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Relationship between Ph and Conductivity toward Accumulation of Heavy Metals In The Soil Of Irrigated Farmlands Of Kaduna Metropolis Nigeria

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ABSTRACT: *In this research work is the level of electrical conductivity and PH in the soil of irrigated farmlands of Kaduna metropolis using 3305 Jenway pH meter and ELE 470 conductivity meter respectively. It was found that most the values were higher than that obtained from Rigachikun (control site) with PH = 5.8 and conductivity of 2.63 µScm^{-1} .This is similar to that obtained from Kawo with PH = 5.8, conductivity of 2.63 µScm^{-1} and Unguwan Sanusi PH = 5.9, conductivity of 2.3 µScm$^{-1.}$ It was also found that the higher the PH the lower the conductivity values(Kurmin Mashi PH =8.5, conductivity of 1.7 µScm^{-1} and Unguwan Dosa PH = 8.3, conductivity of 1.6 µScm^{-1}) while lower PH gave higher conductivity. This shows that most of the soils from the irrigation sites were acidic with the exception of samples from Unguwan Dosa and Kurmin mashi. From the result of this research work, most of the samples were moderately saline while some are non saline and are within the normal range 0 - 200 µScm^{-1}, .The analysed acidic soil are prone to increased leaching of important compounds and increase assimilation of elements by plants. Plant growing in alkaline soil can have trouble with assimilation of element such as Fe and Cu. Acidic PH retard the growth plants since it grows efficiently in soil PH between 6 – 8 and as such increase mobility of heavy metals and their uptake. This also leading the to toxicity and polluting the soil as well as reducing their productivity. Heavy metals are generally more mobile at PH < 7 than at PH > 7*

KEYWORDS: *Soil, Irrigation, PH and Conductivity Meter, Kaduna Metropolis, Nigeria.*

I. INTRODUCTION

The term "heavy metals" refers to any metallic element that has relatively high density and is toxic or poisonous even at low concentration (Lenntech, 2004). Heavy metals are general terms, which apply to the group of metals and metalloids with atomic density greater than 4g/cm^3, (Huton and Symon, 1988; Garbarino *et al., 1995*, Hawkey 1997., Nriagu, 1999). This classification includes transition metals and higher atomic weight metals of group III to V of the periodic table. Heavy metals include lead cadmium, zinc, copper, iron etc (Duruibe *et al.*, 2007).Heavy metals are among the major contaminant of food supply and are considered as problem to the environment (Zaidi *et al, 2005*). Heavy metals contamination may occur due to irrigation with contaminated water, the addition of fertilizers, metal based pesticides, industrial emissions, transportation, harvesting process and storage. Advancement in technology has lead to high levels of industrialization leading to the discharge of effluent bearing heavy metals into our environment.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).

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).The electrical conductivity of soil varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity and clays have a high conductivity. Soil electrical conductivity (EC) can be related to specific soil properties that affect crop yield such as topsoil depth, PH, salt concentrations and available water – holding capacity. 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).Soil is a vital resource for sustaining basic human needs, a quality food supply and a liveable environment (Wild, 1995). It serves as a sink and recycling factory for both liquid and solid waste. Municipal solid waste has been found to contain appreciable quantity of heavy metals such as Cd, Zn, Pb and Cu all which may eventually end – up in the soil (Alloway and Aryes 1997). Other identifiable sources include atmospheric depositions, manure and fertilizers, pesticides and industrial discharge. (Holgate, 1979).

Heavy metal in soil is either from pedogenic or anthropogenic sources. Studies of heavy metals in soil have tended to concentrate on sewage sludge and aerosol deposition source with limited attention being given to municipal solid waste source. Most often the levels of heavy metal in soil reflect the level of industrialization of the area (Ferlex, 2005). In Northern Nigeria and Kaduna metropolis in particular there is no adequate rainfall for the planting season. In order to complement the water need for farming, irrigation with available river is performed. This occurs with reasonable frequency throughout growing season. 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).In some settlements within Kaduna metropolis, substantial amount of vegetables were produced. These farms are irrigated with waste water from Kaduna River and some other rivers and drainages within the metropolis. For the past several decades, the water from these rivers was clean. However, with the increase in the urban population and industrialization, the water has now become contaminated with various pollutants, among which are heavy metals, variation in PH and conductivity.
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 correlate and find the relationship existing between the Soil PH and electrical conductivity on the soils of different irrigation sites of Kaduna metropolis as well as their adverse effect on agricultural product.

II. MATERIAL AND METHOD

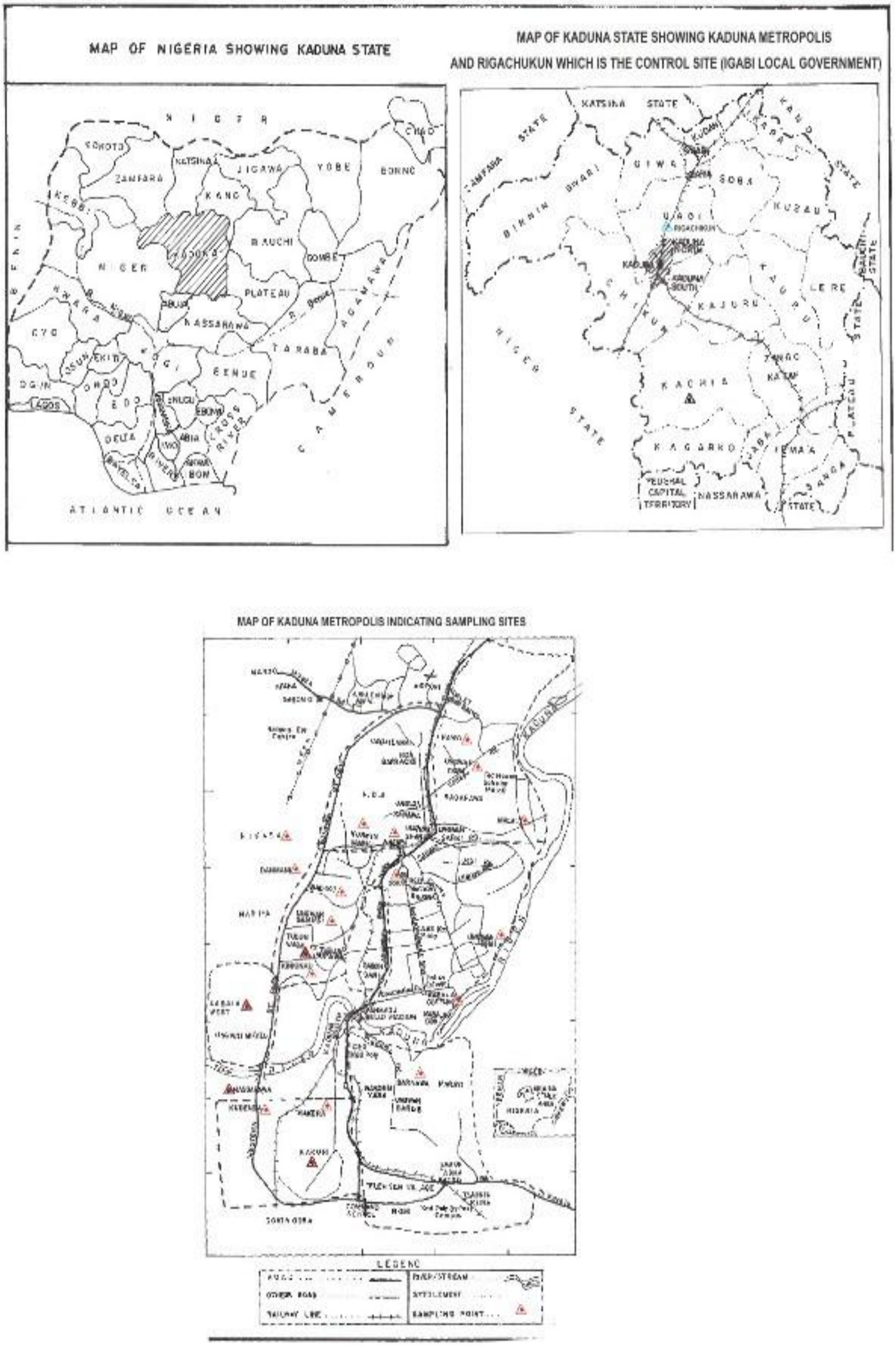
Sample and Sampling:

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.

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. Figure 1.0 shows the detail map of the sampling sites.

Fig 1.0 **Map of the Sampling points and the control site**



III. 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 pH of the sample solutions were determined using a model 3305 Jenway pH meter. This pH meter 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.

Determination of soil conductivity

20g of the ground soil samples was placed in a beaker. 100cm^3 of distilled water was added to form solution. The conductivity of sample solution was determined using a model ELE 470 conductivity meter. The conductivity of the soil samples were taken and recorded.

RESULTS AND DISCUSSION

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

Table 1.0 : Mean pH and Conductivity in soil of different irrigation sites of Kaduna metropolis

Sampling Sites	Mean pH	Mean conductivity (µscm^{-1})
SL (KBL)	6.5 ± 0.306	1.793 ± 0.301
SL (DMN)	6.4 ± 0.451	1.570 ± 0.044
SL (RGS)	6.0 ± 0.681	1.760 ± 0.052
SL (BNW)	6.4 ± 0.400	1.827 ± 0.237
SL (MKR)	6.2 ± 0.115	1.720 ± 0.017
SL (KKR)	6.6 ± 0.173	1.990 ± 0.060
SL (BDK)	6.3 ± 0.306	1.138 ± 0.844
SL (NAS)	5.9 ± 0.473	1.470 ± 0.070
SL (MAL)	6.2 ± 0.252	2.537 ± 0.474
SL (KUD)	6.5 ± 0.173	1.960 ± 0.442
SL (KKN)	5.9 ± 0.603	2.297 ± 0.614
SL (KWO)	5.8 ± 0.300	2.633 ± 0.754
SL (URM)	6.9 ± 1.710	2.260 ± 0.862
SL (UNS)	5.9 ± 0.404	2.343 ± 0.560
SL (TDW)	6.1 ± 0.557	2.453 ± 0.912
SL (DKA)	6.3 ± 0.473	1.723 ± 0.059
SL (UDS)	8.3 ± 0.208	1.610 ± 0.036
SL (CTA)	6.2 ± 0.473	2.110 ± 0.235
SL (KMS)	8.5 ± 0.400	1.723 ± 0.211
SL (ABK)	6.4 ± 0.400	1.620 ± 0.062
SL RCK (Control)	5.8 ± 0.681	2.643 ± 0.625

Table 1.0 shows the summary of mean pH and conductivity in soil from different irrigation sites. pH either directly or indirectly affect several mechanism of metal retaintion by soil.Infact plant grow more in soil with pH between 6 – 8. Cavallaro and McBride (1980) found that copper adsorption by soil showed a stronger pH than Cd. Cu at pH = 6 is hydrolyze and increases its retention by while Cd does not hydrolyze until pH = 8. The effect of pH on heavy metal availability to plant has been reported by many researchers and it is accepted that as pH decreases, the solubility of cationic forms of metals in the soil solution increases and, therefore, they become more readily available to plant (Gray *et al.*, 1998;Salam and Helmke, 1998; Oliver *et al.*, 1998, Singh *et al.*, 1995, Evans *et al.*, 1995, Filius, *et al.*,1998; Mann and Ritchie, 1995; Chlopecka *et al.*, 1996; Vigerust and Selmer – Olensen, 1985). Evans (1989) explained that pH has a major effect on metal dynamic because it controls adsorption and precipitation, which are the main mechanisms of metal retention to soil. Metal solubility product of the solid phase (precipitate) containing the metal. As the pH was increased above 5.5 adsorption of Cu decrease. The explanation for this phenomenon is that at low pH, H^+ competes with the Cu complexation with the organic matter. Also as pH increases, more of the Cu can be complexes with the organic matter and less is therefore adsorbed by the clay. Zinc is retained in an exchangeable form at low pH and become non

exchangeable as the pH was increased above 5.5 (Stahl and James,1991). When the pH was increase above 7.5 however, the solution concentration of Zinc increased. Work by McBride and Blaskiak (1979) showed increased retention of Zn with increasing pH, as is usual for metal cations. Solubility of Fe is also pH – related. Below pH 6 the oxide of Fe dissolves, releasing adsorbed metal ions to solution. (Essen and El- Bassam, 1981). At pH above 6, lead is either adsorbing on clay surface or forms lead carbonate. Most of the soils in this analysis are acidic and acid soils are prone to increased leaching of important compounds and increase assimilation of elements by plants. Plant growing in alkaline soil can have trouble with assimilation of element such as Fe and Cu. The effect of acidifying a soil is visible in decreasing their saturation with exchangeable cations and successive loss of metal like Ca and simultaneous activation of toxic compounds like Fe and accumulation of heavy metals such as Pb by the plant. All the conductivity of the analyzed soil in this research work were within the normal range ,that is, 0 - 200µscm^{-1} as reported by Zaku *et al*., (2011)**.** The pH have strong relationship with the soil as well as the conductivity. From the result of the pH and metals analyzed in this work, some areas had moderate concentration of metals as evaluated in the soil and may account for the low conductivity while others had high metal concentration of metals with respect to their pH and hence account for high conductivity.

IV. CONCLUSION

In the present study, the electrical conductivity of different irrigation sites of Kaduna metropolis were determined and found that most of these sites were within the normal range ,that is, 0 - 200µscm^{-1} as reported by Zaku *et al*., (2011)**.** Also 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. Hence, increase the mobility of heavy metals in the soil. Thereby leading to toxicity and polluting the soil as well as reducing its ability in the production of crops and vegetables in the irrigation sites of Kaduna metropolis.

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