Characterisation and Evaluation of an Indigenous Collection of Greater Yam (*Dioscorea alata* L.)

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The germplasm holding of *Dioscorea alata* L. at National Bureau of Plant Genetic Resources, Regional Station, Thrissur, consisting of 182 accessions collected from different agro-ecological situations of peninsular India was subjected to characterisation and preliminary evaluation during May to January 1999-2001. Data recorded for 43 qualitative and 23 quantitative traits were analysed for frequency distribution, range, mean, standard deviation and coefficient of variation. The results showed wide range of variability in leaf length (9.77 – 23.83 cm), petiole length (5.43 – 20.0 cm), bulbil length (0.38 – 11.95 cm), number of bulbils per plant (0.66 – 268.33), tuber length (10.33 – 45.0 cm) and tuber yield per plant (0.33 – 4.40 kg). The bulbils produced by different accessions varied from very small amorphous callus-like ones to very large oblong ones. The shape of the tuber and the tuber flesh colour showed maximum range of variability. The graphical representation of variance for 20 different leaf, bulbil and tuber quantitative traits indicated large variability in leaf traits, bulbil production, tuber length and tuber perimeter. Observations on flowering indicated erratic female flowering and non-synchronisation of male and female phases. Studies on correlation between different quantitative traits showed maximum correlation coefficient of 0.9187 between basal wing length and leaf breadth. Path coefficient analysis showed maximum direct effect of 0.8296 of individual tuber weight on yield.

Key Words: Correlation, *Dioscorea alata*, Morphotypes, Path Analysis, Variability

Introduction

Dioscorea alata L. (Dioscoreaceae) is a crop of considerable importance under the subsistence farming system in the tropics. It is usually cultivated as a rainfed crop in Kerala, coastal regions of Karnataka, Maharashtra, parts of Orissa and Bihar, West Bengal, North-eastern and North-western states. The plant behaves as an annual under cultivation but can perennate through the underground storage tuber.

Considerable variability of this species occurs in India (Muralidharan *et al.*, 1985; Velayudhan *et al.*, 1991) and both morphological and biometrical techniques have been used for classification of existing variability by various workers (Burkill, 1917; Gooding, 1960; Rhodes and Martin, 1972). The cultivation of this crop is on the decline and its genetic resources are being eroded. Hence this work has been carried out with a view to characterise, evaluate and document an indigenous germplasm collection from different agro-ecological situations under the rainfed condition in humid tropics and to identify the potential lines.

Materials and Methods

On the basis of the subjective morphotypic classification of *D. alata* L. (Velayudhan *et al.*, 1991), 182 different accessions collected from different agro-ecological situations of Peninsular India were grown at the experimental farm of National Bureau of Plant Genetic Resources, Regional Station, Thrissur at 10.5° N latitude and 76.5° E longitude during the cropping seasons of 1999-2001, extending from May to January. The experimental plants were raised in augmented design with three controls and the package of practices as recommended by Kerala Agricultural University was followed (Anonymous, 1996).

The data on various qualitative and quantitative vegetative characters of leaves, bulbils, and flowers were recorded at the maximum vegetative growth period during September to October and the post harvest tuber traits after harvesting during January. Data on 43 qualitative and 23 quantitative traits were recorded on 3 different plants per accession. Frequency distribution of various qualitative characteristics was computed. Range, mean, standard deviation and coefficient of variation were worked out for the quantitative traits and simple correlation and path coefficient analysis were carried out based on Dewey and Lu (1959). The existence of variability in 20 different quantitative traits were analysed by computing variance and a graphical representation has also been made. Incidence of Anthracnose blotch disease in these collections was already reported (Asha and Nair, 2001).

Results and Discussion

1. *Variability in Leaf Traits*

The foliar traits in *D. alata* showed wide variation in leaf shape between ovate, round, cordate, elongated sub-hastate and oblong sub-hastate ones and setting of basal wings from very wide to close overlapping ones through medium wide and wide ones. Leaf margin colour varied between light green and purple through green to dark green, very light purple and light purple. Petiole top and base colour varied from light purple to dark purple. Variation in waviness and colour of the petiole wing were distinct and the former varied between less waviness to very high waviness and the latter between very light green to dark purple through light purple and purple.

The range of variability recorded in quantitative leaf traits are given in Table 1. The percentage coefficient of variation was more for the distance between basal wings (74.05%) followed by depth of sinus of leaves (30.177%). This indicates that range of variability was more in these traits compared to leaf length, breadth and petiole length. The distinct variability in setting up of basal wings of leaves contributes more towards the shapes of leaves and in turn results in the variation of sinus depth of individual leaves. The variability of leaf traits as given in Fig. 1 represents the occurrence of distinct variation in leaf length, breadth and petiole length. The frequency distribution of these traits showed the occurrence of limited numbers of accessions in higher levels of leaf measurements.

2. *Variability in Aerial Bulbil Traits*

Being a vegetatively propagated species, production of aerial bulbils is one of the means of propagation in *D. alata.* Profuse bulbil production of individual accessions coincided with absence of flowering and can be an indication of degeneration of sexuality in this dioecious species. Of the 182 accessions under consideration, 156 accessions bore aerial bulbils and profuse bulbil production was recorded in TCR 265 (IC 87422). The days taken for bulbil initiation ranged between 75 (IC 136850) and 159 days (IC 87398). Variability observed in size and shape of aerial bulbils were so distinct that it varied from very small amorphous

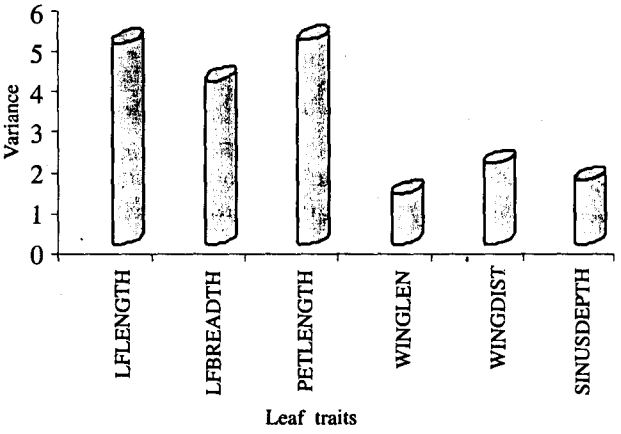

Fig. 1. Variability in leaf traits

Table I. Variability in quantitative traits in *D. alata*

S. No.	Quantitative traits	Accessions (no.)	Range	Mean	SD	% CV
1	Leaf length	182	9.77 - 23.83 cm	16.749	2.226	13.29
2	Leaf breadth	182	6.87 - 16.93 cm	11.995	2.004	16.706
3	Petiole length	182	5.43 - 20.00 cm	10.960	2.246	20.492
4	Basal wing length	182	3.17 - 9.57 cm	6.216	1.104	17.76
5	Dist. between basal wings	182	0.27 - 6.13 cm	1.90	1.407	74.05
6	Sinus depth of leaf	182	1.00 - 6.67 cm	4.119	1.243	30.177
7	Bulbil length	156	0.38 - 11.95 cm	5.395	2.495	46.246
8	Bulbil thickness	156	0.56 - 6.83 cm	3.444	1.196	34.727
9	Bulbil weight	156	0.20 - 124.50 g	33.564	23.809	70.936
10	Total no. of bulbils	156	2.00 - 805.00	139.827	135.194	96.686
11	Bulbils per plant	156	0.66 - 268.33	45.238	45.075	99.639
12	Bulbil yield	156	0.001 - 3.79 kg	0.821	0.835	101.70
13	No. of tubers	182	1.00 - 9.33	2.900	1.722	59.379
14	Individual tuber weight	182	0.30 - 2.63 g	1.158	0.498	43.005
15	Tuber length	182	10.33 - 45.00 cm	20.653	6.292	30.465
16	Tuber perimeter	182	22.67 - 55.67 cm	39.972	6.566	16.426
17	No. of branches of tuber	182	0.00 - 10.00	3.456	1.663	48.119
18	Neck length of tuber	182	0.00 - 10.00 cm	3.186	2.124	66.67
19	Yield per plant	182	0.33 - 4.40 kg	1.788	0.723	40.436
20	Total yield	182	1.00 - 13.20 kg	5.372	2.167	40.338

callus-like ones (IC 266647) to very large oblong ones TCR 266 (IC 87423) through medium to large spherical, irregular and digitate ones. The cortex colour of bulbils varied between light green, green, yellowish purple, purple and dark purple and the flesh colour between light yellow, light purple, white, purplish white, yellow and dark purple. About 50% of the accessions were with bulbil spines and the other 50% without spines on bulbils. The variability recorded in quantitative bulbil traits were summarised in Table I. The percentage coefficient of variation calculated for bulbil traits were more for bulbil yield, bulbils/plant and total number of bulbils (Fig. 2). This considerable diversity probably may be due to polymorphism and adaptation to different cultural conditions.

3. *Variability in Tuber Traits*

The tuber traits in the germplasm showed variation in both qualitative and quantitative characteristics. The shape of the tuber varied between digitate to cylindrical oblong through spherical and irregular ones. Rootiness varied from very low to highly rooted ones, the cortex colour between light green, light purple, purple and dark purple and the tuber flesh colour from pure white to very dark purple one through very light purple tint, light yellow, orange yellow, and yellow.

The variability observed in quantitative tuber traits is also summarised in Table 1. The number of tubers present in individual accessions ranged from 1 to 9.33 and the individual tuber weight between 0.30 kg to 2.63 kg. The yield per plant ranged between 0.33 kg to 4.40 kg and total yield from 1 kg (IC 87422) to 13.20 kg (IC 266655). Of the various tuber traits, the coefficient of variation was more for neck length of tuber (66.67%) followed by number of tubers (59.39%) and number of branches of tuber (48.12%). The frequency distribution curves drawn for the major tuber traits showed discontinuous variation. This highlights the fact that the indigenous germplasm has very few promising lines in the yield-related components. Fig. 3 represents the variation present in tuber traits; it was found maximum in tuber length and tuber perimeter.

4. *Flowering Behaviour*

Observations on flowering deficiencies and fertility status of this dioecious species have earlier been reported (Abraham, 1997). In the present study also, complementary observations were obtained regarding differential flowering behaviour of different accessions. Out of 182 accessions under observation, 90 flowered, of which 6 were female and rest were male. The female accessions include IC numbers 87372, 87389 B and 266653 of M6 and IC numbers 46067, 87339 B, and 87342 A of M16. Female flowering was erratic and significantly lower than the males. Distinctly different flowering periods of the two sexes resulted in the non-synchronisation of the male and female phases. Moreover, flower production of the sexes showed a greater disparity in number, the females producing far fewer flowers than the males and the female flowering commenced only in a later phase against the early male flowers. Withering of inflorescence, non-maturing of buds and non-opening of mature buds were common in female ones in contrast to males.

Analysis of Correlation

The analysis of simple correlation was carried out in 153 different combinations involving 18 traits in 156

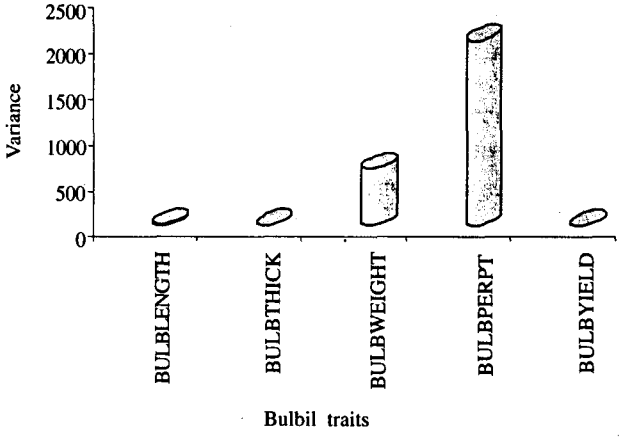

Fig. 2. Variability in bulbil traits

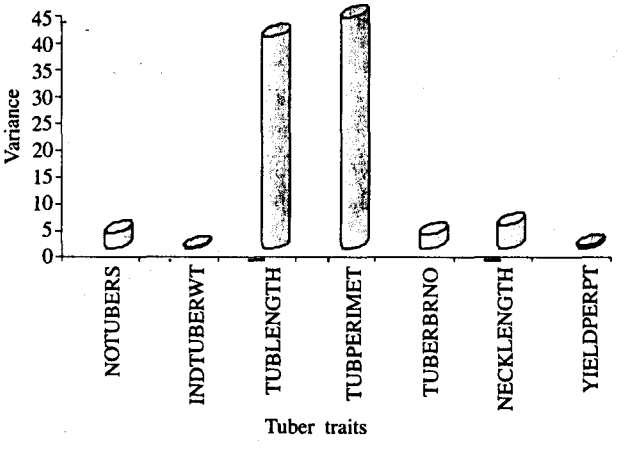

Fig. 3. Variability in tuber traits

accessions. The result in Table 2 revealed maximum correlation between leaf breadth and basal wing length followed by bulbils per plant, bulbil yield, bulbil thickness and bulbil weight, individual tuber weight and yield per plant and leaf breadth and petiole length. Correlation between yield per plant and bulbil traits were negative indicating the fact that more the production of aerial vegetative bulbils less will be the tuber yield.

Analysis of Direct and Indirect Effects

Path coefficient analysis (Table 3) revealed that individual tuber weight had maximum direct effect (0.8296) on yield followed by number of tubers (0.4809) suggesting more value to these traits in selection. Direct effects were negative for leaf length, basal wing length, distance between basal wings, bulbil weight, bulbil yield, neck length and number of branches of tuber.

Maximum positive indirect effect (0.5256) was exerted by individual tuber weight and tuber perimeter followed by tuber weight and tuber length (0.4938). The low residual effect of 0.2132 obtained in the study indicates the adequacy and legitimacy of the characters used.

Promising Lines

Based on the number of tubers produced, individual tuber weight and yield per plant, IC numbers 266649 and 266655 were found more productive giving more than 4 kg/plant. The earlier releases of Central Tuber Crops Research Institute, Trivandrum namely Sree Keerti,

Table 2. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.000																	
2	0.4609	1.000																
3	0.2070	0.7517	1.000															
4	0.4770	0.9187	0.6935	1.000														
5	0.1926	-0.2879	-0.3328	-0.1832	1.000													
6	0.0016	0.5068	0.5440	0.4461	-0.5928	1.000												
7	-0.2884	0.2811	0.3986	0.1673	-0.4455	0.3051	1.000											
8	0.0211	0.1879	0.2237	0.2163	-0.3280	0.1547	0.3534	1.000										
9	-0.0878	0.1501	0.2118	0.1462	-0.3673	0.1734	0.6242	0.8409	1.000									
10	-0.1454	-0.0185	0.0813	-0.0592	-0.2753	0.0245	0.3726	0.4446	0.4761	1.000								
11	-0.1729	0.0724	0.1859	0.0528	-0.2819	0.0689	0.4901	0.6095	0.6855	0.8907	1.000							
12	0.0476	-0.3200	-0.3407	-0.3276	0.5768	-0.3294	-0.4347	-0.4071	-0.4154	-0.3316	-0.3983	1.000						
13	-0.1835	0.3296	0.5058	0.3420	-0.3120	0.3763	0.2054	0.1312	0.1240	-0.0679	0.0852	-0.3454	1.000					
14	-0.4433	0.1115	0.3816	0.0681	-0.2495	0.2791	0.4496	0.0162	0.1036	-0.0478	0.1073	-0.1737	0.5952	1.000				
15	0.0900	0.1773	0.1347	0.2897	0.0262	0.0969	-0.2400	0.1390	0.0152	-0.2162	-0.0838	-0.1293	0.6335	-0.0424	1.000			
16	0.1236	0.0301	0.0197	0.0799	0.2808	0.0217	-0.2587	-0.0827	-0.1835	-0.1764	-0.1291	0.2444	0.2285	0.0401	0.4198	1.000		
17	0.0990	-0.3391	-0.4225	-0.2376	0.3729	-0.4432	-0.3222	-0.0999	-0.1102	-0.0893	-0.1421	0.2670	-0.2791	-0.3099	-0.0008	-0.0929	1.000	
18	-0.1791	0.2673	0.4469	0.2361	-0.1754	0.3513	0.1311	-0.0078	-0.0382	-0.0857	-0.0011	0.0451	0.7834	0.5375	0.4450	0.2677	-0.2839	1.000

Table 3. Matrix of direct and indirect effects

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Corr. value
1	**-0.0108**	0.0181	0.0097	-0.0119	-0.0069	0.0001	-0.0394	0.0032	0.0215	-0.0266	0.0130	0.0229	-0.1522	-0.0145	0.0027	-0.0028	-0.0053	-0.1791
2	-0.0050	**0.0393**	0.0353	-0.0230	0.0103	0.0430	0.0384	0.0287	-0.0368	-0.0034	-0.0054	-0.1539	0.2734	0.0036	0.0053	-0.0007	0.0181	0.2673
3	-0.0022	0.0296	**0.0470**	-0.0173	0.0119	0.0462	0.0544	0.0342	-0.0520	0.0149	-0.0139	-0.1639	0.4196	0.0125	0.0040	-0.0004	0.0225	0.4469
4	-0.0052	0.0361	0.0326	**-0.0250**	0.0065	0.0379	0.0229	0.0330	-0.0359	-0.0108	-0.0040	-0.1576	0.2837	0.0022	0.0086	-0.0018	0.0127	0.2361
5	-0.0021	-0.0113	-0.0157	0.0046	**-0.0356**	-0.0503	-0.0609	-0.0501	0.0902	-0.0503	0.0211	0.2774	-0.2588	-0.0082	0.0008	-0.0063	-0.0199	-0.1754
6	0.0000	0.0199	0.0256	-0.0112	0.0211	**0.0849**	0.0417	0.0236	-0.0426	0.0045	-0.0052	-0.1584	0.3122	0.0091	0.0029	-0.0065	0.0236	0.3513
7	0.0031	0.0111	0.0187	-0.0042	0.0159	0.0259	**0.1366**	0.0540	-0.1532	0.0681	-0.0367	-0.2091	0.1704	0.0147	-0.0071	0.0058	0.0172	0.1311
8	-0.0002	0.0074	0.0105	-0.0054	0.0117	0.0131	0.0483	**0.1527**	-0.2064	0.0813	-0.0457	-0.1958	0.1089	0.0005	0.0041	0.0019	0.0053	-0.0078
9	0.0009	0.0059	0.0100	-0.0037	0.0131	0.0147	0.0853	0.1284	**-0.2455**	0.0870	-0.0514	-0.1998	0.1029	0.0034	0.0005	0.0041	0.0059	-0.0382
10	0.0016	-0.0007	0.0038	0.0015	0.0098	0.0021	0.0509	0.0679	-0.1168	**0.1828**	-0.0670	-0.1599	-0.0571	-0.0015	-0.0066	0.0041	0.0054	-0.0857
11	0.0019	0.0028	0.0087	-0.0013	0.0100	0.0058	0.0670	0.0931	-0.1683	0.1635	**-0.0750**	-0.1916	0.0706	0.0035	-0.0025	0.0029	0.0076	-0.0011
12	-0.0005	-0.0126	-0.0160	0.0082	-0.0206	-0.0280	-0.0594	-0.0622	0.1020	-0.0608	0.0299	**0.4809**	-0.2866	-0.0057	-0.0038	-0.0055	-0.0142	0.0451
13	0.0020	0.0130	0.0238	-0.0086	0.0111	0.0319	0.0281	0.0200	-0.0304	-0.0126	-0.0064	-0.1661	**0.8296**	0.0194	0.0189	-0.0051	0.0149	0.7834
14	0.0048	0.0044	0.0179	-0.0017	0.0089	0.0237	0.0614	0.0025	-0.0254	-0.0082	-0.0080	-0.0835	0.4938	**0.0327**	-0.0013	-0.0009	0.0165	0.5375
15	-0.0010	0.0070	0.0063	-0.0072	-0.0009	0.0082	-0.0328	0.0212	-0.0037	-0.0408	0.0063	-0.0622	0.5256	-0.0014	**0.0298**	-0.0094	0.0000	0.4450
16	-0.0013	0.0012	0.0009	-0.0020	-0.0100	0.0018	-0.0353	-0.0126	0.0450	-0.0330	0.0097	0.1175	0.1896	0.0013	0.0125	**-0.0225**	0.0050	0.2677
17	-0.0011	-0.0133	-0.0199	0.0059	-0.0133	-0.0376	-0.0440	-0.0153	0.0270	-0.0186	0.0107	0.1284	-0.2315	-0.0101	0.0000	0.0021	**-0.0534**	-0.2839

Residual = 0.2132

1. Leaf length 2. Leaf breadth, 3. Petiole length, 4. Basal wing length 5. Distance between basal wings 6. Sinus depth of leaf 7. Bulbil length 8. Bulbil thickness 9. Bulbil weight 10. Bulbils per plant 11. Bulbil yield 12. No. of tubers 13. Individual tuber weight 14. Tuber length 15. Tuber perimeter 16. Number branches of tuber 17. Neck length of tuber 18. Yield per plant

Sree Roopa (25-30 t/ha) and Sree Shilpa (28-40 t/ha) has been compared with the promising lines and it has been found that the IC Nos. 87393, 266657, 87389B (35-40 t/ha) were superior, which can be considered for varietal release.

Conclusion

The characterisation and evaluation of the germplasm revealed that there exists distinct variation in qualitative and quantitative traits. Moreover the production of more vegetative aerial bulbils results in decrease of underground tuber production.

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