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Effect of Poultry Manure Rate and NPK 15:15:15 on the Perfomance and Nutritional Content of Sweet Potato (*Ipomoea batatas* l.)

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Abstract

A field experiment was carried out to determine the effect of different rate of poultry manure and NPK 15:15:15 on vine length, number of leaves, plant height, number and weight of harvested tubers with the Proximate contents of sweet potato. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments replicated three times. The treatments were 0 kg/ha of poultry manure (PM) (no treatment), 15 kg N/ha PM, 30 kg N/ ha PM, 45 kg N/ha PM and NPK 15:15:15. Poultry manure rates were applied to the soil two weeks before planting while NPK 15:15:15 was applied two weeks after planting. The result showed that, application of Poultry manure at 45 and 30 kg N /ha had a positive response significantly on vine length than other treatments. Nitrogen sources also favoured production of leaves and number of tubers but 45 kg N/ha of PM produced tubers with more weight comparable to 30kg N/ha than other rates and sources. Treatment with NPK 15:15:15 gave high value of ash content, crude protein, crude fat and crude fibre which also increases with increase in the rate of Poultry manure application. However, increase in Nitrogen rate or source decreased carbohydrate and moisture content of the crop. Application of poultry manure at the rate of 30 kg N /ha is therefore recommended for best growth, yield and dry matter content of sweet potato since it also increased its quality in terms of crude protein. NPK 15:15:15 can be used to obtain good quality in sweet potato in the absence of poultry manure.

Key words: *poultry manure, tubers, proximate, quality, sweet potato*

Introduction

Sweet potato (Ipomea batata) is one of the major food crops in the world, and it rank second to yam in Nigeria as a major important tuber crop, contributing to the people food requirement. Karam *et al.* (2009). The crop is particularly important crop for subsistence farmers in Africa and other developing countries. Sweet potato is a very important food security crop due to its
relatively short growing period, tolerance to drought and high yield from poor soils. It is used as a famine reserve for many of these households (Ofor, 2011).

Sweet potatoes possess many positive health benefits including sources of anthocyanins, phenolic compounds and other bioactive compounds (Alum *et al.*, 2013). The vegetable crop also possesses antioxidant activities. Sweet Potatoes is highly rich in nutrient elements. A 100g edible portion of sweet potatoes yield 360kj energy, 20.1g carbohydrate, 3.0g dietary fibre, 0.1g fat, 1.6g protein, 30.0mg calcium, 0.6mg iron, 25.0mg magnesium, potassium 337mg, thiamine 0.1mg, riboflavin 0.1mg, phosphorus 47.0mg, sodium 55mg, zinc 0.3mg, folate 11Ng, pantothenic Acid 0.8mg, Niacin (B3) 0.61mg, 79.8% Water, about 2.4mg vitamin C is reported in sweet potato and 0.25mg Vitamin B6. In spite of these, the nutrient compositions as documented by several authors have been revealed to vary from cultivar to cultivar. Eleazu and Ironua (2014) after evaluation of the composition of an unnamed sweet potato cultivar reported that, "the flour was observed to have good functional properties with a pH of 5.32±0.01, high percentage moisture content, indicative of poor shelf life characteristics and high chances of being attacked by microbes, low percentage dry matter, lipid, crude fibre and ash contents but a promising source of starch (20.78±0.02%), carotene (5.0±0.04 µg/g), protein (2.67±0.59%), carbohydrate (40.77±3.05%), energy (179.61±20.97 kcal/100 g), polyphenols, in addition to containing significant quantities of reducing sugar (1.58±0.53%)". In a study by Gebreegziabher et al. (2014) titled "Chemical Composition and In Vitro Dry Matter Digestibility of Vines and Roots of Four Sweet potato (Ipomoea batatas) Varieties Grown in Southern Ethiopia", root and vine proximate compositions were shown to vary with sweet potato cultivars.

The tuber also contains significant amount of vitamins A, B1, B2 and C and minerals such as K, Na, P and Ca. The young leaves are also rich in protein, minerals and vitamins (Onwueme and Sinha., 2011). The crop is efficient in the production of carbohydrates, proteins, vitamins and cash income per unit area of land and time (Magagula *et al*., 2010). The yellow-and orange-fleshed varieties of sweet potatoes are high in beta-carotene, which can be

converted into vitamin A in the intestines and liver. It has been shown that even small amounts of these sweet potatoes as a regular part of the diet will eliminate vitamin A deficiency in adults and children.
Poultry manure contains all 13 of the essential plant nutrients that are used by plants. Using poultry manure as a fertilizer for crops or trees may provide a portion, or all, of the plant requirements. The amount of nutrients provided depends on the nutrient content of the manure (lb of nutrient / ton of manure) and the amount of manure applied (ton of manure / acre) (Zublena *et al*., 2006). Because of the high nutritional and economic value, it is necessary to improve yield and its related traits that can be achieve through balance availability of all the nutrients in the crop. This work is therefore targeted to examine the effect of different rate of poultry manure application on the yield and nutritional composition of sweet potato.

Materials and Method

The experiment was conducted behind the Horticultural Unit Experimental Site of the Federal College of Agriculture, Moor Plantation, Ibadan, Nigeria. The experimental plot size of 19 m x 11 m (209 m^2) was laid out in a Randomized Complete Block Design (RCBD) with five treatments replicated three times. The size of each replicate was 19 m x 3 m. each replicate was divided into five plots measuring 3 m x 3 m. The replicates were separated by 1 m alley in between while the plots were separated by 0.5 m. The treatments were 0 kg/ha (no treatment), 15 kg N/ha poultry manure, 30 kg N/ ha poultry manure, 45 kg N/ha poultry manure and NPK 15:15:15

Cultural practices

Potato vine cuttings were obtained from a commercial farm in Ibadan. The variety used was Kenspot 4 (orange flesh with cream colour).
The land was cleared mechanically with the use of tractor, stumping was done manually using hoe and Cutlass, packed of debris and tilled. Heaps were made at a spacing of 1 m 1 m then the cuttings were planted at a space of 1 m by 1 m. The treatment poultry manure at specified rates were applied before planting (2 weeks before planting and was heavily watered for quick mineralization). NPK 15:15:15 was applied two weeks after planting. Weeding was done manually by hoeing before the establishment of the crop.

Data Collection

Data collection commenced 4 weeks after planting (WAP) and continued until eight weeks. Four plants were tagged on each plot for data collection. Growth and yield parameters measured were; Vine length, Number of leaves, Number of tubers per plot and weight of tubers per plot.
Vine length of each sample plant was measured using a calibrated ruler. The number of fully expanded leaves of each tagged plant physically counted. Then tuber of sweet potato harvested on each plot was weighted using the weighting scale in kilogram.
Harvesting was carefully done twelve (12) weeks after planting, by careful uprooting of the tubers with cutlass and hand. After harvesting, yield parameters were taken by weighing the harvested tubers and taken the samples to the laboratory for proximate analysis after air drying the sliced samples.

Soil and Poultry Manure Analysis

Core soil sample were collected prior to the commencement of the experiment at random from the site at a depth of 0.15 cm using soil auger soil samples collected were sir dried and sieved through 2mm sieve for both physical and chemical analysis.
The poultry manure used for the experiment was air dried and taken to the laboratory for analysis before incorporated into the soil.

Data Analysis

Data collected was subjected to Analysis of Variance (ANOVA) to test for significance of treatment on the crop and the significant means were separated using Least Significant Difference (LSD) $p<0.05$.

Result and Discussion

Pre-cropping physical and chemical properties of the soil

The result of the physical and chemical properties of the soil used for the experiment is presented in Table 1. It showed that the soil was slightly acidic with a pH of 6.8. total nitrogen was at no rmal range (1.05 $mgkg^{-1}$) which falls within the normal standard value of 1-1.5, available phosphorus 12 $mgkg^{-1}$ compared to the standard value of 7-20 was high and organic carbon 1.42 $mgkg^{-1}$ compared to the standard value of 1.0 -1.4 was slightly high (FFD, 2021), Exchangeable base: potassium, calcium, magnesium and sodium were 0.30, 1.53, 0.41 and 0.31(cmol/kg) respectively. The textural class of the soil was sandy soil with sand (914 g/kg), silt (56 g/kg) and clay (30 g/kg)

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The Chemical properties of the Poultry Manure used for the Experiment

The result of the analysis of the Poultry manure used for the experiment is shown in table 1 and it revealed that the Nitrogen content is 18 %, Phosphorus is 24 % and Potassium is 0.90 %

Effect of different rates of poultry manure and NPK 15:15:15 on vine length and number of leaves of sweet potato

The result of effect of different rates of poultry manure and NPK 15:15:15 on vine length of sweet potato was presented in Table 2. At 4WAP, crops treated with 30kg N/ha poultry manure Produced vine length 25.00cm which was significantly longer than vine length of other treatments but not significantly different from those of 45 kg N/ha poultry manure (23.50cm). At 6 WAP, vine length of 30kg N/ha poultry manure was significantly longer (33.75cm) that control (20.50cm), 15kg N/ha poultry manure (20.67cm) and NPK 15:15:15 (22.42cm) but not significantly different from that of 45 kg N/ha poultry manure (30.42cm) in length. At 8 WAP vine length produced by application of 45 kg N/ha poultry manure (48.58cm) was at par with those of 30kg N/ha poultry manure (45.33cm) but statistically different from those of control (31.42cm), 15kg N/ha poultry manure (30.33cm) and NPK 15:15:15 (33.08cm).

Table 1. Pre-planning soil and Poultry manure chemical properties and particle size distribution

Parameters	Units	Values
Ph		6.8
Organic carbon	gkg^{-1}	1.42
Total Nitrogen	gkg^{-1}	1.05
Available Phosphorus	$mgkg^{-1}$	12
Exchangeable bases	cmol/kg	
Ca^{2+}		1.53
Mg^{2+}		0.41
K^{+}		0.30
Na^{+}		0.31
Exchangeable acidity	cmol/kg	3.91
Particle Size Distribution	g/kg	
Sand		914
Silt		56
Clay		30
Textural class		Sandy soil
Chemical properties of Poultry manure		
Parameters	Values (%)	
Total nitrogen	18	
Total Phosphorus	24	
Total Potassium	0.90	

Source: Authors

Table 2. Effect of poultry manure rates and NPK 15:15:15 on vine length (cm) and number of leaves of sweet potato

Treatment :Vine length (cm)	4 WAP	6 WAP	8 WAP
0 kg/ha (control)	16.01bc	20.50c	31.42b
15kg N/ha poultry manure	16.95bc	20.67c	30.33b
30kg N/ha poultry manure	25.00a	33.75a	45.33a
45kg N/ha poultry manure	23.50ab	30.42ab	48.58a
NPK 15:15:15	15.83c	22.42bc	33.08b
LSD (P=0.05)	7.53	8.48	7.71
Number of leaves			
0 kg/ha (control)	9.58b	11.33c	19.33c
15kg/ha poultry manure	11.33a	13.00bc	23.83bc
30kg/ha poultry manure	11.50a	19.17a	28.17ab
45kg/ha poultry manure	11.83a	15.33b	31.50a
NPK 15:15:15	10.17ab	12.00c	23.50bc
LSD P0.05	1.68	3.23	5.03

Significant means were separated by LSD P<0.05

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Effects of different rates of poultry manure and NPK 15:15:15 on number of leaves of sweet potato

The result of effects of different rates of poultry manure and NPK 15:15:15 on number of leaves of sweet potato is presented in Table 2. At 4WAP 45 kg N/ha poultry manure produced more leaves (11.83) which were not significantly different from those of other treatments except control. (9.58).

At 6 WAP more leaves were produced from crops treated with 30kg N/ha poultry manure (19.17) than all the other treatments. At 8 WAP 45kg N/ha poultry manure produced leaves (31.50) significantly more in number than other treatments but at par with those that received 30kg N/ha poultry manure (28.17).

Effects of different rates of poultry manure and NPK 15:15:15 on number of tubers and tuber weight of Sweet potato

The result of effects of different rates of poultry manure and NPK 15:15:15 on number of tubers and tuber weight of sweet potato was presented in Table 3. The result revealed that, sweet potato that received poultry manure of 30 kg N/ha produced more tubers (11.33) which are comparable to those of 45 kg N/ ha (10.67), 15 kg N/ha and NPK 15:15:15 but significantly more in number than control. However, potatoes tubers of 15 kg N/ha and NPK 15:15:15 are not statistically different from each other in number (9.67 and 9.67 respectively) but are significantly higher than that of control (6.00) which is the lowest.

The result of tuber weight also showed that 45 kg N /ha of poultry manure produced tubers which are higher in weight (410.00) significantly than others except those that received 30 kg N/ha. Also, potato that was treated with 15kg N/ha poultry manure produced tubers which were statistically similar in weight (281.33) with those that received NPK 15:15:15 (271.00). but were significantly lower than control (95.77).

Effects of poultry manure rate and NPK 15:15:15 on the Nutritional content of sweet potato

The result of effect of poultry manure rate and NPK 15:15:15 on the nutritional composition of sweet potato is presented in Table 4. It was observed that sweet potato treated with NPK 15:15:15 gave significantly high value of ash content (2.30%), crude protein (8.60), crude fibre (7.21) and crude fat (3.15) than other treatments while control gave the least value significantly in all.

Furthermore the highest moisture content (25.00%) and carbohydrate content (69.93) was observed in sweet potato treated with zero application of poultry manure which was decreasing as poultry manure rate was increasing while the least moisture content and carbohydrate was observed in sweet potato treated with NPK 15:15:15.

The result also shows that, NPK 15:15:15 gave high value of protein content significantly than Other treatments however, the quantity of protein increasing as poultry manure rate was increasing. Sweet potato treated with 30kg/ha poultry manure had the highest value off dry matter (79.00%) and was significantly higher than the other treatments.

Table 3. Effect of different rates of poultry manure on number of tubers and tuber weight of sweet potato

Treatment	No of Tubers	Tuber weight (kg/ha)
0 kg/ha (control)	6.66b	95.77c
15kg/ha poultry manure	9.67ab	281.33b
30kg/ha poultry manure	11.33a	408.33a
45kg/ha poultry manure	10.67a	410.00a
NPK 15:15:15	9.67ab	271.00b
LSD(P=0.05)	3.67	71.11

Significant means were separated by LSD P<0.05

Table 4. Proximate analysis of sweet potato

Treatment	Ash	Crude protein	Moisture content	Crude Fibre	DM	Crude fat	Carbohydrate
0 kg/ha (control)	1.03e	1.90e	25.00a	2.09e	68.93c	1.05c	69.93a
15kg/ha poultry manure	2.15c	3.50d	24.00b	4.15d	76.00d	2.60c	64.60b
30kg/ha poultry manure	2.10d	4.95c	23.00c	5.05c	79.00a	2.45d	64.59b
45kg/ha poultry manure	2.25b	7.70b	23.00c	6.10b	77.00c	2.80b	58.15c
NPK 15:15:15	2.30a	8.60a	22.00d	7.20a	78.00b	3.15a	56.75d
LSD(P=0.05	0.34	0	0	0	0.27	0.48	0

Significant means were separated by LSD P<0.05

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Discussions

The increase in vine length and number of sweet potato leaves with in this experiment with application of high rate of PM is an indication that, Nitrogen is needed for vegetative growth of crops since according to Brady and Weil (2008), poultry manure mineralizes fast hence it releases its nutrients for plant uptake and utilization rapidly and this also buttresses the work of Zelalem *et al*., (2009) who opined that Nitrogen in poultry manure is essential for increasing vine length plant height, leaf area index, shoot dry matter and tuber yield. Izunobi had also opined that poultry manure provides large number of absorbable nutrient for crop growth.

Number of tubers responds positively to application of nitrogen from all the sources and rate. The result probably explains the fact that nitrogen is one of the essential nutrients that can affect the growth and the yield of potato. It is also an indication that potato is highly responsive to N-fertilization and that N is usually the most limiting essential nutrient for potatoes growth and development according to Mohammed *et aL* (1998).This result corroborates the work of Izunobi (2002) who reported that poultry manure, especially those provided from deep litter or battery cage house are the richest known farm yard manure supplying greater amounts of absorbable plant nutrient for optimum tuber growth and yield.

The result obtained regarding tuber weight which was observed to increase with increase in PM application and low with application of NPK 15:15:15 could be because, potato responds positively to nitrate content in PM for large tuber production. Other researchers like Maier *et al.* (2002) and Ahmad *et al.* (2009) have also observed increase in yield of potato when N was supplied in Nitrate form. Nitrogen has also been reported to improve the yield of potato hence the result obtained in this study. Ahmad *et al.* (2009) also observed increase in tuber weight of potato when PM rates were increased

NPK 15:15:15 gave high value of crude protein significantly compare to other treatments this is because, Sweet potato although needs nitrogen but application of excess nitrogen affects the quality of the tubers. This also corroborates the work of Ahmad Ahmed *et al.* (2009) who also observed decline in some quality parameters of potato with increase in nitrogen rate. However, the fact that the nitrogen content in Sweet potato was increasing with increase in PM rate also signify the importance of Nitrogen in nitrate form to the crop. Lin *et al*. (2005) also observed increase in nitrogen content of potato var.'Atica' with increase in rate of PM.

The moisture content of any food is an indication of its water activity in the food and it is used to determine how stable and how susceptible the food is to microbial contamination (Howarth *et al*. 2001). The high moisture content recorded at zero application of Poultry manure implies that with increase in PM, concentration of other nutrients in the crop will decrease when dehydration occurs. This result corroborates the work of Idowu *et at*. (2023) who reported increase in the moisture content of eggplant, with increase application of PM.

Fat is known to help the body to achieve satisfaction after eating and helps the body to absorb vitamin A, D and E (Agbenafle and Bart- Plange, (2015) and Vishruta (2014). It was observed however that, increase in application of PM was decreasing the crude fat in the crop. This could be because, sweet potato being a carbohydrate food, the normal N in NPK 15:15:15 is enough for the crop. Idowu *et al* (2023) also observed that increase in PM leads to decrease in the crude fat in egg plant. Idowu *et al*. (2023) also observed that control experiment gave the highest value for carbohydrate when different rate of PM was applied to the soil for planting eggplant.

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