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Productivity of Sweet Potato (*Ipomoea Batatas (L) Lam*) As Influenced By Variety and Plant Density in Owerri Imo-State of Nigeria

Emma-Okafor L.C[1*], Nnebue O.M.[1], Okezie C.[1], Ibeabuchi C.B.[1], Umelo C .O.[2], Umar I.F.[1], Uba CP.[1], Nnadi K.J.[1], Orji A .C.[1] and Kanu C.B.[1]

[1]*Federal University of Technology Owerri. School of Agriculture and Agricultural Technology, Department of Crop Science and Technology. PMB 1526 Imo State, Nigeria.*

[2]*University of Agriculture and Environmental Science Umuagwo Imo State, NigeriaS.*

***Corresponding author**

EMMA – OKAFOR, L. C,

Federal University of Technology Owerri. Scool of Agriculture and Agricutural Technology, Department of Crop Science and Technology. PMB 1526 Imo State, Nigeria.

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Abstract

Urgent need to obtain sustainable yield as a result of population growth and consequent demand for more food have encouraged the search for innovative methods of crop production .The field study was conducted at the Teaching and Research Farm of Federal University of Technology Owerri, Imo State in 2020 ,2021 and 2022 cropping seasons to determine the effects of variety and density on the productivity of sweet potato. The treatments included three varieties of sweet potato (Tis 87/0007, Umuspo I, Umuspo 3) and four plant densities (66, 666,40, 000, 33, 333 and 20,000) plants ha^{-1}). The experiment was laid out in a 3x4 factorial in Randomized complete block design (RCBD). Data on growth and yield of sweet potato were measured and subjected to analysis of variance. Means were separated using the least significant difference at 5% level of probability. Umuspo1 at densities of 40,000 and 66, 666 plants ha^{-1} gave the highest root yield of 27.67 and 25.11 t ha^{-1} followed by Tis 87/0087 (18.67 and 18.11) t ha^{-1} at the densities of 20,000 and 40,000) plants ha^{-1} respectively. However,TIS 87/0087 at plant density of 20,000 ha^{-1} gave the highest shoot yield of 2.967kg/plant followed by Umuspo I (1.667kg/ha/plant. In other parameter measured, Umuspo 1 at densities of 40,000 and 66, 666 plants out yielded other treatments. Based on the current findings Umuspo 1 at 40,000. Plant density and TIS 87/0087 are recommended for root and shoot production in Owerri Imo State, Nigeria.

Keywords: *Ipomoea batatas*, Productivity Variety and Plant Densities.

Introduction

Population growth and consequent demand for more food have encouraged the search for innovative methods of production that can obtain higher sustainable yield. Sweet potato (*ipomea batatas (L)*) a perennial root crop is the only representative of the convolucaea family that is generally used as food for man. It has a long history to starve off famine especially as a cheap source of calories [1] with its high yield and short maturation period, the crop out ranks all major world food crops in protein production per unit time [4], [3]. The importance of sweet potato in the tropics and subtropical countries has increased in the recent years because of its high solar energy fixing efficiency, primarily because of its capacity, to produce dry matter for a long time [6]. The production of sweet potato has been on the increase in regions where cassava crops is failing due to various pest and diseases. Nutritionally, sweet potato is high in carbohydrates and vitamin A and can produce more edible energy per hectare /day than wheat rice and cassava; especially the orange fleshed varieties which care high in carotene and rich in pro vitamin A that prevents diseases caused by deficiency of vitamin A in children. The strategy of increasing orange flesh sweet potato consumption helps to alleviate vitamin A deficiency [2].

Sweet potato is used in various forms ranging from consumption of roots and leaves to processing into animal feeds , starch, flour, candy and alcohol. The carbohydrate rich root is used as a subsidiary food after boiling and baking. In some countries, the vine tip are used as vegetables. Industrial products like starch, liquid, glucose, citric acid, mono sodium glutamate and ethanol are produced from sweet potato roots in various countries. The growth and yield of sweet potato have shown to be influenced by cultivar, propagation materials, environment and plant spacing or density [11], [13].Various research reports show increased crop yields because of reduced weed competition that resulted from increased plant density. [15] Reported some varieties to better compete and suppress weeds due to their canopy structure. There is paucity of research information on the response of sweet potato varieties to plant spacing hence the objective of this study is to assess the effect of variety and plant density on the productivity of sweet potato in Owerri, Southeastern Nigeria

Materials and Method

The experiment was conducted in school of Agriculture and Agricultural technology Teaching and Research Farm Federal University of Technology, Owerri, Imo State in 2018 and repeated in 2019 and 2020. The study area is located at 5027'N, longitude 7002'E, and latitude 55.6m above sea level in the tropical rain forest zone of southeastern Nigeria. The mean annual temperature (30-320c), annual rainfall (2500mm) spans from March to October and exhibits bimodal pattern and relative humidity of 87.93%. The soil is an ultisol characterized by low mineral reserve and natural fertility [14].

An area 0.019ha was cleared, packed and marked into 3 blocks each with twelve plots (1.5 x 2m each). The experiment was a 3 x 4 factorial in randomized complete block design. The treatments included three varieties of sweet potato (Tis 87/0083 Umuspo 1, Umuspo 3) and four plant densities (66,666, 40,000, 33,333 and 20,000) plant/ha. The planting materials were obtained from National Root Crops Research institute Umudike Abia State. The planting was done in May 2018,2019 and 2020 with vine or stem cuttings (20-40cm) as specified in the treatment. A blanket application of poultry manure at 10 t ha-1 was applied during bed preparation.

Growth and yield data were collected from the tagged sample plants from each treatments. The number of leaves and branches were physically counted, the vine length was taken with measuring tape. The length and width or leaves multiplied by a factor 0.75 gives the leaf area. Fresh and dry weed biomass were determined using 1.0m x 1.0m quadrate. The weed were harvested, weighted, and dried and weighted to obtain the fresh and dry weed measurement respectively. The fresh root weight and shoot weight were obtained at harvest by weight the roots and shoot respectively. All data collected were analyzed statistically using [5] software and means were separated using Fishers Least Significant Difference at 5% level of probability [12].

Results

Effects of variety and density on growth parameter of sweet potato. (Table 1) Shows the effect of variety and density on the number of leaves, number of branches and vine length of sweet potato at 4, 8 and 12 WAP. The result showed that plant density significantly ($p< 0.05$) affected the number of leaves at 4 and 8WAP but not at 12WAP. TIS 87/0087 at the density of 20,000 plants per hectare gave the highest number of leaves (18.55 and 56.7) at 4 and 8 WAP respectively. But Umuspo 1 gave the highest number of leaves (91.0) at density of 66, 666 per hectare at 12 WAP. Variety affected the number of leaves at 8 and 12 WAP. At 12WAP, Umuspo 1 gave the highest leaf number (91.0) at 66,666, density followed TIS 87/0087 (69.7) while the least value was obtained from TI87/0087 at 66,666 density. (15.1).

Only density and interaction (table 1) showed significant effect on number of branches of sweet potato at 4 and 8 WAP. TIS 87/0087 gave the highest number of branches at 20,000 plant density followed by Umuspo 1 (2.33) at 66,666 plant density and Umuspo 3 (2.33) at density of 33, 333. At 12 WAP, only variety showed significant effect. Umuspo 1 gave the highest number of branches followed by TIS 87/0087 and least was Umuspo 3.

Density (table 1) showed a significant ($p>0.05$) effect on the vine length of sweet potato at 4 WAP while variety and interaction had no effect. TIS 87/0087 gave the highest vine length (37.0) at 20,000 density and least vine length was obtained from Umuspo 3 (25.4) at 20,000 density.
At 8 weeks only variety showed significant effect on vine length of sweet potato. TIS 87/0087 gave the highest vine length (115.8) followed by Umuspo 1 (49.6) and least was Umuspo 3 (35.1). But at 12 WAP only interaction showed significant effects on vine length.

Table 1: Effects of variety and plant density on number of leaves, number of branches and vine length of sweet potato at 4, 8 and 12 WAP

Treatments Variety	Density	Number of leaves WAP			Number of Branches WAP			Vine length (cm) WAP		
		4	8	12	4	8	12	4	8	12
TIS87/0087	66,666	8.11	18.6	75.1	0.78	1.00	1.00	15.9	56.0	42.4
	40,000	10.45	30.1	60.1	0.67	0.89	2.00	15.9	43.6	88.7
	33,333	6.59	46.7	58.7	0.67	2.11	4.11	21.3	77.2	119.2
	20,000	18.55	56.7	69.7	0.56	3.22	2.22	37.0	115.8	114.2
Umuspo 1	66,666	12.33	52.0	91.0	0.89	2.33	4.33	28.4	49.6	96.4
	40,000	13.78	28.8	48.4	0.67	0.89	4.34	17.1	29.8	44.7
	33,333	10.11	28.0	25.5	1.33	1.78	4.11	14.0	26.0	81.7
	20,000	12.89	35.7	63.9	1.67	0.87	2.56	32.6	40.8	62.8
Umuspo 3	66,666	11.89	15.4	31.8	60.54	0.78	0.89	21.1	24.5	97.2
	40,000	9.00	21.0	32.1	0.78	0.78	0.67	12.8	34.2	72.3
	33,333	10.78	25.5	46.6	0.89	2.33	3.23	14.8	32.7	39.2
	20,000	13.60	30.5	42.2	1.00	1.55	2.11	32	35.1	65.7

$LSD_{(0.05)}$ Density	3.49	10.00	NS	NS	0.616	NS	11.39	NS	NS
$LSD_{(0.05)}$ Variety	NS	8.66	17.96	NS	NS	0.68	NS	21.3	NS
$LSD_{(0.05)}$ Density x Variety	3.49	10.00	NS	NS	0.616	NS	11.39	NS	NS

Effect of variety and density on the leaf area and weed measurement. (Table 2) shows effect of variety and plant density on the leaf area (cm2) and fresh and dry weed weight of sweet potato. At 8 and 12 WAP, variety and interaction had significant effect on leaf area. Umuspo 1 at 66,666 plant density gave the highest leaf area 144.5 and 179.8 cm2 at 8 and 12 WAP and lowest value (49.0 and 53.7) was obtained from TIS 87/0087 at 66.666 plant density at 8 and 12 WAP.

Variety, density and interaction showed significant effect on weed measurement per treatment. Umuspo 1 and Umuspo 3 at densities of 40,000 and 66,666 plants respectively recorded the least fresh and dried weed weight 183, 8.89, Umuspo 3 at densities of 20,000 and 33, 333 recorded the highest fresh and dried weed weight (87.3 and 43.2g) and (73.3 and 36.8g) respectively.

Table 2: Effects of variety and plant density on leaf area (cm2) and fresh and dry weed of sweet potato length of sweet potato

Treatments Variety	Density	Leaf area (cm^2) WAP		Weed fresh	Weight (g) dry
		8	12		
TIS87/0087	66,666	49.0	53.7	28.3	15.1
	40,000	78.4	64.8	33.3	17.9
	33,333	77.3	73.9	35.0	19.5
	20,000	67.4	120.8	33.3	17.9
Umuspo 1	66,666	144.5	179.8	25.0	12.4
	40,000	73.5	99.1	18.3	8.9
	33,333	71.0	120.2	33.3	17.9
	20,000	101.3	95.2	41.7	21.8
Umuspo 3	66,666	39.4	71.6	18.3	8.9
	40,000	54.9	127.4	35.0	17.3
	33,333	27.5	38.8	73.3	36.8
	20,000	25.8	31.4	87.3	43.2
$LSD_{(0.05)}$ Density		12.33	21.39	10.41	6.11
$LSD_{(0.05)}$ Variety		NS	NS	12.02	7.05
$LSD_{(0.05)}$ Density x Variety		24.66	42.58	20.83	12.21

Effect of variety and plant density on yield of sweet potato. Table 3 shows the effects of variety and density on the number of tubers, shoot weight and root weight of sweet potato. Variety, density and interaction showed significant difference (p =0.05) on the number of tubers, shoot and tuber yield at harvest.

Umuspo 1, at 40,000 plants/ha gave the highest number of tubers 7.33 and tuber yield (27.67 tons/ha). TIS87/0087 at 20,000 plants /ha gave the highest shoot yield (2.97kg/plant) while Umuspo 3 at 20,000 plant/ha gave the lowest number of tubers (1.33) and shoot yield (0.233kg/plant) at harvest.

Table 3: effects of variety and plant density on the mean number of tubers shoot weight (kg) and total root weight that of sweet potato.

Treatments Variety	Density	No of Tubers	Shoot of weight kg/plant	Tuber weight t ha^{-1}
TIS87/0087	66,666	3.00	0.333	17.89
	40,000	6.00	0.867	18.11
	33,333	4.00	0.567	16.67
	20,000	3.67	2.967	18.67
Umuspo 1	66,666	7.33	1.667	25.11
	40,000	6.67	0.83	27.67
	33,333	2.67	0.60	15.56
	20,000	4.67	0.767	18.00
Umuspo 3	66,666	2.67	0.36	17.67
	40,000	2.00	0.367	17.33
	33,333	2.33	0.23	16.54
	20,000	1.33	0.276	15.00
$LSD_{(0.05)}$ Variety		0.786	0.38	0.34
$LSD_{(0.05)}$ Density		0.907	0.44	0.39
$LSD_{(0.05)}$ Variety x Density		1.571	0.77	0.67

Discussion

Effects of variety and density on the growth component of sweet potato. The growth parameter of sweet potato increased with increase in densities. The two higher sweet potato densities (66,666 and 40,000) plants ha-1 had higher growth than the lower densities. This is in line with the findings of Mckenzie et al,. (1992), who reported that higher plant population speeds up canopy closure (when little or no incoming radiation reaches the soil surface) and increase interception of photosynthetically active radiation (PAR) needed for carbohydrate production in plant.

Umusop 1 variety at the densities of 66, 666 and 40,000 plants ha^{-1} produced more number of leaves, branches and leaf area than TIS87/0087 and Umuspo 3.

Effects of variety and density on weed growth. It was observed that varieties with more vegetative growth and closer spacing aided in the reduction of weed weight at 12 WAP and showed significant difference ($p<0.05$) to other varieties as reported by [8] who stated that crop shading ability may improve weed control without extra costs and negative environmental impacts.

Also high weed incidents as observed in varieties with less vegetative growth and more spacing at 12 WAP is in line with the findings of [9], [7] who reported that at relatively low crop densities, crop cover early in the growing season is low leaving a large amount of resources available for the weed thus enabling them to establish and grow quickly.

Effects on yield component of sweet potato. Varieties responded differently to the different plant densities. Umuspo 1 at densities 40,000 and 66,666 plants ha^{-1} gave the highest root yield followed by TIS 87/0087 at densities 20,000 and 40,000 and the least yield was obtained from Umuspo 3 at the densities of (66,666 and 40, 000) plants ha^{-1}.

The morphological differences between sweet potato varieties indicates requirements of different plant densities for their optimum yield. However, the poor yield obtained from Umuspo 3 could be attributed to non –adaptability to our locally [10].

Conclusion

The results obtained from this study showed that varieties responded differently to the different plant densities. Umuspo 1 at densities of 40, 000 plants ha^{-1} produced more root yield while TIS 87/0087 at density of 20,000 plants ha^{-1} gave more shoot yield. Therefore, Umuspo 1 at 40,000 density and TIS87/0087 at 20,000 density are strongly recommended for root and shoot production respectively for farmers in Owerri Imo State, Nigeria.

Authors Contributions

Conceptualization:

Acknowlegdement

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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