, Madison, WI USA: pp 365 – 375.

Brady, N. and R.R Weil (1996).*The Nature and properties of Soils.* Eleventh Edition, Saddle Publisher, New Jersey, pp.65-67.

Brady, N.C. and Weil, R.R,. (2002). *The Nature and Properties of soils.13th edition. Pearson education. India.*

Bray, and Kurtz, L.T. (1995). Determination of total organic and available forms of phosphorus in soil. *Soil Science* 59: pp 39-45.

Esu, I.E. (2005) Characterization, Classification and Management Problems of the Major Soil Orders in Nigeria. *26th Inaugural Lecture of the University of Calabar.* pp.65

Iloeje, N.P. (1981). A new Geography of Nigeria.New Revised edition, Longman. Nig.Ltd. Ikeja

Jaiswal, P.C. (2003). Soil, Plant and Water Analysis.Kalyani Publishers, Ludhiana, New Delhi, NordaHyderabab, India.Pp.1-399.

Havlin, S.L., Nelson, W.L., Beaton, J.D. and Tisdale, J.L. (2003) .Soil fertility and fertilizers. 5th edition. Prentice-Hall of India.

Klute, A. (1986). Water Retention: Laboratory Methods of Soil Analysis, Part 1: Physical and Mineralogical Methods, 2nd ed. ASA, SSSA, Madison USA: Pp 635-660

Mustapha, S., Udom, G.N. and Umar, A.M. (2003).Profile distribution of some physico-chemical properties of some hydromorphic soils of Dass,Bauchi State, Nigeria. *Nigeria Journal of Agriculture Technology* 11: pp.30-38.

Odingo, R. S. (1991). Research and development of land use policies in Africa. Paper presented for the United Nations University Project on the Institute of National Resources in Africa (UNN – INRA) Nairobi, Kenya

Udo, E. J. (1996). Chemical Characteristics of Wetland Soils: A Review with Highlights on Experiences of Other Countries. P46 – 65. In A. G. Ojanuga, T. A. Okusami and G. Lekwa(eds), Wetland Soils in Nigeria: Status of Knowledge and Potentials. Monograph 2. SSSN, Nigeria. pp .139

Vink, A. P. A. (1975) Land Use in Advancing Agriculture. New York. Springer-Verlag.