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Genetic Variation in the Agro-morphological Traits of Elephant Foot Yam (*Amorphophallus paeoniifolius*)

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Abstract

An experiment was conducted using 21 germplasm of Elephant foot yam including one national check to find out genetic divergence among the collected genotypes. The experiment was carried out at T.C.A., Dholi Research Farm of Dr. R.P.C.A.U., Pusa, Samastipur, Bihar, in a completely Randomized Block Design with two replications during 2018. Data were collected for ten characters viz., days to sprouting, pseudostem length (cm), pseudostem girth (cm), leaf canopy diameter (cm), chlorophyll content (SPAD value), calcium oxalate (mg/100gm), dry matter (%), days to maturity, no. of cormels per plant and corm weight per plant (kg.). Analysis of variance revealed highly significant differences among the germplasm for all the ten characters under study. Maximum range was found for the characters like pseudostem length followed by leaf canopy diameter, days to sprouting, days to maturity, chlorophyll content, pseudostem girth and no. of cormels per plant. The phenotypic coefficient of variance was greater than genotypic coefficient of variance for all the characters under study and high magnitude of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for traits like no. of cormels per plant followed by corm weight per plant, pseudostem length, days to sprouting, pseudostem girth, calcium oxalate, chlorophyll content and leaf canopy diameter indicating that these traits could be used for corm yield improvement. High estimates of heritability coupled with high genetic advance expressed as percentage of mean were observed for characters like days to sprouting, pseudostem length, pseudostem girth, leaf canopy diameter, chlorophyll content, calcium oxalate, no. of cormels per plant and corm weight per plant indicating effectiveness of selection due to preponderance of additive gene action for these traits and direct selection may be effective.

Key words: Elephant foot yam, genetic variation, PCV, GCV, heritability, genetic advance

Introduction

Tuber crops play an important role in food and nutritional security apart from generating income, employment and livelihood opportunities. Besides they show potential as sources of alcohol, starch, sago flour, glucose, animal feed and as raw materials for many other industrial products. Tuber crops have higher biological efficiency as food producers and show the highest rate of dry matter production per day per unit area among all the crops (Basant Ram, 2008). Botanically, it is an underground stem tuber, grown as a summer vegetable and harvested at the time when there is a scarcity of vegetables in the market. Among tuber crops, Elephant foot yam is known to possess cheap source of energy especially for the weaker sections of the society. It has high photosynthetic efficiency as well as capability to yield economically under poor, marginal soil and changing climatic conditions. In India, it is commonly known as *Suran or Zimmikand* and is traditionally cultivated on commercial scales in the states of Bihar, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, West Bengal and Kerala.

Considering the potentiality of the crop, there is a prime need for developing varieties suited to specific agro-ecological conditions. Genetic variability is the basic

requirement for crop improvement as it provides wider scope for selection particularly in clonal crops. Loss of locally adapted landraces has been rapid and thus, loss of variability is almost universal, which need to be maintained. Information regarding genetic variability present in a population, and estimation of variability parameters is pre-requisite for planning an effective breeding programme for the improvement of crop like elephant foot yam.

Materials and Methods

The present study was carried-out to estimate the genetic variability present in 21 genotypes of elephant foot yam, obtained from field gene bank maintained at TCA, Dholi, including Gajendra variety as National check (Table 1). The experiment was conducted in Randomized Block Design (RBD) in two replications at T.C.A., Dholi Research Farm of Dr. R.P.C.A.U., Pusa, Samastipur, Bihar. The observations were recorded on five randomly selected plants of each entry and replication by using standard procedures and their mean values were used for statistical analysis. Data were collected for ten characters described in the list given in Table 2.

Table 2. List of ten quantitative characters studied

Sl. No.	Characters
1	Days to sprouting
2	Pseudostem length (cm)
3	Pseudostem girth (cm)
4	Leaf canopy diameter (cm)
5	Chlorophyll content (SPAD)
6	Calcium oxalate (mg 100 g^{-1})
7	Dry matter (%)
8	Days to maturity
9	No. of cormels per plant
10	Corm weight per plant (kg)

The field experiment was carried out with all recommended agronomic practices. The genotypes used are being maintained in the field gene bank. The

Table 1. List of elephant foot yam genotypes and their sources of collection

Sl. No.	Code used	Place of collection	Accession number	Place of maintenance
1	TCA EFY-1	Banmankhi, Purnea, Bihar	593138	Germplasm,T.C.A. Dholi
2	TCA EFY-2	Banmankhi, Purnea, Bihar	593139	Germplasm,T.C.A. Dholi
3	TCA EFY-3	Banmankhi, Purnea, Bihar	593140	Germplasm,T.C.A. Dholi
4	TCA EFY-4	Parora, Purnea, Bihar	593141	Germplasm,T.C.A. Dholi
5	TCA EFY-5	Sukhash, Madhepura, Bihar	593142	Germplasm,T.C.A. Dholi
6	TCA EFY-6	Belwa, Kishanganj, Bihar	593143	Germplasm,T.C.A. Dholi
7	TCA EFY-7	Kursela, Katihar, Bihar	593144	Germplasm,T.C.A. Dholi
8	TCA EFY-8	Pachgacchiya, Saharsa, Bihar	593145	Germplasm,T.C.A. Dholi
9	TCA EFY-9	Manihari, Katihar, Bihar	593146	Germplasm,T.C.A. Dholi
10	TCA EFY-10	Barsoee, Katihar, Bihar	593147	Germplasm,T.C.A. Dholi
11	TCA EFY-11	Manihari, Katihar, Bihar	593148	Germplasm,T.C.A. Dholi
12	TCA EFY-12	Manika, Muzaffarpur, Bihar	593149	Germplasm,T.C.A. Dholi
13	TCA EFY-13	Manika, Muzaffarpur, Bihar	NA*	Germplasm,T.C.A. Dholi
14	TCA EFY-14	Manika, Muzaffarpur, Bihar	NA	Germplasm,T.C.A. Dholi
15	TCA EFY-15	Samastipur, Bihar	NA	Germplasm,T.C.A. Dholi
16	TCA EFY-16	Samastipur, Bihar	NA	Germplasm,T.C.A. Dholi
17	TCA EFY-17	Samastipur, Bihar	NA	Germplasm,T.C.A. Dholi
18	TCA EFY-18	Muraul, Muzaffarpur, Bihar	NA	Germplasm,T.C.A. Dholi
19	TCA EFY-19	Muraul, Muzaffarpur, Bihar	NA	Germplasm,T.C.A. Dholi
20	TCA EFY-20	Muraul, Muzaffarpur, Bihar	NA	Germplasm,T.C.A. Dholi

*Accession number not obtained.

germplasm collection places and accession numbers received for first 12 genotypes are given in Table1.

Results and Discussion

The variability observed for any character is due to differences in the genetic constitution of the population as well as variation arising due to environmental conditions. The genetic variability was determined with the help of certain genetic parameters viz., analysis of variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and heritability estimates coupled with genetic advance.

The analysis of variance indicated the highly significant differences in mean sum of squares among the germplasm observed for most of characters except for days to maturity which exhibited significant differences at 5% level of significance. Several earlier workers, such as Singh et al. (2008), Singh and Tripathi (2012), Poddar et al. (2015) also reported significant variability for different characters in elephant foot yam. Characters with high range of variation with high mean have ample scope of improvement through simple selection in desired direction. The range of differences were found comparatively wider for leaf canopy diameter, pseudostem length, days to maturity, days to sprouting and chlorophyll content showing greater extent of variability among germplasm accessions for these characters. While, for rest of the characters the range of differences were comparatively narrow indicating less variability among the germplasm of elephant foot yam for these characters (Table 1).

Wide range of phenotypic variances and genotypic variances was observed in the experimental materials studied and phenotypic variance was higher than the genotypic variance for all the characters (Table 2). Similar findings in elephant foot yam regarding the role of environmental effect in expression of these quantitative characters have been reported earlier by Paul and Bari (2013), Singh et al. (2008). The maximum phenotypic and genotypic variance exhibited by the traits like pseudostem length, leaf canopy diameter, days to sprouting and days to maturity offering ample scope for selection of these traits in development of suitable varieties.

The estimates of genotypic (GCV) and phenotypic (PCV) coefficients of variation in Table 4, indicated that the values of PCV were higher than GCV due to interaction of the germplasm with the environmental factors influencing the expression of these characters. The higher GCV and PCV were recorded for no. of cormels per plant, corm weight per plant, pseudostem length, days to sprouting and pseudostem girth. Higher estimated value of GCV and PCV for number of cormels and corm weight per plant were reported by Podar et al. (2015) and Singh et al. (2008) while for pseudostem length and girth by Singh and Tripathi (2012) in case of elephant foot yam. In the present study, moderate values of GCV and PCV were observed for calcium oxalate, chlorophyll

Table 3. Mean squares, mean and range for ten characters in elephant foot yam

Sl. No.	Characters	Mean squares		Mean	Range
		Treatment (d.f. = 20)	Error (d.f. = 20)		
1	Days to sprouting	166.1452**	5.4452	39.95 ± 1.65	26.50-53.50
2	Pseudostem length (cm)	475.9027**	53.5234	55.35 ± 5.17	32.60-89.50
3	Pseudostem girth (cm)	15.7503**	3.6853	11.54 ± 1.35	7.20-18.65
4	Leaf canopy diameter (cm)	381.3149**	72.0249	103.94 ± 6.00	78.50-134.10
5	Chlorophyll content (SPAD)	50.8074**	13.1414	32.35 ± 2.56	22.20-40.15
6	Calcium oxalate (mg 100 g^{-1})	4.5461**	0.2155	7.88 ± 0.32	4.94-10.93
7	Dry matter (%)	3.8941**	0.9125	20.94 ± 0.67	17.10-23.10
8	Days to maturity	157.7809*	64.4809	190.73 ± 5.67	178.00-208.00
9	No. of cormels per plant	9.2552**	0.5762	4.70 ± 0.53	1.40-8.25
10	Corm weight per plant (kg)	0.2346**	0.0279	1.09 ± 0.11	0.43-1.60

* Significant at 5 % level of probability ** Significant at 1% level of probability.

Table 4. Estimates of genetic parameters for ten characters in elephant foot yam

Sl. No.	Characters	σ^2g	σ^2p	GCV	PCV	h^2(Broad sense %)	Genetic advance as % of mean
1	Days to sprouting	80.35	85.79	22.43	23.18	94.00	44.73
2	Pseudostem length (cm)	211.19	264.71	26.25	29.39	80.00	48.31
3	Pseudostem girth (cm)	6.032	9.72	21.28	27.007	63.00	34.54
4	Leaf canopy diameter (cm)	154.64	226.67	11.96	14.48	68.00	20.36
5	Chlorophyll content (SPAD)	18.83	31.97	13.41	17.48	59.00	21.21
6	Calcium oxalate (mg 100 g^{-1})	2.16	2.38	18.67	19.58	91.00	36.68
7	Dry matter (%)	1.49	2.40	5.83	7.40	62.00	9.46
8	Days to maturity	46.65	111.13	3.58	5.53	42.00	4.78
9	No. of cormels per plant	4.34	4.92	44.30	47.15	88.00	85.74
10	Corm weight per plant (kg)	0.10	0.13	29.26	32.97	79.00	53.48

σ^2g = Genotypic variance, σ^2p = Phenotypic variance, GCV = Genotypic Coefficient of Variation, PCV = Phenotypic Coefficient of Variation, h^2 = heritability.

content and leaf canopy diameter. Whereas, lower GCV and PCV estimates were observed for dry matter percentage and days to maturity.

The genetic parameters like heritability (in broad sense) and genetic advance as percent of mean were worked out for ten quantitative characters in population of 21 germplasm of elephant foot yam as presented in Table 4 and Fig.1. The results revealed that high heritability estimates (in %) were recorded for days to sprouting (94.00), calcium oxalate (91.00), no.of cormels per plant (88.00), pseudostem length (80.00), corm weight per plant (79.00), leaf canopy diameter (68.00), pseudostem girth (63.00) and dry matter (62.00). While, moderate heritability was recorded for chlorophyll content (59.00) and days to maturity (42.00). The estimates of genetic advance expressed as percentage of mean were found high for no. of cormels per plant (85.74), followed by corm weight per plant (53.48), pseudostem length (48.31), days to sprouting (44.73), calcium oxalate (36.68), pseudostem girth (34.54), chlorophyll content (21.21) and leaf canopy diameter (20.36). It was low for dry matter (9.46) and days to maturity (4.78). Similar results have been also reported earlier for corm weight per plant, no. of cormels per plant

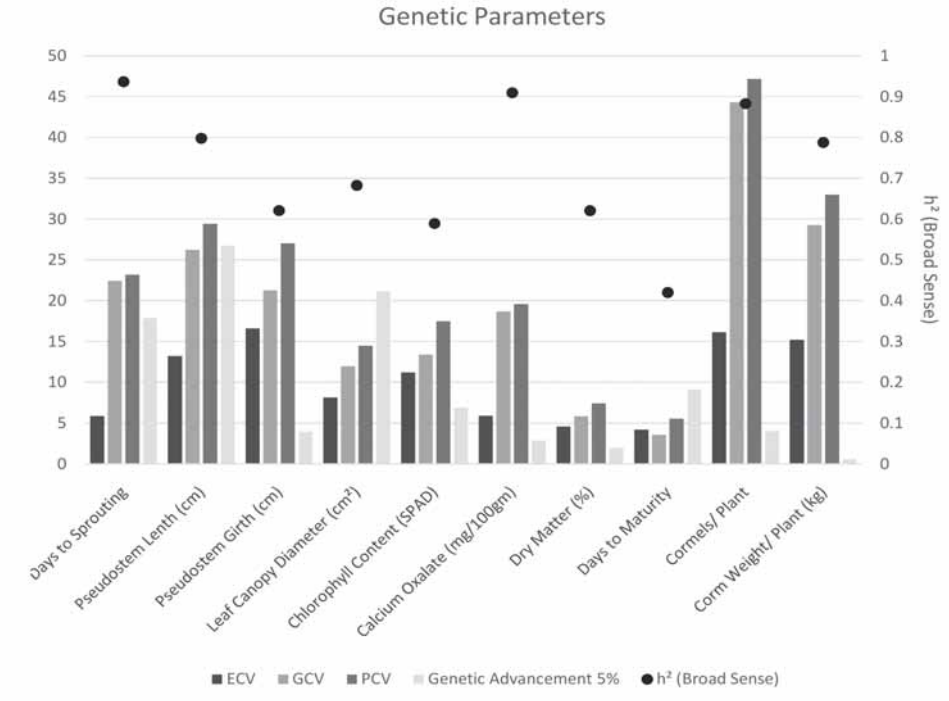

Fig. 1. Histogram depicting genetic parameters of ten characters in elephant foot yam

and leaf canopy diameter by Paul and Bari (2013), for days to sprouting by Singh et al. (2008) although, for pseudostem length and girth by Singh and Tripathi (2012) and Paul and Bari (2013). Studies on assessment of genetic variability in elephant foot yam are very few, however for others tuber crops, it has been carried out by several workers in the past.

Johnson et al. (1955) had suggested that the heritability and genetic advance when considered together would be more reliable and rapid progress in selection can be achieved when high heritability is accompanied with high genetic advance, which forms the most reliable index of selection (Burton, 1952). In the present study, high estimates of heritability coupled with high genetic advance expressed as percentage of mean were observed for days to sprouting, pseudostem length, pseudostem girth, leaf canopy diameter, chlorophyll content, calcium oxalate, no. of cormels per plant and corm weight per plant which may be attributed to the preponderance of additive gene action and possess high selective value and thus, selection pressure could profitably be applied on these characters for their rationale improvement (Panse and Sukhatme, 1967). High heritability coupled with high genetic advance expressed as percentage of mean in case of elephant foot yam for these characters were also reported by Anil et al. (2011); Singh and Tripathi (2012); Paul and Bari (2013) and Singh et.al. (2008).

Conclusion

The study indicated that sufficient genetic variability for different characters are present in the germplasm collection of Bihar. Characters like days to sprouting, pseudostem length, pseudostem girth, canopy spread, chlorophyll content, calcium oxalate content, cormels number per plant and corm weight per plant exhibited considerable variations and selection based on these parameters would be effective.

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