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Analysis of Soil Ph in Guinea Corn and Maize Grown Soils of Kaduna Metropolis-Nigeria

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Abstract: The pH, either directly or indirectly affects several mechanisms of metal retention by soils. In this research work, the pH values of the soils samples from the various locations of Kaduna metropolis were determined so as to assess the bioavailability, mobility and solubility of the metals in the soils. The pH was measured using a microprocessor pH meter model 210. The pH values of the soil samples from the various locations were acidic and a significant difference was indicated in the pH values across the guinea corn and maize grown soils. The least pH value across the guinea corn grown soils was found in the first homogeneous subgroup comprising of Kakuri and Tudun Wada, while the highest pH value was in the forth homogeneous subgroup which included Nasarawa and Unguwan Mu'azu. Similarly, the least pH value across the maize grown soils was found in the first homogeneous subgroup which contained Unguwan Mu'azu and Mando while the highest pH value across the maize grown soil was in the fourth homogeneous subgroup which included Nasarawa and Kachia.

Key words: Guinea corn, kaduna metropolis, maize, pH analysis, soil

INTRODUCTION

In many developing countries, like Nigeria, soils are affected by mine waste disposal, acid deposition and sewage sludge use that could provide large inputs of pollutants and especially heavy metals to the soils. The impact of contamination on the environment should be of scientific concern in order to minimize the threat of soil and groundwater contamination (Matos *et al*., 2001). Soils are receptacles for heavy metals released from industrial activities, municipal wastes, water sludge, urban composts, road traffic, atmospheric deposits and chemicals used in agriculture (phosphate fertilizers, pesticides) and spread out into the environment (Andriano, 1986). Many soils especially those in hazardous waste sites are contaminated with heavy metals, e.g. lead, copper, chromium and cadmium. They may also move through soils to reach ground waters or may be taken up by plants. Plants have been shown to have the ability to accumulate metals from the environment. Metals uptake by plants may pose risks to human health when such plants are grown on or near contaminated areas. Metals accumulation in plant depends on plant species, growth stages, types of soil and metals, soil conditions, weather, pH and environment (Chang *et al*., 1984; Petruzzelli, 1989). The free metal ion concentration not only depends on the total metal content in soils, but also on the pH of the soil (Temminghoff *et al*., 1997).

On the basis of pH measurement it is possible to divide analysed samples into the following groups: acid and sub-acid soils, neutral soils and alkaline soils. Acid soils belong to the sandy soils, neutral to the sandy-loamy soils and alkaline one to the loamy soils. Acid soils are prone to increased leaching of important components and decreased assimilation of such macroelements as P, K and Mg by plants. Plants growing on alkaline soils can have trouble with assimilation of Fe, Cu and Mn. The effect of acidifying of soils is visible in decreasing their saturation with exchangeable cations and successive loss of Ca and Mg and simultaneous activation of toxic compounds of Al, Mn, Fe and accumulation of heavy metals like Pb, Cu, Ni and Zn by plants (Baranowski *et al*., 2002).

The pH of the system is a very important parameter, directly influencing sorption/desorption, precipitation/ dissolution, complex formation and oxidation-reduction reactions. In general, maximum retention of cationic metals occurs at pH>7 and maximum retention of anionic metals occurs at pH<7. Cationic metal mobility has been observed to increase with increasing pH due to the formation of metal complexes with dissolved organic matter (Baham and Sposito, 1986).

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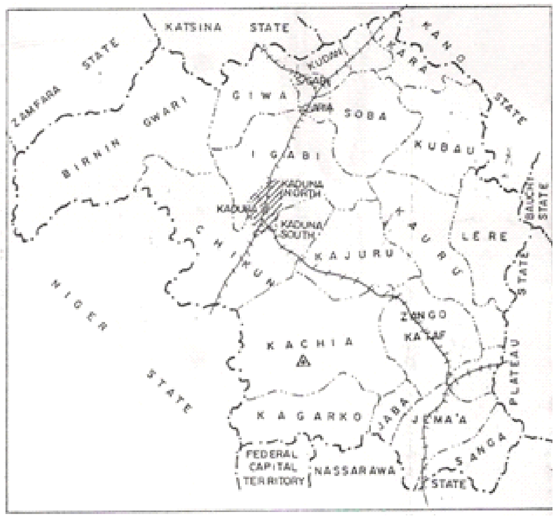
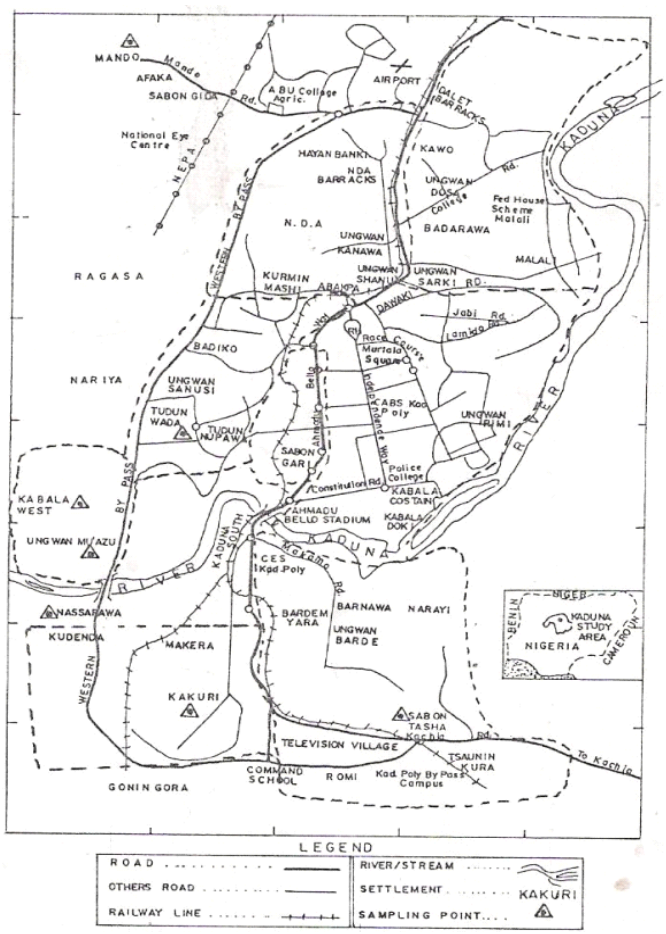


(a)



(b)

Fig. 1: (a) Map of kaduna state showing kaduna metropolis (b) Map of kaduna metropolis

Table 1: Descriptive statistics for soil pH in guinea corn fields

					95% Confidence interval for mean	
Sample Sites	N	Mean	SD	SE	Lower bound	Upper bound
Kabala West	64	4.80	0.38	0.05	4.71	4.89
Nasarawa	64	5.13	0.40	0.05	5.03	5.23
Mando	64	4.90	0.39	0.05	4.80	4.99
Kakuri	64	4.60	0.27	0.03	4.54	4.67
Tudun Wada	64	4.64	0.31	0.04	4.56	4.72
Sabon Tasha	64	4.74	0.42	0.05	4.63	4.84
Ungwan Muazu	64	5.38	0.42	0.05	5.28	5.49
Kachia	56	4.79	0.30	0.04	4.71	4.87
Total	504	4.87	0.44	0.02	4.84	4.91

Table 2: ANOVA table for soil pH in guinea corn fields

Source of variation	SS	df	MS	F	sig.
Between groups	30.987	7	4.427	33.028	0.000
Within groups	66.480	496	0.134		
Total	97.467	503			

Table 3: Duncan test for soil pH in guinea corn fields

		Subset for $\alpha = 0.05$			
Sample site	N	1	2	3	4
Kakuri	64	4.60			
Tudun Wada	64	4.64			
Sabon Tasha	64		4.74		
Kachia	56		4.79		
Kabala West	64			4.80	
Mando	64			4.90	
Nasarawa	64				5.13
Ungwan Muazu	64				5.38
Sig.		0.053	0.371	0.137	1.000

Means for groups in homogeneous subsets are displayed

In this research study, the pH of the soil samples from the various locations appeared acidic. This could be attributed to the various agricultural and anthropogenic activities within the sampling locations (Kashem and Singh, 1998; Chamon *et al*., 2009). The bioavailability of copper, lead, nickel and zinc from soils decreased with increasing pH (Moraghan and Mascani,1991; Morel, 1997).

MATERIALS AND METHODS

Preparation of samples: The research covered seven agricultural sites in Kaduna, Nigeria. The sites are: Nasarawa, Sabon Tasha, Unguwan Mu'azu, Tudun Wada, Kakuri, Mando, Kabala West and Kachia.

To evaluate the variability between the different agricultural locations soil samples were collected between October - November, 2008, 2009 and 2010 from the different agricultural sites. The soil samples were collected from the different areas enumerated at a depth of about 10 cm below the surface (Yaman *et al*., 2005). Kachia, a town situated about 130km away from Kaduna was taken as control (Fig. 1a, b).

pH measurement: The soil samples were crushed, sieved and dried at 85ºC. The soil pH was measured on soil suspension using distilled water at 1:5 (w/v). All pH measurements were made with microprocessor pH meter model 210 and all weighings were done on Mettler Toledo PB203 weighing balance. All the analyses were carried out in the Analytical Laboratory of the Department of Applied Science, College of Science and Technology, Kaduna Polytechnic, Kaduna - Nigeria.

RESULTS AND DISCUSSION

The pH values of the soil samples vary from one agricultural location to another, thus large number of samples was analyzed and the results treated statistically for meaningful correlation. Descriptive statistics and 95% confidence interval for the soil pH in guinea corn and maize grown soils were employed across the eight locations (Table 1-6).

Analysis of soil pH in guinea corn grown soils: The ANOVA ($p = 0.000<0.05$) in Table 2 indicated that there is significant difference in the soil pH across the various guinea corn grown soils.

The real differences of soil pH was further analyzed by a post-hoc test using the Duncan Multiple Range Test (Table 3) where means of homogeneous subgroups were clearly displayed. Moreover, the mean plots clearly

Table 4: Descriptive statistics for soil pH in maize fields

					95% Confidence interval for mean	
Sample sites	N	Mean	SD	SE	Lower bound	Upper bound
Kabala West	64	5.66	0.39	0.05	5.56	5.75
Nasarawa	64	6.04	0.41	0.05	5.94	6.14
Mando	64	4.58	0.47	0.06	4.46	4.70
Kakuri	64	5.23	0.29	0.04	5.16	5.30
Tudun Wada	64	5.29	0.16	0.02	5.25	5.33
Sabon Tasha	64	5.62	0.42	0.05	5.51	5.72
Ungwan Muazu	64	4.40	0.40	0.05	4.30	4.50
Kachia	56	6.12	0.07	0.01	6.10	6.14
Total	504	5.36	0.68	0.03	5.30	5.42

Table 5: ANOVA table for soil pH in maize fields

Source of variation	Sum of squares	df	Mean square	F	Sig.
Between groups	171.123	7	24.446	193.652	0.000
Within groups	62.614	496	0.126		
Total	233.736	503			

Table 6: Duncan test for soil pH in maize fields

		Subset For α = 0.05			
Sample site	N	1	2	3	4
Ungwan Muazu	64	4.40			
Mando	64	4.58			
Kakuri	64		5.23		
Tudun Wada	64		5.29		
Sabon Tasha	64			5.62	
Kabala West	64			5.66	
Nasarawa	64				6.04
Kachia	56				6.12
Sig.		1.000	0.307	0.543	0.206

Means for groups in homogeneous subsets are displayed

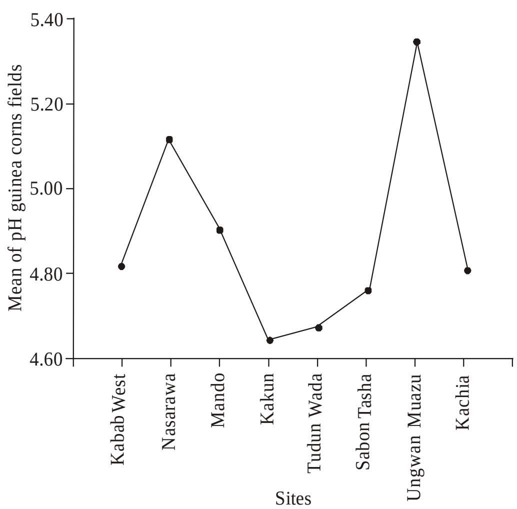


Fig. 2: Mean plot for soil pH in guinea corn grown soils

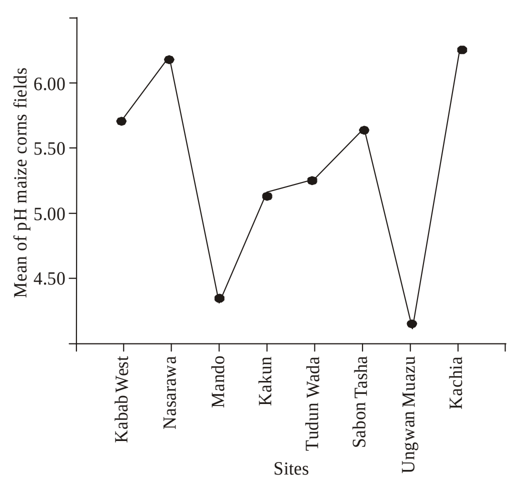


Fig. 3: Mean plot for soil pH in maize grown soils

depicted the mean values of the soil pH across the various guinea corn grown soils (Fig. 1).

From the Duncan Multiple range tests (Table 3), the first homogeneous subgroup contained Kakuri and Tudun Wada which had the least soil pH. The second homogeneous subgroup contained Sabon Tasha and Kachia. Similarly, the third homogeneous subgroup comprised of Kabala West and Mando. The highest soil pH was in the fourth homogeneous subgroup which included Nasarawa and Unguwan Mu'azu. This is depicted in Fig. 1.

Analysis of soil pH in maize grown soils: The ANOVA ($p = 0.000<0.05$) in Table 5 indicated that there is significant difference in the soil pH across the various maize grown soils. The real differences of soil pH was further analyzed by post-hoc test using the Duncan multiple range test (Table 6) where means of homogeneous subgroups were clearly displayed. The mean plots clearly depicted the mean values of the soil pH across the various maize grown soils (Fig. 2).

The Duncan multiple range tests (Table 6) showed that the first homogenous subgroup contained Unguwan Mu'azu and Mando which had the least soil pH. The second homogenous subgroup consisted of Kakuri and Tudun Wada. Similarly, the third homogenous subgroup comprised of Sabon Tasha and Kabala West. The highest pH in maize grown soil was in the fourth homogenous subgroup, which included Nasarawa and Kachia. This was depicted in Fig. 3.

CONCLUSION

The pH of the soil samples from the various locations were found to be acidic as a result of the various agricultural and anthropogenic activities within the sampling locations. The ANOVA ($p = 0.000<0.05$) indicated a significant difference in the soil pH across the various guinea corn and maize grown soils, while the Duncan Multiple range tests indicated that Kakuri and Tudun Wada had the least soil pH and Nasarawa and Unguwan Mu'azu had the highest soil pH across the guinea corn grown soils. Similarly, Unguwan Mu'azu and Mando had the least soil pH and Nasarawa and Kachia had the highest soil pH across the maize grown soils.

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