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MEASUREMENT OF SALINITY AND ELECTRICAL CONDUCTIVITY OF SOME SOIL SAMPLES OF URUAN LOCAL GOVERNMENT AREA OF AKWA IBOM STATE, NIGERIA.

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ABSTRACT

The salinity and electrical conductivity of some selected soil samples from Uruan Local government area of Akwa Ibom state of the Federal Republic of Nigeria were measured. The results show that an increase in salinity gives rise to an increase in electrical conductivity. The salinities of the area under study falls within the range: $0.025 \leq S \leq 0.1951$ ds/cm while the soil electrical conductivity per unit depth E_c was between the range $0.192 \leq Ec \leq 2.64\ \Omega^{-1}cm^{-1}$. Comparison with the United State Department of Agriculture (USDA) soil classification table, shows that soils in Uruan could be classified as salt free because their salinities are between 0 and 2, implying that salinity effects on crops in Uruan are mostly negligible except for most sensitive plants.

Key words: Salinity, Electrical Conductivity, Soil and Samples.

INTRODUCTION

The study of soil properties provides among other advantages, awareness to users like the farmers. In this era of population explosion, various soil tests and analysis are necessary in order to boost agricultural production. Uruan is chosen for this study because it has a lot of water surrounding it and 80% of its citizens are farmers. Uruan is located between lat.05°02'N and long. 07°66'E in Akwa Ibom State of Nigeria.

Similar studies of soil properties in recent times include; comparison of the thermal properties of soil samples for a passively cooled building design (Ekpe and Akpabio, 1994), thermal properties of soil samples in Uyo local government area, (Ekpe et al, 1996) and characteristics wet and land soils of Akwa Ibom state by Stephen, (1997). All these studies are directed toward effective utilization of our soil for agricultural purposes and other developmental projects such as road construction and bricks making.

Salinity is the level of salt content in a medium. Soil salinity results from the accumulated soluble salts in the soils. Electrical conductivity (E_c) is a measure of the total quantities of soluble salts in soils. Apart from water content in the soil, salt is a major factor that determines electrical properties of the soil. A soil with high salt content exhibits a high electrical conductivity and vice versa. This study is therefore directed towards measuring salinity and electrical conductivity of soil samples in Uruan Local Government Area of Akwa Ibom State of Nigeria with the aim of ascertaining this relationship.

Soil Salinity

Although saline soils occur in the humid regions in area affected by sea water, the most extensive occurrences are in acid regions which are usually found in low lying areas. (Black, 1957). Saline soils occur in the flood plain of rivers, the low-lying shores of lakes and in the depressions in which drainage water accumulates or in any region where marsh, swamp or other poorly drained soil would be found in humid region (Russel,1973). Soil salinity may result from three main natural sources namely: mineral weathering, atmospheric precipitation and fossil salts, remaining from former marine or lacustrine environment (Bohn et al, 1979).

The classification of salt affected soil is often made on the basis of chemical properties that convey certain information with regard to the salt problem (Black,1957). Major cationic constituents such as SO_4.Cl and bicarbonates and minor cationic constituents such as KCO_3 and NO_3 enrich the salinity of the soil (Russell, 1973). Numerous ions occur in smaller quantities and among them is borate. The presence of these salts in the soils in larger quantities interfere with growth of most plants (Brady, 1974).

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Electrical Conductivity

Electrical conductivity can be regarded as the product of two factors; namely charge density, N_e, and mobility of electrons, (μe) ie. $\sigma = \mu_e (N_e e)$, where σ is electrical conductivity in mho/cm at 25°C, N_e is the total number of electrons, and e is the electronic charge.

Thus we may have high electrical conductivities because there are lots of electrons around or because they acquire high drift velocities (by having high mobility). In metals, high electrical conductivity is due to the high density of electrons (Yadav et.al. 1979 and Solymar and wash,1990).

There is no full proof conversion factor that can be used to compare electrical conductivities of different soil to the ratios of water content in the soil, since even if the moisture characteristics of the soil are known, the solubility of the salts may vary with increasing dilution. However, the following relationships (which are approximate) may be useful as a rough guide provided the samples do not contain significant amount of gypsum: (Talsma,1968 and Loveday et. al 1972) $E_{Ce} = 2.2 \times E_{C1:1}$ $E_{Ce} = 6.4 \times E_{C1:5}$.

Many interpretations of E_C values have been devised, but no universal precise interpretation is possible because the effects of salinity are modified greatly by other factors such as quality of irrigation waters, soil textu[illegible] salt types present, crop varieties and species, soil drainability, stage of crop growth and climate. Some of the more widely used interpretation are given in table 1 below showing the relationship between conductivity, total salt content and crop yields.

Table 1: Showing electrical conductivity, total salt content in percentage and crop reaction (Richard, 1954).

USAD soil class	Designation	Ecc (mho/cm	Total salt content %	Crop reaction
0	Salt free	0- 2	< 0.15	Salinity effects are mostly negligible
0	Salt free	0- 2	< 0.15	Salinity effects are negligible except for the most sensitive plants.
1	Slightly saline	4 – 8	0.15 – 0.35	Yields of many crops restricted.
2	Moderately saline	8 – 15	0.35 – 0.65	Only tolerant crops yield satisfactorily
3	Strongly saline	> 15	> 0.65	Only very tolerant crops yield satisfactorily

The above table is taken from Richard, 1954.

EXPERIMENTATION

Sample Collection and Preparation:

Soil samples were collected from each of the eleven wards in Uruan Local Government Area of Akwa Ibom State in the Federal republic of Nigeria. The samples were collected at a depth of 10cm by digging with a hoe. The samples were labeled from 1 to 11. Each of the sample was heated to dryness to remove water molecules. The heating was done in a way that the percentage water content in each of the sample was neglegible. This was to ensure uniformity in the result obtained from each of the measurements. Wet soil will normally constitute the problem of redistribution of water under the influence of temperature gradient.

Measurement of Salinity

The following were used during the analysis, silver nitrate, distilled water, shaker, volumetric flask, potassium dicromate method was used where silver nitrate, 25ml of distilled water were added to 10g of the soil and shaken for 30 minutes using mechanical shaker and there after filtered with whatmans filter. The extract was stored for titration.

The water sample was titrated with silver nitrate (silver trioxonitrate v) solution using chromate indicator. An indicator like fluorescein can safely be replaced by chromate. Usually, when silver nitrate is treated with sodium chloride solution containing a small potassium chromate, a white precipitation of silver chromate is formed in the presence of any chloride ions in the liquid. When all the chlorides have reacted, a red precipitate of silver chromate is formed and this is added to a chloride, solution containing fluorescein, that of the precipitate silver chloride formed in a colloidal state and has a great absorbing power. When a slight excess of silver nitrate is added, silver ions (Ag^+) are absorbed in preference to negative nitrate (NO_3) ions. The silver ions so absorbed will attract the negative fluorescein ions which leads to the formation of a

rose pink precipitate of silver fluorescein. A white precipitate of silver chloride turning rose pink is the end point of the titration. These reactions are represented in the following equations:

$Cl^- + Ag^+ \longrightarrow AgCl$ (colourless)
$Br^- + Ag^+ \longrightarrow AgBr$ (light yellow colour)
$I^- + Ag^+ \longrightarrow AgI$ (orange colour)
$CrO_4^{3-} + 2Ag \longrightarrow Ag_2CrO_4$ (red brown colour)

Measurement of Electrical Conductivity

The following were used during the experiment: distilled water, conductometer and shaker and the soil samples. Electrical conductivity meter used to investigate the changes in electrical conductivity which occur during the reaction between acids and alkalis.

The principle of conductometric titration indicate that the solvent and any molecular species in solution exhibit only negligible conductance, that the conductance of dilute solution rises as the concentration of ions is increased and tat at any given concentration the hydrogen ions and the hydroxyl ions are much better conductors than any of the other ions. One of the commonest example is when a dilute hydrochloric acid solution is titrated with one of sodium hydroxide. The initial conductivity is high because the hydrogen ions concentration is high and it falls as the titrant is added.

In our measurement, a 25ml of distilled water was added to 20g of each of the soil samples. The mixture was shaken and left for about 30minutes. Each of these mixtures (soil sample and distilled water) was added to a standard solution with the help of a conductometer. In this way, the electrical conductivity of each sample was measured.

Results

Using the value of E_c and S in table 2 and Spearman rank correleration coefficient:

Table 2: Showing soil salinity and electrical conductivity.

Location in Uruan		Salinity, S (ds/cm)	Conductivity, E_c (mmho/cm)
Mbiaya	U1	0.0388	0.394
Ekpene Ibia	U2	0.0456	0.512
Ekim enem	U3	0.0774	0.976
Ibiaku	U4	0.0852	0.992
ItukMbang	U5	0.1951	2.64
Idu	U6	0.0699	0.989
Ifianyong	U7	0.078	0.999
Ekpene Ukim	U8	0.025	0.310
Ndon Ebom	U9	0.664	0.680
Adiadia	U10	0.524	0.530
Nung Oku	U11	0.034	0.370

Table 2: Experimental result showing values of salinity and conductivity.

$$\rho \quad \frac{1 - 6T}{n(n^2 - 1)} \qquad \ldots\ldots (1)$$

where n = 11 (number of samples) and $T = \sum(E_{cR} - S_R)^2 = 4$ and E_{cR} S_R are correlation coefficient of electrical conductivity and salinity read from correlation table respectively.

Null hypothesis (H_0): $E_c = S$ if $\rho_{cal} > \rho_{table}$

Alternative hypothesis (H_A): $E_c \neq S$ if $\rho_{cal} < \rho_{table}$

Where ρ_{cal} = calculated value of ρ and ρ_{table} = value of ρ from correlation table.

From the correlation table with 10 degree of freedom ρ_{table} at $\alpha = 0.05$, 95% is 0.5515. ie.

$$\rho_{table} = 0.5515 \qquad \ldots\ldots (2)$$

$$\rho_{cal} = 1 - \frac{6T}{n(n^2 - } \qquad \ldots\ldots (3)$$

$$= 1 - \frac{6 \times 4}{11(11^2 - 1)} = 0.9818$$

Hence $\rho_{cal} > \rho_{table}$, and the null hypothesis is upheld that $E_c = S$. The above is summarized in table 3

Table 3: showing E_{CR}, E_R, $E_{CR} - S_R$ and $(E_{CR} - S_R)^2$

	E_c	S	E_{CR}	S_R	$E_{CR} - S_R$	$(E_{CR} - S_R)^2$
U1	0.394	0.039	3	3	0	0
U2	0.512	0.048	4	4	0	0
U3	0.976	0.077	7	8	-1	1
U4	0.992	0.085	9	10	-1	1
U5	2.640	0.195	11	11	0	0
U6	0.989	0.070	8	7	-1	1
U7	0.999	0.078	10	9	1	1
U8	0.310	0.025	1	1	0	0
U9	0.680	0.664	6	6	0	0
U10	0.530	0.524	5	5	0	0
U11	0.370	0.034	2	2	0	0

DISCUSSION

The bar presentation of the data in (fig.1) gives the salinity of soil with the accompanied electrical conductivity. The proportionate increase in conductivity with the salinity is due to the presence of metallic ions in salt. The atoms of these metals are made up of the protons, the electrons and the neutrons

The movement of electrons results in the production of current. Therefore, it can be said that electrical conductivity of the soil increases with a corresponding increase in salinity or the amount of metallic ions present in soil and vice versa.

The salinity and electrical conductivity of some selected soil samples from each ward in Uruan local government of Akwa Ibom state were measured. The results reveal that an increase in salinity gives and increase in electrical conductivity. In Uran local government area, the salinity S is between the range $0,025 \leq S \leq 0.1951$ ds/cm. Also, the electrical conductivity E_C is between the range $0.192 \leq Ec \leq 2.64$ mho/cm.

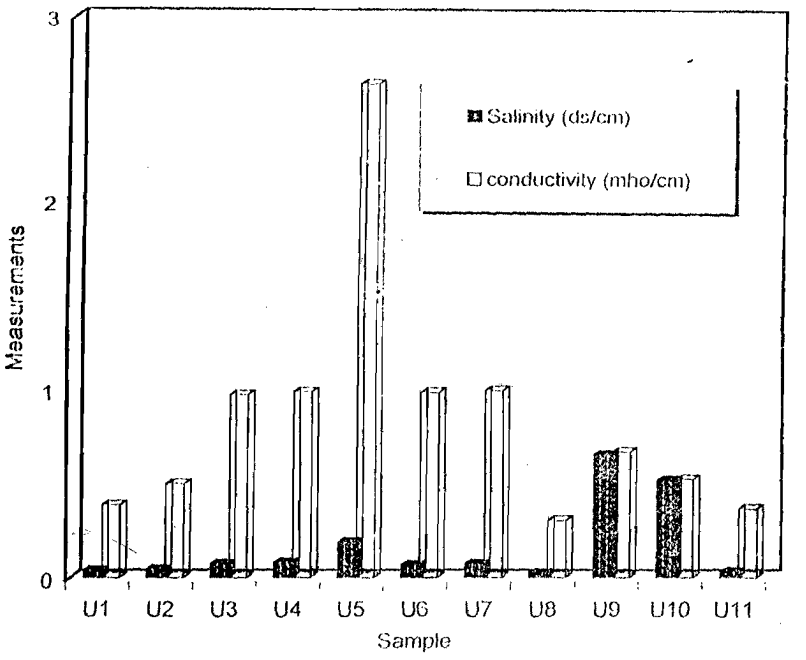

Fig.1: Measurement of soil salinity and conductivity

In comparison with the USAD soil classification Table 1, soils in Uruan could be designated as salt free because their salinities are between 0 and 2. Put in other words, salinity effects are mostly negligible in Uruan except for most sensitive plants.

CONCLUSION

From the results of measurement of salinity and electrical conductivity of some soil samples from Uruan local Government area of Akwa Ibom State, Nigeria, and within the experimental errors, we can conclude that electrical conductivity and salinity are linearly related (ie increase in salinity will cause a corresponding increase in electrical conductivity)

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