**Complementary Application Of N.P.K 15.15.15 Fertilizer with Different Source of Ash Materials on The Soil Properties, Nutritional composition and Yield performance Of *Ipomoea batatas.***

Mbah, N .T.1, Onyiba, P.O.2, Achebe, U.3 and Onuba, M.N.4

1,2,3,4National Root Crop Research Institute, Umudike, Abia State.

Federal Ministry of Agriculture and rural Development, Nigeria

*azodonchedo@gmail.com*

**ABSTRACT**

The research trial was to evaluate the complementary effects of NPK 15.15.15 with different sources of ash materials on the soil chemical properties, proximate content, growth and yield of sweet potato. The field trial was arranged using randomized complete block design(RCBD) with five (5), different treatments; NPK at 400kg/ha, NPK at 200kg/ha + Dried Mango Leave Ash, NPK at 200kg/ha+ Rice Husk Dust, NPK at 200kg/ha + wood Ash and Control(no fertilization) replicated three times. The composite soil sample were collected between (0-20cm) depth, analyzed for pre-cropping soil properties, and after treatments during harvest to determine the changes in soil chemical properties due to soil amendments. The results showed significant difference (p<0.05) among the treatments on all the parameters measured. The results indicated that mineral content, dry matter, crude ash, starch, sugar, fats, crude protein and dietary fiber content were significantly improved in amended soil with ash materials when compared with sole NPK fertilization. The best performance on the growth and yield of sweet potato was significantly recorded from the plot amended with the integration of NPK plus rice husk dust of 18t/ha while the control was the least. There were significant increase of soil organic carbon when treated with inorganic fertilizers and other ash material sources. The highest value of total nitrogen(0.17gkg-1) and lowest organic carbon(1.16gkg-1) was significantly recorded in the sole application of inorganic fertilizer whereas the highest increase in pH(5.7) and organic carbon (1.85gkg-1 ) were significantly recorded in the integration of NPK plus rice husk ash. It showed that sweet potato can perform optimally when there is integration of synthetic fertilizer amended with ash materials.

**Keywords:** Synthetic Fertilizer, Ash Material sources, Sweet Potato, proximate content and soil chemical properties.

**I. INTRODUCTION**

Sweet potato[*Ipomoea batatas* (L) Lam] is simply a root vegetable that belongs to the convolvulaceae family. Sweet potatoes are known for their distinctive sweet taste and are highly nutritious. Sweet potato is cultivated worldwide for its edible tuberous root. This crop is highly valued for its adaptability to different climates. They come in different varieties, with varying colours ranging from orange, yellow, and purple to white. The colour difference is due to the presence of different pigments such as beta-carotene (precursor of vitamin A), and anthocyanins (FAO,2000). In terms of nutrition, sweet potatoes are a rich source of dietary fiber, vitamins and minerals such as Folate, Copper, and Iron. They are popularly high in vitamin A, Vitamin C, B2, B6, E, biotin, manganese, and potassium. Sweet potatoes are also packed with antioxidants, which help to protect the body against oxidative stress and inflammation (Udo *et al*,2005). The leaves serves as leaf vegetables as well as good fodder value and much more industrial value. Sweet potatoes are also a fantastic sources of dietary fibre and can grow best in well-drained sandy loam soils.

Sweet potato productivity is threatened due to decline in soil fertility and inappropriate soil management practises. To enhance the sweet potato crop production, the depleted soils need to be balanced with nitrogen, potassium and phosphorous. Lehmann (2009) reported that integrating organic manure such as ash materials, plant and animal residues etc with inorganic fertilizer like NPK under a recommended quantity enhanced root productivity and quality compared to sole application of any treatments. The use of inorganic or synthetic fertilizer to the soil actually boast the growth and yield performance of the crop. ( Ayeni *et al*. 2009). Different sources of organics, ash materials contain high content of silicon, carbon, potassium and nutrients which have great potential for soil amendments (Lehmann, 2009). Incorporation of Ash materials such as rice husks dust, wood ash, etc can significantly improve soil properties, bulk density, PH, organic carbon content, cation exchange capacity, and increasing nutrients such as nitrogen, phosphorous, potassium. Ash materials have the penchant to remove heavy metals from the soil systems, thereby enhancing crop yields ( Okonkwo *et al.* 2011, Eyitayo, 2009). In addition, wood ash have different amounts of nutrients like magnesium, phosphorous, and calcium which can improve soil pH ( Lim *et al*. 2000, Nottiage *et al.* 2005 and Ikpe *et al.* 1997). Ash materials increase soil pH, mineral nutrients like nitrogen, sulphur and carbon, and improves microbial communities. The research trial seeks to evaluate the complementary effects of NPK 15:15:15 with different source of ash materials on the soil, nutritional content, and yield performance of sweet potato.

**II. MATERIALS AND METHODS**

The research trial was done in 2019 farming season at National Root Crop Research Institute, Igbariam substation and Federal College of Agriculture, Ishiagu. Soil analysis of the field were collected and analyzed according to the standard procedure. The treatments comprised of two levels of NPK 15:15:15 (200kg/ha and 400kg/ha) in combination with dried mango leaves ash, rice husk duct, wood ash and control (no application).The trial was simply arranged in randomized complete block design(RCBD) with nine different treatments; NPK at 400kg/ha(T1), NPK at 200kg/ha(T2); NPK at 400kg/ha + Dried Mango leave Ash (T3), NPK at 400kg/ha + Rice Husk Dust(T4), NPK at 400kg/ha + wood Ash(T5);NPK at 200kg/ha + Dried Mango Leave Ash(T6), NPK at 200kg/ha+ Rice Husk Dust(T7), NPK at 200kg/ha + wood Ash(T8) and Control, T9(no manure application) replicated three times. The planting materials were an improved variety of sweet potato, TIS 87/00087 ( Pink fleshed colour), bred by the NRCRI, Umudike. All the necessary agronomic practices were carried out as required in the trial, and data collected from six randomly selected tagged plant at 4,6, 8,and 12WAP. The parameters considered are number and weight of tubers; soil pH (Mclean,1982), organic carbon content (Nelson and sommers 1982), total nitrogen with Kjedahl method, available phosphorous ( Bray and Kurtz, 1945), CEC (cation exchange capacity) together with nutritional composition of the crops. Data were collected and analysed with analysis of variance. Treatment means were done with Duncans test at p<0.05 to ascertain the significance differences. ( Wahua 1991).

**III. RESULTS AND DISCUSSIONS**

A. **Effects of NPK and Ash materials on the Soil physicochemical properties**

The soil physicochemical properties were presented in table 1 which showed that soil were sandy loam, clay, silt 13% and fine sand 61%. The soil pH was 5.4. The organic carbon and total nitrogen were 0.52gkg-1 and 0.070gkg-1 respectively. The sodium and potassium were recorded to be 0.04 and 0.09cmolkg-1. Calcium and magnesium were recorded to be 1.80 and 1.40cmolkg-1. Table 2 showed that the combination of NPK and ash materials indicated that there were significant (p<0.05) improvement on soil chemical properties (e.g. Soil pH) among the treatments. The results of Table 1 and 2 showed that the influence of NPK complemented with ash materials gave rise to soil pH increase than sole application of NPK. The combination of synthetic fertilizer with rice husk duct recorded a pH of 5.70 within the research trial. This followed by treatment with NPK and mango leaves given rise to soil pH of 5.60, while the least value of soil pH 5.20 was from the application of NPK sole treatments. This may be attributed to liming ability of ash materials. Lombin *et al*(1991) stated that ash materials can influence soil pH increase from 0.60 to 1.00 units in humus soils. The soil organic carbon showed a significant effect due to the treatments. The treatment with NPK and rice husk duct recorded 1.85g/kg, and thereby improved soil organic carbon content over others. Soil organic carbon had the least value of 0.83g/kg in the control treatments. Total Nitrogen was significant among the treatments as the treatments with sole NPK produced the highest value of 0.17g/kg, followed by NPK and rice husk duct with a value of 0.14g/kg while least value of 0.07g/kg was from the control. Soil chemical properties increased with the complementary application NPK and rice husk duct, which might have occurred due to the chemical components of rice husk duct. Eyitalo(2009) revealed that the complementary use of rice husk duct and synthetic fertilizers could improve the soil chemical properties.

**B. Effect of NPK and Ash materials on the yield performance of sweet potato crop.**

Table 3 showed the influence of NPK complemented with Ash materials to the yield performance of sweet potato at harvest. The table indicated that storage roots significantly increased at 62.00 when amended with NPK and rice husk duct followed by the treatments of NPK with mango leave ash at 35.00 while control recorded the lowest value of 20.33. Again, the treatment effect on the weight of the storage roots indicated that there was significant different existing among the treatments applied.NPK and Rice husk duct application recorded the highest value of 18.9t/ha followed by NPK and wood ash materials with value of 11.2t/ha while control recorded the least mean value of 6.20t/ha. The higher values recorded in the storage roots yield were an indication that NPK complemented with rice husk duct may be due to the available mineral nutrients such as nitrogen and phosphorus in the combination. Chand *et al,*(2006) stated that combination in synthetic fertilizer as complemented with ash materials promote crop growth and yield. The mixture of the two fertilizers acts as growth promoters for crop, thereby leading to abundance in storage roots of sweet potato. A soil amended with organic fertilizers shows vigorous vegetative growth and higher yield when compared to synthetic fertilizer alone. The complementary application of ash materials with NPK fertilizers results to improved yields in sweet potato than sole application of each nutrient source (Amujoyegbe et al,2007).

**C. Effect of NPK and Ash materials on the nutritional component of sweet potato crop.**

Table 4. showed that the synthetic fertilizer combined with ash materials could affect the nutritional component of sweet potato. Results revealed that the moisture content increased from 70.50 to 73.50 on the application of NPK combined with rice husk duct. The same trend happened with NPK and wood ash which gave 73.20. Endrias *et al*.(2016) stated that the moisture content of orange- fleshed sweet potato had variations, and they might be attributed to the variety diversities, agro-climatic conditions and agricultural management practices. Orange-fleshed sweet potato flour maintained its long shelf life when moisture content is low. Dry matter content improves significantly as the inorganic fertilizer were combined with organic fertiliser. The results indicated that the dry matter content increased from 30.50 to 34.50 as NPK was combined with rice husk duct. Protein, crude Ash, crude fibre, Fats, starch and energy content of sweet potato increased significantly when NPK fertilizer was combined with organic fertilizer. Mohammad *et al*.,([2016](file:///C:\Users\HP%20User\Documents\Review%20on%20nutritional%20composition%20of%20orange%E2%80%90fleshed%20sweet%20potato%20and%20its%20role%20in%20management%20of%20vitamin%20A%20deficiency.htm#fsn31063-bib-0138)) stated that the sweet potato protein content was ranged from 1.91% to 5.83%. Crude fiber played an important role in reduction of cholesterol level, and could help the increase in natural microbial flora of gut. The dietary fiber was 3.6% in sweet potato but different sweet potato varieties have 0.35% concentrations which could be related to the varietal and agro-climatic differences of the crop (Endrias *et al.,* [2016](file:///C:\Users\HP%20User\Documents\Review%20on%20nutritional%20composition%20of%20orange%E2%80%90fleshed%20sweet%20potato%20and%20its%20role%20in%20management%20of%20vitamin%20A%20deficiency.htm#fsn31063-bib-0056)). Sweet potato Ash content was ranged from 1.17% to 4.33% , which could be related to varietal and agro-geological differences (Mohammad *et al*.,2016). The fat contents were lower than 1% signifying the property of root and tuber crops. The fat contents directly influenced the food energy density, but people living with limited energy can eat orange-fleshed sweet potato to avoids certain disease (Mohammad *et al*., [2016](file:///C:\Users\HP%20User\Documents\Review%20on%20nutritional%20composition%20of%20orange%E2%80%90fleshed%20sweet%20potato%20and%20its%20role%20in%20management%20of%20vitamin%20A%20deficiency.htm#fsn31063-bib-0138)). High starch content of 65.41% was seen in sweet potato on fresh weight basis. Starch serves as energy giving nutrients and sweet potato as one of the staple crop contains enough carbohydrates (Rodrigues et al., [2016](file:///C:\Users\HP%20User\Documents\Review%20on%20nutritional%20composition%20of%20orange%E2%80%90fleshed%20sweet%20potato%20and%20its%20role%20in%20management%20of%20vitamin%20A%20deficiency.htm#fsn31063-bib-0180)). The Energy content in sweet potato was ranged from 344.52 to 375.05 kcal/100 g (Endrias *et al.,* [2016](file:///C:\Users\HP%20User\Documents\Review%20on%20nutritional%20composition%20of%20orange%E2%80%90fleshed%20sweet%20potato%20and%20its%20role%20in%20management%20of%20vitamin%20A%20deficiency.htm#fsn31063-bib-0056)).

**Table 1. Soil physicochemical properties of sweet potato field.**

|  |  |
| --- | --- |
| Soil properties | Values |
| Texture class | Sandy Loam Soil |
| Clay (%) | 8.0 |
| Silt(%) | 13.0 |
| Fine sand(%) | 61.0 |
| Coarse sand(%) | 18.0 |
| Soil pH  Soil organic carbon(g/kg) | 5.4  0.52 |
| Total Nitrogen  Available phosphorous  Sodium(cmol/kg)  Potassium(cmol/kg)  Calcium(cmol/kg)  Magnesium(cmol/kg)  CEC(cmol/kg)  Base Saturation(%) | 0.07  5.60  0.04  0.09  1.80  1.40  15.20  21.91 |

**Table 2. Effects of NPK and Ash materials of some selected Soil physicochemical properties.**

|  |  |  |  |
| --- | --- | --- | --- |
| TREATMENTS | SOIL PH | ORGANIC CARBON(g/kg) | TOTAL NITROGEN(gkg) |
| T1 | 5.20 | 1.17 | 0.17 |
| T3 | 5.50 | 1.65 | 0.11 |
| T4 | 5.70 | 1.85 | 0,14 |
| T8 | 5.0 | 1.45 | 0.10 |
| T9  LSD(0.05) | 5.40  0.15 | 0.83  1.06 | 0.07  0.03 |

**Table 3: Effect of NPK and Ash materials on the storage root yield performance of sweet potato**

|  |  |  |
| --- | --- | --- |
| TREATMENTS | NO of Roots | Weight of Storage Roots(kg) |
| 400kg/ha NPK | 35.00 | 8.60 |
| 200kg/ha NPK | 33.00 | 8.10 |
| 400kg/ha NPK+DMLA | 34.00 | 8.15 |
| 400kg/ha NPK+ RHD | 40.00 | 9.01 |
| 400kg/ha NPK+ WA | 42.00 | 9.20 |
| 200kg/ha NPK+DMLA | 35.00 | 9.40 |
| 200kg/ha NPK+RHD  200kg/ha NPK+WA  Control  LSD(0.05) | 62.00  35.00  20.33  11.08 | 18.90  11.20  6.20  6.20 |

DMLA= Dried Mango leave Ash; RHD = Rice Husk Dust; WA = Wood Ash

**Table 4: Effect of NPK and Ash materials on the Nutritional content of sweet potato**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatments | Moisture  (%) | Dry  matter  content  (%) | Crude  fibre  (%) | Ash contents  (%) | Crude Protein (%) | Fats  (%) | Carbohydrate/starch(%) | Energ  (kcal/100g) |
| 400kg/ha NPK | 70.50 | 30.80 | 1.25 | 1.80 | 2.10 | 0.91 | 68.80 | 350.00 |
| 200kg/ha NPK | 68.90 | 29.50 | 1.10 | 1.91 | 1.91 | 0.80 | 68.00 | 344.05 |
| 400kg/ha NPK+DMLA | 72.50 | 31.00 | 1.50 | 1.82 | 2.45 | 0.83 | 69.50 | 355.50 |
| 400kg/ha NPK+ RHD | 73.50 | 33.00 | 1.80 | 1.85 | 2.50 | 0.95 | 70.00 | 365.00 |
| 400kg/ha NPK+ WA | 73.20 | 34.50 | 1.90 | 1.85 | 2.45 | 0.95 | 70.50 | 362.50 |
| 200kg/ha NPK+DMLA | 70.00 | 34.00 | 1.15 | 1.90 | 1.95 | 0.85 | 69.00 | 345.50 |
| 200kg/ha NPK+RHD  200kg/ha NPK+WA  Control | 70.50  72.00  69.00 | 36.50  34.00  28.50 | 1.15  1.18  1.00 | 1.89  1.95  175 | 2.00  2.10  1.90 | 0.85  0.82  0.89 | 70.00  70.50  68.00 | 349.10  348.05  345.00 |

DMLA= Dried Mango leave Ash; RHD = Rice Husk Dust; WA = Wood Ash

**IV. CONCLUSION**

Soil chemicals have been confirmed to be important for soil health and quality. This research trials revealed the effectiveness of different organic manure sources complemented with NPK fertilizers to the soil, especially chemical component of the soil, proximate content, sweet potato growth and yield performances. The integration of NPK synthetic fertilizer with rice husk duct can improve the nutritional composition as well as the growth and yield of sweet potato for increased food production and sustainability. Farmers should adopt the integration of NPK synthetic fertilizer with organic manure for sustainable crop production, since they increase soil chemical component like pH of the soil, soil organic carbon content together with nutrients for good soil health and subsequent nutrient uptake by the crops.

**REFERENCE**

Amujoyegbe, B.A, Opabode, J.T and Olayinka, A. Effect of Organic and Inorganic fertilizer on yield and Chlorophyll Content of Maize (Zea mays, L) and Sorghum bicolour L. Moench). *African Journal Of Biotechnical* Vol. 6(16),2007:1869-1873.

Ayeni, L.S., Adeleye, E.O and Oso, O.P. Residual Effect of Cocoa Pod Ash Poultry Manure and NPK 20:10:10 Fertilizer on Soil Nutrients, Nutrients Uptake and Yield of Maize(Zea mays). *J. Soil Nature*. Vol. 3(2),2009:04-09.

Bray,R.H and Kurtz, L.T. Determination of Total Organic Carbon and Available Forms of Phosphorus in Soil. *Soil Science J.* Vol. 59,1945:39-43

Chand, S., Anwar, M. and Patro,D. O. Influence of lonf term application organic and inorganic fertilizer to buildup soil fertility and nutrient uptake in min-mustered cropping sequence. *Communication in Soil Science and Plant analysis.* Vol. 37, 2006:63-76

Endrias, D. , Negussie, R. ,and Gulelat, D. Comparison of three sweet potato (Ipomoea Batatas (L.) Lam) varieties on nutritional and anti‐nutritional factors. *Global Journal of Science Frontier Research: D Agriculture and Veterinary*, Vol. 16(4), 2016, 1920–11. Eyitalo, M. Ojeniyi, S.O, Asawalam, D.O. Maize Growth, yield and soil nutrient changes with N-enriched Organic Fertilizer. *Field crop research.* Vol. 77, 2009:43-9. Food and Agriculture Organisation (FAO).United Nations Emergency Call On Food Supply fort the World,2000.*hppt://www.fao.com* Ikpe, F.N, Isirimah, N.O and Ogbonna, I.J. Rice growth and nutrient uptake in amended acid sulfate soil of Niger Delta, Nigeria. *Niger Delta Biologia*. Vol.2,1997:117-124 Lehmann, M. Use of weld germplasm for sweet potato breeding *C.I.P Lima*. vol. 23,2009:154-161 Lim, K.H and Zahara, A.R. Decomposition and N and K release by oil palm empty fruit bunches applied under mature palms. *J. of Oil palm Research*. 12(2),2000:55-62. Lombin, L.G, Adeputu, I.A and Ayetade, K.A. Complementary use of organic manures and inorganic fertilizers in arable crop production. Proceeding of National Organic Fertilizer Seminar held in October 20th-22nd at University of Ibadan, Ibadan. 1991. pp.146-162. Mclean, E.O. Soil pH and Lime requirement. In: A.L Page, R.H Miller and D.R Keeny, (Eds). Methods of Soil Analysis, Part 2. *American Society of. Agronomy., Madison,*1982,pp.199-224. Mohammad, K. A., Ziaul, H. R. ,and Sheikh, N. I. (2016). Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange‐fleshed sweet potato varieties grown in Bangladesh. *Foods,* 5, 2–10. Nelson, D. W and Sommers L.E. Total carbon, total organic carbon and organic matter. In Sparks DL (ed) Methods of Soil analysis, part 3: chemical methods. *Agronomy Monograph No 9. American Society Of Agronomy, Madison*, 1982,pp.961-1010 Nottigdge, D.O, Ojeniyi, S.O, Asawalam, D.O. Comparative effect of plant residues and NPK Fertilizer on nutrient status and yield of maize in a humid ultisol. *Nigeria Journal of Soil Science.*Vol.12,2005.124-132. Okonkwo, C.I., Mbagwu, J.S.C., Egwu, S.O and Mbah, C.N. Effect of decomposd rise huskduct on soil proprties and yield of maize. *Bio-resources Tech.* vol.5,2011;117-123 Rodrigues, N. R. , Barbosa, J. L. ,and Barbosa, M. I. M. J. Determination of physico-chemical composition, nutritional facts and technological quality of organic orange and purple‐fleshed sweet potatoes and its flours. *International Food Research Journal,* Vol. 23(5),2016, 1920–11 Udoh, D.I, Ndom, B.A., Asuquo, P.E and Ndaeyo, N.U. Crop production techniques for the tropics. *Concept publications Limited. Lagos, Nigeria*. 2005. pp.55-56. Wahua, T.A.T. Applied Statistics for Scientific Studies. *Africa-Link Book*,1991;pp.150-154 Walkley, A and Black, C. An examination of digestion of method for determining soil organic matter and a proposed modification of the chromic and titration method. *Soil Science*.1934;pp.29-38