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Character association and diversity analysis in desi cotton (*Gossypium arboreum* L.)

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Abstract
The present Investigation was carried out to study the correlation, path coefficient and D^2 analysis in desi cotton. The material was evaluated in a Randomized Block Design (RBD) with three replications during kharif 2019. In this experiment association analysis revealed significant positive correlation for seed cotton yield per plant with number of sympodia per plant and number of bolls per plant. The path analysis revealed that the number of sympodia per plant and number of bolls per plant exhibited high direct effect on seed cotton yield per plant. This revealed that for improvement of seed cotton yield through selection programme, more emphasis should be given to these traits. D^2 analysis indicated wider genetic diversity among fifty genotypes of cotton which were grouped into four clusters. The maximum inter cluster distance (D^2) was observed between cluster II and IV (21.32) followed by cluster III and IV (19.01).

Keywords: correlation, path coefficient, D^2 analysis and genetic divergence

Introduction
Cotton (*Gossypium arboreum* L.) 2n = 26), is one of the most important fiber and cash crop of India. Cotton, the king of fibre, is one of the momentous and an important cash crop exercising profound influence on economics and social affairs of the world. Any other fibre crop cannot compare with cotton for its fibre quality. The commercial cotton is grown in 77 countries and 123 countries are involved in the cotton related activities. Specific areas of production include countries such as China, USA, India, Pakistan, Uzbekistan, Turkey, Australia, Greece, Brazil, Egypt etc. where climatic conditions suit the natural growth requirements of cotton, which includes periods of hot and dry weather and adequate moisture obtained through irrigation.
India is the only country in the world where all the four cultivated species are grown on commercial scale. In India, cotton is planted in about 122.38 lakh hectares of land and it occupies second position in production with 361.00 lakh bales (each of 170 kg) among all cotton producing countries in the world i.e. next to China. Average productivity of India is 501 kg/ha which is low as compared to world average of 779 kg/ha. Gujarat is the second largest growing state with acreage of 27.09 lakh hectares and the highest cotton producing state of India with production of 92 lakh bales. The average productivity of cotton in state (577 kg/ha) is higher than the national average.
There are four cultivated species of cotton *viz.*, *Gossypium arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense*. The first two species are diploid (2n = 26) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid (2n = 52) and are also known as New world cottons. *G. arboreum* is also known as desi cotton or lowland cotton.

Materials and methods
Plant material
The present investigation carried out at Cotton Research Station, Junagadh Agricultural University, Junagadh during *kharif* 2019. The experimental material consisted of fifty diverse genotypes of cotton (*Gossypium arboreum* L.). The pure seeds of these genotypes were obtained from the Cotton Research Station, Junagadh Agricultural University, Junagadh.

Field trial
Fifty genotypes of cotton were sown on 26th June, 2019 in a Randomized Block Design (RBD) with three replications at Cotton Research Station, Junagadh Agricultural University, Junagadh. Each line was sown in a single row plot of 6.3 × 1.2 m length with each row spaced 120 cm apart and plant to plant distance within row was 45 cm. The genotypes were randomly allotted to the plots in each replication. Fertilizers at recommended doses were applied and other cultural practices were carried out at regular intervals during the course of experimentation. Application

of N was split into two equal installments *i.e*., basal and top dressing. All the recommended agronomical practices along with necessary plant protection measures were followed timely for the successful raising of the crop. The observations were recorded on five randomly selected plants from each genotype in each replication for days to first flowering, days to boll opening, plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed cotton yield per plant (g), ginning percentage (%), seed index (g), lint index (g) and oil content (%), 2.5 % span length (mm), fibre fineness (mv) and fibre strength (g/tex).

Results and discussion

Correlation analysis

The phenotypic correlation of seed cotton yield with various component traits in this population are presented in Table-1. In the present investigation, seed cotton yield per plant had highly significant and positive correlation with number of sympodia per plant and number of bolls per plant at both the genotypic and phenotypic levels indicating that these attributes were more influencing the seed cotton yield and therefore, these were important characters for bringing genetic improvement in seed cotton yield. On the other hand, seed cotton yield per plant had non significant and positive correlation with days to first flowering, days to boll opening, plant height, oil content and fibre fineness at both genotypic and phenotypic levels, while number of monopodia per plant, boll weight, ginning percentage, seed index, lint index, 2.5 % span length and fibre strength had negative and non significant association at both genotypic and phenotypic levels.

Among all the component traits, days to first flowering exhibited positive and highly significant correlation with days to boll opening at both genotypic and phenotypic levels and it is an important component in identifying and deciding the duration of the cotton crop. Similar relationship has been reported by Dhivya *et al.*, 2014 [12]; Latif *et al.*, 2015 [21]; Dahiphale *et al.*, 2015[9]. The days to boll opening showed highly significant and negative correlation at genotypic level with plant height and significant and negative correlation at both genotypic and phenotypic levels with number of monopodia per plant.

Path coefficient analysis

The plant height showed positive and significant correlation only at genotypic level with number of sympodia per plant and non significant and positive correlation with number of bolls per plant, ginning percentage, lint index, oil content and fibre fineness at both genotypic and phenotypic levels. Similar findings were reported by Elango *et al.*, 2012 [13]; Dhivya *et al.*, 2014 [12]; Shahzad *et al.*, 2015 [25] and Sunayana *et al.*, 2017 [26]. Number of monopodia per plant showed positive and non significant correlation with seed index, lint index, 2.5 % span length, fibre fineness and fibre strength. Number of sympodia per plant showed positive and non significant correlation with ginning percentage, seed index, lint index, oil content 2.5 % span length and fibre fineness. Similar findings confounded by Pathak *et al.*, 2007 [22] and Jarwar *et al.*, 2019 [18]. Number of bolls per plant recorded negative and highly significant correlation with boll weight and fibre strength at both genotypic and phenotypic levels. Similar results were obtained by Latif *et al.*, 2015; Chinchane *et al.*, 2018 [21, 6] and Deshmukh *et al.*, 2019 [10]. Boll weight recorded positive and significant association with fibre strength only at genotypic level. Ginning percentage exhibited positive and highly significant correlation at both genotypic and phenotypic levels with seed index and lint index. Similar finding were reported by Hussain *et al.*, 2010; Kulkarni *et al.*, 2011; Latif *et al.*, 2015 and Chinchane *et al.*, 2018 [17, 19, 21, 6]. Seed index exhibited a positive and highly significant correlation with lint index at both genotypic and phenotypic levels. Similar findings were reported by Hussain *et al.*, 2010 [17]; Farooq *et al.*, 2014 [15] and Chinchane *et al.*, 2018 [6]. The lint index showed positive and non significant correlation at both genotypic and phenotypic levels with fibre fineness and fibre strength. Similar finding was reported by Jarwar *et al.*, 2019 [18]. The oil content recorded positive but non significant correlation at both genotypic and phenotypic levels with fibre fineness. Similar finding was reported by Dhivya *et al.*, 2014 [12]. The 2.5 % span length showed positive and highly significant correlation at both genotypic and phenotypic levels with fibre strength and negative and highly significant correlation only at genotypic level with fibre fineness. Similar findings were observed by Sambamurthy *et al.*, 2005 [24]; Tulasi *et al.*, 2012 [29]; Vinodhana *et al.*, 2013 [30]; Dahiphale *et al.*, 2015 [9] and Reddy and Sharma 2014 [23]. The fibre fineness recorded negative and significant correlation only at genotypic level and negative and non significant correlation only at phenotypic level with fibre strength. Similar findings were reported by Thiyagu *et al.*, 2010 [28]; Thiago *et al.*, 2017 [27] and Chinchane *et al.*, 2018 [6].

Genotypic path coefficient analysis

Number of sympodia per plant (Latif *et al.*, 2015) [21] and number of bolls per plant (Abbas *et al.*, 2008; Vinodhana *et al.*, 2013; Balakrishna *et al.*, 2016 and Jarwar *et al.*, 2019) [1, 30, 4, 18] exhibited very high and positive direct effects on seed cotton yield per plant. Fibre strength (Dahiphale *et al.*, 2015 and Sunayana *et al.*, 2017) [9, 26] exhibited high and negative direct effect towards seed cotton yield per plant. These traits turned out to be major components of seed cotton yield per plant for direct selection.

Days to first flowering and days to boll opening (Reddy and Sharma 2014) [23] had positive direct effect of low magnitude on seed cotton yield per plant. Number of monopodia per plant, boll weight, ginning percentage (Latif *et al.*, 2015 and Chinchane *et al.*, 2018) [21, 6] and seed index (Reddy and Sharma 2014 and Chinchane *et al.*, 2018) [23, 6] exhibited low and negative direct effects towards seed cotton yield per plant. Plant height (Abbas *et al.*, 2008; Dahiphale *et al.*, 2015 and Gulhane and Wadikar 2017) [1, 9, 16], oil content (Sambamurthy *et al.*, 2005) [24], and fibre fineness (Deshmukh *et al.*, 2019) [10] had positive direct effect of moderate magnitude on seed cotton yield per plant. Boll weight (Latif *et al.*, 2015 and Reddy and Sharma 2014) [21, 23] and 2.5 % span length (Kumar *et al.*, 2018 and Chinchane *et al.*, 2018) [20, 6] had negative direct effect of moderate magnitude on seed cotton yield per plant (Table-2 and Fig.-I).

Phenotypic path coefficient analysis

Number of sympodia per plant (Abdul *et al.*, 2010; Damayanathi *et al.*, 2010; Erande *et al.*, 2014; Dhivya *et al.*, 2014; Dahiphale *et al.*, 2015 and Deshmukh *et al.*, 2019) [12, 9, 10] and number of bolls per plant (Vinodhana *et al.*, 2013 and Chinchane *et al.*, 2018) [30, 6] exhibited very high and positive direct effects on seed cotton yield per plant. These traits turned out to be major components of seed cotton yield per plant for direct selection. Plant height (Latif *et al.*, 2015) [21], oil content (Sambamurthy *et al.*, 2005) [24] and fibre fineness (Deshmukh *et al.*, 2019) [10] exhibited moderate and positive direct effect on seed cotton yield per plant. Number of monopodia per plant

(Sunayana *et al.,* 2017) [26], ginning percentage (Latif *et al.*, 2015) [21], seed index (Deshmukh *et al.*, 2019) [10] and lint index (Reddy and Sharma 2014) [23] exhibited low and negative direct effect on seed cotton yield per plant.

Days to first flowering (Chovatia *et al.*, 2006; Bayyapu *et al.*, 2015 and Jarwar *et al.*, 2019) [6, 5, 18], and days to boll opening (Dahar *et al.,* 2007; Elango *et al.*, 2012; Dahiphale *et al.*, 2015 [8, 13, 9] and Bayyapu *et al.,* 2015) [5] had positive direct effect of negligible magnitude on seed cotton yield per plant. Boll weight (Latif *et al.,* 2015 and Reddy and Sharma 2014) [21, 23], 2.5 % span length (Reddy and Sharma 2014 and Chinchane *et al.*, 2018) [23, 6] and fibre strength (Latif *et al.,* 2015 and Chinchane *et al.,* 2018) [21, 6] had negative direct effect of moderate magnitude on seed cotton yield per plant (Table-3 and Fig.-II).

Genetic diversity

In the present study, D^2statistics estimated on 50 cotton genotypes for 15 characters. On the basis of D^2 values, four clusters were formed from 50 genotypes (Table-4 and 5). The cluster I having largest number of genotypes (45) followed by cluster II (3), cluster III and cluster IV are solitary clusters. The intra cluster distance (D) ranged from 9.80 (cluster-I) to 10.51 (cluster-II). High intra cluster distance indicated about the wider genetic diversity among the genotypes which could be used in yield improvement of cotton. The maximum inter cluster distance was found between clusters II and IV (D = 21.32) followed by that between clusters III and IV (D = 19.01), I and IV (D = 17.12), II and III (D = 16.07), I and III (D = 14.10) and I and II (D = 13.28). The minimum inter cluster distance was found between clusters I and II (D=13.28). The genotypes belonging to the clusters separated by high statistical distance could be used in hybridization programme for obtaining a wide spectrum of variation among the segregates or to exploit maximum level of hybrid vigour in cotton.

In present investigation, wide range of variation for several characters among multi genotypic clusters was observed (Table-5 and 6). Days to boll opening (19.27 %), number of bolls per plant (17.88 %), oil content (13.31 %) and fibre strength (12.08 %) were the main contributors to the total divergence. These four characters accounted for 62.54 % of total divergence (Table-7). A considerable diversity of 62.54 % was observed due to these four characters. Hence, selection for divergent parents based on these four characters would be useful for heterosis breeding in cotton. Ginning percentage (7.27 %), number of monopodia per plant (5.88 %) and fibre fineness (5.39 %) were other contributors towards the total divergence. Sunayana *et al.,* 2017 [26] also reported higher genetic diversity due to days to boll opening. Sunayana *et al.*, 2017 [26]; Deshmukh *et al.,* 2019 [10] and Jarwar, *et al.,* 2019 [18] supported that more divergence was found due to number of bolls per plant. Dahiphale *et al.*, 2015 [9] and Chinchane *et al.*, 2018 [6] also reported higher genetic diversity due to oil content. Abdul *et al.,* 2010 [2]; Ahmad *et al.,* 2016; Balakrishna *et al.,* 2016 and Jarwar *et al.,* 2019 [4, 18] supported that more divergence was found due to fibre strength, ginning percentage, number of monopodia per plant and fibre fineness. The contribution of lint index (4.08 %), number of sympodia per plant (3.51 %), days to first flowering (3.18), 2.5 % span length (3.02 %), seed cotton yield per plant (1.63 %), boll weight (1.63 %) and plant height (0.90 %) were negligible. Low genetic diversity for these traits in such diverse group of genotypes may also suggest high degree of consistency and moderate to low heritability of these traits.

The clustering pattern could be utilized in selection of parents for crossing and deciding the best cross combinations which may generate the highest possible variability for various traits. The genotypes with high values of any cluster can be used either for direct adoption as improved varieties or for hybridization to exploit heterosis breeding. In the present study, the cluster II differed from other clusters in respect of days to first flowering, days to boll opening, number of monopodia per plant, boll weight and fibre strength had highest rate of mean values. While cluster III had desirable rating for plant height, number of sympodia per plant, number of bolls per plant, seed cotton yield per plant and oil content. Cluster IV had desirable rating for ginning percentage, seed index, lint index and fibre fineness. The cluster I had the highest mean values for 2.5 % span length. Therefore, intercrossing of such genotypes involved in these clusters would be useful for inducing variability in the respective characters and their rational improvement for increasing seed cotton yield.

Table 1: Estimates of Genotypic (rg) and phenotypic (rp) correlation coefficients among 15 characters of cotton

Characters		DF	DBB	PH	MP/P	SP/P	BP/P	BW	GP	SI	LI	OC	FL	FF	FS
SCY	rp	0.0690	0.0323	0.1231	-0.0487	0.4854**	0.8653**	-0.1182	-0.0613	-0.0346	-0.0457	0.1572	-0.1624	0.2238	-0.2478
	rg	0.0810	0.0345	0.1534	-0.0502	0.5505**	0.9507**	-0.1256	-0.0817	-0.0589	-0.0663	0.1732	-0.1643	0.2530	-0.2849*
DF	rp		0.9624**	-0.2526	-0.2023	-0.1188	-0.0855	0.2173	-0.2685	-0.1869	-0.2543	-0.0317	-0.0084	-0.0266	0.2362
	rg		1.0197**	-0.2870*	-0.2198	-0.1380	-0.0886	0.2255	-0.2986*	-0.2206	-0.2794*	-0.0194	-0.0226	-0.0388	0.2667
DB	rp			-0.2644	-0.2742*	-0.1745	-0.1002	0.2001	-0.2454	-0.2035	-0.2554	-0.0650	-0.0315	-0.1137	0.2301
	rg			-0.3207**	-0.2996*	-0.1932	-0.1077	0.2568	-0.2641	-0.2357	-0.2719*	-0.0673	-0.0428	-0.1301	0.2461
PH	rp				-0.1116	0.2600	0.1690	-0.0881	0.0306	0.0269	0.0353	0.0682	-0.1252	0.0785	-0.1492
	rg				-0.1076	0.3039*	0.1653	-0.0900	0.0638	-0.0040	0.0424	0.1009	-0.1243	0.1615	-0.1810
MP/P	rp					0.0000	-0.0275	-0.0195	-0.0577	0.0778	0.0388	-0.0097	0.2077	0.2437	0.1335
	rg					-0.0233	-0.0295	-0.0156	-0.0672	0.0975	0.0451	-0.0040	0.2444	0.2639	0.1459
SP/P	rp						0.1431	-0.0186	0.1695	0.0436	0.1132	0.1995	0.0619	0.2200	-0.0234
	rg						0.4401**	-0.0279	0.2021	0.0747	0.1467	0.2315	0.0552	0.2488	-0.0248
BP/P	rp							-0.5869**	0.0308	0.0007	0.0223	0.1445	-0.1070	0.2059	-0.3360**
	rg							-0.6654**	0.0286	-0.0106	0.0189	0.1559	-0.1291	0.2480	-0.3668**
BW	rp								-0.1600	-0.0549	-0.1228	-0.0572	-0.0946	-0.0114	0.2404
	rg								-0.1896	-0.0856	-0.1520	-0.0427	-0.1437	-0.0647	0.2995*
GP	rp									0.5547**	0.8652**	-0.0656	0.1342	0.0008	0.1293
	rg									0.6502**	0.8944**	-0.0684	0.1470	0.0071	0.1339
SI	rp										0.8880**	-0.2370	-0.0987	0.1009	-0.0214
	rg										0.9156**	-0.2892*	-0.1106	0.1516	-0.0383
LI	rp											-0.1768	-0.0084	0.0663	0.0425
	rg											-0.1947	-0.0084	0.0900	0.0376
OC	rp												-0.2102	0.2022	-0.1129
	rg												-0.2645	0.2406	-0.1173
FL	rp													-0.2686	0.4143**
	rg													-0.3305**	0.4763**
FF	rp														-0.2407
	rg														-0.2740*

*, ** Significant at 5 and 1 % levels, respectively

DF=Days to first flowering, DB=Days to boll opening, PH=Plant height (cm), MP/P=No. of monopodia per plant, SP/P=No. of sympodia per plant, BP/P=No. of bolls per plant, BW=Boll weight (g), SCY=Seed cotton yield per plant (g), GP=Ginning percentage (%), SI=Seed index (g), LI=Lint index (g), OC=Oil content (%), FL=2.5 % Span length (mm), FS=Fibre strength (g/tex), FF=Fibre fineness (mv)

Table 2: Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on seed cotton yield per plant in 50 genotypes of cotton

Characters	DF	DB	PH	MP/P	SP/P	BP/P	BW	GP	SI	LI	OC	FL	FF	FS	SCY
DF	-0.8881	0.8614	-0.0186	0.0298	0.0452	-0.1670	0.2756	0.2292	0.0861	-0.3353	-0.0042	-0.0121	-0.0043	-0.0167	0.0810
DB	-0.9056	0.8448	-0.0208	0.0406	0.0633	-0.2031	0.3138	0.2029	0.0920	-0.3263	-0.0145	-0.0228	-0.0144	-0.0154	0.0345
PH	0.2549	-0.2709	0.0647	0.0146	-0.0995	0.3116	-0.1100	-0.0491	0.0016	0.0509	0.0217	-0.0663	0.0179	0.0113	0.1534
MP/P	0.1952	-0.2531	-0.0070	-0.1355	0.0076	-0.0557	-0.0191	0.0516	-0.0380	0.0541	-0.0009	0.1304	0.0292	-0.0091	-0.0502
SP/P	0.1226	-0.1632	0.0197	0.0032	-0.3274	0.8299	-0.0341	-0.1553	-0.0291	0.1761	0.0498	0.0294	0.0275	0.0016	0.5505**
BP/P	0.0786	-0.0910	0.0107	0.0040	-0.1441	1.8858	-0.8133	-0.0219	0.0041	0.0227	0.0335	-0.0689	0.0274	0.0230	0.9507**
BW	-0.2003	0.2169	-0.0058	0.0021	0.0091	-1.2548	1.2223	0.1457	0.0334	-0.1824	-0.0092	-0.0767	-0.0072	-0.0188	-0.1256

GP	0.2649	-0.2231	0.0041	0.0091	-0.0662	0.0539	-0.2317	-0.7685	-0.2538	1.0735	-0.0147	0.0784	0.0008	-0.0084	-0.0817
SI	0.1959	-0.1991	-0.0003	-0.0132	-0.0244	-0.0200	-0.1046	-0.4997	-0.3903	1.0989	-0.0622	-0.0590	0.0168	0.0024	-0.0589
LI	0.2481	-0.2296	0.0027	-0.0061	-0.0480	0.0357	-0.1857	-0.6873	-0.3574	1.2002	-0.0419	-0.0045	0.0100	-0.0024	-0.0663
OC	0.0173	-0.0568	0.0065	0.0005	-0.0758	0.2940	-0.0523	0.0526	0.1129	-0.2337	0.2150	-0.1411	0.0266	0.0074	0.1732
FL	0.0201	-0.0362	-0.0080	-0.0331	-0.0181	-0.2435	-0.1757	-0.1129	0.0432	-0.0101	-0.0569	0.5334	-0.0366	-0.0299	-0.1643
FF	0.0345	-0.1099	0.0105	-0.0358	-0.0815	0.4677	-0.0790	-0.0055	-0.0592	0.1080	0.0517	-0.1763	0.1106	0.0172	0.2530
FS	-0.2368	0.2079	-0.0117	-0.0198	0.0081	-0.6916	0.3660	-0.1029	0.0149	0.0451	-0.0252	0.2541	-0.0303	-0.0627	-0.2849

*, ** Significant at 5 % and 1 % levels, respectively (Residual effect = 0.4347)

DF=Days to first flowering, DB=Days to boll opening, PH=Plant height (cm), MP/P=No. of monopodia per plant, SP/P=No. of sympodia per plant, BP/P=No. of bolls per plant, BW=Boll weight (g), SCY=Seed cotton yield per plant (g), GP=Ginning percentage (%), SI=Seed index (g), LI=Lint index (g), OC=Oil content (%), FL=2.5 % Span length (mm), FS=Fibre fineness (mv), FF=Fibre strength (g/tex)

Table 3: Phenotypic path coefficient analysis showing direct (diagonal and bold) indirect effects of different characters on seed cotton yield plant in 50 genotypes of cotton

Characters	**DF**	**DB**	**PH**	**MP/P**	**SP/P**	**BP/P**	**BW**	**GP**	**SI**	**LI**	**OC**	**FL**	**FF**	**FS**	**SCY**
DF	0.1229	-0.0878	0.0055	0.0046	0.0009	-0.1047	0.1298	0.0695	0.0468	-0.1181	-0.0011	-0.0003	0.0006	0.0006	0.0690
DB	0.1183	-0.0912	0.0058	0.0062	0.0014	-0.1228	0.1194	0.0636	0.0509	-0.1187	-0.0022	-0.0013	0.0024	0.0006	0.0323
PH	-0.0311	0.0241	-0.0219	0.0025	-0.0020	0.2071	-0.0526	-0.0079	-0.0067	0.0164	0.0023	-0.0050	-0.0017	-0.0004	0.1231
MP/P	-0.0249	0.0250	0.0024	-0.0226	0.0001	-0.0337	-0.0117	0.0149	-0.0195	0.0180	-0.0003	0.0083	-0.0052	0.0003	-0.0487
SP/P	-0.0146	0.0159	-0.0057	0.0001	-0.0078	0.5064	-0.0111	-0.0439	-0.0109	0.0526	0.0068	0.0025	-0.0047	-0.0001	0.4854**
BP/P	-0.0105	0.0091	-0.0037	0.0006	-0.0032	1.2257	-0.3504	-0.0080	-0.0002	0.0104	0.0049	-0.0043	-0.0044	-0.0008	0.8653**
BW	0.0267	-0.0183	0.0019	0.0004	0.0001	-0.7194	0.5970	0.0414	0.0137	-0.0571	-0.0019	-0.0038	0.0002	0.0006	-0.1182
GP	-0.0330	0.0224	-0.0007	0.0013	-0.0013	0.0377	-0.0955	-0.2589	-0.1389	0.4020	-0.0022	0.0054	0.0001	0.0003	-0.0613
SI	-0.0230	0.0186	-0.0006	-0.0018	-0.0003	0.0008	-0.0328	-0.1436	-0.2504	0.4126	-0.0080	-0.0040	-0.0021	-0.0001	-0.0346
LI	-0.0312	0.0233	-0.0008	-0.0009	-0.0009	0.0274	-0.0733	-0.2240	-0.2223	0.4647	-0.0060	-0.0003	-0.0014	0.0001	-0.0457
OC	-0.0039	0.0059	-0.0015	0.0002	-0.0016	0.1772	-0.0341	0.0170	0.0593	-0.0821	0.0339	-0.0084	-0.0043	-0.0003	0.1572
FL	-0.0010	0.0029	0.0027	-0.0047	-0.0005	-0.1312	-0.0565	-0.0347	0.0247	-0.0039	-0.0071	0.0401	0.0057	0.0010	-0.1624
FF	-0.0033	0.0104	-0.0017	-0.0055	-0.0017	0.2524	-0.0068	0.0002	-0.0253	0.0308	0.0068	-0.0108	-0.0213	-0.0006	0.2238
FS	0.0290	-0.0210	0.0033	-0.0030	0.0002	-0.4118	0.1435	-0.0335	0.0054	0.0198	-0.0038	0.0166	0.0051	0.0025	-0.2478

*, ** Significant at 5 % and 1 % levels, respectively (Residual effect = 0.1140)

DF=Days to first flowering, DB=Days to boll opening, PH=Plant height (cm), MP/P=No. of monopodia per plant, SP/P=No. of sympodia per plant, BP/P=No. of bolls per plant, BW=Boll weight (g), SCY=Seed cotton yield per plant (g), GP=Ginning percentage (%), SI=Seed index (g), LI=Lint index (g), OC=Oil content (%), FL=2.5 % Span length (mm), FS=Fibre fineness (mv), FF=Fibre strength (g/tex)

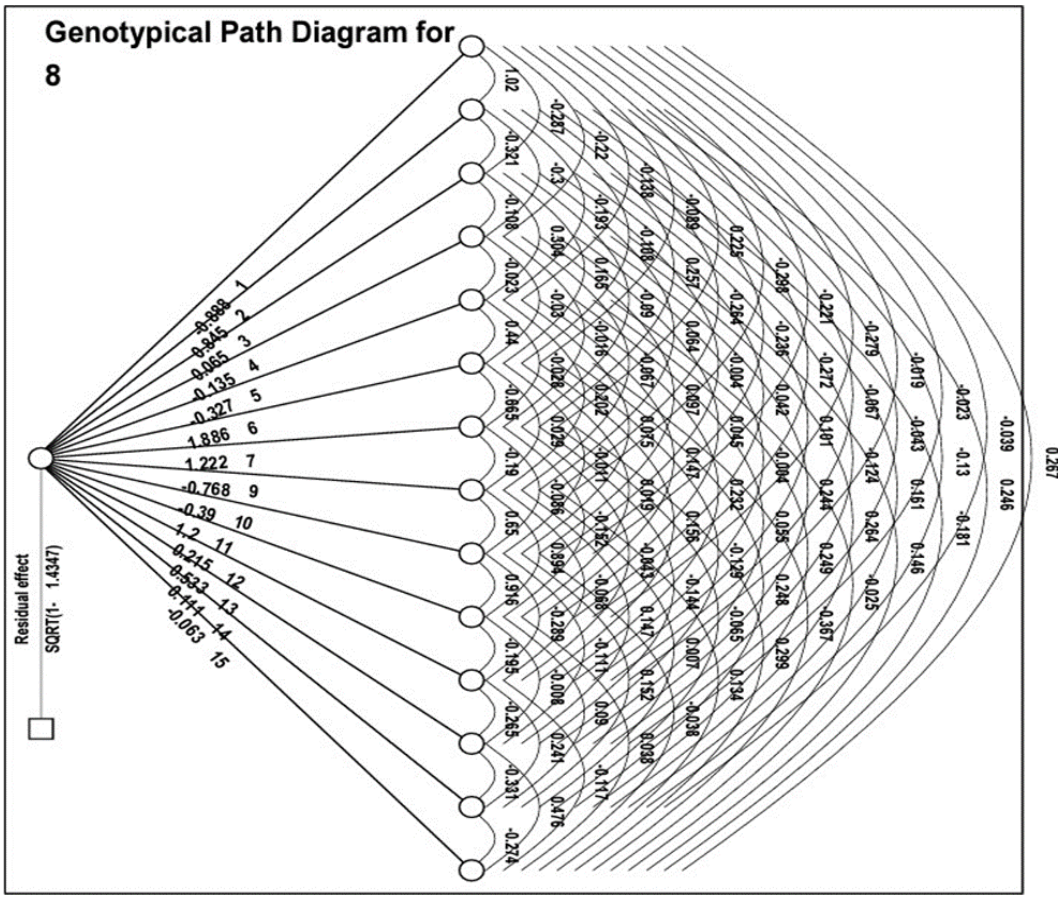

Fig 1: Diagrammatic representation of genotypic path analysis using 15 characters of cotton 1. Days to first flowering 2. Days to boll opening 3. Plant height (cm) 4. Number of monopodia per plant 5. Number of sympodia per plant 6. Number of bolls per plant 7. Boll weight (g) 8. Seed cotton yield per plant (g) 9. Ginning percentage (%) 10. Seed index (g) 11. Lint index (g) 12. Oil content (%) 13. 2.5 % Span length (mm) 14. Fibre strength (g/tex) 15. Fibre fineness (mv)

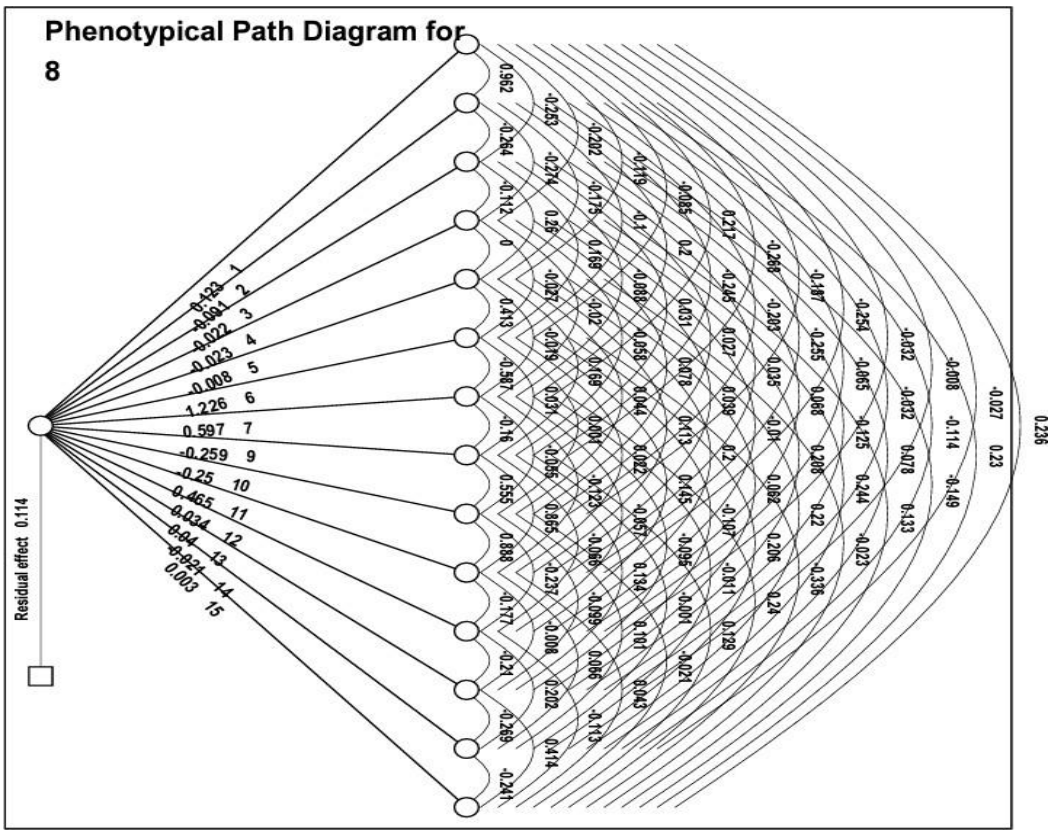

Fig 2: Diagrammatic representation of phenotypic path analysis using 15 characters of cotton 1. Days to first flowering 2. Days to boll opening 3. Plant height (cm) 4. Number of monopodia per plant 5. Number of sympodia per plant 6. Number of bolls per plant 7. Boll weight (g) 8. Seed cotton yield per plant (g) 9. Ginning percentage (%) 10. Seed index (g) 11. Lint index (g) 12. Oil content (%) 13. 2.5 % Span length (mm)14. Fibre strength (g/tex) 15. Fibre fineness (mv)

Table 4: Grouping of 50 genotypes of cotton in various clusters on the basis of D2 statistic

Cluster	No. of Genotypes	Genotypes		
I	45	H1-62	Y-1	MJ-14
		29-7-6	H-41	H-120
		H-368	H-221	A-18
		H-9	2658	H-27
		H-214	Sang NLA	K-1
		H1-34	91	84-AK-14
		Intermedium Jethi	AK-207	H-194
		H-94	Pratap	Pink Top
		H-362	H-83	H-318
		Coconada-2	H-84	.H-240
		1-10	H-42	H-1
		331	H-162	SC-75
		H-76	H-241	H-4
		H-106	H-2(WR)	A-4
		G. Cot-19	270	G. N. Cot-29
II	3	H-380	H-82	Sager Jadi ML WR
III	1	W-31		
IV	1	907		

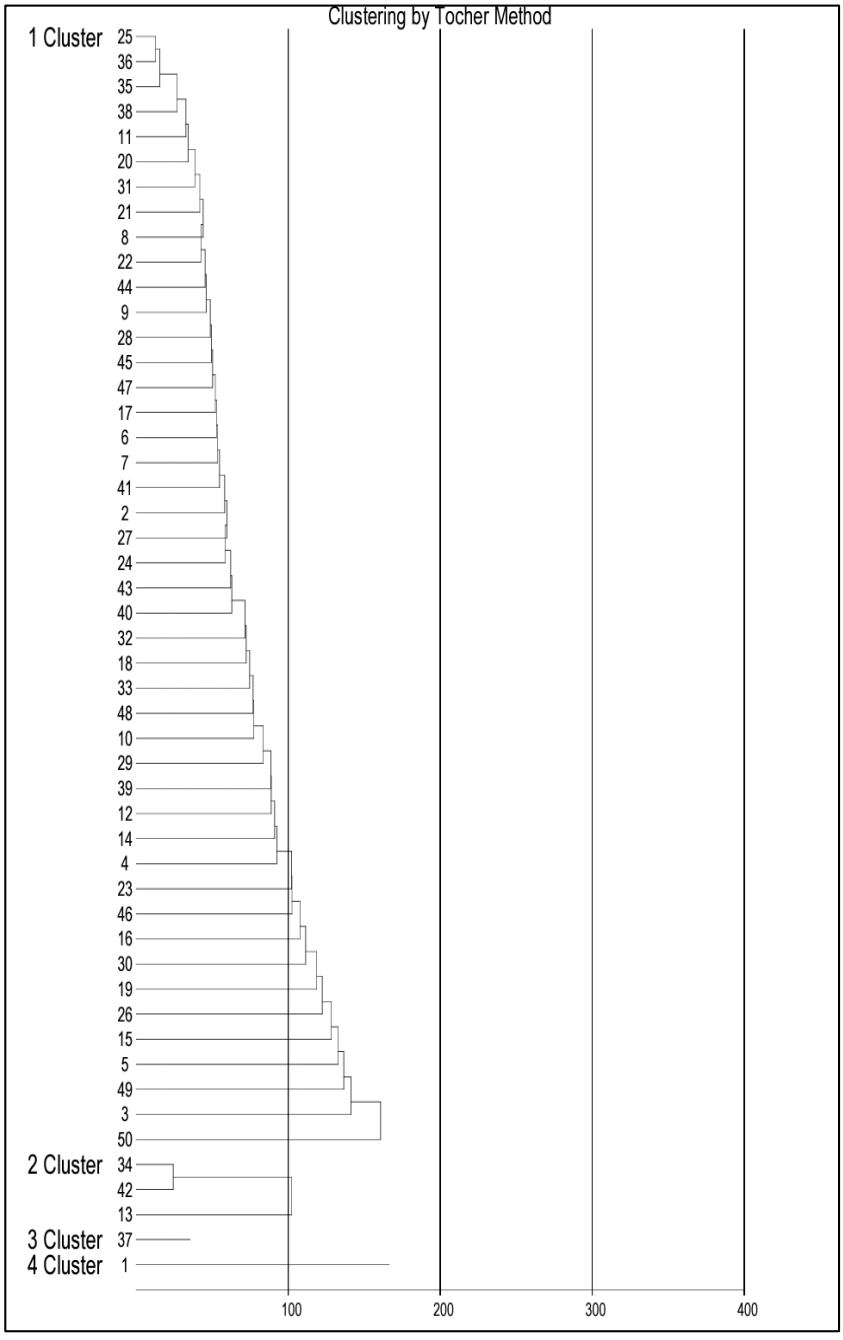

Fig 3: Dendrogram showing distribution of 50 cotton genotypes into 4 clusters

Table 5: Average intra and inter cluster distances between four clusters in cotton

Cluster	I	II	III	IV
I	9.80	13.28	14.10	17.12
II		10.51	16.07	21.32
III			0.00	19.01
IV				0.00

Table 6: Cluster mean values of fifteen characters in four clusters in fifty genotypes in cotton

Sr. No	Characters	I	II	III	IV
1	DF	68.58	78.89	68.67	64.00
2	DB	109.59	120.44	110.00	102.33
3	PH	166.90	151.22	195.67	183.22
4	MP/P	3.01	3.09	2.80	2.73
5	SP/P	18.25	17.73	20.47	20.27
6	BP/P	32.01	32.18	55.73	33.87
7	BW	2.78	3.11	2.37	2.63
8	SCY	82.66	94.00	128.67	84.67
9	GP	35.85	34.14	34.20	41.83
10	SI	6.13	5.78	6.10	8.10
11	LI	3.43	3.01	3.17	5.83
12	OC	18.48	18.49	18.54	18.21
13	FL	25.24	24.82	24.10	23.90
14	FF	6.12	6.26	6.26	6.50
15	FS	32.12	32.69	27.97	31.33

DF=Days to first flowering, DB=Days to boll opening, PH=Plant height (cm), MP/P=No. of monopodia per plant, SP/P=No. of sympodia per plant, BP/P=No. of bolls per plant, BW=Boll weight (g), SCY=Seed cotton yield per plant (g), GP=Ginning percentage (%), SI=Seed index (g), LI=Lint index (g), OC=Oil content (%), FL=2.5 % Span length (mm), FF=Fibre fineness (mv), FF=Fibre strength (g/tex)

Table 7: Contributions of various traits towards genetic divergence in cotton

Sr. No.	Characters	Time ranked first	Contribution (%)
1	Days to first flowering	39	3.18
2	Days to boll opening	236	19.27
3	Plant height (cm)	11	0.90
4	No. of monopodia per plant	72	5.88
5	No. of sympodia per plant	43	3.51
6	No. of bolls per plant	219	17.88
7	Boll weight (g)	20	1.63
8	Seed cotton yield per plant (g)	20	1.63
9	Ginning percentage (%)	89	7.27
10	Seed index (g)	12	0.98
11	Lint index (g)	50	4.08
12	Oil content (%)	163	13.31
13	2.5 % span length (mm)	37	3.02
14	Fibre fineness (mv)	66	5.39
15	Fibre strength (g/tex)	148	12.08

Conclusion

It could be concluded from the present findings that number of sympodia per plant and number of bolls per plant was highly significant and positively correlated at both phenotypic and genotypic levels with seed cotton yield per plant. This was most important attribute which contributed towards higher seed cotton yield. The path analysis revealed that the number of sympodia per plant and number of bolls per plant exhibited high direct effect on seed cotton yield per plant. This revealed that for improvement of seed cotton yield through selection programme, more emphasis should be given to these traits. Days to boll opening, number of bolls per plant, oil content and fibre strength had highest contribution towards total genetic divergence. Therefore, due weightage should be given to these traits for genetic improvement in desi cotton.

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