Concentrations of Some Micronutrients In The Floodplain Soils of Kebbi State, North Western Nigeria

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ABSTRACT
This study was carried out to evaluate the concentration of some micronutrients in the floodplain soils of Kebbi State. Four Local Government Areas adjacent to Rima river which are actively involved in fadama farming were selected for the purpose of this study. Four villages/towns were selected as sampling units from each local government area. Data obtained were subjected to GLM procedure using Statistical Analysis Software SAS (1999).Micronutrients were analyzed using Atomic Absorption Spectrophotometer. The result obtained revealed that Cu, Fe, Mn and Zn were significant at $p<0.05$. Highest value of Cu (0.15mgkg^{-1}) was obtained at Augie. Fe (2.28 – 2.21mgkg^{-1}) was observed to be higher at Birnin Kebbi and Bunza compared to other local governments. Highest value of Mn (0.19mg/kg^{-1}) was obtained at Bunza, and Zn (0.26mg/kg^{-1}) at Argungu. This result showed that the soils are deficient of these elements. The pH was slightly acidic to neutral with mean value of 6.7. For successful agricultural production on these soils, micronutrient fertilizers should be applied to supplement.

INTRODUCTION

Seven of the sixteen elements essential to the growth and reproduction of all higher plants are termed micro-nutrients:-Iron(Fe),Manganese (Mn), Boron(B), Zinc(Zn), Copper(Cu), Chlorine (Cl) and Molybdenum(Mo). Information on the concentrations of these elements is of prime importance in planning any fertilizer application program. Their deficiencies can cause serious decrease in crop yield and under extreme condition total crop failure (Bowern and Kratray,1983).Yusuf *et al.* (2004) observed that very little information is available on micronutrients status of Nigerian savanna soils. For the purpose of this research only four of these important elements (Fe,Mn, Zn and Cu) were studied to determine their concentrations in the flood plains of Kebbi State. Although occupying smaller area (130.84) square kilometers of the total arable land (13,745. 25 km2) in the State (Kebbi Investment Company Limited,2000),the agricultural potential of the floodplains of Kebbi State have been properly exploited for many years now in providing year –round agricultural activities in the area. The consequences of which is the continuous depletion of both macro and micro nutrients reserve in these soils and even when the nutrients are applied to improve the fertility, it is often the macronutrients that are replenished. Leaching and introduction of higher yielding varieties could also continually deplete these soils of their micronutrients reserve. As a result of all these, it becomes necessary to evaluate and assess the micronutrients status of these soils with a view to provide appropriate management strategies for successful crop productions in the area.

MATERIALS AND METHODS

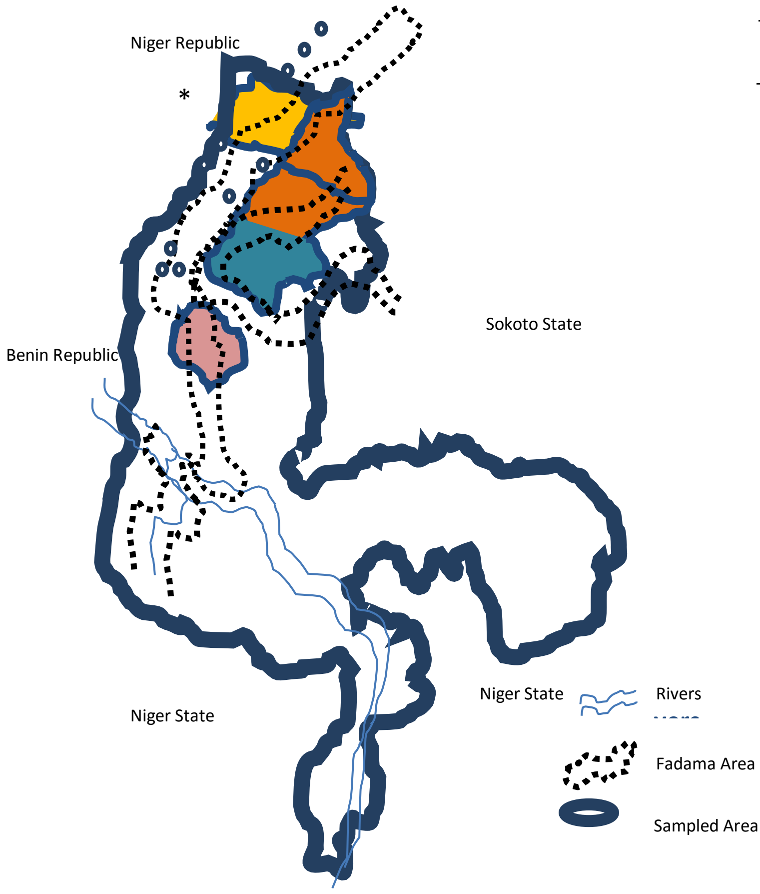
Kebbi State - Location and Agro-climate

Kebbi State is situated in the extreme north-west of Nigeria between Latitudes 10º06^1-13º10^{1}N and Longitudes 3º0^1- 6º03^{1}E (KARDA, 1998). It shares borders with both Niger and Benin Republics in the west. On the East, it is bordered to Sokoto State and in the South to Niger State. The State enjoys a semi-arid climate where precipitation is usually less than the normal requirement of most agricultural crops. The rainy season consists of a short (May – October) period with rainfall poorly distributed throughout the growing period. The annual rainfall ranges from 400 to 850mm(KICL, 2000). Arnborg (1988) stated that areas situated within the semi-arid sub-Saharan region, Kebbi State inclusive, enjoy the mean maximum and minimum temperatures of 40ºC and 15ºC respectively.

Distribution and Sampling of the floodplains

Four floodplain areas (villages or towns) were selected from each of the four selected local government areas in the state. In Augie local government area, the floodplain areas (villages) studied were Zagi, Augie, Bubuce and Yola. In Argungu local government area, the selected areas were Argungu, Gulma, Helande and Gotomo. Those in Birnin Kebbi local government area included Birnin Kebbi, Kola, Makera and Ambursa floodplain areas, while those in Bunza local government area were Bunza, Zogirma, Maidahini and Banganda floodplain fadama lands. From each of the selected areas, 10 composite soil samples were collected in May, 2013,giving a total of 160 composite samples with the help of soil auger at a depth of 0-15cm.

MAP OF KEBBI STATE



SOURCE: Office of the surveyor general, Kebbi State (2010)

Map of Kebbi State showing the selected Local Government Areas

Analytical Procedures

pH was determined using pH meter in a ratio 1:2 soil water mixture as recommended by Alberta Provisional Laboratory (1988). Micro nutrients- Fe, Mn, Zn, and Cu contents were determined in the digest after DTPA extraction by the use of atomic absorption spectrophotometer as recommended by Cowley (1980).

Statistical Analyses

The data were subjected to GLM procedure using Statistical Analysis Software SAS (1999) to see the relationship between the four local government areas studied. Significant means were separated using Duncan New Multiple Range Test at 5% level of significance to observe the specific sports where the differences exist.

RESULTS AND DISCUSSIONS

Table 1: Mean values of selected micronutrients in the floodplains of the four local government areas studied

LGA pH	Fe ($mgkg^{-1}$)	Mn ($mgkg^{-1}$)	Zn ($mgkg^{-1}$)	Cu ($mgkg^{-1}$)
Augie 6.7^{ab}	1.23^{b}	0.17^{ba}	0.23^{b}	0.13^{a}
Argungu 6.6^{b}	1.61^{b}	0.15^{b}	0.26^{a}	0.10^{b}
B/ Kebbi 6.9^{a}	2.28^{a}	0.15^{b}	0.24^{a}	0.10^{b}
Bunza 6.5^{b}	2.21^{a}	0.19^{a}	0.19^{c}	0.09^{b}
Overall 6.7	1.83	0.16	0.23	0.11

abc = Means bearing different letters along the same column differ (P<0.05)

The results obtained in this study have been related with standard rating scale given by Saltanpour and Schweb (1977). Table 1 showed that the mean values of pH, Fe, Mn, Zn and Cu obtained were significant at p<0.05. The overall Fe concentration in the soils of study area was 1.83$mgkg^{-1}$were thus depicting low concentration of Fe. Agboola and Fube (1983) and Kayode (1984) reported Fe deficiency while working on some Nigerian soils. Higher concentration of Fe (2.28$mgkg^{-1)}$ was observed at Birnin Kebbi and the lowest Fe value (1.23$mgkg^{-1}$)Augie local government area. The overall low value(1.83$mgkg^{-1}$) of Fe in the soils of the study area could be attributed to the slightly acidic to neutral pH level (6.7) of these soils as well as the nature of parent materials from which the soil was drived. The availability of iron has inverse relationship with pH that is increase in pH causes reduction in availability of Fe and *vice- versa*(Singh, 2004).Table 1 also showed that the overall Mn concentration in the soils of the study area was 0.16$mgkg^{-1}$. The soils were rated low in manganese level in these soils. Of the four local government areas studied, the soils of Bunza and Augie were the highest in Mn concentration with mean values of 0.19$mgkg^{-1}$ and 0.17 $mgkg^{-1}$, respectively. Soils of Argungu and Birnin Kebbi on the other hand were statistically the same in Mn contents with mean value of 0.15$mgkg^{-1}$ each (Table 1). Soils of Bunza was significantly the highest in Mn concentration than the soils of all other sampling areas with mean value of 0.26$mgkg^{-1}$. Soil reaction is considered the most important factor that determines Mn availability. As pH increases, availability of Mn decreases. Bowen and Kratky (1983) observed that the availability of Mn to plants is only greatest in pH range of 5.0 - 6.5. Cu was observed to have its highest concentration (0.13$mgkg^{-1}$) at Augie, while other local governments were observed to have statistically the same Cu concentration. Table 1further showed that the Zn concentration of the soils of the study area was higher at Argungu (0.26$mgkg^{-1}$) and Birnin Kebbi (0.24$mgkg^{-1}$) and lowest at Bunza (0.19$mgkg^{-1}$)It was rated low as per the rating scale given by Saltanpour and Schwab (1977).

Table 2: Mean values of selected micronutrients in the floodplains of individual sampled areas

Sample Area	No of samples	pH	Fe ($mgkg^{-1}$)	Mn ($mgkg^{-1}$)	Zn ($mgkg^{-1}$)	Cu ($mgkg^{-1}$)
Zagi	10	7.0^{a}	1.50^{d}	0.18^{b}	0.33^{b}	0.15^{a}
Augie	10	6.9^{b}	1.35^{d}	0.19^{b}	0.18^{e}	0.11^{b}
Bubuce	10	6.8^{b}	1.00^{e}	0.17^{b}	0.19^{e}	0.12^{b}
Yola	10	6.0^{c}	1.10^{e}	0.16^{c}	0.23^{d}	0.14^{a}
Argungu	10	6.6^{c}	1.20^{e}	0.18^{b}	0.28^{c}	0.09^{c}
Gulma	10	6.5^{c}	1.95^{c}	0.10^{d}	0.19^{e}	0.08^{c}
Helande	10	6.1^{d}	1.20^{e}	0.15^{c}	0.31^{b}	0.09^{c}
Gotomo	10	7.3^{a}	2.10^{b}	0.17^{b}	0.29^{c}	0.09^{c}
B/Kebbi	10	7.0^{a}	2.30^{b}	0.15^{c}	0.36^{b}	0.09^{c}
Ambursa	10	6.2^{c}	2.70^{a}	0.13^{d}	0.52^{a}	0.09^{c}
Makera	10	7.1^{a}	2.20^{b}	0.16^{c}	0.15^{f}	0.10^{c}
Kola	10	7.2^{a}	1.95^{b}	0.15^{c}	0.16^{e}	0.13^{b}
Bunza	10	7.0^{a}	2.10^{b}	0.26^{a}	0.23^{d}	0.09^{c}
Zogirma	10	5.6^{e}	2.35^{b}	0.17^{b}	0.24^{d}	0.08^{c}
Maidahini	10	6.8^{b}	1.85^{c}	0.18^{b}	0.16^{e}	0.11^{b}
Banganda	10	6.5^{c}	2.55^{a}	0.18^{b}	0.16^{e}	0.11^{b}
Overallmeans	10	6.7	1.83	0.16	0.23	0.11

abcd = Means bearing different letters along the same column differ (P<0.05)

Table 2 showed that soils of Ambursa and Banganda have higher Fe concentrations with mean values of 2.70 and 2.55mgkg^{-1}, respectively while soils of Bubuce (1.00mgkg^{-1}), Helande (1.20mgkg^{-1}), Yola (1.10mgkg^{-1}), and Argungu (1.20mgkg^{-1}) were significantly (P>0.05) the lowest. Mn was observed to have the higher concentration (0.26mgkg^{-1}) at Bunza while Gulma(0.10mgkg^{-1}) and Ambursa (0.13m/kg^{-1}) has the lowest Mn values.

Higher level of Znwas obtained at Ambursa (0.52mgkg^{-1}), while the lowest as observed at Makera (0.15mgkg^{-1}).Based on individual sampling units, soils of Augie, Bubuce, Gulma, Kola, Banganda, Maidahini were statistically the same in the value of Zn contents with mean values of 0.18, 0.19, 0.19, 0.16, 0.16 and 0.16mgkg^{-1}, respectively. The overall low Zn level of these soils could be due to near neutral pH level (6.7) of the soils of the studied area. According to Agboola and Corey (1976), pH, soil phosphorus level, organic matter and micro-organisms levels in the soils could be the contributing factors that affect Zn availability in the soil.

The overall mean value for Cu in the floodplains of the area studied was 0.11mgkg^{-1}. The soils were therefore rated low in Cu fertility. Of the four local government areas studied, soils of Zagihad significantly(P<0.05), the highest Cu content with mean value of 0.15mgkg^{-1}, while the remaining three local government areas had statistically the same copper contents with mean value of 0.10mgkg^{-1} each. Of the 16 sampling units, Zagie was significantly (P<0.05) the highest in Cu fertility with mean value of 0.15mgkg^{-1}. Gulma and Zogirma on the other hand were significantly(P>0.05) the lowest with mean value of 0.08mgkg^{-1} each (Table 2). Increase in pH results in the increase of Cu availability. Microorganisms while decomposing organic matter lock up Cu atoms in their cells and therefore, cause its deficiency in the soil. Clay fraction of the soil, especially Kaolinite and Montmorillonite can absorb Cu and cause its deficiency in the soil (Singh, 2004). In view of all these therefore, the pH level of 6.7 coupled with nature of clay contents in the floodplains of the studied area could be the contributing factors of low Cu content of these soils.

CONCLUSION

The results of this research revealed low concentrations of Fe (1. 83 mg/kg), Mn (0.1 mg/kg), Zn(0.23mg/kg) and Cu (0.11mg/kg), an indication that the floodplains of the studied areas were deficient of these important elements. Slightly acidic to neutral pH could be one of the contributing factors for the low concentration of these elements. Other possible contributing factors could be due to nature of the parent materials, frequent bush burning, nature of tillage operation, leaching and use of higher yielding crop varieties as observed by Chude and Obigbesan (1982).For successful agricultural productions on these soils therefore, in planning for any fertilizer application program in the area, micronutrient fertilizers should be included. Also adequate knowledge of the micronutrients requirements of the various crops grown on these soils should be of utmost importance to avoid excessive application to the toxic levels.

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