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Evaluation of the Agronomic Characters of Sweet Potato Varieties Grown at Varying Levels of Organic and Inorganic Fertilizer

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Abstract: Sweet potato (*Solanum tuberosum*), a staple tuber crop in parts of the Sudan and Guinea savanna zone of Nigeria is known for its resistance to drought, vigorous early growth and low input requirements. Increase in population which has resulted to land shortages has led to reduction in traditional methods of maintaining soil fertility. Technologies based on combinations of organic and inorganic sources of fertilizer would produce higher and more sustainable yields than either organic or inorganic fertilizer alone or farmers' indigenous management practices. Field trials to evaluate the agronomic characters of two sweet potato varieties were conducted during the wet seasons of 2004 and 2005 at the Institute for Agricultural Research (IAR) farm Samaru Zaria. The treatments consisted of three rates each of organic and inorganic fertilizer and two varieties of sweet potato. Organic and inorganic fertilizer application did not have significant effects on vine length, number of leaves, number of branches and total dry matter. *Dan Zaria* however produced significantly more number of branches than *Dan Bakalori*, which is attributed to differences in genetic composition of the sweet potato varieties. Application of organic fertilizer increased the yield of sweet potato in both years. Yield obtained from the variety *Dan Bakalori* was significantly heavier than that obtained from *Dan Zaria*. Application of 4t/ha organic fertilizer resulted in the highest yield of sweet potato which was not significant. The result however suggests that further increase in organic fertilizer might lead to increases in yield. This requires further long term studies.

Key words: Agronomic characters · Organic fertilizer · Inorganic fertilizer · yield

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is believed to have its center of origin in tropical America. The sweet potato was brought to Europe by Columbus and subsequently introduced to Africa and Asia by Portuguese and Spanish traders. The status of the sweet potato in most parts of the tropics is that of a minor secondary crop. However, cultivation is increasing as it gives high yields and requires minimum attention during cultivation. According to FAO [1] statistics world production is 127,000,000 tons. The majority comes from China with a production of 105,000,000 tons from 49,000km^2 [1]. Other Asian producing countries include: Indonesia, Japan, Korea and Taiwan. Brazil is the most important commercial grower, but sweet potatoes are mainly consumed domestically and do not enter international trade either in the fresh state or in a processed form.

In Africa, sweet potato is an important part of the staple diet of the populations in tropical regions where it is grown up to an elevation of 2,000m. Nutritionally, sweet potatoes usually have a rather higher protein content than other tubers such as cassava and yams. Protein content varies from 1 to 2.5 percent. Carotenes, precursors of vitamin A production are often present in yellow varieties. Sweet potatoes are usually consumed without special processing. The fresh tuber is boiled, baked, roasted or fried as chips, which may be sold as snacks or may be salted and eaten like potato crisps. Sweet potato flour and starch may also be prepared. The leaves of sweet potato rich in carotenes, pro-vitamin A and calcium are also a valuable addition to the diet. Sweet potato varieties with dark orange flesh and richer in vitamin A than light fleshed varieties and their increased cultivation is being encouraged in Africa where vitamin A deficiency is a serious health problem.

Sweet potatoes are often considered a small farmer's crop. However, in African countries such as Burundi, Rwanda and Uganda, sweet potato is a staple food. According to FAO [2], Per-capita production in Burundi was 130kg.

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In Africa, sweet potato is grown in abundance around upland lakes in the East African Rift valley (Uganda, Rwanda, Burundi, Tanzania, Kenya). It is also found in most African regions with large variations in relief (Cameroon, Guinea, Madagascar) or where the dry season is too marked for cassava growing like in the Sudan-Sahelian fringe or in North Africa. In Nigeria, sweet potato is grown in Sokoto, Zamfara, Kebbi, Kaduna, Kano, Katsina, Gombe, Bauchi and parts of Plateau and Nassarawa states.

Because it readily produces adventitious roots and has trailing vines, sweet potato can colonize marginal soils. Consequently, it is not very demanding as regards soil type. However, the application of 300kg NPK/ha and 50kg N/ha is considered beneficial in the savanna zones of Nigeria. This is to ensure high yields under extensive and commercial production. Due to intensification of agricultural production, the application of inorganic fertilizers could have negative effects on soils. Lal and Kang [3] found that the continuous application of inorganic fertilizer in the absence of crop residues had negative effects on soil, greatly increasing soil acidity. The addition of organic matter in combination with fertilizer can create a beneficial interaction.

In various experiments, the use of inorganic nitrogen fertilizer together with pruning from hedgerows has increased maize yield to a larger degree than either measure alone [4]. Inputs of organic material can enhance the nutrient balance by serving as a nutrient reservoir in the soil supplying nitrogen, phosphorus and other elements. Also, studies conducted by IITA [5] involving various types of farming practices have shown that the activity of micro-organisms such as earthworms is much greater under systems that return organic matter to the soil than those that leave the soil bare.

This study was therefore carried out to determine the most suitable combination of inorganic fertilizer and organic matter to adopt for profitable cultivation of sweet potato.

MATERIALS AND METHODS

Experimental Site: The experiment was conducted during the rainy season 2005 at the Institute for Agricultural Research Farm, Ahmadu Bello University, Samaru, Zaria, Nigeria (Lat 11°'N and 07°38'E and 686m in altitude).

Land Preparation: The land was cleared, harrowed and made into 0.75m row ridges.

Planting Materials: Two sweet potato varieties were used. The sweet potato vines were obtained locally from farmer in Milgoma town. The two varieties used were selected because they are most common types cultivated in the locality "Dan Bakalori" or "Karas" is yellow-orange skinned with orange flesh while "Dan Zaria" is reddish-purple skinned with white flesh. Planting was done on 13th July 2005.

Plot Size: Individual plots consisted of four rows of 3m long and 0.7m apart. This constituted the gross plot while net plot consisted of the two inner rows, 3m long and 0.75cm apart. Within row spacing was approximately 30cm. Plots were kept weed free by regular manual weeding.

Data Collection: Growth data such as vine length, number of branches and number of leaves and total dry matter were recorded at harvest, while tuber fresh weight also recorded after harvest. Yellowing and falling of leaves and also cracking of the soil indicated maturity of the sweet potato.

Fertilizer Application: Inorganic fertilizer and organic fertilizer were applied at 2 and 4 weeks after sowing (WAS),respectively. The source of fertilizer was NPK 15:15:15, while the source of inorganic fertilizer used was poultry manure.

Treatments and Experimental Design: Treatments consisted of two varieties of sweet potato, three rates of inorganic fertilizer and three rates of organic fertilizer. All possible combinations of the treatments were made and assigned in plots. The experimental design was randomized complete block design with three replications. The plots were regularly observed to record data relating to the experiment.

Soil Analysis: Soil samples were collected from the site for analysis to determine soil physical and chemical properties. Physical and chemical properties of the soil from the experimental site and the inorganic fertilizer source was also subjected to analysis and the properties are presented in Table 1.

Statistical Analysis: The data collected was subjected to analysis of variance (ANOVA), using the `F' test as described by Snedecor and Cochran [6]. Where such treatments were found to be significantly different, the means were compared using Duncan Multiple Range Test (DMRT) [7].

Table 1: Physical and Chemical Properties of the soil at the site and chemical composition of poultry manure at Samaru

Soil Physical Properties				
Particle size distribution (%)				
Clay	18.7			
Silt	44.7			
Sand	36.6			
Textural class	Loam			
Chemical properties of the soil				
pH in water 1:2.5	4.8			
pH in $cacl_2$	4.4			
Organic carbon	0.42			
Available P (PPM)	8.06			
Total N (%)	0.073			
Exchangeable bases (meg/100g soil)				
Ca	0.58			
Mg	0.32			
K	0.23			
Na	0.22			
CEC.	6.2			
Exchangeable acidity (meg/100g soil)				
H+ Al	0.14			
Poultry manure				
% Chemical composition		N	P	K
		2.63	1.37	0.437

RESULTS

Table 2 shows the effect of inorganic and organic fertilizers on the growth parameters of sweet potato. Application of inorganic fertilizer rates did not lead to significant differences in vine length, number of leaves, number of branches and total dry matter of sweet potato. Similarly the application of different rates of organic fertilizer did not have significant effect on vine length, number of leaves, number of branches and total dry matter. *Dan Zaria* produced significantly higher number of branches than *Dan Bakalori*. There were no significant varietal differences in vine length, number of leaves per plant and total dry matter.

Table 3 shows the effect of inorganic and organic fertilizers on the yield and yield component of two sweet potato varieties. Yield of sweet potato was not significantly affected by the application of inorganic and organic fertilizer rates. However, the two sweet potato varieties used exhibited significant response to fertilizer rates where it was observed that '*Dan Bakalori'* yielded significantly higher than '*Dan Zaria*'. The varieties of sweet potato used exhibited significant response with regards to the number of tubers per hill. *Dan Bakalori* produced significantly higher number of tubers per hill than *Dan Zaria*. Application of inorganic and organic fertilizer did not lead to significant differences in number of tuber per hill. The tuber fresh weight was not significantly affected by application of organic and inorganic fertilizer rates. There was also no significant difference between the two varieties with regards to tuber fresh weight and tuber dry yield/4.5m^2

Table 2: Vine length, number of leaves, number of branches and total dry matter as affected by rates of inorganic and organic fertilizers in 2005 rainy season, Samaru

Treatments	Vine length	Number of leaves	Number of branches	Total dry matter
Inorganic Fert. (Kg/ha)				
150	104.16	71.44	5.11	98.84
300	100.44	71.61	5.11	96.10
450	111.66	81.88	5.94	99.31
SE	6.099	3.747	0.440	9.864
Organic Fertilizer (O t/ha)				
2	104.11	72.55	5.16	88.33
4	102.05	73.72	5.16	104.19
6	110.11	78.66	5.83	101.72
SE	6.099	3.747	0.440	9.864
Variety				
Dan Bakalori	99.55	72.11	4.81b	104.14
Dan Zaria	111.29	77.85	5.96a	92.02
SE	4.980	3.059	0.360	8.054

Means followed by the same letter(s) within the same row or columns are statistically similar at 5% level of significance

Table 3: Tuber yield/4.5m^2 and tuber fresh weight (Kg) of two sweet potato varieties as affected by rates of inorganic and organic fertilizer in 2005 rainy season, Samaru

Treatments	Tuber yield/4.5m^2	Tuber fresh weight (kg)
Inorganic Fertilizer (I kg/ha)		
150	6.233	0.711
300	5.978	0.772
450	6.050	0.811
SE	0.3508	0.1034
Organic Fertilizer(O t/ha)		
2	5.878	0.661
4	6.033	0.783
6	6.350	0.850
SE	0.3508	0.1034
Variety		
Dan Bakalori	6.715a	0.767
Dan Zaria	5.459b	0.763
SE	0.2864	0.0844

Means followed by the same letter(s) within the same row or column are statistically similar at 5% level of significance

DISCUSSION

Due to land shortage imposed by high population pressures, permanent cultivation will become more and more the rule in the near rather than far future. Thus, measures that will promote soil fertility; productivity and sustainability need to be adopted.

The lack of significant response exhibited by the sweet potato varieties can be attributed to; the innate quality of the crop itself; sweet potato can colonize marginal soils, because it readily produces adventitious roots and trailing vines [8]. Who observed that the crop also shows good tolerance to aluminum-rich phosphorus-poor acid soils; this means that the crop was able to utilize the nutrients in the soil for its growth and development. The late application of organic fertilizer could also be a factor for the lack of response of the sweet potato.

CONCLUSION

The differences due to inorganic and organic fertilizers were not statistically significant, however it was observed that the application of the lowest fertilizer rate of 150kgNPK/ha led to production of higher tuber yield than the other rates.

Vine length, number of leaves and branches and total dry matter were highest when supplied with 450kg/ha NPK fertilizer. Number of leaves and number of branches were highest when 6t/ha of organic fertilizer was applied; contrastingly application of 2t/ha led to longer vines than other rates while 4t/ha led to higher dry matter accumulation than other rates.

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