Comparative Analysis of Fertility Status in Irrigated and Non-Irrigated Rice Fields.

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ABSTRACT

Changes of cropping system due to increased human population and the consequences associated with climate change and poor management of soils grossly influence the nature and productivity of most soils. These conditions warranted occasional studies of the fertility status of our soils especially in the far northern part of Nigeria, where such effects were more pronounced. This work involved comparative studies of fertility status of irrigated and non-irrigated rice fields in Talata Mafara, Zamfara State, Nigeria.

Soil samples were collected at the depth of 0-15cm and 15-30cm from five irrigated and five non irrigated rice fields, bulk separately and from which one sample was prepared for each depth making a total of four samples. Soil analysis was carried out at Department of Agronomy, Institute of Agricultural Research, Ahmadu Bello University Zaria, Nigeria. The result showed that texture of the irrigated rice fields were sandy loam at both depths, while that of non-irrigated rice fields were loam at 0-15cm and clay loam at 15-30cm. The result further showed that, both soils at all depths have relatively low N, K, Na, and organic carbon concentrations, but have appreciable concentration of P.

The pH for both soils at both depth were slightly acidic to slightly basic that are within limit for rice production. Soils from irrigated rice fields at both depths had slightly high concentration of Mg but showed lower CEC and Ca concentrations. The study concludes that both soils had low concentration of N and K but relatively good available P. However, the CEC and Ca obtained from non-irrigated rice fields make that soil more fertile compared to the soils obtained from irrigated rice fields.

(Keywords: soil, fertility, rice crops, northern Nigeria, nitrogen, sodium, potassium, pH, organic carbon)

INTRODUCTION

Soil fertility in crop production is basically the ability of a soil to supply plant nutrients. It involves a complex process of continuous cycling of nutrients between organic and inorganic forms The capacity of soils to be productive depends on more than just plant nutrients. The physical, biological, and chemical characteristics of a soil, for example its organic matter content, acidity, texture, depth, and water-retention capacity all influence fertility. These attributes differ among soils in both quantity and quality. Some soils, because of their texture or depth are inherently productive because they can store and make available large amounts of water and nutrients to plants. Conversely, other soils have such poor nutrient and organic matter content that they are virtually infertile or non productive (Gruhn *et al* 1998).

Harsh climatic conditions contribute to soil erosion in several parts of Sub-Saharan Africa. Rapid water evaporation and inadequate and highly variable rainfall, for instance, deprive plants of the water necessary for growth. These couple with high atmospheric temperatures, dry wind and heat-retentive sandy soils can combine to make the local environment too hot for proper plant growth (Lawson and Sivakumar 1991). Poor management contribute to soil degradation which increases the opportunity for drought and erosion that resulted in the reduction of the water and nutrient holding capacities of the soil (Smalling 1993). In such an environment effective soil, water, pest, and crop management becomes absolutely essential. But economic and other pressures often make it difficult for farmers and their families to efficiently manage the soil for long-term profitability and sustainability. The objective of this study is to compare the fertility status of irrigated and non-irrigated rice fields in the study area for the purpose of improving their productivity.

MATERIALS AND METHODS

The experimental site was Talata Mafara, located at latitude 12^0 33' N and longitude 6^0 4' E in the Sudan Savannah of Nigeria. Soil samples were randomly collected from five irrigated and five non irrigated rice fields at the depth of 0 to 15, and 15 to 30cm using soil sampling auger. The samples was sun dried, then bulk separately for irrigated and none irrigated and for same depth. The bulk samples were mixed thoroughly and from each, one sample was prepared for analysis. Soil analysis was done at the soil science laboratory of the Department of Agronomy, Institute for Agricultural Research, Ahmadu Bello University Samaru Zaria. Nigeria.

Soil texture was measured using hydrometer method as described by Bouyoucos (1951) and the samples were classified using USDA (1960) system of soil classification. Organic carbon content of the soil was determined by the wet oxidation method of Walkley-Black as described by Allison (1965). Soil total nitrogen of the sample was determined by micro Kjeldahl procedure. Soil available phosphorus in the soil was determined by dilute acid-fluoride extraction (Bray 1 method).

Exchangeable bases were determined by extraction with neutral 1N NH4OAC (Chapman 1965). Sodium, potassium, calcium and magnesium were determined from the leachate. Na and K in the extract were determined with flame photometre, while Ca and Mg in the extract were determined using atomic adsoption photometre.

RESULTS

Result of soil analysis collected from irrigated and non-irrigated rice fields in Talata Mafara from 0 – 15cm depth is presented in table one. Non irrigated soil was found to contain slightly higher N and K compared to irrigated soils but the two soils contained the same Na. However irrigated soil was found to contain about seven and half times more P than non-irrigated soils (111.45 and 14.95), respectively. Irrigated soil was slightly acidic while non-irrigated soil was slightly basic (pH in water 6.74 and 7.36) respectively, while the two soils were slightly acidic when the pH was measured in $CaCl_2$. (6.41 and 6.47), respectively.

Irrigated soil was found to contain slightly higher Mg than non-irrigated soil (1.54 and 1.2) and organic carbon (1.04 and 0.86), respectively. However, non-irrigated soil contains higher Ca and CEC (2.43 and 0.76) and (14.4 and 5.7) for non-irrigated and irrigated soils respectively. Result of the soil physical properties at this depth showed that, irrigated rice fields are principally sandy loam having higher percentage of sand (70%), while non-irrigated rice field are loamy soils having only 44% sand.

Table 1: Comparative Result of Irrigated and Non-irrigated Soils Analysis Collected from in and around Talata Mafara town. Zamfara State.

Depth. 0 – 15cm	irrigated	non-irrigated
Chemical properties		
N (mg/kg)	0.87	1.39
P (mg/kg)	111.45	14.95
K (Meq/100g)	0.28	0.34
Na (Meq/100g)	0.73	0.73
pH 1:2.51:1 H_2O	6.74	7.36
pH 0.01 $CaCl_2$	6.41	6.37
Ca (Meq/100g)	0.76	2.43
Mg (Meq/100g)	1.54	1.20
CEC (Meq/100g)	5.7	14.4
Organic carbon (%)	1.04	0.86
Physical Properties		
% Clay	14	26
% Silt	16	30
% Sand	70	44
Textural class	**Sandy loam**	**Loam**

Table 2: Comparative Result of Irrigated and Non-irrigated Soils Analysis Collected from in and around Talata Mafara town. Zamfara State.

Depth. 15 – 30cm	irrigated	non-irrigated
Chemical properties		
N (mg/kg)	0.82	0.80
P (mg/kg)	4.57	10.68
K (Meq/100g)	0.19	0.28
Na (Meq/100g)	0.61	0.65
pH 1:2.51:1 H_2O	8.16	6.97
pH 0.01 $CaCl_2$	6.23	5.73
Ca(Meq/100g)	0.71	2.32
Mg(Meq/100g)	1.49	1.17
CEC(Meq/100g)	6.0	20.1
Organic carbon (%)	0.91	1.2
Physical Properties		
% Clay	16	32
% Silt	12	38
% Sand	72	30
Textural class	**Sandy loam**	**Clay loam**

Result of soil analysis collected from irrigated and non-irrigated rice fields in Talata Mafara from 15 – 30cm depth is presented in Table 2. Both irrigated and non-irrigated soil were found to contain about the same N and Na, however non irrigated soil contain higher P and K than irrigated soil (10.68 and 4.57) and (0.28 and 0.19), respectively.

Irrigated soil was basic while non-irrigated soil was about neutral (pH in water 8.16 and 6.97) respectively, while the two soils were both acidic when the pH was measured in $CaCl_2$. (6.23 and 5.73), respectively but non irrigated soil was more acidic than irrigated soil. Irrigated soil was found to contain slightly higher Mg than non-irrigated soil (1.49 and 1.17) but the non-irrigated soil contain slightly more organic carbon than irrigated soil (0.91 and 1.2), respectively.

The result further showed that non irrigated soil contains higher Ca and CEC (2.32 and 0.71) and (20.1 and 6.0) for non-irrigated and irrigated soils respectively. Result of the soil physical properties at this depth showed that, irrigated rice fields are principally sandy loam having higher percentage of sand (72%), while non-irrigated rice fields have clay loam soils having only 30% sand.

When the fertility status of the soils were compared at different depth of 0-15 and 15-30cm, the N and Na concentrations of irrigated soil were about the same at both depths while that of non-irrigated rice field showed a high N concentration at 0-15cm compared to 15-30cm. The K concentrations for both irrigated and non-irrigated rice fields were slightly higher at 0-15cm compared to 15 to 30cm. A very high concentration of P at 0-15cm was observed for irrigated rice fields compared to 15-30cm but only a slight difference was observed for non-irrigated rice field under the same conditions. The pH in water of irrigated rice fields was about neutral at 0-15cm and slightly basic at 15-30cm, while that of non-irrigated rice field were about neutral at both depth. However, the pH in 0.01 $CaCl_2$ of both irrigated and non-irrigated soils were slightly acidic.

The Ca and Mg concentrations were about the same at both depth and for both irrigated and non-irrigated soils. Same trend was observed for the CEC of irrigated soils, but non-irrigated soils showed a higher CEC at 15-30cm compared to 0–15cm depth. The organic carbon concentration was slightly higher for irrigated soil at 0-15cm while that of non-irrigated soil was slightly lower at the same depth compared to 15-30cm. The soil of irrigated rice field were sandy loam at both depths while the soil from non-irrigated rice fields were loam and clay loam at 0-15 and 15-30cm, respectively.

DISCUSSION

The low N, K and organic carbon concentrations in both irrigated and non-irrigated rice fields are associated with almost all tropical soils. High temperatures and marked dry and rainy seasons, coupled with intensive overgrazing due to large livestock population and alternative uses for farm residues as fuel and thatching must have been responsible for this phenomenon. The higher P obtains in irrigated field compared with the non-irrigated field must have been associated with the heavy usage of fertilizer as the irrigated fields are under intensive cropping throughout the year not only for rice but for high value crops such as vegetables. This is in addition to the fact that, the study area possesses some deposits of rock phosphate which is the principal source of P fertilizers. The pH of both irrigated and non-irrigated rice fields are slightly acidic except for the non-irrigated field where the pH in water was slightly above neutral, however, these pH ranges are about optimum for most crops including rice.

The low amount of Na concentrations in both soils is a good indicator that the soils are not sodic, a condition developed due to high Na concentration that make soils hard and impervious to water and air. Despite the near same Mg concentration in both irrigated and non-irrigated rice fields, the high CEC in non-irrigated fields must have been associated with the higher calcium concentration compared with the irrigated fields, therefore provide more sites for cation exchanges in this soil. The sandy nature for rice irrigated fields compared to non-irrigated ones is associated with the cropping system practice by the farmers in the study location. Irrigated fields are subjected to continuous cropping not only for rice but for some high value crops particularly vegetables that require well drain soils. The loamy soil of non-irrigated fields is best suited for rainfed rice production since the study area has a little above 700mm rainfall per year.

CONCLUSION

A comparative study of fertility status of irrigated and non-irrigated rice fields in Talata Mafara Zamfara State, Nigeria was conducted to evaluate the physical and chemical properties as it affect rice productivity. Soil samples were collected at the depth of 0-15cm and 15-30cm from five irrigated and five non irrigated rice fields, bulk separately and from which one sample was prepared for each depth making a total of four samples. Soil analysis was conducted at the Department of Agronomy, Institute for Agricultural Research, Ahmadu Bello University Zaria. The result showed that, the texture of the irrigated rice fields were principally sandy loam at both depths, while that of non-irrigated rice fields were loam at 0-15cm and clay loam at 15-30cm, respectively.

The result further showed that, both soils at all depth have relatively low N, K, Na, and organic carbon concentrations. But both soils at both depths contain appreciable concentration of P. The pH for both soils at both depths were slightly acidic to slightly basic that are within limit for rice production. Soils from irrigated rice fields at both depths had slightly high concentration of Mg but showed lower CEC and Ca concentration. The study concludes that both soils had low concentration of N and K but relatively good available P. However, the high CEC and Ca concentration obtained from non-irrigated rice fields make it more fertile compared to the soils obtained from irrigated rice fields.

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