MORPHOLOGICAL CORRELATION ANALYSIS ON SOME AGRONOMIC TRAITS OF TARO (*COLOCASIA ESCULENTA*) IN THE PLAINS OF NSUKKA, NIGERIA

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Abstract
A field experiment was conducted in 2008 and repeated in 2009 cropping season at the Linkage Farm of the University of Nigeria, Nsukka to evaluate the morphological differences among five taro cultivars as well as the relationship between their agronomic traits. The experiment was laid out in a randomized complete block design (RCBD) with three replicates. Phenotypically, there were little morphological variations among the five taro cultivars with all of them showing the same growth habit and oval corm shape. All of them except "Ugwuta" or coco-India and Nach produced flowers. On the average, they produced between two and nineteen suckers per stand. The plant girth and number of leaves per stand were positively and significantly correlated with plant height but negatively correlated with the number of suckers/stand. More so, the number of suckers/stand showed highly significant correlation with the number of leaves/stand. The number of cormels/stand was also significantly correlated with the number of suckers/stand. The weight of cormels and corm per stand was positively and significantly correlated with the parameters.

Keywords: *Colocasia esculenta*, cultivars, phenotype, correlation analysis.

Introduction

Cocoyam (*Colocasia sp*) is a monocotyledonous crop that has the character of being an underground stem. It differs from yam as it is not a tuber but a corm. Eatable cocoyam belongs to the family of plants called Araceae with two genera-*Colocasia* (taro) and *Xanthosoma* (tania) (Uguru, 1996).

Taro is a staple food for many people in developing countries in Africa, Asia and the Pacific (Agueguia *et al*., 1992). The corm and cormels which are the major economic parts have a nutritional value comparable to sweet potato (Wang, 1983), while the young leaves and petioles which are occasionally used for food contain about 23% protein on a dry weight basis. It is also a rich source of calcium, phosphorus, iron, vitamin C, thiamine, riboflavin, and niacin which are important constituent of human diet (Onwueme, 1999; Ndom *et al*., 2003). Taro corms and cormels have a high economic value in urban markets. Its production provides employment to many people and the crop maintains good ground cover or canopy in the fields (Talwana, *et al*., 2009).

In spite of the advances made in cocoyam research, several factors remain as challenges to sustain cocoyam production in Nigeria. The ignorance of the nutritive and diversities of food forms from cocoyam by a large percentage of the populace is a major limiting factor to general acceptability and extensive production of the crop. The notion that cocoyam is a poor man's crop is still prevalent and needs to be dispelled through the extension of proper information about the crop. The recycling of planting materials year by year results in the accumulation of pathogens in them and this translates to yield decline with time (NRCRI, 2009). The 11% drop in national production figure between 2000 and 2004 (FAO, 2001, 2004) may not be unconnected with this phenomenon. Therefore, generation of "clean" planting materials through meristerm tip culture and multiplication of these will not only stem this process but also increase yield. A breakthrough in conventional breeding or biotechnology is necessary to develop cultivars with more desirable traits particularly resistance to disease, other than those in local cultivars. This will widen the current narrow genetic base of the crop in the country. Nigerian cocoyam needs to enter the international and trade market to generate foreign exchange for Nigeria (NRCRI, 2009). Asfaw (2006) reported that positive and significant correlation was observed between root fresh yield and root girth, length and diameter of taro and cassava. All taro growth parameters significantly correlated among themselves except for root fresh weight (Nsalambi *et al*., 2011). In view of the above challenges, the objective of this study is to evaluate the morphological differences among five taro cultivars and the correlation between their agronomic traits.

Materials and Methods

The yield experiment was conducted at the Linkage Farm of the University of Nigeria, Nsukka. Nsukka lies on a longitude $6^0 45^l$E and latitude 7^0 12.5^{l}N with altitude 447m above the sea level. Three local cultivars of taro were sourced from the study area (Nsukka) among which were Odogolo, Nworoko and Nach. Two others-Nkpong and Ugwuta (Coco-India) were obtained from National Root Crops Research Institute, Umudike bringing the total number of cultivars to five. NPK 15:15:15 fertilizer was purchased from Enugu State Agricultural Development project station at Nsukka.

A piece of land with a dimension of 11m x 32m was cleared with matchet due to the thickness of the bush. It was stumped with hoe and the dried rubbish burnt to ash. The land was ploughed and harrowed with tractor into ridges. The ridges were prepared into plots of beds manually. Twenty cormels with average weight of 20g were planted on each of the forty five plots. Each plots had a dimension of 3m x 2m with plant spacing of 0.3m x 1.0m. All planting operations took place between 23rd and 24th June, 2008 and 2009 cropping seasons. The experiment was laid out in a randomized complete block design (RCBD). N:P:K 15:15:15: fertilizer was applied at each of the plots at the rate of 200kg/ha at eight weeks after planting (WAP). Weeding was done twice. The first weeding was done at four weeks after planting. The second weeding was done at six (WAP), during which enough plant canopies had been formed to smother weeds.

The following agronomic records on crop attributes were taken: plant height, plant girth, number of leaves and suckers/stand, number of cormels/stand, weight of corm and cormesl/stand and total yield/ha. The height of each of the four sampled plants per plot was measured with a meter rule from the ground level to the leaf apex in site and the plant girth was also measured.

The weight of the corm was also determined by using a calibrated compression scale. The total yield/ha was determined by multiplying the sum of the total weight of corms and cormels/plot by $10,000m^2$ and dividing the result by the area of the plot ($6m^2$).

Soil samples were collected with an auger at the beginning of planting from six locations at the depth of 0-20cm. The samples were properly mixed to get a composite sample from which a subsample was used for laboratory analysis to determine both the physical and chemical properties of the soil. Particles size analysis was down using hydrometer method. Soil pH was determined in calcium chloride in soil solution ratio of 1:2.5 using a glass electrode pH meter. Organic carbon content was determined by wet oxidation method while total nitrogen content was determined by Kjidehal method. Available phosphorous was determined by Bray and Kurtz No.1 method. The exchangeable bases were determined by leaching the soil sample with ammonium acetate at pH 7 to extract the basic cations (Ca, Mg, K and Na). K and Na were determined by flame photometer while Ca and Mg were determined by using EDTA titration method. The daily weather conditions on rainfall, temperature and relative humidity were also collected and recorded.

Correlation analysis was done on the field data collected using Genstat 7.1 Second Edition according to Steel and Torrie, (1980).

Results

Data on rainfall indicated that the mean rainfall for 2009 planting season was higher compared to 2008 while other meteorological parameters were relatively the same (Table 1). The soil was texturally clayey and moderately acidic with a pH of 5.0. The soil was low in organic carbon, organic matter, calcium, phosphorous and moderate cation exchange capacity (CEC) (Table 2).

There were few morphological differences among the five taro cultivars under study. All cultivars except Ugwuta (Coco-India) and Nach did not produce flowers. Nkpong and Odologo produced flowers at three months of maturity while Nworoko took its turn at five months after planting. The five test taro cultivars exhibited erectophilous growth habit. They all have dark green lamina except Nkpong which has pale green lamina and petiole colour whereas "Nkworoko" and Nach have brown petiole colour. Ugwuta has brownish green coloration. All the cultivars are brown in colour at their petiole junction. Their corm shape is oval or egg-shaped with Nkpong, Odologo and Nach have rough skin while Nworoko and Ugwuta have smooth skin. Nkpong has milk flesh colour whereas Odologo, Nworoko and Ugwuta are deep in flesh colour but Nach has light green colour. The test crops mature within six months after planting except Nworoko which matures within five months. Senescence or maturity sets in when the leaves and petioles dry up and wither (Table 3).

Nach was observed to be fairly resistant to taro leaf blight (TLB) while Nkpong, Ugwuta, Nwokoro and Odologo were found to be susceptible. The cultivars can produce suckers numbering from two to nineteen (Table 3). A concomitant observation made on the post harvest storage of the cultivars indicated that Ugwuta (Coco- India) was the most susceptible in the ranking while Nach was the most resistant to corm rot (Table 3). Plant girth recorded positive and highly significant correlation with plant length (Table 4). At 6, 8 and 12 WAP, the number of suckers/stand was negatively correlated with plant height and girth but positively and non-significantly correlated with plant height and girth at 16 WAP. Table 4 also showed that the number of suckers/stand showed positive and significant correlation with number of leaves/stand across the measuring intervals. The number of cormels/stand had positive correlation with plant height and girth but was significantly correlated with other measured attributes. The weight of cormels/stand was positively and significantly correlated with plant height/girth as well as the number of suckers/leaves per stand. In the same vein, the weight of corm/stand had

significant correlation with plant height but positively correlated with plant girth. The same trait showed positive correlation with the number of suckers/leaves per stand with the juvenile stage but became highly significantly correlated with the traits as maturity progressed (Table 4).

Discussion

The agro-meteorological data in Table 1 showed that there were remarkable differences in the mean rainfall and temperature. There was 19.4% reduction in the average rainfall in 2008 and 32.2% reduction in the mean rainfall between August and September, 2009 during which "cormelization" takes place. The variations in these climatic factors might have resulted in the variations expressed in the agronomic traits measured in taro in the two planting seasons.

The increase in the soil fertility through NPK fertilization might have contributed immensely to the positive and significant tuber yield which agreed with the result obtained by Ramon (2008). The highly significant correlation observed between plant height and girth of taro implies that the genes controlling the two growth parameters could be closely related which agrees with the result of an experiment conducted by Nsalambi, *et al*. (2011). The positive and significant correlation between the number of suckers/stand and number of leaves/stand of taro indicated that closely related genes controlled the two parameters. Therefore, an increase in the number of suckers will likely increase the number of leaves/stand which in turns will increase the yield. The positive and significant correlation between the number of suckers and number of cormels also showed that they are likely to be controlled by similar genes. This implies that an increase in the number of suckers/stand will increase the number of cormels/stand. All these results are in tandem with the results obtained by (Asfaw, 2006).

Conclusion

Morphologically, the five cultivars of taro are almost similar except in flower production in which Nkpong, Odologo and Nworoko exhibit flowering ability. So, these three cultivars can be selected for improvement or breeding purposes for better yield and resistance to cocoyam diseases.

Since there was a significant correlation between the number of suckers and the number of cormels as well as total yield, "Odologo" cultivars which produced the highest number of suckers is hereby recommended to farmers in the study area for greater productivity.

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Table 1: Weather records of Nsukka during the periods of the experiments

Month	Rainfall (mm)		Max. Temp.		Min. Temp (^{0}C)		R. H (%)	
	2008	2009	2008	2009	2008	2009	2008	2009
Jan.	0.00	53.59	31.39	31.90	20.32	21.45	56.03	71.39
Feb.	0.00	2.19	34.14	32.46	21.97	22.79	57.16	73.30
Mar.	61.23	0.00	33.77	33.61	22.87	23.32	74.13	72.81
Apr.	143.30	180.60	31.73	31.73	22.00	21.60	74.83	76.20
May	254.01	283.69	31.16	30.23	20.81	21.41	75.00	74.16
June	186.43	152.37	29.83	29.13	21.40	20.83	76.93	74.67
July	246.10	248.17	28.94	28.65	20.84	20.58	78.16	74.84
Aug.	203.20	260.33	27.81	27.48	20.68	20.84	79.55	75.84
Sept	326.02	175.76	27.60	27.87	20.80	20.63	78.67	74.67
Oct.	198.63	387.10	29.48	28.39	20.87	20.26	76.35	74.94
Nov.	08.38	103.18	31.10	29.83	22.00	19.30	74.35	63.80
Dec.	10.98	00.00	31.50	32.70	22.88	30.70	72.93	65.35
Mean	136.52	153.92	30.70	30.31	21.45	21.98	72.88	72.59

Table 2: Physico-chemical properties of the soil of the experimental site before planting.

Parameter	Value
Sand (%)	16.00
Silt (%)	20.00
Clay (%)	64.00
$_P$H (H_20)	5.00
$_P$H (KCl)	4.60
Organic carbon (%)	0.60
Organic matter (%)	1.03
Total Nitrogen (%)	0.05
Exchangeable bases (Meq/100g soil)	
Sodium	0.10
Potassium	0.09
Calcium	1.00
Magnesium	0.80
Cation Exchange Capacity (CEC)	6.00
Base Saturation (%)	33.00
Phosphorus ppm	2.60
Exchangeable Acidity (Meq/100g)	
EA	1.40
Al	1.00
H	0.40

Table 3: Phenotypic Comparison of the test Cocoyam Cultivars

Trait	"Nkpong"	"Odogolo"	"Nworoko"	"Ugwuta"	"Nachi"
Flowering	Often	Often	Often	Rare	Rare
Growth habit	Erect	Erect	Erect	Erect	Erect
Leaf lambina colour	Pale green	Dark green	Dark green	Dark green	Dark green
Petiole colour	Pale green	Pale green	Brown	Brownish green	Brown
Petiole junction colour	Brown	Brown	Brown	Brown	Brown
Corm shape	Oval	Oval	Oval	Oval	Oval
Corm skin	Rough	Rough	Smooth	Smooth	Rough
Flesh colour	Milk colour	Deep green	Deep green	Deep green	Light green
Time to maturity	6 months	6 months	5 months	6 months	6 months
Taro leaf Bright	Susceptible	Less susceptible	Resistant	Resistant	Resistant
Sucker production	2-5	4-19	2-9	3-9	2-9
Fungal attack	Severe	Less Severe	More Severe	Most Severe	Least Severe
Corm rot	Fairly resistant	Less resistant	More susceptible	Most susceptible	Least susceptible

Table 4: Correlation analysis of the measured physical traits of *Colocasia esculenta*

TRAITS	PH10	PG10	PS6	PL6	PS8	PL8	PS12	PL12	PS16	PL16	NC/P	WC/P	WCC/P	TY/P
PH10	1													
PG10	648**	1												
PS6	-88	-128	1											
PL6	341**	251*	820**	1										
PS8	-50	54	420**	458**	1									
PL8	321**	-159	602**	728**	802**	1								
PS12	-76	-9	260*	167	645**	450**	1							
PL12	-81	139	392**	293**	717**	568**	828**	1						
PS16	197	118	111	27	531**	310**	869**	771**	1					
PL16	30	78	286**	172	640**	482**	931**	891**		1				
NC/P	34	83	223*	115	486**	465**	689**	794**	638**	747**	1			
WC/P	35	47	187	90	508**	346**	702**	801**	660**	732**	931**	1		
WCC/P	222*	89	48	91	342**	122	521**	561**	508**	487**	650**	770**	1	
TY/P	52	60	157	51	515**	312**	691**	803**	629**	713**	903**	978**	808**	1

PH_{10} = Plant height at 10 WAP , PG_{10}= Plant girth at 10 WAP, PS_6=Number of suckers/plant at 6 WAP, PS_8=Number of suckers/plant at 8 WAP, PS_{12}=Number of suckers/plant at 12 WAP , PS_{16} =Number of suckers/plant at 16 WAP, PL_6=Number of leaves/plant at 6 WAP, PL_8=Number of leaves/plant at 8 WAP, PL_{12}=Number of leaves/plant at 12 WAP, PL_{16}=Number of leaves/plant at 16 WAP, NC/P =Number of cormels/plant, WC/P=Weight of cormels/plant, WCC/P =Weight of corm/plant, TY/P=Total Yield/plant