EFFECT OF NPK FERTILIZER ON GROWTH AND YIELD OF SWEET POTATO (*Ipomea batatas* (L) Lam) IN UNWANA SOUTH-EASTERN NIGERIA

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Abstract
Sweet potato (Ipomoea batatas (L) Lam) is a vegetable crop often grown without fertilizer by peasant farmers in Nigeria. With the increased pressure on land resources for other competing uses, farmers adopted the use of fertilizer to boost crop production. The experiment was conducted for the purpose of evaluating the influence of NPK fertilizer on the growth and yield attributes of sweet potato. The experiment was carried out under open field condition in 2021 cropping season at the Teaching and Research farm, Department of Horticulture and Landscape Technology, Akanu Ibiam Federal Polytechnic, Unwana, Ebonyi State. The farm is located on latitude $06^0 5^{'} N$ and longitude $08^0 3^{'} E$ about 300m above sea level. NPK 20:10:10 compound fertilizer was applied using band method at the rates of (0, 100, 200, 300 and 400kg/ha). The experiment was a randomized complete block design and replicated six times. Each plot size was 4m x 4m and a total of 30 sub plots, while the plants were spaced 90cm x 90cm. data were taken on growth and yield parameters such as; vine length, number of leaves and vines, leaf area, plant girth, number of tubers, fresh weight of tubers, average root length and tuber yield. The results of the experiment show that vegetative parameters significantly ($P<0.05$) increased from control plots to 400kgNPK/ha except at plant girth where they are statistically the same. Number of tubers significantly ($P<0.05$) increased from 18 tubers in control to 74 tubers at fertilizer rates between 100 to 300kgNPK/ha. Weight of tubers also increased from 4kg to 19kg between control and 300kgNPK/ha. Total tuber yield recorded at 300kgNPK/ha (47t/ha) differed significantly from other tuber yield recorded. Therefore, 300kg/ha of NPK fertilizer is recommended to farmers in the study area due to an increase in fertilizer above that level will lead to decrease in yield attributes.

Keywords: Growth, NPK fertilizer, Sweet potato and Yield

Introduction
Sweet potato (*Ipomoea batatas* (L) Lam) belongs to the family "Convulaceae". It is ranked as the fifth most important food crop after rice, wheat, maize and cassava in the developing countries. It is being grown for its tubers and leaves. Nigeria is the second largest producer of sweet potato in Africa and third in the world with 2,746,820mt in 2009 (FAOSTAT, 2011). According to Ojiako (2009), sweet potato yield per hectare in Nigeria was 3t/ha in 2009 which has a significant decline from 11.73t/ha record between 1960 and 1970.Sweet potato adapted to a wide range of altitude ranging from sea level to 22,500cm above sea level. It requires high temperature of up to 24^0C and grows well in regions with 750 to 1,250mm of rainfall and long sunny conditions without shade (Uguru, 2011).

Sweet potato is used for human consumption when boiled, roasted and fried. Industrially, it can be processed into chips, candy, starch, noodles and flour (EPAR, 2012). Lareo *et al.* (2013) reported that sweet potato can be exploited for ethanol and biofuel production. According to

Uguru (2011), the tuber contains 70% H_2O, 20% starch, 1.5% protein, 1.5% sugar and vitamins and minerals in trace amount. Application of fertilizer is one of the most important inputs for increasing the productivity of crop (Ali *et al.,* 2009). Stathers *et al.* (2005) reported that fertilizer application may increase yield of sweet potato by at least 32% under poor soil conditions and nearly double (89.93%) the yield under better soil conditions. Under application of fertilizer can retard crop growth and lower yields in the short term and in the long term jeopardize sustainability through soil mining and erosion (Smalling & Braun, 1996).

In the developing and under developed countries farmers using inorganic fertilizers faced with challenges like high cost and unavailability of the input at the right time, thereby leading to under application or non-application most times. Sweet potato is cultivated in all agro-ecological zones of the country and information about its nutrients requirements for optimum production in terms of in organic fertilization is necessary. This has necessitated the need for this research aimed to evaluate and determine the optimum rate of NPK fertilizer on growth and yield of sweet potato in Unwana South-eastern Nigeria.

Materials and Methods

Study Area

The field experiment was conducted at the Teaching, Demonstration and Research (TDR) farm of the Department of Horticulture and Landscape Technology, Akanu Ibiam Federal Polytechnic, Unwana-Afikpo South Local Government Area in the South eastern part of Nigeria during 2021 cropping season. Unwana is located on the latitude 06^0 05' N and longitude 08^o 03' E with an elevation of 300 m above sea level (NIMET, 2014). The climatic and vegetation types of the area are generally humid tropical rainforest with mean annual rainfall of about 3,500 m and mean daily temperature of 21^0C to 32^0C (Njoku *et al*., 2006).

Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments. The fertilizer used as treatment was; NPK 20:10:10 (100, 200, 300 and 400) and control replicated six times.

Soil Analysis

Before the commencement of the experiment, soil samples (0 to 20 cm depth) were randomly collected at the experimental site using soil auger at twelve (12) different points. The samples were bulked to produce composite samples which were air dried and sieved with 2 mm sieve were subjected to chemical analysis.

Land Preparation and Planting

The experimental fields were cleared manually and thirty (30) beds were constructed using big hoe. Each plot measured 4m x 4m ($16m^2$) with 1m used as alley ways to separate between blocks. Vines of sweet potato TIS – 8164 sourced from National Root Crop Research Institute, Umudike, Abia State were cut into 25cm long pieces with at least three nodes per plant. Planting was done at a spacing of 90cm x 90cm inter row and intra row, respectively which gave a plant population of 12,345 plants per hectare as a sole crop (Uguru, 2011). Supplying was done at 2 weeks after planting (WAP).

Fertilizer Application
NPK 20:10:10 was applied two weeks after planting (WAP) using band method and covered after application.

Data Collection
Vegetative/growth parameters on vine length (cm), number of leaves and vines per plant, leaf area (cm^2), plant girth (cm) were collected at 12 WAP. Yield parameters were taken at harvest, number of tubers, fresh weight of tubers (kg), average root length and tuber yield (t/ha). Data generated were statistically analyzed using GENSTAT 17 version, treatment means were separated using Least Significant Difference (LSD) at 5% level of probability as described by Obi (2012).

Results and Discussion
The results of the chemical and physical properties of the experimental plots are presented in Table 1. It showed that the surface soil was slightly acidic with pH value of 5.80, low in organic carbon, nitrogen, phosphorus and exchangeable bases which could be as a resulted in the loss of basic cations from the soil (Ayeni and Ezeh, 2017). The low soil nutrient contents justified the need for additional fertilizer treatment.

Effect of NPK Fertilizer on growth of Sweet Potato
The result showed a significant difference ($P<0.05$) with increase in vine length, number of leaves, number of vines and leaf area with increased levels of NPK fertilizer. 400kg of NPK fertilizer had the longest vines and number of leaves of approximately 347cm and 26 leaves, respectively, which differed significantly from other levels of fertilizer used except on 300kg/ha were they are statistically the same (Table 2). This is in agreement with the report of Abdel-Mawgoud *et al.* (2005). Sowley *et al.* (2015) also reported that fertilizer increased vine length with increased level of fertilization.
NPK fertilizer, 400kg/ha, had the highest number of vines per plant of approximately 26 vines which differed significantly from other number of vines recorded on other NPK fertilizer rates. The significant response of leaf area to higher rates of NPK fertilizer at 400kg/ha may be an indication that nitrogen was taken up by the plant and subsequently utilized in cell multiplication, amino acid synthesis and energy formation that acts as structural compound of the chloroplast which carries out photosynthesis. Lawlor (2002) reported that nitrogen fertilizer is a constituent of chlorophyll. Leaf area increased as NPK fertilizer increased from 0khNPK/ha to 400kgNPK/ha. This is in agreement with Josiah *et al.* (2007) who reported that an increase in leaf area of cucumber attributed to the use of nitrogen in the soil. NPK fertilizer had no significant effect on the plant girth of sweet potato. Although, 100kgNPK/ha produced the widest stem of sweet potato (1.13cm).

Table 1: Pre-planting Soil Physico Chemical Properties of the Experimental Site

Soil Properties	Values
pH	5.80
Total N (g/kg)	1.50
Available P (mg/kg)	7.80
Organic Carbon (g/kg)	14.3
Organic Matter (g/kg)	24.9
Ca^{2+} ($Cmolkg^{-1}$)	3.00
Mg^{2+} ($Cmolkg^{-1}$)	1.00
K^{+} ($Cmolkg^{-1}$)	0.32
Na^{+} ($Cmolkg^{-1}$)	0.02
ECEC ($Cmolkg^{-1}$)	7.16
Exchangeable Acidity ($Cmolkg^{-1}$)	2.82
BS (%)	60.11
Sand (g/kg)	380
Silt (g/kg)	140
Clay (g/kg)	480

Table 2: Effect of NPK Fertilizer rates on vegetative growth of sweet Potato

NPK Fertilizer Rates (kg/ha)	Vine Length (cm	Number of Leaves	Number of Vines	Leaf Area (cm^2)	Plant Girth (cm)
0	**207.13**	**36.63**	**12.13**	**70.23**	**0.97**
100	**260.30**	**42.30**	**19.90**	**91.03**	**1.01**
200	**323.93**	**47.33**	**21.10**	**96.97**	**1.13**
300	**342.23**	**49.27**	**22.43**	**114.27**	**1.02**
400	**347.30**	**52.53**	**25.60**	**120.83**	**1.09**
F-$LSD_{0.05}$	**13.307**	**2.960**	**2.298**	**19.829**	**n.s**

Means in the same column having the same letters are not significantly (P<0.05) different using F-LSD
N.S = Not Significant (P<0.05)

Effect of NPK Fertilizer on yield and yield Attributes of Sweet Potato

The parameter measured at harvest were all influenced significantly (P<0.05) by NPK fertilizer used in the study (Table 3). 300kg/ha of NPK fertilizer gave the highest mean value (74.44) for number of tubers which differed significantly from other number of tubers produced at other treatment rates used. Number of tubers increases as NPK fertilizer increase from 0kg/ha to 300kg/ha beyond which there was a decrease. Maximum weight of tubers 19.00kg was recorded at 300kgNPK/ha differed significantly from other rates used. These result are in agreement with the work of Waseem *et al.* (2008) who noted that high dose fertilizer significantly maximizes number of cucumber, weight and fruit girth.

300kg/ha of NPK fertilizer produced longest roots and tuber yield of sweet potato of 77.63cm and 46.53t/ha, respectively significantly from root length recorded at other fertilizer rates used (Table 3). Tuber yield per hectare were significantly influenced by the application of NPK fertilizer. The positive response could be accepted in view of the role of nitrogen with its inherent capacity of promoting the physiology of plant thereby, producing good canopy to trap sunlight for photosynthetic activity. This finding agrees with Dosantos *et al.* (2009) who observed significant yield increase on plots treated with nitrogen when compared to the control. Application of NPK fertilizer increases tuber yield of sweet potato to a point where further increase in fertilizer results into a decline in productivity.

The reductions in yield at high fertilizer rates could be as a result of high concentration of soluble nitrogen which increases the osmotic potential of the soils solution causing a reduction in water uptake by the plant roots (Onyango, 2002).

Conclusion

The results of this study showed that NPK fertilizer application had a positive effect to the performance of sweet potato. The application of 300kg/ha NPK fertilizer gave the highest yield of 46.53t/ha and has proven to be the best rate to be used at this study area.

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