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Effect of Electrical Conductivity on the Soil of Irrigated Farmlands of Kaduna Metropolis Nigeria

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ABSTRACT
The objective of this research work is to assess the level of electrical conductivity in the soil of irrigated farmlands of Kaduna metropolis using conductivity meter. It was found that lowest electrical conductivity of 1.14 μScm^{-1} was obtained from Badiko samples and the highest from Kawo with conductivity of 2.63 μScm^{-1} . It was also found that from the ANOVA $p = 0.000<0.05$ shows that there is significant differences in the electrical conductivity of soil across the various sampling sites. The real differences of soil conductivity was further analyzed by a post-hoc test using the Duncan Multiple range test with samples from Badiko and Nasarawa having the least soil conductivity. In the second homogeneous subgroup there is Danmani, Abakpa, Makera, Doka etc. The third subgroup include Rigasa, Kabala, Barnawa,Kakuri, Kawo, Malali while the highest soil conductivity fall in the fourth subgroup which include Kawo and Rigachikun (control sites). Infact most of the samples were moderately saline while some are non saline, as a result of human activities occurring in such sites, hence, increase the mobility of heavy metals in the soil. Thereby leading to the toxicity and polluting the soil as well as reducing its ability in the production of crops and vegetables in the affected agricultural areas.

Keywords: Soil, conductivity Meter, Kaduna Metropolis, Nigeria.

I. INTRODUCTION

Electrical conductivity (EC) is the ability of a material to transmit (conduct) an electrical current and is commonly expressed in units of milliSiemens per meter (mS/m).

Soil electrical (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salanity and subsoil characteristic

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.

Soil is a dynamic layer in which many chemicals, physical and biological activities are going on constantly. It is not a lifeless zone but an active system having inputs and outputs of energy and matter. The soil has become adjusted to a prevailing condition of climate and plant cover may change when the prevailing condition change (Ademoroti, 1996).

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 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).

In Nigeria the use of polluted water in the immediate surroundings of big cities for growing of vegetables is a common practice. Although this water is considered to be rich source of organic matter and plant nutrients, it also contains sufficient amounts of soluble salts and heavy metals like Fe, Mn, Cu, Zn, Pb, etc. When such water is used for cultivation of crops for a long period, heavy metals may accumulate in soil and may be toxic to the plants. (Kirkhan, 1983).

Long term waste water irrigation may lead to the accumulation of heavy metals in agricultural soils and plants. Food safety issues and potential health risks make this as one of the most serious environment concerns (Cui et al., 2004).

Consequently, with the increasing use of fertilizers, biosolid and other related amendments to boost agricultural production and increasing reuse of treated and untreated wastewater as irrigation water, especially in the developing regions of the world, there is need to adequately assess the possible environmental impacts of such applications and agricultural practices.(Tijani and Agakwu)

The aim of this research work is to assess the effect of electrical conductivity on the soils 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. Figure 1.0 shows the detail map of the sampling sites.

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

SAMPLE PREPARATION

Determination of conductivity

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 conductivity meter of the sample solutions were determined using a model ELE 470 conductivity metre. This conductivity metre was turned on and the probe was inserted into the decanted suspended solution of soil samples. The conductivity 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.

IV. RESULTS AND DISCUSSION

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

Fig 1.0: Distribution of conductivity in soil from different sites of the Kaduna metropolis.

				95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
SL (KBL)	1.793	0.301	0.174	1.045	2.541
SL (DMN)	1.570	0.044	0.025	1.462	1.678
SL (RGS)	1.760	0.052	0.030	1.631	1.889
SL (BNW)	1.827	0.237	0.137	1.238	2.415
SL (MKR)	1.720	0.017	0.010	1.677	1.763
SL (KKR)	1.990	0.060	0.035	1.841	2.139
SL (BDK)	1.138	0.844	0.488	0.960	3.235
SL (NAS)	1.470	0.070	0.040	1.296	1.644
SL (MAL)	2.537	0.474	0.273	1.360	3.713
SL (KKR)	1.960	0.442	0.255	0.861	3.059
SL (KKN)	2.297	0.614	0.355	0.771	3.822
SL (KWO)	2.633	0.754	0.435	0.760	4.506
SL (URM)	2.260	0.862	0.497	0.120	4.400

SL (UNS)	2.343	0.560	0.323	0.952	3.735
SL (TDW)	2.453	0.912	0.527	0.187	4.719
SL (DKA)	1.723	0.059	0.034	1.578	1.869
SL (UNS)	1.610	0.036	0.021	1.520	1.700
SL (CTA)	2.110	0.235	0.136	1.526	2.694
SL (KMS)	1.723	0.211	0.122	1.200	2.247
SL (ABK)	1.620	0.062	0.036	1.465	1.775
SL RCK (Control)	2.643	0.625	0.361	1.092	4.195

Table 1.0 shows the electronic conductivity soil samples obtained from the 21 irrigation sampling sites of the Kaduna metropolis. Conductivity of the Soil Samples

The electrical conductivity of the soil samples from the irrigation sites indicated the lowest conductivity of 1.14 µScm^{-1} from Badiko sample and highest from Kawo with conductivity of 2.63 µScm^{-1} and were both lower than the conductivity value of 3.00µScm^{-1} obtained in soil from Zaria 3.00µscm^{-1}(Uba *et al.*,2008). The higher conductivity value of the soil obtained from Zaria when compared to that obtained in this work may be attributed to the presence of certain element such as Na,Ca,Mg,K,Fe,Cu Zn etc were constituent of the soil and were abundance in the former than in the later.

Table2.0: ANOVA Table for Conductivity

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	10.295	20	0.515	2.337	0.010
Within Groups	9.250	42	0.220		
Total	19.545	62			

From the ANOVA table 2.0 above, $p = 0.010 < 0.05$ there is significant difference in the conductivity across the various sample sites. The real differences of conductivity 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 conductivity across the various locations.

Table 3.0: Duncan Test for Conductivity

	Subset for alpha = 0.05			
	1	2	3	4
Badiko	1.14			
Nasarawa	1.47			
Danmani		1.57		
Unguwan Dosa		1.61		
Abakpa		1.62		
Makera		1.72		
Doka		1.72		
Kurmin Mashi		1.72		
Rigasa			1.76	
Kabala			1.79	
Barnawa			1.83	
Kudenda			1.96	

Kakuri			1.99	
Costain			2.11	
Unguwan Rimi			2.26	
Kinkinau			2.30	
Unguwan Sanusi			2.34	
Tudun Wada			2.45	
Malali			2.54	
Kawo				2.63
Rigachikun (Control)				2.64
Sig.	0.070	0.066	0.063	0.051

From the Duncan multiple range tests displayed in Table 3.0, Badiko and Nasarawa, have the least conductivity. In the second homogeneous subgroup we have Danmani, Unguwan Dosa, Abakpa, among others. Similarly, in the third homogeneous subgroup we have Rigasa, Kabala, Barnawa, among others. The highest conductivity fall in the fourth subgroup; which include only Kawo and Rigachikun. This is depicted in figure 2.0

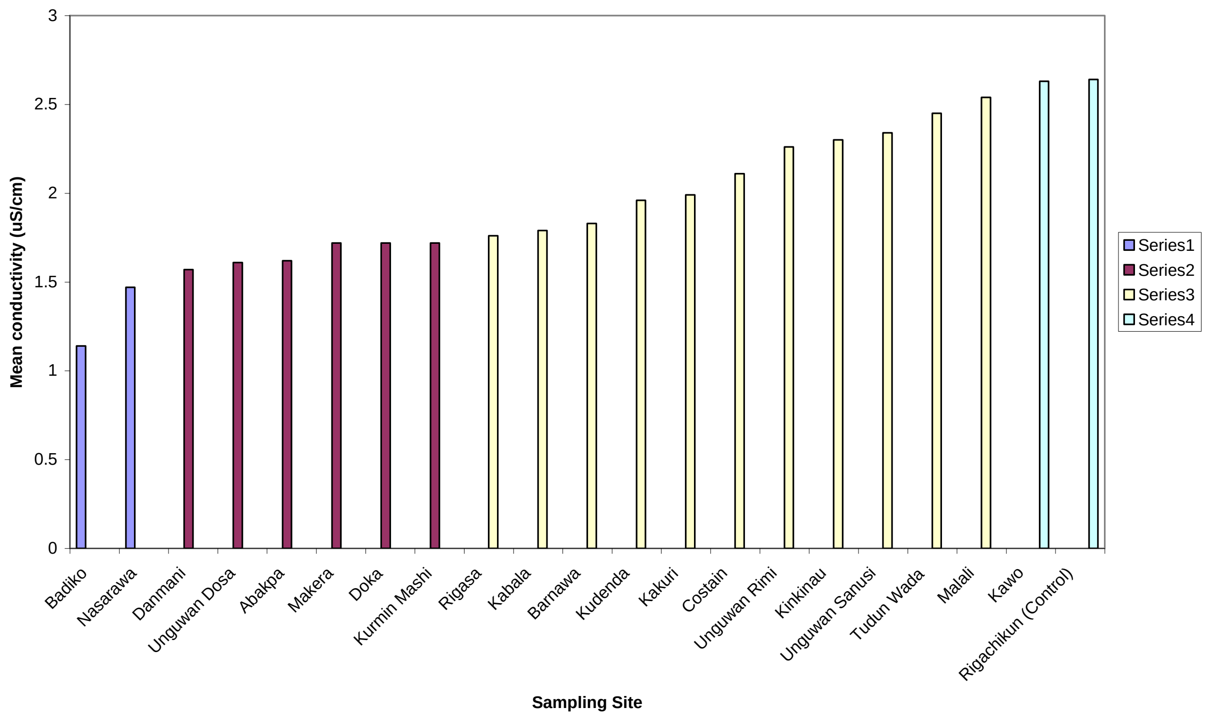

Fig.2.0: A mean Plot for Conductivity

However, all conductivity values 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 soil electrical conductivity varies significantly from one farmland to another ($p < 0.005$). Boulding (1994) classified electrical conductivity of soil as non – saline < 2; moderately saline 2 – 8; very saline 8 – 16 ; extremely saline >16. From the result of this research work, most of the samples were moderately saline while some are non saline, as a result of human activities occurring in such sites . Hence, increase the mobility heavy metals in the soil.

V. 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 most of the samples were moderately saline while some are non saline, as a result of human activities occurring in such sites. 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 affected agricultural areas..

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