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Research Article

Genetic variability studies for yield components and fibre quality traits in upland cotton (*Gossypium hirsutum* L.)

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Abstract
The study was aimed to investigate the degree of genetic variability, heritability, and genetic advance among eight parents and fifty-six hybrids. The experiment was laid out in a randomized complete block design with two replications. The genetic parameters for 18 yield components and fibre quality traits were assessed. Analysis of variance was found to be highly significant for all the tested traits. Assessment of mean performance indicated the heterotic potential of hybrids over parents. The phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation suggesting a high level of environmental influence on these characters. The number of monopodia per plant and the number of bolls per plant had high PCV and GCV. High heritability coupled with high genetic advance was reported for the number of monopodia per plant, the number of sympodia per plant, the number of bolls per plant, boll weight, the number of seeds per boll and seed cotton yield, which implies additive gene effects and selection based on these traits will be effective for future crop improvement.

Keywords: Cotton, Genetic variability, heritability, genetic advance

INTRODUCTION

Cotton, widely known as white gold, is one of the most predominant fibres and cash crops of global importance and is cultivated in more than 60 countries (Jarwar *et al.,* 2018). Of the four cultivated species, *Gossypium hirsutum* contributes 4% of GDP and 14% to industrial production in India. It plays a vital role in India's economy by providing employment both directly and indirectly to 4-5 crore people and also an important commodity in foreign exchange (Jangid *et al.,* 2019). Cotton is mainly known for its fibre which is used to make many clothing products needed by the textile industry. In addition to fibre, the cotton seed contains 18% oil (Abdullah *et al.,* 2016).

Genetic variation in cotton for many yield and quality traits is enormous because of its ease in hybridization due to its often-cross pollination nature (Joshi and Patil, 2018). The prime objective of any plant breeder is to improve yield and fibre quality to fulfil the demands of farmers and textile industries. Lint yield can be broken into various component traits such as boll weight, the number of bolls per plant, seed index, lint index, the number of seeds per boll, and the number of locules per boll. However, the negative association between yield and fibre quality governed by multiple QTLs with linkage drag (Gapare *et al.,* 2017), limits their combined improvement. Information regarding the degree of variability along with heritability and genetic advance is indispensable for effective cotton breeding and the development of elite varieties and hybrids. Genetic variability indicates the feasibility of selection on both phenotypic and genotypic basis. Thus, the present study focuses on understanding genetic variability in upland cotton parents and their hybrids for eighteen yield and its component traits along with fibre quality traits and a detailed analysis of its heritable components for further selection in breeding programmes.

MATERIALS AND METHODS

The study was conducted using eight parents and their 56 F_1s derived by crossing in a diallel fashion including direct and reciprocal crosses (**Table 1**). These F_1s and their parents were planted during *kharif* 2021 at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore, in two rows each with a row length of 6 m, in a randomised complete block design with two replications with a spacing of 90 cm x 60 cm. All recommended packages of practices were followed for the betterment of the crop. The data were recorded by tagging five randomly selected plants from each replication of each cross for eighteen characters including plant height (cm), days to 50 per cent flowering (number of days), days to first boll bursting (number of days), the number of monopodia per plant, the number of sympodia per plant, the number of bolls per plant, the number of locules per boll, boll weight (g), the number of seeds per boll, seed cotton yield per plant (g), seed index (g), lint index (g), ginning out turn (%), upper half mean length (mm), fibre strength (g/tex), fibre fineness or micronaire (µg/inch), uniformity index, and elongation percentage (%). The data were subjected to analysis of variance for RCBD using R studio version 1.4.1717 © 2009-21. The coefficient of variation was calculated for all the traits to compare the variability. The phenotypic (PCV) and genotypic coefficient of variation (GCV) were estimated by following Burton and De Vane (1953), broad sense heritability (h^2) by Lush (1940) and genetic advance as per cent of mean (GAM) by Johnson *et al.* (1955) using R studio version 1.4.1717 © 2009-21 package.

Table 1. List of parents and their F_1s used in this study

Parents	Hybrids	Parents	Hybrids
	CO 14 X GISV 328		GISV 328 X CO 14
	CO 14 X MCU 5		GISV 328 X MCU 5
	CO 14 X IS 360041		GISV 328 X IS 360041
P1 (CO 14)	CO 14 X IS 359538	P2 (GISV 328)	GISV 328 X IS 359538
	CO 14 X IS 358478		GISV 328 X IS 358478
	CO 14 X IS 359464		GISV 328 X IS 359464
	CO 14 X IS 292130		GISV 328 X IS 292130
	MCU 5 X CO 14		IS 360041 X CO 14
	MCU 5 X GISV 328		IS 360041 X GISV 328
	MCU 5 X IS 360041		IS 360041 X MCU 5
P3 (MCU 5)	MCU 5 X IS 359538	P4 (IS 360041)	IS 360041 X IS 359538
	MCU 5 X IS 358478		IS 360041 X IS 358478
	MCU 5 X IS 359464		IS 360041 X IS 359464
	MCU 5 X IS 292130		IS 360041 X IS 292130
	IS 359538 X CO 14		IS 358478 X CO 14
	IS 359538 X GISV 328		IS 358478 X GISV 328
	IS 359538 X MCU 5		IS 358478 X MCU 5
P5 (IS 359538)	IS 359538 X IS 360041	P6 (IS 358478)	IS 358478 X IS 360041
	IS 359538 X IS 358478		IS 358478 X IS 359538
	IS 359538 X IS 359464		IS 358478 X IS 359464
	IS 359538 X IS 292130		IS 358478 X IS 292130
	IS 359464 X CO 14		IS 292130 X CO 14
	IS 359464 X GISV 328		IS 292130 X GISV 328
	IS 359464 X MCU 5		IS 292130 X MCU 5
P7 (IS 359464)	IS 359464 X IS 360041	P8 (IS 292130)	IS 292130 X IS 360041
	IS 359464 X IS 359538		IS 292130 X IS 359538
	IS 359464 X IS 358478		IS 292130 X IS 358478
	IS 359464 X IS 292130		IS 292130 X IS 359464

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant (@ 1%) differences for all the traits except elongation percentage, which is significant at 5% (**Tables 2 and 3**). These findings are in concordance with Sahar *et al.* (2021), Ishaq *et al.* (2021), Nawaz *et al.* (2019) and Nikhil *et al.* (2018).

The mean performance for evaluated parents and their hybrids were enlisted in **Tables 4 and 5** and **Fig. 1.** It indicated that the hybrids recorded maximum range for most of the yield components and fibre quality traits than parents. All the parents except MCU 5 (4.10g) had documented high boll weight of above 5 gms. In terms of the hybrids, IC 292130 x GISV 328 and CO 14 x IC 359538 recorded higher boll weight of 5.65g and 5.46g, respectively. The highest seed cotton yield was recorded in hybrid IC 292130 x GISV 328 (133.78g) followed by GISV 328 x IC 359538 (130.48g). The hybrid MCU 5 x GISV 328 had a higher number of bolls (45.80) followed by the hybrid GISV 328 x IC 359538 with 45 bolls. The parent IC 358478 (14.75g) and the hybrid CO 14 x IC 359464 (14.62g) had the maximum seed index when compared with other parents and hybrids. The hybrids viz., IC 359464 x GSV 328 and CO 14 x IC 359464 had recorded high lint index of 6.73g and 6.72g, respectively. The upper half mean length is the most important among fibre quality traits as it is critical for processing fibres and yarns. Usually, long fibre length is preferred, accordingly the hybrid MCU 5 x IC 292130 and MCU x IC 359464 had the maximum of 30.10 mm and 30.05 mm, respectively while the parents, CO 14 (35.10 mm) and MCU 5 (31.24 mm) had longest fibre length than hybrids. Ginning out turn was found maximum in the parent MCU 5 (39.72%) and the cross CO 14 x GISV 328 (39.34%). This result was supported by Ahsan et al. (2015), Khokhar et al. (2017), Baloch et al. (2018), Abro et al. (2021) and Muhammed et al. (2016) for seed cotton yield.

The range for a phenotypic and genotypic coefficient of variation for different economically important traits were presented in **Table 6**. Estimation of genetic variability revealed that the phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation. This denotes the environmental effect on the expression of these traits. The traits including the number of monopodia per plant (37.19%, 35.14%) and the number of bolls per plant (28.26%, 26.73%) were found to have a high magnitude of phenotypic as well as genotypic coefficient of variation, respectively. This suggests that genetic variance played a major role in the inheritance of the number of monopodial branches and the number of bolls, thus intensive selection at earlier generations can reduce the vegetative branches. A similar result was reported by Khokhar *et al.* (2017), Sahar *et al.* (2021) and Rao *et al.* (2021). Moderate phenotypic coefficient of variation was recorded for the number of sympodia per plant (16.43 %), boll weight (13.42 %), the number of seeds per boll (13.38 %), seed cotton yield (16.42 %), lint index (13.69 %), and fibre fineness (11.08 %). The traits *viz.,* the number of sympodia per plant (12.96%), boll weight (11.79%), the number of seeds per boll (11.42%), and seed cotton yield (15.85 %) revealed a moderate level of genotypic coefficient of variation. These findings were in accordance

Table 2. Analysis of variance for yield related traits

SOV	DF	DFF	DFBB	PH	NMON	NSYM	NOB	NOL	BW	NOS
Replication	1	1.125	2.258	6.882	0.116	78.125	129.364	0.011	0.091	1.831
Genotypes	63	35.919**	41.385**	233.833**	0.498**	15.001**	113.308**	0.032**	0.601**	24.029**
Error	63	7.157	11.559	24.688	0.028	3.498	6.272	0.014	0.077	3.775

Note: DFF-days to 50 per cent flowering, DFBB-days to first boll bursting, PH-plant height, NMON-number of monopodia per plant, NSYM-number of sympodia per plant, NOB-number of bolls per plant, NOL-number of locules per boll, BW-boll weight , NOS- number of seeds per boll

**highly significant @ 1%

Table 3. Analysis of variance for yield fibre quality related traits

SOV	DF	SCY	SI	LI	UHML	FS	MIC	UI	EP	GOT
Replicatin	1	19.399	0.080	0.001	0.203	3.445	0.661	0.207	0.162	0.260
Genotypes	63	399.826**	2.099**	0.789**	4.243**	7.394**	0.326**	0.352**	0.037*	7.910**
Error	63	14.172	0.332	0.298	1.306	0.678	0.165	0.126	0.021	1.101

SCY-seed cotton yield per plant , SI-seed index, LI-lint index, UHML-upper half mean length, FS-fibre strength, MIC-fibre fineness , UI-uniformity index, and EP-elongation percentage, GOT-ginning out turn

**highly significant @ 1%, *significant @ 5%

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Table 4. Mean performance for yield component traits in parents and F_1s

Parents/F_1s	DFF	DFBB	PH	NMON	NSYMP	NBPP	NLPB	BW	NSPB
CO 14	57.00	90.50**	123.60	1.70	20.10	22.50	4.10	5.15**	27.70
CO 14 X GISV 328	52.50*	100.50	128.20	1.70	17.90	30.40	4.30	4.14	28.80
CO 14 X MCU 5	52.00*	106.50	119.70	1.10	18.10	26.00	4.10	4.39	25.70
CO 14 X IC 360041	63.50	107.00	121.00	0.90*	18.40	23.50	4.30	3.74	26.90
CO 14 X IC 359538	55.00	95.00	124.30	1.10	20.10	28.33	4.10	5.46**	25.00
CO 14 X IC 358478	57.50	96.00	125.70	2.00	25.50**	29.90	4.25	4.30	21.50
CO 14 X IC 359464	52.50*	96.00	128.10	1.10	18.30	32.80*	4.25	4.47	28.60
CO 14 X IC 292130	58.50	100.00	119.40	1.10	15.10	25.60	4.10	4.94*	30.30
GISV 328	64.00	92.50*	99.30**	1.50	16.40	22.10	4.10	5.49**	27.80
GISV 328 X CO 14	56.50	109.00	109.80	1.50	16.60	30.20	4.35*	4.24	27.00
GISV 328 X MCU 5	60.50	93.50	116.90	1.60	18.20	32.60*	4.05	4.39	29.00
GISV 328 X IC 360041	61.00	96.50	115.30	1.20	18.90	28.20	4.10	4.94	29.40
GISV 328 X IC 359538	67.00	105.50	123.60	1.50	18.30	45.00**	4.10	5.38**	28.10
GISV 328 X IC 358478	65.00	108.00	104.60**	1.50	17.00	23.60	4.10	4.68	26.40
GISV 328 X IC 359464	52.50*	100.00	125.90	1.60	20.10	36.50**	4.10	4.17	30.40
GISV 328 X IC 292130	65.00	102.00	122.70	1.80	18.90	43.50**	4.00	4.42	27.70
MCU 5	63.50	101.00	100.50**	1.80	14.10	15.70	4.10	4.10	30.70
MCU 5 X CO 14	54.50	96.50	136.40	1.60	22.40*	33.10*	4.05	4.47	29.40
MCU 5 X GISV 328	59.00	98.50	122.70	1.40	17.80	45.80**	4.05	5.36**	25.80
MCU 5 X IC 360041	66.50	101.00	130.37	2.10	23.70*	29.47	4.30	4.68	33.83**
MCU 5 X IC 359538	53.50	95.50	133.97	1.70	24.07**	30.07	4.10	4.26	28.00
MCU 5 X IC 358478	57.00	96.50	129.20	1.60	17.50	21.40	4.10	4.03	25.60
MCU 5 X IC 359464	51.50**	96.00	120.90	0.70**	17.80	25.40	3.93	5.35*	33.20**
MCU 5 X IC 292130	60.00	93.50	110.70	0.70**	15.80	22.60	4.10	4.02	25.80
IC 360041	55.50	95.50	111.50	0.60**	20.80	20.40	4.00	5.85**	31.30
IC 360041 X CO 14	61.50	103.00	103.30**	0.90**	16.50	24.50	4.15	4.01	28.80
IC 360041 X GISV 328	58.00	96.50	114.80	1.60	18.30	34.30**	4.10	4.02	30.00
IC 360041 X MCU 5	63.50	94.00	106.30*	2.20	16.40	25.00	3.93	3.54	31.20
IC 360041 X IC 359538	58.50	95.00	99.00**	1.50	15.00	19.50	4.25	3.20	28.90
IC 360041 X IC 358478	56.00	102.50	120.40	1.50	19.40	20.90	4.30	3.88	24.90
IC 360041 X IC 359464	55.00	95.50	128.60	0.70**	20.40	31.70	4.05	4.20	28.40
IC 360041 X IC 292130	63.00	100.50	99.25**	0.90**	17.50	20.50	3.95	4.65	22.00
IC 359538	61.00	96.50	106.50*	0.60**	14.70	21.80	4.05	5.66**	31.10
IC 359538 X CO 14	61.00	99.50	103.13**	1.68	13.75	19.38	3.98	4.08	35.00**
IC 359538 X GISV 328	61.50	102.50	127.40	1.70	20.70	34.05**	4.05	4.55	30.00
IC 359538 X MCU 5	61.50	95.00	117.80	0.80**	17.70	37.10**	3.93	4.40	27.17
IC 359538 X IC 360041	59.50	98.50	133.95	1.90	18.13	38.00**	3.98	4.02	28.60
IC 359538 X IC 358478	56.50	108.50	125.53	1.90	23.48**	28.43	3.98	4.37	28.60
IC 359538 X IC 359464	67.00	95.00	131.40	1.30	19.10	33.70*	3.93	5.24**	26.00
IC 359538 X IC 292130	57.00	96.50	114.40	1.10	15.40	23.90	4.05	4.71	28.20
IC 358478	58.50	101.50	129.50	2.60	20.20	19.90	3.93	5.97**	27.20
IC 358478 X CO 14	59.50	99.50	129.90	1.50	18.50	24.90	4.10	4.12	22.60
IC 358478 X GISV 328	59.00	105.00	124.80	1.60	20.70	30.60	4.15	4.14	18.10
IC 358478 X MCU 5	62.50	98.00	126.40	2.20	21.10	42.00**	4.23	4.22	21.60
IC 358478 X IC 360041	52.00*	94.50	125.00	2.70	19.00	27.60	4.30	4.40	24.20
IC 358478 X IC 359538	52.00*	102.00	103.00**	1.90	15.00	15.75	4.00	4.35	32.23*
IC 358478 X IC 359464	57.50	99.50	115.93	2.00	24.85**	31.10	4.18	3.85	20.68
IC 358478 X IC 292130	63.00	105.50	120.95	1.55	20.90	28.70	4.10	4.65	27.80
IC 359464	55.00	106.00	111.00	1.30	13.70	15.50	4.10	5.25**	31.20
IC 359464 X CO 14	64.00	104.00	114.90	0.50**	20.00	30.90	4.10	4.05	27.90

Table 4. Continued...

Parents/F_1s	DFF	DFBB	PH	NMON	NSYMP	NBPP	NLPB	BW	NSPB
IC 359464 X GISV 328	56.00	97.50	126.20	1.60	19.50	35.60**	4.10	4.95*	31.70
IC 359464 X MCU 5	61.50	104.50	123.25	0.80**	23.00*	35.00**	4.00	4.25	30.75
IC 359464 X IC 360041	58.50	95.50	129.25	1.00*	18.00	25.00	4.45**	2.80	29.00
IC 359464 X IC 359538	64.50	100.00	118.07	0.80**	19.03	19.90	4.10	4.03	30.53
IC 359464 X IC 358478	59.50	95.00	124.20	1.50	19.30	26.50	4.40*	4.20	28.10
IC 359464 X IC 292130	51.50**	99.00	110.30	0.30**	16.80	17.20	4.00	4.80	30.80
IC 292130	55.00	95.50	114.20	0.90**	14.90	19.60	4.20	5.90*	29.40
IC 292130 X CO 14	54.50	99.50	118.25	1.20	17.80	31.90	4.05	4.85	29.30
IC 292130 X GISV 328	61.00	102.50	134.00	1.60	20.80	37.70**	4.05	5.65**	33.10**
IC 292130 X MCU 5	63.50	99.00	107.73*	1.20	14.03	16.53	3.75	3.72	23.93
IC 292130 X IC 360041	54.00	108.00	94.58**	0.90**	14.17	14.50	4.05	3.85	24.50
IC 292130 X IC 359538	62.00	107.50	94.95**	1.00*	18.00	16.75	4.00	2.78	19.75
IC 292130 X IC 358478	62.00	101.50	127.65	1.30	17.70	27.70	4.10	3.90	24.20
IC 292130 X IC 359464	58.00	104.50	134.60	1.00*	19.10	23.10	4.10	4.65	31.60
Mean	58.84	99.63	118.67	1.38	18.51	27.37	4.10	4.34	27.86
SE	1.89	2.40	3.51	0.12	1.32	1.77	0.09	0.20	1.37
SEd	2.68	3.40	4.97	0.17	1.87	2.50	0.12	0.28	1.94
CD(P=5%)	5.35	6.79	9.93	0.34	3.74	5.00	0.24	0.56	3.88
CD (P=1%)	7.04	8.94	13.07	0.44	4.92	6.59	0.32	0.73	5.11
CV (%)	4.55	3.41	4.19	12.18	10.11	9.15	2.93	6.42	6.97
Max	67.00	109.00	136.40	2.70	25.50	45.80	4.45	5.97	35.00
Min	51.50	90.50	94.58	0.30	13.70	14.50	3.75	2.78	18.10

Note: PH-plant height (cm), DFF-days to fifty per cent flowering (number of days), DFBB-days to first boll bursting (number of days), NMON-number of monopodia per plant, NSYM-number of sympodia per plant, NOB-number of bolls per plant, NOL-number of locules per boll, BW-boll weight (g), NOS- number of seeds per boll (**highly significant @ 1%), (*significant @ 5%)

Table 5. Mean performance for yield component and fibre quality traits in parents and F_1s

Parents/F_1s	SCY	SI	LI	UHML	FS	MIC	UI	EP	GOT
CO 14	74.56	14.18	6.52*	35.10**	29.25**	4.03	46.70	5.80	35.22
CO 14 X GISV 328	69.11	12.60	6.14	27.38	25.10	4.41	46.70	5.58	39.34**
CO 14 X MCU 5	65.17	11.58	4.55	28.50	26.50	4.66	46.65	5.75	37.84
CO 14 X IC 360041	68.48	14.53	6.51*	26.82	24.73	5.19	47.75*	5.65	36.16
CO 14 X IC 359538	122.61**	12.32	5.53	29.68*	24.80	4.22	47.38	5.65	36.70
CO 14 X IC 358478	72.84	13.23	6.58*	26.88	24.85	5.10	47.48	5.70	36.93
CO 14 X IC 359464	82.83	14.62*	6.72*	27.63	25.15	4.33	46.70	5.65	38.28
CO 14 X IC 292130	74.69	13.44	6.41	26.55	24.48	4.31	47.20	5.55	34.64
GISV 328	84.24	10.33	5.18	27.65	27.55	3.97	46.58	5.63	35.65
GISV 328 X CO 14	93.81	13.79	5.98	28.00	25.53	5.14	46.45	5.70	38.08
GISV 328 X MCU 5	88.30	12.47	4.71	27.25	25.00	4.21	47.53	5.55	39.09**
GISV 328 X IC 360041	76.57	11.50	4.94	26.10	25.13	4.50	46.98	5.50	38.25
GISV 328 X IC 359538	130.48**	13.97	5.94	29.80*	28.58**	4.38	47.15	5.75	36.14
GISV 328 X IC 358478	76.03	13.91	4.93	25.65	24.05	4.41	47.38	5.53	36.31
GISV 328 X IC 359464	78.32	14.05	4.69	27.22	24.73	4.42	46.55	5.53	35.27
GISV 328 X IC 292130	85.50	14.00	6.09	26.75	27.35	3.91	46.75	5.53	32.57
MCU 5	85.71	13.85	4.63	31.24**	29.33**	4.54	46.43	5.70	39.72**
MCU 5 X CO 14	95.74*	12.15	5.18	27.88	29.75**	4.14	46.80	5.80	35.84
MCU 5 X GISV 328	102.40**	13.95	5.02	27.25	27.88*	4.45	47.58	5.68	38.87*
MCU 5 X IC 360041	94.40	13.90	5.28	26.27	22.95	4.61	47.08	5.45	34.86
MCU 5 X IC 359538	89.65	13.15	5.72	28.18	29.28**	4.51	47.05	5.75	34.10
MCU 5 X IC 358478	86.41	12.00	4.98	27.43	25.05	4.19	46.53	5.68	35.85

Table 5. Continued..

Parents/F_1s	SCY	SI	LI	UHML	FS	MIC	UI	EP	GOT
MCU 5 X IC 359464	127.63**	13.85	5.45	30.05**	28.08**	5.02	47.25	5.73	37.69
MCU 5 X IC 292130	85.61	13.80	5.00	30.10**	26.38	5.24	46.08	5.75	38.90*
IC 360041	78.78	13.20	5.52	24.63	27.18	4.34	47.30	5.50	37.46
IC 360041 X CO 14	90.72	12.70	5.50	25.15	24.65	4.39	47.98**	5.63	33.76
IC 360041 X GISV 328	90.64	12.35	6.02	26.40	24.50	3.76	47.30	5.63	31.97
IC 360041 X MCU 5	93.19	13.80	5.52	26.13	24.80	4.02	47.08	5.60	33.73
IC 360041 X IC 359538	74.18	14.10	5.22	23.60	21.75	3.89	47.80*	5.38	35.65
IC 360041 X IC 358478	74.14	13.90	4.72	26.63	25.40	5.22	47.08	5.68	36.90
IC 360041 X IC 359464	99.88**	13.65	4.73	26.08	25.15	4.67	46.90	5.53	33.82
IC 360041 X IC 292130	83.10	13.95	5.19	24.70	22.65	4.51	47.95**	5.40	38.54*
IC 359538	78.50	13.35	4.50	23.98	26.08	4.74	47.53	5.30	37.47
IC 359538 X CO 14	98.22**	12.70	5.13	26.73	25.03	4.70	47.45	5.65	37.35
IC 359538 X GISV 328	114.14**	13.25	4.67	26.75	25.95	4.57	47.23	5.53	31.72
IC 359538 X MCU 5	103.37**	12.25	4.83	26.75	26.00	4.53	47.08	5.60	37.82
IC 359538 X IC 360041	89.06	12.25	4.54	25.95	27.43*	4.50	47.50	5.65	35.80
IC 359538 X IC 358478	81.39	13.65	5.58	27.68	25.40	4.52	46.60	5.68	37.10
IC 359538 X IC 359464	75.63	14.20	5.85	26.73	25.93	4.97	47.00	5.60	34.71
IC 359538 X IC 292130	95.64*	11.30	5.63	27.25	29.25**	4.67	47.18	5.83	36.82
IC 358478	96.88*	14.75**	5.91	28.45	29.38**	4.06	46.58	5.75	37.28
IC 358478 X CO 14	83.13	13.35	5.39	28.18	28.58**	4.14	46.33	5.88	33.18
IC 358478 X GISV 328	79.54	12.90	5.07	29.72*	28.35**	4.00	46.10	5.83	37.24
IC 358478 X MCU 5	78.15	13.95	4.71	28.05	28.35**	3.98	46.88	5.78	36.76
IC 358478 X IC 360041	88.83	11.50	5.44	27.52	28.35**	4.02	46.90	5.68	36.03
IC 358478 X IC 359538	90.18	13.55	4.76	28.32	26.25	3.75	47.05	5.65	36.67
IC 358478 X IC 359464	91.03	14.10	6.25	27.18	26.43	4.47	46.50	5.68	38.29
IC 358478 X IC 292130	93.02	11.95	5.77	26.65	26.60	4.34	47.08	5.70	36.27
IC 359464	99.78**	11.90	4.81	25.23	27.85	4.39	47.28	5.33	33.07
IC 359464 X CO 14	91.04	14.15	4.16	25.72	23.13	4.56	46.95	5.40	33.65
IC 359464 X GISV 328	101.27**	14.30	6.73*	27.60	25.03	4.49	46.93	5.60	36.97
IC 359464 X MCU 5	94.40	13.25	5.48	26.33	23.68	4.18	46.83	5.43	32.81
IC 359464 X IC 360041	70.25	14.10	5.20	24.65	23.85	4.01	47.45	5.30	39.20**
IC 359464 X IC 359538	77.19	13.15	5.34	26.02	25.13	4.59	46.90	5.45	34.23
IC 359464 X IC 358478	82.36	13.85	5.37	27.48	27.10	4.69	46.63	5.73	37.36
IC 359464 X IC 292130	77.51	11.95	5.94	27.50	25.73	4.60	46.55	5.63	32.37
IC 292130	73.59	12.30	4.34	26.60	27.88	4.04	47.00	5.60	36.60
IC 292130 X CO 14	96.11*	14.35*	5.00	25.20	26.80	4.56	47.43	5.63	35.99
IC 292130 X GISV 328	133.78**	13.90	5.86	29.50*	29.50**	4.35	46.98	5.78	38.37*
IC 292130 X MCU 5	77.14	13.75	4.95	26.03	24.45	4.72	47.00	5.63	37.99
IC 292130 X IC 360041	77.48	11.30	5.09	25.65	24.05	4.17	47.40	5.55	35.97
IC 292130 X IC 359538	74.23	10.75	5.21	23.88	23.13	3.89	46.95	5.33	35.15
IC 292130 X IC 358478	77.89	13.65	5.78	25.95	26.60	4.56	47.40	5.73	38.71*
IC 292130 X IC 359464	74.56	14.18	6.31	27.35	26.05	4.80	46.63	5.58	36.86
Mean	87.62	13.17	5.39	26.94	25.78	4.47	47.02	5.61	36.25
SE	2.66	0.41	0.39	0.81	0.58	0.29	0.25	0.10	0.74
SEd	3.76	0.58	0.55	1.14	0.82	0.41	0.36	0.14	1.05
CD(P=5%)	7.52	1.15	1.09	2.26	1.65	0.81	0.71	0.29	2.10
CD (P=1%)	9.90	1.52	1.44	3.01	2.17	1.07	0.93	0.38	2.76
CV (%)	4.30	4.38	10.14	4.24	3.19	9.07	0.75	2.56	2.90
Max	133.48	14.75	6.73	35.10	29.75	5.24	47.98	5.88	39.72
Min	65.17	10.33	4.16	23.60	21.75	3.75	46.08	5.30	31.72

Note: SCY-seed cotton yield per plant (g), SI-seed index (g), LI-lint index (g), GOT-ginning out turn (%), UHML-upper half mean length (mm), FS-fibre strength (g/tex), MIC-fibre fineness (µg/inch), UI-uniformity index, and EP-elongation percentage (%) (**highly significant @ 1%), (*significant @ 5%)

Table 6. Estimation of parameters of genetic variability and heritability

Traits	PCV (%)	GCV (%)	h^2 (%)	GAM (%)
DFF	7.89	6.45	66.77	10.85
DFBB	5.16	3.88	56.33	5.99
PH	9.58	8.62	80.90	15.97
NMON	37.19	35.14	89.27	68.39
NSYM	16.43	12.96	62.18	21.05
NOB	28.26	26.73	89.51	52.10
NOL	3.72	2.29	38.00	2.91
BW	13.42	11.79	77.15	21.33
NOS	13.38	11.42	72.85	20.08
SCY	16.42	15.85	93.15	31.51
SI	8.37	7.13	72.67	12.53
LI	13.69	9.20	45.11	12.72
UHML	6.18	4.50	52.94	6.74
FS	7.79	7.11	83.20	13.36
MIC	11.08	6.36	32.96	7.52
UI	1.04	0.72	47.33	1.01
EP	3.01	1.59	27.98	1.74
GOT	5.86	5.09	75.56	9.11

Note: DFF-days to 50 per cent flowering , DFBB-days to first boll bursting, PH-plant height, NMON-number of monopodia per plant, NSYM-number of sympodia per plant, NOB-number of bolls per plant, NOL-number of locules per boll, BW-boll weight , NOS- number of seeds per boll, SCY-seed cotton yield per plant , SI-seed index , LI-lint index, UHML-upper half mean length, FS-fibre strength, MIC-fibre fineness , UI-uniformity index, and EP-elongation percentage, GOT-ginning out turn

with Rao *et al.* (2021), Gnanasekaran *et al.* (2020), Bhatti *et al.* (2020) and Manonmani *et al.* (2019). However, the smallest PCV and GCV values were found for days to 50 per cent flowering (7.89 %, 6.45 %), days to first boll bursting (5.16 %, 3.88 %), plant height (9.58 %, 8.62 %), the number of locules per boll (3.72 %, 2.29%), seed index (8.37 %, 7.13 %), upper half mean length (6.18 %, 4.50 %), fibre strength (7.79 %, 7.11 %), uniformity index (1.04 %, 0.72 %), elongation percentage (3.01 %, 1.59 %), and ginning out turn (5.86 %, 5.09 %). This suggests that there is less span for the improvement of these traits. The high heritability estimate coupled with high genetic advance as a per cent of mean was recorded for the number of monopodial branches per plant (89.27 %, 68.39 %), the number of sympodial branch per plant (62.18 %, 21.05 %), the number of bolls per plant (89.51 %, 52.10 %), boll weight (77.15 %, 21.33 %), the number of seeds per boll (72.85 %, 20.08 %), and seed cotton yield (93.15 %, 31.51 %) **(Table 6).** This indicates that heritability is due to additive gene action and hence direct selection will be profitable in these traits. Previous studies by Sahar *et al.* (2021), Abro *et al.* (2021), Nandhini *et al.* (2019), Nikhil *et al.* (2018) and Shao *et al.* (2016) documented similar results. Higher heritability with medium genetic advance was found for days to 50 per cent flowering (66.77 %, 10.85 %), plant height (80.90 %, 15.97 %), seed index (72.67 %, 12.53 %) and fibre strength (83.20 %, 13.36 %). High heritability (75.56 %) with a low response to selection (9.11 %) was observed for ginning out turn. This is indicative of non-additive gene action thus, heritability may be due to the influence of environment rather than genotype and selection for the such trait will not be rewarding. The traits *viz.,* days to first boll bursting (56.33 %, 5.99 %), the number of locules per boll (38.00 %, 2.91 %), fibre fineness (32.96 %, 7.52 %), and uniformity index (47.33 %, 1.01 %) had moderate heritability with low genetic advance as per cent of mean. Low heritability (27.98 %) with a low response to selection (1.74 %) was recorded for elongation percentage suggesting the environmental influence on the trait and selection is highly ineffective.

The present study concluded that hybrids performed superior to parents based on mean performance. The hybrids *viz.,* CO 14 X IC 359538, GISV 328 X IC 359538, MCU 5 X IC 359464, and IC 292130 X GISV 328 can be used for the attainment of better yield and fibre quality as these hybrids had maximum seed cotton yield along with higher boll weight and fibre quality. Considerable genetic variability has been observed for various yield attributing and fibre quality traits. High heritability and high genetic advance as per cent of the mean for economically important traits confirmed the predominance of genetic factors and effective selection at earlier generations for these traits is recommended for future crop improvement.

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