Nwanne AJ and Ikeh AO, J Agron Agri Sci 2020, 3: 019
DOI: 10.24966/AAS-8292/100019

HERALD

HSOA Journal of Agronomy and Agricultural Science

Research Article

Response of Sweet Potato (*Ipomoea Batatas* (*L.*) Lam) to Organic Soil Amendment in an Ultisol of Southeastern Nigeria

Nwanne AJ[1] and Ikeh AO[2]*

[1]Department of Horticulture and Landscape Technology, Akanu Ibiam Federal Polytechnic, Unwana, Nigeria

[2]Department of Crop Science, University of Uyo, Uyo, Nigeria

Abstract

Decline in soil fertility is among the factors affect yam production in southeastern Nigeria. The use of organic fertilizers such as kitchen waste, sawdust, kitchen ash and compost manure in maintaining soil have not been properly research and documented. The study was carried out to fill the gap. The experiment was laid out in a randomized complete block design, replicated three times. The treatments were kitchen waste, sawdust, compost and kitchen ash while 300 kg/ha NPK-15:15:15 and no fertilizer application served as control treatments. Data generated from the study were subjected to analysis of variance at 5 % probability level. The result of the study indicated significant increased in sweet potato yield when the treatments received fertilizer were compared to the no application treatment. The treatment of 300 kg/ha NPK fertilizer produced the highest root yield of 21.45 and 22.44 t/ha in 2015 and 2016, followed by 17.13 and 17.17 t/ha obtained from compost manure in both cropping seasons. The least root yield; 9.56 and 8.52 t/ha was harvested from the no fertilizer treatment. The study therefore recommended compost manure application as alternative when NPK fertilizer becomes expensive and scarce.

That investigated the effect of land preparation and organic fertilizer utilization in an ultisol of southeastern Nigeria

***Corresponding author:** Ikeh AO, Department of Crop Science, University of Uyo, Uyo, Nigeria, Tel: +234 08033934217; E-mail: iykeh2007@yahoo.com

Citation: Nwanne AJ, Ikeh AO (2020) Response of Sweet Potato (*Ipomoea Batatas* (*L.*) Lam) to Organic Soil Amendment in an Ultisol of Southeastern Nigeria. J Agron Agri Sci 3: 019.

Received: December 20, 2019; **Accepted:** January 21, 2020; **Published:** January 28, 2020

Introduction

Farmers in southeastern Nigeria often apply different types of organic fertilizers including mulch, compost, an Organic manure to improve the soil fertility for vegetables, root and tuber crops and grains cultivation. Different organic agriculture is one of the fastest growing sectors of agriculture globally. Its main objective is to create a balance between the interconnected systems of soil organisms, plants, animals and humans [1]. Plants need nutrients in specific proportions to be present in the soil [2] and fertilizer use is a key factor in soil fertility management and yield increase in crop production [2,3].

Organic manure is supplied at different rates, sometimes farmers used to top-dress with inorganic fertilizer at lower dose. The application of either conventional or non-conventional fertilizers is a common approach to maintain and improve the biological and physicochemical properties of soils, as well as to supply essential elements for plant growth [4]. The deficiency of macro and micro nutrients does not only reduce crop yield but also reduces the nutrient concentration in crops.

Sweet potato (*Ipomoea batatas* (*L.)* Lam) belongs to the morning glory family, Convolvulaceae [5]. It is widely grown as important staple food crop in most parts of Nigeria [6]. It originated from North Western South America or Central America from where it spread to other regions of the world [7]. Its introduction to Europe by Columbus and to Asia, Africa and North America by Spanish and Portuguese explorers and traders occurred in more recent times [7]. It is an important root crop which is extensively cultivated almost all agro-ecology of Nigeria. It is short duration crop (3-4 months) that could be cropped more than once a year in humid zones or in wetland. Sweet potato is a warm weather crop and thrives best at temperatures above 24°C and where light intensity is relatively high. Its growth is best in regions with an annual rainfall of 75-100 cm on sandy-loam soils. Sweet potato is cultivated mostly as a subsistence crop in developing countries for its edible storage tubers.

African survey reports, Nigeria ranked 2nd in production of sweet potato in Africa with an annual production output of 2.6 million metric tons, while the global survey reports, Nigeria ranked 3rd followed by Uganda (2.5 million metric tons) in global sweet potato production output [8]. These figures have changed in the last decade. Presently, Nigeria is the first largest producer of sweet potato in Africa with 3.46 million metric tons annually. Globally, Nigeria is now the second largest sweet potato producer after China at the top of the list with 106 million metric tons [9]. In Nigeria, sweet potato is produced virtually in every part of the country but predominantly in the Northern Guinea Savannah where many landraces abound. In the North Central part of the country large quantities of sweet potato are produced by small scale farmers but the yields realized are low due to the use of low yielding varieties and low soil fertility.

The trend in the worldwide is to produce food in the organic way for quality food that could promote good health of people and livestock. The present study was therefore carried out to evaluate the comparative effect of recommended dose of NPK fertilizer to sweet potato in southeastern and locally available organic fertilizer sources on the growth and yield of sweet potato.

Materials and Methods

This study was conducted at National Cereals Research Institute (NCRI) out station located at Owot Uta, Ibesikpo/Asutan Local Government Area of Akwa Ibom State during 2015 and 2016 planting seasons. Owot Uta is situated between latitudes 0430˚, 5˚27˚N, longitude 07˚50˚E and 80˚20˚ with altitude of 80 m above sea level (Uyo Capital Development Agency Report). Owot Uta is located the humid tropical rainforest zone of southeastern Nigeria and has an annual mean rainfall of 2500 mm and monthly sunshine of 3.14 hours with a mean annual temperature of 20˚C. Owot Uta has a mean annual relative humidity of 70 % and evaporation rate of 2.6 cm^2 [7]. The rainfall pattern in Owot Uta is bimodal. Rainfall usually starts in March and ends in November with a short period of relative moisture stress in August, traditionally referred to as "August Break" [7]. The temperature of the area is generally high in the months of February through April [7]. Composite soil samples were collected with aid of soil augar, before planting and at harvest at two soil depths: 0-15 cm and 15-30 cm. The soil samples were collected in polythene bags, labeled air dried, crushed and sieved through a 2.0 mm-mesh, for physico-chemical analysis. Soil pH: Soil pH was determined in water 1:2 (soil: Water ratio) using a pH meter with glass electrode (Tables 1 and 2) [10].

Soil Properties	Soil Depth (cm)	
Soil Properties	0-15	15-30
Soil pH	5.10	5.00
Organic matter (%)	1.34	1.9
Total N	0.08	0.07
Aval. P (mg/kg)	56.11	45.01
Soil Particle Size (%)		
Sand	86.55	83.73
Silt	5.45	6.91
Clay	8.00	9.36

Table 1: Soil chemical properties of the experimental site.

Chemical Properties	Organic Fertilizers			
	Sawdust	Kitchen Ash	Kitchen Waste	Compost
Organic matter (%)				
Total N (%)	1.56	1.04	2.01	3.12
Aval. P (mg/kg)	3.71	6.77	6.51	2.68
Calcium	8.45	9.45	5.20	7.67
Magnesium	2.81	2.88	1.99	3.11
Potassium	1.01	3.40	1.60	0.78
Sodium	0.15	1.19	0.13	0.12

Table 2: Chemical properties of organic fertilizers.

Total nitrogen in the soil was determined by micro-Kjeldahl digestion and distillation method [11]. Organic matter content of the soil was determined by the dichromate wet oxidation method of Walkley and Black. Available P in the soil was determined by Bray-1 method [12]. Exchangeable cations were extracted with neutral NH_4 OAC. Calcium and magnesium were determined in the extract by EDTA titration [13], while potassium and sodium was determined using flame photometer.

The experiment was laid out in a randomized complete design, replicated three times. The entire experimental area was 36 m × 22 m. Each plot was 5 m × 5 m (25 m^2) with 5 plots in each replicate and total 15 plots in all. Spacing of 1 m and 2 m paths separated the plots and replications from each other, respectively. The experimental site was prepared with aid of spade and machetes and marked out with measuring tapes, rope and pegs. Planting was done on crest of ridges, using 15 cm vine cuttings long at the spacing of 1 m × 0.3 m. Inorganic fertilizers were incorporated to the soil after land preparation, on treatment basis. Application of NPK (15:15:15) fertilizer was done at 1 Month After Planting (MAP) on treatment basis using ring method. Manual weeding was carried out using a native weeding hoe at 1 and 3 MAP. Harvesting was done at 5 MAP. The following growth data were assessed. Ten plants were randomly tagged within each plot for data collection. The following data were collected; number of leaves per plant, this was determined by physical counting of the functional leaves. Vine length was determined by measuring the tagged vine from the base to the terminal bud. Leaf area was determined by measuring the length and width of the centre lobe and multiplied by a correction factor of 0.47 as describe by Nwankwo et al, [14]. Number of braches per plant was determined by counting the number of braches per plant. The number of storage roots per plant was determined by counting the number of harvested storage roots. The storage root yield was determined by weighing the harvested storage root yields in top load weighing balance and later converted to tonnes per hectare. Data generated from the study were subjected to analysis of variance at 5 % probability level. Significant means were compared with least significant difference.

Results and Discussion

Number of branches per plant as influenced by soil amendment is presented in table 3. The results showed significant difference in both cropping seasons. The treatments amended with fertilizers (organic and inorganic) had significant higher number of branches per plant when compared with the control treatment (Table 3). Among the treatments, the highest number of branches per plant was recorded in the treatment of 300 kg/ha NPK; 15.12 and 14.67 branches at 3 Months After Planting (MAP) in 2015 and 2016, respectively. This was followed by 14.67 and 14.00 branches per plant at 3 MAP, recorded in the treatment of compost manure. In both cropping seasons, the result showed no significant difference ($p < 0.05$) when number of branches per plant recorded from the soil amended plots were compared to each other (Table 3). The least number of branches per plant in both cropping seasons; 6.39 and 6.33 at 3 MAP respectively were recorded in the control treatment. The significant increase in number of branches per plant in the plots that received fertilizers could be that fertilizer supplied the required nutrients for plant growth. This observation agrees with the report of Ibia that organic and inorganic fertilizers replenish the nutrients in a soil with low fertility status.

Vine length as influenced by soil amendment is presented in table 4. The results showed significant difference in both cropping seasons. The treatments amended with fertilizers (organic and inorganic) had significant longer vines when compared with the control treatment. Among the treatments, the longest vine (114.55 cm and 116.91 cm in both cropping seasons) was recorded in the treatment of compost followed by 103.00 cm and 112.34 cm in both cropping seasons recorded in the treatment of NPK. In both cropping seasons, the result showed no significant difference ($p < 0.05$) when the vine length measured from soil amended compost manure were compared to NPK treatment. The shortest vine was recorded in the control (no soil amendment) treatment 61.57 cm and 55.81 cm in both cropping season. The vigorous increase in vine length from the fertilized treatment demonstrated that fertilizer is necessary in improving soil especially in rainforest zone where leaching of soil nutrient is pronounced. This observation agrees with Ikeh [3], that judicious application of organic and inorganic fertilizers in ultisol is one of the best ways of improving soil fertility in high humid zone of Nigeria.

Treatment	2015			2016		
	Months After Planting			Months After Planting		
Genotype	1	2	3	1	2	3
Control	2.33	5.67	6.39	2.23	3.30	6.33
300 kg/ha NPK	2.33	10.67	15.12	2.67	9.22	14.67
Compost	4.67	9.50	14.67	3.10	9.56	14.00
Sawdust	3.33	8.20	13.33	3.03	8.67	12.03
Kitchen waste	2.67	8.03	13.10	3.46	7.33	11.06
Kitchen Ash	2.67	9.10	13.30	3.30	5.90	10.30
LSD (P < 0.05)	NS	2.79	2.23	NS	2.01	2.51

Table 3: Number of sweet potato branches as affected by fertilization.

NS = Not Significant, LSD = Least Significant Difference at 5 % probability.

Treatment	2015			2016		
	Months After Planting			Months After Planting		
	1	2	3	1	2	3
Control	16.01	27.41	61.57	16.44	27.90	55.81
300 kg/ha NPK	18.59	37.65	103.00	19.09	39.78	112.34
Compost	31.60	59.72	114.55	32.63	55.77	116.91
Sawdust	18.17	26.22	101.27	17.99.	27.09	100.66
Kitchen waste	24.47	26.12	88.80	24.81	28.15	91.80
Kitchen Ash	27.43	30.45	98.97	28.45	32.56	100.91
LSD (P < 0.05)	2.14	3.11	6.33	3.02	4.25	7.09

Table 4: Vine length as affected by fertilization.

LSD =Least significant difference at 5 % probability.

Number of leaves per plant as influenced by soil amendment is shown in table 5. The results showed significant difference in both cropping seasons. The treatments that received fertilizers produced significant higher number of leaves per plant when compared with the control treatment. The highest number of leaves per plant was recorded in the treatment of compost manure, followed by the treatment of NPK. In both cropping seasons, the result showed no significant difference ($p < 0.05$) when the vine length measured from soil amended plots were compared to each other. The shortest vine was recorded in the control (no soil amendment) treatment. The significant number of leaves per plant in the fertilized plots compared to the control showed that the fertilizers were well utilized.

Treatment	2015			2016		
	Months After Planting			Months After Planting		
	4	6	8	4	6	8
Control	7.00	13.33	17.67	9.67	13.33	20.67
300 kg/ha NPK	8.00	20.00	36.33	29.67	31.67	39.67
Compost	1933	29.67	46.67	28.33	26.67	36.33
Sawdust	10.01	18.88	31.67	32.67	24.33	38.69
Kitchen waste	11.35	22.67	29.67	29.67	26.33	33.69
Kitchen Ash	14.01	23.30	27.67	25.67	25.67	30.69
LSD (P < 0.05)	2.12	2.41	3.11	2.18	2.99	3.08

Table 5: Number of leaves per plant as affected by fertilization.

LSD = Least Significant Difference at 5 % probability.

Number of storage root as affected by soil amendment is presented in table 6. The result indicated significant difference in both cropping seasons. The treatment of compost manure produced the highest number of storage roots per plant, followed by the treatment of 300 Kg/ha NPK. The least number of storage roots per plant (Table 5). Comparing the storage root yield in 2015 and 2016, the significant storage root yield (21.45 and 22.44 t/ha) was recorded in the treatment of NPK, followed by 17.13 and 17.17 t/ha recorded in the treatment of compost manure. The treatment of sawdust produced 16.22 and 16.01 t/ha storage yield while kitchen waste had 16.67 and 16.33 t/ha in both cropping seasons. The treatment of kitchen ash produced storage root yield of 15.33 and 15.75 t/ha in both cropping seasons. The least storage root yield, 6.81 and 6.04 t/ha, was harvested from the control treatment. The significant greater yield obtained from the fertilizer treated plots could be that those organic origins were able supply both micro and macro nutrients to the soil which enhanced nutrient utilization compared to the control (no soil amendment). Ikeh et al. [15], reported significant increase in yam yield in the treatment of different organic fertilizer application.

Treatment	2015		2016	
	Number of Storage Roots per Plant	Storage Root Yield (t/ha)	Number of Storage Roots per Plant	Storage Root Yield (t/ha)
Control	1.77	9.56	1.56	8.52
300 kg/ha NPK	6.9	21.45	6.5	22.44
Compost	5.55	17.13	5.7	17.17
Sawdust	4.11	16.22	4.08	16.01
Kitchen waste	4.2	16.67	4.18	16.33
Kitchen Ash	3.56	15.33	4.11	15.75
LSD (p < 0.05)	2.13	3.01	1.56	2.55

Table 6: Yield and yield components of sweet potato as affected by fertilization.

LSD = Least Significant Difference at 5 % probability.

Conclusion

The present work had clearly shown that sweet potato could be successfully produced organically using compost, sawdust, kitchen waste and ash in southeastern Nigeria. Considering that these manures are readily available and accessible to farmers, it will be useful for farmers at very low cost and thus reduce the high cost associated with Inorganic Fertilizer (NPK). The ultisol nature of soils in southeastern Nigeria would also be protected from the level of acidity associated with synthetic fertilizer use. The study therefore recommended organic manure application as alternative when NPK fertilizer is expensive not available.

References

1. Karanatsidis G, Berova M (2009) Effect of organic-n fertilizer on growth and some physiological parameters in pepper plants (*Capsicum annum L.*). Biotechnology & Biotechnological Equipment 23: 254-257.
2. Akinrinde EA (2006) Issues of optimum nutrient supply for sustainable crop production in tropical developing countries. Pakistan Journal of Nutrition 5: 377-387.
3. Ikeh AO (2017) Effects of time of harvesting and fertilization on yield, garrification traits and economic returns of some cassava *(Manihot esculenta Crantz*) genotypes. Department of Crop Science, Faculty of Agriculture, University of Uyo, Uyo, Akwa Ibom State Nigeria.
4. Ebrahimi E, Ghorbanali A, Peter von FN (2019) A field study on the effect of organic soil conditioners with different placements on dry matter and yield of tomato (*Lycopersicon esculentum L.*). International Journal of Recycling of Organic Waste in Agriculture 8: 59-66.
5. Woolfe JA (1992) Sweet potato: An untapped food resource. Cambridge University Press, New York Uk. Pg no: 1-39.
6. Njoku JC, Muoneke CO, Okocha PI, Ekeleme F (2009) Effect of propagule size and intra row spacing on the growth and yield of sweet potato in hmid agro ecolgreal zone. Niger Agric J 40: 115-124.
7. Udoh DJ, Ndon BA, Asuquo PE, Ndaeyo NU (2010) Crop production techniques for the tropics. Concept Publications Limited, Lagos, Nigeria.
8. Mwanja YP, Goler EE, Gugu FM (2017) Assessment of root and vine yields of sweet potato (*Ipomoea batatas (L.*) Lam) landraces as influenced by plant population density in jos-plateau, Nigeria. International Journal of Agricultural Research 12: 88-92.
9. FAO (2018). FAO production statistics. FAO Rome, Italy.
10. Bates RG (1954) Electrometric pH Determination. John Wiley and Son Inc, New York, USA.
11. Ibia TO, Udo EJ (2009) Guide to fertilizer use for crop in akwa ibom state, Nigeria. Sibon Books Limited, Lagos, Nigeria. Pp no: 28.
12. Bray RH, Kurtz LT (1954) Determination of Total organic and available forms of phosphorus soils. Soil Science Journal 34: 45-49.
13. Jackson ML (1964) Soil chemical analysis: Advance course (2nd ed). Department of Soil Soil Science, University of Wisconsin, USA.
14. Nwankwo IIM, Bassey EE, Afuape SO, Njoku J, Korieocha DS (2012) Morpho-agronomic characterization and evaluations of in-country sweet potato accessions on South Eastern Nigeria. J Agric Sci 4: 281-288.
15. Ikeh AO, Ndaeyo NU, Akpan EA, Udoh EI, Akata OR (2013) Evaluation of complementary use of organic manure for sustainable water yam production in Uyo, Southeastern Nigeria. American Journal of Research Communcition 1: 38-48.