QUALITY OF IRRIGATION WATER OF BAKALORI DAM IN ZAMFARA STATE

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Abstract

Nearly all waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface in addition, drainage waters from irrigated lands and effluent from city sewage and industrial wastewater can impact water quality. In most irrigation situations the primary water quality concern is salinity levels, since salts can affect both the soil structure and crop yield. However, several trace elements are found in water which can limit its use for irrigation. Irrigation water quality has great significance, especially in arid and semi-arid regions and it is based on salinity and permeability. In this research, water samples were collected in a dry season from Bakalori Dam Irrigation Schemes in Zamfara State Nigeria. Electronic Conductivity (EC), Total Dissolved Solids (TDS) and Total Hardness (TH) tests in accordance with APHA 2005, standard methods for examination of water and wastewater were conducted to determine the Salinity level in irrigation water. The result shows that the average value of EC is 5.22dS/m, while TDS value is found to be 357mg/l and the TH value is 105.42mg/l. WHAT IS THE IMPLICATION OF THIS FINDING? This means that both the TDH and TH values are within the acceptable limits and have no any harmful to crop growth, but the value of EC will definitely affects the plant growth and reduce the quantity of crops during harvesting, but this can be minimized through the planting of field crops, planting on the shoulder row and using of sloping bed method. However leaching fraction can also take care of the excess amount of EC in the irrigation water.

Keywords: *Irrigation, Electronic Conductivity (EC), Total Dissolved Solids (TDS) and Total Hardness (TH)*

Introduction

Irrigation being the artificial application of water to the land or soil, it is used to assist in the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protection against frost, suppressing weed growing in grain fields, helping in preventing soil consolidation and also used for dust suppression, etc (Somnath, 2012). Irrigation scheme is an orderly arrangement and combination of irrigable land and hydraulic structures like dams, reservoirs, and canals for the purpose of growing crops, efficient functioning of these parts will help in producing both food and cash crops for sustainable development (Isiya, 2014).

Irrigation water can come from groundwater (extracted by springs or by using well), from surface water (withdrawn fro rivers, lakes, or reservoirs) or from nonconventional sources like treated wastewater, desalinated water, drainage water or fog collection (Peter, 2009).

Water with high salinity is toxic to plants and poses a salinity hazard; soils with high levels of total salinity are called saline soils (Tanji, 1990). High concentrations of salt in the soil can result in a physiological drought condition (Tanji, 1990). That is even though the field appears to have plenty of moisture; the plants wilt because the roots are unable to absorb the water.

In semi-arid regions, environmental deterioration and scarcity of water have increasingly become a serious problem (Ajon, et, al, 2014), especially in extreme part of Northern Nigeria like Zamfara State. In order to decelerate the degradation of the environment and to lessen the conflicts between water users sectors, there is need to control the unprecedented waste released into the environment (Danazumi and Bichi, 2010; Ekiye and Luo, 2010) as well as efficient quantity and quality of water for domestic, industrial and agricultural purposes. Natural resource depletion was caused by the increasing demand for water due to industrialization, agricultural practice and rapid population growth (Kristen et al., 2016; Kumar et al., 2016). In such region, surface water, especially in the dams shoulder the responsibility for water supply and play detrimental role for satisfying industrial, drinking, domestic and agricultural demands (Zahedi et al., 2016; Sadat-Noor, et al., 2013). Forecast on water need globally, predicts sharp future increase in demand in order to satisfy the aforementioned conflicting sectors of interest, because more than one billion people yet have access to good quality and quantity of water and sanitary (Fererer and Maria, 2007) and little attention is being paid to meet the requirement of water for healthy ecosystem. General belief is that there is scarcity of water worldwide and there uncertainty about the intensity of the problem in future. Irrigation sector is one of the main users of global diverted water with a proportion above 70- 80% in semi-arid zones (Martina et al., 2016) and account for more than 40% of the total land and utilizes only 17% of the land for production of crops (Fererer et al., 2004) to cater for the present teaming and increase in population in the future.

Therefore, management of irrigation water in the with water scarcity must be effectively carried out to save water and maximize productivity. Water conservation through increasing water use efficiency in irrigation and promoting dry land farming with effective use of rain fall during rainy season will play great detrimental role in maintaining food production and security (Adamu, 2013; Deng et al, 2006). Irrigated agriculture being combination of dams, canals, gates and irrigable land for growing crops, in essence, plant growth and its yield depend solemnly on the quality of irrigation water. This quality is a function of anthropogenic activities ranging from urbanization, industrialization to agricultural practices like application of organic and/or inorganic fertilizers and pesticides, as well as weathering, catchment erosion and other natural processes (Bhaat et al., 2016). Among the natural phenomenon, geology of the region, rate of weathering of some types of rocks, other inputs apart from rock-water interaction play vital roles in controlling the quality of surface water bodies and this may lead to reduction of irrigation water quality (Drechsel et al., 2015; Schacht et al., 2016; Wada et al., 2012), with increase in dissolved substances, salinity and subsequent restrain of growth and yield of plants (Anikwe et.al, 2002; Munns, 1973) Generally, all waters for irrigation contain certain level of salt and as evapotranspiration take place, salt concentrations increases in the soil profile and should be displaced away from plant root region before reaching the level that inhibit growth and yields of plants. Application of excess irrigation water above required for crop water relationship and evapotranspiration in order to leach the excess salt concentration in soil deep down to ground away from root zone is needed (Nematian, 2016).

In this, there is unavoidable water loses to checkmate the balances of salts and will only be possible and efficient in an area with abundance water resources supply not the areas with water shortages like Zamfara State. Plant growth was reduced due to high salts and water absorption by roots of the plant was hindered by excessive osmotic pressure of water, and high level of soluble salts in the roots. Globally, salt-affected potential arable covered about 33% (Assouline et al., 2015), with 950million hectares in semi-arid and arid regions. About 20% of the land (450,000Km2) allocated for irrigation globally affected by salt and 2000 hectares of farm land is lost every day by degradation related to salts and the inflation adjusted cost of salt-induced land degradation in 2013 was estimated at $440 per hectares (Qadir et al., 2014), yielding $27 billion/year in excess to an estimate of global economic loses. Due to alliance of economic, agronomic and environmental implications of irrigation with saline water coupled with global stress in freshwater supply, there is need to check the salinity of an irrigation in order to improve the growth of plant and yields of irrigated crops and also avoid unnecessary excessive water use for leaching. This research intended to assess the quality of irrigation water of Bakalori Dam in Zamfara State to prevent the problems associated with the high salinity in the irrigation systems by investigating the electrical conductivity (EC), total dissolved solids (TDS) and total hardness (TH) (Ismail et al., 2016; Martina et al., 2016; Bassuony et al., 2012; Jahin and Gabar, 2011) and comparing the values obtained with standard practiced all over the world due the lack of such documented research in the schemes under considerations.

Irrigation projects can fail if the sediments load of water supply is higher than the capacity of irrigation canals to transport the sediments also siltation in canals shortens active life mostly in tertiary canals as observed in the project that is why I intend to assess the quality of irrigation water of Bakalori irrigation scheme.

Materials and Methods

Dam: There are somany dams in Zamfara State such as Gusau Dam, Kaura Namoda Dam, Maradun reservoir, Bakura reservoir but Bakalori dam is the biggest in term of size for the water storage and also intern of the land area covered for irrigation scheme in the state that is why the Bakalori dam was choosing for this research work.

A field research was conducted to assess the salinity level of water for irrigation purposes in Talata Mafara, Bakura and Maradun irrigation Schemes in Zamfara State. Twelve Water samples each from the schemes (a total of thirty-six) were collected at different point inside the bottles on 10th March, 2024 and then taken to laboratory for testing. The collected water samples were preserved in separate containers according to the parameters needed to be measured and they were preserved in cold icebox until they reach the laboratory. The chemical analyses were conducted according to the Standard methods for the analysis of water and wastewater (APHA 2005). The Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were measured using an Orion (T^414) multi-parameter meter and Total Hardness (TH) using EDTA-titrimetric

Method

Test: APHA (2005) was choosing for TDS, TH and EC test being it the current standard methods for the examination of water and wastewater

Bakolori Reservoir is being fed by River N'kaba and Tarka in the Niger Republic and joining Rima River after entering Nigeria. The reservoir has the capacity of 450million m^3, with corresponding lake area and length of 8000ha and 19km respectively and a spillway discharge of 1650m^3/s at the time of construction in1979. The dam had 450million m^3 water storage capacity and was substantially completed by 1983 but is current capacity is estimated at 351, 010, 027 m^3 in 2003 (Enplan Group, Nigeria, 2013; USAID, 2010; FAO, 2004; SRRBDA, 1992). The Bakolori Irrigation Scheme covers three Local Governments namely; Talatan Mafara, Bakura and Maradun, commanding an area of 23000ha. 65% irrigated by sprinkler system (15000ha) while the gravity fed surface irrigation used in the remaining 8,000ha, hosting more than 22,000 farmer unit located110Km southeast of Sokoto city. Presently the irrigation area under gravity is 7,039ha for surface and converted sprinkler areas, while the non-irrigable area is 15,961ha which is mainly sprinkler and some surface lift (Enplan Group Nigeria, 2013; USAID, 2010; Kebbeh et al., 2003).

Results and Discussions

Table 1.1: Water Salinity Test Results

S/N	Conductivity EC (ds/m)	Total Dissolved Solid TDS (mg/l)	Total Hardness TH (mg/l)
1	5.16	356	108
2	5.18	353	110
3	5.19	358	106
4	5.20	350	104
5	5.20	354	103
6	5.21	355	100
7	5.23	358	102
8	5.24	360	106
9	5.25	357	107
10	5.26	359	106
11	5.26	360	107
12	5.27	361	108

Electrical conductivity (EC) was used to measure hazards associated with salinity being one of the most important water quality guidelines on the growth of plants and their subsequent yield (Jahin and Gaber, 2011). It can be seen from Table 1, that the EC values obtained from Bakalori dam range between 5.16-5.27dS/m with an average of 5.22dS/m. It can be observed from Fig.1.1 that the graph looks like a straight line due to their location and the same water source. TDS values range from 353-361 (mg/l) with an average of 357 mg/l and TH of water samples range from 100-110 mg/l with an average value of 105.42 mg/l. All the graphs seem to be a straight line graph because, the source of the water and the types of waste are the same.

Elevated values of EC in irrigation water can damage plant growth media and rooting, resulting in nutrient imbalances and water uptake. Even though EC values are important for dissolution of salts, but it should not be more than 3dS/m (FAO, 1994; Christiansen et al., 1977). TDS levels should be below 640mg/l to avoid problems in plugs and below 960mg/l (Bryan, 2017) for other plants growing conditions, while levels above 2000mg/l are likely to cause plant growth problems (FAO, 1994).

Therefore, the TDS values obtained is within the limit specified by FAO. High EC waters will need advanced treatment or dilution to make it suitable for irrigation purposes. Dissolved salts in irrigation water present numerous challenges to plants especially to the growers. Salts reduce the osmotic potential of water, increasing the energy that plants use to extract moisture from soil (Adamu, 2013; USDA, 1954), and making them more susceptible to wilting. In addition to contributing to water stress, some constituents of salts are toxic if they accumulate in the leaves and stem. High sodium levels can also reduce the rate which water infiltrates into soil. Most of the irrigated crops grown in the schemes, including rice, wheat, cassava, tomatoes, pepper, lettuce, and onion, are all moderately tolerant, for TDS and EC (George, 2004; Tanji, 1990). Hardness being determined by the calcium and magnesium content of water, since calcium and magnesium are essential nutrients for plant growth and development. Moderate levels of hardness ranges between 100-150mg/l are considered ideal for plant growth (Bryan, 2017). Total hardness (HT) test from the dam under consideration revealed that the values for TDS and TH are within the standard.

According to FAO (1994) for efficient plant growth, the total hardness of irrigation water should not be less than 80mg/l. Higher concentrations of hardness above 150mg/l (Bryan, 2017; George, 2004) will build up on contact surfaces, plug pipes and irrigation lines especially for sprinkler and drip methods of irrigation and also cause foliar deposits of scales on plants.

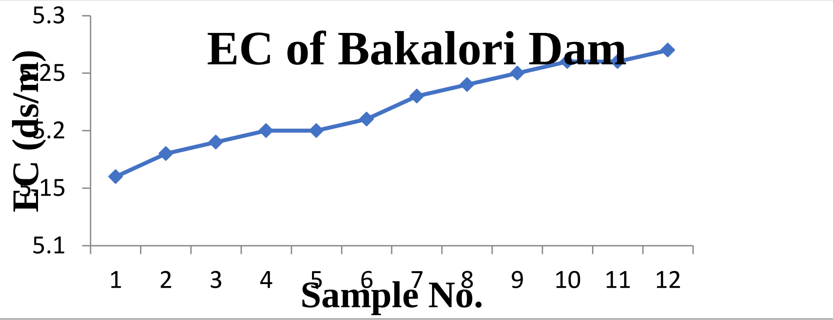

Figure 1.1: Electric Conductivity (EC) of Bakalori Dam

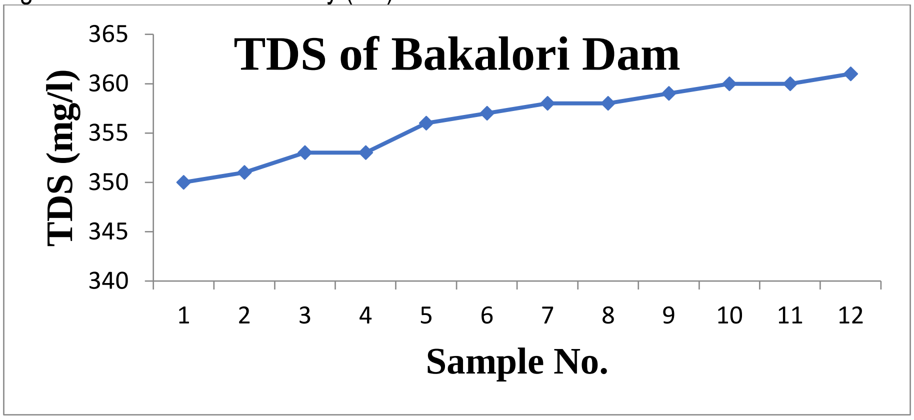

Figure 1.2: Total Dissolved Solid (TDS) of Bakalori

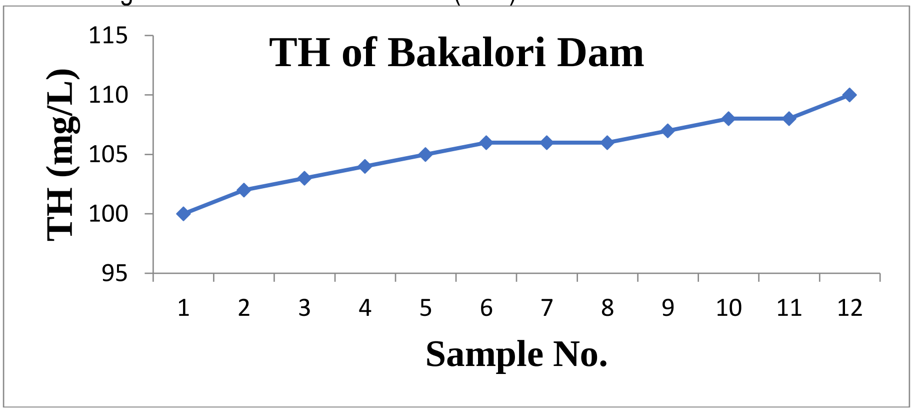

Figure 1.3: Total Hardness (TH) of Bakalori Dam

Conclusions

The EC, TDS and TH parameters of water samples from Bakalori Dam irrigation scheme were obtained to be 5.22ds/m, 357mg/l and 105.42mg/l respectively. When compared with water quality standards for irrigation purposes. The results show that the average values of EC was found to be above the limit 3dS/m specified by FAO (1994), TDS value was within the acceptable range specified for proper plant growth. Lastly, the TH value obtained from the samples and tests carried out is within the limit for plant growth.

However, since some areas are planting field crops there will be no much problems of the excess EC while for the vegetable crops using leaching fraction, planting on the shoulder row and using sloping bed methods would definitely enhance the output by reducing the salt content.

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