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Characterization of Cotton (*Gossypium hirsutum L.*) Genotypes and Evaluation of Genetic Divergence

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Abstract: An investigation was taken up to compare the genetic variability of 150 cotton (*Gossypium hirsutum*) genotypes after grouping them visually into three different growth habits. The evaluation led to the grouping of accessions into 67 robust, 66 semicompact and 17 compact genotypes. The genotypes in the above three groups came under 13, 20 and 5 clusters respectively, when Mahalanobis D^2 technique was applied. The grouping of genotypes supported that the visual evaluation was in good agreement with the character evaluation of robust and compact types but not in the case of the intermediate semicompact types. Relatively higher contribution towards genetic divergence was noticed from quality characters, leaf area index and earliness characters.

Key words: Cotton, Growth habits, Genetic variability, Scoring

INTRODUCTION

Cotton, known as "the King of fibres", continues to be the predominant fibre in the Indian textile scene, despite stiff competition from the man-made synthetic fibres. It assumes a place of pride in Indian economy, as cotton production, processing and trade in cotton goods provide employment to about 60 million people in our country. Further, the export of raw cotton, yarn, textile, garments, cotton seed cake, oil and other byproducts earn valuable foreign exchange.

In India, cotton is grown in three agro climatic zones - northern zone where cotton is raised entirely under irrigation, central and south zones where it is predominantly a rainfed crop. Under rainfed cultivation a compact plant type with short internodes, low leaf area and high harvest index is preferred to get the best yield besides withstanding the drought in different phases of crop growth. However, under irrigated conditions, the crop attains a luxuriant growth with large leaves, open plant type, big bolls and longer duration. A specific plant type has acclimatized in a particular tract and is able to interact well with the weather parameters and perform well in respect of yield. The studies on suitability of particular ideotype to a particular environment have not been taken up by breeders either in tetraploid or diploid species. Such studies will be useful to pinpoint and fix the most efficient genotype for a particular location. Further the characterization of the robust, semicompact and compact genotypes in terms of crop growth, physiological efficiency, agronomic characters and quality parameters will be useful not only to increase the yield level in this important fibre crop but also helps to classify and select the most desirable ones for each of the target environments. Therefore, the present study was attempted to define the robust and compact plant types and a group intermediate between them using the agronomic, physiological and yield parameters for attaining the highest biological efficiency and fibre yield.

MATERIAL AND METHODS

One fifty genetic accessions of *Gossypium hirsutum* were raised in an experimental layout in Randomized Block Design (RBD) with two replications during kharif 2002-03. The genotypes were sown in six meter long ridges spaced 75 cm apart and with an interplant distance of 30cm so as to accommodate 20 plants in each row. Five randomly selected plants were tag-labelled for recording observations. Average of data recorded on each character from these five plants represented the mean of that replication. For determining the physiological traits fourth leaf from the top was used. For analyzing the biochemical constituents youngest, fully unfold, disease free leaves were collected from the sample plants and pooled to form the composite sample.

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Sampling Was Done at Flowering Stage Observations were recorded on morphological, yield and quality traits *viz*.,plant height (PH), number of sympodia per plant (NOS), number of monopodia per plant (NOM), length of sympodia (LOS), number of flower bearing nodes in sympodia (NFBN), days to first flowering (DFF), internode length (IL), petiole length (PL), number of flowers per plant (NOF), number of bolls per plant (NOB), boll weight (BW), number of locules (NOL), number of seeds per locule (NOSL)**,**days to first boll bursting (DFBB), days to fifty percent boll bursting (DFFBB), seed cotton yield (SCY), seed index (SI), lint Index (LI), ginning outturn (GOT), 2.5 per cent span length (2.5%SL), bundle strength (BS), uniformity ratio (UR), micronaire (MIC), elongation per cent (EL). Apart from this physiological parameters namely leaf area per plant (LA), specific leaf area (SLA), specific leaf weight (SLW), photosynthetically active radiations (PAR), canopy temperature (CT), diffusive resistance (DR) and transpiration rate (TR), root length (RL) and biochemical traits like chlorophyll content (CC),soluble protein (SP),total phenols (TP),nitrate reductase activity (NRA) were also recorded.

By visual evaluation the accessions were grouped into robust, semicompact and compact plant types. Based on all the above characters robust, semicompact and compact plant types were characterized and they were analysed for their genetic divergence.

RESULTS AND DISCUSSIONS

The genotypes were visually evaluated based on their stature, branching habit, leaf size, internode length and grouped into three distinct morphological groups *viz*. robust, semicompact and compact.

In order to characterize the three groups in terms of agronomic, physiological and yield traits a grade index was formulated for the three plant types which would be highly useful to visualize robust, semicompact and compact types. For each of the characters, low, intermediate and high range was fixed based on the expression (minimum and maximum values) and they were assigned with scores 1, 2 and 3. Then the grade index was calculated as follows:

$$\text{Grade index} = \frac{\text{Grade1 x number of accessions in grade 1 (A1) + grade2 x number of accessions in grade 2 (A2) + grade3 x number of accessions in grade 3 (A3)}}{\text{Total number of accessions (A1 + A2 + A3)}}$$

The grade indexes for different characters are presented in the Table 1. Based on this, the robust plant types can be characterized as tall, with longer petioles, more number of sympodia, longer fruiting branches, late flowering, more number of bolls and high yield. They also had high lint index, high span length and medium bundle strength. Moreover, it occupies more ground area with more number of leaves and consequently high total leaf area but relatively low specific leaf area, specific leaf weight, canopy temperature and transpiration rate.

A compact plant type can be characterized by short plant with intermediate petiole length, less number of sympodias, short fruiting branches, early flowering, low number of bolls and low seed cotton yield. Compact genotypes had superior fiber quality like high bundle strength, high lint index, medium span length and seed index. Compact types occupy less ground area with low total leaf area but they had relatively high specific leaf area, high leaf temperature and low transpiration rate. Compact genotypes had high leaf soluble proteins and chlorophyll contents. The semi compact types were intermediate for all the characters.

The percentage of genotypes of each group under different range for different characters was calculated. In robust group, high frequency of genotypes were in the minimum range of expression for the characters number of flower bearing nodes, days to first boll bursting, days to fifty per cent boll bursting, specific leaf area, canopy temperature, diffusive resistance, chlorophyll 'a' and oil content. For the characters petiole length, internode length, number of sympodia, length of sympodia, number of bolls, seed cotton yield, ginning outturn, 2.5 per cent span length, uniformity ratio, micronaire, bundle strength, elongation length, root length, photosynthetically active radiations, transpiration rate, phenol content, high frequency of genotypes fell in the intermediate range. More than fifty per cent of the robust genotypes had high total leaf area, soluble proteins and nitrate reductase activity.

Compact group had majority of genotypes under low expression for the characters plant height, internode length, number of flower bearing nodes, number of bolls, seed cotton yield, specific leaf weight, diffusive resistance and chlorophyll 'a'. All the accessions had registered low range for length of sympodia. Intermediate range was predominant for the character petiole length, number of sympodia, boll weight, lint index, ginning

Table 1: Grade index for the three plant types

Characters	Grade index for plant type		
	Robust	Semi compact	Compact
Plant height	2.37	1.91	1.47
Petiole length	2.16	1.82	1.88
Internode length	1.87	1.50	1.35
Number of sympodia	2.24	1.97	1.65
Length of sympodium	2.43	1.55	1.00
Number of flowering bearing nodes	1.31	1.29	1.24
Days to first flowering	1.97	2.20	2.12
Days to first boll bursting	2.34	2.30	2.12
Number of bolls	2.07	1.79	1.47
Boll weight	1.94	2.09	1.88
Seed cotton yield	2.04	1.79	1.47
Seed index	1.42	1.94	1.94
Lint index	2.25	1.65	2.24
Ginning outturn	2.39	2.24	2.35
2.5% Span length	2.10	1.94	1.88
Uniformity ratio	2.27	2.33	2.29
Micronaire	2.25	2.03	2.12
Bundle strength	1.85	1.83	2.59
Elongation percentage	2.00	1.95	2.00
Total leaf area	2.36	1.88	1.59
Specific leaf area	2.70	2.70	2.41
Specific leaf weight	1.72	1.67	1.41
Leaf area index	2.36	1.88	1.59
Root length	1.78	1.62	1.79
Canopy temperature	1.91	2.20	2.24
Photosynthetically active radiations	2.30	2.60	2.50
Transpiration rate	2.10	1.80	2.30
Diffusive resistance	1.20	1.20	1.30
Phenol content	2.10	2.40	2.10
Soluble proteins	2.20	2.00	2.80
Chlorophyll ‘a’	1.40	1.90	1.80
Chlorophyll ‘b’	2.40	1.90	2.30
Nitrate reductase activity	2.20	2.10	2.30
Oil content	1.60	1.80	1.90

outturn, 2.5 per cent span length, uniformity ratio, micronaire, elongation percentage, canopy temperature and phenol content. High frequency of plants fell under the high range for bundle strength and nitrate reductase activity.

The distribution of genotypes under the different levels of expression indicated that in general, robust genotypes can serve as donors for earliness, leaf area, soluble protein and nitrate reductase activity while compact genotypes can be considered for improving bundle strength, photosynthetically active radiations, and nitrate reductase activity.

The genetic divergence in the genotypes was estimated by subjecting them to distance analysis, using Mahalanobis D^2 statistics. A groupwise analysis of genetic divergence indicated that the sixty seven robust genotypes could be grouped into 13 clusters. It was observed that cluster I was the largest including 54 genotypes followed by cluster XIII comprising of two genotypes. All the other clusters had only one genotype. In a similar way, the 66 semicompact genotypes came under twenty clusters. Cluster I comprised the maximum number of 14 genotypes followed by cluster II (13 genotypes) cluster III (11 genotypes), cluster VII (4 genotypes), cluster IX and XII (3 genotypes), cluster XIII, XV and XX (2 genotypes). All the other clusters had only one genotype. The 17 compact genotypes which were subjected to diversity analysis using 12 characters after stepwise elimination of less important characters were grouped into five clusters. Cluster I comprised the maximum number of nine genotypes followed by cluster II (5 genotypes). Cluster III, IV and V had only one genotype each. The above grouping supported that visual evaluation was in good agreement with the character evaluation in respect of robust and compact types as most of the genotypes came under a single cluster. However, the agreement in respect of semicompact types was not as much as in the other two groups because for some characters it is towards robust type and for others it is towards compact type and so further detailed study is needed. The clustering pattern of the genotypes from various geographical regions into different clusters was random indicating the absence of parallelism between genetic grouping and diversity. Earlier studies of Kowsalya and Raveendran (1996) and Gururajan and Manickam (2002) also indicated more are less similar observations. This may be due to frequent exchange of breeding material between the breeders

Table 2: Inter and intra cluster distances (D) (D^2 values in brackets) in robust genotypes

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	9.09 (82.68)	10.01 (100.11)	10.01 (100.28)	10.00 (99.91)	10.20 (104.03)	10.16 (103.17)	10.66 (113.67)	10.44 (109.09)	10.23 (104.60)	10.01 (100.26)	10.11 (102.21)	11.17 (124.80)	12.34 (152.20)
II		0.00 (0.00)	11.35 (128.91)	11.09 (122.97)	10.93 (119.39)	11.81 (139.58)	13.07 (170.86)	12.08 (146.04)	9.91 (98.29)	10.78 (116.27)	10.33 (106.65)	11.93 (142.24)	14.43 (208.23)
III			0.00 (0.00)	10.24 (104.83)	10.53 (110.79)	12.16 (147.75)	10.76 (115.76)	9.42 (88.71)	9.62 (92.53)	9.53 (90.83)	11.42 (130.42)	9.65 (93.18)	11.71 (137.02)
IV				0.00 (0.00)	8.19 (67.05)	9.39 (88.26)	9.93 (98.54)	11.85 (140.46)	11.22 (125.83)	10.97 (120.37)	11.79 (139.05)	10.70 (114.40)	11.26 (126.85)
V					0.00 (0.00)	9.51 (90.35)	11.14 (124.04)	11.00 (121.04)	12.16 (147.87)	12.29 (150.94)	12.65 (160.08)	8.27 (68.43)	13.18 (173.73)
VI						0.00 (0.00)	9.91 (98.20)	11.58 (134.01)	12.75 (162.59)	12.12 (146.86)	11.47 (131.56)	11.92 (142.07)	12.15 (147.70)
VII							0.00 (0.00)	11.81 (139.46)	11.60 (134.64)	11.54 (133.18)	12.04 (144.93)	12.06 (145.54)	9.94 (98.72)
VIII								0.00 (0.00)	12.21 (149.17)	10.99 (120.73)	11.24 (126.23)	10.24 (104.89)	12.79 (163.58)
IX									0.00 (0.00)	9.22 (85.04)	10.64 (113.23)	12.37 (152.90)	12.79 (163.48)
X										0.00 (0.00)	8.68 (75.36)	12.84 (164.77)	11.03 (121.76)
XI											0.00 (0.00)	13.44 (180.60)	12.45 (155.08)
XII												0.00 (0.00)	13.96 (194.98)
XIII													0.00 (0.00)

Table 3: Mean values of 13 clusters for different characters in robust genotypes

	PH (cm)	IL (cm)	PL (cm)	NOS	LOS (cm)	NF BN	DFF	NOB	DF BB	DFF BB	BW (g)	SCY (g/ plant)	SI	LI	GOT (%)	SLW (mg/ cm²)	SLA (cm² /g)	LAI	RL (cm)	2.5% SL	UR	MIC	BS (g/tex)	EL
I	120.75	5.20	11.28	18.78	40.44	1.52	58.66	14.58	141.43	147.21	3.73	51.98	7.98	4.68	37.03	9.06	114.71	3.34	24.87	26.21	47.78	3.79	19.85	6.00
II	136.30	5.08	9.35	16.92	38.17	2.50	59.50	11.00	136.50	141.50	4.96	48.64	8.95	5.15	36.49	8.21	123.27	3.41	22.70	26.51	47.00	2.80	18.80	5.40
III	141.95	4.50	11.22	19.50	39.50	2.42	60.00	15.33	141.50	149.50	2.59	38.79	8.17	5.30	39.37	8.30	121.74	2.09	37.05	27.10	43.00	3.20	20.20	6.20
IV	121.07	6.05	11.55	19.50	43.50	1.33	61.00	12.50	140.00	149.50	4.21	53.96	8.61	5.15	36.23	7.89	133.33	2.15	33.60	27.20	47.00	4.10	17.70	6.10
V	124.82	5.50	9.50	21.50	37.83	1.00	61.00	12.83	137.50	143.00	4.75	47.50	8.99	5.36	38.39	8.90	108.60	2.72	26.45	30.10	46.00	4.10	20.00	4.70
VI	102.50	4.70	12.25	19.33	30.92	2.00	62.00	10.34	137.00	142.00	5.00	53.26	7.04	4.15	37.40	10.0	93.53	3.50	31.70	24.30	47.00	4.70	17.70	5.10
VII	126.92	5.28	12.14	19.50	41.50	1.83	53.50	15.67	130.50	137.00	3.32	44.52	8.15	5.06	38.34	8.32	124.00	4.50	30.40	25.20	48.00	4.70	19.10	7.40
VIII	98.59	6.27	12.65	14.50	33.00	1.00	64.50	9.84	140.00	149.50	3.37	32.57	8.55	5.54	39.36	8.92	116.26	1.47	16.45	27.90	46.00	4.00	23.00	5.00
IX	120.85	5.03	10.78	21.00	52.34	1.00	60.50	17.33	140.00	149.00	3.13	55.73	7.57	3.58	37.58	8.92	111.72	4.25	20.75	25.70	47.00	2.80	19.10	7.70
X	130.84	6.45	12.54	13.17	33.67	2.58	58.50	13.50	165.00	169.00	2.84	38.32	7.05	4.07	35.64	7.48	135.85	1.76	15.95	25.00	50.00	3.60	19.80	7.30
XI	116.56	4.59	10.45	16.00	32.33	1.50	55.50	13.84	131.50	138.00	3.60	48.37	6.94	5.24	38.62	9.09	120.30	1.94	27.00	23.40	52.00	3.70	19.80	7.00
XII	111.48	3.78	8.67	16.50	41.34	1.42	62.00	18.00	125.50	130.00	2.90	51.02	8.77	5.18	32.86	10.6	106.55	2.47	18.10	31.40	43.00	3.60	21.70	4.51
XIII	89.38	4.44	12.59	10.09	35.34	1.50	58.50	12.50	167.00	172.00	3.81	48.43	7.24	5.50	43.14	8.50	136.02	1.28	30.85	23.30	49.00	4.90	18.00	8.20

and common objectives of selection in different locations. Murthy and Arunachalam (1966) also suggested that the forces of genetic drift and natural selection under diverse environmental conditions within a country cause considerable diversity than geographic isolation. So, selection of parents for hybridization programmes should be based on genetic rather than the geographical diversity. However, a comparison between the two methods of parental selection based on geographical and genetic diversity, and study of segregating progenies of the hybrids synthesized within each group will give a better result on further use of parents.

Inter cluster distances were greater than intra cluster distances, revealing considerable amount of genetic diversity among genotypes studied. Use of genetically distant genotypes as parents to get most promising hybrids or segregants have been suggested by Kowsalya and Raveendran (1996), Manimaran and Raveendran (2001) and Gururajan and Manickam (2002).

In case of robust genotypes (table 2) the minimum inter cluster distance was recorded between the genotypes S-1622 and 560 whereas highest distance was noticed between cluster II(Able - 51(P)) and cluster XIII (Gregg and 5143) followed by cluster XII (920) and cluster XIII. Cluster XIII recorded highest mean value for the characters ginning outturn, specific leaf area, micronaire and elongation percentage (table 3). Cluster II showed low mean values for all the characters. Cluster XII recorded high mean values for number of bolls, specific leaf weight and 2.5 per cent span length. It would be a good effort to hybridize the genotype 920 with genotypes of cluster XIII to get better segregants showing good performance for yield components, earliness and fibre quality. Cluster IX (Empire-16 WR) also can be involved in hybridization programme to improve the seed cotton yield.

In semicompact group, the lowest inter cluster distance recorded was between clusters IV and XI and highest distance was recorded between clusters XIII and XIV followed by clusters XIII and XVI and cluster VI and XVIII(table 4). Cluster XIII (Stoneville and Acala-1577-D) recorded the highest mean value for specific leaf area (table 5). Cluster XIV (47-2) showed high expression for plant height, number of sympodia and number of bolls. These results indicate that Stoneville and Acale-1577-D can be crossed with 47-2 to get desirable recombinants. Further cluster XVI (Nectariless) which had recorded second highest distance with cluster XIII showed desirable expression for quality traits *viz.* uniformity ratio, micronaire value and elongation

Table 4: Inter and intra cluster distances (D) (D^2 values in brackets) in semi compact genotype

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	6.61 (43.74)	8.91 (79.47)	7.95 (63.21)	7.38 (54.43)	9.03 (81.51)	7.59 (57.57)	8.35 (69.70)	7.79 (60.63)	7.83 (61.25)	9.66 (93.37)	7.51 (56.47)
II		6.35 (40.28)	8.33 (69.34)	7.44 (55.35)	7.09 (50.20)	9.04 (81.64)	10.51 (110.37)	10.07 (101.46)	8.40 (70.54)	7.33 (53.71)	7.21 (51.95)
III			6.45 (41.62)	7.62 (58.09)	7.07 (50.05)	7.20 (51.83)	8.47 (71.69)	10.07 (101.40)	9.30 (86.44)	10.07 (101.38)	7.60 (57.74)
IV				0.00 (0.00)	8.16 (66.61)	6.52 (42.53)	8.76 (76.66)	8.81 (77.64)	7.71 (59.39)	8.38 (70.27)	5.95 (35.36)
V					0.00 (0.00)	8.75 (76.49)	10.12 (102.44)	10.79 (116.46)	9.54 (90.99)	9.18 (84.30)	7.61 (57.92)
VI						0.00 (0.00)	7.01 (49.10)	9.70 (94.18)	9.16 (83.92)	10.34 (107.00)	7.44 (55.38)
VII							6.59 (43.45)	10.05 (100.99)	9.97 (99.40)	11.66 (136.06)	9.46 (89.53)
VIII								0.00 (0.00)	7.42 (55.10)	9.69 (93.87)	9.05 (81.84)
IX									6.57 (43.19)	8.04 (64.60)	7.99 (63.78)
X										0.00 (0.00)	8.07 (65.17)
XI											0.00

Clusters	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
I	9.37 (87.83)	10.32 (106.51)	8.86 (78.55)	9.18 (84.33)	7.97 (63.47)	8.95 (80.13)	9.74 (94.78)	8.32 (69.18)	7.88 (62.05)
II	9.34 (87.24)	7.62 (58.10)	10.80 (116.56)	10.23 (104.65)	11.13 (123.78)	10.29 (105.87)	8.81 (77.70)	9.42 (88.65)	9.83 (96.63)
III	10.71 (114.64)	8.98 (80.62)	10.91 (118.99)	8.89 (78.99)	9.72 (94.47)	10.89 (118.68)	10.71 (114.62)	8.13 (66.02)	9.50 (90.22)
IV	8.75 (76.59)	8.93 (79.70)	9.59 (91.88)	8.71 (75.92)	9.58 (91.72)	8.95 (80.15)	9.29 (86.29)	8.11 (65.81)	8.45 (71.45)
V	10.70 (114.54)	7.44 (55.33)	11.53 (132.94)	10.08 (101.55)	11.06 (122.22)	11.36 (129.08)	10.24 (104.92)	8.94 (80.01)	10.39 (108.05)
VI	10.44 (108.97)	9.87 (97.36)	10.34 (106.98)	7.64 (58.40)	9.01 (81.26)	10.25 (105.08)	10.86 (117.95)	7.94 (63.07)	8.67 (75.14)
VII	11.51 (132.55)	11.06 (122.39)	10.87 (118.26)	7.36 (54.10)	8.78 (77.10)	10.97 (120.39)	11.99 (143.87)	8.37 (70.00)	9.28 (86.06)
VIII	8.30 (68.92)	11.67 (136.13)	6.23 (38.78)	10.66 (113.67)	8.10 (65.69)	6.33 (40.12)	9.00 (81.03)	9.93 (98.55)	7.59 (57.61)
IX	8.06 (64.90)	9.99 (99.76)	8.78 (77.05)	9.93 (98.70)	9.75 (95.12)	7.94 (63.12)	8.26 (68.23)	9.54 (91.03)	7.83 (61.29)
X	7.73 (59.80)	9.16 (83.85)	10.12 (102.41)	11.40 (129.96)	11.61 (134.85)	9.28 (86.14)	6.41 (41.10)	10.47 (109.57)	10.02 (100.36)
XI	8.58 (73.65)	8.98 (80.62)	9.62 (92.53)	9.80 (96.06)	9.59 (91.92)	9.27 (85.86)	8.90 (79.18)	8.47 (71.67)	8.76 (76.80)
XII	6.67 (44.44)	11.12 (123.58)	8.42 (70.86)	11.68 (136.31)	10.57 (111.77)	7.10 (50.48)	7.36 (54.24)	10.68 (114.03)	9.54 (91.07)
XIII		5.99 (35.88)	12.52 (156.70)	10.44 (108.95)	12.46 (155.14)	11.97 (143.32)	10.78 (116.15)	10.22 (104.45)	11.06 (122.39)
XIV			0.00 (0.00)	11.54 (133.22)	8.38 (70.19)	6.26 (39.17)	8.96 (80.27)	10.51 (110.49)	8.81 (77.61)
XV				6.24 (38.89)	10.33 (106.68)	11.31 (127.82)	12.04 (145.01)	8.64 (74.60)	9.59 (92.01)
XVI					0.00 (0.00)	9.43 (88.85)	11.20 (125.51)	9.27 (86.02)	8.93 (79.69)
XVII						0.00 (0.00)	8.51 (72.39)	10.51 (110.37)	8.74 (76.36)
XVIII							0.00 (0.00)	11.08 (122.86)	9.83 (96.70)
XIX								0.00 (0.00)	10.33 (106.63)
XX									0.00 (0.00)

Table 5: Mean values of 20 clusters for different characters in semi compact genotypes

	PH (cm)	IL (cm)	PL (cm)	NOS	LOS (cm)	NF BN	DFF	NOB	DF BB	DFF BB	BW (g)	SCY (g/ plant)	SI	LI	GOT (%)	SLW (mg/ cm²)	SLA (cm² /g)	LAI	RL (cm)	2.5% SL	UR	MIC	BS (g/tex)	EL
I	103.22	4.52	10.97	17.89	27.48	1.43	66.03	12.86	137.63	144.20	3.90	45.48	7.70	4.60	37.08	8.76	116.58	2.85	24.33	25.37	49.23	3.90	19.51	6.55
II	98.84	4.52	10.28	15.00	25.34	1.37	67.42	12.36	136.42	142.96	3.56	43.25	8.62	4.65	35.92	8.05	127.64	2.35	24.08	27.12	47.28	4.10	20.51	4.93
III	104.20	4.38	9.84	16.75	28.73	1.66	66.08	11.51	137.17	142.83	4.15	47.43	8.03	4.55	37.04	8.38	121.53	1.89	23.38	24.41	48.83	4.24	18.53	6.23
IV	101.04	5.17	11.15	14.17	25.00	1.33	69.00	11.33	164.50	169.00	3.96	45.04	8.46	5.68	40.16	7.39	128.69	2.76	31.65	26.00	49.00	3.91	19.20	6.20
V	101.73	4.21	11.26	15.00	29.50	1.83	62.50	15.67	130.00	137.00	3.49	54.71	9.62	4.66	39.43	8.03	122.75	1.68	33.00	26.80	47.00	4.30	18.51	6.00
VI	104.43	4.50	11.27	13.00	24.59	1.42	63.50	7.17	167.00	170.00	3.09	22.72	8.44	4.96	37.53	8.93	111.48	2.30	27.75	24.90	48.00	4.20	18.20	7.10
VII	102.15	3.74	10.74	18.37	26.15	1.46	64.38	9.65	148.88	156.88	3.56	32.65	7.81	4.24	35.69	9.35	112.61	2.00	24.65	23.60	50.50	3.83	20.20	6.83
VIII	126.51	5.59	9.67	14.25	27.34	2.17	69.00	17.34	140.50	143.50	3.95	67.08	9.62	5.07	33.96	8.86	109.87	3.90	32.75	25.10	47.00	3.00	18.80	6.40
IX	97.42	5.87	11.39	13.39	26.20	2.25	67.17	17.50	134.50	140.67	2.31	39.97	7.87	4.07	33.69	9.96	115.93	3.11	25.58	26.97	46.67	3.33	21.60	5.27
X	107.86	3.82	8.97	16.25	25.00	1.50	68.00	13.00	141.50	149.00	3.41	44.04	9.70	4.65	33.05	7.85	122.72	3.27	26.70	30.00	46.00	3.80	21.10	5.10
XI	77.40	3.67	8.75	14.09	28.00	1.33	66.00	10.17	156.00	159.00	4.29	43.70	6.89	3.95	40.99	12.61	92.11	2.92	26.85	26.80	47.00	4.60	19.10	6.30
XII	95.61	4.97	11.05	17.35	30.56	2.00	67.63	13.56	153.88	160.50	4.21	56.86	7.96	4.52	36.13	9.93	101.66	4.26	23.88	26.30	47.75	3.90	20.05	5.08
XIII	63.83	3.54	8.54	11.83	24.83	1.54	68.00	10.54	136.00	143.50	4.20	42.92	6.81	3.92	35.11	6.84	155.17	1.41	20.80	26.75	47.50	3.40	18.65	5.25
XIV	160.52	5.55	11.92	24.83	22.00	1.00	69.00	18.67	150.50	156.00	2.92	52.12	7.70	3.65	34.06	10.66	95.27	4.48	30.10	26.60	45.00	3.51	18.60	7.00
XV	122.92	4.89	11.92	18.29	26.50	1.87	68.75	13.84	154.50	160.75	2.64	36.78	8.67	3.93	31.10	10.59	104.77	1.47	19.68	25.55	47.50	3.40	23.55	5.55
XVI	124.10	5.15	11.42	21.83	28.00	1.00	69.00	17.67	140.00	149.00	3.43	59.95	8.15	4.97	37.15	9.03	122.67	3.46	21.35	24.70	51.00	4.60	20.00	7.60
XVII	118.75	8.10	12.00	16.38	26.08	2.00	65.50	14.00	161.00	166.50	4.26	60.38	8.56	5.43	37.03	9.44	103.52	4.47	29.25	25.60	46.00	3.20	19.20	5.90
XVIII	151.42	4.58	9.67	19.00	29.00	1.33	68.50	12.00	134.50	139.00	2.27	27.18	9.27	5.09	34.80	8.81	113.57	3.86	18.50	29.20	44.00	3.80	20.30	5.10
XIX	111.54	3.50	8.92	23.92	27.08	1.00	68.50	15.09	130.50	167.00	4.73	71.39	8.14	4.36	35.97	8.30	121.57	2.29	13.60	26.10	47.00	3.80	19.90	6.90
XX	121.09	4.40	11.59	15.67	24.17	1.33	68.50	16.50	166.50	140.50	2.49	40.76	9.24	5.02	36.00	9.05	122.07	2.98	23.95	28.30	45.00	3.40	21.00	6.70

Table 6: Intra and Inter cluster distances (D) (D^2 values in brackets) in compact genotypes

Clusters	I	II	III	IV	V
I	5.77 (33.33)	8.41 (70.70)	7.49 (56.07)	6.49 (42.16)	7.84 (61.45)
II		5.91 (34.95)	33.39 (111.03)	9.63 (92.67)	9.88 (97.65)
III			0.00 (0.00)	6.73 (45.30)	7.91 (62.60)
IV				0.00 (0.00)	8.93 (79.67)
V					0.00 (0.00)

Table 7: Mean values of five clusters for different characters in compact genotypes

Character ---------- Cluster	PH (cm)	IL (cm)	PL (cm)	NOS	LOS (cm)	NOB	SCY (g/plant)	SLW (mg/cm²)	SLA (cm²/g)	LAI	2.5% SL	BS (g/tex)
I	87.14	3.95	10.56	14.71	18.64	11.15	40.67	7.61	137.38	2.46	25.46	19.19
II	87.30	4.89	11.34	12.61	19.50	10.37	30.83	9.00	120.85	1.59	25.38	21.36
III	85.57	3.49	9.21	20.83	17.83	11.16	32.16	9.05	110.29	3.01	25.30	16.90
IV	97.50	8.08	11.91	15.00	20.49	15.66	68.53	8.04	129.20	3.05	24.90	18.40
V	83.15	4.31	11.58	12.00	14.83	7.66	21.29	7.71	117.03	0.87	28.20	19.50

Table 8: Percentage contribution of different characters to total genetic divergence in robust, semicompact and compact genotypes

Character	Contribution (percent)		
	Robust	Semicompact	Compact
Plant height	-	0.09	1.47
Days to first boll bursting	1.04	2.08	-
Days to fifty percent boll bursting	0.09	1.96	
Seed cotton yield	0.14	0.70	2.21
Bundle strength	17.37	5.83	72.79
Micronaire	22.57	3.08	-
Uniformity ratio	22.52	2.33	-
Elongation length	28.99	44.76	-
Leaf area index	7.28	38.69	18.38
Specific leaf area	-	-	4.41
Specific leaf weight	-	-	0.74
Total	100	100	100

percentage. Thus, to combine high physiological efficiency and good fibre quality characters, cluster XIII and cluster XVI can be used in crossing programme while, cluster VIII (Buri-147) will serve as a good source for yield improvement. To produce hybrids with wide genetic base and with pronounced hybrid vigour this genotype can be crossed with any other highly divergent cluster having desirable genotypes.

The compact genotypes (table 6) registered highest inter cluster divergence between cluster II (Kapland, BP-52NC-62, Stardel, Brazos and Deltapine) and cluster III (72/1). Cluster II showed high expression for bundle strength whereas cluster III registered high sympodial number and specific leaf weight (table 7). The cluster IV (199F) recording high mean values for seed cotton yield, number of bolls, length of sympodia, plant height, internode and petiole length showed high divergence with cluster II. So 199F can be hybridized with the genotypes of cluster II to improve the seed cotton yield.

The data pertaining to robust and semicompact genotypes (table 8) have also shown that quality characters were found to be good indices for selection of genotypes in the present study. As the yield and yield components failed to exhibit high degree of influence on genetic divergence, care should be taken to identify segregants for good yield performance from the limited variability available in the material under study. Similar reports have been given by Amudha *et al.,* (1997).

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