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Studies of genetic parameters on seed cotton yield and fibre quality traits in Egyptian cotton (*Gossypium barbadence* L.)

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Abstract : Forty seven Egyptian cotton (*Gossypium barbadense* L.) genotypes of diverse origin were evaluated to observe the genetic variability, heritability and genetic advance in yield and fibre quality traits. The analysis of variance study indicated the presence of significant difference among all the traits. The highest PCV and GCV were observed for single plant yield (36.2) followed by bolls/plant (20.4). Genotypic co efficient of variation had a similar trend as PCV. High heritability along with high genetic advance was observed in traits like single plant yield and bundle strength. The combinations of high heritability with high genetic advance will provide a clear base on the reliability of that particular character in selection of variable entries. Based on *per se* performance, the accessions Suvin, SIV 135, Barbados, EC 101786 and EC 9257 were identified as potential donors which were recorded highest mean values for single plant yield, bolls/ plant, 2.5 per cent span length(mm) and bundle strength (g/tex). Hence these accessions may be exploited for further improvement of the above traits by breeding programmes.

Key words : Egyptian cotton, genetic advance, genetic parameters, heritability, variability

Cotton (*Gossypium* spp.), "King of Fibres" is the world's leading natural fibre crop and it is the corner stone of textile industries worldwide. It is providing directly and indirectly livelihood to more than 60 million people and accounting for about 30 per cent of India's export earnings (Anonymous,2014). Cotton is the number one commercial crop of India. The economy of many countries depends on production on utilization and export of cotton, mainly in apparel manufacturing. *Gossypium* is a large, diverse and economically viable genus, which include many diploid and tetraploid species. The extensive genetic variation is present in this genus is distributed among 50 species, of which four are cultivated, 44 are wild diploids and two are wild tetraploids. India is the only country growing all the four species of cultivated cotton *Gossypium arboreum* L. and *G. herbaceum* L. (Asian cotton), *G. barbadense* L. (Egyptian cotton) and *G. hirsutum* L. (American upland cotton) besides hybrid cotton. Among the two cultivated tetraploid species, upland cotton (*Gossypium hirsutum)* in considered the most important one for its wide adaptability high yielding and better spinning ability as democrated by the release of number of stable varieties, while Egyptian cotton in capable of spinning to high counts due to its fine and larger lint which processes high spindle strength. Simultaneous important of lint yield and quality of cotton has been one of the serious problem among the breeders throughout the world. Even though both the characters are negatively alternated, it could be processeble to combine these properties in F_1 hybrids. Yield and fibre qualities are the two important criteria which decides the sustainability of the variety or hybrid for commercial cultivation. Genetic diversity enables for long term sustainability and agricultural self reliance. The presence of genetic diversity is important for improving any crop species. Often plant breeders limit their effort to a narrow range of adapted lines for genetic improvement, which may likely to produce economic gains in short term but may have enhanced genetic vulnerability to biotic insects and other abiotic stress. The precious evaluation of the genetic diversity of the excellent germplasm will provide a guide for choosing parents and predicting the degree of in heritance, variation and level of heterosis, which are essential for releasing the breeding goal. The present investigation was carried out with 47 *G. barbadense* lines of diverse origin to estimate their *per se* performance, variability, heritability and genetic advance on the genetic architecture of 16 yield, yield components and fibre quality traits.

The experiment was conducted at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore during winter, 2012. Forty seven *Gossypium barbadense* cotton genotypes were planted in randomized block design with two replications. Uniform spacing of 90 x 45 cm and all the recommended field operations were carried out. In each replication five competitive plants were randomly selected and observations were recorded for 16 characters *viz.,* days to 50 per cent flowering, plant height (cm), internode length (cm), sympodia/plant, ovules/flower, bolls/plant, boll weight(g), seeds/bolls, seed setting percentage, seed cotton yield/plant, lint index, seed index, ginning outturn(%), 2.5 per cent span length(mm), bundle strength (g/tex) and fibre fineness. Analysis of variance was carried out statistically utilizing the mean values. The phenotypic and genotypic coefficient of variation were estimated and expressed in percentage. The phenotypic and genotypic variances were calculated by utilizing the respective mean sum of square from variance Table. Heritability, expected genetic advance and genetic gain in the broad sense was calculated.

The *per se* performance of yield and fibre quality characters were recorded on 47 germplasm accessions and the range of variations observed in respect of all the 16 traits studied were presented in the Table 1. Based on *per se* performance, the accessions such as Suvin, SIV 135, Barbados, EC 101786 and EC 9257 were identified as potential donors which were recorded highest mean values for single plant yield, bolls/plant, 2.5 per cent span length(mm) and bundle strength (g/tex). These accessions may be exploited for further improvement of the above traits by breeding programmes. Regarding the identification of donor for specific trait, the highest performer of that particular trait can be considered. Among the accessions, the highest boll weight (4.6 g) was registered by 16/2R and high GOT (40.7%) by ED (A) and EC111254. The highest 2.5 per cent span length was recorded by SBYF (38.5 mm) and high bundle strength by SBS (YF) (45.2 g/tex). The *per se* performance of individual *G. barbadense* germplasm accessions for yield and fibre quality characters are shown in Table 2. So these accessions may be utilized for crossing programme to improve that particular character in crop improvement.

The analysis of variance showed highly significant differences among genotypes for all the characters studied and infers existence of considerable genetic diversity among genotypes. phenotypic variance, genotypic variance, phenotypic coefficient of variation, genotypic coefficient of variation, heritability in broad sense and genetic advance as percentage of mean which were estimated for sixteen characters are furnished in Table 3. The

Table 1. Mean and range performance for different characters among accessions of *Gossypium barbadence* L.

Characters	Min.	Max.	**Mean**
Days to 50 per cent flowering	63.5	69.0	**66.3**
Plant height (cm)	69.5	148.5	**103.1**
Inter node length(cm)	3.0	7.7	**4.9**
Sympodia/plant	12.5	22.5	**18.0**
Bolls/plant	7.5	31.5	**19.6**
Boll weight (g)	2.6	4.6	**3.8**
Seeds/boll	12.5	20.5	**17.0**
Ovules/flower	16.5	25.5	**20.4**
Seed setting percentage	55.5	97.5	**84.1**
Yield /plant (g)	6.2	67.1	**33.7**
Lint index	4.5	7.9	**5.9**
Seed index	8.2	12.4	**10.7**
Ginning outturn (%)	31.0	40.7	**35.7**
2.5 per cent span length (mm)	29.0	38.5	**33.4**
Bundle strength (g/tex)	21.5	45.2	**26.0**
Micronaire value	3.3	4.9	**4.0**

knowledge of nature and magnitude of variability available in the genotypes for different characters is an important prerequisite for making simultaneous selection over more number of characters to bring remarkable improvement in cotton. The improvement of crop mainly depends upon the nature and magnitude of genetic variability present in the base population (Ashoka Kusugal *et al.,* 2014). The heritable (genotypic) variation is usually masked by non heritable variation creating difficulty in exercising selection. Hence it becomes necessary to partition overall variability into heritable and non heritable components to enable the breeders to plan for proper breeding programme. The plant height recorded the highest phenotypic variance and genotypic variance with the values of 618.3 and 280.8, respectively. The boll weight recorded the lowest phenotypic variance (0.2) and micronaire and boll weight exhibited the lowest genotypic variance (0.1). The co efficient of phenotypic and genotypic variance were calculated for all the characters under study.

The PCV range varied from 2.6 to 37.1 per cent. The highest PCV was observed for single plant yield (37.1) followed by bolls/plant (30.3), inter node length (25.2) and plant height (24.1). The medium PCV value was recorded for the traits *viz.,* seed index (10.4), ovules/flower (11.4), lint index (11.7), boll weight (12.8), seeds /boll (13.3), bundle strength (14.9), seed setting percentage (15.1) and sympodia/plant (16.2) whereas the remaining traits exhibited values less than 2.6. The GCV ranged from 2.0 to 36.2 and the maximum GCV was observed for single plant yield (36.2) followed by bolls/ plant (20.4). Whereas medium GCV was observed in the traits *viz.,* inter node length (16.9), plant height (16.2), bundle strength (12.5) and sympodia/plant (11.7). The minimum GCV value was exhibited by days to 50 per cent flowering (2.0). In the present study there was a close correspondence between phenotypic and genotypic variance for days to 50 per cent flowering, inter node length, boll weight, single plant yield, lint index, micronaire value and 2.5 per cent span length indicating less environmental influence. But plant height, sympodia/plant, bolls/plant, seeds/boll, seed setting percentage and ginning outturn showed higher variation indicating the influence of environment on these characters. Since the variations are influenced by the magnitude of the units of measurements of different traits, a measure of coefficient of variation which is independent of the unit of measurement is more useful in comparison between population (Gamal *et al.,* 2009). In *G. barbadence* accessions PCV was higher than the genotypic coefficient of variation (GCV) for all characters. From this we can understand that the environment plays a major role on expression of all these traits leads

Table 2. *Per se* performance of G. *barbadense* accessions for yield and fibre quality traits

Characters Accessions	Days to 50 per cent flowering	Plant height (cm)	Inter node length (cm)	Symp-odia/ plant	Bolls/ plant	Boll weight (g)	Seeds/ boll	Ovule/ flower	Seed setting (%)	Single plant yield (g)	Lint index	Seed index	Gin-ning out turn (%)	2.5 per cent span length (mm)	Bundle strength (g /tex)	Micr-onaire value
SIV 135	68.0	128.0	6.3	17.0	25.0	3.8	17.0	18.0	94.5	49.9	6.7	11.2	37.5	34.5	31.1	4.1
TNB 1	68.0	133.5	7.3	18.5	22.5	4.0	17.0	17.5	97.0	37.8	6.6	10.6	38.5	34.5	27.4	4.2
TCB472/4	67.5	108.0	5.5	18.0	19.5	4.1	19.5	20.5	95.0	40.8	6.0	10.6	36.0	31.1	26.2	4.4
Giza	65.5	100.5	4.6	18.0	23.5	3.9	18.5	22.0	84.5	67.1	6.2	10.5	37.1	34.5	23.9	3.7
Giza7	65.0	128.5	7.7	18.5	20.0	4.1	14.5	23.0	63.5	33.5	6.1	10.6	36.5	35.0	25.7	3.9
EC111248	65.5	97.0	4.8	18.5	21.0	4.4	16.0	16.5	96.5	37.9	6.4	10.3	38.4	33.0	26.5	3.8
SIA 9	64.5	95.0	4.6	21.0	26.5	4.0	16.0	22.0	73.0	53.7	6.3	11.5	35.5	35.0	25.8	3.9
TCB 472/5	67.0	114.5	5.4	20.5	17.5	3.8	19.0	20.0	95.5	54.5	5.1	11.1	31.5	34.5	25.8	4.3
EC101786	64.0	91.0	4.8	16.5	14.0	3.9	14.0	25.5	55.5	28.0	5.8	11.2	34.3	36.0	28.1	3.6
Mono stem	66.0	148.5	6.5	20.0	13.0	3.4	18.0	19.0	94.5	6.4	5.6	10.1	35.7	33.5	25.1	4.2
16/2R	66.0	93.0	4.8	15.0	14.5	4.6	17.5	21.5	81.5	40.8	6.3	10.2	38.1	31.5	26.2	4.1
Orissa SI	67.5	108.0	5.3	17.5	18.0	4.3	16.0	21.5	76.0	25.3	6.3	11.4	35.5	33.0	25.8	4.2
6002-1	66.0	70.0	3.8	13.0	17.5	3.8	19.0	19.5	97.5	43.9	6.5	10.5	38.4	32.0	26.0	4.2
BCS 5919	64.5	78.5	4.7	15.0	16.5	3.1	16.0	20.0	81.0	25.5	5.1	8.2	38.5	35.5	26.0	3.7
76/3	68.5	97.0	4.6	18.5	21.0	4.2	19.5	22.5	87.5	46.4	6.8	10.5	39.3	32.5	24.8	4.0
Giza 70	69.0	113.5	5.7	16.5	24.0	4.3	19.5	20.0	97.5	50.0	6.8	12.3	35.7	32.0	21.5	4.6
Bar x LT	65.0	74.5	4.0	15.0	12.0	2.8	15.5	22.0	71.5	6.2	5.1	8.9	36.3	32.5	26.8	3.6
Sudan G 45	67.5	79.5	4.4	17.5	13.0	4.3	17.0	19.0	90.0	40.6	6.3	11.8	34.9	33.3	24.2	4.2
SB 1085-6	66.5	106.5	6.0	18.0	16.5	3.7	18.0	22.0	82.0	18.1	6.2	10.8	36.6	30.0	23.3	4.3
TCB 209	68.0	76.5	4.4	14.5	16.0	4.1	18.0	20.0	90.0	21.1	5.7	12.0	32.1	35.5	26.4	3.9
Barbados	63.5	84.5	4.8	19.5	26.5	4.1	12.5	18.5	67.5	41.1	6.1	11.8	34.0	35.5	25.2	3.7
SBYF	64.0	69.5	3.4	14.0	19.5	3.9	19.5	21.5	90.5	27.3	5.9	11.0	35.0	38.5	26.7	3.6
Sudan G 55	68.5	102.5	4.6	18.0	14.5	4.1	16.0	18.5	86.0	27.2	6.1	12.4	33.0	34.5	27.0	4.0
ED(A)	66.5	116.5	5.4	19.5	18.0	3.5	16.5	20.5	81.5	29.4	6.2	9.1	40.7	30.5	24.1	3.9
17/3A	64.5	118.0	5.8	18.0	21.0	3.8	16.5	19.0	86.0	26.2	6.3	9.4	40.0	29.0	25.8	4.3
85/2	66.0	82.5	3.8	16.5	22.0	3.9	18.0	22.0	82.5	43.8	5.3	10.0	34.5	32.5	24.8	4.0

contd...

Table 2 contd...

Suvin	69.0	77.5	3.7	15.0	22.0	3.4	15.5	20.0	78.0	33.1	5.7	9.9	36.5	36.9	34.4	3.7
EC 111254	66.0	70.0	3.0	12.5	7.5	2.6	17.5	24.5	71.5	27.9	6.6	9.6	40.7	33.5	27.1	3.6
19/61	64.0	85.5	3.6	16.5	20.0	3.3	13.5	17.5	77.0	22.5	5.6	10.8	34.1	34.5	25.1	3.3
Giza 1467	64.5	85.5	3.7	16.0	13.5	4.3	17.5	19.5	90.0	29.7	6.4	11.8	35.2	33.7	23.4	4.0
TCB 377	68.0	113.5	4.2	20.5	20.0	3.2	18.0	19.5	92.0	34.7	5.3	10.0	34.8	33.0	23.4	4.2
SBS(YF)	66.5	79.0	3.8	17.5	19.5	4.0	18.0	20.0	90.5	30.9	6.0	11.0	35.1	35.5	45.2	3.3
B 125	66.5	79.0	3.2	18.5	21.0	3.3	20.5	23.0	89.5	47.9	5.6	9.6	36.9	31.0	25.9	4.3
Sudan G 53	66.0	113.0	5.0	20.5	17.5	4.0	16.0	20.0	80.0	30.1	7.9	12.1	39.5	34.0	24.2	3.7
EC 97631	66.0	109.0	5.2	17.0	16.0	3.8	17.0	19.0	89.5	35.7	5.3	10.1	34.5	33.0	27.3	4.1
PSH	66.5	130.5	6.0	20.0	22.0	4.3	18.5	19.5	94.5	21.0	4.9	10.7	31.3	34.5	26.8	3.8
EC 131979	66.0	114.0	6.0	17.0	19.5	3.8	18.5	20.5	90.5	45.0	5.9	9.7	38.0	31.8	25.0	4.3
EC 9257	67.0	88.0	3.8	18.0	31.5	3.0	18.5	19.5	95.0	42.1	4.5	10.0	35.0	35.0	28.3	4.9
Tadia	69.0	128.5	5.5	20.0	27.5	3.7	17.5	20.0	87.5	15.7	5.9	11.0	31.0	33.0	24.4	3.5
Egyptian 1	68.5	128.5	6.0	19.5	14.0	4.3	15.0	22.5	68.0	19.1	5.9	12.4	32.2	31.9	24.0	3.8
K 2308	65.5	105.5	4.5	20.0	22.5	3.4	16.5	18.0	91.5	43.5	5.6	10.6	34.5	31.5	23.2	3.8
87/1	65.5	85.5	4.2	13.5	13.5	4.2	16.0	19.5	82.5	31.2	6.2	12.0	34.1	33.0	23.5	4.7
Menoufi	66.5	125.5	5.3	22.5	26.0	4.2	20.0	20.5	97.5	33.2	5.1	9.9	34.0	32.0	23.0	4.2
K 3475	68.5	133.0	5.2	22.5	29.5	3.7	14.5	20.0	73.0	38.2	6.4	11.6	35.5	32.5	25.3	4.0
24/2 W	64.5	132.5	6.0	22.5	17.0	4.2	15.5	22.5	69.0	17.4	4.9	10.7	31.2	34.0	27.0	3.7
CBS 148	64.5	127.5	4.3	22.0	21.5	4.1	16.0	21.5	75.0	31.8	6.0	11.1	35.4	30.5	26.2	4.4
K 5309	65.5	121.0	4.3	21.5	29.0	3.9	13.0	18.0	72.0	32.1	6.4	11.8	35.2	34.0	22.3	3.9
Mean	**66.3**	**103.1**	**4.9**	**18.0**	**19.7**	**3.9**	**17.0**	**20.4**	**84.1**	**33.7**	**5.9**	**10.7**	**35.7**	**33.4**	**26.1**	**4.0**
CD (p=0.05)	2.1	37.0	1.8	4.0	8.9	0.7	3.6	3.9	20.9	5.5	0.8	1.6	4.8	2.3	4.2	0.3

to increase the PCV more than GCV. The highest PCV and GCV estimates were recorded for bolls/ plant and single plant yield in indicating the presence of significant genetic variability in this character. Selection pressure can be applied on this character to isolate promising genotypes. The observations of similar nature in cotton was reported by Usman Aziz *et al.,* (2014); EL-Mansy *et al.,* (2012) and Dhamayanthi *et al.,* (2010). Moderate PCV and GCV estimates were noticed for the characters such as sympodia/plant and bundle strength. Yanal Alkuddsi *et al.,* (2013) and Vinodhana *et al.,* (2013) also reported the moderate PCV and GCV in various traits with the suggestion that these characters can be improved though rigorous selection. The characters such as days to 50 per cent flowering, 2.5 per cent span length and micronaire value exhibited low PCV and GCV which indicated that the breeds should go for source of high variability for these characters to make improvement. Similar suggestions were given by Sajid and Tanwar, (2008);Rafazy and Razak, (2013). In a population, the observed variability is a combined measure of genetic and environment causes, where as the genetic variability is the only estimate heritable from generation to generation. However a measure of heritability alone does not give an idea about the expected gain in the next generation but it has to be considered in conjunction with genetic advance. The traits which expressed high heritability and high genetic advance as percentage of mean could be used as a powerful tool in selection process. The heritability estimates ranged from 28.5 (ovules/flower) to 88.2 per cent (single plant yield). The higher heritability estimates of 88.2 per cent was followed by micronaire value (82.0%), bundle strength (70.8 %) and 2.5 per cent span length (68.5 %) where as the low heritability was observed in ovules/flower (28.5%). For efficient selection, we cannot completely depend on heritability alone. The combinations of high heritability with high genetic advance will provide a clear base on the reliability of that particular character in selection of variable

Table 3. Components of variance for yield and fibre quality traits among the accessions of *G. barbadence*

Characters	Phenotypic variance	Genotypic variance	PCV (%)	GCV (%)	h^2 (%)	GA	GA as per cent of mean
Days to 50 per cent flowering	2.9	1.8	2.6	2.0	61.3	2.8	4.2
Plant height (cm)	618.3	280.8	24.1	16.2	45.4	29.8	28.9
Inter node length (cm)	1.5	0.7	25.2	16.9	45.0	1.4	29.9
Sympodia/plant	8.5	4.5	16.2	11.7	52.6	4.0	22.5
Bolls/plant	35.6	16.0	30.3	20.4	45.0	7.1	36.1
Boll weight (g)	0.2	0.1	12.8	9.6	56.1	0.7	18.9
Seeds/boll	5.1	1.9	13.3	8.1	37.0	2.2	13.0
Ovules/flower	5.3	1.5	11.4	6.1	28.5	1.7	8.5
Seed setting percentage	163.5	54.5	15.1	8.8	33.6	11.3	13.4
Single plant yield (g / plant)	155.9	148.6	37.1	36.2	88.2	22.7	67.3
Lint index	0.5	0.3	11.7	9.4	64.4	1.2	19.9
Seed index	1.2	0.6	10.4	7.4	50.9	1.5	14.0
Ginning outturn (%)	8.9	3.3	8.4	5.1	36.8	2.9	8.1
2.5 per cent span length (mm)	4.2	2.8	6.1	5.1	68.5	3.7	11.0
Bundle strength (g /tex)	15.0	10.6	14.9	12.5	70.8	7.2	27.8
Micronaire value	0.1	0.1	8.9	8.0	82.0	0.8	19.2

Table 4. Potential donors for yield and fibre quality traits in *G. barbadence* accessions

Sl.No.	Characters	Potential accessions
1	Days to 50 per cent flowering	EC 101786, Barbados, SBYF
2	Plant height	Monostem,K 475, 24/2W, TNB 1
3	Inter node length	TNB 1, Giza 7, Monostem
4	Sympodia/plant	Menoufi, K 3475, 24/2W
5	Ovules/flower	EC 111254, EC101786
6	Bolls/plant	SIV 135, TNB 1, GIZA, SIA 9,Giza 70, Barbados, EC 9257,Tadia, Menoufi,K 3475, K 5309
7	Boll weight (g)	16/2R, EC 111248, Egyptian 1
8	Seeds/boll	Menoufi, TCB 472/4, 76/3
9	Seed setting percentage	Giza 70, TNB 1, 6002 1
10	Single plant yield (g)/plant	K 2308, EC 9257, EC131979, B 125,85/2, Barbados, Sudan G 45, 76/3, 6002 1, SIA 9, Giza
11	Lint index	Sudan G 53, Giza 70, 76/3
12	Seed index	Sudan G 55, Egyptian 1, SIA 9,Giza 70
13	Ginning outturn	ED(A), EC 111254
14	2.5 per cent span length	EC 101786, SBYF, Suvin
15	Bundle strength	SIV 135, Suvin, SBS (YF)
16	Micronaire value	TCB 472/4, Giza 70, EC 9257, 87/1, CBS 148

entries. The genotypic advance as per cent of mean for 16 traits ranged from 4.2 to 67.3 per cent. The higher genetic advance as per cent of mean was recorded by single plant yield (67.3 %) followed by bolls/plant (36.1%), inter node length (29.9%), plant height (28.9 %). Days to 50 per cent flowering recorded the lowest value of 4.2 per cent. High heritability along with high genetic advance was observed in traits single plant yield and bundle strength (Srinivas and Bhadru, 2015; Patell *et al.,* 2014). These traits are highly reliable during selection. High heritability combined with moderate genetic advance was found in the traits *viz.,* lint index, seed index and micronaire value. It was in accordance with the similar results of Harshal, 2010 and Vinodhana *et al.,* 2013. From this it was concluded that the characters such as single plant yield, bundle strength, lint index, seed index and micronaire value were governed by additive gene action which will lead to high genetic gain in phenotypic selection. High heritability coupled with low genetic advance was found in the characters *viz.,* days to 50 per cent flowering, 2.5 per cent span length which fall in line with the findings of Usman Aziz *et al.,* (2014). Among the study materials some of the accessions were identified as potential donors for the improvement of different characters (Table 4). The accessions with high mean performance are generally preferred for all the traits except days to 50 per cent flowering, since earliness is the preferred attribute and early flowering was taken into consideration. From the results of the present study it can be concluded that direct selection can be done for most of the yield attributing traits since it exhibited high genetic variability and high range of variation. A high PCV over GCV for the characters studied indicated that environment influences the expression of these characters under study. The high heritability was registered in the traits *viz.,* Days to 50 per cent flowering, single plant yield, lint index, seed index, 2.5 per cent span length, bundle strength, micronaire value and high heritability along with high genetic advance was observed in traits like single plant yield and bundle strength indicated that selection can be resorted for the improvement of these characters in the future crop improvement programmes.

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