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Impact of Rate of Poultry Manure on Nutritional Qualities of African Eggplant (*Solanum macrocarpon* L.) Grown on a Degraded Soil

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ABSTRACT

In the last few decades, agricultural soils of the world are greatly affected by soil degradation which worsened food security. The ill effects of the unscientific and continuous use of chemical fertilizers coupled with expensive agrochemical input have necessitated the use of manure. Therefore, this work studied the effect of using poultry manure to amend degraded soil on the selected nutritional qualities of African eggplant (*Solanum macrocarpon*) leaves. Soil samples were collected from an undisturbed degraded area at three depths 0-10, 10-20 and 20-30 cm respectively. The level of degradation was determined and the poultry manure was applied at 0, 10, 15 and 20 t/ha rate respectively. At maturity, the fresh leaves were harvested and the effect of the rate of poultry manure application on moisture content, fat content, crude fibre, crude protein, ash content and carbohydrate content were determined. The highest moisture content (88.88% db), crude protein (4.79%) and ash content (1.79%) were recorded at 20 t/ha poultry manure application while carbohydrate content (4.98%), crude fibre (0.64%) and fat content (1.78%) have its highest at 0 t/ha. The result of this experiment shows great potential for land reclamation using poultry manure.

Keywords: land degradation, poultry manure, land reclamation, Africa eggplant, nutritional qualities

INTRODUCTION

African Eggplant (*Solanum* ma*crocarpon* L) is a plant in the *Solanaceae* family, widely cultivated for its phytochemical's properties, nutritional content and as an ornamental plant [1]. The leaves are rich in protein, fat, crude fibre, calcium and zinc ([2] and [3])**.** Moreover, the roots, leaves and fruit of this crop contain phytochemicals that are of vital use in modern and traditional medicine [4]. Despite its qualities, the plant has not been well exploited [2]. Soil degradation is the major cause of reduced agronomic productivity and a decline in food security in sub-Saharan Africa [5]. Most African soils are inherently low in organic carbon and highly susceptible to nutrient leaching due to accelerated soil erosion ([6] and [7]). In Nigeria low soil fertility hinders farmers from optimum crop productivity ([8] and [9]). Hence, the reliance on intensive fertilization to boost output ([10] and [11]).

In the last century, mineral fertilizers have made a major contribution to increasing food production worldwide. However, unfair use, poor management and over-utilization of chemical fertilizers lead to soil quality deterioration and soil and environmental pollution [6]. Moreover, its continuous use leads to toxicity as well as deficiency of some major and minor nutrients in the soil ([12] and [13]). Also, the cost implication of chemical fertilizer and the efficiency of its procurement and distribution limit its application in the African context ([9] and [11]). This scenario emboldened alternative soil fertility

maintenance measures such as the use of organic manure (OM). OM has been recommended as a viable means to boost agronomic productivity and enhance resourceful utilization of agro-industries waste ([14] and [15]). OM is cheap, eco-friendly, readily available and enriched with nutrients. OM is rich in organic matter which has a stimulatory effect on the soil structure and its aggregate stability [5]. Poultry manure (PM) is an exceptional source of organic fertilizer due to its high concentration of macro-nutrients (nitrogen, phosphorus, potassium) and other important nutrients readily available for plant uptake as compared to other organic sources ([6] and [16]). PM has a residual effect and the ability to improve soil structure compared with chemical fertilizers [8].

This project aims to determine the nutritional qualities of African eggplant sown on degraded soil amended with PM.

2. MATERIALS & METHODS

2.0. Experimental location

The study was carried out on the experimental farm of the Department of Agricultural Engineering, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria, which is on (latitude 8º 10^1N and longitude 4° 10^1E) of the equator. The area has an average daily maximum temperature of 33°C and an average daily minimum temperature of 28ºC.

2.1 Preliminary soil Investigation

The soil surface was cleared and the core cutters were used to collect the sample at various soil horizons; surface (0-10), subsoil (10-20), and root zone (20-30 cm) for evaluation of the nitrogen and organic carbon content to confirm the level of soil degradation.

2.2 Sample collection

Soil samples were collected from a degraded area in three layers, at a depth of 0-10, 10-20 and 20-30 cm. Plant roots were removed from the collected soil to prevent them from decaying, thus adding organic matter to the soil. The soil was uniformly compacted and arranged in the perforated bucket in sequential order of 20-30cm, 10-20 and 0-10 cm. A space of 3cm was required at the top to give room for water infiltration. The bucket was then moved into an open field for 10 days in the rain so that natural packing of the soil will be achieved. Poultry manure was collected, weigh with a weighing balance, and mixed manually at the surface of the soil. The seedlings of the African Eggplant which have earlier been raised in the nursery within the experimental field for two weeks were transferred to the lysimeter.

2.3 Proximate Analyses of Crops

The proximate composition of moisture, crude protein, crude ash, crude fibre, crude fat and carbohydrate content of *S. macrocarpon* were measured using the procedure described by [17].

2.4. Statistical Analysis

The results obtained were subjected to regression analysis and analysis of variance (ANOVA) and the means were separated using Duncan's multiple range test. All analyses were performed using SPSS (v. 20).

3.0 RESULTS AND DISCUSSION

The results of the experiment are as discoursed below.

3.1 Result of Preliminary Soil Test

Soil organic carbon is a key physical and chemical parameter critical in nutrient management for farming system [18]. The results from the measurement of the soil organic carbon and total nitrogen were compared with FOA standard. This result indicated degraded soil when compared with FAO standard threshold of 2.5% (Fig. 1) and 0.13% (Fig. 2) limit for organic carbon content and total nitrogen, respectively. [19] Also reported 0.5 and 2% threshold as the threshold for organic carbon and total nitrogen.

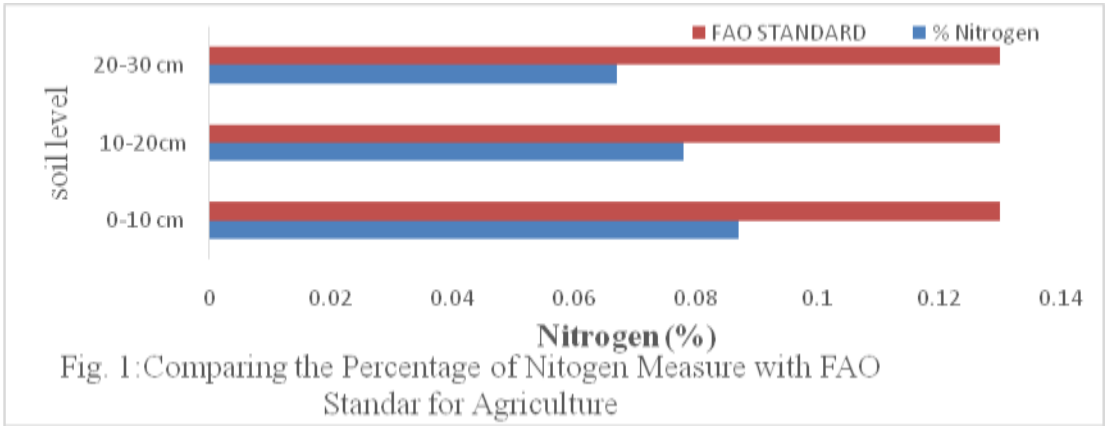

Fig. 1:Comparing the Percentage of Nitogen Measure with FAO Standar for Agriculture

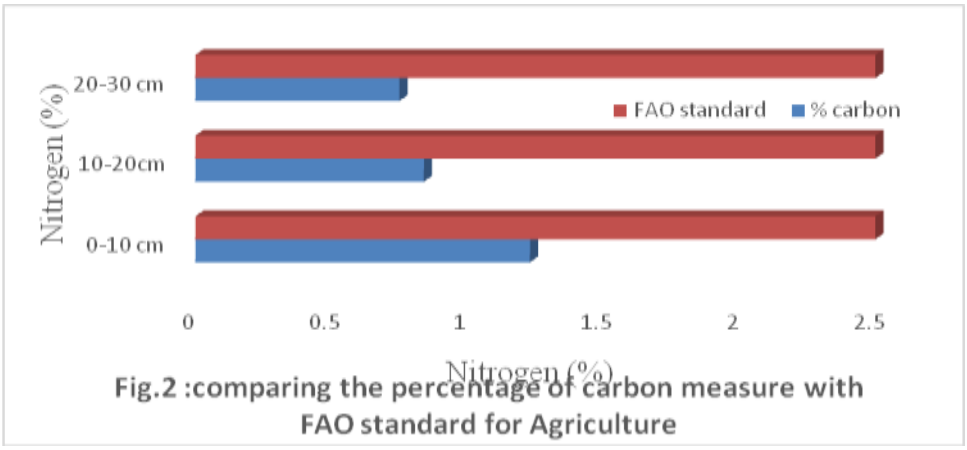

Fig.2 :comparing the percentage of carbon measure with FAO standard for Agriculture

Figure 1: Preliminary Investigation of Soil Samples compared with FAO standard

3.2 Effect of Poultry Manure on the Chemical Composition of Eggplant leaves

Minerals are very important and essential ingredients of diet required for normal metabolic activities of body tissues. The result of effects of using PM in reclaiming a degraded soil for planting African Eggplant on selected essential nutrients composition (moisture content, ash content, fat content, crude protein content, crude fibre content and carbohydrate content) of the plant leave is as presented below.

3.2.1 Effect of poultry manure on the moisture content of eggplant leaves

The moisture content (MC) of any food is an index of its water activity and is used as a measure of stability and the susceptibility to microbial contamination [20]. The MC recorded was between 87.22 and 88.88% wb. The application of poultry manure increases the MC of the eggplant leaves (Fig. 3). This is similar to the work of [21] and [22] who reported that applications of poultry manure encourage greater availability of water and nutrient to plant. The MC recorded is in the range of MC reported by [23] (89.7%) for eggplant but higher than 75% moisture reported by [24] for *Solanum macrocarpon*. The high moisture content implies that dehydration would increase the relative concentrations of the other food nutrients and improve the industrial usability of the crop as a raw material in food industries.

Regression analysis was performed on the results from the effect of rate of poultry manure on the moisture content of eggplant leave; the empirical formula is as shown in Equation 1. The result of the plotting shows a high correlation (R^2 = 0.9411) which shows that the empirical model can be used to predict the effect of poultry manure on moisture content of the eggplant leave.

$$M_c = -0.375r^2 + 2.361r + 85.355 \quad (1)$$

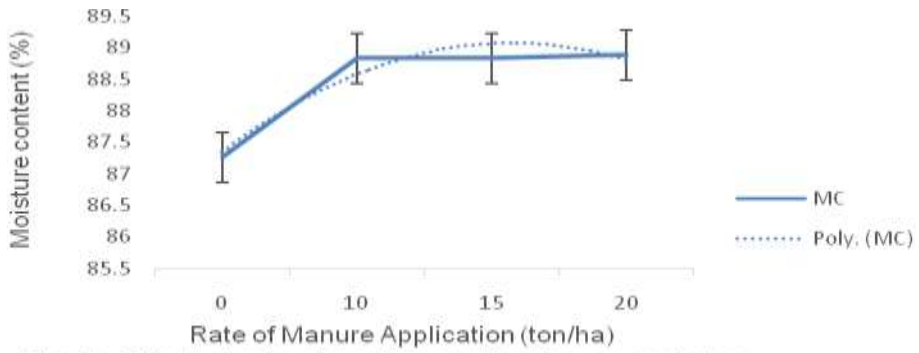

Fig. 3 : Effect of rate of poultry application on moisture content of eggplant

3.2.2 Effect of poultry manure on the ash content of eggplant leaves

The ash content (**AC**) of a food substance is an indication of the degree of its inorganic matter content. The ash content of the eggplant leaves increases with the PM application rate and peaked at 1.79%. The ash content of food substance is an indication of the mineral content of the food [25]. It shows the degree of the inorganic matter.

The effect of different rates of application of poultry manure on the ash content of the eggplant leave is as presented in Fig.4**.** It was observed that application of poultry manure to the degraded soil increase the Ash content of the eggplant leaves. The value of Ash content measured from this study (1.7-1.68%) were within the range of (1.8-1.78%) reported by [21], higher than 1.3 reported by [23] for eggplant leaves but lower than (3.07– 3.34) reported by [24].

The regression equation representing the relationship between the rate of poultry manure applied to the soil and the measured ash content of eggplant leaves is a polynomial with high correlation (R^2 = 0.9571) as presented in Equation 2.

$$\mathbf{AC} = 0.005r^2 + 0.003r + 1.695 \qquad (2)$$

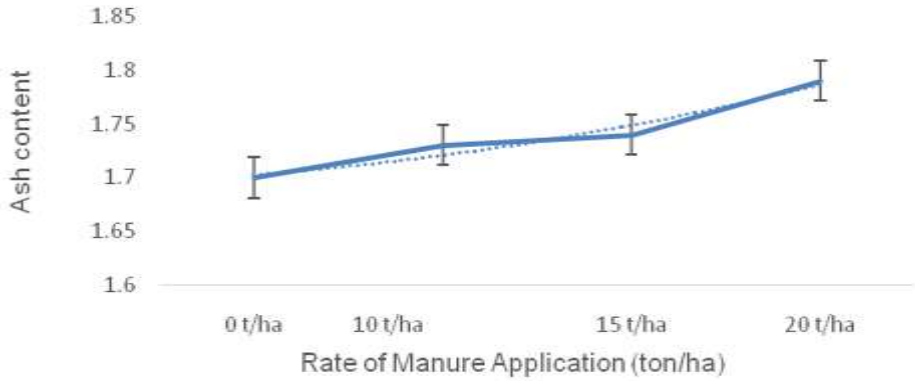

Fig. 4: Effect of rate of poultry application on ash content of eggplant

3.2.2 Effect of poultry manure on the fat content of eggplant leaves

A small amount of fat (FC) is an essential part of a healthy and balanced diet**.** Fats gives energy helps body to feel satisfied after eating and helps the body absorb vitamin A, D and E [25] and [26]. The range of 0.64 to 0.50% recorded in this

experiment was congruent with [2] but lower than (1.18-1.24) reported by [27].

The effect of different rates of application of poultry manure on the fat composition of eggplant leaves is as presented in Fig.5.This result showed that as the rate of poultry waist incorporation to the soil is increasing the fat content of the eggplant leaves is decreasing. The range of 0.64 to 0.50% recorded in this experiment was in the range of 0.6% reported by [23] for eggplant leaves but lower than (1.18-1.24) reported by [24].

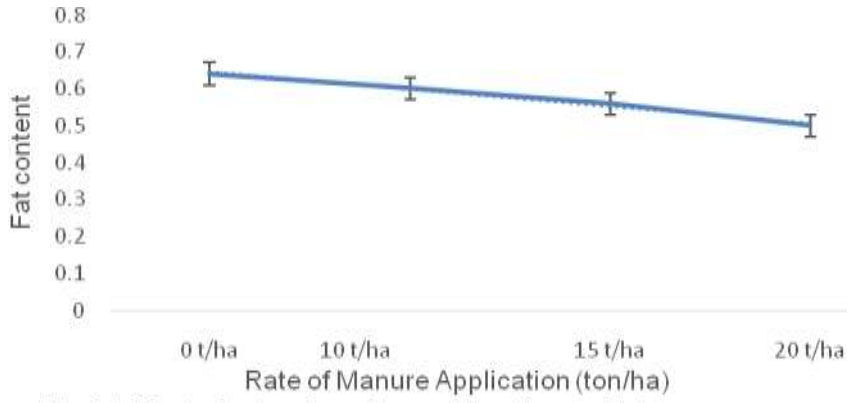

Fig.5 :Effect of rate of poultry application on Fat content of eggplant leaves

The regression equation that represents the relationship between the rate of poultry waist incorporation to the soil and the fat content of the eggplant leave is as presented in Equation 3.

$FC = -0.046r + 0.69$ ($R^2 = 0.9888$) (3)

3.2.3 Effect of poultry manure on the crude protein content (CP) of eggplant leaves

Protein is an essential nutrient for the proper growth and function of the human body. It is found in every cell and tissue, including skin, hair, muscles, organs, and glands. World health organization (WHO) reported that about 500 million world population is suffering from protein malnutrition. The presence of appreciable plant protein in eggplant leaves make the vegetable an important diet in human diet.

The effect of different rates of poultry manure applied to the soil on the measured crude protein content of the eggplant leaves is presented in Fig 6.The result shows an increase in protein content of the leaves from 3.64 to 4.79% when the poultry application rate was increased from 0 to 20 t/ha. This was in agreement with the results of [28] who reported highest protein content when poultry manure was used to grow *Amaranthus vegetable.* This may be due to the useful nutrient contain in poultry manure which is released to the soil for the plant [29]. The 3.4 to 4.79% protein reported was in agreement with [23] who reported 4.3%protein for eggplant leaves, but lower than 5.79% and 4.9 - 5.9% reported by [20] and [28].

The regression equation that represents the relationship between the rate of poultry waist incorporation to the soil and the protein content of the eggplant leave is as presented in Equation 4.

$CP = 0.04r^2 + 0.172r + 3.445$ ($R^2 = 0.9918$) (4)

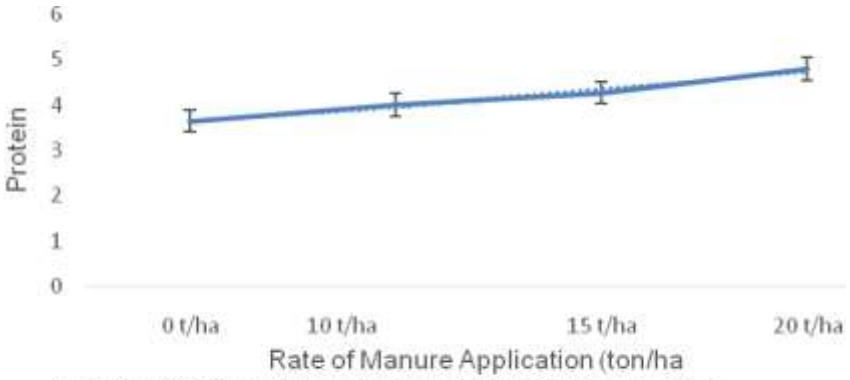

Fig. 6 : Effect of rate of poultry application on Crude Protein content of eggplant

3.2.4 Effect of poultry manure on the crude fibre content of eggplant leaves

The presence of crude fibre in food is very important because of its ability to lowers the cholesterol level and consequently decrease the risk of cardiovascular diseases. Fiber in food helps in digestion by removing toxins and harmful materials from the stomach thus reducing stomach and colon cancer [29] and [30]**.**

The effect of different rates of application of poultry manure on the crude fibre content (CF) of the eggplant is shown in Fig. 7. The results show that the rate of poultry waist application is inversely proportion to the fibre content of the plant leaves, though higher than the 1.4 % fibre reported for eggplant leaves by [2]. The measure fibre of between 1.6 and 1.78% was higher than 1.4 % fibre reported for eggplant leaves by [23] but in the range of 0.42 to 2.8 reported for tomato by [25].

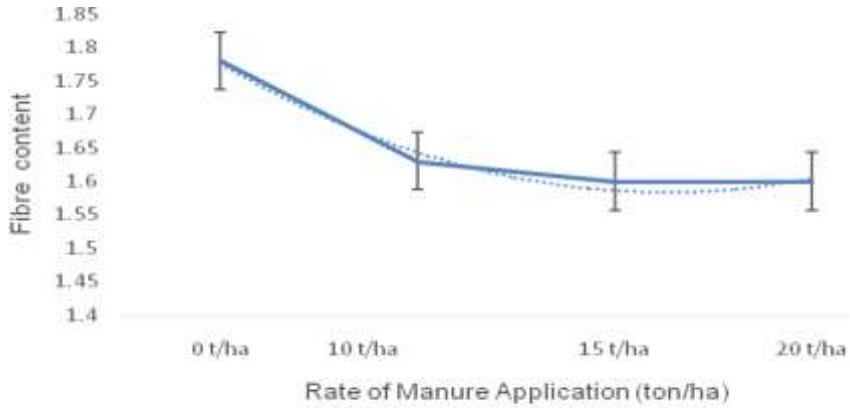

Fig. 7 : Effect of rate of poultry application on the Crude Fibre of eggplant leaves

The regression equation that represents the relationship between the rate of poultry waist incorporation to the soil and the fibre content of the eggplant leave is polynomial with high correlation (R^2 = 0.9818) as presented in Equation 5.

$$FC = 0.0375r^2 - 0.2445r + 1.9825 \quad (5)$$

3.2.5 Effect of poultry manure on the carbohydrate content of eggplant leaves

Carbohydrates are the body's main source of energy. The effect of different rates of application of poultry manure on the carbohydrate content (CHO) content of the eggplant leaves is as presented in Fig.8.The control experiment indicates highest value and the carbohydrate content decreases with increase in the rates of application. The carbohydrate recorded in the experiment was between 2.44 and 4.98% which were in the range of 2.4 -7.18% reported by [24] but lower than (5.72 and 9.0) reported for tomato by [25].

The regression equation that represents the relationship between the rate of poultry waist incorporation to the soil and the fibre content of the eggplant leave is polynomial with high correlation (R^2 = 0.949) as presented in Equation 6.

$$CHO=0.3025r^2-2.2955r+6.8775 \quad (6)$$

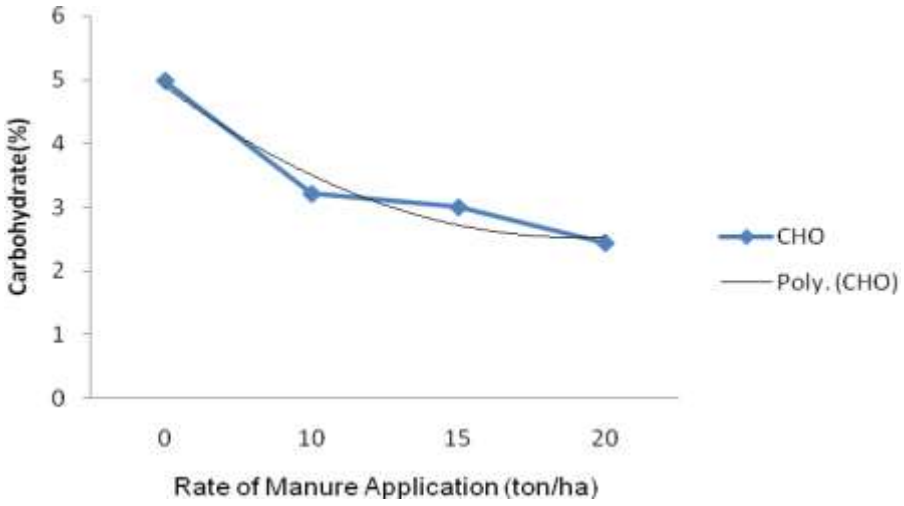

Fig. 8: Effect of rate of poultry application on the Carbohydrate of eggplant leaves

CONCLUSIONS

Minerals are very important and essential ingredients of diet required for normal metabolic activities of body tissue [4]. The marginal difference in MC and ash content of the soil treated with PM points to the stimulatory effect of PM in encouraging greater availability of water and nutrient to plants [9]. Moreover, PM application enhances the crude protein content of the eggplant leaf thus improving its nutritive value. The study has shown that the use of PM as an organic amendment influenced the selected proximate composition of African Egg Plant. PM improves the Moisture content, ash content and crude protein content.

AUTHORS' CONTRIBUTIONS

Dr Idowu, D.O. designed the study and wrote the first draft of the manuscript. Engr. Adebayo, T.B and Mr Onofua, O.E managed the analyses of the study and literature searches while Engr. Adebayo, J.M managed the experimental procedure for the analysis of the selected food values of the eggplant leaves. All authors read and approved the final manuscript.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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