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PRODUCTIVITY OF SWEET POTATO (*IPOMOEA BATATAS* (L.) LAM) AS AFFECTED BY NPK FERTILIZER RATE, INTRA-ROW SPACINGS AND VINE CUTTING LENGTHS IN THE NORTHERN GUINEA SAVANNA AGRO-ECOLOGICAL ZONE OF NIGERIA

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Abstract

A two year field study was conducted during the rainy seasons of 2013 and 2014 at the research farm of institute for Agricultural Research, Ahmadu Bello University, Samaru Zaria North Western Nigeria (11^0 11^1N: 7^0 38^1E and 686m above sea level) to determine the effects of NPK fertilizer rate, intra-row spacing and vine length on the productivity of sweet potato variety (Dan Zaria) in the northern Guinea Savanna Agro Ecological Zone of Nigeria. The treatment consisted of three NPK fertilizer rates (0, 150 and 300 NPK kg/ha), three intra-row spacings of (15, 30 and 45cm) and three vine cutting lengths (10, 20 and 30cm). The treatments were laid in split-plot design with NPK fertilizer rate and vine lengths in the main plot and intra-row spacing in the sub-plot and replicated three times. Results indicated that application of NPK fertilizer significantly enhanced most of the growth and yield components of the crop in the two years, namely: vine length, number of branches per plant, crop growth rate, relative growth rate, leaf area index and tuber yield (t/ha). Varying intra-row spacing from 15 to 45cm significantly increased most of the growth components due to decreased in competition among the plants.Planting of sweet potato using 30cm vine length performed better than 10cm or 20cm which were statistically similar in both years.Based on the results obtained in the study area it can be concluded that application of NPK fertilizer at 300 kg/ha, planting sweet potato on intra-row spacings of 45cm and 30cm vine cutting length could support good production of sweet potato in Samaru.

Keywords; *Sweet Potato, NPK Fertilizer Rates, Intra-row Spacings, Northern Guinea Savanna Agro Ecological Zone*

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is one of the world's most important and widely grown starchy crops, with annual production in over 110 countries currently estimated to 114 million tonne (FAO 2010). Sweet Potatoes are cultivated in areas with optimal annual rainfall between 750-2000mm. In areas with rainfall level below 850mm irrigation may be necessary but it should be stopped before harvest in order to prevent the tubers from rotting. Sweet Potato is mildly drought tolerant and can survive dry spells during the summer.However, low humidity impairs crop quality even if the plant resumes

growth after water stress (Eco port, 2010).Sweet Potato is a warm season annual crop, requiring 20-25^{0}C average temperature and full sunlight for optimal development. It thrives in well drained loamy soils with high humus content that provides warm and moist environment to the roots (Eco crop, 2010; Eco Port, 2010).

In developed nations, sweet potato is primarily grown for fresh consumption or as a canned product, but the markets for Sweet Potato as a value added processed food and bio based industrial products are growing. For example, sales of processed Sweet Potato in the United States increased by an average of 20,000 1b per year during 2007 to close to 110,000 1b in 2009 (U.S. Sweet Potato council, 2011). Sweet Potato can also produce large yields of biomass suitable for conversion to industrial product (*Ziska et al.,* 2009). For example, the starch can be converted to simple sugars and then used to produce plastics or fuels, such as ethanol and butanol (Klass, 1998). Cuevas *et al*. (2011) reported that purple fleshed sweet potatoes are used in juices, alcoholic beverage jams, confectionaries, bread and snacks. Sweet potatoes tubers are rich in vitamins A, B and C and minerals such as K, Na, Cl, P and Ca (Onwueme and Sinha, 1991).

Sweet Potato has very high grade starch used in food and pharmaceutical industries (Chittaranjan 2007) Sweet Potatoes can be used as an ingredient in industrial compound feeds (Gupta *et al*., 2009).In all parts of the world Sweet Potato crops are propagated using un-rooted sprouts or vine cuttings (Loebenstein and Thottapilly, 2009).The soils in the savanna areas where bulk of the Sweet Potato is produced were deficient in essential nutrients that promote good growth and yield of the crop; namely NPK, Ca, Mg etc. Therefore, varying NPK fertilizer in this trial was aimed at finding the appropriate rate for optimizing yield of the crop. Planting spacing on the other hand, is an important agronomic practice which influenced yield of crops.Therefore, the use of varying space in this trial was conceived at finding suitable space for increased production. Depending upon the soil type and rainfall condition the use of planting material of the highest quality is essential for the achievement of a successful sweet potato production.

However, the use of different vine lengths in this trial was designedto determine appropriate vine length for sweet potato production.

In view of the above this study was carried out with the following objectives:

- To determine the appropriate NPK fertilizer rate for sweet potato production.
- To study the effect of intra-row spacing on the productivity of sweet potato
- To evaluate the influence of vine cutting length on the productivity of Sweet Potato
- To determine interaction among the various factors.

MATERIALS AND METHOD

A two year field study was conducted during the rainy seasons of 2013 and 2014 at the research farm of institute for Agricultural Research, Ahmadu Bello University, Samaru Zaria North-Western Nigeria (11^0 11^1N 7^0 38^1E and 686m above Sea Level) to

determine the effects of NPK fertilizer rate, intra-row spacing and vine cutting length on the productivity of Sweet Potato variety (Dan Zaria) in the Northern Guinea Savanna Agro Ecological Zone of Nigeria.

The treatments consisted of three NPK fertilizer rates (0, 150 and 300NPK Kg/ha), three intra-row spacings of (15, 30 and 45cm) and three vine cutting lengths (10, 20 and 30cm). The treatments were laid out in split-plot design with NPK fertilizer rate and vine cutting length in the main plot and intra-row spacing in the sub-plot and replicated three times. The gross plot size was 13.5m^2 consisting of 6 ridges spaced at 0.75m and 3m in length. The net plot was 4.5m^2 made up of 2 inner ridges spaced at 0.75m and 3m in length in both years.Young vines of the variety *(Dan Zaria)* a white skinned and white fleshed sweet potato were planted in both years.

Fertilizer application was carried out in both years of the experiment in 2 split applications as per the varied treatment rates. NPK 15-15-15 fertilizer was first applied the whole of P and K and half of N was applied at 2 WAP while the remaining N was applied at 6 WAP using urea (46%N) to supply the remaining half of nitrogen. The fertilizer was applied using side dressing application method in both years.Pre-planting weed control was carried out in both years two weeks before planting by the application of round up at 5Lha^{-1}. Two hoe weeding were carried out at 3 and 6 WAP.

Sweet potato weevil *Cylas formicaries and Cylas brunnens* were the most common pest that infested the field in both years. The pests were controlled using 0.1% *Carbaryl* and were applied twice at two weeks interval starting from 4 WAP.There were no diseases incidence observed during the periods of the trial in both years and therefore no control measure was applied.

Vine cutting lengths were measured using metre rule, leaf area index was calculated using leaf area metre, crop growth rate was determined using formula: CGR = W_2-W_1 / $T_2 - T_1$ and RGR was determined using formula: Log W_2 – Log W_1/ T_2– T_1. The crop was harvested manually with the aid of hoe at 12 WAP in both years.

Data collected were analysed statistically in accordance with Snedcor and Cockran (1967) and treatments means were compared using Ducans Multiple Range Test (Duncan 1955)

RESULTS AND DISCUSSION

The effects of NPK fertilizer rate, intra-row spacing and vine cutting length on vine length, number of branches per plant, leaf area index, (LAI) crop growth rate (CGR) and relative growth rate (RGR) and Tuber Yield (t/ha) in both years are presented in Tables 1 and 2 respectively. Varying NPK fertilizer rates in both years was significant on number of branches per plant and crop growth rate in 2013 relative growth rate and tuber yield t/ha in both years.Increased in NPK fertilizer rate from O to 150kg NPK ha^{-1}significantly increased all the above parameters, a further increase to 300kg NPK ha^{-1} were statistically similar.

NPK fertilization significantly increased growth and development of sweet potato in this study from the control up to 150kg NPK ha^{-1}.Nitrogen fertilization was reported to increase the average fresh tuber, plant height, leaf number, leaf area index and tuber weight per plant. (Kandit, 2011 and Semiha 2009).

Variation in intra-row spacing significantly influenced vine cutting length, number of branches per plant in 2013, Leaf area index (LAI) in both years and tuber yield in 2013 as presented in Tables 1 and 2 respectively.Increase in intra-row spacing from 15 to 30cm was statistically similar on vine length in 2013 and leaf area index in both years a further increase to 45cm significantly increased these parameters.Onwueme and Sinha (1991) and Sharifari (2011) reported that increasing intra-row spacing beyond 40cm increase productivity per plant, due to less competition for light and nutrient among the crop, as well as decreased in shading.

Varying the intra-row spacing between plants has been found to have great influence on growth and development of many cultivated crops (Ramat, 2007).In both years planting sweet potato using vine cutting length of 30cm significantly produce superior growth and yield attributes than 10cm or 20cm. Onwueme (1978) indicated that tuber yield tend to increase with increase in the length of vine cuttings used.

CONCLUSION

Based on the results in the study area in both years, it can be concluded that application of NPK fertilizer rate at 300kg/ha, planting of sweet potato on intra-row spacing of 45cm and 30cm vine cutting length could support good production of sweet potato in Samaru.

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Table 1: Effect of NPK Fertilizer rates, intra-row spacing and vine cutting length on vine length, number of branches/plant and leaf area index at 12 WAP in 2013 and 2014 rainy seasons

	Vine Length		No. of Branches		Leaf Area Index	
Treatment	2013	2014	2013	2014	2013	2014
NPK Fertilizer rate (Kg/ha)						
0	114.20b	110.10b	7.60b	7.40b	6.20b	4.50b
150	121.30a	121.70a	8.50a	7.60a	7.10a	4.87b
300	126.60a	125.10a	9.10a	8.90a	7.80a	4.92a
Significance	*	*	*	*	*	*
SE ±	6.60	6.50	1.70	1.70	1.60	1.30
Intra-row spacing (cm)						
15	119.20ab	112.20b	7.51b	7.12b	6.11b	5.61b
30	120.40a	118.30a	7.94a	7.62a	6.92a	5.91a
45	127.30a	125.50a	8.33a	8.21a	7.40a	6.53a
Significance	*	*	*	*	*	*
SE ±	6.60	7.00	8.00	1.70	1.60	1.50
Vine cutting length (cm)						
10	122.10b	111.30b	7.85b	7.41b	6.15b	5.12b
20	126.40b	115.60ab	8.51ab	7.71a	7.43b	5.80b
30	131.00a	127.30a	8.92a	8.10a	8.12a	6.62a
Significance	*	*	*	*	*	*
SE ±	6.70	6.50	1.70	1.70	1.60	1.50
Interaction						
F X S	NS	NS	NS	NS	NS	NS
F X VL	NS	NS	NS	NS	NS	NS
S X VL	NS	NS	NS	NS	NS	NS
F X S X VL	NS	NS	NS	NS	NS	NS

Means followed by unlike letter(s) in a treatment group are significantly different at 5% level of probability using DMRT

NS = Not Significant
F = NPK Fertilizer Rate
S = Intra-row Spacing
VL = Vine Cutting Length

Table 2: Effect of NPK Fertilizer rates, intra-row spacings and vine cutting length on crop growth rate, relative growth rate and tuber yield at 12WAP during 2013 and 2014 rainy seasons

Treatment	CGR		RGR		Tuber Yield t/ha	
	2013	2014	2013	2014	2013	2014
NPK Fertilizer rate (Kg/ha)						
0	7.21b	5.60b	0.05ab	0.06b	13.60b	12.10b
150	8.92ab	6.53b	0.07a	0.08a	17.20a	15.20a
300	9.83a	7.82a	0.08a	0.09a	19.40a	18.30a
Significance	*	*	*	*	*	*
SE ±	1.70	1.60	0.20	0.20	2.40	2.30
Intra-row spacing (cm)						
15	9.80b	8.42c	0.03c	0.02b	13.0b	12.50b
30	10.20a	9.63a	0.04a	0.05a	15.10a	14.20a
45	10.41a	10.21a	0.06a	0.07a	17.20a	16.30a
Significance	*	*	*	*	*	*
SE ±	1.90	1.80	0.12	0.12	2.30	2.30
Vine cutting length (cm)						
10	9.31b	8.20b	0.04	0.03	13.60b	12.50
20	9.49a	8.42a	0.06	0.05	16.50a	15.30
30	10.10a	9.31a	0.08	0.06	18.10a	19.10
Significance	*	*	*	*	*	*
SE ±	1.90	1.80	0.14	012	2.40	2.40
Interaction						
F X S	NS	NS	NS	NS	NS	NS
F X VL	NS	NS	NS	NS	NS	NS
S X VL	NS	NS	NS	NS	NS	NS
F X S X VL	NS	NS	NS	NS	NS	NS

Means followed by unlike letter(s) in a treatment group are significantly different at 5% level of probability using DMRT

NS = Not Significant
CGR = Crop Growth Rate
RGR = Relative Growth Rate
F = NPK Fertilizer Rate
S = Intra-row Spacing
VL = Vine Cutting Length