RESEARCH ARTICLE

Assessment on the Effect of pH on the Soil of Irrigated Farmlands of Kaduna Metropolis Nigeria

W. L.O Jimoh[1] and Mahmud Imam Mohammed[2]
[1] Department of Pure and Industrial Chemistry, Bayero University, Kano Nigeria.
[2] Department of Applied Science, College of Science and Technology, Kaduna Polytechnic.

ABSTRACT
The aim of this research work is to assess the level of pH in the soil of irrigated farmlands of Kaduna metropolis using PH meter. It was found that Samples obtained from Nasarawa and Kawo (pH = 5.8) were the lowest pH in the samples analyzed. These were similar to the pH of the control site Rigachikun with pH = 5.8 (acidic). Sample from Kurmin mashi had the highest pH value (pH = 8.5) and is alkaline. This revealed that most of the soils from the irrigation sites were acidic with the exception of samples from Unguwan Dosa and Kurmin mashi. It was also obtained from the ANOVA $p = 0.000<0.05$ which shows that there is significant differences in the PH of soil across the various sampling sites. The real differences of soil PH was further analyzed by a post-hoc test using the Duncan Multiple range test with samples from Kawo, Nasarawa,Kinkinau and Rigasa were the least soil PH. In the second homogeneous subgroup there is Makera, Malali, Badiko, Barnawa, Kakuri, Kudenda, Danmani, etc. while the highest soil PH fall in the third subgroup which include samples from Uuguwan Dosa and Kurmin Mashi. The absorption and accumulation of heavy metals in plant tissues depend upon soil PH and nutrient availability which in turn increase the mobility of heavy metals. This variation in soil PH is due to excessive usage of fertilizer such as NPK, urea, super phosphate, manure, pesticides, herbicides and other agro – chemicals as well as human activities and the use of waste water in irrigating the soil. As such resulting to an adverse effect on such agricultural areas.
Keywords: Soil, PH Meter, Kaduna Metropolis, Nigeria.

I. INTRODUCTION

PH is the negative logarithm to the base ten (10) of hydrogen ion concentration and is used in determining the acidity and alkalinity of soil. This is because most of the plants will grow in soil with PH value between 6 and 8. (Mahmud, 2008).

As the soil pH decreases, metals are desorbed from organic and clay particles enter the soil solution and become more mobile. When the pH is higher (i.e. greater than 7), metal remain adsorbed and precipitate out in the form of salts (Chen *et al;* 1997).

Whether a soil is acid, neutral or alkaline is determined by the relative concentrations of H^+ and OH^- ions. No other single characteristic is more important in determining the chemical environment of higher plants and soil microbes than the pH.
Soil pH is largely controlled by fine soil particles and their associated exchangeable cations. Aluminium and hydrogen enhance soil acidity, whereas calcium and other base - forming cations especially sodium encourages soil alkalinity (Daniel and Edward, 1998; Ademoroti 1996).

As PH decreases, the solubility of cationic forms of metals in the soil solution increases and therefore, they become more readily available to plants (Gray et al., 1998., Salam and Helmke,1998.,Oliver et al.1988,Singh et al.,1995.,Evans et al 1995; Filius et al., 1996., Mann and Ritchie,1995., Chlopecka et al1996.,Vigerust and Selmer – Olsen, 1995.)

Evans (1989) explained that PH has a major effect on metal dynamics because it controls absorption and precipitation, which are the main mechanisms of metal retaintion to soils. Metal solubility product of the solid phase (presipitation) containing the metal (Akan et al., 2010)

The soil society of America (1995) defines soil quality as the capacity of a specific kind of soil to function within the natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or improve water and air quality and support human health and habitation (Lal, 1995)

Major categories of soil pollutions include nutrients (fertilizers, sewage sludge), acids, heavy metals, radioactive elements and organic chemicals, herbicides, insecticides and other pesticides). Many of these pollutants are continuously discharged into the soil through land waste disposal, inputs from the atmosphere and irrigation by municipal waste water on a daily basis (Radojevic and Bashkin, 1999).

Plants take heavy metals from soil through different processes such as; absorption, ionic exchange, redox reaction, precipitation-dissolution etc. The solubility of trace elements depends on minerals in soil (carbonates, oxide, hydroxide etc), soil organic matter (humic acid, fulvic acids, polysaccharides and organic acids), redox potential, soil temperature and humidity (Tarradellas *et al.*, 1996). The amount of element in soil solution is much lower than amount of elements absorbed by plant. A higher rate of bio available fraction is located in the solid phase.

Irrigation is the artificial means of water supply to the agricultural crops ranging from surface irrigation, micro sprayer and low-head barber irrigation. Irrigation is design to permit farming in arid regions and offset drought in semi-arid or semi humid regions.

The purpose of irrigation is to introduce water into the part of the soil profile that serves as the root zone, for the subsequent uses of the crop. (Zapella, 2003).

The type of irrigation system employed in the farmlands of the Kaduna metropolis is the surface irrigation where water is applied directly to the soil surface through channel which varies in size from individual furrow to large basin.

Domestic waste water contains metal from metabolic waste, corrosion of water pipes and consumer products. Industrial effluents and water slug may substantially contribute to the metal loading (Zapella, 2003).

The aim of this research work is to assess the effect of PH on the soil used as agricultural areas of Kaduna metropolis so as to ascertain the extent of its pollution.

II. MATERIAL AND METHOD

Sample and Sampling:

Soil samples were randomly collected in a hole of 10cm deep which was dug from the irrigated farmlands where vegetables were grown and irrigated with water. These samples were then stored in polythene bags and taken to the laboratory and dried in an oven at a temperature of 105^0C.

The dried soil samples were ground with mortar and pestle and sieved with 2mm sieve.

III. DESCRIPTION OF THE SAMPLING SITES

Soil samples for heavy metal determination were collected from twenty one (21) irrigation sites of the Kaduna metropolis. These sites were Kabala (KBL), Danmani (DMN), Rigasa (RGS), Barnawa (BNW), Makera (MKR), Kakuri (KKR), Badiko (BDK) Nasarawa (NAS, Malali (MAL), Kudenda (KUD), Kinkinau (KKN), Kawo (KWO), Unguwan Rimi (URM), Unguwan Sanusi (UNS), Tudun Wada (TDW), Doka (DKA), Unguwan Dosa (UDS), Kabala Costain (CTA), Kurmin Mashi (KMS) and Abakpa (ABK). In this research work soil sample from Rigachikun (RCK) irrigation site was taken as control site.

IV. SAMPLE PREPARATION

Determination of soil pH

20g of the ground soil sample was taken into a beaker and $100cm^3$ of distilled water was added and mixed thoroughly. The sample was allowed to stand for 10 minutes. The sample solution was then decanted into another clean beaker. The pHs of the sample solutions were determined using a model 3305 Jenway pH metre. This pH metre was turned on and the probe was inserted into the decanted suspended solution of soil samples. The pH of each solution was taken and recorded. The probe was removed from the samples and thoroughly rinsed with distilled water. The procedure was repeated for all the samples collected from the various farmlands in the present study.

Fig 1.0 Map of the Sampling points and the control site

V. RESULTS AND DISCUSSION

The mean PH of the soil from the various irrigation sites of the Kaduna metropolis are summarized in the below the Table 1.0.

Table 1.0: Distribution of pH in soil from different irrigation sites of the Kaduna metropolis.

				95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
SL (KBL)	6.5	0.306	0.176	5.8	7.3
SL (DMN)	6.4	0.451	0.260	5.3	7.6
SL (RGS)	6.0	0.681	0.393	4.3	7.7

SL (BNW)	6.4	0.400	0.231	5.4	7.4
SL (MKR)	6.2	0.115	0.067	5.9	6.5
SL (KKR)	6.6	0.173	0.100	6.2	7.0
SL (BDK)	6.3	0.306	0.176	5.5	7.0
SL (NAS)	5.9	0.473	0.273	4.7	7.0
SL (MAL)	6.2	0.252	0.145	5.6	6.9
SL (KUD)	6.5	0.173	0.100	6.1	6.9
SL (KKN)	5.9	0.603	0.348	4.4	7.4
SL (KWO)	5.8	0.300	0.173	5.1	6.5
SL (URM)	6.9	1.710	0.987	2.7	11.2
SL (UNS)	5.9	0.404	0.233	4.9	6.9
SL (TDW)	6.1	0.557	0.321	4.7	7.5
SL (DKA)	6.3	0.473	0.273	5.1	7.4
SL (UDS)	8.3	0.208	0.120	7.8	8.8
SL (CTA)	6.2	0.473	0.273	5.0	7.3
SL (KMS)	8.5	0.400	0.231	7.5	9.5
SL (ABK)	6.4	0.400	0.231	5.4	7.4
SL RCK (Control)	5.8	0.681	0.393	4.1	7.5

Table 1.0 shows the pH of soil samples obtained from the 21 irrigation sampling sites of the Kaduna metropolis. Samples obtained from Nasarawa with pH = 5.8 and Kawo with pH = 5.8 also, were the lowest pH in the samples analyzed. These were similar to the pH of the control site Rigachikun with pH = 5.8 (acidic). Sample from Kurmin mashi had the highest pH value (pH = 8.5) and is alkaline. This suggests that most of the irrigation sites were acidic in nature with the exception of samples from Unguwan Dosa and Kurmin mashi. This is also in contrast with the pH of soil from Zaria (9.21) which is alkaline (Uba *et al.,* 2008).

Table 2.0: ANOVA Table for Soil pH

Source of Variation	Sum of Squares	dF	Mean Square	F	Sig.
Between Groups	30.439	20	1.522	4.920	0.000
Within Groups	12.993	42	0.309		
Total	43.433	62			

From the ANOVA Table 2.0 above, $p = 0.000 < 0.05$ shows that there is significant difference in the soil pH across the various sampling sites. The real differences of soil pH can further be analyzed by a post-hoc test using the Duncan Multiple range test in the table below where means of homogeneous subgroups are clearly displayed. Moreover, the mean plots that follow clearly depict the mean values of the soil pH across the various locations.

Table 3.0: Duncan Test for Soil pH

	Subset for alpha = 0.05		
	1	**2**	**3**
Kawo	5.80		
Rigachikun (Control)	5.83		
Nasarawa	5.87		
Unguwan Sanusi	5.87		
Kinkinau	5.93		

Rigasa	5.97		
Tudun Wada		6.10	
Makera		6.17	
Costain		6.17	
Malali		6.23	
Badiko		6.27	
Doka		6.27	
Barnawa		6.40	
Abakpa		6.40	
Danmani		6.43	
Kudenda		6.50	
Kabala		6.53	
Kakuri		6.60	
Unguwan Rimi		6.93	
Unguwan Dosa			8.27
Kurmin Mashi			8.50
Sig.	0.153	0.052	0.610

From the Duncan multiple range tests displayed in Table 3.0, Kawo, Rigachikun, Nasarawa, among others have the least soil pH. In the second homogeneous subgroup there is Tudun Wada, Makera, Costain, among others. The highest soil pH fall in the third subgroup; which include Unguwan Dosa and Kurmin Mashi. This is also depicted in figure 2.0

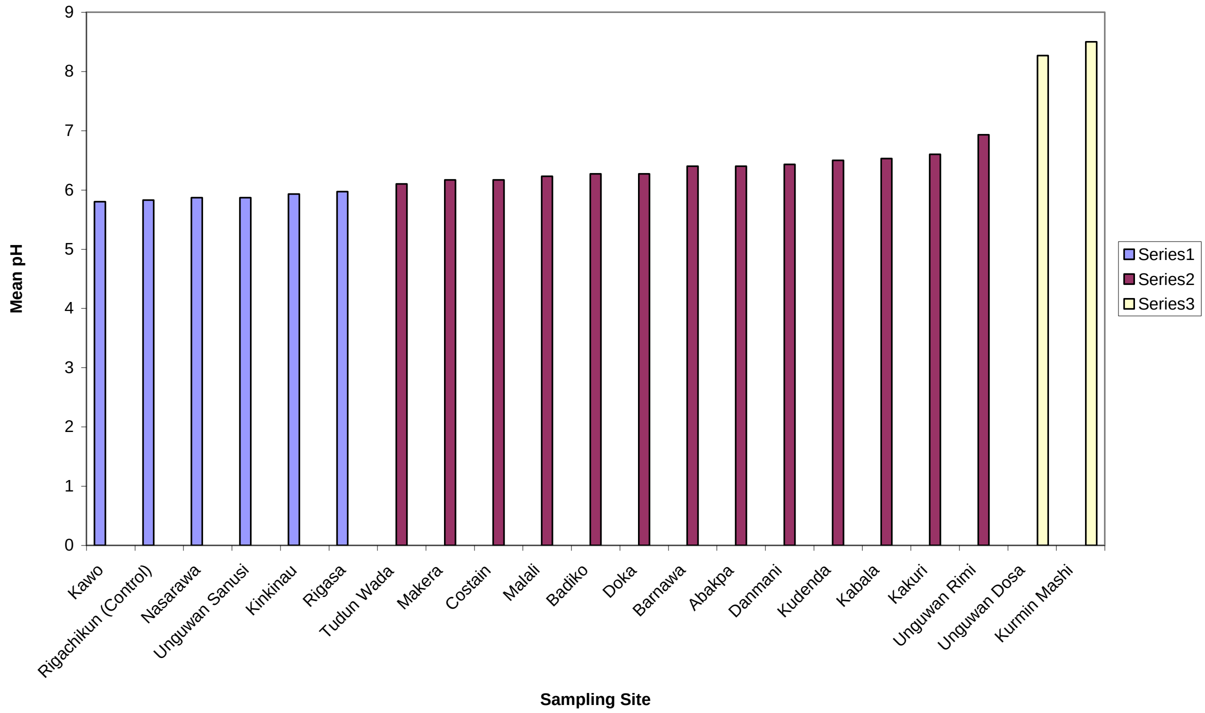

Fig. 2.0: A mean plot for Soil pH

Infact, all PH values of the analyzed soil samples in this research work were mostly acidic since PH is one of the factor that influence the bioavailability and transport of heavy metal in the soil, this is decrease with increase in soil PH. Heavy metals are generally more mobile at PH < 7 that at PH > 7 as reported by Akan., *et al*., (2010)**.** The soil PH varies significantly from one farmland to another ($p < 0.005$)., as a result of human activities occurring in such sites .

VI. CONCLUSION

In the present study, the PH values of different irrigation sites of Kaduna metropolis were determined and found that most of these sites were acidic. Radujevic and Bechkin (1999) explained that acidic soils with PH from 4.0 – 5.5 can have high concentration of soluble aluminum and manganese ions, which may be toxic to the growth of some plant. Winterhalder (1984) stated that toxicity may rise if PH below 5 and also reported that a PH range of approximately 6 to 7 can release most readily available plant nutrients. This is also as a result of excessive usage of fertilizer such as NPK, urea, super phosphate, manure, pesticides, herbicides and other agro – chemicals as well as human activities and use of waste water in irrigating the soil in the study area, thereby reducing the productivity such agricultural area. It is obvious to know that, the absorption and accumulation of heavy metals in plant tissues depend upon soil PH and nutrient availability. This also increase the mobility of heavy metals thus increasing their uptake.

VII. ACKNOWLEDGEMENT

The Authors were grateful to the management of Kaduna Polytechnic for sponsoring this research work.

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