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Research Paper

Phenotypic Elasticity of Yam Tuber *Dioscorea rotundata* Dior. Shapes: A Case Study of "Kpako" White Yam Landrace

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The study was carried out with the intention of finding out if geographical location or differences in heap sizes will have any significant effect on the phenotypic elasticity of yam tuber shapes of Kpako yam (*Dioscorea rotundata* Dior). The seed yam was purchased from Katamba Bologi in Edati Local Government of Niger State, Nigeria. The result showed a non-significant difference in the shape of yam irrespective of the agro-ecological place of production. The resultant shape did not depend on the heap sizes either. The study concluded that tuber shapes of yam varieties or landraces are elastic attributes that may not depend on phenotypic features but rather a varietal characteristic. Fertilizer may also not have any effect on the expression of tuber shapes either. More work is needed to confirm this finding.

Keywords: Tuber shapes, *Dioscorea rotundata,* elasticity of tuber shapes, phenotypic feature.

INTRODUCTION

Yam (*Dioscorea sp*) is a highly valued and preferred root crop for food in the tropical regions of the Caribbean, Africa and some Asiatic countries. The crop is grown in Nigeria by mainly small holder farmers, dotting the length and breadth of the southern guinea savannah and the rain forest agro-ecological zones of the country. These areas are referred to as "the yam belt" of Nigeria. This belt covers most states in the central part of Nigeria (Niger State being part of this geographical location). In Niger State, yam growing areas cover Lapai; Suleja; Paikoro; Bosso and Minna Local Governments Areas.

They receive an average annual rainfall of between 680 to 1000 mm (Maikasuwa and Ala, 2013). It has been established that a total of 275,852 Ha of farmland was put into yam production in Niger state in 1994(Maikasuwa and Ala, 2013). Of this number, the yam belt of the state accounted for about 90% of the total area. Yam setts are planted early in February to about the end of March (in the dry season) and referred to as early planting or in April through June (with the establishment of the rains) otherwise referred to as the late planting. Anthony (1992) and Jibrin (1997) reported that early varieties mature early in the rainy season.

The ''Kpako'' landrace used in the current study, falls in the early planted variety/landrace. Onwueme, (1978) refers to these types of varieties as those that can be double-harvest. Yams are cultivated mainly for some of their inherent tuber characteristics and their selection is based on either on their tuber, shape, sizes, time to maturity or the length and skin finish. They are allowed for lower peeling loses during processing for food. The simple amorphous or cylindrical un-branched yam tubes are more frequently first selected above the lobbed or branched ones, thus commanding higher commercial value. In the case of early maturing tubers however, shape does not really have any importance in their selection. Instead the availability of ''new'' yam in the market enables farmers, consumers and retailers to cash in on high market prices available at this period. Several selected tubers and/or ''new'' yam are often transported away from centres of production. There is that tendency for farmers to try to plan for planting these early yam varieties/landraces on their fields.

The main source of yam seeds/setts for planting however, comes from the previous harvests or from local markets. Because of the diversity in source of yam seeds/setts, only the farmers may know names of the varieties/landraces and their morphological characteristics. There is the tendency therefore, that one yam variety/landrace may be called different names at any one place or depending on source of setts or locations of growth (Horton, 1983; Tsado, 1995). The Kpako yam landrace gets its name from its broad shape. In both the Gwari and Nupe languages dominating the yam belt of Niger State, the name Kpako means a "door". The implication is that this yam landrace has a shape typical of a door.

This study therefore sought to establish the degree of elasticity of yam shape when a variety of yam setts are grown outside of its normal area of cultivation (the Kpako yam is used for this study). There was also the desire to establish the effect of heap size on the shape and yield of this early yam variety.

MATERIALS AND METHODS

The trial was conducted at the Federal University of Technology Minna, farm situated at Kilometer 18 along Minna to Bida road of Niger State, during the 2015 growing season. The planting material was purchased from Katamba Bologi in Edati Local Government of Niger State. A local landrace - Quasi, was used as the control.The site where the yam setts were planted had a previous cropping history of maize intercropped with sorghum during the 2010 season and left to fallow in 2011. The soil on which the yam setts were planted was characterized as loamy sand, slightly acidic with low content of available P, and total N and low content of exchangeable bases (Table 1) (Taidi, 2004).

Yam heaps were constructed according to the normal traditional method peculiar to the cultivation of yam in Niger State. Heaps were mounted three days before the setts were planted on the 20th of May, 2015. The trial was laid out in a randomized complete block design (RCBD) with 3 replications. Three distinctive heap sizes (big, medium and small) were used as described in (Table 2).

Holes about 15 cm deep were dug through the top of each heap where a yam sett weighing about 500- 700 grams was placed. Tuber setts were laid down at a slanting angle of 45 degrees to the top surface of the heap, covered and also mulched to prevent the yam sett from been sun scorched. The planting was done between 8-10 am.The best weed control method as suggested by Jibrin, (1997) was used. One application of a chemical herbicide followed by two hand hoe weeding was used. Primextra (active ingredient, 330 g/l metolachlor and 170g/l atrazine) + Gramaxone (a.i 200g/l paraquat/l) at the rate of 2.5l Primextra + 0.7L Gramaxone in 200l water/ha was applied as pre-emergence the second day after planting the yam setts. This was followed by two hand hoe weeding at 8 and 17 weeks after planting - WAP. Each of the yam heaps was stacked on the 25th of June 2015 which coincided with 6 WAP at which time the vines had attained about 25% of germination.

Yam milking

On the 26th of September (19 WAP), tubers on selected heaps were milked as described by Onwueme, (1978). This was done for 15 big, medium and small sized heaps respectively. The tubers were brought into the laboratory and allowed to air dry. The weight were taken weekly over the next 6 weeks period.

Data collected were for the following parameters

Germination counts at 4, 8, 12 WAP, Stand count at milking stage; Number of ware tubers per heap at milking stage/size of heaps. Weight of ware tubers of the 15 heaps balance per size of heap. Weight loss of tubers for 6 weeks after harvest and Percentage dry matter was also taken.

RESULTS AND DISCUSSION

Germination and leave canopy

Results showed that yams planted on small heaps had a better germination compared to the other two heap sizes. This was followed closely by that of the medium sized heaps, while growth among big heaps was poorest. Seeding emergence and tuber germination continued to increase. This germination percentage of soil, may be able to heat up with from small heaps was better than those from the other two sizes of heaps. This may not be unconnected with the higher amount of soil moisture relative to the size of the heaps. Small heaps, because of the quantity little change in atmospheric temperature and loose heat quickly with the change or drop in the atmospheric temperature. Absorption of rain water is one other factor that could rapidly change the temperature within these heap sizes. Both temperature and water

Table 1. Soil characteristics of the University farm.

Soil Properties	composition
Sand	71.0
Silt	19.0
Clay	10.0
Textural class	Loamy sand
pH (1.2 1m KCl)	5.87
Available P (ppm) Bray 1	3.27
Total organic C(%)	0.53
Total N (%)	0.05
Exchangeable Cation (cm/kg)	
K^+	0.2
Na^+	0.2
Ca^{2+}	3.0
Mg^{2+}	0.6
CEC	4.96

Taidi, (2004).

Table 2. Sizes of heaps used in the study (meters).

Heap Sizes	Heap Diameter (m)	Heap height (m)
Big	1.5	1.00
Medium	1.00	0.75
Small	0.75	0.50

content are good factors for germination of all crops.

The leaf canopy was better with the size of the heaps at 19 WAP. Bigger heaps had dense canopy while that of the smaller heaps was lowest. The dense foliage (canopy cover) of the yam vines observed in the bigger size heaps may possibly be related to the amount of top soil collected to form the heaps. This would have given the growing yam setts a good enough area for root development hence good canopy cover. It had been reported (IITA; 1995), that tillage increased ‘‘root room’’ particularly when ridges and heap mouldings were practiced. The report also showed that leaf area index increased with tillage. It is possible also that heap size may have affected canopy size.

Tuber shape

The shape of the milked yam was almost the same with all heap sizes, although they were slightly broader among big heaps followed by medium sized heaps and near conical shape in small heaps. The difference in tuber shape in milked yam is presented as (Plate 1).The shape of the yam at full maturity and time of normal harvest from each heap sizes followed the same trend as that of the milked sample. In Plate 1, are the yam shapes of the tubers at fully matured yam at time of normal harvest. The sizes of milked yam (size defined as weight of tuber) varied proportionally with the sizes of the heaps. Big sized tubers were harvested from the bigger heaps. Tubers from the medium sized heaps had a mixture of both large and small sized tubers. Small heaps had more of smaller tubers the likes of which can be classified as seed material. This is shown in (Table 1).

The sizes of milked yam based on the average weight of yam were found to vary with the size of the heap. Big sized tubers were harvested from the higher heaps. Tubers from the medium sized heaps had a mixture of both large and small sized tubers. A report originating from IITA (1995) showed a similar trend. That study was carried out at the south-western part of Nigeria using three different soil types and in the 2 year trial period, showed that tuber yields were affected more by heap size rather than soil type or the amount of fertilizer added.

Ratio of harvested ware yam to seed yam as affected by heap size

The ratio of seed yam to ware yam in smaller and medium sized heaps was greater in both the milked yam and at full maturity. The sized heaps at full maturity and time of normal harvest had about equal number of seed yam to ware yam with a ratio of 1:1. This is shown in (Table 2).

Dry matter content as affected by time of harvesting

The dry matter content of tubers (expressed in percentage) for the milked yam from the big heaps was the highest followed by those of the medium heaps and lastly the small heaps. This result is shown in (Figure 1). At full maturity, tubers from the small sized heaps had the highest percentage dry matter followed by big heaps and lastly medium heaps. From the same figure, the dry matter content from milked tubers appeared to be greater than those from full matured yam tubers.

As reported in this current study, yam products that could be classified as seed were more than the ware yam irrespective of whether harvesting was at the milked stage or at full harvest. This result is in agreement with a study conducted at Abebubu, Ghana and reported by IITA (1995). They concluded that planting ‘‘after first rains reduced tuber yields but the loss could be minimized with small mounds’’. The variety of yam planted was also observed by the researchers to play a vital role in determining the yields.

Loss of weight of tubers as affected by time of harvest

There was a significant (P=0.05) loss of weight of the milked yam over the six weeks of observation. Elasticity of the shape of yam tubers is defined by the ability of the

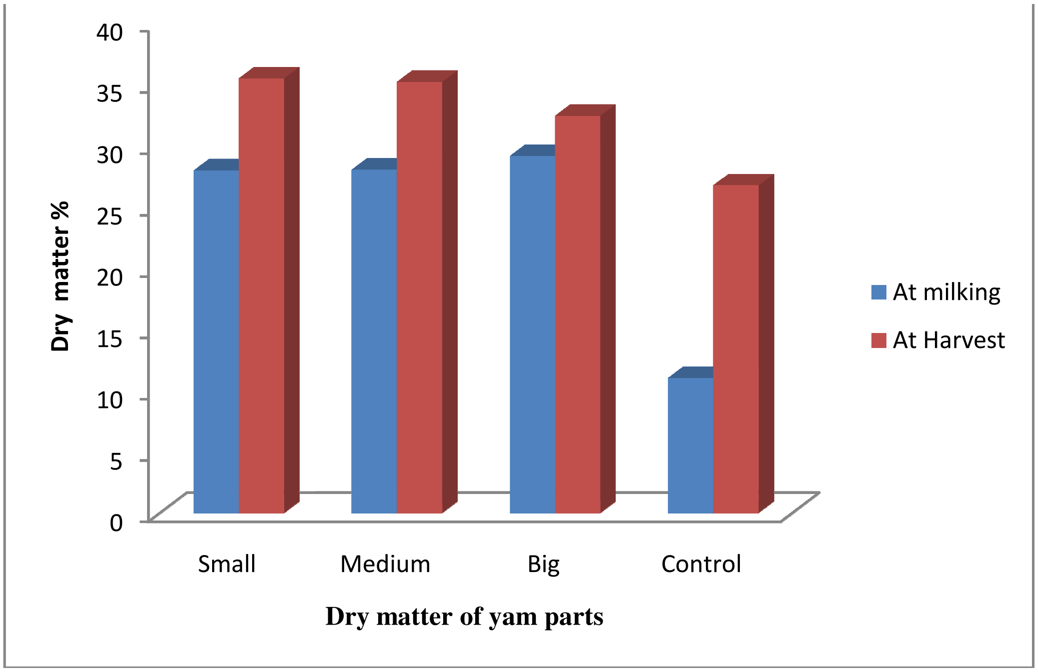

Figure 1. Dry matter content of tubers as affected by time of harvesting.

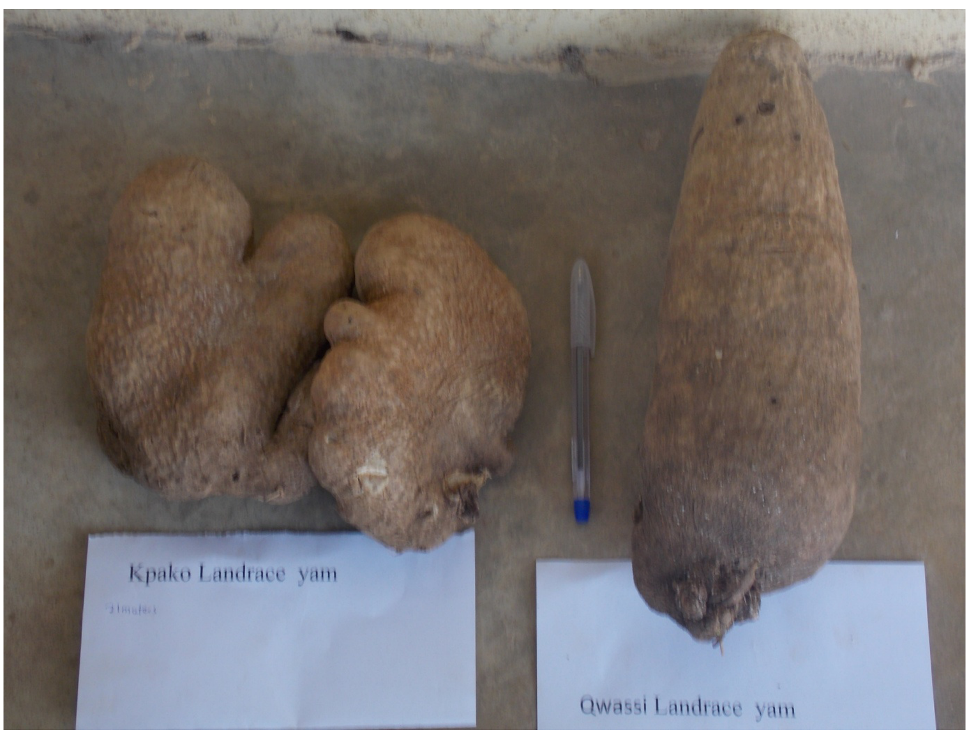

Plate 1.Differences in yield (fresh tuber weights) of Kpako and Qwassi landraces yam.

shape of yam tubers to be maintained even though changes exist in geographical locations or agro-ecological zones of their growth. This led to the proposal of the hypothesis tested in this current study. Based on the findings of this study, the shape of the Kpako yam variety at both stages of harvesting retained its normal broad shape. Since the shape of the yam variety did not differ from those of Kuta where it is native to, the hypothesis related to the shape of yam as not been ‘‘significantly affected by the geographical location of growth/production’’ is therefore retained. This result supports the finding of the works of Coursey (1967); Waitt (1960) and NSADP, (1995) who concluded that shape of yam might be more related to the genotype of yam than their phenotypes. Since the ratio of ware yam to seed yam appeared to have a good association with heap size the bigger the heap size, the higher the number of ware and the total yield (by weight) obtained, the second hypothesis of ‘‘no existing association between heap size and tuber yield’’ is rejected. The result showed a strong association between seed yam produced and heap size i.e. the smaller the heap size, the higher the number of seed yams produced. This however, may not have any effect on the average weight of the yam crop yield.

Conclusion and Recommendation

It is concluded therefore that the shape of yam especially the early maturing types, using Kpako as an example, may not change irrespective of where it is planted. The wide shape observed (Picture 1), was similar to those from the source of the yam variety (which is from Katamba Bologi in Edati Local Government, or at Kuta, Shiroro Local Government Area of Niger State).It was also observed that the sizes of heaps on which the yam were grown did not significantly affect the shape of the yam variety. However, the ratio of ware yam to seed yam appears to be associated with heap size. The study is continuing with the testing of the elasticity of Kpako yam variety over the three different agro-ecological zones covering the yam belt of Niger State. More work will be intensified in the identification of major differences that may distinguish varieties from each other. It may be well to also take a look at the effect of soil on the sizes and culinary properties/acceptability of early maturing yam varieties.

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