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Genetic characterization of seedling progenies of elephant foot yam *Amorphophallus paeoniifolius* (Dennst.) for quantitative traits through principal component analysis

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Abstract
A total of twenty six seedling progenies of elephant foot yam were evaluated for 24 quantitative characters at Horticultural Research Station, Kovvur to determine the pattern of variation, relationship among the individuals and their characteristics. The principal component analysis reduced the data set into seven principal components which explained 84.61% percent towards variability. The first principal component analysis accounted a maximum of 27.3% of the total variation and contributed by discriminating traits of pseudo-stem height, plant height, breadth of largest leaflet, height of corm and thickness of pseudo-stem base. In general, this study reveals the presence of diversity among 26 seedling progenies of elephant foot yam which can give opportunity for genetic improvement for desirable characters.

Keywords: Principal component, elephant foot yam, variability, genetic improvement

Introduction
Amorphophallus paeoniifolius (Dennst.) is a herbaceous monoecious C_3 crop and is an important tuber crop of tropical and subtropical regions. It serves as a source of protein as well as starch. It has been used as a local staple food in many countries like Philippines, Java, Indonesia, Sumatra, Malaysia, Bangladesh, India, China and South Eastern Asian countries. Owing to its production potential and popularity as a vegetable in various delicious Indian cuisines, it is commercially cultivated in India in the states of Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh and Jharkhand. In the Northern and Eastern states of India local cultivars grown in wild form are generally being used for making vegetable pickles and indigenous for various ailments. Because of its high yield potential, culinary properties medicinal utility and therapeutic values it is referred to as King of tuber crops (Sengupta *et al.* 2008) [5]. The production potential of this crop varies from 50-60 t /ha and net economic return is over 1 lakh rupees per ha (Ravi *et al*., 2009) [4]. This crop also offers export potential since it is not commercially cultivated in other countries (Misra and Shivalingaswamy, 1999, Misra *et al*., 2001) [1, 2]. Elephant foot yam is a highly cross pollinated and vegetatively propagated crop. Though it is reported to be a highly cross pollinated crop, sexual reproduction is reported to be very rare due to scarce flowering, non -synchronization of flowers and the presence of extreme protogyny and hence the vegetative propagation is in common practice.

The knowledge of genetic diversity is very important for conservating, evaluating and utilising genetic resources in breeding programmes such as breeding for required quality, increasing yield, pests and disease resistance. Principal component analysis is one of the important techniques useful for characterisation, evaluation and classification of plant genetic resources based on morphological and agronomic traits when large of accessions are to be assessed for several characters (Peeters and Martinelli, 1989) [3]. This procedure permits to establish the relationship among the variables and to determine how the plants vary in terms of all variables considered together.

Materials and Methods

The experimental material consists of 26 seedling progenies of elephant foot yam which were being maintained at Horticultural Research Station, Kovvur. Experiment was laid out in an augmented block design consisting of four augmented blocks with six entries per each block. The standard package of practices were followed to raise the crop. Morphological observations for all the 24 quantitative characters were recorded on five randomly selected plants of each accession. Principal component analysis was carried out to find out the relative importance of different traits in capturing the variation.

Results and Discussion

In the present study, the genetic variation present among the accessions was divided into seven principal components with eigen values more than one which contributed 84.61 percent towards the variability. The principal component with eigen values less than one were considered as non-significant. It is therefore inferred that the essential features of the data set had been represented in the first seven principal components in table 1 and 2. The first principal component (PC I) contributed maximum towards variability (27.389)and the characters *viz.*, pseudo-stem height (0.339), plant height (0.334), breadth of largest leaflet (0.301), height of corm (0.294), thickness of pseudo-stem base (0.284) explained the maximum variance in this component. The second principal component (PC II) described 16.56 percent of total variance and the characters *viz.*, weight of cormels per plant (0.354), length of cormel (0.352), thickness of cormel (0.320), number of leaflets per primary partition (-0.318) explained the maximum variance. The third principal component PC III was characterised by 13.422 percent contribution towards variability and the characters *viz.*, number of primary partitions (0.395), diameter of corm (0.082), pseudo-stem height (0.058), plant height (0.054) contributed in a positive way, whereas number of secondary partitions (-0.39) showed negative correlation towards the total variability. The fourth principal component PC IV was characterised by 10.638 percent contribution towards the total variability and showed high loadings for the characters., days to senescence (0.372), fresh weight of corm (0.256) and yield (0.256) in a positive way, whereas the trait oxalates percent (-0.442) showed negative correlation towards the variability. The fifth principal component PC V was characterised by 7.146 percent contribution towards the variability. The characters length of largest leaflet (0.459), oxalates percent (0.369) has shown the highest positive contribution towards variability and the traits breadth of primary partition (-0.458), length of primary partition (-0.403) and starch content (-0.314) has shown the negative correlation towards the total variability. The sixth principal component PC VI explained about 5.383 percent variability. The characters *viz.*, starch percent (0.601), breadth of largest leaflet (0.286), number of leaves per rachis (0.258), diameter of corm (0.240) has contributed towards the variability, whereas the trait number of leaflets per rachis (-0.269), fresh weight of corm per plant (-0.242) has shown the negative correlation towards the variability.

Table 1: Eigen values, per cent variability and cumulative variability for principal components of morphological characters in elephant foot yam

Sl. No.	Principal component	Eigen value (Root)	Percent variation explained	Cumulative variation explained
1	1 Vector	6.57	27.38	27.38
2	2 Vector	3.97	16.56	43.94
3	3 Vector	3.22	13.42	57.37
4	4 Vector	2.55	10.63	68.00
5	5 Vector	1.71	7.14	75.15
6	6 Vector	1.29	5.38	80.53
7	7 Vector	0.97	4.07	84.61

Table 2: Character loading of principal components for morphological characters in elephant foot yam

Sl. No.	Character	1 Vector	2 Vector	3 Vector	4 Vector	5 Vector	6 Vector	7 Vector
1	Plant height (cm)	0.333	0.085	0.054	0.112	0.074	0.055	0.142
2	Pseudo-stem height(cm)	0.339	0.075	0.057	0.119	0.050	0.117	0.142
3	Thickness of pseudo-stem base (cm)	0.284	0.078	-0.127	-0.244	-0.029	-0.144	-0.056
4	Leaves per rachis	0.004	0.08	-0.211	0.100	-0.126	0.257	-0.689
5	Leaflets per rachis	0.194	0.045	-0.144	-.0429	-0.011	-0.268	-0.220
6	Primary partitions	-0.025	0.299	0.395	-0.058	-0.003	-0.073	-0.161
7	Secondary partition	0.014	-0.310	-0.391	0.058	0.006	0.071	0.141
8	Tertiary partitions	0.069	-0.310	-0.285	-0.066	0.143	-0.175	-0.107
9	Length of primary partition (cm)	0.209	0.175	-0.142	-0.222	-0.402	-0.081	0.084
10	Breadth of primary partition (cm)	0.160	0.211	-0.051	-0.189	-0.457	-0.004	0.255
11	Leaflets/primary partition	0.066	-0.317	-0.232	-0.047	-0.211	-0.002	0.148
12	Length of largest leaflet (cm)	0.219	-0.109	0.000	-0.131	0.458	0.137	-0.177
13	Breadth of largest leaflet (cm)	0.300	-0.004	0.048	-0.211	-0.001	0.286	-0.051
14	Days to senescence	0.142	-0.044	-0.226	0.371	0.044	-0.190	0.218
15	Fresh weight of corm per plant (kg)	0.307	0.050	-0.072	0.256	0.002	-0.242	-0.209
16	Height of corm (cm)	0.293	0.159	0.048	0.076	0.141	0.179	0.082
17	Diameter of corm (cm)	0.266	0.109	0.081	0.147	0.150	0.239	0.187
18	Cormels per corm	-0.122	0.310	-0.335	0.134	0.117	-0.072	0.001
19	Weight of cormels per corm (g)	-0.107	0.353	-0.260	-0.092	0.124	-0.017	0.038
20	Length of cormel (cm)	-0.143	0.351	-0.265	-0.068	0.100	0.022	-0.021
21	Thickness of cormel (cm)	-0.141	0.320	-0.276	0.157	0.091	0.160	0.147
22	Yield (t/ha)	0.307	0.050	-0.072	0.256	0.002	-0.242	-0.209
23	Starch (%)	0.027	-0.091	-0.145	0.098	-0.313	0.600	-0.136
24	Oxalates (%)	0.014	-0.02	-0.149	-0.441	0.369	0.196	0.164

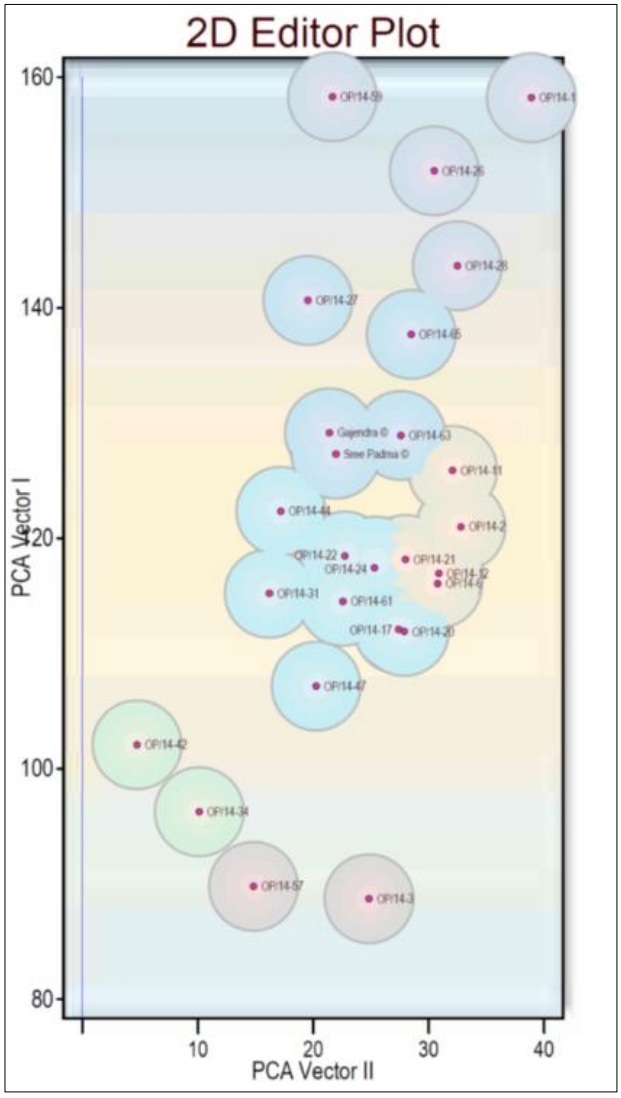

Fig 1: Relative position of elephant footyam accessions based on PCA scores of growth and yield parameters

The seventh principal component PC VII has described 4.075 percent variability. Among the characters breadth of primary partition (0.255), days to senescence (0.219) and diameter of corm (0.187) has shown positive correlation towards the variability whereas the number of leaves per rachis (-0.689), number of leaflets per rachis (-0.220) and fresh weight of corm (-0.209) has exhibited negative correlation towards the variability.

Results thus obtained from PCA using correlation matrix of the traits reduced the dimensionality of the data set by creating seven significant principal components having eigen values more than one. The analysis thus identified that maximum contributing variables for diversity were pseudo-stem height (0.339) and plant height (0.334) for PCA-1. In all the seven components, Plant height, pseudostem height, height of cprm and diameter of corm contributed positively to the total variation and hence these characters can be used for selection in crop improvement programme.

Conclusion

From the above study, it can be inferred that presence of trait diversity among seedling progenies of elephant foot yam suggests that there is oppurtunity for genetic improvement through selection directly from accessions and selection of diverse parents for hybridization programme and conservation of germplasm for future utilization.

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