



Correlational Study of the Soil Micro-Nutrients Availability and Soil PH of the Flood-Plain Soils of Sokoto Rima River

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ABSTRACT

The study was conducted to determine the relationship between soil micro-nutrient and pH level at the up-stream of the flood-plain soils of Sokoto Rima river, determine the relationship between soil micro-nutrient and pH level at the mid-stream of the flood-plain soils of Sokoto Rima river and determine the relationship between soil micro-nutrient and pH level at the down-stream of the flood-plain soils of Sokoto Rima river. The flood-plain was divided into three zones (up-stream, mid-stream and down-stream). Thirty (30) composite samples were collected each from the 3 zones and a total of ninety (90) samples were used for the study. The Soil samples were prepared and analysed for some micro-nutrients using standard laboratory procedures. Routine analysis for Soil texture, Soil pH, organic carbon, CEC, EC, total Nitrogen, available phosphorus, exchangeable potassium, Ca and Mg were carried out. Result of the study indicated that, the soils of the study area were slightly acidic (6.4, 6.2 and 6.1 for up, mid and down-stream respectively) mainly due to leaching, flooding and use of chemical fertilizers such as urea. Copper contents of the mid-stream and down-stream were statistically similar but significantly higher than the up-stream (mean=3.2, mean=4.3 and mean=4.3 mgkg⁻¹). Micro-nutrients were sufficiently supplied in the studied area and their deficiencies are unlikely to occur in the study area. Correlation study to determine the relationship between pH and the micro-nutrients revealed no significant relationship between them. Increased use of organic matter by the farmers will help to maintain the levels of these elements for a long term sustainable Agriculture in the area.

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INTRODUCTION

Sokoto State is an agrarian state with over 80 % of its population engaged in subsistence farming (SOSG, 2019). The state is endowed with vast area of land for crop production. The arable land is estimated at 839,569 hectares while the Fadama land occupies 142,075 hectares (SOSG, 2019).

Fadama land has great potentials for all years round crop production than the adjacent upland. According to Singh (2011) the Sokoto State Fadama land can be grouped into three (3) based on their hydrological and geo-morphological characteristics. The classes are Fadama without stream channel; stream plain

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Fadama and flood plain Fadama. However, the state lifeline for growing crops is the floodplain of the Sokoto Rima River system which is covered with rich alluvial soil. During the rainy season, lowland rice is commonly grown but during the dry season, especially where irrigation facilities are used, varieties of crops like rice, onion, garlic, carrot, tomatoes, okra and many other vegetables are grown.

The quest to increase food production to meet the need of the increasing population and the zeal to diversify the export base of the State has led to a more intensive use of the flood-plain soils (Mustapha, 2017). The consequence of this is that, soils become increasingly depleted of both macro and micro-nutrients. Micro nutrient elements play a significant role in crop production and have great influence on yield and quality of agricultural produce (John *et al.*, 2006). Deficiency of micro-nutrients causes serious decrease in crop yield just like the macro-nutrients and under extreme condition result to total crop failure (Chaudry *et al.*, 1983). In view of these the research work is conceived to assess the micro-nutrients fertility status of the floodplain soils of Sokoto Rima River.

Micronutrients in Plant Nutrition: There are seventeen (17) mineral elements essential for higher plants growth. These include nine macronutrients required in large quantities. Among them are the Carbon (C), hydrogen (H), and oxygen (O) which are supplied by air and water. While the others six are commonly obtained from soil minerals and organic matter. These include Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S). Eight other elements are needed in only very small or trace quantities and are referred to as micronutrients. The essential micronutrients elements are boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), molybdenum (Mo) and nickel (Ni). Silicon (Si), and cobolt

(Co) have been reported to be beneficial to many plants.

Micronutrients Status of Soils and distribution of micronutrient elements in soils is influenced by parent materials, level and form of soil organic matter, soil pH, mineralogy, particle size distribution, soil age, soil formation processes, drainage, vegetation, microbial activities and natural processes (John *et al.*, 2006). Micronutrient elements concentrations are generally higher in surface soil horizon (AP) and decrease with soil depth. In spite of the relatively high concentration of micronutrient elements reported in soils on a global basis, micronutrient elements deficiencies have been frequently reported on many crops (Bell, 1997). Sandy soils are more often deficient in micro-nutrients all along their profiles (Samuel *et al.*, 2003).

As a result of the growing need to increase food production in Nigeria, attention is being directed to a more intensive use of land on continuous basis (Mustapha, 2017). This is particularly so in Fadama land where the soil is utilized for all years round farming. The consequence of this is that, soils become increasingly depleted of both the macro and micro nutrients (Singh, 2011). Even when nutrients are applied to improve fertility, it is often the macro nutrients that are replenished. Other factors such as weathering, leaching, and decreased proportion of farm yard manure compared to chemical fertilizers and introduction of high yielding varieties continuously deplete the flood-plain soils of their micro nutrients reserve (Singh, 2011). These trends will continue unless appropriate steps are taken. It is on this basis that this research work is conceived to conduct a correlational study of the soil micro-nutrients availability and soil pH of the flood-plain soils of Sokoto Rima river in order to determine the relationship between the micro-nutrients fertility status and the soil pH of the flood-plain soils of Sokoto Rima



River with the view to proffer appropriate recommendations towards long term and sustainable increase in food production in the state.

Objectives of the Study

The main purpose of the study was to conduct a correlational study of the soil micro-nutrients availability and soil pH of the flood-plain soils of Sokoto Rima river. This will go a long way in helping farmers and other stakeholders in agriculture to boost their farming activities in order to increase food production. Specifically, the study will:

- i. Determine the relationship between soil micro-nutrient and pH level at the up-stream of the flood-plain soils of Sokoto Rima river
- ii. Determine the relationship between soil micro-nutrient and pH level at the mid-stream of the flood-plain soils of Sokoto Rima river
- iii. Determine the relationship between soil micro-nutrient and pH level at the down-stream of the flood-plain soils of Sokoto Rima river

Research Questions

- i. What is the relationship between soil micro-nutrient and pH level at the up-stream of the flood-plain soils of Sokoto Rima river?
- ii. What is the relationship between soil micro-nutrient and pH level at the mid-stream of the flood-plain soils of Sokoto Rima river?
- iii. What is the relationship between soil micro-nutrient and pH level at the down-stream of the flood-plain soils of Sokoto Rima river?

MATERIALS AND METHODS

Sokoto State has a total land area of 28,232.37 sqkm and is located between Latitude 11°30' - 13° 55'N and Longitude 4° 07' - 6° 56'E in the dry sub humid agro-ecological zone (Ojanuga, 2016). The state is situated in the North Western part of Nigeria and shares boundaries with Niger Republic to the North, Zamfara State to the East and South and Kebbi State to the South and Western parts respectively. The state enjoys the Sudan savanna type of vegetation with few scattered trees and numerous shrubs and herbs (Singh, 2011).

The agro-climate of Sokoto State consists of a long dry season (October-April) and a short rainy season (May-September). The average annual rainfall of the state is 565mm and occurs between May-October (Abubakar & Gaddafi, 2017). From late October-February during the cold season, the climate is dominated by the Hammatan wind blowing Sahara dust over the entire land of the state. The dust dim the sun light thereby lowering the temperature significantly. The temperature varies between 15°C during the cold season (December-February) with an average of 27°C to 40°C during the hot season (March-May) (Singh, 2011).

The Sokoto Rima River runs through the state from Sabon Birni to Silame in the north-east to south-west direction (Figure 1). Within the available resources of this research work, it was not possible to sample all the soils of the flood plain. Hence, the floodplain in sokoto state which is roughly 212 km from Sabon Birni to Silame was divided into three zones (up-stream, mid-stream and down-stream) respectively. This division was based on land use system in the floodplain (Singh, 2011).

The upstream and down- streams were exclusively cultivated by the peasant farmers in the area while the mid-stream was cultivated by the peasant farmers with some input assistance from the government



(because of the government project "Goronyo - Wurno irrigation scheme"). From each zone, areas of high agricultural activities were identified and selected for soil sampling. These areas thus served as sampling units.

From each sampling unit, five (5) transects were formed. On each transect there were six (6) sampling points. The sampling spots on each transect were 10m apart. In each sampling location, ten (10) soil samples were taken randomly between the depths of 0-20cm with the aid of soil augur and made into a composite sample. Thirty (30) composite samples were therefore collected from each zone and a total of ninety (90) composite samples were collected from the three zones.

Each composite sample was labeled and put into a clean polythene bag for easy conveyance and avoidance of contamination. The samples were then air dried, ground using ceramic pestle and mottle and then sieved through 2 mm sieve and stored for laboratory analysis. Basic determinations were carried out using standard laboratory procedures.

The soil samples were analysed for total and available micro nutrients particularly Zn, Cu, Fe, Mn, and Mo. Routine analysis for soil pH, soil texture, organic matter, CEC, EC, total nitrogen, available phosphorus, exchangeable potassium, Ca and Mg were also carried out.

The perchloric-nitric-sulphuric acid digestion method as described by Sparks (1999) was employed to dissolve the total micro-nutrients for analysis. While the available micro-nutrients (Zn, Cu, Fe, Mn and Mo) were extracted using dilute hydrochloric acid extraction (0.1N HCl method) developed by Nelson *et al* (1959). The micro-nutrients in the digest and extract were read using Atomic Absorption Spectrophotometer (AAS) as recommended by Cowley in 1980. Soil pH was determined

using soil pH meter in a 1:2 soil-water suspension (McLean, 1982). The particle size distribution analysis was carried out by the Bouyoucos (1951) hydrometer method as modified by Day (1965). The textural classes were determined using USDA textural triangle. Organic carbon was determined by Walkley (1934) wetoxidation method (CF = 1.33) and Cation Exchange Capacity (CEC) by Ammonium Acetate method. Nitrogen was determined by macro-Kjeldahl method. Phosphorus was determined by Bray and Kurtz (1945) method. Potassium and sodium were determined with a flame photometer while calcium and magnesium were determined by EDTA titration method. Correlational analysis was used to achieve the objectives.

RESULTS AND DISCUSSION

Simple correlation study between total micro-nutrients and soil pH in the study area were made and the result is presented in Table 4. The result however indicated that there was no significant relationship between the total micro-nutrients and soil pH in the study area.

The r-value between total manganese and soil pH in the up-stream soils was -0.31. This showed that there is a negative non-significant (weak -ve) correlation between the total manganese and soil pH. Total manganese in the up-stream soils therefore does not depend on any significant extent on soil pH. This result corroborates with the report of Patiran *et al.* (2000).

The relationship between total molybdenum and soil pH was a positive non-significant relationship (weak +ve). This means that increase in total molybdenum in the up-stream soils is dependant on the increase in soil pH. This result is in agreement with the findings and conclusions of Agboola (2008) who noted that molybdenum increases as the pH increases.



Table 4. Correlation Coefficient Values Showing the Relationship between Micro- nutrients and Soil pH

Sample location (pH)	Cu	Fe	Mn mgkg ⁻¹	Zn	Mo
Up-stream	-0.16	0.29	-0.31	0.12	0.03
Mid-stream	0.36	0.42	-0.36	-0.21	-0.08
Down-stream	-0.22	-0.22	0.14	-0.36	0.14

*=significant relationship ns= no significant relationship.

The correlation coefficient (r) between the total zinc and soil pH in the up-stream soil was 0.12. It showed that there was a positive (weak +ve) correlation between the total zinc and soil pH of the area. Similar result was obtained by Saddiq *et al.* (2008).

The r-value between total copper and soil pH was -0.16. This on the contrary to zinc indicated a negative correlation (weak -ve) between the total copper and the soil pH of the up-stream soils. This therefore means that, total copper in the up-stream soils is not dependant on soil pH. The result obtained is dissimilar to the findings of Saddiq *et al.* (2008) and Samndi *et al.* (2007) who reported that copper was positively correlated with soil pH.

The correlation value (r) between total iron and soil pH was 0.29. This showed that there is a positive but non-significant correlation (weak +ve) between the total iron and soil pH. The result obtained in this study is in agreement with the findings of Kparmwang and Malgwi (1997) while analyzing micro-nutrients in soil profile of Ultisols and Entisols developed from sandstone in northern Nigeria.

In the mid-stream section of the studied area, correlation study revealed that there was a negative non-significant (moderate -ve) correlation between total manganese and soil pH. This corroborates with the report of Patiram *et al.* (2006). Correlation value (r) between the total molybdenum and soil pH in the mid-stream soils was -0.08. This value indicated a

negative non-significant (weak -ve) correlation. This result disagrees with the findings and conclusion of Agboola (2008), who noted that molybdenum increases as the pH increases. The relationship between total zinc and soil pH in the mid-stream soils was a negative weak relationship. This is against the earlier result reported by Saddiq *et al.* (2008) which indicated a positive correlation between zinc and soil pH. Result of correlation study from Table 4 above indicated a positive non-significant (moderate +ve) correlation between total copper and soil pH. This result was supported by Saddiq *et al.* (2008) and Samndi *et al.* (2007) who reported that copper was positively correlated with soil pH. The correlation between total iron and soil pH was equally positive (moderate +ve) indicating that total iron content is dependant on soil pH.

From Table 4, the correlation values (r) between total manganese and soil pH and between total molybdenum and soil pH were 0.14 and 0.14 respectively. These values indicated that there was a positive non-significant (weak +ve) correlation between the total micro-nutrients and soil pH. Total zinc, copper and iron in the studied area had negative but insignificant correlation with soil pH (weak -ve). The negative correlation of the total copper, iron and zinc with soil pH was in contrast with the result obtained by Saddiq *et al.* (2008), Samndi *et al.* (2007) and Kparmwang and Malgwi (1997).



CONCLUSION

The results presented show that, micro-nutrient elements studied were sufficiently supplied and so deficiencies of such elements are unlikely to occur in the study area. The result however indicated that there was no significant relationship between the total micro-nutrients and soil pH in the study area. The results presented and discussed also confirmed that the soils of the study area are slightly acidic. This soil condition is appropriate for most of the crops grown in the area. Sodium was high in the soils of the study area and that was an indication of possible salinity problem. Phosphorus was generally low in the soils of the study area and may have a negative effect on the overall fertility of the soil. Calcium was low particularly in the up and mid-stream soils and may contribute to the decline in the fertility of the soils.

RECOMMENDATIONS

The following recommendations were made based on the findings of the study

1. Effective management strategies such as drainage, mulching and application of gypsum should be adapted to reduce excess salt accumulation and to minimize subsequent build-up.
2. The deficiency of phosphorus in the area can be prevented by increased organic matter usage in addition to the application of phosphatic fertilizers. This will be in consonance with the current advocacy of integrated soil fertility management (ISFM), which combines the use of inorganic and organic fertilizers for the maintenance of fertility on fragile soils for sustainable and maximum productivity.
3. Particular attention should be given to improve the calcium contents of the soils of the study area (especially in the up-stream and mid-stream sections)

mainly due to its low contents compared to the other elements.

4. Although, the micro-nutrients of the area studied were relatively sufficient, application of organic matter by the farmers will help to maintain the levels of these elements for a long term sustainable agriculture in the area.

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