

THE STATUS OF 0.1N HCl EXTRACTABLE CATION MICRONUTRIENTS IN KADAWA SOILS OF KANO RIVER PROJECT KANO STATE, NIGERIA

Abdulkadir, N. A.

Department of Soil Science, Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology, Wudil, Kano State.

ABSTRACT

A research was conducted in 2004 to assess the status of Cation Micronutrients (Copper, Iron, Manganese and Zinc) in the soils of Kadawa in Kano State, Nigeria. Objective of this study was to investigate the level of these important elements in the soils under Kadawa area of Kano River Project Area phase 1. Status of Cation micronutrient elements (Copper, Iron, Manganese and Zinc) extractable in 0.1N HCl were investigated in 50 composite samples from Kadawa sector of Kano River Irrigation Project by use of Atomic absorption spectrophotometer (AAS). The results revealed that in most of the locations the concentrations of micronutrients ranges from medium to high. Study on physico-chemical properties of the composite soil samples showed that the soils were sandy loam texture with a pH range of 6.00 to 8.70, EC 0.090 to 0.310 dSm⁻¹, soil organic carbon 0.42 to 1.02%, total nitrogen 0.070 to 0.105%, available phosphorus 10.50 - 26.25mg/kg, cation exchange capacity 4.80 to 10.20 cmol/kg. The soil was endowed with sufficient amount of micronutrients (Copper, Iron, Manganese and Zinc) above the critical level. Correlation co-efficient was employed to measure the degree of association between important soil parameters (pH, EC, TN, OC, AP and CEC) and micronutrients (Cu, Fe, Mn and Zn). It was found that some micronutrients showed significant relationship with some soil properties.

KEYWORDS: Metallic Micronutrients, 0.1N HCl extractable, Kadawa

INTRODUCTION

Micronutrients are elements needed in small quantities by plants for proper growth and reproduction. In recent time, increasing attention is being directed towards micronutrients deficiencies due to intensive plant production practices, usage of high analysis chemical fertilizer and increase knowledge of plant and animal nutritional needs. The effect of micronutrients deficiency can be very severe in terms of stunted growth, low yields and even plant death. Investigation into the micronutrient status of soils in Nigeria and most developing countries receive little attention in the past due to rare incidences of deficiency. Now in Nigeria the spate of investigations have been scanty, with much of the earliest studies conducted in the 1970's Osiname et. al, (1973), followed by much less in the early 1950's (Lombin, 1983a; 1983b). Micronutrient investigation are however, on the increase as more recent studies showed deficiency to be on the increase. This has been documented especially on soils from the basement complex rocks (Lombin, 1983a; 1983b; Kparmwang et al., 1995.) and also on sedimentary soils (Kparmwang and Malgwi, 1997).

Micronutrients are required in lower amounts for growth and serve mainly as constituents of prosthetic groups in metalloproteinase and as activators of enzyme reactions. The specific roles of various micronutrient elements in plant and microbial growth processes are not well understood (Tisdale et.al., 1985). It is known, however that several of the trace elements are effective through a number of enzyme systems (Donahue et al., 1990). For example, copper and iron are

capable of acting as "electron carriers" in enzyme systems that bring about oxidation-reduction reaction in plants. Apparently, such reactions will not take place in the absence of these micronutrient enzyme systems that are necessary for important reactions in plant metabolism (Brady, 1999).

MATERIALS AND METHODS

Location and Extent the Study Area

Kano River Project Phase 1 covered an area of 22,000 hectares in Kura, Bunkure, Bebeji and Rano Local Govt. Areas in Kano State. The study area, Kadawa is one of those areas. Kadawa is located between latitude 11°33' and 11°35'N and longitude 8°27' and 8°30'E. The area covered by this study is approximately 567 hectares and includes the land under the Kano Hadejia River Basin and Rural Development Authority, the land under the control of Kano State Ministry of Agriculture, the land shared by individuals, the land under Ahmadu Bello University Institute of Agricultural Research and the land under Kano Agricultural Research Development Authority (KNARDA). NEDECO (1974).

Soil Sampling

The sampling locations were selected to reflect the soil of the area and to cover Kadawa irrigation area as a whole. A total of 50 composite- (0 - 25cm) surface soil samples were collected from the study area. Care was taken to cover the whole area evenly. New plastic bags and thoroughly washed spade were used for collecting the soil samples to avoid contamination.

Preparation of the Soil Samples

Soil samples were spread on paper sheets and allowed to air dry for one day.

The soil samples were crushed sieved through a 2mm stainless steel sieved and labeled. The samples were packed in labeled polythene bag separately prior to analysis.

Physico-chemical Analyses of the Soil

Ten composite soil sample of 10 blocks were used for the physico-chemical properties analysis as shown in Table 1.

Physical Analyses of the soils

Particle size distribution was determined by Bouyoucos hydrometer method for dispersing the soil with 5% calgon (Sodium hexameta phosphate) as described by Gee and Bauder (1986). The textural class was obtained using the International Soil Textural Triangle. For Chemical Analyses, soil pH was measured in both H₂O and 0.1 N CaCl₂ at 1:2.5 soil- solution ratio using glass electrode pH meter. Electrical conductivity (EC) was read on conductivity meter. Organic carbon was determined by Walkley-Black wet combustion as described by Allison, 1965. Total Nitrogen (TN) was determined by macro Kjeldahl digestion distillation method (Bremner 1965). Bray No.1 method was used for the determination of available phosphorus as described by Bray and Kurtz, (1945). Exchangeable acidity was estimated in the extract with 1M KCl extractant as described by Juo (1979). Cation Exchange Capacity (CEC) was determined by NH₄ saturation method where NH₄OAc filtrate was used for estimation of the exchangeable bases, Ca, Mg, K and Na on the atomic absorption spectrometer (AAS) as described by Black (1965).

Micro nutrients (Cu, Fe, Mn, and Zn) Analysis

This analysis was done by employing the 0.1N HCl extraction method, developed by Lindsay and Norvell (1979). The extracts were used to determine the concentration of micronutrients by the usage of Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

Physical and Chemical Properties of the Soil Sample

The result of physical and chemical properties of the soil from Kadawa area are presented in Table 1

Particle size distribution

Clay content ranged from 7 to 11% with a mean value of 8.2%. Silt content ranged from 26 to 32% with a mean value of 29% while the sand ranged from 59 to 65% with a mean value of 62.8%. The textural class of the soil is sandy loam. The coarse nature of the soil may be attributed to parent material which contains Granite and Quartz. (Ojanuga, A.G. 1979)

Soil pH in (1:2.5 Solution)

The pH in H₂O ranged from 6.00 to 8.70 with a mean value of 7.37. while pH in CaCl₂ ranged from 5.40 to 7.40 with a mean of 6.46.

Electrical conductivity (EC in dSm⁻¹)

The EC of the soil ranged from 0.090 to 0.31 dSm⁻¹ with a mean value of 0.203 dSm⁻¹.

Organic carbon (OC)

Organic carbon contents of the soil ranged from 0.42 to 1.02% with a mean of 0.67%. The low content of organic matter is in agreement with the report of FAO (1969) and Ojanuga (1979) on the soil of dry savanna which characterized savanna with low OC content.

Total nitrogen

The percentage total nitrogen ranged from 0.070 to 0.105% with a mean value of 0.088%. The low total nitrogen content could be due to leaching, intensive cultivation, burning, denitrification and immobilization (Olaitan *et al*, 1988).

Available Phosphorus (AP mg/kg)

The Available Phosphorus content ranged from 10.50 mg/kg to 26.25 with a mean value of 15.48mg/kg. This is contrary to the findings of Manu *et al*. (1995) which characterized savanna soil with low P.

Cation exchange capacity (CEC cmol kg⁻¹)

The CEC values ranged from 4.80 to 10.20 Cmol kg⁻¹, with a mean value of 6.12 Cmol kg⁻¹. The value is low as described by Esu (1991).

Status of micronutrients extractable in 0.1N HCl from the soils of Kadawa Sector of Kano River Project.

The variability in the distribution of micronutrients within the soil profile is in the order Cu<Mn<Zn<Fe. The concentration of Zn in some locations is very minute (Table 2).

The 0.1N HCl extractable Copper (Cu) in the soil ranged from 9.82 to 17.19 mg/kg with a mean value of 13.93mg/kg. With standard deviation of 1.99, Cu has low variability in its distribution within the soil profile as compared to the Fe, Mn and Zn.

Dilute acid (0.1N HCl) extractable Iron (Fe) ranged from 19.51 to 204.88mg/kg soil with a mean value of 73.74 mg/kg soil, iron has the highest variability in its distribution considering a standard deviation of 38.53

TABLE 1: PYSICO- CHEMICAL PROPERTIES OF SOILS FROM KADAWA AREA IN KANO STATE

Sample No	Particle size distribution				pH	EC (dSm ⁻¹)	OC (gkg ⁻¹)	TN (gkg ⁻¹)	AP (mg/kg)	Ca	Mg	K	Na	H+Al ³⁺	CEC	
	Clay	silt	sand	Tex. Class												
Composite	← (%) →				pH H ₂ O	← 0.01M CaCl ₂ (1:2.5) →	← (dSm ⁻¹) →	← (gkg ⁻¹) →	← (mg/kg) →	←	←	←	←	←	←	←
KA	9	32	59	Sandy Loam	7.50	6.50	0.180	0.65	0.070	14.00	3.07	0.81	0.34	0.24	0.10	6.40
KB	9	30	61	Sandy Loam	7.40	6.20	0.120	0.45	0.105	20.65	2.22	0.69	0.17	0.61	0.10	5.20
KC	7	28	65	Sandy Loam	7.30	5.90	0.290	0.57	0.070	17.50	1.73	0.59	0.32	1.22	0.20	5.50
KD	9	26	65	Sandy Loam	7.30	6.40	0.150	0.69	0.070	13.13	2/04	0.59	0.20	0.37	0.20	4.40
KE	7	30	63	Sandy Loam	8.70	7.40	0.310	0.52	0.105	9.63	3.60	0.08	1.18	1.65	0.10	10.20
KF	9	26	65	Sandy Loam	7.70	7.00	0.20	0.80	0.105	26.25	2.15	0.90	1.28	0.35	0.10	6.70
KG	11	30	59	Sandy Loam	6.00	5.40	0.090	0.85	0.105	19.25	2.14	0.56	0.41	0.35	0.20	5.20
KH	7	28	65	Sandy Loam	7.00	6.30	0.150	0.69	0.070	12.25	1.80	0.55	1.38	1.22	0.10	6.80
KI	7	30	63	Sandy Loam	8.00	7.00	0.250	0.42	0.070	10.50	2.14	0.55	0.38	0.35	0.10	5.00
KJ	7	30	63	Sandy Loam	6.80	6.50	0.290	1.02	0.105	12.25	2.61	0.62	0.33	0.22	0.20	5.40
MEAN X	8.20				7.37		0.66		0.08	15.54						6.12
SD	1.39				0.71		0.18		0.018	5.25						1.60

Table 2 The 0.1N HCl extractable Micronutrients Distribution in Kadawa Soils

	Sample Location	Copper (Cu)	Iron (Fe) mg/kg soil	Manganese (Mn)	Zinc (Zn)
1.	KA1	12.27	56.10	78.03	49.38
2.	KA2	11.66	46.34	83.37	60.00
3.	KA3	11.66	157.32	97.56	7.50
4.	KA4	10.43	130.49	94.01	34.38
5.	KA5	10.43	26.83	99.33	76.25
6.	KB1	11.04	67.07	90.46	1.25
7.	KB2	9.82	47.56	78.05	ND
8.	KB3	12.27	82.93	67.40	1.25
9.	K.B4	12.88	63.41	94.01	19.38
10.	KB5	14.72	86.58	83.37	1.25
11.	KB6	1.96	57.56	20.93	4.13
12.	KB7	3.31	56.34	21.29	4.13
13.	KB8	2.45	60.24	20.58	3.75
14.	KB9	2.33	51.46	14.9	4.25
15.	KC1	1.96	54.1 5	13.13	3.25
16.	KC2	1.84	51.95	15.61	3.50
17.	KC3	1.35	51.71	12.06	3.38
18.	KC4	2.21	54.88	17.74	6.88
19.	KC5	1.96	5 1.71	10.64	3.63
20..	KD1	2.21	57.56	24.83	4.25
21.	KD2	14.11	37.80	42.57	14.85
22.	KD3	15.34	37.80	44.35	27.50
23.	KD4	14.72	42.68	39:02	25.63
24.	KD5	11.04	19.51	76.27	28.13
25.	KD6	14.11	63.41	83.37	28.13
26.	KD7	12.27	30.49	65.63	21.88
27.	KE1	14.72	63.41	60.31	29.38
28.	KE2	14.11	80.49	40.80	15.63
29.	KF1	15.34	117.07	67.40	15.00
30.	KF2	14.72	75.61	76.27	17.50
31.	KG1	14.34	96.34	67.40	45.63
32.	KG2	13.50	151.22	76.27	18.13
33.	KG3	15.95	204.88	85.14	41.25
34.	KG4	14.72	91.46	81.59	27.50
35.	KG5	16.56	87.80	72.73	35.00
36.	KH1	15.95	96.34	79.82	40.63
37.	KH2	14.11	103.66	67.40	37.50
38.	KH3	14.11	50.00	81.59	37.50
39.	KI1	12.88	18.29	85.14	10.50
40.	KI2	14.11	100.00	86.92	30.00
41.	KI3	13.50	79.27	83.37	50.63
42.	KI4	14.11	19.51	56.76	33.80
43.	KI5	14.34	78.05	90.46	51.25
44.	KJ1	14.72	89.02	79.82	32.50
45.	KJ2	16.56	90.24	97.56	69.38
46.	KJ3	17.19	71.95	72.73	27.50
47.	KJ4	15.95	43.90	97.56	46.25
48.	KJ5	17.19	53.66	79.82	32.50
49.	KJ6	16.56	53.66	76.27	21.88
50.	KJ7	16.56	39.02	65.63	28.13
X		13.93	73.74	76.77	26.61
SD		1.99	38.53	14.41	18.48

SD = Standard Deviation
 ND= NOT DETECTED

Table 3: Correlation coefficient between 0.1N HCl extractable Micronutrients and some important soil properties

value	r
X ₁ Y ₁ - Clay Vs Cu	-0.199
X ₃ Y ₁ - pH Vs Cu	-0.254
X ₅ Y ₁ -%OC Vs Cu	0.680**
X ₄ Y ₁ - %TN Vs Cu	0.395
X ₂ Y ₁ -AP Vs Cu	-0.069
X ₆ Y ₁ -CEC Vs Cu	-0.140
X ₁ Y ₁ - Clay Vs Fe	0.624**
X ₃ Y ₁ - pH Vs Fe	-0.404
X ₅ Y ₁ -%OC Vs Fe	0.280
X ₄ Y ₁ - %TN Vs Fe	0.542*
X ₂ Y ₁ -AP Vs Fe	0.493
X ₆ Y ₁ -CEC Vs Fe	0.129
	r value
X ₁ Y ₁ - Clay Vs Mn	0.001
X ₃ Y ₁ - pH Vs Mn	-0.365
X ₅ Y ₁ -%OC Vs Mn	0.073
X ₄ Y ₁ - %TN Vs Mn	-0.136
X ₂ Y ₁ -AP Vs Mn	0.219
X ₆ Y ₁ -CEC Vs Mn	-0.405
X ₁ Y ₁ - Clay Vs Zn	0.117
X ₃ Y ₁ - pH Vs Zn	0.299
X ₅ Y ₁ -%OC Vs Zn	0.325
X ₄ Y ₁ - %TN Vs Zn	0.388
X ₂ Y ₁ -AP Vs Zn	-0.461
X ₆ Y ₁ -CEC Vs Zn	-0.096

* Significant at P(0.1) 10%>0.521

** Significant at P(0.1) 5%>0.602

APPENDIX 1: Sample Locations and the Composite Sample Constituents of the Kadawa Soils.

Sample S/No	Sample Locations	Composite Sample of Block	S/No.	Sample Locations	Composite Sample of Block
1.	KA1	KA	29.	KF1	
2.	KA2		30.	KF2	KF
3.	KA3		31.	KG1	
4.	KA4		32.	KG2	
5.	KA5		33.	KG3	KG
6.	KB1		34.	KG4	
7.	KB2		35.	KG5	
8.	KB3	KB	36.	KH1	
9.	KB4		37.	KH2	KH
10.	KB5		38.	KH3	
11.	KB6		39.	KI1	
12.	KB7		40.	KI2	
13.	KB8		41.	KI3	KI
14.	KB9		42.	KI4	
15.	KC1		43.	KI5	
16.	KC2		44.	KJ1	
17.	KC3		45.	KJ2	
18.	KC4	KC	46.	KJ3	
19.	KC5		47.	KJ4	
20.	KC6		48.	KJ5	KJ
21.	KD1		49.	KJ6	
22.	KD2		50.	KJ7	
23.	KD3	KD			
24.	KD4				
25.	KD5				
25.	KD6				
26.	KE1	KE			
27.	KE2				

KA = Composite of block A plots

KB = Composite of block B plots

KJ = Composite of block J Plots

The content of available Manganese (Mn) extractable in 0.1N HCl ranged from 39.02 to 99.33mg/kg soil with a mean value of 76.77mg/kg soil. Standard deviation of 14.41 shows moderate variability in the distribution of Mn within the soil profile.

Zinc extractable in dilute acid (0.1N HCl) ranged from trace to 76.25 mg/kg soil with a mean value of 26.61 mg/kg soil.

The 0.1N HCl extractable micronutrients and some soil properties

The relationship between available metallic micronutrients extractable in 0.1N HCl and some soil properties is presented in Table 3. Significant relationship was observed between Cu and OC. Iron show a relationship with the Clay and TN. No

significant relationship with other soil properties.

CONCLUSION

The aim of this study was to study the status of Cation Micronutrients in soils of Kadawa in Kano State of Nigeria. Fifty composite soil samples were collected and analysed for 0.1N HCl extractable Cation Micronutrients using Atomic Absorption Spectrophotometer. The result showed that, the soil of Kadawa was endowed with sufficient amount extractable Cation Micronutrients. However, this area is intensively cultivated, a good soil management coupled with periodic investigation of the nutrients status should be maintained to ensure sustainability in Agricultural activities.

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