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FERTILITY STATUS OF SOILS UNDER IRRIGATION ALONG THE JAKARA STREAM IN METROPOLITAN KANO

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ABSTRACT
This study was conducted on the irrigated lands along the banks of the Jakara Stream in metropolitan Kano, with the aim of assessing its fertility level. Two sites (Hajj Camp and Magami) were selected based on concentration of irrigation activity and irrigation water source. Grid sampling was employed in which 100m^2 of land was selected in each area and divided into ten equally sized grid cells of 1m^2. Five samples were collected from each cell to a depth of 20cm from the surface using an auger, and the five samples were mixed up to make a composite sample. Analytical methods were employed in determining the levels of various fertility related parameters. The fertility parameters determined were organic carbon, organic matter, CEC, exchangeable bases (K, Ca, Mg and Na), total nitrogen, pH and available phosphorus. Analysis of the data obtained shows that values fell between medium to low fertility level except for organic matter at Hajj Camp which was high. On the whole, results of the research revealed soils of marginal fertility when USDA/NRSC (2001) guideline for soil quality assessment was adopted and values were compared with those recommended by Landon (1991).

Key words: Quality, Soil, Fertility, Jakara Stream, Irrigation

INTRODUCTION

Soil Quality is relatively a new concept that is gradually gaining popularity among land users, developers, planners and soil scientists. Quality as Eswaran *et al* (2000) explained is the essential character, distinguishing feature or property of an object, and is the feature which makes the thing useful or performs a task in a beneficial way. Soil quality has been defined in several ways (Eswaran *et al*, 2000). USDA (2002) defines it as the capacity of a soil to function within the natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality and support human habitation.

Many factors are responsible for the quality of any given soil and these factors are generally called indicators and they include agro-climatic, hydrogeology and cropping/cultural practices (NAS, 1993). Although, soil quality is difficult and expensive to measure (Cannon and Winder, 2004), however it still needs to be evaluated regularly, because nearly all land uses depend on healthy soil functions (USDA, 2002). The necessity for regular investigation of soil in order to evaluate its quality is further heightened because of the simple fact that land use and management can change the capacity of the soil to function (Karlen, 1997; USDA, 2002).

The practice of raising vegetables along the banks of rivers in metropolitan Kano has been going on for many years. It involves the use of stream water to irrigate land at the banks of rivers. Principal of these rivers are *Challawa, Getsi, Jakara* and *Salanta*. The main objective is to produce fruits and vegetables for consumption by city dwellers. This system of land use has been called urban and peri-urban agriculture (UPA) by Binns *et al* (2003). The continuous use of these lands throughout the year for both irrigation and rain-fed agriculture (Binns *et al*, 2003) is what may likely trigger fertility depletion which would affect the quality of the soil. This has been established in some other soils under similar usage (Alhassan, 1996; Dawaki, 1996). The aim of this research is to assess the fertility status of the soils under this system of land use. The objectives of this paper include; to determine the mean values of some key fertility indices in the soil and to compare the values with base values

STUDY AREA

This research was conducted on the irrigated soils along the banks of the *Jakara River* within metropolitan Kano and its suburb. The study area is located between latitude 11°59′ and 12° 08′N and longitude 8°34′ and 8° 42′E at an altitude of 486.5m. In the *Jakara* Plains, there is a pre-dominance of sand particles in some of the analytical works conducted (Foloronsho, 1998; Faruk, 1999). Hydromorphic soils tend to occur in areas where annual flooding occurs. These hydromorphic soils are dark-grayish in color and have a high content of clay. These hydromorphic soils are also called *fadama* and according to Nichol (1992), these soils are normally utilized in the production of crops under limited irrigation because of their high amount of residual moisture.

MATERIALS AND METHODS

Field Methods

Two sites were selected for this study, namely Hajj camp and Magami, located in the urban and the peri-urban parts of the metropolis respectively. Grid sampling was employed in which $100m^2$ of land was randomly selected in each of the two sampling areas and was divided into ten equally sized grid cells of $1m^2$ that ran horizontally along the bank of the river and vertically to the edge of a settlement where there was one. Five samples were randomly collected from each grid, and the five were mixed up thoroughly to produce a composite sample. Sampling was done using steel auger, and samples were collected from the surface to a depth of 20cm. Sampling was done in the period between late May and the first week of June when irrigation activities were winding up and the rains were just setting in so as to avoid the dilution and leaching effects rainfall might have on some of the parameters. Samples collected were stored taken to the laboratory where they were air-dried; crushed and sieved with 2mm sieve; and restored into the polythene bags.

Laboratory Methods

In the laboratory, six key parameters affecting fertility were determined namely; organic carbon; available phosphorus; exchangeable bases (including sodium Na^+, potassium K^+, calcium Ca^{2+} and Magnesium Mg^{2+}); CEC, total nitrogen and pH.

Organic carbon was determined using the Walkley-Black (1934) method. Phosphorus (P) content determination was done using the colorimeter method using sodium hydrogen carbonate extraction. The determination of exchangeable bases was done using Flame photometry using the ammonium acetate extraction technique. The CEC was determined using the ammonium acetate saturation method as described by Hesse (1971). The total nitrogen was determined using the Kjeldal Method. pH was determined using 1:2.5 $CaCl_2$ dilution method.

Statistical Techniques

The mean values obtained were compared with the set of values suggested as low, medium and high by Landon (1991) using one way analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

The mean values for all the parameters measured are as shown in Table 1. In trying to assess the quality of the soil in terms of fertility, mean values of the indices determined were compared with the values suggested by Landon (1991) as a baseline based on the quality assessment recommendation by USDA/NRSC (2001). The results are presented in the Table 2.

Using USDA/NRSC (2001) guidelines and comparing with the values suggested by Landon (1991) (Table 2) it could be said that the soil in all the respective areas sampled is only marginally fertile, especially as most of the parameters for which more is better (organic matter, CEC and nitrogen), are only within the low- medium range (except for organic matter at Hajj Camp). Marginal fertility is a characteristic of many tropical soils (Young, 1981), mainly because of the high rate at which organic matter is lost, high rate of leaching, highly weathered mineral and low input agricultural practices. The values recorded at Hajj Camp for most of the parameters may even be regarded as the only values that can be described as reasonably above marginal level probably due to the fact that higher levels of organic wastes are incorporated into the cultural practices of the areas as is clear from the difference in the organic matter values of the area compared to the other area. The phosphorus levels in the two areas are excessively higher than even the values suggested by Landon (1991) as high. This could be attributed to excessive use of phosphorus fertilizer during both rain-fed and irrigation periods with the consequent manifestation of the residual effects of phosphorus. Such high levels of phosphorus may lead to nutrient imbalance which would show up in nutrients deficiencies.

Table 1: Mean values of the fertility indices determined for the different areas

Parameter	Hajj Camp	Magami
Organic carbon (O.C) (%)	1.87	0.63
*Organic matter (O.M) (%)	3.22	1.09
CEC (cmol/kg)	14.50	6.82
Exchangeable Ca (cmol/kg)	5.52	4.54
Exchangeable Mg (cmol/kg)	2.30	2.16
Exchangeable K (cmol/kg)	1.68	1.54
Exchangeable Na (cmol/kg)	0.43	2.64
Total Nitrogen N (%)	0.021	0.007
Available Phosphorus P ($mgkg^{-1}$)	322.72	179.06
Mean pH (1:2.5$CaCl_2$)	6.6	7.26

*% O.M calculated by multiplying % O.C with a constant, 1.724 (Brady and Weil, 1996)

Table 2: Fertility status and quality assessment of the area

Site	Organic Matter (%)	CEC cmol/kg	N (%)	P cmol/kg	Ca cmol/kg	Mg cmol/kg	K cmol/kg	Na cmol/kg
Hajj Camp	3.22a	14.50a	0.021a	322.72a	5.52a	2.30a	1.68a	0.43a
Magami	1.09b	6.82b	0.007b	179.06b	4.54b	2.16b	1.54a	2.64b
Landon (1991)								
High	3.35a	30c	0.30c	140c	15c	8.0c	1.2b	2.0c
Medium	2.00c	15d	0.15d	60d	5a	3.0d	0.6c	0.7d
Low	0.75d	6e	0.05e	20e	2d	0.5e	0.2d	0.3e

Sources: Field Data and Landon (1991)

Values followed by the same letter in the same column are not significantly different at $p \leq 0.05$

CONCLUSION AND RECOMMENDATIONS

The results have indicated that the quality of the soil for cultivation is only marginal in terms of fertility, largely caused by cultural practices that result in over utilization of the land transiting from rain-fed to irrigation agriculture.

Based on the findings therefore, the following recommendations are suggested;

1. Incorporation of higher levels of organic matter. Preferably, the organic matter to be used should be composted, which will rule out the need for decomposition within the soil environment, thereby enhancing utilization of the minerals released by the organic matter.
2. Continuous monitoring of fertility situation in the soil with the aim of evaluating its quality for the land use.
3. Diversification of income generating activities. This will go a long way in shedding off some of the pressure on the land. These activities could be farm or non-farm based. For example, commercial composting may be encouraged as an avenue to supply some of the farmers with alternative safe and cheap farm inputs. Other activities may include apiculture, renewable energy generation etc.
4. Re-planned farming system. This may involve a change in the crops being grown, such that high income generating crops may be incorporated in one round of farming so as to reduce the necessity of having to go for second round within the same season.

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