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CORRELATION AND PATH COEFFICIENT ANALYSIS OF EARLINESS, FIBER QUALITY AND YIELD CONTRIBUTING TRAITS IN COTTON (*Gossypium hirsutum L.*)

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ABSTRACT

The present investigations were designed to determine genotypic, phenotypic correlation coefficients and path analysis between seed cotton yield, earliness, fiber and yield contributing traits in 53 cotton cultivars. Heritability and genetic advance was computed to determine the selection procedure for the material studied. Maximum value of GCV% and PCV % was observed in CLCuV% and seed cotton yield. Maximum broad sense heritability was found in traits like FS (99%) followed by BW (98%) GOT% (97%) and FF (96%). Moderate estimates of heritability were found for nodes to 1^{st} fruiting branch (35%) monopodia per plant, (34%) and sympodia per plant (43%). Regarding correlation studies seed cotton yield have positive genotypic correlation with bolls per plant, plant height, boll weight, staple length and strength, earliness index and GOT%. Path coefficient analysis results revealed that the traits like earliness index% showed maximum positive direct effect on yield (0.63) followed by days taken to 1^{st} square (0.17), GOT% (0.16) plant height (0.15), boll weight (0.15) and sympodia per plant (0.11). The traits like EI% and boll weight showed positive correlation, higher heritability estimates and positive direct effect on yield thus may be used as selection criteria to increase yield.

Key words: Heritability, Genetic Advance, genotypic correlations, path analysis, cultivars, seed cotton yield, Cotton,

List of abbreviations used: NTFFB= Nodes to 1^{st} fruiting branch, MPP= Monopodia per plant, SPP= sympodia per plant, PH= Plant height, BWT= boll weight, SL= Staple length, FF= fiber fineness, FS= Fiber strength, EI= earliness index, GOT= Ginning out turn, DFS= days to 1^{st} square, DFF= days to 1^{st} flower, CLCuV= Cotton leaf curl virus, GCV= genotypic coefficient of variation, PCV= phenotypic coefficient of variation

INTRODUCTION

Cotton plays a vital role in boosting our national economy being the principle source of earning foreign exchange, therefore, it is considered to be the backbone of the economy of Pakistan. It is termed as white gold due to its importance as cash and industrial crop. Alongside fiber, it also produces edible oil and cotton seed cake for human and animal consumption, respectively.

The development of varieties having tolerance to CLCuV, possessing better fiber quality and greater yield potential are the primary objectives of a cotton breeder. Seed cotton yield is influenced by both genetic and environmental factors. Interaction between these two factors makes the selection difficult. Knowledge about the relationship between yield and its components facilitates the breeders in the selection of desirable genotypes.

The correlation analysis provides a good index to predict the corresponding change which occurs in one trait at the expanse of the proportionate change in the other (Khan *et al*., 2007; Ahmad *et al*., 2008). Taohua and Haipeng (2006) and Meena *et al.* (2007) studied the adaptability and stability of *Gossypium hirsutum* varieties and observed diverse values for different agronomic, morphological and yield related traits. Iqbal *et al.* 2003 and Wang *et al.* 2004 found genetic variation and positive correlation for seed cotton yield and yield components in *Gossypium hirsutum.* Performance and positive association of seed cotton yield with yield components was observed in *hirsutum* cultivars (Mendez-Natera *et al*., 2012). Khan *et al.* (1999) and Khan (2003) found high genetic variability for yield and yield components in cotton. Khan *et al.* (2000) studied the earliness and agronomic traits of upland cotton cultivars using correlation analysis and found that monopodia had a negative direct effect on yield. Jost and Cothren (2000) and Badr (2003) also studied earliness and other yield contributing traits in different cotton cultivars and observed varied performance. DeGui *et al.* (2003) studied yield and yield components and found that the higher yield in cotton cultivars was mainly due to more number of bolls per plant. For a simultaneous selection of both yield and fiber quality traits, knowledge about association of yield and fiber quality traits is a prerequisite. The present study was designed to explore the genetic potential of different cotton cultivars and relationship of seed cotton yield with different earliness, fiber and yield related traits.

MATERIALS AND METHODS

Plant Material & Site Characteristics: A total of 53 genotypes were evaluated at experimental area of Cotton Research Institute, Faisalabad during the year 2011-12. Experiment was laid following a randomized complete block design (RCBD) with three replications. Each entry/treatment was a plot of 4.572 m × 6.096 m size comprising 75 cm apart six rows. Distance between plants within rows was 30 cm. Normal agronomic and cultural practices (irrigation, weeding, hoeing, and fertilizer applications) were adopted uniformly.

For collecting data 10 guarded/representative plants were selected in each treatment and marked for identification. Data were collected for nodes to 1st fruiting branch counted from zero node (cotyledonary node) to the node at which first flower was appeared, number of days to 1st square and 1st flower, plant height, monopodia and sympodia per plant, number of bolls per plant, boll weight, seed cotton yield, and ginning out turn (GOT).

Earliness index was calculated as mean yield of first picking divided by total yield and multiplied by 100 of each family in each replication for the purpose of data analysis.

Fiber characteristics such as staple length, fiber fineness and fiber strength of each guarded plant were measured by using spin lab HVI-900.

CLCuV disease incidence (%) and reaction of the cultivars was determined with the help of disease scale (Table 1) as described by Akhtar *et al*. 2010 and Farooq *et al*. 2011 using the following formula used by Akhtar *et al*. 2003 in cotton.

CLCuV disease incidence (%) = Sum of all disease ratings/total number of plants ×100/6

According to this formula Individual symptomatic plant ratings for each genotype are summed up and divided by the total number of plants to calculate the corresponding disease incidence percentage.

Statistical Analysis: The data were subjected to analysis of variance (ANOVA) using the MSTAT-C package (Russell, D. Freed, Michigan State University, USA, 1984). The means were separated using Fisher's protected Least Significance Difference test (LSD) at P = 0.05. Heritability in broad sense was estimated according to the technique of Burton and De Vane (1953). Genetic advance was calculated at 20 % selection intensity using formula given by Poehlman and Sleper (1995). All correlations (phenotypic and genotypic) were computed following the statistical technique prescribed by Kowon and Torrie (1964). Genotypic correlations were tested following the method of Lotherop *et al*. 1985. Statistical significance of phenotypic correlations was determined by T-test as described by Steel and Torrie (1984). Path coefficient analysis was done following to the method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The means performance of 53 genotypes is given in Table-2. The data of all the traits studied showed significant differences (Table 3). PCV % was higher in magnitude than GCV% for all the traits which are in accordance with the results of Mendez-Natera *et al*., (2012). Ali *et al*., 2009 reported higher values of GCV and PCV% for fiber traits and seed cotton yield. Heritability (broad sense) revealed higher estimates for the traits like fiber strength (99%), boll weight (98%), GOT% (97%), fiber fineness (95%), staple length (91%), yield kg/ha (89%) CLCuV % (86%), plant height (77%) bolls per plant (77%) days taken to 1st flower (74%), days taken to 1st square (71%), while the traits like sympodia per plant (42%), nodes to 1st fruiting branch (35%), and monopodia per plant (34%) showed moderate heritability values. Basbeg and Gencer (2004) reported higher estimates of heritability for fiber fineness and strength but low for bolls per plant and seed cotton yield and recommended early generation selection for traits having higher heritability. Mendez-Natera *et al*., 2012 reported higher values of broad sense heritability for fiber fineness but moderate values for plant height, fiber length and fiber strength and low values for bolls per plant, boll weight and seed cotton yield. Naveed *et al*., 2004 reported low values of heritability for lint percentage and boll weight. Mass or early generation selection could be practiced in traits showing higher and moderate estimates of broad sense heritability in current studies. Higher values of genetic advance were observed for bolls per plant (5.16), plant height (14.2), fiber strength (5.67), earliness index (7.00) and for yield (778.7). Higher values of genetic advance for plant height (26.3) and fiber strength (3.9) were observed in the findings of Mendez-Natera *et al*., (2012). High heritability and genetic advance are more useful in predicting gain under selection than heritability alone. Higher magnitude of both these components is indicative of additive genetic effects, thus, higher genetic gain may be anticipated. The differences in the findings of various workers may be due to the variation in experimental material and environmental factors.

Genotypic and phenotypic correlations of 15 traits are presented in Table-4. Seed cotton yield had positive genotypic correlation with bolls per plant, plant height, boll weight, staple length and strength, earliness index and GOT. These results are in agreement with the findings of Ashokkumar and Ravikesavan (2010). Significant genotypic correlations followed by phenotypic correlations were observed in the present studies which are in conformity with the findings of Desalegn *et al*., 2009 who reported the chief role of genetic effects. Qayyum *et al*. 2010 also found the important role of genotypic correlation coefficients. For nodes to 1st fruiting branch, positive and significant association was shown by the traits like days to 1st flower, days taken to 1st square both at genotypic and phenotypic level but the CLCuV% only showed significant positive association at genotypic level. The traits like seed cotton yield, bolls per plant and boll weight showed negative and significant phenotypic association with nodes to 1st fruiting branch. Contrasting results were reported by Shah *et al.* 2010 which reported negative correlation for nodes to 1st fruiting branch with days taken to 1st square and flower. The earliness related traits like days taken to 1st square and flower showed positive and significant correlation with each other, CLCuV% and monopodia per plant both at genotypic and phenotypic level but negative significant phenotypic correlations with seed cotton yield. The earliness index showed positive and significant genotypic correlation with bolls per plant and negative significant phenotypic estimates with CLCuV% but Shah *et al.* 2010 reported negative estimates with different morphological and earliness related traits.

While considering sympodia per plant its significant positive genotypic and phenotypic association was found with bolls per plant, plant height, staple length, fiber fineness and GOT. While it showed negative and significant phenotypic correlation with monopodia per plant.

The traits like plant height, boll weight, staple length, CLCuV% and seed cotton yield had positive and significant genotypic and phenotypic correlations with bolls per plant. Only significant positive genotypic correlations were shown by the traits like GOT and days taken to 1st square. Ashokkumar and Ravikesavan (2010) reported positive correlation of sympodia per plant with boll weight and bolls per plant which are in agreement with the present studies. The earliness index% showed negatively significant phenotypic correlations with bolls per plant. Plant height had positive significant genotypic and phenotypic correlation with boll weight, GOT and seed cotton yield. Correlation of plant height with bolls per plant has been reported by Ashokkumar and Ravikesavan (2010). However, staple length, earliness index, days taken to 1st square and flowers along with CLCuV% showed positive significant genotypic association with plant height. Boll weight has positive and significant genotypic association with seed cotton yield and negative significant phenotypic association with earliness index and days taken to 1st square. Similar association was reported by Ashokkumar and Ravikesavan (2010). While considering staple length, it showed positive significant genotypic and phenotypic estimates with GOT and seed cotton yield. Swati Bharad *et al*. (1999) reported negative correlation with fiber fineness. In terms of phenotypic correlations only significant positive estimates were shown by days taken to 1st flower, however, days taken to 1st square and fiber fineness showed negative significant phenotypic correlations. Fiber fineness showed positive significant genotypic and phenotypic correlations with days taken to 1st flower and CLCuV% whereas it had only positive significant phenotypic association with days taken to 1st square. Negative significant phenotypic association was found for earliness index and seed cotton yield with fiber fineness. Earliness index, GOT and seed cotton yield had positive significant genotypic and phenotypic correlations with fiber strength. Negative significant phenotypic correlations were found for days taken to 1st square and flower along with CLCuV% with fiber strength.

GOT had negative significant phenotypic association with days taken to 1st flower and CLCuV%. Ashokkumar and Ravikesavan (2010) found positive correlation of GOT with plant height, bolls per plant and boll weight which are in disagreement with the present findings. CLCuV% had negative significant phenotypic estimates with seed cotton yield.

Path coefficient analysis results revealed that the traits like sympodia per plant (0.11), plant height (0.15), boll weight (0.15), earliness index (0.63), GOT (0.16) and days taken to 1st square (0.17) showed positive direct effect on seed cotton yield table-5. While all other traits showed negative estimates. Mendez-Natera *et al*., 2012 observed maximum direct effect of sympodial branches with seed cotton yield. In the path coefficient studies of Ashokkumar and Ravikesavan (2010) maximum direct effects were imposed by boll weight and sympodia per plant. Nodes to 1st fruiting branch showed negative direct effect but it exerted positive influence on seed cotton yield indirectly through bolls per plant, staple length, fiber strength, earliness index and days taken to 1st square, however, it had negative indirect effects with all other traits. Days taken to 1st square exerted positive influence, however days taken to 1st flower showed negative direct impact on yield. For both the traits plant height, staple length and strength exerted positive indirect effect.

All the remaining traits showed negative indirect effect on seed cotton yield via days taken to 1st square and flower. Indirect effects of days to flowering influenced seed cotton yield through fiber finenesss and 50% flowering (Ashokkumar and Ravikesavan, 2010). Indirect effects of Monopodia per plant influenced the seed cotton yield positively through bolls per plant, staple length, fiber fineness, fiber strength, earliness index, GOT, days taken to 1st square and CLCuV% but other traits showed negative estimates. Iqbal *et al*. 2003 reported negative direct effects of monopodia per plant on yield. Sympodia per plant showed positive direct effect on seed cotton yield. It showed positive indirect effect on yield via nodes to 1st fruiting branch, Monopodia per plant, plant height, boll weight, fiber strength and GOT. Ashokkumar and Ravikesavan (2010) found positive indirect effects of sympodia per plant via plant height, bolls per plant, boll weight and ginning out turn%. Bolls per plant did not showed positive direct effect on seed cotton yield however, it exerted positive indirect effects via nodes to 1st fruiting branch, Monopodia per plant, sympodia per plant, plant height, boll weight, fiber strength, GOT and days taken to 1st square but unable to exert any positive indirect effect through other traits. Ashokkumar and Ravikesavan (2010) reported the positive role of bolls per plant via sympodia per plant, boll weight and ginning out turn. Plant height had positive direct effect on yield and the traits like nodes to 1st fruiting branch, monopodia and sympodia per plant, boll weight, fiber fineness, fiber strength, GOT, earliness index and days taken to 1st square exerted positive indirect effect on yield.

Boll weight had positive direct effect on seed cotton yield and it has positive indirect effect via nodes to 1st fruiting branch, monopodia per plant, sympodia per plant, plant height, fiber fineness, GOT, days taken to 1st flower and CLCuV%. Rauf *et al*. 2004 observed positive direct effect of boll weight on yield and its indirect positive effect through monopodial and sympodial branches which are also found in the current studies. The negative indirect effects were shown by the traits like bolls per plant, staple length and strength, earliness index% and days taken to 1st square. Negative indirect effects of boll weight on bolls per plant were reported by Rauf *et al*. 2004.The staple length showed negative direct effect on yield however, it had positive indirect effect via nodes to 1st fruiting branch, monopodia and sympodia per plant, plant height, boll weight, fiber fineness and strength, earliness index, GOT, days taken to 1st flower and CLCuV%. The negative indirect effect was observed through bolls per plant and days taken to 1st square. Negative direct effects of fiber length on yield were also reported by Iqbal *et al.* 2003. Fiber fineness also had negative direct effect on yield but had positive indirect effect through monopodia per plant, sympodia per plant, staple length, strength and days taken to 1st square. The remaining traits exerted negative indirect effects on yield. Same like fiber fineness and length, fiber strength had negative direct effect on seed cotton yield but traits like nodes to 1st fruiting branch, monopodia per plant, bolls per plant, boll weight, staple length, fineness, earliness index, days taken to 1st flower and CLCuV% exerted positive indirect effects. However, all other remaining traits showed negative indirect effect on seed cotton yield. Maximum positive direct effect on seed cotton yield was shown by the trait earliness index. It showed positive indirect influence via bolls per plant, plant height, fiber fineness, GOT, days taken to 1st square and flower and CLCuV% on seed cotton yield while showed negative indirect effects via all the remaining traits. GOT showed positive direct effect on seed cotton yield but negative indirect effects were observed through, monopodia per plant, bolls per plant, staple length, strength and days taken to 1st square. All the remaining traits exerted positive indirect influence on seed cotton yield. CLCuV% showed negative direct effect on yield. The traits like Monopodia and sympodia per plant, plant height, staple length, strength and days taken to 1st square showed positive but indirect influence on yield and nodes to 1st fruiting branch, bolls per plant, boll weight, fiber fineness, earliness index, GOT and days taken to 1st flower showed negative impact.

Table 1. Rating scale for cotton leaf curl virus (CLCuV) symptoms

Symptoms	Disease rating	Disease index (%)	Disease reaction
Absence of symptoms.	0	0	Immune
Thickening of a few small veins or the presence of leaf enations on 10 or fewer leaves of a plant.	1	0.1- 1	Highly resistant
Thickening of a small group of veins.	2	1.1- 5	Resistant
Thickening of all veins but no leaf curling.	3	5.1-10	Moderately resistant
Severe vein thickening and leaf curling on the top third of the plant.	4	10.1 – 15	Moderately susceptible
Severe vein thickening and leaf curling on the half of the plant.	5	15.1 – 20	Susceptible
Severe vein thickening, leaf curling, and stunting of the plant with reduced fruit production.	6	>20	Highly susceptible

Table 2.Mean performance of 53 genotypes/ strains in terms of earliness, fiber quality, CLCuV% and yield contributing traits in cotton.

Genotypes	NTFFB	MPP	SPP	BPP	PH (cm)	BWT (g)	SL (mm)	FF (µg/inch)	FS (tppsi)	EI (%)	GOT (%)	DFS	DFF	CLCuV (%)	Yield (kg/ha)
FH-142	6	2	18	29	140	4.6	28.0	4.2	99.7	74	38.2	29	49	0.1	2696
FH-162	7	1	23	34	177	4.4	28.3	5.1	99.9	74	41.5	29	49	3.3	3041
FH-163	6	1	21	33	160	4.0	29.0	5.1	93.8	65	38.9	29	49	2.8	2806
FH-167	6	1	23	34	174	4.8	30.5	5.1	92.7	66	38.2	28	49	3.5	2892
FH-172	6	2	20	34	153	4.3	31.0	4.1	90.3	69	38.8	29	49	2.3	2681
FH-184	6	1	24	42	192	4.7	30.0	5.2	92.4	69	39.5	30	50	2.7	3424
FH-113	6	2	21	30	153	3.8	27.5	5.4	90.4	67	36.8	31	50	5.2	2930
IR-3701	7	2	17	19	146	3.5	27.5	5.0	87.7	60	38.1	30	50	1.6	1403
FH-201	8	3	20	25	171	3.8	28.5	4.5	91.3	77	38.2	29	50	0.2	2545
FH-202	8	2	21	25	171	3.5	30.0	4.2	98.7	80	38.6	30	50	1.0	2925
FH-203	7	3	18	27	169	4.4	28.0	5.0	95.5	81	38.6	30	50	1.7	3197
FH-204	7	3	20	20	141	4.4	27.5	5.5	90.0	62	38.4	30	50	2.1	1291
FH-205	7	2	21	24	167	3.9	27.3	5.0	98.6	81	38.3	30	49	1.4	3303
FH-206	8	2	18	26	147	3.9	28.5	4.9	93.4	84	39.2	30	50	0.2	3252
FH-208	7	1	21	28	165	3.9	27.2	5.5	95.2	75	38.0	29	49	1.0	2930
FH-209	8	2	18	27	169	4.0	30.0	5.0	94.6	73	42.0	30	49	1.9	2355
FH-210	8	2	20	24	162	3.1	28.0	5.2	96.5	72	39.9	30	49	0.9	2997
FH-211	8	2	20	29	159	4.3	28.0	5.1	94.4	77	38.5	30	50	1.5	2513
FH-212	7	2	21	31	168	4.5	28.3	5.1	87.4	81	38.8	31	50	2.7	2777
FH-213	10	2	20	30	166	4.0	27.6	5.3	92.3	74	38.2	31	50	2.1	2197
FH-215	8	2	23	30	160	4.0	28.2	5.3	100.0	76	41.0	31	51	1.4	1573
FH-2015	7	2	21	34	167	4.0	27.8	5.3	90.2	80	38.3	32	51	7.3	2396
FH-4243	6	2	21	16	157	3.7	27.8	5.2	89.5	61	36.5	31	50	4.0	1174
FH-146	8	2	21	23	178	3.3	26.5	5.1	90.0	88	39.0	30	49	4.8	2135
FH-147	7	2	19	30	158	4.1	27.2	5.2	100.1	81	38.2	31	51	5.9	2253
FH-148	8	2	19	20	124	3.0	31.0	5.3	89.1	79	38.2	31	50	4.8	1976
FH-149	7	2	22	23	165	3.4	27.2	5.1	96.0	82	40.0	31	51	2.0	1638
FH-150	7	2	21	27	165	3.8	28.0	5.0	91.0	86	38.1	30	50	1.5	2978
FH-151	7	3	21	32	152	3.8	28.5	5.1	92.5	81	39.6	29	48	2.0	3217
FH-152	8	1	21	28	172	4.0	27.0	5.0	101.0	77	38.3	31	51	3.5	2550
FH-154	7	2	21	32	162	3.8	29.0	4.6	89.0	79	38.3	30	49	5.9	2585
FH-155	8	2	22	27	175	4.1	30.0	4.8	93.0	76	41.6	30	49	1.6	2843
FH-157	8	2	20	33	172	3.9	28.3	5.0	90.2	68	38.8	32	51	2.6	2422
FH-160	7	2	22	39	188	4.8	29.0	4.8	91.9	69	38.6	31	50	4.7	2557
FH-164	8	1	20	31	181	4.3	30.0	4.9	86.2	79	38.3	31	51	5.7	2164
FH-194	6	2	23	37	189	3.6	28.2	5.0	85.6	79	38.5	31	50	1.3	2427

NS-121	8	2	21	35	174	4.1	27.5	5.1	88.7	68	36.8	32	52	11.2	2050
FH-160	7	2	22	14	149	3.7	27.0	5.5	86.5	54	38.2	31	51	4.5	987
FH-118	6	3	24	30	160	3.8	29.0	4.8	98.2	83	41.4	30	49	1.9	3577
FH-166	7	3	16	27	166	3.9	29.0	4.7	94.4	74	39.6	30	49	2.7	3191
FH-171	8	1	19	28	168	3.8	29.0	4.7	88.1	80	39.2	30	49	1.4	3201
FH-173	7	1	20	27	156	3.6	29.0	4.6	95.0	78	38.9	29	49	3.0	3241
FH-177	8	2	23	33	182	4.4	28.8	4.6	94.7	75	39.0	30	50	3.4	2922
FH-179	8	3	24	31	184	5.0	29.0	4.7	96.6	68	39.8	29	50	1.5	2406
FH-181	7	3	24	32	178	3.8	32.0	4.7	87.0	71	38.3	31	51	4.3	2363
FH-183	6	4	20	28	178	4.1	28.3	5.1	90.2	73	40.5	31	50	3.7	3167
FH-193	6	3	19	29	179	4.7	28.5	4.8	91.9	69	38.3	30	50	3.0	1882
FH-195	8	3	21	30	164	3.5	27.0	5.0	94.7	75	38.3	32	52	4.1	2341
FH-196	7	2	22	32	177	4.7	28.0	5.5	89.5	78	41.4	32	53	2.6	2589
FH-197	9	3	21	28	167	3.6	28.0	5.0	90.0	78	38.7	31	53	2.3	2109
FH-198	6	4	16	23	168	4.5	26.8	4.7	95.4	74	38.3	31	50	2.7	2330
FH-199	9	3	22	29	173	3.6	27.8	5.2	87.7	69	37.3	31	50	13.2	2083
FH-194	8	2	21	31	170	3.6	27.0	5.5	88.5	56	37.7	30	51	5.9	1121
LSD (0.05)	2.06	1.42	3.97	6.36	17.40	0.17	0.98	0.19	1.08	11.29	0.56	1.30	1.40	2.52	569.41

Table 3. Mean squares, genotypic and phenotypic coefficients of variation, heritability and genetic advance for various traits of 53 genotypes/strains of cotton

Characters	**Mean squares**	**GCV (%)**	**PCV (%)**	**Heritability* (%)**	**GA (%)**
NTFFB	2.52**	7.49	12.60	35	0.45
MPP	1.17**	17.10	29.16	34	0.30
SPP	10.52**	5.90	9.04	43	1.12
BPP	68.07**	14.42	16.40	77	5.16
PH	511.72**	6.91	7.85	77	14.2
BW	0.59**	10.96	11.06	98	0.61
SL	4.17**	3.97	4.15	91	1.51
FF	0.32**	6.42	6.56	96	0.44
FS	50.03**	4.39	4.41	99	5.67
EI (%)	159.30**	8.21	9.85	70	7.00
GOT (%)	4.38**	3.06	3.11	97	1.65
DFS	2.24**	2.40	2.85	71	0.86
DFF	2.88**	1.69	1.96	74	1.00
CLCuV%	17.87**	71.38	76.77	86	2.95
Yield (kg/ha)	1162327.98**	23.52	24.88	89	778.7

* Broadsense

Table-4. Genotypic and phenotypic Correlation coefficient of various plant traits in cotton

		NTFFB	MPP	SPP	BPP	PH (cm)	BW (g)	SL (mm)	FF (µg/inch)	FS (tppsi)	EI (%)	GOT (%)	DFS	DFF	CLCuV %	Yield (kg/ha)
NTFFB	rg	1.00	0.40	-0.08	-0.44	-0.01	-0.55	-0.21	0.16	-0.10	0.12	-0.05	0.35*	0.65*	0.21*	-0.44
	rp		0.03	0.01	-0.19*	0.04	-0.34**	-0.10	0.11	-0.06	0.11	-0.02	0.21**	0.29**	0.12	-0.21**
MPP	rg		1.00	-0.45	-0.69	-0.03	-0.13	-0.22	-0.13	-0.12	0.28*	0.20	0.65*	0.61*	-0.13	-0.16
	rp			-0.21**	-0.35**	-0.01	-0.09	-0.14	-0.07	-0.07	0.13	0.10	0.28**	0.24**	-0.02	-0.08
SPP	rg			1.00	0.67*	0.75*	0.03	0.33*	0.37*	-0.04	-0.29	0.30*	-0.12	0.01	0.24*	0.01
	rp				0.42**	0.44**	0.02	0.18*	0.20*	-0.03	-0.09	0.17*	0.01	0.06	0.13	0.02
BPP	rg				1.00	0.54*	0.51*	0.28*	0.01	-0.14	-0.27	0.09*	0.12*	0.08	0.33*	0.23*
	rp					0.46**	0.44**	0.23**	0.01	-0.12	-0.16*	0.06	0.11	0.03	0.25**	0.21**
PH (cm)	rg					1.00	0.36*	0.10*	-0.13	-0.05	0.06*	0.22*	0.10*	0.23*	0.15*	0.23*
	rp						0.31**	0.08	-0.11	-0.06	0.07	0.18*	0.12	0.14	0.13	0.21**
BW (g)	rg						1.00	0.12	-0.15	0.11	-0.27	0.13	-0.25	-0.08	-0.12	0.12*
	rp							0.12	-0.14	0.11	-0.23**	0.13	-0.21**	-0.06	-0.12	0.11
SL (mm)	rg							1.00	-0.47	-0.14	0.03	0.25*	-0.25	-0.32	-0.10	0.34*
	rp								-0.44**	-0.14	0.02	0.25**	-0.21**	0.26**	-0.10	0.30**
FF (µg/inch)	rg								1.00	-0.23	-0.30	-0.07	0.33	0.37*	0.27*	-0.40
	rp									-0.21**	-0.25**	-0.06	0.26**	0.30**	0.26**	-0.37**
FS (tppsi)	rg									1.00	0.34*	0.35*	-0.38	-0.34	-0.40	0.37*
	rp										0.28**	0.35**	-0.32**	-0.29**	-0.37**	0.35**
EI (%)	rg										1.00	0.33*	0.05	-0.11	-0.25	0.60*
	rp											0.28**	0.03	-0.09	-0.23**	0.52**
GOT (%)	rg											1.00	-0.14	-0.20	-0.44	0.34*
	rp												-0.12	-0.18*	-0.40**	0.32**
DFB	rg												1.00	0.98*	0.64*	-0.51
	rp													0.75**	0.47**	-0.39**
DFS	rg													1.00	0.42*	-0.63
	rp														0.33**	-0.50**
CLCuV(%)	rg														1.00	-0.31
	rp															-0.30**
Y (kg/ha)	rg															1.00
	rp															1.00

Table 5. Direct (diagonal) & Indirect (off-diagonal) effects of various plant traits in cotton

	NTFFB	MPP	SPP	BPP	PH (cm)	BW (g)	SL (mm)	FF (µg/inch)	FS (tppsi)	EI (%)	GOT (%)	DFS	DFF	CLCuV%	r_g
NTFFB	**-0.3023**	-0.2050	-0.0098	0.1473	-0.0028	-0.0841	0.0020	-0.0409	0.0114	0.0756	-0.0082	0.0605	-0.0755	-0.0108	-0.4426
MPP	-0.1224	**-0.5064**	-0.0522	0.2304	-0.0058	-0.0204	0.0021	0.0338	0.0131	0.1809	0.0330	0.1127	-0.0713	0.0069	-0.1656
SPP	0.0259	0.2326	**0.1137**	-0.2225	0.1160	0.0051	-0.0032	-0.0900	0.0042	-0.1883	0.0499	-0.0220	-0.0012	-0.0128	0.0075
BPP	0.1342	0.3517	0.0763	**-0.3317**	0.0838	0.0770	-0.0026	-0.0016	0.0154	-0.1765	0.0139	0.0216	-0.0093	-0.0172	0.2349
PH(cm)	0.0054	0.0190	0.0857	-0.1806	**0.1540**	0.0555	-0.0010	0.0315	0.0062	0.0423	0.0366	0.0182	-0.0271	-0.0081	0.2375
BW(g)	0.1685	0.0684	0.0039	-0.1694	0.0566	**0.1508**	-0.0012	0.0364	-0.0117	-0.1721	0.0221	-0.0438	0.0095	0.0066	0.1246
SL(mm)	0.0637	0.1137	0.0386	-0.0931	0.0161	0.0184	**-0.0094**	0.1140	0.0149	0.0241	0.0419	-0.0445	0.0376	0.0054	0.3413
FF(µg/inch)	-0.0512	0.0708	0.0423	-0.0022	-0.0200	-0.0227	0.0045	**-0.2418**	0.0240	-0.1922	-0.0122	0.0572	-0.0431	-0.0146	-0.4013
FS(tppsi)	0.0332	0.0638	-0.0046	0.0490	-0.0092	0.0170	0.0014	0.0559	**-0.1039**	0.2182	0.0586	-0.0671	0.0401	0.0210	0.3736
EI (%)	-0.0361	-0.1449	-0.0339	0.0926	0.0103	-0.0411	-0.0004	0.0735	-0.0358	**0.6323**	0.0541	0.0092	0.0133	0.0131	0.6062
GOT (%)	0.0151	-0.1021	0.0347	-0.0281	0.0344	0.0203	-0.0024	0.0180	-0.0372	0.2090	**0.1637**	-0.0255	0.0237	0.0233	0.3468
DFB	-0.1062	-0.3313	-0.0145	-0.0416	0.0163	-0.0384	0.0024	-0.0802	0.0404	0.0338	-0.0243	**0.1723**	-0.1136	-0.0335	-0.5182
DFS	-0.1986	-0.3139	0.0012	-0.0267	0.0363	-0.0125	0.0031	-0.0906	0.0362	-0.0733	-0.0338	0.1702	**-0.1150**	-0.0223	-0.6396
CLCuV%	-0.0629	0.0670	0.0279	-0.1095	0.0239	-0.0190	0.0010	-0.0676	0.0418	-0.1586	-0.0731	0.1107	-0.0493	**-0.0521**	-0.3198

r_g = genotypic correlation coefficient

Conclusion: Heritability estimates were higher for most of the traits except for nodes to 1st fruiting branch, monopodia and sympodia per plant which showed moderate values. Maximum values of genetic advance were observed for seed cotton yield, plant height, and earliness index. Characters showing high heritability and genetic advance may be further evaluated through early generation selection as increased values of both are indicative of additive genetic effects. Bolls per plant, plant height, boll weight, staple length and strength, earliness index and GOT had positive genotypic correlation with seed cotton yield and have reasonable heritability, thus, may be used as selection criteria to enhance seed cotton yield

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