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SEMIQUANTITATIVE ANALAYSIS OF GENETIC RESOURCES OF *DESI* COTTON (*G. ARBOREUM* L.)*

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An assessment of potential variability and genetic diversity was undertaken in the genetic resources of G. arboreum *using metroglyph and hybrid index score technique. The 150 accessions evaluated were identified into 15 distinct groups for economic and morphological characters. The suitability of the technique for preliminary classification of a large number of germplasm and classifying them into distinct group for qualitative and quantitative characters were found effective.*

The current collection of germplasm at the National Gene Bank for cotton at Central Institute for Cotton Research, Nagpur includes over 1455 accessions of *Gossypium arboreum*. These collections mainly comprise materials collected from various cotton growing areas, as well as those developed out of various breeding programmes from within India. A limited number among the *G. arboreum* (desi) accessions are exotics, primarily from China, Pakistan, Bangladesh, Myanmar and Sri Lanka. These also represent the four races of the species.

Variability in *G. arboreum* cotton has been reported for limited number of accessions and for a few characters only (Singh, 1969; Singh and Kalsy, 1979; Singh and Nandeshwar, 1983, 1984 and Singh and Singh, 1984). There is considerable genetic variability in *G. arboreum* cotton with regard to different morphological and quantitative characters (Singh, 1969) and varieties of race *cernuum* are low yielders with sympodial habit, high G.O.T., high boll weight, high number of seeds per boll and high locule retentivity (Singh and Nandeshwar, 1983).

A fresh assessment of potential variability and genetic diversity using reliable criteria was done to get new information for classification into various basic types and for making a judicious choice of parents for breeding programmes. Adequately large sample of germplasm were assessed and a semi-quantitative analysis was performed in assessing the variability present in the gene bank of *Gossypium arboreum*.

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MATERIALS AND METHODS

One hundred fifty accessions were raised under field conditions during 1984-85 in an augmented block design. The spacing adopted was 60 x 45 cm. Accordingly, 20 plants were accommodated in a row, the length of the row being 12 m and 8 m respectively. The recommended cultural practices including fertilizer application and plant protection measures were adopted. Data were taken for 11 morphological and economic characters on five randomly selected plants and these were subjected to Anderson's metroglyph analysis in conjunction with hybrid index scores. The 11 characters used for the semi-quantitative classificatory analysis were leaf length, leaf hairiness, bract length, plant height, sympodia number, boll number, boll weight, boll volume, seeds per boll, ginning out turn and mean halo length. The metroglyph analysis and hybrid index scores procedure (Anderson, 1936, 1957) were carried out using the mean values of 11 characters for 150 accessions (Stebbins, 1950; Singh and Chaudhary, 1985).

For plotting the metroglyph, two most variable and widely different characters namely leaf length and mean halo length were used on X and Y axis respectively. The actual means of Y values were plotted against the means of X values for each accession on a glyph in the graph. For another eight characters, the values were classified into three arbitrary classes or groups for each character and used accordingly for plotting the rays at an appropriate axis on the glyph. For leaf hairiness, the grade was indicated on the glyph itself by shading it fully (high hairy), partially (medium hairy) and leaving empty (glabrous or least hairy). The ray for a specific character was given the same position on each glyph. The length of the rays on the appropriate position of glyph was short (1 mm), medium (2 mm) or long (3 mm) for low, medium or high range of values, respectively for each character. The index values were decided on the basis of range of variability. The whole scatter was demarcated into 16 sectors by running parallel lines vertically and horizontally at equal intervals. In each of the 16 sectors thus demarcated, the total accessions were counted and assigned to the metroglyph cluster groups I-XVI.

Using the suitable class intervals, the range of variability for each character was classified into three groups assuming an index score of 1 for the lowest grade, 2 for middle grade and 3 for the highest grade. All the characters were given the index score grades from 1-3 (Table 1). The sum of index values for the 11 characters in each accessions was taken as an indication of its total worth. Histogram of index scores was constructed using these data. The frequency distribution of index scores for groups of accessions representing geographic/racial collections was also tabulated. The total index scores of all the accessions in each cluster group was added and mean index score of each cluster was calculated.

Table 1. Ray position on metroglyphs and Index scores for 11 characters in *G. arboreum*

Sl. No.	Character	Glyph position	Range	Mean	INDEX SCORES		
					Low (1)	Medium (2)	High (3)
1.	Leaf length (cm)	X axis	7.1 –12.1	9.30	7.1 –8.7	8.8 –10.4	10.5 –12.1
2.	Mean halo length (mm)	Y axis	14.3 –25.7	21.20	14.3 –18.1	18.2 –22.0	22.1 –25.7
3.	Leaf hairiness grade		Glabrous to highly hairy	Medium hairy	Glabrous/ less hairy	Medium hairy	Highly hairy
4.	Boll weight (g)		1.4 –4.2	2.08	1.4 –2.3	2.4 –3.3	3.4 –4.2
5.	Sympodia/plant		10.7 –34.0	19.77	10.7 –18.4	18.5 –26.2	26.3 –34.0
6.	Bract length (cm)		2.3 –4.6	2.94	2.3 –3.0	3.1 –3.8	3.9 –4.6
7.	Seeds/boll		14.8 –32.3	22.87	14.8 –20.7	20.8 –26.7	26.8 –32.3
8.	Bolls/plant		7.8 –23.8	14.88	7.8 –13.1	13.2 –18.5	18.6 –23.8
9.	Ginning outturn (%)		29.6 –46.8	37.98	29.6 –36.2	36.3 –42.9	43.0 –46.8
10.	Plant height (cm)		75.5 –178.5	120.42	75.5 –109.8	109.9 –144.2	144.3 –178.5
11.	Boll volume/boll (cc)		5.8 –17.3	8.71	5.8 –9.6	9.7 –13.5	13.6 –17.3
			Ray length		1 mm	2 mm	3 mm

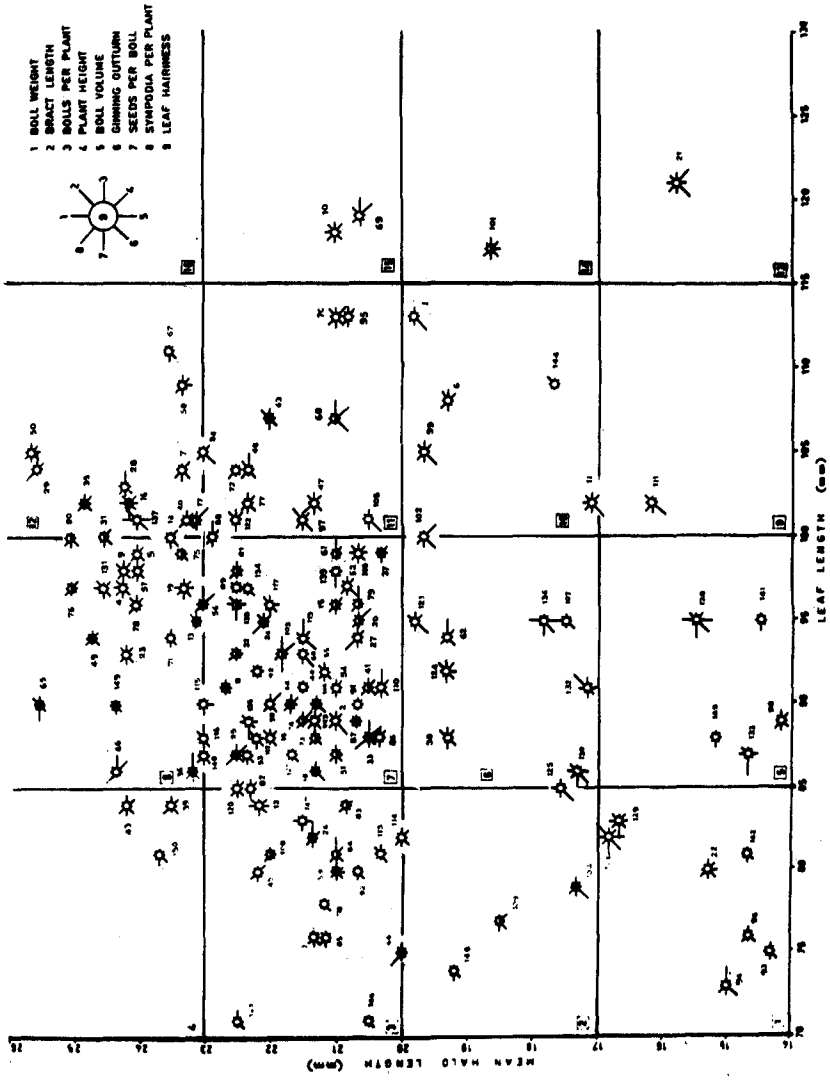

Fig. 1. Scatter diagram of metroglyphs of 150 germplasm accessions of *G. arboreum* L.

RESULTS AND DISCUSSION

Genetic variability in 150 *G. arboreum* accessions which included accessions developed in North India (33), North-East Hill region (18) and Central India (92) besides 5 from South India and two exotics were analysed. Based on racial origin, 126 accessions represented race *bengalense*, 18 of race *cernuum*, five of *indicum* and one of race *sinense*. Average performance, mean, range and variance for the 11 characters have been presented in Table 2 alongwith estimates of SE and CV. The construction and results of metroglyph analysis were also presented (Fig. 1). The 150 glyphs shown in the metroglyph scatter diagram were divided into four groups for fibre length as short (14 to 17 mm), medium (17.1 to 20 mm),

Table 2. Range, Mean, CV, SE and Variance analysis

Sl. No.	Characters	Range	Mean	CV	SE	Variance
1.	Leaf lenth cm)	7.10 – 12.10	9.30	10.75	0.08	1.00
2.	Leaf hairiness grade	9.01 – 1.10	0.24	0.35	0.01	0.01
3.	Bract length (cm)	2.30 – 4.60	2.94	4.83	0.03	0.14
4.	Plant height (cm)	75.50 – 178.50	120.42	17.06	1.67	422.30
5.	Nof of sympodia per plant	10.70 – 34.00	19.77	89.09	0.34	17.64
6.	No. of bolls per plant	7.80 – 23.80	14.88	83.15	0.29	12.39
7.	Boll weight (g)	1.40 – 4.20	2.08	9.05	0.04	0.19
8.	Boll volume (cc)	5.80 – 17.30	8.71	35.98	0.14	3.13
9.	No. of seeds per boll	14.80 – 32.30	22.87	19.09	0.25	9.18
10.	Ginning outturn (%)	29.60 – 46.80	37.98	10.26	0.32	15.21
11.	Mean halo length (mm)	14.30 – 25.70	21.20	30.66	0.21	6.50

superior medium staple 20.1 to 23 mm) and long staple (above 23 mm). Similarly, four arbitrary categories of leaf length namely short (70 to 85 mm), medium (86 to 100 mm), long (101 to 115 mm) and very long (above 115 mm) were also made so as to classify all the genotypes into 16 groups. Composition of metroglyph clusters are presented in Table 3. The genotypes falling under each group showed a wide range of variability in this species and are described below :

CLUSTER GROUP CHARACTERISTICS

In cluster I, seven genotypes exhibited high scores for boll weight but short leaf and short fibre were combined with low boll weight, low boll

Table 3. Composition of metroglyph clusters

Metroglyph Cluster Number	Number of accessions	Name of accessions
I	7	AC 36, G 27, 30804, 79/Lohit, 30815, G 26, G 29
II	4	Gao 145-B-5, Malvil, 30800, Maljari,
III	17	Arboreum (Kanpur), AC 48, AC 629, AC 17, B 5, Bani 306, CJDC-37-W, Cocanada 20, G 23, Dokras 9-2-8-3, LD 153, AKA 603, 5-63-572, 3058, 8410-3, IC 377/8, 331,
IV	3	AC 617, AC 624, AC 730
V	5	G 45, 30814, 30824, Desi 56, 79/BH-113,
VI	8	AC 261, LD 133, 30798, 30822, 30817, 30839, B 15-30, 7662
VII	47	A 4, A 41, AC 21, AC 22, AC 32, AC 42, AC 50, CC-1-1-3-2, Cernuum, Gao-CB-9, CC-1-137-PN-10, Chinese Broad Leaf, G 2, Dhulia 2-1-5, AC 541, AC 543, AC 567, AC 570, Dhulia 2-2-5-W, Arvensis. 0-91, G 53, AC 619, AC 623, AC 627, AC 733, AC 41, AKH 2, AKH 214, 30847, Desi 97, Adonicum, B 10-24-A-84, B 11, BA 2 W, G 1-35-49-W, Kumptha Black Seeded, 7249, Sanguineum BL-RF, 1773, CC-1-1-3, G 22, 7526, 30810, 30835, 30837, 30844,
VIII	21	A 14, A 27, AC 1, AC 18, AC 30, AC 38, AC 630, AC 729, Arboreum (Surat), BA 15-W, BJ 6, CC-1-1-3-4, 1391-N, CC-1-1-3-33, NAA 2, 30820, 30860, CC-1-1-3-BK, 554, AC 546, B 3
IX	1	35-1
X	6	A, A 32-8-W, AC 15, G 47, G 92, Desi 101,
XI	12	AC 727, AC 728, B 32-48, Bishnoor, G 1 Banilla Faint Spot, Burma Silk, G 33, 7763, CC-1-1-3-41, G 27-51, Gao 61-6
XII	15	A 33, AC 23, AC 24, AC 25, AKH 4, B 4, AC 65, AC 418, AC 544, AC 545, Banilla, AC 730, AC 618, CC-2-1-11-15, 30840
XIII	1	AC 35
XIV	1	G 54-1
XV	2	AC 3, BDN 5628
XVI	0	–

volume and short plant height. The four genotypes of cluster II exhibited low score for boll weight, plant height, boll volume and medium score for seeds per boll coupled with high ginning outturn. Cluster III was large with 17 genotypes having 11 medium hairy types and three each of hairy and densely hairy types exhibiting low scores for boll weight, bract length and boll volume. Cluster IV included only three long staple accessions with medium hairy leaves and none exhibited high boll weight. The 5 glyphs of cluster V had low scores for most of the traits. Most of the 8 accessions of cluster VI showed high ginning per cent coupled with medium scores for seeds per boll and plant height. In cluster VII with highest number of 47 glyphs more than half had low scores for leaf hairiness coupled with boll weight, sympodia number and boll volume and 6 had high values for number of bolls per plant coupled with medium values of seeds per boll. Cluster VIII was the second largest group involving 21 accessions having medium lead and long staple and most of the genotypes had medium scores for bolls per plant, ginning per cent and plant height and low values for boll weight and boll volume. Cluster IX had a single glyph exhibiting high scores for ginning per cent, medium value for seeds per boll, sympodia per plant and bract length. Of the 6 glyphs of cluster X, four had high scores for ginning per cent, medium scores for seeds per boll, bolls per plant and plant height. In cluster XI, all the glyphs exhibited low scores for boll weight and boll volume. Cluster XII showing long leaf and long staple included 15 genotypes mostly having medium hairy leaves and medium boll weight with medium scores for boll volume and bract length. The single glyph in cluster XIII exhibited high score for ginning per cent, plant height and number of sympodia. There was a single genotype in cluster XIV with medium scores for most of the characters. In cluster XV, two genotypes were present with very long leaf and superior medium staple and medium scores for sympodia per plant, bract length, seeds per boll and low score for boll volume. There was no glyph conforming to cluster XVI.

HYBRID INDEX SCORES

Though central India had the largest number of accessions (92), its average index score (19.0) was almost similar to those of North Indian accessions (19.6), which also had the highest average index score with 18 accessions (Table 4). North Indian accessions (33) had the next best average index score of 17.2. South Indian and exotic accessions having a few entries only had almost similar average index score of 16.6 and 16.0 respectively.

About fifty per cent (74) of the total accessions (150) represented the three index score 18, 19 and 20 classes. Maximum number of accessions (28) were found in the index score category of 19 followed by 24 accessions under index score of 18. The lowest number of accession (1) was found in the index score class of 24 followed by class of 14 which had 3 accessions.

Table 4. Frequency distribution of index scores for *G. arboreum* accessions

Accesions from / Race	Total No. of Accessions	INDEX SCORES 13	14	15	16	17	18	19	20	21	22	23	24	Total Index Score	Average Index Score
NORTH INDIA	33	3	3	4		5	8	5	2	3				568	17.2
NORTH EAST INDIA	18			1	2	1		3	7		1	3		352	19.6
CENTRAL INDIA	92	1		4	9	7	16	19	13	11	6	5	1	1747	19.0
SOUTH INDIA	5	1					3		1					83	16.6
EXOTICS	2			1		1								32	16.0
TOTAL	150	5	3	10	11	17	24	28	22	14	7	8	1	2782	18.5
race *bengalense*	126	5	3	8	9	13	23	24	15	14	6	5	1	2327	18.5
race *indicum*	5			1		2	1	1						86	17.2
race *cernuum*	18			1	2	1		3	7		1	3		352	19.5
race *sinense*	1					1								17	17.0
TOTAL	150	5	3	10	11	17	24	28	22	14	7	8	1	2782	18.5

The highest number of 126 accessions belonged to the race *bengalense* which had an average index score of 18.5, while the race *indicum* having only 5 accessions recording the average of 17.2. The highest average index score (19.5) was obtained in the accessions (18) representing race *cernuum*.

Table 5. Germplasm accessions forn D^2 analysis

Metroglyph cluster group	Number of germplasm accessions	Mean index Score	Number of accessions selected for D^2 analysis	Mean index score of selected accessions
I	7	16.9	2	20.00
II	4	16.0	2	15.50
III	17	16.4	5	15.80
IV	3	17.3	2	17.00
V	5	16.6	1	16.00
VI	8	19.0	3	19.70
VII	47	18.8	9	18.90
VIII	21	19.5	4	19.70
IX	1	17.0	1	17.00
X	6	18.7	1	21.00
XI	12	19.1	3	19.00
XII	15	19.8	4	20.20
XIII	1	24.0	1	24.00
XIV	1	19.0	1	19.00
XV	2	21.5	1	21.00
XVI	0	0	0	0

The single *sinense* accession had a mean index score of 17.0. It was observed that the largest number of genotypes had been grouped under the average index score categories of 16-21 indicating that maximum number of accessions had medium values for various characters.

Proportionate representation for the accessions from various metroglyph clusters was made while selecting them for further studies. The distance of the accessions from the centre was considered important while selecting the genotypes besides total hybrid index scores within the cluster. Maximum number of accessions (9) were selected from cluster VII followed by 5 from cluster III, 4 each from VIII and XII and 3 each from VI and XI. From the remaining clusters one or two genotypes were taken and a total of 40 accessions were selected from each metroglyph cluster and their mean index score values are presented (Table 5).

A close examination of the clusters revealed that there were two homogeneous clusters (IV and XV) which included 3 and 2 entries, respectively, from central India alone. Almost all other clusters were heterogeneous with respect to the origin of the component entires. Cluster VIII included 19 accessions of central India clubbed with two from the North-Eastern (N.E) region. Similarly, the cluster XII had 14 central Indian accessions clubbed with a single accession of the N.E. region.

The frequency distribution of total index scores of accessions of different geographic origin in India (Table 4) also reflected on the distinct pattern of variability in the present material. The highest index score of 19.6 was exhibited by the accessions of N.E. region followed by north Indian accessions (19.0). South Indian and the two exotic accessions had the lowest average index scores of 16.6 and 16.0, respectively. Central Indian accessions had the maximum range (13 to 24) of total index scores, with genotypes of all categories, followed by accessions from north India.

Accessions representing same race, similar geographic area and arising from similar parentage got distributed into distinct clusters. North-east region accessions recorded higher average hybrid index scores followed by central Indian, north, south Indian and exotic accessions in that order. This indicated the significant contribution made by particular combinations in characters to diversity.

Based on the elucidation obtained about the distribution and diversity in the species accessions, the metroglyph analysis in conjunction with hybrid index score, appeared to be a useful technique for preliminary classification of large number of germplasm for several qualitative and quantitative characters and identifying diverse types for breeding programmes.

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