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ESTABLISHMENT OF SELECTION CRITERIA FOR FIBRE QUALITY CHARACTERS IN SEGREGATING F_4 AND F_5 GENERATIONS OF COTTON (*GOSSYPIUM HIRSUTUM* L.)

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Abstract

The research work was conducted at NIAB, Faisalabad and consists of three combinations of both F_4 and F_5 populations along with their parents and check varieties. In F_4 generation significant differences for fibre strength and lint weight were observed whereas in F_5 generation significant difference in micronaire, maturity, fibre length, fibre strength, lint weight were observed. Cross combination NIAB-2008 x MNH-886 form F_4 generation and from F_5, cross combination NIAB-852 x MNH-886 followed by NIAB-777 x MNH-886 showed high mean values for fibre maturity, lint weight, micronaire and seed cotton yield per plant. In F_4 and F_5 generations, seed cotton yield per plant was significantly and positively correlated with ginning out turn (GOT %), fibre maturity, fibre length, micronaire and lint weight at genotypic level. In both F_4 and F_5, path coefficient analysis showed that ginning out turn, fibre uniformity, fibre strength and lint weight had direct positive effects on seed cotton yield at both phenotypic and genotypic level. From the present findings it is concluded that cotton breeders can enhance the efficiency of selection with the help of information generated on the relationship between components associated with fibre quality and yield itself in the early generations. Both F_4 and F_5 generations exhibited highest direct effects combined with positive correlation in ginning out turn%, fibre length and lint weight with seed cotton yield. The result showed that while making selection these fibre traits should be given more emphasis.

Key words: Cotton, Fibre, Quality, Selection, Hybrids, Generations.

Introduction

Cotton (*Gossypium hirsutum* L.) is well known due to its importance as cash and industrial crop of Pakistan. It is a source of different by products but cotton is mainly cultivated for its fibre and seed oil (Sial *et al*., 2014). It is related to family Malvaceae and genus known as *Gossypium*. It includes 45 diploid (2n=13(2)= 26) and six allopolyploids species (2n =13(4)= 52), in which few being cultivated and rest are wild (Fryxell, 1992; Brubaker *et al*., 1999).

Cotton resides a primary position in the world as fibre crop of masses, particularly in Pakistan. Cotton plant yields fibres, the most important of all natural textiles. It is recognized as king of fibres (Ashokkumar & Ravikesavan, 2008i). It is generally uses in world's textile production. According to an estimate, in Pakistan textile industry would require 20 million bales of lint by 2020 (Haidar *et al*., 2007). Cotton being a white gold for textile industry faces a severe problem of low fibre quality (Ahmad *et al*., 2018)

Cotton seeds are the prominent source of edible oil and protein. Cotton is therefore second largest plant protein source while fifth highest oil-producing crop (Ahmad *et al*., 2007). Cotton plays vital role in crop production which contributes 1.5 percent in GDP and in agriculture it accounts 7.1 percent. In Pakistan, cotton crop is cultivated on an area of 2961 thousand hectares, with annual cotton lint production of 13.983 million bales (Anon., 2014-2015).

High yielding genotypes with desired yield components are prerequisite to increase seed cotton yield per unit area. Limited availability of genetic variability in the native germplasm is a matter of concern (Haidar *et al*., 2012). Genetic behavior of crop for different traits in segregating generations plays crucial role in establishing selection criteria in breeding cotton genotypes with more yield potential. It can be determined with various genetic parameters like phenotypic and genotypic variances and correlations, direct & indirect effects of different developmental and economic characters. Selection based on fibre traits is also very important if fibre related traits have been well established and documented. Selection of characters like, early flowering, different mrophological traits and quality parameters play a very important roles to improve yield in cotton (Haidar *et al*., 2016: Haidar & Aslam, 2016).

Fiber quality of a particular cotton genotype is a combination of different characters including staple length (mm), fiber strength (g/tex), fineness (µg/inch), uniformity (%) and maturity (%) (Ali *et al*., 2009; Phoelman & Sleeper, 1999). Path coefficient analysis determines the direct or indirect association of different economic traits. It is helpful in the selection process and enables to understand and select a plant type on the basis of two or more traits simultaneously (Salahuddin *et al*., 2013; Ahuja *et al*., 2006). Correlations between different fiber traits can be employed as selection criteria for successful cotton breeding (Asif *et al*., 2008).

The main goal is to use different yield characters and expression of various yield related components to enhance the productivity of the crop through plant breeding programs. This study was conducted to search out the importance of different fibre related traits in cotton genotypes through the estimation of genetic parameters so that suitable selection criteria may be find out for developing genotypes possessing high yield potential.

Material and Method

Plant material and experimental design: The research work was conducted at NIAB, Faisalabad during the year 2015-2016. The experimental material comprises of three combinations of F_4 generation populations and three combinations of F_5 generation populations along with parents, check variety MNH-886 and two advance lines (Table 1). The experiment was planted in Randomized Complete Block Design (RCBD) with three replications. Row to row (R x R) distance of 2.5 feet and plant to plant (P x P) distance of 1 feet was maintained.

Table 1. Recombinant genotypes in F_4 and F_5 along with standards, parents of cotton used as experimental material.

Experimental material	Genotypes	Code
F_4 recombinants	NIAB-2008 × MNH-886	G-1
	NIAB-2009 × MNH-886	G-2
	NIAB-2010 × MNH-886	G-3
F_4 Parents	NIAB-2008	G-4
	NIAB-2009	G-5
	NIAB-2010	G-6
Standard variety (male parent)	MNH-886	G-7
Two advance lines (standards)	NIAB-51-37	G-8
	NIAB-32-16	G-9
F_5 recombinants	NIAB-852 × MNH-886	G-1
	NIAB-777 × MNH-886	G-2
	NIAB-846 × MNH-886	G-3
F_5 Parents	NIAB-852	G-4
	NIAB-777	G-5
	NIAB-846	G-6
Standard variety (male parent)	MNH-886	G-7
Two advance lines (standards)	NIAB-51-37	G-8
	NIAB-32-16	G-9

Evaluation of hybrid generations: The F_4 and F_5 generations were raised and evaluated at NIAB where the soil type is sandy to clay loam having pH=7.2-7.5, EC value of 0.8-1.5 dS.m^{-1}and NPK used (60:23:23 kg/acre). Agronomic practices (hoeing, removal of weeds both by manually and use of weedicides, irrigations, application of fertilizers etc), were carried out for normal and uniforrm plant growth. Various plant protection measures by spray of insecticides/pesticides were also carried out to control or minimize the sucking (thrips, jassid, whitefly, aphid) and bollworm (heliothious, spotted, pink and army bollworms) insect pests.

Recording of data: At maturity the data of different morphological and quality traits were recorded. The data were recorded on five randomly selected plants from each genotype and replication for eight characters viz., ginning out turn (%), micronaire value (µg/inch), fibre maturity (%), fibre strenght (g/tex), fibre length (mm), uniformity (%), lint weight (gm) and seed cotton yield per plant (g). Ginning Out turn (%) was recorded by ginning of the total seed cotton of the selected plants weighing in (gms). Then weighing of the cotton lint and deviding it with total weight of seed cotton and multiplying with 100.

Fibre characters analysis: The fibre quality parameters were recorded using High Volume Instrument (HVI) as well as manually operated instruments at NIAB. The samples were collected from selected plants in different hybrids, paranets, standards and fibre traits in the lab were analyzed.

Statistical analysis

The data for fibre quality characters and seed cotton yield in different generations were subjected to analysis of variance (ANOVA) using the methodology of Steel *et al.*, 1997. In addition data for fibre quality traits and seed cotton yield in both generations were compared using Fisher's least significant difference (LSD) procedure. Genotypic & phenotypic correlations and direct & indirect effects of different traits were studied according to Singh & Choudhry, 1985; Kown & Torrie, 1964 and Dewey & Lu, 1959.

Results and Discussion

F_4 and F_5 recombinats developed through hybridization between elite lines, cultivars were studed in field conditions for fibre quality parameters and seed cotton yield to establsih a selection criteria for early stage selection. The F_4 and F_5 recobminats showed morphologically different features like earliness, medium height, more number of bolls, better opening and yield potential compared to parents and standsrds. Morphological differences were noted from seedling to maturity stages in F_4 and F_5 recombinat generations. Seed cotton yield along with fibre traits were recorded from selected single plants in all cross cobbinations, parants and standards were analysed.

Performance of F_4 and F_5 recombinants: Main focus of the present study was related with fibre traits and yield. Significant differences were recorded for all fibre traits and yield as shwon in Figs. 1 and 2. The highest ginning out turn (GOT) was recorded for cross combination NIAB-2009 x MNH-886 (40.03%) in F_4 generation and cross combination NIAB-852 x MNH-886 (41.67%) in F_5 generation, non significantly different than standard MNH-886 (41.6%). All the recombinats in both F_4 and F_5 generations, standards and advance lines showed desirable fibre finess (micronaire). Maximum fibre maturity was recorded for cross comination NIAB-2008 x MNH-886 (87.20%) in F_4 generation. Maximum staple length was recorded for cross combination NIAB-2010 x MNH-886 (27.33 mm) in F_4 generation. All the cobminations in both F_4 and F_5 showed desirable fibre maturity ranging from 80.2 to 81.7%. The highest lint weight (56.73 g) and seed cotton yield (142.2g) was recorded for cross combination NIAB-2008 x MNH-886 in F_4 generation. Whereas maximum lint weight of (57.8g) and seed cotton yield (138g) was recorded for cross combination NIAB-852 x MNH-886 in F_5 generaion. Significant variations for different traits in initial stage mutant lines (early generations) of Cassava were earlier reported by Joseph *et al.*, 2004.

Analysis of variance: Significant differnces were observed for some fibre quality parameters in both F_4 and F_5 generation recombinats. The data presented in F_4 generation showed significant differences for fibre strength, lint weight and seed cotton yield that indicates that genotypes present in this generation are different from each other on the basis of these traits, while other characters showed non-significant differences (Table 2). Genotypes present in F_5 generation showed significant difference in micronaire, maturity, fibre length, fibre strength, lint weight and yield (Table 3). Similar findings are earlier recorded by Asif *et al*., 2008. Cross combination NIAB-2008 x MNH-886 form F_4 generations and from F_5 cross combination NIAB-852 x MNH-886 followed by NIAB-777 x MNH-886 showed high mean values for fibre maturity, lint weight, micronaire and yield per plant (Tables 4, 5). In F_4 generation cross combination NIAB-2010 x MNH-886 showed all the fibre qulity parameters up to the prescribed standards. While in F_5 generation cross combination NIAB-852 x MNH-886 showed all fibre quality parameters up to prescribed standards.

Genotypic and phenotypic correlations in F_4 generations: These correlations were calculated for all possible combinations among fibre quality parameters and yield. Genotypic & phenotypic correlation matrix of F_4 generation is given in Table 6. Generally genotypic correlarions were higher then phenotypic correlations which reflected that genetic factors were more active in the development of association as comapred to environmental ones. Similar findings were earleier recorded by Haidar and Khan, 1998.i. Yield per plant was significantly and positively correlated with ginning out turn, fibre maturity, fibre length, micronaire and lint weight at genotypic level. It was also reported earliar that yield had positive correlation with fibre length and GOT percetage (Ashokkumar & Ravikesavan, 2008ii). Significant and positive correlations at both levels were also observed between component characters themselves like micronaire with fibre maturity, staple length with yield, fibre uniformity with fibre strength, lint weight with yield. Positive correlation between lint weight and yield is also reported by Hussain *et al*., 2010. Earleir in upland cotton, estimation, magnitude and type of genetic variation controlling fibre length was repoted as significant by May and Green, 1994. Similar results are recorded in the present findings.

Table 2. Significance of different fibre quality parameters in F_4 generation of cotton.

Source of variation	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
Varieties	19.65ns	0.2142ns	1.553	24.86ns	2.057ns	9.373**	50.62*	29.832*
Replicates	07.09ns	7.766ns	0.0313ns	23.19ns	0.2109ns	3.063ns	46.9ns	211.9ns
Error	10.204	0.10236	0 .777	24.53	0.9756	1.0208	143.76	965.40

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight

Table 3: Significance of different fibre quality parameters in F_5 generation of cotton.

Source of variation	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
Varieties	15.65ns	3543**	2.818**	5.204**	35779.49ns	9.194**	681.64**	4073.64**
Replicates	14.69ns	7.706ns	0472ns	4072ns	20257.78ns	1.3315ns	38.110ns	228.79ns
Error	11.573	8.119	5973	5973	43343.01	84289	104.609	656.809

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre Length, UF= Uniformity, FS= Fibre strength, LW= Lint weight

Table 4. Mean values of different fibre traits in F_4 generation of cotton.

Genotypes	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
G-1	39.70	4.47	87.20	25.03	80.83	25.00	56.73	142.20
G-2	40.03	4.13	85.73	26.07	80.80	24.73	45.73	114.07
G-3	37.33	3.67	85.13	27.33	81.90	26.97	34.27	92.13
G-4	38.93	4.17	86.83	26.50	81.37	27.03	38.00	96.87
G-5	35.07	4.20	85.47	25.87	81.73	28.13	33.53	43.90
G-6	36.20	3.93	86.10	26.87	82.30	26.50	24.40	67.43
G-7	41.60	3.67	85.26	24.57	80.20	22.47	25.53	66.87
G-8	43.23	4.23	86.33	28.00	82.70	27.77	47.77	128.47
G-9	38.70	3.93	85.47	27.10	82.27	25.90	38.53	99.67

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight

Table 5. Mean values of different fibre traits in F_5 generation of cotton.

Genotypes	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
G-1	41.67	4.33	86.73	25.57	80.90	26.20	57.80	138.00
G-2	40.97	4.13	86.60	26.30	81.90	26.40	51.47	130.8
G-3	42.10	4.27	86.03	24.40	81.53	24.70	28.67	69.27
G-4	37.57	3.50	84.07	28.00	81.90	26.87	24.27	67.07
G-5	39.03	4.57	87.40	26.40	82.03	27.10	17.43	43.80
G-6	36.50	3.83	85.57	26.97	82.17	28.50	17.50	48.40
G-7	41.60	3.67	85.26	24.57	80.20	22.47	25.53	66.87
G-8	43.23	4.23	86.33	28.00	82.70	27.77	47.77	128.47
G-9	38.70	3.93	85.47	27.10	82.27	25.90	38.53	99.67

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight

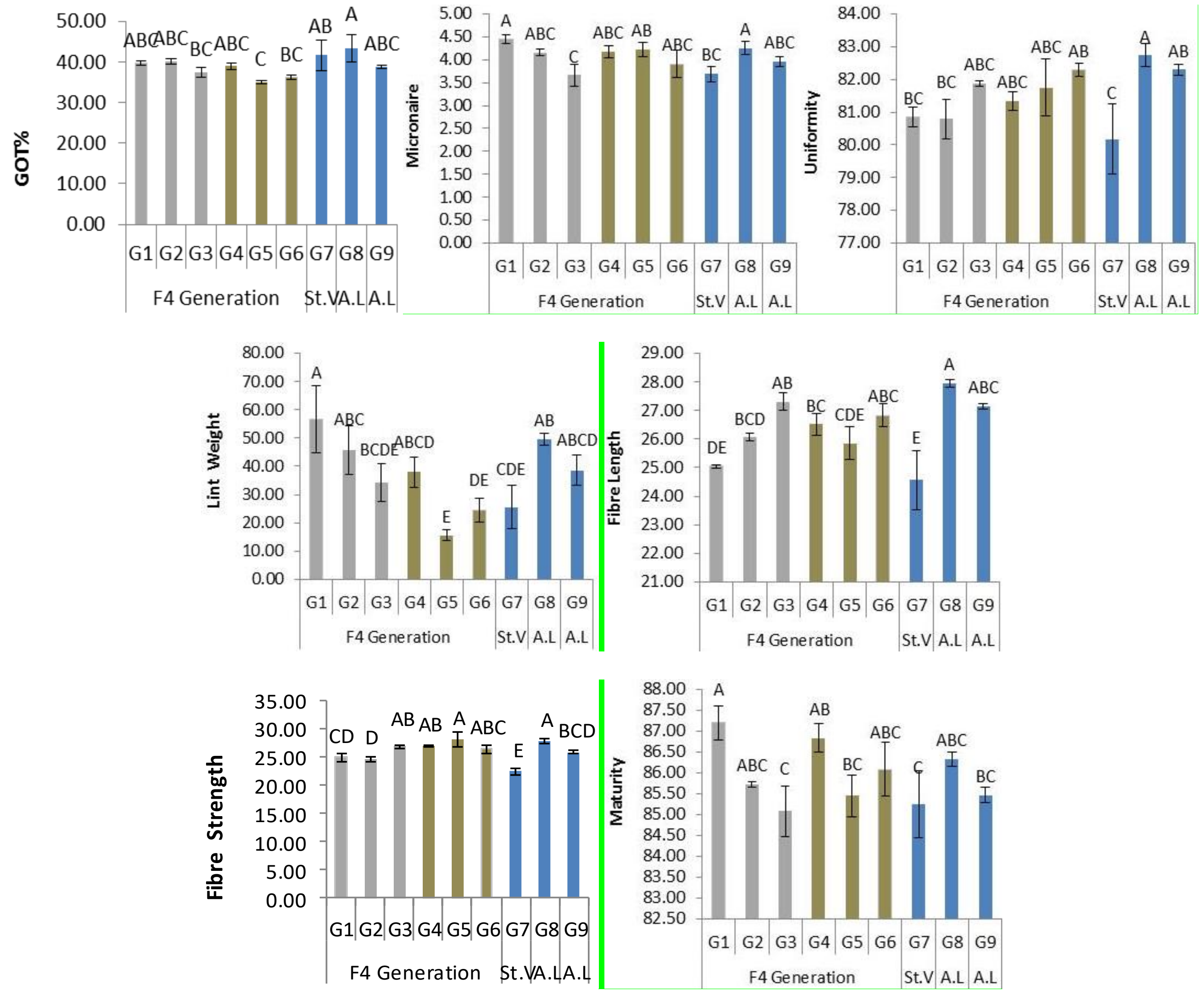

Fig.1. Graphical representaion and significance (LSD) of different fibre traits in F_4 generation of cotton.
(G1, G2, G3=cross recobminants F_4 generation, G4, G5, G6 = female parents, G7= male parent +standard variety, G8, G9 = two advansce/stable lines)

Genotypic and Phenotypic Correlations in F_5 generations: These correlations matrix of F_5 generation are given in Table 7. Yield per plant was significantly and positively correlated with GOT percentage, fibre uniformity and lint weight at genotypic level. Significant and positive correlation of GOT with yield was earlier reported by Haidar and Khan, 1998.ii; Haidar *et al*., 1999. Significant and positive correlations at both levels were also observed between component characters themselves like micronaire with fibre maturity, fibre length with fibre strength and lint weight, fibre maturity with fibre strength, lint weight with yield. The correlation information showed the positive association between fibre strength and length and these resullts were also confirmed but some researchers diagree with these results (Ali *et al*., 2009ii). Jarwar *et al*., recorded significant correlation between lint index and staple length. These positively correlated fibre traits would be used as selection criteria for successful cotton breeding.

Direct and indirect effects in F_4 generations: The estimation of direct and indirect effects in F_4 generation (Table 8) showed that ginning out turn, fibre uniformity, fibre strength and lint weight had positive direct effects on yield at both phenotypic and genotypic level. The positive indirect effect of yield per plant at both phenotypic & genotypic level by GOT with micronaire, maturity, length, uniformity and lint weight, microaire with fibre uniformity, fibre maturity with fibre uniformity, fibre strenght with all traits except gining out turn and, lint weight with all the traits except fibre strength and uniformity were observed.

Direct and indirect effects in F_5 generations: The direct and indirect analysis in F_5 generation (Tabl 9) showed that ginning out turn, fibre maturity, fibre length and lint weight had positive direct effects on yield at both phenotypic and genotypic level. The positive indirect effect of yield per plant at both phenotypic and genotypic level by ginning out turn with micronaire, fibre maturity, uniformity and lint weight, microaire with fibre length, fibre length with fibre uniformity and fibre strenght with gining out turn, lint weight with all the traits except fibre length was observed. It was reported earlier that fibre traits like GOT, fineness and strength showed positive direct effect on yield (Asad *et al*., 2002; Rauf *et al*., 2004) which are also in accordance with our present results.

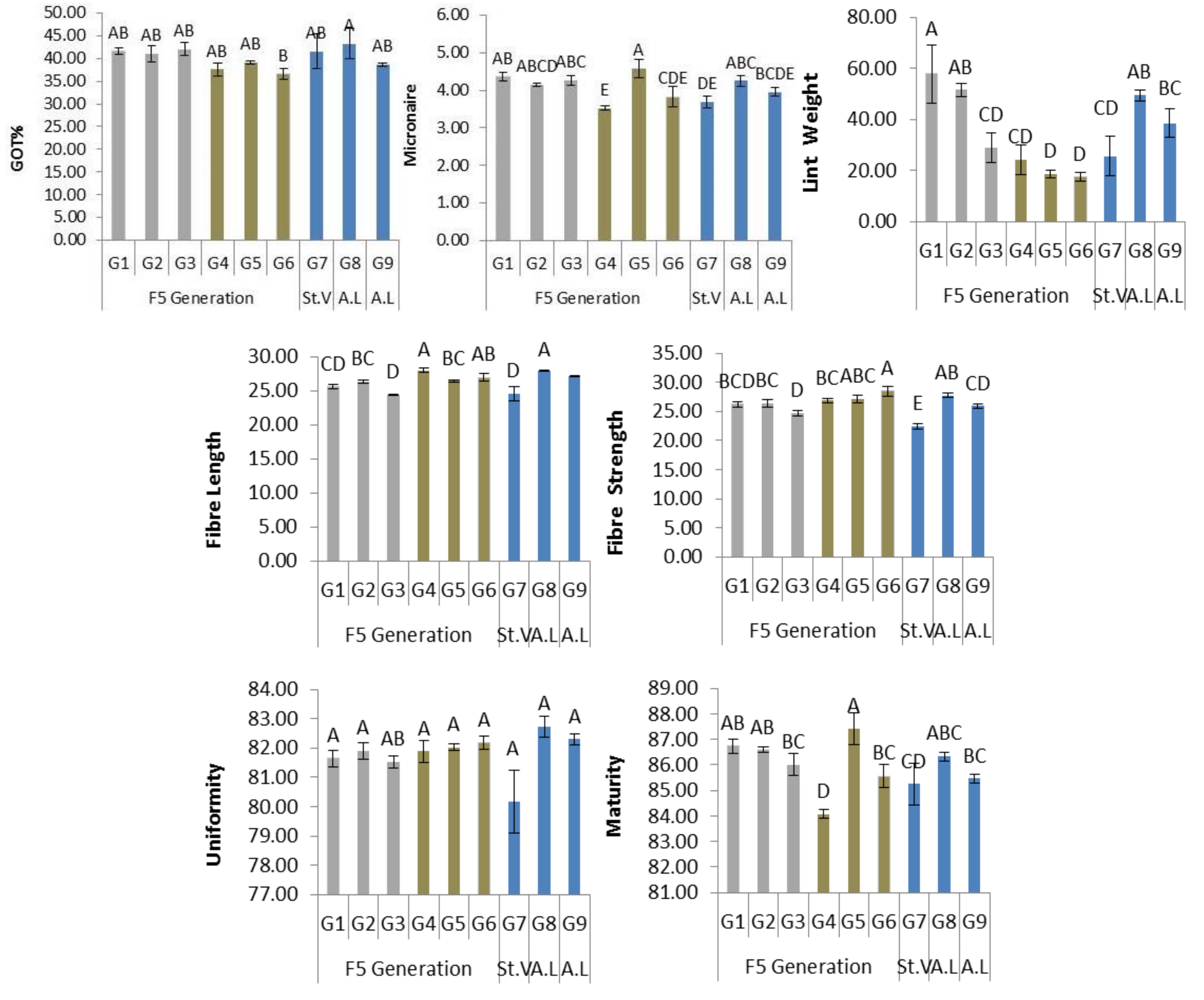

Fig. 2. Graphical representaion and significance (LSD) of different fibre traits in F_5 generation of cotton.
(G1, G2, G3=cross recobminants F_5 generation, G4, G5, G6 = female parents, G7= male parent + standard variety, G8, G9 = two advansce/stable lines)

Table 6. Genotypic and phenotypic orrelation matrix in F_4 generation of cotton.

Variables	Correlation	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
GOT	rg	1							
	rp	1							
Mic	rg	0.151	1						
	rp	0.077	1						
Mat	rg	0.589	0.667	1					
	rp	0.058	0.855	1					
FL	rg	6.466	0.646	0.848	1				
	rp	0.053	0.247	0.146	1				
UF	rg	0.251	0.107	-0.477	3.119	1			
	rp	-0.439	0.117	0.201	0.315	1			
FS	rg	-0.493	0.411	0.115	2.030	0.935	1		
	rp	-0.387	0.244	0.152	0.223	0.716	1		
LW	rg	1.223	0.889	1.043	2.290	-0.372	-0.241	1	
	rp	0.222	0.278	0.333	0.114	0.133	-0.019	1	
Seed cotton yield	rg	1.305	0.939	1.086	3.186	-0.281	-0.188	0.999	1
	rp	0.212	0.236	0.302	9.749	0.190	0.031	0.992	1

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight, rg = Genotyoic correlation, rp= Pheotypic correlation

Table 7. Genotypic and phenotypic correlation matrix in F_5 generation of cotton.

Variables	Correlation	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
GOT	rg	1							
	rp	1							
Mic	rg	1.084	1						
	rp	0.175	1						
Mat	rg	0.927	0.960	1					
	rp	0.130	0.907	1					
FL	rg	-0.59	-0.263	-0.407	1				
	rp	-0.410	-0.152	-0.183	1				
UF	rg	3.317	1.091	0.521	0.562	1			
	rp	0.051	0.119	0.174	0.026	1			
FS	rg	-0.664	0.271	0.176	0.826	0.711	1		
	rp	-0.379	0.142	9.749	0.687	0.065	1		
LW	rg	1.493	0.289	0.272	-0.223	1.254	0.075	1	
	rp	0.231	0.322	0.324	9.399	0.478	-0.065	1	
Seed cotton yield	rg	1.487	0.223	0.189	0.078	1.251	0.120	0.993	1
	rp	0.215	0.276	0.285	0.171	0.485	-0.028	0.990	1

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight, rg = Genotyoic correlation, rp= Pheotypic correlation

Table 8. Direct and indirect effects in F_4 generation of cotton for different fibre traits.

Variables	GOT	MIC	Mat	FL	UF	FS	LW	Seed cotton yield
GOT	**(.0252)**	-.0123	-.0101	-9.880	.0272	-0.0328	1.4068	1.3051
Mic	0.0038	**(-0.0816)**	-0.0115	-0.0099	-0.0116	0.2740	1.0232	0.9398
Mat	0.0148	-0.0545	**(-0.0172)**	-0.0130	-0.0516	0.0077	1.2001	1.0868
FL	0.1628	-0.0527	-0.0146	**(-0.0153)**	0.3369	0.1352	2.6337	3.186
UF	0.0063	0.0088	0.0082	-0.0477	**(0.1080)**	0.0623	-0.4278	-0.2818
FS	-0.0124	-0.336	-0.002	-0.0310	0.1010	**(0.0666)**	-0.2772	-0.1885
LW	0.0308	-0.0726	-0.0179	-0.0350	-0.0102	-0.0161	**(1.1500)**	0.9990

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight

Table 9. Direct and indirect effects in F_5 generation of cotton for different fibre traits.

Variables	GOT	Mic	Mat	FL	UF	FS	LW	Seed cotton yield
GOT	**(.0639)**	-0.5303	0.7343	-0.4783	-0.0178	0.3838	1.3317	1.4873
Mic	0.0694	**(-0.488)**	0.7604	-0.2133	-0.0058	-0.1566	0.2584	0.2236
Mat	0.0593	-0.4694	**(0.7919)**	-0.3305	-0.0028	-0.1019	0.2431	0.1897
FL	-0.0377	0.1286	-0.3228	**(0.8107)**	-0.0030	-0.4771	-0.0199	0.0788
UF	0.2122	-0.5331	0.4130	0.4563	**(-0.0054)**	-0.4106	1.1192	1.2513
FS	-0.0425	-0.1326	0.1398	0.6700	-0.0038	**(-0.5770)**	0.0674	0.1208
LW	0.0955	-0.1416	0.2159	-0.0181	-0.0067	-0.4360	**(0.8919)**	0.9932

GOT= Ginning out turn, Mic= Micronaire, Mat= Maturity, FL= Fibre length, UF= Uniformity, FS= Fibre strength, LW= Lint weight

Conclusion

It is concluded that crop breeders can enhance the efficiency of selection with the help of information generated on the relationship between components associated with fibre quality and yield in the early generation. F_4 and F_5 generations exhibited highest direct effects combined with positive correlation in ginning out turn%, fibre length and lint weight with seed cotton yield. The result showed that while making seslection these fibre traits should be given more emphasis.

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