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Assessment of Surface Water Within And Outside Federal University of Agriculture, (Funaab) Ogun State Nigeria For Irrigation Purpose

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Abstract - *Irrigation is the artificial application of water to crops for the sustainability and growth of the crops. Studies have shown that an estimated more than 80% of water demand in the agriculture sector is currently being met from non-renewable groundwater sources. To meet the growing demand for water for domestic, industrial, and agricultural purposes, exploration of alternative sources of water, especially for use in agriculture, is important. This study aim at assessing the suitability of surface water within and outside FUNAAB for irrigation purpose. Two samples were collected from five different streams. Parameters studied includes pH, Temperature, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Potassium (K+), Sodium (Na+), Magnesium (Mg), Calcium (Ca2+), Sulphate (SO42-), Iron (Fe), Sodium Adsorption Ratio and Exchangeable Sodium Percentage. The result of the samples obtained was subjected to One-way ANOVA to determine the differences between means of each parameter studied for each sampling point. Statistical Package for Social Sciences (SPSS) version 20 was also used to analyze the results of samples obtained from the five (5) streams. From the results, it was shown that most of the streams were not suitable for irrigation as they did not fall within the Food and Agriculture Organization (FAO) irrigation water standard. It was concluded that only water from stream 1 is suitable for irrigation as it met with the standard of Sodium Adsorption Ratio (SAR) and also the Exchangeable Sodium Percentage (ESP) as given by FAO (1985). While stream 2, stream 3, stream 4, and stream 5 have to be subjected to further treatment before they can be used for irrigation as they will only affect plants negatively if used.*

Keywords — *Agriculture, Crops, Growth, Irrigation*

I. INTRODUCTION

Acceptability of water for any kind of purpose is defined by the type and level of impurities it contains. Drinking water, for instance, is considered safe if it contains some dissolved impurities at concentrations within the permissible limit of a given standard, such as the World Health Organization's (WHO) standard. The same applies to water for agricultural and industrial purposes in terms of the type and level of impurities they might contain, which makes them suitable for their respective uses. (Sharma, 2009).

Dispersion of heavy metals in irrigated soils and the plants that are growing results in the contamination of food that may be hazardous to humans and animals (Jolly et al., 2013).

Heavy metals in effluents are poorly soluble in water and cannot be degraded; they tend to accumulate in soils and subsequently accumulate in plants (Ghoneim et al., 2014). In addition, heavy metals persist in soil which then leaches down into the groundwater and may induce enhanced antioxidant enzymatic activities in plants or become adsorbed with solid soil particles (Iannelli et al., 2002).

According to Roy and McDonald (2013), carrots grown in soils contaminated by Cadmium have the potential to cause toxicological problems in men, women, and young children. Accumulation of toxic heavy metals in living plant cells results in various deficiencies, reduction of cell activities, and inhibition of plant growth (Farooqi et al., 2009). Heavy metal pollution is persistent, covert, and irreversible (Wang et al., 2011). This kind of pollution not only degrades the quality of the food crops, atmosphere, and water but also threatens the health of humans and animals (Dong et al., 2011). In most irrigation situations, the primary water quality concern is salinity levels, since salts can affect both the soil structure and crop yield. However, a number of trace elements are found in water which can limit its use for irrigation (Collins, 2002).

Salts reduce crop health mostly by the osmotic effect on the plant. The more salts in the root zone, the harder it is for plants to take up water. Severe salinity stress will ultimately cause crop death. High salt content reduces crop quality. Even in moist soils, high salt content will cause wilting in crops.

II. PROBLEM STATEMENT

- Agriculture is constantly competing with domestic, industrial, and environmental uses for water as most of the residents in the study area are farmers, so there is a need to manage the available water for efficient use.
- Agriculture has always been tasked with meeting the demand of the growing population in the aspect of food production, but with surface water being polluted by various means such as; indiscriminate dumping of refuse by humans and discharge of industrial waste into water bodies, this task is almost impossible to achieve.
- A number of other substances may be found in irrigation water and can cause toxic reactions in plants. Sodium, Chloride, and Boron are of most concern. Boron can also accumulate in the soil. Crops grown on soils having an imbalance of Calcium and Magnesium may also exhibit toxic symptoms. Sulphate salts affect sensitive crops by limiting the uptake of calcium and increasing the adsorption of Sodium and Potassium, resulting in a disturbance in the cationic balance within the plant.
- The bicarbonate ion in soil solution harms the mineral nutrition of the plant through its effects on the uptake and metabolism of nutrients. High concentrations of potassium may introduce magnesium deficiency and iron chlorosis. An imbalance of magnesium and potassium may be toxic, but the effects of both can be reduced by high calcium levels.

III. JUSTIFICATION

To meet the growing demands of water supply for irrigation purposes, there is a need to source alternatives sources, which can be used for irrigation of crops as Agriculture is a major aspect of any society in the provision of food for human consumption.

IV. BROAD OBJECTIVE

The aim of this study is to access surface water within and outside the Federal University of Agriculture, Abeokuta (FUNAAB) for irrigation purposes, so as to provide means of meeting up with the crop requirements.

V. SPECIFIC OBJECTIVES

- To determine the physical and chemical parameters of surface water samples collected from the streams within and outside FUNAAB to meet up with the crop requirement.
- To identify the rate of pollution of the surface water and its effects on crops.
- To compare the results with Food and Agriculture Organization Standard for irrigation.

VI. DESCRIPTION OF STUDY AREA

The Federal University of Agriculture Abeokuta, popularly known as FUNAAB is located on latitude 7.1990° N and longitude 3.4501° E is one of the four institutions in Ogun State State. This location is classified as tropical savannah. The temperature has an average of 27.1°C, and the precipitation is averaged from 1238 mm. The least amount of rainfall occurs in January, with an average of 13 mm. In June, the precipitation reaches its peak, with an average of 197 mm.

FUNAAB fell within the Freshwater swamp region, and it is characterized by its intense vegetation and its network of lagoons and creeks. The most common species of vegetation in these areas is the Raffia Palm. Areas with better drainage systems can support big trees like Iroko and Oil Palm trees. Farming is a major activity among the indigenes of this area, and they are also known for processing cassava into cassava flakes.

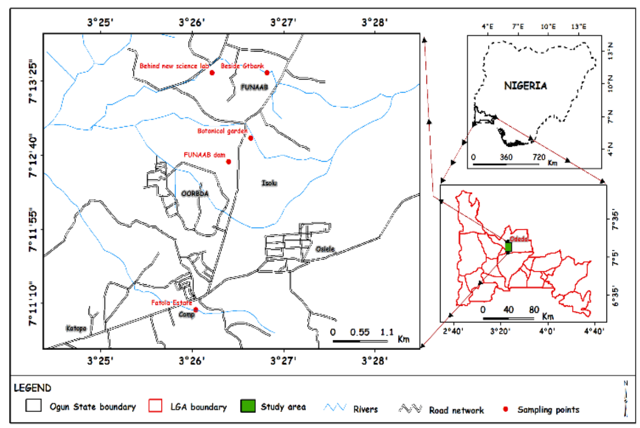

Fig. 1: Map of the sampling sites

VII. RESULTS AND DISCUSSION

pH

The pH value of all the streams except stream 1 as shown in table 1 below, did not fall within the FAO standard of 5.5-6.0. The implication is that water from stream 1 has a pH value that is acceptable by FAO irrigation standard. Stream 1 has the lowest pH value, while stream 4 has the highest pH value. Continual use of irrigation water with a high pH value will make the soil alkaline, and this is not suitable for the crops.

Electrical Conductivity (EC)

The Electrical Conductivity of all the streams sampled falls within the FAO standard, which is <1500 (µs/cm). The EC is highest in stream 5 and lowest in stream 3; the higher the salt content, the greater the flow of electrical current. Electrical conductivity level higher than 1500 (µs/cm) is a potential problem, and if higher than 3000, it will burn crops under certain conditions (FAO, 1985).

Temperature

Temperature is the degree of hotness or coldness of a body. Temperature is very essential in irrigation water as very hot water or water above the FAO standard of 40°C is very dangerous to the plants as this will eventually kill the plants. The temperature was highest in stream 3 and lowest in stream 1, as shown in table 3 below.

Sodium

The sodium (Na+) cation is often in natural waters due to its high solubility. When it is linked to chloride and sulfide, sodium is often associated with salinity problems. High concentration in the soil can adversely affect plants. Poor soil physical properties for plant growth will result as a consequence of continued use of water with high sodium levels. Sodium was highest in stream 4 and lowest in stream 1. What this means is that based on sodium level, only stream 1, stream 2, and stream 3 pass for irrigation according to FAO (1985) standard.

Magnesium

The magnesium value was highest in stream 5 and lowest in stream 2. Only streams 5 and stream 4 fall outside the acceptable FAO magnesium range. Magnesium (Mg^{2+}), together with calcium, manganese may be used to establish the relationship to total salinity and to estimate the sodium hazard. Magnesium helps create and maintain chlorophyll production.

Calcium

The calcium value was highest in stream 4 and lowest in stream 3. Calcium, when adequately supplied with exchangeable calcium, soils are friable and usually allow water to drain easily. Sodium will be replaced from the root zone when the Ca^{2+} replaces the Na^{+} on the soil colloid. Irrigation water that contains ample calcium is suitable for the crops.

Total Dissolved Solids (TDS)

The Total dissolved solids (TDS) were highest in stream 2 and lowest in stream 3, as shown in figure 2 below. All the streams fall within the FAO irrigation standard as their values are all below 960 mg/L. Application of water with a high TDS value will affect the root system of the plants as they will have difficulty taking up many of the nutrients applied to the crop.

Sulphate

Sulphate has no major impact on the soil other than contributing to the total salt content. Irrigation water high in sulphate ions reduces phosphorous availability to plants. The sulphate value is highest in stream 5 and lowest in stream 1. All other streams except for stream 1 are not suitable for irrigation based on their sulphate level as they all will have an adverse effect on the crop. Excessive sulfur in irrigation water lowers soil pH, making the soil more acidic.

Iron

This can be problematic in many irrigation waters as excess iron can compete with other needed micro-nutrients. As shown in table 1. Iron level is lowest in stream 2 and highest in stream 4; the iron value of streams 1, 3, 4, and 5 all did not fall within the acceptable range of FAO irrigation standard hence the water from these streams do not pass as irrigation water based on their iron level.

Potassium (K+)

Potassium (K+) cation is also found in most natural waters. Together with calcium and Magnesium may be used to establish the relationship to total salinity and to estimate the sodium hazard. Stream 3 has the highest potassium value, while stream 4 has the lowest potassium value. Potassium regulates the opening and closing of stomata, and therefore regulates CO^2.

Sodium Adsorption Ratio (SAR)

From table 1, the result showed that the SAR value was highest in stream 4 and lowest in stream 1. From the table also, only stream 1 fell within the acceptable limit of < 6.0 as specified by the FAO irrigation water standard. The effect of using water with a high SAR value is that it breaks down the physical structure of the soil.

Generally, if a stream falls within the FAO standard of SAR the stream is suitable for irrigation. T-test was also carried out on the SAR value of stream 2 to the significant difference between the result and the FAO standard for SAR as a result obtained was closer to the FAO standard. The result showed that there was a significant difference as the t-calculated was greater than t-tabulated.

Exchangeable Sodium percentage

The ESP value was highest in stream 2 and lowest in stream 1. The excessive amounts of exchangeable sodium reverse the process of aggregation and cause soil aggregates to disperse into their constituent individual soil particles. The major issue arising from high sodium levels relative to the other exchangeable cations is on the physical properties of the soil.

To test the hypothesis (Null hypothesis (H_o): there is no significant difference in the mean of each parameter at various selected sampling points within the study area). The formulated hypothesis was tested using the student test (t-test statistics) at a significant level of $p = 0.05$. The f-test analysis was used to analyze the results obtained from the laboratory in two ways experimental survey. Table 4 shows the mean and standard deviation of the distribution, the f-test statistics calculated from each of the sampling points are significantly less than the tabulated value of 248.0. Therefore, the null hypothesis stated above is accepted. This implies that there is no significant difference in the mean of each parameter at various selected sampling points.

Table 1: Water quality result of streams in the morning.

Parameters	*Stream 1*	*Stream 2*	*Stream 3*	*Stream 4*	*Stream 5*	*FAO*
pH	*6.1*	*6.3*	*7.4*	*8.29*	*7.61*	*5.5 - 6.0*
TDS (mg/L)	*394.2*	*487.8*	*273.2*	*425.2*	*292*	*< 960*
EC (µs/cm)	*680*	*820*	*380*	*680*	*550*	*< 1500*
Temperature °C	*27.5*	*29*	*28.5*	*28.2*	*28.1*	*< 40*
Sodium (mg/L)	*54.62*	*47.91*	*49.12*	*78.21*	*68.82*	*0 – 50*
Magnesium (mg/L)	*21.32*	*17.78*	*22.24*	*29.33*	*37.72*	*6 – 24*
Calcium (mg/L)	*214*	*180*	*155*	*205*	*172*	*40 – 120*
Sulphate (mg/L)	*390*	*570*	*574*	*520*	*656*	*< 400*
Iron (mg/L)	*6.67*	*4.45*	*6.76*	*8.54*	*6.62*	*2 – 5*
Potassium (mg/L)	*4.66*	*4.67*	*6.54*	*3.14*	*5.12*	*5 – 10*
SAR	*6.34*	*8.32*	*8.32*	*10.31*	*9.68*	*< 6.0*
ESP	*14.7*	*19.13*	*21.0*	*24.7*	*24.2*	*10 – 15*

Table 2: Mean and standard deviation of water quality parameters at sampling sites.

Parameters	**Stream 1 Mean±S.D**	**Stream 2 Mean± S.D**	**Stream 3 Mean± S.D**	**Stream 4 Mean± S.D**	**Stream 5 Mean±S.D**
pH	5.99 ± 0.3	6.35 ± 0.05	7.25 ± 0.15	8.22 ± 0.07	7.95 ± 0.35
TDS (mg/L)	414.7 ± 20.5	506.3 ± 18.5	258.2 ± 15	430.2 ± 5	322 ± 30
EC (µs/cm)	695 ± 15	885 ± 65	445 ± 65	580 ± 100	1050 ± 500
Temperature °C	27.4 ± 0.3	28.5 ± 0.5	28.75 ± 0.25	28.35 ± 0.15	28.4 ± 0.3
Sodium (mg/L)	53.25 ± 1.375	45.92 ± 1.99	48.61 ± 0.51	81.56 ± 3.35	67.85 ± 0.98
Magnesium (mg/L)	21.265 ± 0.055	18.28 ± 0.5	20.84 ± 1.4	27.33 ± 2	32.6 ± 5.13
Calcium (mg/L)	204 ± 10	120 ± 60	115 ± 40	202.5 ± 2.5	142 ± 30
Sulphate (mg/L)	385±5	580 ± 10	582.5 ± 8.5	515 ± 5	648 ± 8
Iron Mg/L	5.67±1	3.945 ± 0.51	7.31 ± 0.55	7.54 ± 1	5.82 ± 0.8
Potassium (mg/L)	4.81±0.15	4.17 ± 0.5	7.04 ± 0.5	2.84 ± 0.3	5.06 ± 0.06
SAR	5.02±2.02	7.36 ± 1.13	8.7 ± 0.8	9.84 ± 2.89	9.23 ± 2.88
ESP	15.1 ± 0.4	25.82 ± 6.68	26.5 ±5.5	26 ± 1.22	27.7 ± 3.5

Table 3: F-test ANOVA Result for the sampling points.

VARIABLE	**MEAN**	**S. Dev.**	**f_{CAL}**	**f_{TAB}**	**DECISION**
STREAM 1	1137.2	24.4	4.57	248	Accept
STREAM 2	112.3	32.7	3.53	248	Accept
STREAM 3	91.8	26.9	3.49	248	Accept
STREAM 4	111.6	28.5	4.61	248	Accept
STREAM 5	108.2	30.9	3.68	248	Accept

VIII. CONCLUSIONS

From this study, the value of pH located within FUNAAB dam (stream 1) was higher in the afternoon than in the morning, except for streams 2 and 3, which fell within the FAO standard of 5.5 -6.0. This implies that the water is acidic during the afternoon due to human activities and, when used for irrigation, could be toxic to plants and affect human health.

The result for Temperature, Electrical Conductivity, and Total Dissolved Solids for samples collected in the morning and afternoon also fell within the permissible limit, which is given to be < 1500 (µs/cm).

The result obtained for Potassium from all the streams sampled fell within the FAO standard of 5 to 10 mg/L.

Also, the result obtained for Magnesium, Calcium, and Sulphate for the afternoon were higher than the FAO standard given as (6-24), (40-120), and (< 400 mg/L), respectively. The Sodium Adsorption Ratio (SAR) value and Exchangeable Sodium Percentage (ESP) result obtained were higher in the afternoon than the morning, except for stream 1, other streams, and does not fall within the permissible limit of FAO standard. Therefore, the implication of this result is that water from stream 1 alone is suitable for irrigation, and water from the remaining streams sampled is not suitable for irrigation, and when used, it can cause an adverse effect on the crops.

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