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EVALUATION OF SOIL FERTILITY FOR MAIZE (*ZEA MAYS L.*) PRODUCTION ATTAMBURAWA IN DAWAKIN KUDU, KANO NIGERIA

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ABSTRACT

Soil fertility is a vital component of stable society because it ensure growth of plant needed for survival of living organisms. Fertilizers are normally applied to the soil without considering the specific nutrients requirement of the plant, therefore fertilizer use is not rationalized. This study aimed at evaluating the soil fertility for the appropriate recommendation of fertilizer amount and composition for maize production. This will be achieved by assessing the nutrient contents (N, P and K) of the soil and evaluating the nutrient supply using QUEFTSmodel and identify the appropriate fertilizer requirement for recommendation. The sampling area was selected purposively to include area where maize is the major crop grown. Grid soil survey technique was adopted whereby ten soil samples were collected using composite sampling techniques.The results shows that, the mean and standard deviation of the nutrient are N (0.12%±0.03), P (1.36±0.43), K (0.01±0.01) and pH (6.44±0.18). The nutrient supply were recorded as SN= 148.9, SP= 0.09 and SK= 37.45, however it is not all the amount of nutrient in supply form can be absorbed by the plant. The fertility factor rating revealed that N and K ranked high and P ranked low. Based on these analyses, 60kg K_2O (nutrient rates/ha) and MOP (100kg/ha) at planting are recommended for maize production in the area.

Keywords: Nutrient supply; factor rating; fertilizer imbalance; fertilizer recommendation; maize production

INTRODUCTION

The production of maize in Kano has increased due to the increases in the demand for various uses such as roasting, *tuwo*, *akamu* and popcorn as well as due to the introduction of new varieties such as Summaz 17 and 19 (striga tolerance), Summaz 21 (drought resistance) summaz 26 resistance to streak and low nitrogen and summaz 32 (99TZEZ- extra early) (Onyibe *et al.*, 2014). The high rate of nutrient uptake for maize production and nutrients removal with harvested straw and grain per unit area of cultivated land has increased considerably (Sarkar *et al.*, 1994). Estimates of nutrient requirements, internal efficiency of nutrient and fertilizer recommendation for maize production is very important for increase maize production. Accurate soil information is crucial for management decisions particularly crop specific fertilizer recommendation. (Ghosh *et al.*, 2015)

Soil fertility in the tropics is low due to rapid organic matter mineralization and the presence of highly weathered secondary minerals (Van Wambeke, 1992). However, fertility can be successfully improved using both inorganic and organic fertilizers. The major drawbacks of inorganic fertilizers are their low accessibility to resource-poor farmers (Garrity, 2004). While organic fertilizers are able to improve nutrient use efficiency, under tropical conditions they mineralize rapidly in soil and benefits through increases in organic matter last only for a few growing seasons (Diels *et al*., 2004).

Maize is one of the important crop for the smallholder farmers in sub-Saharan Africa, but yield has not increased significantly and per capita food production has declined since the 1980s (Muchena *et al*., 2005). The main contributing factors are poor inherent soil fertility, high rate of nutrient uptake particularly N and P (Bekunda *et al*., 2007), exacerbated by soil fertility depletionand other biophysical factors (Lynam *et al*., 1998). Declining soil fertility and land degradation have particularly affected the land on which the poor depend and threatened food security for the smallholder farmers (Sanchez, 2002).

The maize production is affected by a range of factors such as climate which is beyond farmers' control, others however, such as soil fertility, are more influenced by farmers' past and present activities. Soil fertility both affects and is affected by the choices that farmers make regarding agricultural production, fertilization, and soil and water conservation regimes. In order to study these effects there is the need to measure the soil fertility status as well as nutrients supply. Fertility is not a distinct property of the soil, as such, many soil properties influence fertility and also influence each other. This study aimed at evaluating soil fertility and nutrient supply using Quantitative Evaluation of the Fertility of Tropical Soils (QUEFTS) model with a view to recommend the appropriate fertilizer amount and composition for maize production in the area.

MATERIALS AND METHODS

Description of the study area

The study area is located in Tamburawa village of Dawakin Kudu Local Government Area which lies between latitude 11º 57´ to 11º 58´N and longitude 8º31´ to 8º 32´E as shown in Figure 1. The study area received about 800 mm to 1000 mm of rainfall (Olofin, 1987). The rainfall is a very important element because it determined the variety of maize grown in the area due it deficiency during the dry season. The soils of the study area is ferruginous tropical soils type whose equivalent to Nitrosols according to Food and Agricultural Organization (FAO, 1988). The textural class of the soil of the study area is sandy loam which is suitable for maize production (Adamu, 2014).

Soil Sampling

The materials used for sampling include global navigation system, soil auger and spade for collection of soil samples, polythene bags for storing soil samples and marker for marking the soil samples. The sampling location was irrigated lands which was selected purposively based on the major crop grown (maize) in the area.

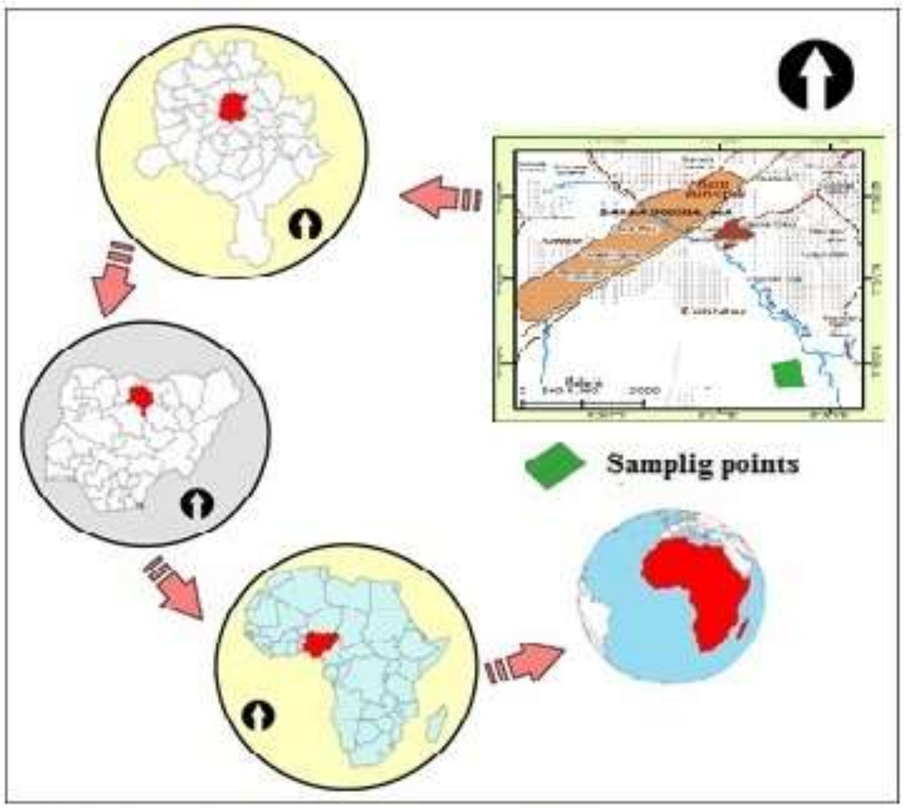

Fig. 1: Study Area Showing Sampling Points

Grid soil survey technique was adopted whereby ten small square (grid of 20 X 20 m^2) were constructed and superimposed on the base map of the area. In each grid, five different soil samples were collected from different location, homogenized and mixed vigorously and then taken sub sample of about half kilogram. The samples collected were air dried and then taken to laboratory for the analyses oforganic carbon (OC.), pH (H_2O), phosphorus (P), nitrogen (N) andexchangeable potassium (exch. K).

Laboratory Analysis

The air dried samples were crushed and passed through 2 mm sieve and then analysed for organic matter which was determined by wet digestion method using dichromate method as described by Walkley and Black (1978), soil pH was determined by pH meter in soil: water ratio of 1:1 as described by Eaton *et al.* (2005). Available phosphorous was determined using Bray no. 1 method (Sarkar and Haldar, 2005), exchangeable potassium was determined by extraction method with 1M NH_4OAC. Buffered at pH 7 and the concentration of potassium was measured with Atomic Absorption Spectrophotometer. Total nitrogen was determined using Kjeldahl method as described by Sarkar and Haldar (2005).

Data analyses

The laboratory results were analyzed using Statistical Package for Social Science (SPSS, IBM, version 20) (State the version and origin) whereby descriptive statistics such as mean, standard deviation and coefficient of variability were also employed.

Description of the evaluation Model (QUEFTS)

Quantitative Evaluation of the Fertility of Tropical Soils (QUEFTS) evaluate the potential supply of the N, P and K and deals with the interactions between them. QUEFTS gives a quantitative estimation of the overall fertility level of soil so that fertilizer forms and level to be used can be predicted. The maximum quantity that can be taken up from the soil by the plant is considered as the potential supply of that nutrient, represented by SN, SP, SK, where S = Supply. Therefore,it is not all available nutrients that can be taken up by the plant. Some are fixed with other elements or matter. The soil properties considered for the evaluation are: Soil reaction (pH) which is the soil property that influences the uptake of all the nutrients by the plant, Organic carbon, is the major potential supply of N, P and K and is the one of the main components of the soil organic matter, from which the plant obtains most of its nutrients. On average organic matter contains 58% C, 5% N, 0.5% P and 0.5% S (Euroconsult, 1989). The supply of the three major nutrient were evaluated using equation i, ii and iii:

$$SN = max[\ 17\ x\ (pH - 3\ )\ x\ org.C] \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots i$$

$$SP = max[(0.0375\ x\ total\ P + 0.45\ x\ org.C)\ x\ (1 - 0.25\ x)(pH - 6.7\ ))^2] \ldots \ldots \ldots \ldots \ldots \ldots ii$$

$$SK = max[0.35\ x\ (2 + exch.K)\ \ x\ (55 - org.C)] \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots iii$$

RESULTS AND DISCUSSIONS

The results of the laboratory analyses of the selected soil properties were in Table 1. The mean value of total nitrogen content of the soil is 0.13% with range values between 0.09 to 0.18 and therefore ranked low (Chude *et al.*, 2011). However, the mean value of total nitrogen obtained in this work is higher than the value obtained by Adamu and Yusuf (2014). Thus, this could be attributed to continuous N- fertilizer application, N-rich biomass decay along with favourable condition for microbial population and activities which may influence the organic matter decomposition serving as major source of N in the soil.

Table 1: Mean, Standard Deviation and CV of the Nutrient Capital

Statistics	N (%)	Avl. P (mg/kg)	K exch. (cmol/kg)	OC (%)	pH (H_2O)	Clay (%)
Range	0.09 - 0.18	0.97 - 1.45	0.06 - 0.1	2.2 - 3.85	6.2 - 6.8	32.32 - 48.32
Mean	0.13	1.361	0.06	2.92	6.44	40.75
±Sd	0.03	0.43	0.01	0.58	0.18	4.17
CV%	22.94	32.12	30.42	20	2.94	10.24

The available phosphorus (mg/kg) content in the soil ranges between 0.97 to 1.45 mg/kg (Table 1), and therefore, considered low based on soil fertility manual which ranked mean phosphorus value of < 10 mg/kg as low for Nigerian soils (Chude *et al.*, 2011). The values of phosphorus obtained in this work is lower than the values (179.06 mg/kg) reported by Dawaki *et al.* (2007).This indicates that there is gradual reduction in the available phosphorus in the soil of the area which is probably attributed to crops uptake, leaching and runoff which are major sources of phosphorus losses in the soil. This is adduced by Sanchez (2002) who explained that the principal pathways through which phosphorus is reduced or lossed from soil are plant removal, erosion of phosphorus-taking soil particles and runoff water which dissolve the phosphorus and then taken away as runoff.The values of exchangeable potassium in the study locations ranges between 0.06 to 0.1cmol/kg. The values of potassium in the study locations were ranked low as compared to soil fertility assessment manual which ranked mean value of potassium of < 0.15 cmol/kg as low for Nigerian soils (Chude *et al.*, 2011). The value of exchangeable potassium obtained in this work is lower than the value reported by Binns *et al.* (2003). This is probably attributed to crops uptake and leaching.

The value of organic carbon ranges between 2.2 to 3.85% with mean valueof 2.92%.Therefore the value of organic carbon in the area is considered low based on the rating of London (1991). The mean value of organic carbon obtained in this work (Table 1) is higher than the value obtained by Adamu (2004) who assessed the organic carbon content (0.3%) around Tomas Dam.This shows an increase in organic carbon accumulation in the soil of the area. This implies that, the rate of microbial decomposition of organic materials is high in the study area.The soil pH (Table 1) ranges between 6.2 to 6.8 with mean value of 6.4 which is slightly acidic and is ideal for most crops. The pH value recorded in this work is higher than the pH value obtained by Adamu and Yusuf (2014). This is probably due to the gradual accumulation of base cation. Brady and Weil (2002) reported that, low level of base cation in soil results in acidic condition of the soil, while high level of base cation increase the soil pH because at high pH more hydrogen ion and aluminum dissociated themselves so that more base cation can be adsorb.

The textural class of the soil of the study area is sandy loam based on the United State Department of Agriculture (USDA) textural classification system. The result obtained in this work is in line with the results obtained by Tanko (1999) and Adamu (2014) who reported in their findings that the major textural class of the soil of the area is sandy loam.The consistency of these findings is probably attributed to the fact that the soils of the study area are not altered by denudation agents which are the major factor responsible for alteration of soil texture. This is supported by Brady and Weil (1999) who explained that soil texture on a field scale can be altered by pedologic processes such as weathering and erosion.

Nutrient Supply and Uptake

The maximum quantity of nutrient supply for the three major nutrients (N, P and K) that can be taken up from the soil by the plant were evaluate and expressed as SN, SP and SK. The values of nutrient supply of N (148.92 kg/ha) and K (37.45 kg/ha) shows that, there is relatively high supply of N and K with low supply of P (0.092kg/kg) in the area. These nutrient supply values are not all the available amount of nutrients in the soil, because not all available nutrients can be taken up by the plant. However, the pH level of the soil of the area (6.44) is within the level whereby N, P and K are soluble, available and then taken to plant body. This implies that, high proportion of the nutrient supply values of N, P and K can be taken and use by plant.

Comparison of Nutrient Requirement With Nutrient Status of The Soil

The nutrient requirement of maize (Table 2) which show the most suitable level of nutrient (N, P, and K) required for maize production as described by Arnon (1975) was compared with the main nutrient status of soil of the area. This evaluation provided the information on the level of N, P and K in the soil of the area. Table 2 shows that N and P were ranked high based on the factor rating, this indicates that the nitrogen and phosphorus level of soil in the area is high while K was found to be low. The level of N, P, and K (Table 2) was used for the recommendation of the amount and composition of fertilizer required for maize production in the area.

Table 2: Comparison of factor rating and nutrient value of soil inkg/ha

Nutrient	Rank	Range Values	Range value of the area	Remark
N	High	10 to above	12.8	High
	Medium	8 to 10	-	-
	Low	< 8	-	-
P	High	131 to above	136	High
	Medium	70 - 130	-	-
	Low	<70	-	-
K	High	50 to above	-	-
	Medium	20 - 30	-	-
	Low	<20	6	Low

Fertilizer Recommendation For Maize Production in the Area

Based on the factor rating (Table 2) the values of the N, P and K were ranked and the fertilizer amount and composition were recommended (Table 3) in the area for maize production. Table 3 shows that the level of N and P was ranked high, while potassium ranked low based on the factor rating (Arnon, 1975) this revealed that the N and P contents of the soil are high which are the most important soil nutrient for crop production. This is contended by Ahemad and Kibret (2013) who reported that, nitrogen and phosphorus are the first and second important plants growing-limiting nutrients in soil. Urea 63kg/ha and MOP 100kg/ha were recommended, while no amount specifically recommended for potassium because its value was found to be high in the area.

Table 3: Fertilizer Recommendation Based on Factor Rating

Nutrient	**Fertility Class**	**Nutrient Rate/ha**	**Nutrient value of the area**	**Fertilizer recommendation and source/ha**
	High	30kg N	8 -12 kg/ha*	urea 63kg/ha at planting
	Medium	60Kg N	-	urea 133kg/ha or 20-10-10
Nitrogen	Low	120Kg N	-	urea 260kg/ha
	High	NIL	136 kg/ha*	No need of phosphate
	Medium	30kg P2O5	-	-
Phosphorus	Low	60kg P2O5	-	-
	High	Nil	-	-
	Medium	30 Kg K2O	-	-
Potassium	Low	60 Kg K2O	6kg/ha*	MOP 100kg/ha at planting

* **Mean/range of nutrient content in the soil of the area**

CONCLUSION AND RECOMMENDATION

From the finding it was concluded that, the level of N and K were found to be high. However, the soil pH need to be enhanced through organic matter incorporation in order to enhance the solubility and availability of N and K for crop uptake and the soil have low P. Based on this, it is recommended to use fertilizer with high proportion of P to avoid fertilizer imbalance. Uses of organic manure to maintain the current level of N and Kand also increase the level of P in the area.

REFERENCES

Ahemad, M. and Kibret, M. (2013). Mechanisms and applications of plant growth promoting rhizobacteria: Current perspective,*Journal of King Saud University – Science,* (26): 1 – 20.

Adamu, G.K. (2014). An Assessment of the Characteristics and Potentils of Fadama Soils in The Reaches of Two Major Stream in Kano State, Nigeria, Unpublished Ph.D. Thesis, Department of Geography, Bayero University Kano, Nigeria, 6 – 19.

Adamu, G.K. and Yusuf, M. A. (2014). A comparative Study of Changes in Soil Fertility Under Two Farming Practices in the Kano Close Settle Zone, *European Scientific Journals,* 10 (2)*:* 1857 – 7881

Arnon, I. (1975). *Mineral Nutretion of Maize*. International Potash Institute, Hebrew University of Jeruselem Israel.

Bekunda, M.A., Galloway, J., Syers, K. and Scholes,M. (2007). Background, current status and African context of the international nitrogen initiative. p. 115– 119. In A. Bationo et al. (ed.) Advances in integrated soil fertility research in sub-Saharan Africa: Challenges and opportunities. Springer-Verlag, Dordrecht, the Netherlands.

Binns, J. A, Maconachie, R. A. and Tanko, A. I. (2003).Water, Land and Health in Urban and Peri-urban Food production: The Case of Kano, Nigeria, *Land Degrad Develop,* 14: 413–444.

Brady, N. C. and Weil, R. R. (2002). *Nature and Properties of Soils,* 14th Edition, Pearson Education Inc, Upper Saddle River, New Jersey.pp?

Chude, V. O., Malgwi, W. B., Amapu, I. Y. and Ano, A. O. (2011). Manual on Soil Fertility Assessment, workshop Paper on Soil Fertility Interpretations and fertilizer recommendations. State the conference; date, place.

Dawaki, M. U., Yusuf, M. A. and Adamu, G. K. (2007). Quality Assessment of Soils Under Irrigation along the Jakara Stream in Kano Metropolis, *International Journal of Pure and Applied Science,* 1 (3): 37 – 42.

Diels, J., Vanlauwe, B., van der Meersh, M. K., Sanginga, N. and Merck, R.J. (2004). Long term soil organic carbon dynamics in subhumid tropical climate: 13C data and modeling with ROTHC. *Soil Biol. Biochem.* 36:1739–1750.

Eaton, A. D., Clesceri, L. S., Rice, E. W. and Greenberg, A. E, eds. (2005). pH value in water by potentiometry using a standard hydrogen electrode. In: Standard methods for the examination of water and wastewater. 21st ed. Washington (DC): Public Health Association, Water Environment Federation, and American Water Works Association. 1368.

Euroconsult (1989). Agricultural Compendium for Rural Development in the Tropics and Subtropics, Edited by Amsterdam and Oxford, *Elservier*, 778,

Food and Agricultural Organization (FAO, 1988). *Soils map of the world: revised legend*. Food and Agriculture Organization of the United Nations, Rome. 119

Garrity, D. P. (2004). Agroforestry and the achievement of the millenium development goals. *Agroforest Syst,* 61:5–17.

Ghosh, R. A., Padmanabhanb, N. K. C. and Patel, C. (2015). Soil Fertility Evaluation For FertilizerRecommendation Using Hyperion Data,*International Conference On Sensors & Models In Remote Sensing & Photogrammetry,* (11): 23–25.

London, J. R. (1991). *Booker Tropical Soil Manual,* John Wiley and Sons Inc., New York, 465.

Lynam, J.K.S., Nandwa, S.M. and Smaling, E.M.A.(1998). Editorial. Agric. Ecosyst. Environ. 71:1–4. doi:10.1016/S0167-8809(98)00127-3.

Muchena, F., Onduru, D., Gachini, G.and de Jager, A.(2005). Turning the tides of soildegradation in Africa: Capturing reality and exploring opportunities. Land Use Policy 22:23–31. doi:10.1016/j.landusepol.2003.07.001.

Olofin, E.A. (1987). Some Aspect of Physical Geography of Kano Region, Department of Geography Lecture Series BUK, Dabis Standard Printers 73A, Zaria Road Kano, 5 – 34

Onyibe, J.E., Sani, B.M., Baba, D., Chindo, H., Ibrahim, I.K. and Malumfashi, M. (2014). MaizeProduction, Marketing, Processing & Utilization In Nigeria Extension Bulletin No. 217 National Agricultural Extension Research Liaison Services.

Sarkar, S., Mandal, S.S., Maiti, P.K. and Chatterjee, B.N. (1994). Sulphur nutrition of crops with and without organic manures under intensive cropping. Ind. J. Agri. Sci. 64: 88-92.

Sarkar, D. and Haldar, A. (2005). *Physical and Chemical Methods in Soil Analysis: Fundamental Concepts of Analytical Chemistry and Instrumental Technique*, Newage International, Publishers, 4835/24, Ansari Road, Daryaganji, New Delhi-India

Sanchez, P.A. (2002). Soil fertility and hunger in Africa. Science 295:2019–2020. doi:10.1126/science.1065256.

Tanko, A.T. (1999). Changes in Soil and Water Quality and Implication for Sustainable Irrigationin the Kano River Project

(KRPI), Kano State Nigeria, Unpublished Ph D. Thesis, Department of Geography, Bayero University, Kano, Nigeria

USDA (2001). United State Department of Agriculture. Guideline For Soil Quality Assessment inConservation Planning, National Resource Conservation Services, Soil Quality Status, 3 – 20.

Van Wambeke A (1992). Soils of the Tropics. McGraw-Hill, New York, 253 - 266

Walkley, A. and Black, C.A. (1934). An Examination of the Djetgareff Method for Determining Organic Matter and Proposed Modification of the Chromic Acid Titration Method, *Soil Sciences*, 37: 29–38