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Comparative Study of Electrical Conductivity and Salinity of Three Land Form in Akwa Ibom State.

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Abstract

The electrical conductivity (EC) and salinity of some selected soil samples collected from three landforms, namely Beach Ridge Sand (BRS), coastal plane sand (CPS), sandstone/shale Hill ridges (SHR) from Akwa Ibom State of the Federal Republic of Nigeria were measured, the obtained data were subjected to spearman rank order statistics and result shows that there were positive correlation of 3.98 between EC and salinity. The electrical conductivity of the area under study falls within the range of 0.033 ds/m and 0.123 ds/m while the salinities are between 0.70 mg/l and 0.85mg/l. From the EC data the signal strength of EC measurements decreases with decrease in salinity, the EC range of the three landforms is the optimum level for most plants, usually indicates well fertilized soils, and salt sensitive plants may be injured.

Keywords: Salinity, Electrical conductivity, and soil samples.

Introduction

The study of soil properties is very important and useful to determine the salinity content of a particular land before cultivation can be done. This is so because various crops have different salt tolerance for good yielding and plant growth. If the salt tolerance level of a crop is known, the types of crop to be cultivated on that land will as well be known and this will increase crop yields in a situation whereby the salt concentration of a land is too high. By knowing the electrical conductivity of their soils, farmers can make more precise management decisions about fertilization applications, irrigation use of infanticides and other pesticides applications.

The physical mechanism of conductivity in silicate rock is by semi-conductivity and its electrical conductivity is temperature dependent. It varies with temperature and to a small degree with physical conditions. The conductivities of the ground vary with type of soil. Sandy soil is not as good as conductor as a black soil. The higher the moisture of the soil, the poorer the conductor the soil is.

Similar studies of soil properties in recent times include: measurement of salinity and electrical conductivity of some soil samples of uruan local government area of Akwa Ibom State. (Akpan et al, 2001), measuring the electrical properties of soil using a calibrated ground – coupled GPR system (Oden at al 2008) and characteristics wet and land soils of Akwa Ibom State. (Stephen 1997).

Soil electrical conductivity (EC) is a property of soil that is determine by standardized measures of soil conductance (resistance-^{1}) by the distance and cross sectional area through which a current travels

(Rhoades, 1996). Salinity is the level of salt content in a medium. Soil salinity results from the accumulated soluble salts in the soils. Apart from water content in the soil, salt is major factors that determine 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 Akwa Ibom State, Nigeria.

Experimentation

Sample Collection and Preparation

Soil samples used for the experiments were collected from three landforms in Akwa Ibom State. The landform are: Beach Ridge sand (BRS), sandstone/shale –hill Ridges (SHR) and coastal plane sand (CPS) the soil samples were collected using “soil ogre” from different depth (0 – 30cm)

Seven different soil samples were collected; locations and sources of collection are as shown in the table below:

Table 1 : Showing Landforms and Sources of soil samples

Landforms	Sources
Beach Ridge Sand (BRS 1)	Ikot Ibiok (Eket LGA)
Beach Ridge Sand (BRS 2)	Ikot Akpan Mkpe (Onna LGA)
Sand Stone / Shale Hill Ridge (SHR 1)	Ikpe Ikot Nkon (Ini LGA)
Sand Stone / Shale Hill Ridge (SHR 2)	Ibiaku Nfok Okpo (Ikono LGA)
Sand Stone / Shale Hill Ridge (SHR 3)	Ntak Inyang (Itu LGA)
Costal Plane Sand (CPS 1)	Ikot Akan (Nsit Ubium LGA)
Costal Plane Sand (CPS 2)	Uniuyo Annex (Uyo LGA)

Measurement of Electrical Conductivity

The following were used during the analysis: weighing balance, 2.0mm sieve, distilled water, mortar and pestle, shaking cups, measuring cylinder, mechanical shaker and electrical conductivity meter.

The samples were taken to the laboratory in labeled polythene bags, they were airdried and also dried in an oven to remove water molecules. They were then crushed and passed through a 2.0mm sieve before the analysis.

10g of each of the soil samples were weighed into 100ml polyethylene tube and 20ml of distilled water was added to each of the 100ml polyethylene tube. They were agitated on a mechanical shaker for 1.5 minutes, and then allowed to stand for at least an hour. They were returned to the mechanical shaker for 2 hours. Centrifuged (filtered) and carefully decant the supernatant solution. The electrical conductivity of each of the soil samples were measured using electrical conductivity meter (Conductometer) by taking reading directly from the meter.

Measurement of Salinity

The following were used during the experiment: weighing balance, 2.0mm sieve, 20m pipettes, mortar and pestle, plastic cups beaker, funnel, conical flask, distilled water, filter paper, (whitman's), soil samples, mechanical shaker, measuring cylinder, 50cm burette, reagent (silver nitrate ($AgNO_3$) and potassium dichromate (K_2CrO_4).

10g of each of the sieved soil samples were measured into plastic cups and 40ml of distilled water was added to each of the samples and shake for 30 minutes using mechanical shaker. Filtration was carried out using Whitman's filter paper; the extract was stored for about 1 hour. Silver nitrate ($AgN0_3$) and potassium dichromate (K_2CrO_4) were used as reagent. 20ml of the extract was pipetted into the conical flask then 1ml of K_2CrO_4 was added to the pipette extract. They were then titrated with sliver nitrate ($AgN0_3$) solution to an end point of red brow color, and the titer value was recorded.

Table 2: Results showing values of Electrical Conductivity and Salinity of Soil Samples

Landforms	Electrical Conductivity (ds/m)	Salinity (mg/l)
BRS 1	0.073	0.70
BRS 2	0.049	0.85
SHR 1	0.045	0.75
SHR 2	0.123	0.85
SHR 3	0.033	0.80
CPS 1	0.050	0.80
CPS 2	0.057	0.80

Table 3: Showing result of calculating $EC_R – S_R$ for soil samples

Landforms	EC(ds/m)	Salinity (mg/l)	EC_R	S_R	$D=EC_R – S_R$	D^2
BRS 1	0.073	0.700	4.000	15.000	- 11.000	121.000
BRS 2	0.049	0.850	10.750	4.500	6.250	39.060
SHR 1	0.045	0.750	13.500	11.250	2.250	5.060
SHR 2	0.123	0.850	2.000	4.500	- 2.500	6.250

SHR 3	0.033	0.800	17.000	7.500	9.600	90.250
CPS 1	0.050	0.800	11.000	7.500	3.500	12.250
CPS 2	0.057	0.800	9.750	7.500	2.250	5.060

$\sum d^2 = 278.93$

Using the value of EC and salinity in table 2 and spearman rank correlation co-efficient.

$$\alpha_S = 1 - \frac{6 \sum d^2}{n (n^2-1)} \qquad (1)$$

$n = 7$

$d = EC_R - S_R$

$$d^2 = (EC_R - S_R)^2 \qquad (2)$$

$EC_R - S_R$ are correlation coefficient of electrical conductivity and salinity read from correlation table respectively.

$$\alpha_S = 1 - \frac{6 \text{ X } 278.98}{7 (7^2 - 1)}$$

$$= 1 - \frac{1673.58}{7 (48)}$$

$$= 1 - 4.98$$

$$= 3.98$$

Analysis of Result

Using analysis of variance (ANOVA) to determine whether the EC values for the three landforms where the soil samples were collected area the same,

Null hypothesis (H_O): EC = S if $\alpha_{cal} > \alpha_{table}$

Alternative hypothesis (H_A): EC = S if $\alpha_{cal} < \alpha_{table}$

Where α_{cal} calculated value of α and α_{tzble} value of α from collection table with 10 degree of freedom α_{table} at

$\gamma = 0.01$, 95% is 0.0986 i.e.

$\alpha_{tzble} = 0.0986$

$\alpha_{cal} = 3.98$

Hence $\alpha_{cal} > \alpha_{tzble}$ and the null hypothesis is upheld that EC = S, the above is summarized in the table 3.

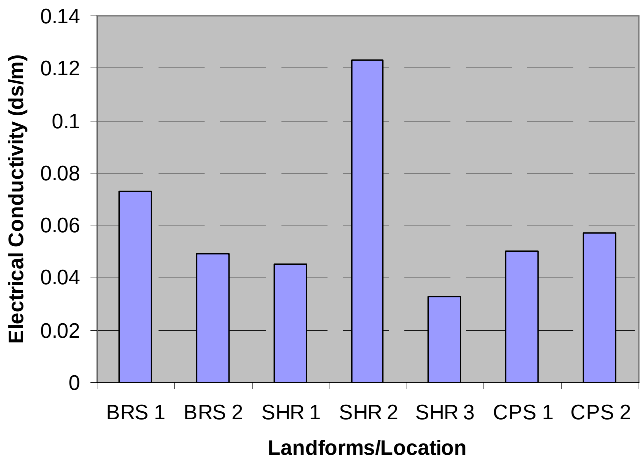


Figure 1: Measurement of Electrical Conductivity

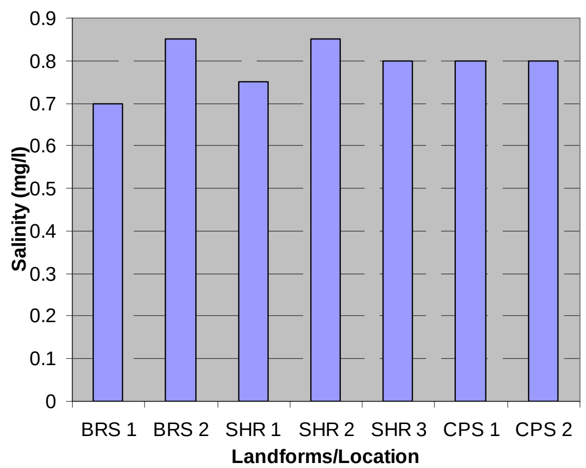
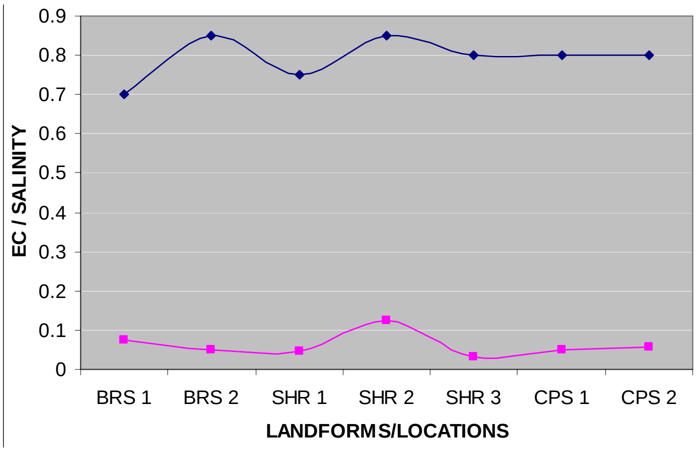


Figure2: Measurement of Salinity



Graph1: Electrical conductivity and Salinity of Different Landforms

Discussion

Using spearman's rank correction coefficient, the correlation between electrical conductivity and salinity of the soil samples was found to give a position relationship of 3.98. This implies that electrical conductivity of the soil is directly proportional to the salinity of soil samples, the higher the salinity of the soil sample the higher the Electrical conductivity of the soil samples,(this also can be seen from the graph of EC and Salinity) and also it shows that the type of salt (metallic or non-metallic) will determine how well the soil will conduct.

Considering the Histogram showing EC and Salinity measurement of different soil samples of figure 1 and 2. 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.

Conclusion

From the result of measurement of salinity and Electrical conductivity of some soil samples from different landforms in Akwa Ibom State, Nigeria, the EC is between 0.033ds/m and 0.123ds/m. It is a fact that Electrical Conductivity data were less that 2ds/m which indicates that the land where the soil samples were collected are suitable for cultivation and the signal strength of the Electrical Conductivity measurement decreases with that soil Electrical Conductivity is directly proportional.

References

[1] Akpan U. E. Okon A. A. and Itue E. E. (2002) measurement of salinity and Electrical Conductivity of Akwa Ibom State, Nigeria. Global Journal of pure and applied sciences 8(3): 399 – 403

[2] Bamlusel, R. I. G. M. S. Bitzer and J. H. Grove (1996): Agromonic benefits of varying corn seed population: a central Kentucky study p. 951 – 966.

[3] Nycle C. Brady and Lay .R. W. (1999): The Nature and properties of soils, 12th edition prentice Hall, Inc.

[4] Oden .C.P. Ohoeft G. R. Wright D. C and power (2008) M.H: Measuring the Electrical properties of soil using a calibrated ground – coupled GPE system. Vadose Zone Journal, 7(1): 171-183.

[5] Rhoades, J. D (1996): Salinity; Electrical conductivity and total dissolved solids, p. 417 435.

[6] Stephen O.E (1997): characteristics and hydrologic grouping of representative wetland soils of Akwa Ibom State (a there is unpublished), department of soil science. University of Uyo. Pp. 38-43.

[7] Huisman J.A. Hubbard S. S, Redman J.D, Amman A. P. (2003): measurement soil water content with ground penetrating Radar: vadose Zone Journal. 2(4): 476 – 491.