

**RESPONSE OF SWEET POTATO VARIETY TIS-8186 (IPOMEA BATATA {L} LAM)
TO APPLICATION OF THREE SOURCES OF FERTILIZER IN OTOBI, BENUE
STATE, SOUTHERN GUINEA SAVANNA NIGERIA**

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<https://doi.org/10.35410/IJAEB.2021.5635>

ABSTRACT

A field experiment was conducted at National Root Crops Research Institute Otobi, Benue State, located between 7°11'N and 8°10'E during 2019 cropping season to evaluate the effect of three fertilizer sources on growth and yield of sweet potato variety TIS-8186 (*Ipomea batata* {L} Lam). The fertilizer sources used as treatments were: NPK20:10:10 (100, 200 and 300 kg/ha), Poultry manure (2.5 and 8t/ha), Fertiplus (2, 5 and 8t/ha) and control. The treatments were laid out in a Randomized Complete block Design (RCBD) and replicated three times. Vines of sweet potato TIS-8164 was sourced from National Root Crops Research Institute Umudike, cut into 25 cm long and planted at a spacing of 0.3m (100 cm x 30 cm) inter-row and intra-row respectively which gave a plant population of 33,333 plants per hectare. All the fertilizer sources significantly influenced the growth parameters (vine length, plant girth, number of leaves, leaf width) and yield of sweet potato over the control. The longest vine length (218 cm) at 12 WAP was obtained from poultry 8t/ha and the least from the control (14.53 cm) at 4 WAP. The longest leaf length (12.80 cm) was obtained from poultry 8t/ha at 12 WAP and the least (4.67 cm) from the control at 4 WAP. The broadest leaf width (11.47 cm) was obtained from poultry 8t/ha at 6 WAP and the least (4.13 cm) from the control at WAP. The highest yield (78.33) in terms of number of marketable roots was obtained from poultry 5t/ha and the least (21.27) from the control. The highest weight of marketable root (21.27) in Kg/plot was obtained from poultry manure 5t/ha and the least (3.67) from the control. Application of 5t/ha of poultry manure is recommended for soil fertility improvement and root yield of sweet potato in the study area.

Keywords: Potato variety TIS-8186, three sources of fertilizer, Southern guinea savanna.

1. INTRODUCTION

The challenge of Agriculture over the coming decades shall be to meet the world's increasing demand for food. Declining soil fertility and mismanagement of plant nutrients have made this task more difficult (Brady and Weil, 2014). The increased population has led to intensive land cultivation in other to cater for the ever increasing population. This practice of intensive cropping, slash and burn farming system associated with bush fallow among other factors has led to decline in fertility and productivity of such soils (Zingore *et al.*, 2003).

Over-application of fertilizers while inexpensive for some farmers in developed countries, induces neither substantially greater crop nutrient uptake nor significantly higher yields rather, is economically wasteful and can damage the environment. Under-application on the other hand, can retard crop growth and lower yields in the short term and in the long term jeopardize sustainability through soil mining and erosion (Smalling and Braun, 1996).

It was observed among other factors that, in the developing and under developed countries, farmers using inorganic fertilizers are faced with challenges like high cost and unavailability of the input at the right time, there by leading to under application or non-application most times. These have necessitated the need for alternative strategies that are environmental friendly, affordable and, accessible to poor resourced farmers (Akanni *et al.*, 2011).

The importance of Sweet potato to man and livestock cannot be overemphasized; it is used for human consumption when boiled, roasted and fried. Industrially, it can be processed into fried snacks, chips, candy, starch, noodles, flour and crisps (EPAR, 2012) and can be exploited for ethanol and biofuel production (EPAR, 2012; 2010; Ziska *et al.*, 2009; Lareo *et al.*, 2013). Research carried out by Williams *et al.* (2013) also indicated that, Sweet potato contains chlorogenic acids, a phenolic compound responsible for suppressing obesity in humans. Similarly, the vines can be used for feeding goats and cattle, and it contains protein and minerals required in the livestock's feeding diet (Kebede *et al.*, 2008; EPAR, 2012). Recent studies by Asep *et al.*, (2019) showed that, animals fed with Sweet potato vines actually produce less methane gas than animals given other types of feed, suggesting that, Sweet potato animal feed can help mitigate greenhouse gas emission.

Sweet potato is fast becoming emerging food security crop in Nigeria and is cultivated in all agro-ecological zones of the country, information about its nutrients requirements for optimum production in terms of organic and inorganic fertilization is necessary, therefore this study was conducted with three sources of fertilizers to guide farmers' in Otobi, Benue State Southern Guinea Savannah of Nigeria.

2. MATERIALS AND METHOD

Study site

The experiment was conducted during the cropping season of 2019 at the National Root Crops Research Institute Otobi Sub-station Benue State, located between 7^o11'N and 8^o10'E Southern Guinea Savannah of Nigeria.

Design of experiment

This was randomized complete block design (RCBD) consisting of 10 Treatments. The fertilizer sources used as treatments were: NPK20:10:10 (100, 200 and 300 kg/ha), Poultry manure (2, 5 and 8t/ha), Fertiplus (2, 5 and 8t/ha) and control replicated three times.

Land preparation and planting

The fields were cleared manually and debris removed from the field. Four (4) ridges of 3 meters long were constructed using big hoe. Each plot measured 3m x 4m =12m² with 1m used as alleyways used to separate between plots and between replications.

Vines of sweet potato TIS-8164 sourced from National Root Crops Research Institute Umudike were cut into 25cm long pieces with at least three nodes per plant. The vine cuttings were planted at an angle to the ground (Parwada *et al.*, 2011) with at least two third of the vine buried under the soil for easy sprouting and establishment. Supplying was done at 2 weeks after planting (WAP).

Planting was done at a spacing of 1m by 0.3m (100cm x 30cm) inter-row and intra-row respectively which gave a plant population of 33,333 plants per hectare.

Fertilizer application

Poultry manure sourced from a deep litter system was cured and applied 2 weeks before planting. Application was done by properly incorporating the poultry manure into the soil to allow for easy decomposition and mineralization. NPK 20:10:10 and fertiplus were applied 2 weeks after planting (WAP) using side placement method. The openings were properly covered after application.

Data collection

Soil: A composite sample was collected at the 0 – 15 cm depth from random points on the field before treatments application. After harvest, soil samples were also taken from each plot based on the treatment applied. The soil samples were air dried and sieved with a 2mm sieve and was subjected to standard laboratory analysis as outlined by Udo *et al.* (2009).

Plant: Five plants were randomly tagged in each net plot from where growth parameters were taken; sprout count at 2WAP, number of leaves, vine length, vigour, girth, leaf length and, leaf width at 4, 6,8,10 and, 12 WAP respectively. Yield parameters were taken at harvest; number of marketable roots, weight of marketable roots, number of non-marketable roots, weight of non-marketable roots, weight of top biomass, total root weight.

Analysis

The data generated from the field was subjected to Analysis of Variance (ANOVA) using GENSTAT 17 version, while significant means was separated using Duncan's New Multiple Range Test at 5% probability level

3. RESULTS AND DISCUSSION

Soil properties of the experimental site:

The chemical properties of the soil used for the conduct of the experiment is presented in Table 1. The soil was slightly acidic, low in OM, N, P exchangeable bases and CEC which could be attributed to continuous cultivation which resulted in the removal and loss of basic cations from the soil (Ayeni *et al.*, 2017).

Effect of Treatment on Growth of Sweet potato

Observation on plant vine length and number of leaves (Table 2). The result showed a significant difference ($p < 0.05$) with increase in vine length and number of leaves with increased levels of fertilizer for all the fertilizer types. 300kg/ha gave the highest vine length of 44.6 cm at 4WAP, 70.40 cm at 6WAP, 106.0 cm at 8WAP, 155.50 cm at 10 WAP and 207.0 cm at 12WAP, for number of leaves 8t/ha of PM gave the highest mean value for number of leaves 22.13 at 4WAP, 29.20 at 6 WAP, 35.27 at 8 WAP and 38.80 at 12 WAP while control gave the least mean values for all the sampled weeks. Table 3 shows the effect of fertilizer on leaf length with 300 kg/ha having the highest leaf length of 9.07 cm at 4WAP, 11.27 cm at 8 WAP, and 12.67 cm at 12 WAP, 8 t/ha poultry manure had the highest leaf length value at 6 WAP (12.27 cm) and 10 WAP (12.80 cm), while the control gave least mean values. For leaf width (Table 3), the result showed significant difference for all the treatments except at 12 WAP. Poultry manure at 8 t/ha (11.47 cm) gave the highest at 6 WAP followed by NPK 300 kg/ha (10.37 cm) also at 6 WAP and the least was obtained from the control (4.13 cm) at 4 WAP. Plant girth (Table 4) Poultry manure at 8t/ha gave the highest plant girth (1.27 cm) at all the sampled weeks, the least mean value (0.54 cm) was obtained from the control at 4 WAP. The response of Sweet potato to these sources of fertilization supports the work of Owudike, 2010; Sanni *et al.*, 2012 and, Sowley *et al.*, 2015 that fertilizers Either organic or inorganic increased vine length with increased level of fertilization. Havlin *et al.*, (2005) also reported that an adequate supply of nutrients to plant release N which is associated with vegetative growth and yield.

Table 1: Initial Physical and Chemical Properties of Soil of the study area

Soil Parameters	Value
Sand (%)	80
Silt (%)	5.4
Clay (%)	14.6
Textural class	Sandy loam
pH	6.59
O.C (%)	1.08
O.M (%)	1.86
N (%)	0.13
P (mgkg^{-1})	3.60
K (cmolkg^{-1})	0.23
Ca (cmolkg^{-1})	3.00

Mg (cmolkg ⁻¹)	2.80
Na (cmolkg ⁻¹)	0.21
E.B (cmolkg ⁻¹)	6.24
E.A (cmolkg ⁻¹)	1.10
CEC (cmolkg ⁻¹)	7.34
B.S %	85.01

Table 2 Effect of fertilizer on vine length (VL) and number of leaves (NOL) of sweet potato.

Treatment	VL 4WAP		VL 6WAP		VL 8WAP		VL 10WAP		VL 12WAP	
	VL NOL	cm	VL NOL	cm	VL cm	NOL	VL cm	NOL	VL cm	NOL
CONTROL	14.53b	6.73g	28.80h	18.67d	79.67b	28.33b	109.7b	26.93b	121.3d	31.63a
NPK 100Kg/ha	20.73b	8.93efg	40.07fg	21.80bcd	86.00b	29.53b	135.5ab	30.07ab	157.5bcd	33.66a
NPK 200Kg/ha	23.47b	12.67cd	57.20bc	25.73abc	101.87ab	31.27ab	149.6a	35.53ab	199.7ab	34.60a
NPK 300Kg/ha	44.60a	18.13b	70.40a	26.93ab	106.00ab	34.60ab	155.5a	36.93ab	207.0abc	36.67a
PM 2 t/ha	20.07b	7.80fg	37.00g	23.27bcd	87.33b	30.60ab	137.5ab	34.87ab	174.1abcd	34.20a

PM 5 t/ha	23.00b	14.47c	52.40cd	26.80abc	105.87ab	31.73ab	152.4a	37.67a	213.8ab	37.73a
PM 8 t/ha	24.80b	22.13a	61.73b	29.20a	125.00a	35.27a	152.9a	38.27a	218.8a	37.80a
OMF 2 t/ha	16.87b	6.93g	31.87h	21.00cd	84.13b	28.93ab	129.5ab	34.40ab	152.9cd	33.67a
OMF 5 t/ha	18.73b	10.00ef	44.00ef	23.33bcd	88.47b	31.00ab	143.9ab	36.20ab	180.5abc	35.27a
OMF 8 t/ha	22.07b	11.33de	47.87de	23.67abcd	105.13ab	33.07ab	149.1a	36.87ab	186.3abc	37.20a

Values with the same letter within the same column are not significant using DNMRT (P<0.05) NPK=20-10-10, PM = poultry manure, OMF = fertiplus. VL= Vine length

Table 3. Effect of fertilizer on leaf length (LL) and Leaf width (LW) of sweet potato.

Treatment	4 WAP (cm)		6 WAP (cm)		8 WAP (cm)		10WAP (cm)		12 WAP (cm)	
	LL	LW	LL	LW	LL	LW	LL	LW	LL	LW
NPK 0 Kg/ha	4.67g	4.13f	8.53d	7.67f	9.60c	9.07c	9.20c	8.47c	10.67a	8.80a
NPK 100 Kg/ha	6.53de	5.20de	10.07c	9.13de	10.13bc	9.13c	10.40bc	8.87bc	11.20a	9.67a
NPK 200										

Kg/ha	7.67b	6.47bc	10.87bc	10.20bc	10.33abc	9.60bc	10.47bc	9.60abc	12.47a	10.13a
NPK 300 Kg/ha	9.07a	7.33ab	11.67ab	10.73ab	11.27a	10.07ab	11.33ab	9.67abc	12.67a	10.33a
PM 2 t/ha	6.40de	5.53cd	10.00c	9.33cde	10.13bc	9.20c	9.93bc	9.26abc	11.40a	9.87a
PM 5 t/ha	7.40bc	6.47bc	10.53bc	10.40b	10.80ab	9.80abc	10.67abc	9.80ab	12.13a	10.40a
PM 8 t/ha	8.60a	8.00a	12.27a	11.47a	10.93ab	10.40a	12.27a	10.33a	12.80a	10.53a
OMF 2 t/ha	5.47f	4.33ef	9.53cd	8.53e	9.87bc	9.20c	9.80bc	9.13abc	10.93a	9.80a
OMF 5 t/ha	6.07e	5.53cd	9.80c	9.80bcd	10.27abc	9.47bc	10.67abc	9.40abc	11.80a	9.87a
OMF 8 t/ha	6.87cd	6.13cd	10.53bc	9.93bcd	10.60abc	9.53bc	11.20ab	9.60abc	12.47a	10.20a

Values with the same letter within the same column are not significant using DNMR (P<0.05) NPK=20-10-10, PM = poultry manure, OMF = fertiplus and LL= Leaf Length.

Effect of Treatment on Yield and Yield Parameters of Sweet potato

Observation on yield and yield parameters of Sweet potato (Table 5) All the parameters measured at harvest were all influenced significantly ($p < 0.05$) by the sources of fertilizers used in the study. 5 t/ha of poultry manure gave the highest significant mean value (78.33) for number of marketable root (NMR) while control had least value of 18.33. For weight of marketable root (WMR) poultry manure applied at 5 t/ha had the highest mean weight of 21.27kg/plot (17.73t/ha) while control had a least mean weight value of 3.67 kg/plot (3.0 t/ha). The number of non-marketable root (NNMR) presented in (Table 5) shows that NPK 100 Kg/ha has the highest mean value of 94.33, followed by the Control (83.67) which is statistically similar; poultry manure 5t/ha has the least mean value of 29.67. For WNMR, NPK 100 kg/ha had the highest mean values of 1.00 t/ha; Control has 0.88 t/ha the least value of 0.33 t/ha was obtained from

OMF 8 t/ha. Weight of top biomass (Table 5) was significantly responded positively to varying rates of fertilizer types used. The highest weights were recorded in plots receiving 8 t/ha of poultry manure 47.33 kg/plot (39.40 t/ha) and the least from the control 12.80 kg/plot (10.67 t/ha).

The positive response of yield parameters of potato in this study to the three sources of fertilizers namely; organic, mineral and organo-mineral fertilizers supports the findings of Albert Nyarko (2015) who reported that 6 t/ha poultry manure gave the highest number of marketable root (NMR) of sweet potato. Havlin et al., (2005) also reported that an adequate supply of nutrients to plant influence yield increased. The work of Agbede and Adekiya (2011) also affirmed that yield of sweet potato was influenced by poultry manure and also improve the soil fertility status by activating the soil microbial biomass

Table 4. Effect of fertilizer on girth (PG) of sweet potato

Treatment	4 WAP PG (cm)	6 WAP PG (cm)	8 WAP PG (cm)	10 WAP PG (cm)	12 WAP PG (cm)
CONTROL	0.54g	0.57e	0.64a	0.91b	0.97c
NPK 100 Kg/ha	0.57efg	0.58e	0.65a	0.91b	1.03ac
200 Kg/ha	0.65c	0.69bcd	0.68a	1.04ab	1.10abc
300 Kg/ha	0.69b	0.75ab	0.73a	1.05ab	1.13abc
PM 2 t/ha	0.59ef	0.60e	0.65a	0.99ab	1.03ac
PM 5 t/ha	0.64cd	0.72abc	0.77a	1.07ab	1.26ab
PM 8 t/ha	0.74a	0.77a	0.82a	1.17a	1.27a

OMF 2 t/ha	0.55fg	0.57e	0.64a	0.95b	1.03
OMF 5 t/ha	0.60de	0.63de	0.67a	1.04ab	1.13abc
OMF 8 t/ha	0.61de	0.65cde	0.70a	1.04ab	1.20abc

Values with the same letter within the same column are not significant using DNMRT (P<0.05)

NPK=20-10-10, PM = poultry manure, OMF = fertiplus and PG= Plant girth.

Table 5. Effect of fertilizer on yield of sweet potato

Treatment	NMR	NNMR	WMR (t/ha)	WNMR (t/ha)	WTB (t/ha)
CONTROL	18.33h	83.67ab	3.67g	1.06b	12.80h
NPK 100 Kg/ha	38.67fg	94.33a	5.83fg	1.20a	19.70g
200 Kg/ha	48.00de	59.00d	11.13cd	0.53cde	22.23fg
300 Kg/ha	66.33b	51.33d	12.33c	0.46de	31.60cd
PM 2 t/ha	43.33ef	64.33cd	9.47de	0.73bc	27.43de
PM 5 t/ha	78.33a	29.67e	21.27a	0.33ef	41.93b
PM 8 t/ha	63.33b	52.67d	19.67a	0.20f	47.33a
OMF 2 t/ha	34.00g	57.33d	6.93ef	0.80b	21.10fg
OMF 5 t/ha	53.00cd	75.00bc	13.87bc	0.66bcd	24.80ef

OMF 8 t/ha	59.00bc	38.33e	16.13b	0.40ef	33.77c
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Values with the same letter within the same column are not significant using DNMR (P<0.05) NPK=20-10-10, PM = poultry manure, OMF = fertiplus, NMR= number of marketable roots, NNMR= number of non-marketable roots, WMR = weight of marketable roots, WNMR = weight of non-marketable roots, WTB = weight of top biomass

4. CONCLUSION

The results of this study showed that the application of three sources of fertilizers namely; organic, mineral and organo-mineral fertilizers (OMF) are generally beneficial to the performance of sweet potato. The application of 5 t/ha poultry manure gave the highest yield of 17.73 t/ha, this may be appropriate to be used at this study area.

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