

EFFECTS OF NPK 15:15:15, BIOCHAR AND COWDUNG ON PERFORMANCE OF SWEET POTATO (*Ipomea batatas* L. Lam)

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Abstract

A field experiment was conducted at Department of Crop Production Technology, Oyo State College of Agriculture and Technology Igboora to evaluate the effect of biochar, NPK 15:15:15 and cowdung on growth and yield of sweet potato. Pre-soil, cowdung and biochar were carried out in the laboratory for physico-chemical and chemical composition analyses. Sweet potato, orange flesh variety vines of 10cm long with 5 nodes were planted at a spacing of 1m by 1m on the experimental plot. The experimental plots were treated with 10tons/ha of cowdung and biochar before planting while NPK 15:15:15 at the rate of 400kg/ha was applied two weeks after planting. The control had no application of fertilizer. The four treatments were arranged in a randomized complete block design (RCBD) in five replicates. Data were taken four weeks after planting. The growth (length of vines, leaf area, numbers of leaves, stem diameter) and yield (numbers of tubers and weight of tubers) parameters were collected and analysed using Analysis of Variance (ANOVA), while significant means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level. The application of organic (biochar and cowdung) and inorganic NPK 15:15:15 fertilizers enhanced the growth and yield of sweet potato. NPK 15:15:15 at 400kg/ha had the highest length of vine (206.20cm) and number of leaves (74.40) compared to other treatments at 10 weeks after planting. NPK 15:15:15 was not significantly higher in number of vines and stem diameter than other treatments at 10 weeks after planting. However, NPK 15:15:15 had the highest yield (10.80t/Ha) than the control (4.00t/Ha) at 10 weeks after planting. For optimum production of sweet potatoes, NPK 15:15:15 at the rate of 400kg/ha is recommended for farmers in the study area.

Keywords: Sweet Potato; NPK 15:15:15; Biochar; Cowdung.

Introduction

Sweet potato is an important food and vegetable crop that is grown throughout the world especially in the tropics for its edible tubers and leaves. Today, the crop remains one of the three most important root crops in the world, following the Irish potato (*Solanum tuberosum*) and cassava (*Manihot esculenta*). Nigeria ranks second largest producer of sweet potato in Africa and third in the world (Mwanja *et al.*, 2017). Generally, sweet potato shoots and tuberous roots provide energy, protein, vitamins and minerals sufficient for both man and livestock (Anonymous, 2010).

Sweet potato may be adapted to grow on poor soils; as such most farmers do not apply fertilizer on their farms, resulting in poor yield. Though inorganic fertilizers have been the conventional method of soil mineral input in sweet potato production, these fertilizers may pose danger to the environment especially when inappropriately applied. According to

Buresh *et al.*, 1997 and Palm *et al.*, 1997, and generally, both inorganic and organic inputs are needed to increase crop production in West Africa.

The potentials of organic fertilizer for soil fertility management, the deleterious effect of inorganic fertilizers on soil properties, the scarcity and cost are well known.

One of the major constraints to potato production in Nigeria is low soil fertility. Hence, the use of soil amendments like application of biochar, cowdung and inorganic fertilizers are highly encouraged (Abdulraheem and Charles, 2016). Chemical fertilizers are commonly used to improve soil fertility (FAO, 2000). Biochar is described as a 'black carbon manufactured through pyrolysis of biomass' (Lehmann and Rondon, 2006). Biochar application in soils has positive influences on improving soil quality and plant growth (Chan *et al.*, 2007). Biochar is beneficial for sequestration of carbon, improvement of cation exchange capacity, durability of soil

aggregates, microbial activity, bioenergy production and water retention capacity; reduction of nitrous oxide and methane emissions from soils, leaching, soil erosion and need of fertilization, enhancement of soil fertility and crop yields (Brandstaka *et al.*, 2010). Cow dung abounds in cattle markets as waste product and are useful organic materials that can be utilized to supplement the quantity of mineral fertilizers needed for sweet potato production (Asawalam and Onwuidike, 2011). The advantages of organic farming includes increased soil fertility and thus resulted in higher yields, conservation of the environment and being friendly to soil organisms. Organic fertilizer improves both the physical and chemical soil properties. It also promotes infiltration, protects against erosion and facilitates the spread and penetration of plant roots. The slow release nature of organic fertilizer prevents loss of nutrients through leaching and has long term effect on soil fertility (Ojeniyi, 2002).

Presently, the use of chemical fertilizers as soil amendment has become cost intensive and linked to negative effects on environment (causing residual effects on the soil). In view of these, the use of organic manures, crop rotation, crop residues, legumes and green manures are substitutes for chemical fertilizers (Salau, 2005). Therefore, this study aimed to determine the effect of N.P.K, biochar, and cowdung on performance of sweet potato.

Materials and methods

The experiment was carried out at the Teaching and Research Farm of Crop Production Technology department, Oyo State College of Agriculture and Technology Igbo-ora, Latitude $7^{\circ} 26'1''N$ and Longitude $3^{\circ}17'16''E$ in Ibarapa Central Local Government Area of Oyo State, Nigeria. Igboora has two distinct seasons. The dry season is usually from November to March and wet season is from April to October. Also, the average high temperature of the region is $33^{\circ}C$, while the average low temperature is $22^{\circ}C$ (weatherspark.com).

Composite soil samples were collected from the experimental field at 0-20cm depth, air dried, passed through 2mm sieve and sent to the laboratory for physical and chemical analysis. The pH was determined with pH meter and available phosphorus was estimated using Bray and Kurtz, 1945 method. Macro-Kjeldahl method was used to assess the total

nitrogen of the soil (Jackson, 1958) and exchangeable Ca, Mg, K, Na and effective C.E.C in soil by use of atomic absorption spectrophotometer (Tel and Hargerty, 1984). Soil particle analysis was determined by Bouyoucos (1962) method. The experimental field was cleared using hoe and cutlass. Mounds experimental plot were prepared using hoe.

Cowdung manure (obtained from Dairy Unit, Oyo State College of Agriculture and Technology Igboora) and biochar (from cassava peeling and saw-dust was obtained from department of Crop Production Technology, Oyo State College of Agriculture and Technology Igboora). The samples were air dried and sent to the laboratory for chemical properties evaluation.

Sweet potato (Orange Flesh variety) vines of 10cm long with 5 nodes (2 in the soil and 3 above the soil level) were planted at a spacing of 1m by 1m on the experimental plot. The middle portions of the vines were selected for planting. Cowdung and biochar were incorporated into the soil two weeks before planting at 10t/ha (500g/plant) and 5t/ha (250g/plant), while NPK 15:15:15 was applied two weeks after planting at the rate of 400kg/ha (20g/plant). The control plots had no application. Cultural practices like staking and weeding were carried out. The treatments were laid out in a Randomized Complete Block Design (RCBD). The four treatments were replicated five times making twenty experimental plots.

Data collection commenced four weeks after planting. The growth and yield parameters collected were length of vines using measuring tape, leaf area using measuring tape, numbers of leaves through visual counting, stem diameter using Venires Caliper, numbers of tubers through visual counting and weight of tubers using weighing balance. Data taken were statistically analysed using Analysis of Variance (ANOVA) and the significant means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

Results and discussion

Pre-physico-chemical analysis of the experimental site

The pH of the experimental site is 6.47 indicating that the soil was slightly acidic. The soil is low in essential plant nutrients nitrogen, phosphorus and potassium. The experimental site is sandy soil (Table 1).

Table 1: Pre-physico-Chemical Analysis of the Experimental soil

Elements	Values
pH(H ₂ O)	6.47
Organic carbon (g/kg)	35.50
Total nitrogen (g/kg)	3.22
Available P (mg/kg)	49.27
Exchangeable acidity (cmol/kg)	0.70
H ⁺ (mol/kg)	0.30
Ca mol/kg	15.03
Al ⁺ (cmol/kg)	0.40
Mg (cmol/kg)	2.10
K (cmol/kg)	0.72
Na (cmol/kg)	0.83
Mn (mg/kg)	260.0
Fe (mg/kg)	184.0
Cu (mg/kg)	4.17
Zn (mg/kg)	10.03
Sand (g/kg)	67.2%
Silt (g/kg)	15.4%
Clay (g/kg)	17.4%

Proximate analysis of biochar and cowdung manure

The biochar analysis shows that it is alkaline with pH value of 9.12 and it is low in nitrogen, phosphorus and potassium which are low in essential plant nutrient (Table 2). The cow dung analysis shows that it is alkaline pH value of 8.74 and it is low in nitrogen, phosphorus and potassium which are low in essential plant nutrients (Table 2).

Table 2: Proximate analysis of biochar and cowdung manure

Element	Biochar	Cow dung
pH	9.12	8.74
Total N	0.084gm/kg	1.65
Available P	1.96mgkg ⁻¹	0.39 (g/kg)
K	1.78 (cmolkg ⁻¹)	0.08 (g/kg)
Na	0.38 (cmolkg ⁻¹)	0.07 (g/kg)
Mg	0.05 (cmolkg ⁻¹)	0.37 (g/kg)
Ca	0.08 (cmolkg ⁻¹)	0.09 (g/kg)

Effect of N.P.K 15:15:15, biochar and cowdung on length of vines (cm) of sweet potato

The use of NPK 15:15:15 fertilizer, biochar and cowdung manure significantly ($P \leq 0.05$) increased the vine length of sweet potato (Table 3). From the fourth to tenth weeks, after planting, NPK 15:15:15 had the highest vine length compared to other treatments, while the control gave the lowest vine length. The

highest vine length (206.20cm) was recorded at 10 weeks after planting, while the lowest vine length (73.60cm) was recorded at 10 weeks after planting for NPK and control respectively (Table 3). At 10 weeks after planting, biochar had 158.40 cm vine length higher than cowdung (124.40cm) and control (73.60cm) gave the least.

Table 3: Effects of N.P.K 15:15:15, biochar and cowdung on length of vines (cm) of Sweet Potato

Treatment	LV4WAP	LV6WAP	=LV8WAP	LV10WAP
Control	54.60c	63.80c	68.00c	73.60c
Biochar	134.40b	145.60b	152.00b	158.40b
NPK	192.80a	198.00a	203.60a	206.20a
Cowdung	107.40ab	116.60ab	120.60ab	124.40ab

Means with the same letter are not significantly different at 5% significant level. WAP – Week after planting, LV – Length of Vines

Effects of N.P.K 15:15:15, biochar and cowdung on numbers of leaves of Sweet Potato

The application of NPK 15:15:15 fertilizer, biochar and cowdung manure significantly ($P \leq 0.05$) increased the number of leaves of sweet potato (Table 4). NPK plot gave higher number of leaves than other treatments from the fourth to tenth week, after

planting. Highest value (74.40) observed at the tenth weeks, after planting, while the control had the lowest number of leaves (36.80) at that period (Table 4). Also, at tenth week after planting, biochar had (53.4) number of leaves higher than cowdung (46) and the control (36.8).

Table 4: Effect of N.P.K 15:15:15, biochar and cowdung on number of leaves of Sweet potato

Treatment	NL4WAP	NL6WAP	NL8WAP	NL10WAP
Control	24.60b	33.40b	34.80b	36.80b
Biochar	43.20ab	49.40b	50.40ab	53.40ab
NPK	60.40a	70.40a	72.20a	74.40a
Cowdung	33.40b	42.00b	43.80b	46.00b

Means with the same letter are not significantly different at 5% significant level. WAP – Week after planting, NL– Number of Leaves

Effect of N.P.K 15:15:15, biochar and cowdung on leaf area on Sweet Potato

The use of NPK 15:15:15 fertilizer, biochar and cowdung manure significantly ($P \leq 0.05$) increased the vine length of sweet potato (Table 5). The use of NPK

15:15:15 had higher leaf area but was closely followed by the use of biochar and with no significant differences in the value of all the leaf area produced from fourth to tenth, weeks after planting.

Table 5: Effect of N.P.K 15:15:15, biochar and cowdung on leaf area of Sweet Potato

Treatment	LA4WAP	LA6WAP	LA8WAP	LA10WAP
Control	7.30b	7.83b	7.83b	7.87b
Biochar	11.53a	13.33a	13.73a	15.80a
NPK	13.42a	15.54a	15.44a	16.94a
Cowdung	10.80a	12.31a	12.53a	15.91a

Means with the same letter are not significantly different at 5% significant level. WAP – Week after planting, LA – Leaf Area

Effect of N.P.K 15:15:15, biochar and cowdung on number of vines of Sweet Potato

The use of NPK 15:15:15 fertilizer, biochar and cowdung manure significantly ($P \leq 0.05$) increased the number of vines of sweet potato (Table 6). The application of NPK 15:15:15 had highest vine number

(6.80) than other treatments from the fourth to tenth week, after planting. The control had the lowest number of vines (4.00) and was not significantly different from biochar and cowdung plots from the fourth to tenth week, after planting.

Table 6: Effect of N.P.K 15:15:15, biochar and cowdung on number of vines of Sweet Potato

Treatment	NV4WAP	NV6WAP	NV8WAP	NV10WAP
Control	2.80b	3.00b	3.20b	4.00b
Biochar	3.00b	4.00b	4.40b	4.40b
NPK	5.60a	6.20a	6.60a	6.80a
Cowdung	3.00b	4.20b	4.40b	4.20b

Means with the same letter are not significantly at 5% significant level, WAP – Week after planting, NV – Number of Vines

Effect of N.P.K 15:15:15, biochar and cowdung on stem diameter (cm) of Sweet Potato

The use of NPK 15:15:15 fertilizer, biochar and cowdung manure significantly ($P \leq 0.05$) increased the stem diameter of sweet potato (Table 7). The

application of NPK 15:15:15 had higher stem diameter (5.64cm) but was closely followed by the use of biochar (5.48cm) and with no significant differences in the value of all the stem diameter produced from fourth to tenth, weeks after planting.

Table 7: Effect of N.P.K 15:15:15, biochar and cowdung on stem diameter (cm) of Sweet Potato

Treatment	SD4WAP	SD6WAP	SD8WAP	SD10WAP
Control	4.10b	4.44b	4.47b	4.49b
Biochar	4.42b	4.92a	5.25a	5.48a
NPK	5.57a	5.59a	5.61a	5.64a
Cowdung	4.23b	4.25b	4.29b	4.31b

Means with the same letter are not significantly different at 5% significant level, WAP – Week after planting, SD – Stem Diameter

Effect of N.P.K 15:15:15, biochar and cowdung on yield of Sweet Potato

NPK gave highest yield of 10.80 tons/ha at harvest compared to other treatments. Biochar and cowdung

had 6.80 tons/ha and 6.40 tons/ha respectively, but were not significantly different from each other, while the control gave the least yield of 4.00 ton/ha (Table 8).

Table 8: Effect of NPK 15:15:15, biochar and cowdung on yield of Sweet Potato

Treatment	Yield tons/ha
Control	4.00c
Biochar	6.80b
NPK	10.80a
Cowdung	6.40b

Means with same letter are not significantly difference at 5% significant level, WAP – Week after planting

Discussion

From the results, sweet potato responded positively to the application of organic and inorganic fertilizers in growth and yield of the crop. Application of NPK 15:15:15 at the rate of 400kg/ha had the highest growth and yield responses when compared to other treatments. This result is in line with the work of Adeleye *et al.*, 2010 that NPK 15:15:15 produced the optimum growth and yield compared to organic manure (Poultry manure) and soil amendment (Biochar). This is because organic manures need more time to decompose for nutrients to be available for plant absorption (Ouda and Mahadeen, 2008). According to Ramamurthy and Shivashankar (1996), nutrients present in organic matter are not fully available to the crops in the season of its application. Similarly, Eghball and Power (1999), found that about 40% cattle manure becomes available to plants in the

first year after application. It has also been observed that the effect of organic fertilizers on plant growth seem varied and some studies showed decreased plant growth or yields when using organic fertilizers compared with conventional fertilizers (Ali *et al.*, 2009). Thus, the application of NPK15:15:15 fertilizer, biochar and cowdung manure ($P \leq 0.05$) significant increased the yield of sweet potato.

Conclusion and recommendation

From the results, the application of organic (biochar and cowdung) and inorganic NPK 15:15:15 fertilizers enhanced the growth and yield of sweet potato. NPK at the rate of 400kg/ha gave the highest significant growth and yield responses. This was followed by biochar and cowdung at 10tons/ha application rate. It is recommended that either biochar or NPK fertilizer should be used for soil fertility improvement to



enhance growth and yield of sweet potato. For optimum production of sweet potato, NPK 15:15:15 at the rate of 400kg/ha is recommended to farmers in the study area.

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