I J T A © Serials Publications

National Academy of Agricultural Science (NAAS) Rating : 3. 03

Evaluation of Elephant foot yam (*Amorphophallus paeoniifolius*) germplasm : polymorphism among morphological traits

Poddar A. and Mukherjee A*

ABSTRACT: *Elephant foot yam (Amorphophallus paeoniifolius) is an important food and vegetable crop. High yield and dry matter content with minimum input and prolonged period of storage makes it an ideal crop for livelihood security. Collection and evaluation for superior genotypes is imperative for future crop improvement in elephant foot yam. 33 genotypes of elephant foot yam were evaluated for their pre and post harvest morphological characters. Wide range of variations due to genotypes for all the traits indicate the prevalence of considerable variation among the collections. Polymorphism is pre-requisite for breeding of elephant foot yam. The genotypes Pallavaram, AM-42, Ambajipeta, Veeravada and Kothagudem were found to have considerable polymorphism in morphological traits. These genotypes along with other three local collections showed maximum storability in shaded conditions (8-12 months). Pest and disease incidences were found to be minimum (0-5%) in these eight genotypes. Cluster analysis revealed two major groups and narrow genetic base among the studied genotypes. Similarly, characters extracted by principal component analysis were used to generate a scatter plot. The distribution pattern of dendrogram and scatter plot was found to be similar. Characters like plant height, weight of corm, number of cormels, corm flesh colour and canopy spread were identified with high polymorphism and can be exploited for characterization and genetic advancement of elephant foot yam.*

Keywords: *Germplasm, Elephant foot yam, Morphological traits, cluster analysis*

INTRODUCTION

Amorphophallus paeoniifolius (Dennst.), Nicolson commonly called as elephant foot yam is a herbaceous, perennial crop. South Eastern Asia is its centre of origin. The tubers are rich in starch as well as protein, calcium, (50 mg g^{-1}), phosphorus (34 mg g^{-1}) and vitamin A (260 IU g^{-1}) [AICRP, 2006]. It is used as staple food in countries like Philippines, Java, Indonesia, Sumatra, Malaysia, Bangladesh, India, China and southeastern Asian countries (Chandra, 1984). The commercial cultivation of this crop is fast gaining importance due to its yield potential (50-80 t ha^{-1}), food, nutrition efficiency and wide adaptability. In India, it is cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, Jharkhand and in some pockets of north-eastern states. Wild and local cultivars are also grown along with commercially released varieties like Gajendra, Sree Padma, Sree Athira (a hybrid), Bidhan Kusum and NDA-9. Further genetic advancement of the crop requires systematic classification and evaluation of the available genetic diversity to realize its potential towards food and nutrition security.

METHODOLOGY

Thirty three genotypes of elephant foot yam maintained at Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar were evaluated during 2010-11 in randomized block design with three replications. Genotypes were maintained following standard package of practices. Observations were collected from randomly selected 9 plants of each variety. The morphological characteristics were scored in accordance with standard descriptors. Altogether, 27 pre-harvest and post-harvest characters were scored. The mean of the data pertaining to quantitative characters were taken for multivariate analysis. Principal component analysis (PCA) with varimax rotation was done using SPSS 17.0, 2004 while cluster analysis and scatter plot depicting principal component scores were plotted using Genstat (DE3), 2007. In PCA the scored characters

* ICAR-Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar, Odisha, India, *E-mail- archanapsm2@ rediffmail.com*

were extracted in factors. The number of factors was based on proportion of total variance explained. Scatter plots were plotted using two main principal component scores. Hierarchical cluster analysis with city block distance and average linkage algorithm was used to evaluate clustering pattern of the genotypes.

RESULTS AND DISCUSSIONS

The distribution of genotypes among the states are unimodal for most of the traits, though some traits showed polar distribution. Analysis based on morphological traits showed low polymorphism and high correlations among the genotypes. Principal component analysis (PCA) using varimax rotated component matrix revealed correlation (Table.1) among the morphological traits observed. Nine components were extracted by PCA. These 9 components loaded 20 traits (Table 1).

The shoot growth parameters were loaded in the first component and accounts for 18.89% of total variance. Traits like pseudostem height, canopy spread and length/breadth of primary branches are loaded in the first component. All the characters are quantitative in nature. Similarly, Second component were represented by yield parameters like corm size and corm weight (Table.2). The characters of the second component are also quantitative in nature. The second component accounts for 14.78% of total variance explained. The quantitative nature of the first two components indicate the influence of environment and gene interactions on growth and yield of the crop. As reported earlier, the growth is influenced by size of the corm used as planting material (Das *et. al.,* 1995, Kabeerathumma *et. al.*, 1987), plant spacing and plant density (Das *et. al.,* 1997, George J and Nair, 1993, Geetha, 2001, Mohankumar *et. al.*, 1973), soil type and fertilizer dose (Mukhopadhyay and Sen, 1986), region of the corm used as minisett (Mondal *et. al.,* 2004) and intercultural practices.

Table 1
Total variance of observed morphological characters by PC analysis

Total Variance Explained

Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	5.101	18.893	18.893	5.101	18.893	18.893	3.629	13.441	13.441
2	3.993	14.788	33.681	3.993	14.788	33.681	3.035	11.241	24.683
3	3.124	11.570	45.251	3.124	11.570	45.251	2.698	9.993	34.676
4	2.519	9.328	54.579	2.519	9.328	54.579	2.400	8.887	43.563
5	1.933	7.160	61.739	1.933	7.160	61.739	2.380	8.814	52.377
6	1.680	6.224	67.963	1.680	6.224	67.963	2.340	8.666	61.043
7	1.423	5.270	73.233	1.423	5.270	73.233	2.256	8.354	69.397
8	1.211	4.486	77.719	1.211	4.486	77.719	2.014	7.459	76.856
9	1.108	4.105	81.823	1.108	4.105	81.823	1.341	4.967	81.823

Extraction Method: Principal Component Analysis.

Stem characters like number of secondary branches and psuedostem surface were represented in the third component. Leaf characters were represented in fourth and fifth components, whereas corm quality attributes were loaded as six, eight and nine components. Rachis characters were loaded in seventh component. The nine components accounts cumulatively for 81.82% of total variance explained (Table.1). Thus, the present study identifies growth parameters (Component-1) and yield parameters (Component-2) as most important traits in determining variation. These agronomic traits can further be used as selection criteria in determining superiority and to augment future breeding programmes. Further, the variance explained by growth components is more than that of yield component indicating the importance of growth parameters in suitable selection.

The 33 genotypes were plotted against principal components 1 and 2 pertaining to growth and yield parameters respectively. The scatter plot (Fig.1) shows the tendency of genotypes from similar geographical location to be grouped together, indicating narrow genetic base within the group and considerable variation among the groups. The genotypes laying at the positive side of both the principal component axes can be taken as superior types for both growth and yield parameters. Accordingly, the genotypes like Pallavaram, AM-42, Ambajipeta, Veeravada and Kothagudem were found to be promising for both growth and yield.

Table 2
Component wise loading of morphological traits based on variance derived by PCA

Component	*Morphological traits*
1	Pseudostem height, canopy spread, length/ breadth of primary branches
2	Corm size, corm weight
3	No. of secondary branches, surface of psuedostem
4	Emergence ratio, Leaflet size, leaflet number
5	Leaf spot, stalk of leaflet
6	Corm shape, corm flesh colour, cormel flesh colour
7	Nature of rachis, shape of rachis
8	Corm skin colour, Cormel skin colour
9	Corm surface hairiness

Further, these five genotypes along with 70/89, 64/89 and BBSR-4 showed minimum disease and pest incidence (0-5%) along with high storability (8-12 months) in shaded conditions. The yield of these eight genotypes was also found to be high (21.8-25.33 t/ ha), with Veeravada registering the highest yield.

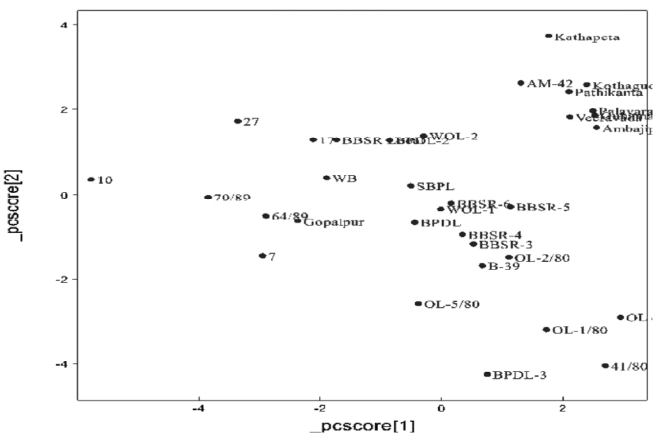

Figure 1: PCA derived scatter plot of 33 elephant foot yam genotypes

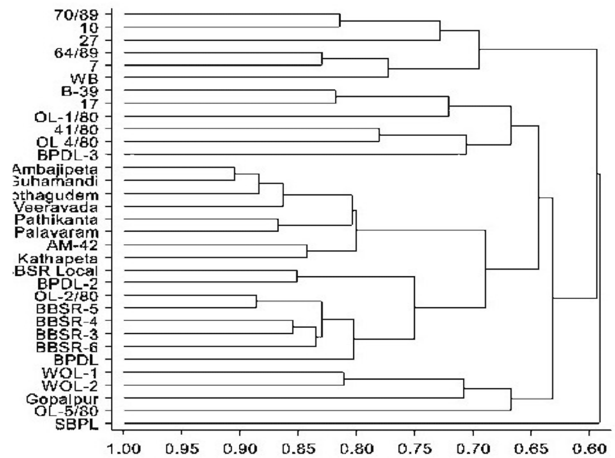

Figure 2: Scatter plot distribution of elephant foot yam genotypes

The UPGMA derived cluster confirms the scatter plot distribution of the genotypes. The cluster also indicates the tendency of genotypes from similar geographical area tends to be grouped together (Fig. 2) 33 genotypes are grouped under two major groups (Table.3) with strong affiliation towards geographical area of collection. One genotype Sambalpur Local was grouped as an outlier and comes under group II. Maximum number of genotypes were in major group I. The major group I has four sub-groups. The sub-group 3 has two clusters, the genotypes collected from Andhra Pradesh and superior genotypes from Odisha in terms of disease and pest incidences were loaded in these two clusters. Thus, the superior genotypes performing well have low genetic base.

This pattern indicates narrow genetic base among varieties with similar geographical base as well as superior performance. There was no duplicates among genotypes under study as revealed by both scatter plot and dendrogram.

Table 3
Clustering of elephant foot yam genotypes in dendrogram

Major group	*Sub group*	*Cluster*	*Genotype*	*No. of genotypes*
I	1	I	10, 70/89, 27	3
		II	64/89, 7, WB	3
	2	III	B-39, 17, OL-1/80	3
		IV	41/80, OL 4/80, BPDL-3	3
	3	V	Ambajipeta, Guhamandi, Kothagudem, VeeravadaPathikanta, Palavaram, AM-42, Kathapeta	8
		VI	BBSR Local, BPDL-2, OL-2/80, BBSR-5BBSR-4, BBSR-3, BBSR-6, BPDL	8
	4	VII	WOL-1, WOL-2, Gopalpur, OL- 5/80	4
II		VIII	SBPL	1

Further, similar distribution of genotypes in both scatter plot and dendrogram indicates the variation explained by growth and yield parameters in principal component analysis can characterize the genotypes. The growth components showing more variation can be taken as a predictive criteria to select superior genotypes in terms of yield. The eight genotypes selected shows greater growth parameter values and subsequently found to be superior in the present study in terms of yield, storability and biotic stress susceptibility.

CONCLUSIONS

The present study offers a cross section of morphological polymorphism of elephant foot yam germplasm. There was no duplicate found among the genotypes studied. Polymorphism is low among the genotypes collected from similar geographical area. Among the thirty-three genotypes, eight genotypes are being identified as superior based on growth and yield parameters. These genotypes found to have longer storability (8-12 months) with less disease and pest incidence (0-5%). These results can be utilized to augment breeding especially in the context of climate change Vs food security.

ACKNOWLEDGEMENT

The financial support of PPV & FRA, Govt. of India, New Delhi is gratefully acknowledged for the present study.

REFERENCES

All India Coordinated Research Project on Tuber Crops, (2006), Region specific technologies for tropical root and tuber cropsin India. (Palaniswami, M.S. and Shirly Raichal Anil, (eds.), Tech. Bul. Ser., No. 47. p. 67.

Chandra, S. (1984), Edible aroids. Clarendor Press, Oxford, p. 252.

Das, P. K., Sen, H., Banerjee, N. C. and Panda, P. K. (1995), Light interception, yield attributes and seed corm production of elephant foot yam as influenced by varying plant densities and sett sizes. *J. Root Crops,* 21: 90–96.

Das, P. K., Sen, H., Banerjee, N. C. and Panda, P. K. (1997), Biomass production and growth rate at different phenophases of elephant foot yam as influenced by chemical treatments. *Indian J. Agric. Res.*, 31: 115 – 121.

Geetha, K. (2001), Nutrient management in Amorphophalus grown as inter crop in reclaimed alluvial soils of Kuttanad, Kerala. *J. Root Crops,* 27: 263-266.

George J and Nair, G. M. (1993), Influence of spacing and seed corm size on yield and yield attributes of elephant foot yam. *J. Root Crops*, 19: 57 - 59.

Kabeerthumma, S., Mohankumar, B. and Nair, P.G. (1987), Nutrient uptake and their utilization by yams aroids and coleus. Technical Bulletin No. 10. Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India.

Mohankumar, C. R., Mandal, R. C. and Singh, K. D. (1973), Effect of mulching and plant density on growth, yield and quality of Amorphophallus. *Indian J. Agron.*, 18: 62 – 66.

Mondal, S. and Sen, H. (2004), Seed corm production of elephant foot yam through agronomical manipulation. *J. Root Crops*, 30: 115 – 119.

Mukhopadhayay, S K. and Sen, H. (1986), Effect of nitrogen and potassium on yield and quality of elephant foot yam (Amorphophallus campanulatus Blume). *J. Root Crops*, 12: 103-106.