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Response of Polynesian Arrowroot *Tacca leontopetaloides* to Fertilizer and Intra-Row Spacing at Garkawa

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Abstract
A field experiment was conducted at the Plateau State College of Agriculture, Garkawa to investigate the response of Polynesian arrowroot to fertilizer sources and intra-row spacing in 2011 and 2012 wet seasons. Treatments consisted of three intra-row spacing (20, 25, 30cm) and five fertilizer sources (NPK, poultry manure, goat manure, cow dung and a control).These were factor ally combined and laid on a randomized complete block design with three replications. Polynesian arrowroot growth related characters (plant height, Leaf area) increased with decreased levels of intra-row spacing. Similarly, number of tillers/ha as well as fresh bulb weight kg/ha increased with decreased levels of intra-row spacing. The use of NPK fertilizer and poultry manure gave significant differences among all the fertilizer sources tried in both years. It is therefore concluded that among the intra-row spacing tried 20 and 25 cm were most appropriate, while among fertilizer sources tried NPK fertilizer and poultry manure were most appropriate.
Keywords: Polynesian arrowroot, Fertilizer, Manure, Intra-row spacing

Introduction

In spite of its importance as a food source in Nigeria (Spennemann,1994) as a starch in stiffening fabrics (Tangden,2004) and as a panacea in the treatment of diarrhoea, dysentery (John-Rey,1997), Polynesian arrow root (*Tacca leontopetoloides)* or locally called 'Amora' is still a wild plant in Nigeria (Ukpabi, 2009).
Polynesian arrowroot is indigenous to Nigeria based on the abundance of wild species and very large diversities that are found in Plateau and Nasarawa States of Nigeria. In areas where Polynesian arrowroots are used, almost all the varieties are used as a delicacy for newly wedded couples. The medicinal value of taccalin found in the tuber as well as the seeds cherished by the birds' needs further investigation (Ukpabi , 2009).
Tubers are dug out after harvest of major staple crops. In fresh form, the leaves are harvested and used for various dietary preparations. The production and use of this crop has been hampered by its inability to be domesticated. There is insufficient knowledge on the way it should be grown, there is a knowledge gap on the optimum spacing required for the growth of the crop as well as the quantity and type of fertilizer required. Major constraints facing farmers wishing to grow Polynesian arrowroot and many other indigenous crops is lack of scientific information. However, the rains nowadays are unpredictable, unreliable and highly vulnerable to the vagaries of weather such that the demand for food in Nigeria always exceeds its supply, Borokin and Ayodele(2012). Indigenous crops can withstand the effect of drought and weather stress hence increasing quantity of food production.
When Polynesian arrowroot (*Tacca* leontopetaliodes) [L.] Kuntze is domesticated, what is the effect on the crop? What type of fertilizer should be applied and at what rate to optimized its yield? What is the maximum intra-spacing should this crop be grown. The tubers harvested from fertilized and adequately spaced Polynesian arrowroot is the same with those grown in the wild.
Optimum yield of this crop can be reached if the farmers gained an understanding of what they can fertilize their lands with and the spacing required for its growth. The sun rays which help in photosynthesis falls on bare soils as a result of inadequate spacing. To arrive at optimum tuber yield at a specific environment, it would be necessary to make such recommendations based on information derived from field trials conducted in such areas. Research on Polynesian arrowroot was intended to primarily provide a basis for recommendations to farmers considering increase in population and the need to diversify.
Polynesian arrowroot was cultivated during the 2011 and 2012 wet season in Garkawa, Plateau state of Nigeria only due to financial constraint. Garkawa is located at latitude 10^0 11'N and longitude $8^0$21'E, and falls in the Southern guinea savannah. It investigated the response of Polynesian arrowroot to spacing and fertilizer application during the period for optimum tuber yield. It does not cover the adequate time of planting.
In view of the above, the present study was undertaken with the following objectives:
1. To investigate the response of Polynesian arrowroot to different intra-row spacing.
ii. To investigate the type of fertilizer(s) to be applied during the period of growth.

Materials and methods

The experiment was conducted during the 2011 and 2012 wet seasons at the experimental farm of Plateau State College of Agriculture, Garkawa, Nigeria. Garkawa is approximately situated at latitude 10^0 11' N and longitude

8^0 21'E (Badi and Magaji, 2005).
The treatments consisted of two factors: Intra-row spacing (20*20cm, 25*25cm and 30*30cm) and Fertilizer sources (Cow dung, Goat manure, Poultry manure, NPK compound fertilizer and a Control). Polynesian arrowroot was sourced from farmer's field in the wild at Garkawa. There were fifteen treatment combinations each of the treatment was assigned to a plot using picking from the hat without replacement and replicated three times. These were arranged in a Randomized Complete Block Design (RCBD). The land was ploughed to a fine tilth, which was then marked into forty five plots (45) of $15m^2$(3 x 5). The size of the area was 44 x 10m with 2m spacing between blocks and 1m spacing between plots. Fertilizers were applied at tillage except for NPK which was splitted into two, with the first half applied at four weeks after and other half applied at eight weeks after cropping.
Soil samples were taken from the experimental plot after ploughing at the depth of 0 – 15cm and 15 – 30cm using soil auger. These soil samples were analyzed to determine the physico-chemical properties (Table 1) of the soil using standard procedures as determined by Black, (1968). Samples were analyzed at Soil and Plant laboratory of Abubakar Tafawa Balewa University, (ATBU) Bauchi.

Statistical Analysis of Data
All data collected were subjected to statistical analysis of variance as described by Snedecor and Cochran (1967) and significant differences among the treatment means were evaluated using the Duncan Multiple Range Test (DMRT) Duncan, (1955). The standard errors of non significant means were computed. The land was cleared of bushes and stones. It was then ploughed and harrowed twice using the College tractor to give a fine tilth. The field was then marked into 45 plots of 15m (3 x 5) each, with 2m spacing between blocks and 1m spacing between plots. The size of field was 44 x 10m. Fertilizers were incorporated into the plots using broadcasting method.
Immediately after land preparation, during the dry season, selected, large and disease free tuber seeds were planted at one tuber per hole at a depth of 5cm at the intra-row spacing of 20 *20cm, 25*25cm and 30*30cm according to the treatments.
First weeding was done at three weeks after tuber emergence. Another weeding was done six weeks after tuber emergence. Harvesting was carried out when the leaves of the plant dried off and turn brown. The tubers were harvested using a small hoe by carefully digging underneath root of the crops to avoid wounding the tubers. To asses various growth and yield characters, 20 plants were randomly selected from each plot in the inner rows for sampling at 4, 6, and 8 weeks after sowing (WAS). The following growth parameters and yield parameters were recorded: Plant height, leaf area, number of tillers, as well as fresh bulb weight.
Plant height per hectare: was measured from the ground level to the tip of the plant where the newest leaf was using a meter rule graduated in centimeter.
Leaf area per hectare: was measured using a glass graph method as propounded by Evans and Kang (1978).
3.9.2 Yield Parameters
The Number of tillers per hectare and fresh weight of tubers per hectare were assessed after harvest.
Number of tillers per hectare: The number of tillers of 20 plants was taken and the mean weight was determined.

Table 1: Physico-chemical properties of experimental site

Soil Property	
Mechanical Analysis	(%)
Sand:	75.90
Silt:	10.03
Clay:	14.07
Textural Class:	Sandy loam
pH :(1:1 Water)	6.09
%Organic Carbon gKg-1	5.89
%Total NgKg-1	1.07
C/N ratio	6.78
Available (Pmgkg-1)	6.88
Exchangeable cations(Cmolkg-1)	5.02
Exchangeable bases (Cmol+kg)	2.68
Calcium	0.87
Magnesium	0.56
Potassium	0.15
Sodium	4.70
Cation Exchange Capacity (cmolkg-1)	75.60

Table: 2 Effect of fertilizer sources and Intra-row spacing on plant height of Polynesian arroroot at Garkawa.

		Plant height (cm)	
Treatment	4 WAS	6WAS	8WAS
Fertilizer			
NPK	7.89[a]	23.06	43.31
Poultry manure	7.80[a]	23.04	45.30
Cow dung	7.18[b]	23.02	43.20
Goat manure	7.16[b]	23.01	43.19
Control	3.11[c]	22.90	43.10
SE±	0.22	0.94	1.74
Spacing			
20 X 20cm	7.40	23.92	40.77[a]
25 X 25cm	7.41	23.63	33.40[b]
30 X 30cm	7.39	23.64	33.38[b]
SE±	0.27	1.15	2.12

Means within a column of a set of treatment follow by unlike letter (s) are significantly different using DMRT at 5 % level of significance.

Table: 3: Effect of Intra-row spacing and fertilizer Sources on Leaf area

		Leaf area	
Treatment	4 WAS	6WAS	8WAS
Fertilizer			
NPK	0.89[a]	1.11	1.73[a]
Poultry manure	0.86[a]	1.10	1.70[a]
Cow dung	0.56[b]	1.05	1.23[b]
Goat manure	0.55[b]	1.04	1.20[b]
Control	0.10[c]	1.01	1.11[b]
SE±	0.03	0.05	0.05
Spacing			
20 X 20cm	0.59	1.06	1.32
25 X 25cm	0.58	1.06	1.30
30 X 30cm	0.58	1.08	1.31
SE±	0.03	0.05	0.05

Means within a column of a set of treatment follow by unlike letter (s) are significantly different using DMRT at 5 % level of significance.

Table 4: Effect of Intra-row spacing and fertilizer sources on number of tillers/ha

		Number of tillers
Treatment	**2011**	**2012**
Fertilizer		
NPK	5.77[a]	5.78[a]
Poultry manure	5.75[a]	5.77[a]
Cow dung	5.15[b]	5.15[b]
Goat manure	5.14[b]	5.15[b]
Control	3.10[c]	3.11[c]
SE±	0.21	0.21
Spacing		
20 X 20cm	6.30[a]	6.31[a]
25 X 25cm	6.29[a]	6.31[a]
30 X 30cm	5.30[b]	5.31[b]
SE±	0.24	0.24

Means within a column of a set of treatment follow by unlike letter (s) are significantly different using DMRT at 5 % level of significance.

Table5: Effect of Intra-row spacing and fertilizer sources on fresh bulb weight kg/ha

	Fresh bulb/hectre	
Treatment	2011	2012
Fertilizer		
NPK	105.94a	105.96a
Poultry manure	103.99a	103.99a
Cow dung	81.98b	81.99b
Goat manure	81.87b	81.88b
Control	61.21c	61.22c
SE	0.164	0.164
Spacing		
20 X 20cm	100.03a	100.04a
25 X 25cm	100.01a	100.01a
30 X 30cm	92.10b	92.12b
SE±	0.243	0.243

Means within a column of a set of treatment follow by unlike letter (s) are significantly different using DMRT at 5 % level of significance.

Discussion

Plant height (table 2) was significantly affected by fertilizer sources at early stage of growth. This is because Nitrogen is required when rapid uninterrupted growth is needed (Borokin and Ayodele,2012).Young seedlings require phosphorus to stimulate early development and root growth(Caddike et al.,2002).Potassium plays vital role in the uptake of water for utilization by crops(John-Rey 19997).Most farmers do not apply fertilizer to Polynesian arrowroot in the areas is not yet. With increase decline in soil fertility due to continues cropping, it is profitable to apply fertilizer. Incorporation of animal manure improves both fertility and structure (Poyer, 1990).

Plant height was significantly influenced by spacing. Higher population resulted in taller plants. This could be due to ranked growth in densely populated plants due to greater competition for light which induced etiolating resulting in spindly plants. This agrees with the findings of Ukpabi,(2009) and Poyer(1990) who reported that plant height increases with increase in plant population.

Leaf area (table3) was significantly affected by fertilizer sources at early and late stages of growth, higher than the control. It shows that this crop needs some manure or NPK for its growth. These nutrients are essential components in the formation of meristematic cells and for cell division, the process which initiates growth. This is similar with the findings of Poyer,(1990) who reported increase in leaf area with increase in intra-row spacing. On the contrary is the work of Ukapi, 2009 who reported that intra-row spacing had no significant effect on Irish potato.

The number of tillers per hectare (table4) is significantly affected by application of fertilizer. This is because more foods are assimilated for economic yield. This is similar with the work of Spennenman(1994) who reported that more tubers were formed with adequate supply of fertilizers. Number of bulbs decreased with increase in spacing. This could be due to increase in competition between the plants at high plant population.

The application of fertilizer showed significant effect on fresh bulb weight of Polynesian arrowroot. This is because fertilizer encourages mineral and water uptake. This is similar with the work of Bailey (1992) who reported that phosphorus was important in the uptake of water.

Intra-row spacing (table5) showed significant increase with in intra-row spacing. This is because of an increase in plant population. This is in conformity with the with the findings of poyer,(1990)who reported an increase in yield of Irish potato with increase in plant population. The significant increase in fresh bulb weight could be due to the fact that decrease in plant population exerts a positive effect on the development bulbs as a result of low competition for light and other favourable factors of growth and development. Bailey (1992) reported that the developments of bulbs of herbaceous annuals are characterized by increase in spacing.

Summary and Conclusions

A field experiment was conducted at the Plateau State College of Agriculture; Garkawa. The aim was to investigate the response of Polynesian arrowroot to investigate the response of Polynesian arrowroot to fertilizer source and intra-row spacing. Treatments consisted of three intra-row spacing (20, 25,30cm) and five fertilizer sources (NPK, Poultry manure, Goat manure, Cow dung and Control).These were factor ally combined and laid in a randomized complete block design with three replications. Polynesian arrowroot growth related characters (plant height, Leaf area) increased significantly with decreased levels of intra-row spacing .Similarly, number of tillers/hectare as well as fresh bulb weight kg/hectare as Polynesian arrowroot increased with decreased levels of intra-row spacing. The use of NPK fertilizer and poultry manure gave significant differences among all the fertilizer sources tried.

It is therefore concluded that among the intra-row spacing tried 20 and 25cm were most appropriate, while among fertilizer sources tried NPK fertilizers and poultry manure were most appropriate.

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