**Storage Root Performance and Nutrient Composition of Two Varietal Sweet Potato (Ipomoea *batatas (L) Lam*) to same rate of Organic Soil Amendments in Igbariam, Anambra State, Nigeria**.

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**ABSTRACT**

Decline in soil fertility constitutes one of the major constraints to root and tuber crops production. The application of organic fertilizers such as Neem leaves(NL), Rice Husk Dust(RHD), Cow dung(CD), Swine dung(SD) and Poultry Droppings(PD) can be an alternative to improve soil quality resulting to improved root quality and nutritional value of crops. The research trial was conducted to evaluate the influence of different organic soil amendments on the nutrient composition and storage root quality of two sweet potato varieties such as Umuspo 3 (Orange-fleshed) sweet potato and TIS 8164. A split plot in a randomised complete Block Design was adopted. Tropical improved varieties of sweet potato constituted the main plot, whereas different organic soil amendments that constituted the sub-plots were applied as follows: Neem leaves at 10t/ha, Rice Husk Duct at 10t/ha, Cow Dung at 10t/ha, Swine Dung at 10t/h, Poultry Droppings at 10t/ha including the control(untreated plot). Each of the six treatments in the sub-plots was replicated three times in each main plots. The two sweet potato varieties were planted with the spacing of 50cm x 100cm inter and intra row respectively. The parameters considered was the storage root yield at harvest as well as the nutritional composition of the roots. Data generated was subjected to statistical analysis. The Results showed that the storage root was significantly improved by the two varietal sweet potatoes and organic soil amendments. Umuspo 3 performed relatively better than TIS 8164. The results also indicated that poultry droppings at 10t/ha are significantly far more better than other soil amendments, followed by Cow dung at 10 t/ha. Umuspo 3 (orange-fleshed) significantly(P<0.05) produced higher number and weight of storage roots as well as root quality than TIS 8164 when poultry droppings were applied to the soil, followed by cow dung at the same rate. Other organic soil amendments performed significantly less when compared to poultry manure. The application of different organic manure sources significantly improve the nutrient status of the soil thereby improving the storage root quality of sweet potato especially Orange-Fleshed sweet potato( Umuspo3). It is pertinent to say that farmers are encouraged to make use of organic manure(especially poultry droppings) to enrich the soil, as their source of soil fertilization for better yield and high storage root quality.

**Keywords: Sweet potato, Organic manure, nutritional composition, and root quality**

**I. INTRODUCTION**

Sweet Potato (*Ipomoea batatas L*.) is a starchy vegetable sgrown for man’s food and livestock feeds in sub-saharan Africa. It is used for both domestic and industrial purposes, with its nutritional value far exceeds other roots and tuber crops such as yam, cassava and cocoyam(NRCRI,2009). It ranks as the fifth most important food crops on fresh weight bases in developed countries after rice, wheat, maize and cassava, as the crop contains beta carotene which is a precursor for vitamin A(Filie-pequenine,2000). The root crops thrive in a marginal soil but improved soil fertility increases its performance and root yield. However, due to the growth and yield of the crop in a marginal poor soil without adequate and proper use of soil organic amendment sources, the growth and yield performance has depreciated. According to Ayeni et al,(2009) reduced soil fertility after years of cropping activities always remain the bane of humid tropical soils. As reported by Mbagwu(2001) and Nwite et al,(2008), soils of southeastern Nigeria are generally poor in their native availability of nutrients due to degradation resulting from improper land use and other management practices which has limited the ability of soil to produce optimally quality crops. In view of this, organic manure becomes the surest way to improve the soil for better sweet potato production.

Organic residue addition to the soil is particularly important for maintenance of tropical soil. Many crop species respond very well to the application of organic fertilizer such as animal dung as it can sustain yield under continuous cropping on most soils. It aims at protecting the ecosystem, ensure environmental cleanliness and make the soil to be more productive and sustainable. Salawu and Mukhar (2008) reported that the application of organic amendments have significantly improved on the growth and yield of root and tuber crops especially sweet potato. Animal manures are an organic material high in nutrients. As decomposed animal organic materials contain beneficial bacteria which converts nutrients into easily accessible form that can be moderately released for plant uptakes.

Organic manure is known to be effective in maintenance of adequate supply of organic matter in the soil with attendant improvement in soil physical, chemical conditions and enhanced crop performance.(Ikpe and powel,2003; Ano and Agwu, 2005). Soil physical characteristics such as water infiltration rate, water holding capacity, and aeration as well as biological characteristics such as biomass, biological activity and biodiversity are generally improved by organic manures. Organic materials such as neem leaves, which are extracted from neem tree has insecticidal and medicinal tendencies for pest control(Babu et al, 2001). When utilised as soil organic amendments, it enriches the soil with organic matter and lowers nitrogen losses by inhibiting nitrification. In addition, rice husk dust, wood remains, nut shells and crop residues are regarded agricultural wastes which has been transformed into biochar for the purposes of carbon sequestration(Lehmann et al,2001). Rice husk contains a high content of silicon and potassium, nutrients which have great potential for amending soil(Lehmann et al,2001). The application of rice husk in the soil can significantly improve soil properties by decreasing soil bulk density, enhancing soil pH, organic carbon, available nutrients and reducing heavy metals from the soil systems, hence increasing crop yields(Peterson et al, 2010). Further, poultry droppings remain an excellent organic fertilizer as it contains high nitrogen, phosphorus and other essential nutrients(Oyewole et al, 2011). Poultry wastes, which contains droppings, waste feeds, broken eggs, feathers and sometimes sawdust from poultry floor, were being used by farmers as a source of nutrient for crop improvement and development. Lustasa et al 2017 reported an increase in the growth and yield of sweet potato on poultry manure treated plots. There is an increase in soil pH, Organic matter, total nitrogen, available phosphorus, exchange cations and percent base saturation due to application of poultry manure(Adeleye et al ,2010). Swine dung and cow dung as an organic manure source improves the soil functions especially organic matter, and provide nutrients to the soil for better crop yield performance. Organic manure has shown to increase crop quality by increasing crop nutrient concentration not only in the year of application but also in succeeding years. In addition, the research paper is aimed to evaluate the influence of difference organic sources on the storage root yield of the two sweet potato varieties as well as its impact on the nutritional composition of the crop.

**II. MATERIALS AND METHODS**

The research was conducted in an experimental field at Igbariam, Anambra State in 2022. The initial soil sampling, at a depth of 0-20cm, were also carried out and analyzed. The soil samples analyzed include; Soil pH, organic carbon(wet oxidation method of walky and black, 1934 as modified by Nelson and Somme, 1982), CEC (ammonium acetate method), Nitrogen (semi- micro kaldahl method), and Available Phosphorus( Bray 11 methods, Bray and kurtz,1945).

The experimental design was a split plot arrangement in a randomised complete block design which consist of two factors: A (two different sweet potato varieties which includes Umuspo 3 and TIS 8164), and B (different organic manure sources such as cow dung, swine dung, poultry droppings, neem leaves, rice husk dust at the same rate of 10t/ha) with six levels of B treatments including control replicated three times. These treatments were incorporated into the soil a week before planting. The two varieties of sweet potato vines, at 30cm long, were planted on the bed prepared at a spacing of 50cm x 100cm. All agronomic practices observed, and weeded at 3 and 6 weeks before the vines covered the ground. Harvesting were done as the vines turn yellowish and dried up at about sixteen weeks after planting.

At eighteen weeks after planting, the storage roots of the two sweet potato from different plots were processed into floor, as shown in fig. 1, using standard procedure for proximate analysis. The following proximate analysis were determined, in percentage, using gravimetric method according to AOAC, 2004; Moisture content, dry matter, ash (furnace incineration), Crude fiber(weende method) , ether Oil/fat/ lipid extract(continuous solvent extraction method using soxhlet apparatus), crude protein(Kjeldahl method), carbohydrate, and energy value. Data collected were number of storage root yield per plot and weight (kg) of storage roots per plot, and was statistically analyzed using analysis of variance (ANOVA) according to the procedure for split plot in randomised complete block design, with treatment of means separated and compared using F-LSD at 5% probability level.

**III. RESULTS**

**A. Soil Physicochemical Analysis of the Experimental Trial**

The soil phyiscal and chemical analysis of the studied soil before application of the organic soil amendment were presented in Table 1. The soil is sandy loam with 76.5% sand, 9.4% clay and 14% silt. The soil pH was 5.4, organic carbon 1.43%, nitrogen 0.16% and phosphorus 21.00mg/kg. The exchangeable bases showed Calcium as 6.40cmol/kg, potassium 0.10cmol/kg, and sodium 0.30cmol/kg whereas cation exchange capacity was 8.24 and exchangeable acidity 0.64cmol/kg and base saturation was 92.20%.

**B. Effect of sweet potato varieties and Organic soil amendments on storage roots at harvest**

There are significant effect of sweet potato varieties and organic manure sources on the number of storage roots per hectare, which was presented on the Table 2. There is an increase in the number of yield per hectare as affected by soil amendments which ranged from 13,889 produced by RHD 10t/ha to 38,194 produced by poultry droppings at 10 t/ha. There was significant (p<0.05) difference among the varieties of the number of the storage roots per hectare at harvest. Umuspo 3( oranged-fleshed) produced the higher mean number of storage roots of 18,576. There were significant (p<0.05) difference among the soil amendments and the interaction between varieties and soil organic amendments on the roots yield per hectare at harvest. Poultry droppings at 10t/ha significantly produced the highest mean number of storage roots which was 38,194 than other amendments, followed by swine dung with mean number of 26,562 whereas the rice husk dust at 10t/ha produced the least mean number of 13,889 storage roots at harvest.

**C. Effect of varieties and soil organic sources on weight of storage Roots**

Table 2 showed the effects of varietal two sweet potatoes and different organic sources at harvest**.** The weight of storage roots were affected by soil amendments, ranging from 6.5t/ha as produced by no applications of manure sources to 15.5t/ha produced by the poultry manures at 10t/ha. There was significant difference(p<0.05) among the varieties on the weight of the roots. Umuspo 3 significantly (p<0.05) produced the higher mean weight of storage root of 10.7t/ha than TIS 8164 with lower mean weight of 7.1t/ha. There also significant difference among the soil amendment and interaction between varieties and soil amendments on the weight of storage roots at harvest. Poultry droppings produced the highest mean weight of 15.5t/ha than other organic sources, followed by cow dung with a weight of 9.1t/ha whereas the control recorded the mean weight of 6.5t/ha at harvest.

**D. Effect of varieties and soil organic sources on the nutrient composition of the yielded Storage Roots.**

Table 4 showed that there were significant effect of two varietal sweet potatoes and organic soil amendments on the nutritional composition of yielded roots. Umuspo3 has less moisture content, crude fiber content, ether extract(fats), dry matter contents compared to TIS 8614 whereas TIS 8614 significantly has improved nutritional value. The same trend happens with regard to soil organic amendments which significantly showed that cow dung and poultry droppings increase the nutritional contents of the storage roots of TIS 8614 than Umuspo 3. Other organic manures such as neem leaves, swine dung, rick husk duck can equally play a significant role to the improvement of nutritional value of the yielded roots.

**Table 1. Initial Soil Properties of the experimental field**

|  |  |
| --- | --- |
| Soil Properties | Values |
| Sand(%) | 76.60 |
| Clay(%) | 9.40 |
| Silt(%) | 14.00 |
| Textural Class | Sandy Loam |
| pH(H20) | 5.40 |
| Organic Carbon(%) | 1.30 |
| Total Nitrogen(%)  Available Phosphorus (mg/kg)  Ca(cmol/kg)  Mg(cmol/kg)  K(cmol/kg)  Na(cmol/kg)  Exchangeable Acids(cmol/kg)  CEC(cmol/kg)  Base Saturation(%) | 0.16  21.00  6.40  0.80  0.10  0.30  0.64  8.24  92.20 |

**Table 2. Effect of sweet potato varieties and organic manure on storage roots at harvest**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Crop Varieties** | **CD** | **SD** | **PD** | **NL** | **RHD** | **CT** | **MEAN** |
| **No of Storage Roots** |  |  |  |  |  |  |  |
| **Umuspo 3** | 20.49 | 34.37 | 43.40 | 21.18 | 15.63 | 190.97 | 25.69 |
| **TIS 8164** | 15.63 | 18.75 | 32.99 | 16.32 | 12.15 | 156.25 | 18.58 |
| LSD0.05 for variety |  |  |  |  |  |  | 4.13 |
| LSD0.05 for organic sources |  |  |  |  |  |  | 3.26 |
| LSD0.05 for variety and organic sources |  |  |  |  |  |  | 5.24 |
| **Weight of Storage Roots(t/ha)**  **Umuspo 3**  **TIS 8164**  LSD0.05 for variety  LSD0.05 for organic sources LSD0.05 for variety and organic sources | 11.00  7.20 | 9.70  6.20 | 17.40  13.50 | 9.30  5.40 | 8.50  5.50 | 8.50  4.50 | 10.70  7.10  2.40  0.38  0.53 |

CD= Cow dung. SD = Swine dung, PD= poultry droppings, NL = Neem leaves, RHD= Rice husk duct, CT= control (no application). LSD= least significant difference

**Table 3. Effect of two varietal sweet potatoes and organic soil amendments on the nutritional Composition**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Crop Varieties** | **CD** | **SD** | **PD** | **NL** | **RHD** | **CT** | **MEAN** |
| **Moisture content**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **64.92**  **70.50**  **67.79** | **63.43**  **70.18**  **66.81** | **62.35**  **68.23**  **65.29** | **61.52**  **66.57**  **64.05** | **66.14**  **65.42**  **65.78**  **2.36**  **ns**  **ns** | **60.23**  **62.36**  **61.30** | **63.10**  **67.24** |
| **Dry Matter content (%)**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **35.07**  **29.32**  **32.20** | **36.57**  **29.85**  **33.21** | **37.65**  **31.77**  **34.71** | **38.48**  **33.43**  **35.96** | **33.86**  **34.58**  **34.22**  **3.84**  **ns**  **ns** | **39.77**  **37.64**  **38.71** | **36.90**  **32.77** |
| **Ash Content (%)**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **2.36**  **1.84**  **2.10** | **1.96**  **1.91**  **1.94** | **1.76**  **1.87**  **2.07** | **2.32**  **1.83**  **2.07** | **1.83**  **1.78**  **1.80**  **ns**  **ns**  **ns** | **1.89**  **1.78**  **1.84** | **2.02**  **1.83** |
| **Fibre content(%)**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **0.91**  **1.21**  **1.01** | **0.79**  **1.18**  **0.99** | **0.79**  **1.13**  **0.95** | **0.72**  **1.15**  **0.95** | **0.72**  **1.15**  **0.95**  **ns**  **ns**  **ns** | **0.74**  **1.15**  **0.94** |  |
| **Ether Extract(fat) (%)**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **0.79**  **0.93**  **0.89** | **0.74**  **0.87**  **0.81** | **0.76**  **0.83**  **0.80** | **0.72**  **0.89**  **0.81** | **0.78**  **0.82**  **0.80**  **2.36**  **ns**  **ns** | **0.73**  **0.86**  **0.80** | **0.75**  **0.87** |
| **Food energy**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **391.31**  **389.36**  **390.34** | **391.09**  **389.36**  **390.07** | **390.88**  **388.42**  **389.54** | **390.66**  **388.42**  **389.54** | **390.43**  **388.09**  **389.26**  **ns**  **ns**  **ns** | **390.23**  **387.75**  **388.99** | **390.77**  **388.57** |
| **Crude Starch (%)**  **Umuspo 3**  **TIS 8164**  **Mean**  **LSD0.05 for var.**  **LSD0.05 for organic**  **LSD0.05 for var and organic** | **91.22**  **88.17**  **89.70** | **90.82**  **89.87**  **90.35** | **90.52**  **89.67**  **90.10** | **90.02**  **89.67**  **90.10** | **89.82**  **89.72**  **89.82**  **Ns**  **Ns**  **ns** | **90.52**  **89.77**  **90.15** | **90.50**  **89.36** |

CD= Cow dung. SD = Swine dung, PD= poultry droppings, NL = Neem leaves, RHD= Rice husk duct, CT= control (no application). LSD= least significant difference

**VI. DISCUSSIONS**

**A. Effect of two varietal sweet potatoes and different organic manures on the number and weight of storage roots**.

Table 3 showed there was significant (p<0.05) difference among the varieties on the number of storage roots per hectare. Umuspo 3(oranged-fleshed) significantly produced the higher number of yielded roots than TIS 816. Also there were significant difference among the soil amendments and interaction between varieties and soil amendments on the number of storage roots. Poultry droppings 10t/ha significantly produce the highest mean number of storage roots than other organic manure sources. The increase in the number of storage roots could be attributed to the improvement of soil properties as the poultry organic droppings improves both the physical and chemical soil properties. Udo et al, 2005 reported that organic manures supply nutrients to the plant as well as improving the soil structures, aeration and encourage good root growth, which may invariably had resulted in increased growth and yield of storage roots of sweet potato.

Umuspo 3 significantly (P<0.05) produced higher mean weight of storage roots(10.7t/ha) than TIS 8164. There were significant difference among the soil amendments on the weight of roots leading to poultry manure producing the highest mean weight of storage roots(15.5t/ha) than other soil organic amendments. The relatively increase in the weight could be attributed to the increase in elemental plant nutrient as a result of plant nutrient in the organic soil amendments. Akanbi,(2004) reported that application of organic manure sources improve some of the physiological properties of the plant. FAOSTAT (2010) estimated the average root yield of sweet potato in developed countries to be 13.2t/ha which was close to the results obtained by some treatments in the trial.

**B. Effect of varietal sweet potato and different organic sources on the nutritional composition of sweet potato**

Table 4 showed the mean values for moisture content which ranged from 61.30% to 67.79%, and these values agreed with the report of Robertson et al,(2000). The differences in the moisture content among sweet potato varieties can be attributed to the difference in the genetic composition and also the agro-cultural practices. In comparison with other roots and tuber crops, sweet potato has a high moisture content resulting in relatively low dry matter content. High moisture products require further costly drying operation to allow easy handling and storage.

The mean values of dry matter content ranged from 32.2% to 38.71 %. The low values of dry matter with high amount of moisture content obtained as shown in the table agrees with the report by Robertson et al,(2000) . The average dry matter content is approximately 30%, but varies widely depending on factors such as cultivars, locations, climate, day, length, soil type, pests, diseases, and cultivation practices (woolfe,1992). The high dry matter is an indication of desirable quality attributes, high root yields ( fresh and dry) meet end user's characteristics. Dry matter is a practicable approach to improving the shelf life and marketability of sweet potato products. Sweet potato is the world 's leading crop in dry matter content per unit time(Woolfe,1992).

The mean values of crude ash ranged from 1.8% to 2.10%. The low ash contents would mean that the sweet potato varieties, might be low in some minerals. The amount of minerals furnished in 100g of sweetpotato is small for all the minerals with the possible exception about 11.4% or 18% of the recommended dietary allowance (RDA)(Robertson et al,2000).

The dietary fibre mean values ranged from least (1.13%) in the TIS 8164 to higher values of 2.33%. Robertson et al,(2000) reported that the total fibre content in eighteen sweet potato varieties in developed countries especially Hawaii had a range of 2.01 to 3.87g/100 fresh weight. Pectin, cellulose, hemicellulose together with lignin are classified as dietary fibre. Tropical and vegetables contribute to dietary fiber and are found to be 1.4% from cellulose, 0.4% from lignin, and 0.9% from hemicellulose of the peel of sweet potatoes (kamer et al, 1952). The crude fibre content of sweet potato storage root samples used in this study was generally low and as reported by Robertson et al,(2000) that some varieties of sweet potato have low fibre content when compared to other roots and tuber crops. There is evidence that dietary fibre improves glucose tolerance and is therefore, beneficial in treating maturity preset diabetes. Dietary fiber has recently gained much importance as it is said to reduce the incidence of colon cancer diabetics, heart diseases and certain digestive diseases.

The mean ether extract(fat values for the different varieties ranged from 0.8% to 0.86%). Although these values were low, they are comparable to the values of 1.2% to 2.7% reported by Giwa et al (2004) and 1.10% to 2.0% reported by kamer et al(1952). The present research trial showed a low fat content in all the storage root samples which is in agreement with the work of Velmurugu *et al*, 1995, but its consumption should be encouraged since it is a type of fat that is easily used by the body system. The mean values of fat content are also in line with the previous research that lipids and fatty acids ranged from 0.29 to 2.7% (Purcell *et al*, 1972).

The mean value of crude protein ranged from 4.43% to 5.08%. According to Robertson et al,(2000) , sweet Potato has little protein which agrees with the results in the Table 4. Protein content in the diets of low income groups in developing countries like Nigeria is derived mostly from foods of vegetable origin. The average total Protein content of sweet potato is low as 1.5%(fresh weight basis). However, it is superior to other roots and tuber crops such as cassava, plantain, taro and inferior to potato, yams and cereals even those cooked as porridges(woolfe,1992). The Protein content of the these tubers varied from 1.0% to 2.5% (about 5% dry weight basis).

According to Robertson et al,(2000) , sweet potato selected for similar trial in Rwanda had less than 1% protein content which is 0.71% to 0.91%. The low protein of the sweet potato products is not a serious issue as the products is usually consumed with different protein sources both of animal and vegetable origin. The results seen in the table revealed that sweet potato samples were generally low in protein contents. It is desirable that plant foods should be consumed along with animal foods to enhance the nutritive value and reduce the malnutrition of the vulnerable group.

The mean value for carbohydrate range from 89.70% to 90.35%. The carbohydrate content was high in most of the varieties. The high carbohydrate content of sweet potato makes it a good source of energy. This confirms the carbohydrate as the main nutritional component of sweet potato storage roots with about 80% as starchy (Purseglove, 2004). The research trial revealed that carbohydrate constitutes the highest nutrient in the storage roots of sweet potato. Sweet potato is freely available for consumption thereby reducing the rate of energy malnutrition in the society.

The mean value of food energy as seen in the table 4 ranged from 388.99kcal/100g to390.35/100g. The chemical composition of sweet potato storage roots indicated significant difference(p<0.05) among varieties. The variability among varieties could be genetic in nature. Robertson et al,(2000) reported significant difference(p<0.05) for the chemical composition of sweet potato storage roots.

**V. CONCLUSION**

As the research is to evaluate the influence of different organic manure sources on the storage roots and nutritional composition of two varietal sweet potatoes, the results obtained indicated that poultry droppings (10t/ha) performed statistically better than other soil organic amendments, followed by cow dung in both Tis 8164 and Umuspo 3( Orange-fleshed). The manure source improves the storage roots of the crops as well as their nutritional contents of sweet potato. Umuspo 3 yield more storage edible roots than TIS 8164. The application of organic manure source highly improves the soil nutrients as well as their contents. Farmers are encouraged to use poultry organic manure as their source of fertilizer to enable them obtain quality root yield of sweet potato. Orange-fleshed sweet potato is better suited for higher yield and for better nutritional contents when organic manure is used as soil amendments to improve the soil properties.

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