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Yield and Nutrient Content of Sweet Potato (*Ipomoea batatas*) Responses to N.P.K 15:15:15 Fertilizer Complemented with Different Sources of Ash

[*1]Olejeme, O. C., [2]Nwaigwe, M.O., [1]Eluagu, K. F., [1]Diobi, A.B. and [1]Diken, J.

[1]Department of Crop Production Technology, Federal College of Agriculture, Ishiagu, P.M.B. 7008, Ishiagu, Ivo Local Government Area, Ebonyi State, Nigeria
[2]Department of Agricultural Science and Vocational Science, Alvan Ikoku Federal College of Education, PMB 10033, Owerri, Imo State
*Corresponding Author:'s email: obicasole@yahoo.com

Abstract
A trial on the complementary use of NPK 15.15.15 with different sources of ash materials as it affects the yield and nutrient content of sweet potato *(Ipomoea batatas)***,** was evaluated at the student's project site at Federal College of Agriculture, Ishiagu, Ebonyi State in the 2021 cropping seasons**.** The experimental design used was the randomized complete block design (RCBD) with five (5) treatments: NPK fertilizer 15:15:15, NPK fertilizer 15:15:15 + palm bunch ash (PBA), and NPK fertilizer 15:15:15 + rice husk ash (RHA), NPK fertilizer 15:15:15 + wood ash (WA), control (No fertilizer), each replicated three (3) times. Pre-planting physicochemical properties of the soils were determined to know the soil status before planting. Tuber yield, moisture, dry matter and nutritional content were determined at ($P \leq 0.05$). The best yield performance of 18.9 tons/ha was recorded from the plots amended with the integration of NPK+ RHA. The highest value of % protein, % ash and % fibre, were also gotten from the integration of NPK+ RHA. It is therefore recommended that farmers integrate NPK fertilizer with ash especially rice ash dust to reduce soil acidity and toxicity, which in the long run will increase crop yield.

Keywords: Ash, NPK, nutrient content, Sweet potatoes, yield

Introduction

The application of NPK fertilizers to the soil boasts the performance of all crops however, its persistent use destroys soil reaction and impedes the activities of soil micro-organisms by making the soil acidic and toxic (Omisore, 2010). Most chemical fertilizers used in conventional agriculture contain few minerals, which dissolve quickly in damp soil and give the plants large doses of minerals (Nwite *et al*., 2008). In Southeastern Nigeria, the dependency of farmers on these chemical fertilizers has in the long run reduced soil productivity by increasing its acidity (Ibeawuchi *et al*., 2007). Soils in Southeastern Nigeria are generally characterized by low pH and exchange capacity, poor buffering capacity and toxicity largely due to leaching continuous use of synthetic fertilizer (Nwite *et al*., 2008). Application of organic manures has been reported to have enhanced soil microbial activities that in turn improve crop growth and restrain pests and diseases compared with chemical fertilizers (Ahmad and Khahid, 2007). Ash is a powder that remains after burning materials such as; wood, leaf and coal; it is a good acid-neutralizing agent and can supply the soil with bases such as silicon and potassium which can be added to the soil to decrease its acidity (Adekayode and Olojugba, 2010). Examples of ash sources are, rice husk ash is obtained from the burning of rice husk the husk is a by-product of rice milling (Ayeni, 2011). Wood ash gotten from the burning of wood and palm bunch ash is a product obtained from the incineration of palm bunch residues after fruit extraction of oil palm fruits also contain varying amounts of other nutrients such as Mg, P and calcium (Ca) which can improve the pH of acidic soils (Lim and Zahara, 2000). Sweet potato (*Ipomoea batatas*) belongs to the family *Convolvulaceae*. Its tuber is large, starchy, and has a sweet taste (F.A.O, 2000). It also serves as raw materials in the bakery industry for the production of many snacks like piles and cakes etc. It can also be consumed in different ways like boiling, frying and roasting (Ayeni *et al*., 2009). A major constraint to the intensive production of sweet potato in this agroecology is the low level of the natural fertility of the acid sandy soils and the lack of soil management practices for sweet potato cultivation (Ayeni *et al*., 2009). Ashes generally have a good acid-neutralizing capacity and the ability to supply the soil with basic elements (Nwite *et al*., 2011), hence the objective of this study is to use complementary ash material with inorganic fertilizer to improve the fertility of acidic soils of southeastern Nigeria and its potential to support sweet potato production.

Materials and Method

Location of Experimental Site

The experiment was conducted at the Research and Teaching Farm of the Federal College of Agriculture, Ishiagu, Southeast Nigeria. The area lies between latitude 5º 55´ N and 6º 00´ N and longitudes 7º 30´ E and 7º 35´ E in the Derived Savannah Zone of Southeastern Nigeria. The mean annual rainfall for the area is 1350 mm, spread from April to October with the average air temperature being 29ºC (Lekwa *et al*., 1995).

Land Preparation/Experimental Design/Layout

The field was cleared and prepared manually into fifteen beds measuring 2m x 2m which represents the plot size. The treatments were arranged in a randomized complete block design (RCBD). There were 5 treatments replicated three times. The treatments are NPK fertilizer 15:15:15 at 400kg/ ha, NPK fertilizer 15:15:15 at 200kg/ ha +Palm bunch ash 5t/ha, NPK fertilizer 15:15:15 at 200kg/ ha+ rice husk Ash 5t/ha, NPK fertilizer 15:15:15 at 200kg/ ha + wood ash 5t/ha, Control (No fertilizer). The treatments were incorporated into the soil two weeks before planting except NPK fertilizer treatment which was applied 2 weeks after plant sprouting. The test crop used is TIS 89/10087 (pink-fleshed), which is an improved variety, bred by the National Root Crops Research Institute (NRCRI) Umudike Abia State. It was planted at a spacing of 50cm x 50cm. while weeding was carried out three weeks and six weeks after planting.

Data Collection on Plant Parameters

The number of roots was determined by counting while the weight of roots was determined by weighing the tubers per stand and plot.

Plant Sampling and Analysis

The harvested roots were collected per treatment rinsed with distilled water, oven-dried at 70°C for 48 hours and ground using the Thomas stainless steel milling machine. Nutritional contents of the roots (crude protein, fat as well as crude fibre, total ash and moisture contents were determined (AOAC, 1990). The concentrations of the selected heavy metals were determined using atomic absorption spectrophotometer (Unicam Solar 32 model) following the standard procedures presented in AOAC,(1990) And the rating for the adequacy or otherwise of concentrations was according to Landon, (1991). Total nitrogen was determined by the modified micro Kjeldahl distillation methods (Bremmer and Mulvancy, 1982).

Statistical analysis

Data collected were analyzed using analysis of variance (ANOVA) and significant treatment means were separated using the least significant difference. (F-LSD) and all inferences made at 5% level of probability according to (Obi, 2002).

Results and Discussion

Results

Pre-planting Physical-chemical Properties of the Soil

The pre-planting physical and chemical properties of the soil are presented in Table 1. The soils were texturally sandy loam with 12% clay, 20% silt and 68% sand contents. The bulk density was 1.39 mg/m^3, soil porosity 47.57%, saturated hydraulic conductivity 0.36 cm/h and particle size 2.56 mg/m^3. The weight for soil organic carbon concentration was 6.47 g/kg, whereas the total soil nitrogen was 1.35 g/kg. The pH measured in water was 5.0 and the value of 10.60 cmol/kg was recorded for cation exchange capacity. The analysis also indicated that the exchangeable sodium, potassium, calcium and magnesium were; 0.11 cmol/kg, 0.17 cmol/kg, 3.37 cmol/kg and 2.40 cmol/kg, respectively. In addition, the exchangeable acidity and available phosphorous in the studied soil had values of 1.10 cmol/kg and 4.31 mg/kg respectively.

Effect of soil amendments on sweet potatoes root yield and nutrients compositions

The number of roots (Table 3) differed significantly ($P<0.05$) among the treatments and ranged from 3 to 8 as obtained in control and NPK + Rice Husk Dusk (NPK+RHA) respectively. On the weight of roots, the value of 34.54 tons/ha gotten from plots amended with NPK + Palm bunch ash was statistically similar to those amended with NPK+RHA (33.46 tons/ha) but significantly differed from other amendments. The results (Table 4) indicated that treatments significantly ($P < 0.05$) increased the nutritional composition of the sweet potato roots within the study period except for calcium content. The percentage fat (0.35%), fibre (5.01%), protein (4.31%), dry matter (31.24%) and starch (13.59%) contents of the roots increased more in plots amended with NPK+RHA than the other amendments (Table 3). The application of NPK+PBA had the highest values of ash (4.72%) phosphorus (5.71%) and magnesium (0.29%) content when compared with the control and the other soil amendments. The percentage moisture content (70.81%) was significantly ($P < 0.05$) highest in the control plots.

Discussion

The higher value seen in the number of storage roots, and yield weight in the plot where NPK was complimented by ash, especially rice husk ash may be due to reduced acidity which led to the availability of total nitrogen (N) and available phosphorus (P) in the combination. Adekayode and Olojugba (2010) asserted that ash is a good acid-neutralizing agent and can supply the soil with bases such as silicon and potassium which can be used to counteract natural and anthropogenic acidification of soil and loss of nutrients. This was also reported to be the opinion of Ibeawuchi *et al.*(2007) who found that the application of an appropriate ratio of organic and inorganic fertilizers in the field acts as a growth promoter for crops and that plants grown in soil amended with ash show vigorous vegetative growth and high yield compared with application of chemical fertilizer alone. The increase in the values of the nutrient content of the sweet potato roots in plots where NPK was complimented by ash, especially rice husk ash may be due to the chemical contents of rice husk ash. This agrees with Nwite *et al.* (2008) who asserted that rice husk dust can be used for the improvement of the nutrient status of such soils as it contains those elements like Ca, Mg, S, Na, Cu, Mn, Fe, K, P, N and other elements necessary in plant nutrition and for soil improvement. The result is also in line with the submission of Bokhatiar and Sakurai, (2005) who stated that combined application of organic manure ash with inorganic fertilizer can increase the absorption of Nitrogen, Phosphorus and potassium in crop production.

Conclusion

The study revealed that the integration of NPK fertilizer with ash can help in the short-term improvement of the yield and nutrient content of sweet potato for increased food production and live sustainability in Southeastern Nigeria.

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Table 1 Initial physical and chemical properties of the studied soil (0-20cm) depth.

Soil properties	Value
Clay (%)	12
Silt (%)	20
Sand (%)	68
Textural class	Sandy loam
Bulk density (mg/m^3)	1.39
Porosity (%)	47.57
Saturated hydraulic conductivity (cm/h)	0.36
Particle size (mg/m^3)	2.56
pH (H_2O)	5.0
Organic Carbon	6.47
Total nitrogen (gkg^{-1})	1.35
Exchangeable bases	
Sodium (Na^+) (cmol/kg)	0.11
Potassium (K^+) (cmol/kg)	0.17
Calcium (Ca^{2+}) (cmol/kg)	3.37
Magnesium (Mg^{2+}) (cmol/kg)	2.40
Cation exchange capacity (cmol/kg)	10.10
Exchangeable acidity (cmol/kg)	1.10
Available phosphorous (mg/kg)	4.31

Table 2: Chemical analysis of Ash used in the experiment

Parameters	Rice husk ash	Palm bunch ash	Wood ash
pH	9.2	8.7	10.2
Total N gkg^{-1}	2.01	1.89	0.9
Available P Mg gkg^{-1}	12.5	12.95	11.5
Exchangeable K gkg^{-1}	1.82	1.97	1.51
Exchangeable Mg gkg^{-1}	1.91	2.20	0.92
Organic Carbon gkg^{-1}	1.35	0.84	0.71

Table 3 Effect of NPK complimented with Ash on root yield of sweet potato

Soil Amend	Number of roots per bed	Weight of roots tons/ha
NPK SOLE	5	25.21
NPK+PBA	7	34.54
NPK+RHA	8	33.46
NPK+WA	6	26.84
CONTROL	3	19.01
$LSD_{(0.05)}$	1.08	6.2

NPK fertilizer+ Palm bunch ash (NPK+PBA), NPK fertilizer + rice husk Ash (NPK+RHA), NPK fertilizer + wood ash (NPK+WA), Control (No fertilizer)

Table 4 Effect of NPK complimented with Ash on some nutrient content of sweet potato

Soil Amend	Fat%	Fiber%	Ash%	Protein%	Ppm	Ca%	Mg%	Dry Matter%	Starch%
NPK SOLE	0.20	3.24	3.94	2.54	5.21	1.41	0.18	30.11	12.09
NPK+PBA	0.30	4.90	4.72	4.01	5.71	1.49	0.29	31.01	12.31
NPK+RHA	0.35	5.01	4.57	4.31	5.34	1.43	0.25	31.24	13.59
NPK+WA	0.24	3.57	3.99	3.51	5.20	1.43	0.24	30.24	12.26
CONTROL	0.14	2.49	3.70	1.84	5.11	1.38	0.11	29.33	10.21
LSD(0.05)	0.11	1.42	0.88	2.01	0.12	NS	0.10	1.05	2.54

NPK fertilizer+Palm bunch ash (NPK+PBA), NPK fertilizer + rice husk Ash (NPK+RHA), NPK fertilizer + wood ash (NPK+WA), Control (No fertilizer)