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Research Article

Soil Chemical Properties As Influenced By Irrigation Water Sources in Sokoto, Nigeria

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Abstract: The study was carried out on farms around Kwalkwalawa Fadama area along Usmanu Danfodiyo University, Sokoto to assess the effect of irrigation water sources on the chemical properties of soils. The experiment consisted of three (3) treatments (Well, river and combined sources of well and river). Water samples were taken and analysed for pH, EC, SAR and Exchangeable bases to assess the quality of the water used for the irrigation. Soil samples was also collected for at 0-20 cm depth and analyzed for similar parameters including CEC. The result indicated that the water is adequate for irrigation and chemical properties the soil was influenced by application of different irrigation water source.
Keywords: Irrigation, Water Quality and Soil Chemical Properties.

INTRODUCTION

The outlook for the food security of many developing nations is a cause for serious concern. To overcome this problem, alternative strategies and options to increase food production, ensure maximum utilization of limited land, and use of appropriate technologies need to be considered. One option includes that of opening up more land for crop production through irrigation in the arid and semi-arid lands (Adhan, 2009; Ndegwa and Kiiru, 2012). Arid and semi-arid regions are characterized by evapotranspiration that exceeds precipitation during the largest part of the year. Therefore, agriculture in these regions relies on irrigation to achieve satisfactory yields (Jimenez-Cisneros, 1995). Irrigation water is obtained from groundwater, surface streams, artificial and natural sources. Ayers and Wescot (1994) argues that a major concern of irrigation in agriculture is that irrigation and drainage systems generate problems that make them unsustainable. Some of these problems include salinization, alkalization, water logging and acidification. It has been estimated that up to 20% of irrigated lands in the world are affected adversely by different levels of salinity and sodium contents (Feizi, 1993).

This study aims at accessing the effects of the major irrigation water sources on the chemical properties of soils at Kwakalawa irrigation farms, Sokoto state, Nigeria.

METHODOLOGY

Study Area:

The study was carried out during the 2018 dry season at KwalkwalawaFadama area. The area lies along the Rima River flood plain in Wammako, Sokoto, Sokoto state of Nigeria. Sokoto is located in the Sudan Savannah ecological zone of Nigeria on Latitude $13^{0}01$'N, Longitude $5^{0}15$'E and at an altitude of about 350 m above sea level. The climate of the area is semi-arid with mean (20 years) annual rainfall of about 645 mm (Sokoto Energy Research Center (SERC, 2012).

The treatments consisted of the two major irrigation water sources identified in the study area (i.e.: River and well irrigation sources. It was also gathered that some farmers make use of both sources at different times. Hence, there were three treatments: River (R), Well (W) and Combined sources (RW).

Water quality assessment was conducted by collecting samples of water from the two identified sources (i.e. three wells were used as replicate for well water, while for river; samples were from three

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different points along the river within the study area catchment) and evaluated in the laboratory for: pH, Electrical Conductivity, Sodium, Magnesium, Potassium, Calcium and Sodium Absorption Ratio. The result obtained was compared with the guidelines on the assessment of irrigation water as given by Ayers and Westcot, (1994).

Simple random sampling technique was adopted in the collection of soil samples. The samples were collected in replicates from three farms each receiving a particular water source (river, well and combined) for its irrigation. Sampling was made at the depths of 0-20cm.

The soil samples was air dried, crushed, sieved using 2mm diameter sieve and analysed for;

Soil pH: The pH of the samples will be determined using the Electrometric method (Glass Electrode) in a 1:1 soil-water solution.

Electrical Conductivity: The electrical conductivity was determined using the conductivity cell by measuring the electrical resistance of a 1:5 soil-water suspension (Rayment and Hagginson, 1992).

Exchangeable Bases: Exchangeable calcium and magnesium were determined using the EDTA titration method, while exchangeable sodium and potassium were read using flame photometer (Black *et al.*, 1934).

Sodium Absorption Rate: The Sodium Absorption Rate was calculated on the basis of the standard equation as outlined by Richards, (1954). The equation is given below:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

Organic Carbon:

The organic carbon of the samples was determined using the Walkley Black method (Walkley and Black, 1934).

Available Phosphorus:

Available phosphorus was determined using the Bray-1 method (Bray and Kurtz, 1945).

Cation Exchange Capacity:

The CEC was determined using the ammonium acetate saturation.

Statistical Analysis:

Data obtained was subjected to analysis of variance (ANOVA) using statistic 9.0 analytical software. Means were separated using least significant difference (LSD) test at 5% level of probability.

RESULTS AND DISCUSSION

Irrigation Water Quality

Table 1.0: Properties of irrigation water from River and Wells at Kwakwalawa Fadama, Sokoto

Parameter	Water Source	Sample			Mean
		1	2	3	
pH	**River**	5.65	5.75	5.72	**5.71**
	Well	6.14	6.29	6.20	**6.21**
EC (dSm^{-1})	**River**	0.08	0.11	0.17	**0.12**
	Well	1.60	1.84	1.71	**1.72**
Sodium ($cmolkg^{-1}$)	**River**	0.04	0.09	0.17	**0.10**
	Well	3.04	3.30	3.17	**3.17**
Potassium ($cmolkg^{-1}$)	**River**	0.08	0.10	0.13	**0.10**
	Well	0.18	0.13	0.21	**0.17**
Calcium ($cmolkg^{-1}$)	**River**	0.65	0.80	0.85	**0.77**
	Well	1.95	1.80	2.05	**1.93**
Magnesium ($cmolkg^{-1}$)	**River**	2.80	2.15	2.00	**2.31**
	Well	4.25	5.00	4.00	**4.42**
SAR	**River**	0.03	0.07	0.14	**0.08**
	Well	1.73	1.79	1.83	**1.78**

EC: Electrical conductivity, SAR: Sodium Absorption ratio

Table 1: presented result on the properties of irrigation water from Kwalkwalawa Fadama area Sokoto. The result indicated that the mean pH values of water from river and well respectively, were slightly acidic which is within the adequate pH range for irrigation water (Lucia, *et al*., 2018).

The electrical conductivity (EC) values for river and well were low and moderate respectively. According to Lucia *et al*., (2018), EC values <0.70 is adequate for irrigation, 0.70- 6.50 is warning while > 6.50 is extreme restriction. Therefore, the EC value of the water from river have indicated no risk of salinity while continuous use of water from the well in the study area is attributed to potential salinity problem and adverse effect to crop production.

The mean value for Sodium Adsorption ratio (SAR) from river and well indicated an unlikely occurrence of sodium hazard. According to Lucia, *et al*., (2018), SAR value < 3.00 is adequate for irrigation, 3.00 – 9.00 is warning and > 9.00 is under extreme restriction. The SAR express the toxicity effect of irrigation water on crops and degradation effect on soil fertility due to sodium ions.

Table 2: Effects of Irrigation Water Sources on Soil Chemical Properties

Treatment	pH	O/C g/kg	Avail. P. g/kg	Exchangeable Bases cmolkg^{-1}				CEC cmolkg^{-1}	EC	SAR
				Ca	Mg	Na	K			
Well	5.97^{a}	1.31^{b}	0.99^{a}	2.27^{a}	2.37	0.46^{b}	0.25^{c}	14.53^{a}	0.23	0.32^{b}
River	5.74^{ab}	1.41^{b}	0.91^{ab}	2.58^{a}	2.67	0.58^{b}	0.56^{b}	10.93^{b}	0.20	0.36^{b}
Combined	5.72^{c}	2.28^{a}	0.88^{b}	1.52^{b}	2.08	1.47^{a}	1.14^{a}	8.40b^{c}	0.34	1.09^{a}

O/C: organic carbon, CEC: Cation exchange capacity, EC: Electrical conductivity, SAR: Sodium Absorption ratio

Table 2: presented the result on the effect of irrigation water sources on soil chemical properties at Kwalkwalawa Fadama, Sokoto. The result indicated that different water sources for irrigation have significant effect (P<0.05) on almost all the considered soil chemical properties.

Soil that received water from well recorded the highest pH value, this was however, statistically similar (P<0.05) to soils irrigated with river water. The lowest pH value was recorded in soil with combined water sources (river and well). The high pH value due to well water irrigation could be attributed to the direct addition of basic cations to the soil (Table 1). Hailu *et al*., (2003) and Getaneh *et al*, (2007) reported significant change in pH of soils upon irrigation with different water sources.

Irrigation water sources had a significant influence (P <0.05) on the cation exchange capacity (CEC) of soil. Maximum mean CEC value was obtained from soils under well water irrigation followed by farms receiving river water which was statistically same to soils irrigated with combined well and river water. The overall high CEC in the irrigated farmlands could be attributed to the transportation of exchangeable cations to the soils by erosion (Getaneh *et al*., 2007) or due to the increase in the organic matter content resulting from continuous irrigation (Denef *et al*., 2008).These findings are in line with Adejumobi *et al*., (2014) who reported a significant change in CEC after irrigation at OMI Irrigation Scheme.

Electrical conductivity of the soil was not significantly influenced (P >0.05) due irrigation with different water sources. However, the higher EC values from the combined sources may be due to the effect of the salt content of wells used for irrigation during the dry season (Hakim *et al*., 2009). Irrigation plays a role of promoting leaching of salts (Valenzo *et al*., 2001). This could be the reason for the generally low EC values obtained from the study area. The low EC values are in line with Richard (1954) who reported a decrease in the EC level through leaching on irrigated soils. In general the EC values suggest that there is no accumulation of soluble salts to the depth sampled to such an extent that can limit crop production. This was supported by FAO, (2014) who reported EC of (<0.8 dS/m) as low in range, to cause any salinity hazards.

Irrigation water sources significantly influenced (P< 0.05) the sodium adsorption ratio of the soil at Kwalkwalawa Fadama, Sokoto. However, all the SRA values fall below the toxicity margin (6). The low SAR values may be attributed to the chemical properties of the irrigation water sources which show a dominance of calcium and magnesium ions to that of sodium. Quirk (1971) reported that the relative amounts of cations (Ca, Mg, and Na) in the exchange sites of the soil particles determine the effect of salts on the soil. Increasing sodicity hazards may be associated with values exceeding 6 (Yahaya *et al*., 2016). Soils irrigated with combined water sources recorded the highest SAR Value and was statistically at par to those soils irrigated with river or well's water alone.

Based on the findings from this research it was concluded that; farmers in Kwalkwalawa fadama, Sokoto uses more than one source of water for irrigation and that the water is of adequate quality with limited risk for acidification, salinization and sodicity problem to the soil in the production farms. However, continuous use of the water from well is attributed to those risks mentioned. The chemical properties of the soil was found to be influenced (P<0.05) due application of water from different irrigation sources.

RECOMMENDATIONS

The Following Are The Recommendations Based On The Study:

- Regular analysis of water used for irrigation is very necessary in order to monitor its salt contents.
- Frequent monitoring and analysis of soil should be carried out to determine the soil's present state as influenced by irrigation. This is necessary to

determine when and what type of management practices to employ.

- Farmers using wells should adopt measures to manage sodium toxicity. These may include the use of gypsum and leaching.
- Measures should be adopted to prevent the build-up of salinity especially where well water is used. These measures may include the use of leaching and adequate drainage.

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REFERENCES

1. Adejumobi, M. A., Aremu, S. K., Idowu, D. O., & Ojo, O. I. (2015). Effect of irrigation frequency and manure on growth paraters, crop coefficient and yield of Okra (Abelmoscus esculentus). *Environmental Earth Science*. 5, 18.
2. Adhan, M. N. (2009). Evaluation of Livelihood, Soil and Water resources in small holder irrigation scheme along the Tana River in Garissa District. Msc Thesis, University of Nairobi, Kenya.
3. Ayers, R. S., & Westcot, D. W. (1994). Water Quality for Agriculture. Food and Agricultural Organization of the United Nations. Irrigation and Drainage Paper 29.
4. Bray, R., & Kurtz, L. T. (1945). Determination of total, organic, and available forms of phosphorous in soils. Soil Science. 59(1), 39-46.
5. Denef, K., Stewart, C. E., Brenner, J., & Paustian, K. (2008). Does long-term center-pivot irrigation increase soil carbon stocks in semi-arid agro-ecosystems? Geoderma 145:121–129. doi:10.1016/j.geoderma.2008.03.002
6. Feizi, M. (1993). Considering the effect of water quality and quantity on desalinization of Isfahan Roudasht Soils. Technical Research Report, Isfahan Agricultural and Natural Resources Research Center, Isfahan, Iran, 8, 16–34.
7. Food and Agriculture Organization-FAO. (2014). Assessment of soil nutrient balance approaches and methodologies.
8. Getaneh, F., Deressa, A., & Negassa, W. (2007). Influence of Small scale Irrigation on Selected Soil Chemical Properties. Tropentag, Witzenhausen, Germany.
9. Hailu, E.K., Abate, B., & Hordofa, T. (2003). Effect of blended irrigation water quality on soil physico-chemical properties and cotton yield in Middle Awash Basin Ethiopia. *International Journal of Water Resources and Environmental Engineering* Vol. 8(1) Pp 1-10.
10. Hakim, M., Islam, M. M., Juraimi, A. S., Begum, M., Hasanuzzaman, M., & Uddin, M. K. (2009). Suitability Evaluation of Groundwater for Irrigation, Drinking and Industrial Purposes. *American Journal of Environmental Sciences*, 5 (3), 413-419.
11. Jimenez-Cisneros, B. (1995).Wastewater reuse to increase soil productivity. *Journal of Water Science and Technology.* 32, 173e180.
12. Lucia, B., Carmelo, M. & Maurizio, B. (2018). A tool for the evaluation of irrigation water quality in the Arid and Semi- Arid Regions. *Agronomy* **2018,** 8, doi: 10.3390/agronomy8020023
13. Ndegwa, G. M., & Kiiru, L. (2012). Investigations on soil and water quality as affected by irrigation in Turkana district, Kenya. *Journal of Agriculture, Science and Technology*. Jomo Kenyatta University College of Agriculture and Technology.
14. Quirk, J. P. (1971). Chemistry of Saline Soils and their Physical Properties. In T. Talsma and J. R. Phillip, (ed.). Salinity and Water Use. Wiley-Interscience, New York. p. 79-91
15. Rayment, G. E., & Hagginson, F. R. (1992). *Australian Laboratory Handbook of Soil and Water Chemical Methods*, Melbourne, Inkata Press. (Australian Soil and Land Survey Handbooks, 3.
16. Richards, L. A. (1954). Diagnosis and Improvement of Saline Alkali Soils. Agricultural Handbook 60, USDA and IBH Publishing Co. Ltd., New Delhi, India, pp: 98-99. http://naldr.nal.usda.gov/NALWeb/Agricola_Link.asp? Accessed on 27/03/2018.
17. SERC (Sokoto Energy Research Center). (2012). Rain fall, temperature and humidity data record sheets 2012.
18. Valenzo, F. P., Murphy, B. W., & Greene, R.S.B. (2001). The Long Term Effects of Lime ($CaCO_3$), Gypsum and Tillage on the Physical and Chemical Properties of a Sodic Red-Brown Earth. *Australian Journal of Soil Science.* 39, 1307-1331.
19. Walkley, A., & Black, A. (1934). Determination of organic matter. *Journal of Soil Science. 37, 29-38.*
20. Yahaya, R. A., Ojanuga, A. G., Noma, S. S., Isah, A. D., Sokoto, A. L., Aliyu, M., & Anka, M. R (2016). Evaluation of Soil Fertility/Salinity Status of The Tutudawa Main Canal of The Wurno Irrigation Scheme in Sokoto State of Nigeria, After September 2010 Flood. *The Beam: Journal of Arts and Science, 9.*