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Research Article

Combining ability analysis for yield and fibre quality traits in intraspecific hybrids of *Gossypium hirsutum* L.

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Abstract
Line x tester analysis was carried out involving six lines and 4 testers for seed cotton yield, yield contributing traits and fibre quality traits for estimation of combining ability effects of parents for sixteen characters. The analysis of combining ability revealed that the variance for SCA were larger than GCA except uniformity ratio which corresponds with non-additive gene action which can be improved by heterosis breeding. Based on the high *per se* performance and high gca effect, the parents C 10-8 and RAHC 1917 were considered as best general combiner for boll weight and single plant yield per plant. Regarding boll weight, TCH 1822 and C 10-8 were good general combiners with significantly high *per se* performance. These parents were found to be recorded as good general combiners for different characters. Hence, these can be used in recombination breeding to obtain more favorable gene recombinations for seed cotton yield. The cross TCH 1819 x RS 2821 showed a positive and significant sca effect for the number of bolls, boll weight and seed cotton yield. The cross Anjali x CPD 1501 showed a positive and significant sca effect for boll weight, lint index, seed index and seed cotton yield. The cross TCH 1926 x RS 2821 exhibited a positive significant sca for the number of bolls, 2.5 % span length and fibre strength. The non – additive gene action has played an important role in expression of seed cotton yield and its component traits which justify the heterosis breeding and its exploitation commercially.

Keywords
Cotton, *Gossypium hirsutum* L., Line x Tester, combining ability, gca, sca, seed cotton yield, fibre quality traits

INTRODUCTION

Cotton is one of the most important natural fibre crops. It occupies the place of pride in Indian economy by earning valuable foreign exchange. It provides employment opportunities to nearly 215 million people. The development of new variety with high yield and fibre quality is the primary objective of breeders. For developing potential hybrids in cotton, it is necessary to exploit the hybrid vigour available in cotton. Choice of parent for hybridization is the most important aspect, which depends not only on diversity of parents but also on combining ability. Combining ability provides information for the selection of parents as well as the nature and magnitude of gene action involved in the expression of traits. Line x tester analysis is useful technique suitable for identification of cross combination and parents to be used in crossing programme for hybrid breeding (Kempthorne, 1957). The primary objective of this study is to identify parents with better potential to transmit desirable characters to the progeny and the best combination of parent for future hybrid breeding programme. In addition, also to evaluate specific combining ability of crosses for yield and yield components with good fibre quality traits that can be used in breeding programmes of cotton.

MATERIALS AND METHODS

The experimental materials for the present investigation consisted of six lines namely TCH 1822, TCH 1819, TCH 1926, C 10-8, 343-1-1 and Anjali and four testers namely GSHV. 173, CPD 1501, RAHC 1017 and RS 2821. Crossing was effected in a line x tester fashion. Twenty four hybrids along with ten parents were raised during 2017-18 in a randomized block design with two

replications at Department of Cotton, Centre for Plant Breeding and Genetics, TNAU, Coimbatore. Parents and F1's were raised in two rows of 6 m length with a spacing of 90 x 60 cm between and within the rows. The data were recorded on five randomly selected parents in each replication on various component characters. The observations were recorded for 16 characters *viz*., days to first flowering, plant height (cm), the number of sympodial branches per plant, the number of monopodial branches per plant, the number of bolls per plant, boll weight (g), internode length (cm), seed index (g), lint index, seed cotton yield per plant (g), ginning percentage (%), 2.5% span length (mm), fibre/bundle strength (g/tex), fibre fineness (mv), uniformity ratio and elongation percentage (%). and mean values were used for statistical analysis.

RESULTS AND DISCUSSIONS

Analysis of variance for combining ability revealed significant variability among parents for all the characters. Variance due to lines was highly significant for the number of sympodia per plant, the number of bolls per plant, seed index, ginning out turn, single plant per plant, plant height, fibre strength and uniformity ratio. Variance due to testers was highly significant for the number of bolls per plant, seed index, ginning out turn, single plant per plant, plant height, fibre length, fibre strength and uniformity ratio. The variance due to interaction effects of lines and testers was significant for all the characters studied except boll weight, lint index and micronaire value. The results of the analysis of variance (mean squares) for combining ability for yield, yield components and fibre quality parameters were presented in **Table 1**. The variance due to SCA was higher in magnitude larger than GCA variance for all the characters except uniformity ratio. It is presumed that GCA variance reflects additive gene action and SCA variance corresponds with non- additive gene action which can be improved by heterosis breeding. The estimate of GCA and SCA variances was presented in **Table 1**. The results are in concordance with the finding of Punitha and Raveendran (1999), Saravanan *et al,* (2010), Shinde *et al,* (2018) Swetha *et al.* (2018) and Chinchane *et al.* (2018) for yield and quality characters.

Table 1. Analysis of variance for combining ability for different characters

Source of variance	Degrees of freedom	Days to 50 % flowering	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight (g)	Lint index	Seed index
Replication	1	1.333	65.333**	0.021	9.188**	-0.000	0.015	3.060	0.955
Cross	23	3.550**	423.098**	0.499	8.521**	28.040**	0.508	0.540	4.642**
Lines	5	8.383**	931.750**	0.221	14.971**	42.633**	0.821	0.328	5.497**
Testers	3	1.389	267.361**	0.576	2.688	18.633**	0.182	0.784	14.434**
Lines x Testers	15	2.372*	284.694**	0.576	7.538**	25.156**	0.469	0.561	2.400*
Parents	9	10.050**	1343.02**	1.089	20.450**	41.467*8	0.945	1.646	2.800*
Parents Vs Crosses	1	1.900	26.691**	4.735*	93.912**	1409.412**	0.028	2.805	0.000
Error	23	0.899	37.594	0.021	2.709	0.304	0.017	0.149	0.099
σ^2gca		0.05	5.24	-0.003	0.04	0.11	0.002	0	0.08
σ^2sca		0.74	123.55	0.28	2.41	12.43	0.23	0.21	1.15
σ^2gca/ σ^2sca		0.042	-0.011	0.017	0.009	0.009	0	0.07	0.035

Source of variance	Degrees of freedom	Ginning outturn %	Single plant yield per plant (g)	2.5 % span length (mm)	Fibre strength (g/ tex)	Micronaire value	Uniformity ratio	Elongation percentage
Replication	1	76.003**	11.496**	3.308	0.188	0.217	2.803	0.005
Genotypes	23	13.853**	1055.051**	8.397**	9.161**	0.560	5.917**	0.014
Lines	5	8.866**	447.544**	2.166	4.273**	0.653	10.833**	0.015
Testers	3	38.444**	3041.331**	18.561**	8.362**	0.064	10.858**	0.011
Lines x Testers	15	10.597**	860.270**	8.441**	10.951**	0.627	3.289**	0.014
Parents	9	13.136**	863.905**	8.986**	5.069**	0.585	11.750**	0.007
Parents Vs Crosses	1	36.628**	20474.988**	22.740**	48.972**	1.728	1.438	0.032
Error	23	3.699	3.366	2.811	4.218	0.145	3.318	0.011
σ^2gca		0.12	7.37	-0.001	-0.07	-0.002	0.1	0
σ^2sca		3.45	428.47	2.81	3.37	0.24	0.01	0.001
σ^2gca/ σ^2sca		0.017	0	-0.021	-0.008	-0.01	0	0.042

The *per se* performance was considered as the first important selection index in the choice of parents and the selection of suitable parents with high *per se* performance will result in superior hybrids (Gilbert, 1958). Information on the *per se* performance and nature of general combining ability (gca) of characters is necessary for the selection of suitable parents for developing hybrids. However, combining ability is a more dependable parameter used for selection of parents, which furnishes useful information of their hybrids when the characters are under the control of non additive genes. Therefore, the present study was aimed for their *per se* performance and gca effects. Among the lines, based on *per se,* parent TCH 1822 had recorded a positive and significant gca effect for the number of bolls per plant and boll weight. The parent TCH 1819 was a good combiner for plant height, the number of bolls per plant and single plant yield, while TCH 1926 was a good combiner for the number of sympodia per plant, ginning outurn and single plant yield per plant. These three parents *viz.,* TCH 1822, TCH 1819 and TCH 1926 were also found to be compact plant type and also suitable for high density plant system. C 10-8 exhibited a positive and significant gca effects for the number of sympodia per plants, boll weight, single plant yield per plant and micronaire value. Good general combiner for boll number was the female parent Anjali. Parent GSHV 173 exhibited a positive and significant gca for seed index and plant height and CPD 1501 recorded for lint index and seed index and RS 2821 for single plant yield per plant. The parent RAHC 1917 recorded a positive and significant gca effects for the number of bolls, boll weight, single plant per plant and 2.5 % span length. Thus, high gca effect in desirable selection indicates the presence of additive genes for that character in the parent. Rajamani *et al.* (2014), Bayyapu Reddy *et al.* (2017), Bilwal *et al.* (2018) also reported different parents with good general combining ability for seed cotton yield and yield attributing characters. These observations are in conformity with the findings obtained by Senthil kumar *et al.* (2013)

Identification of parents for breeding programme based on either *per se* performance or gca effects alone was misleading in the selection programme. Based on the high *per se* performance and high gca effect, the parents C 10-8 and RAHC 1917 were considered as good general combiner for boll weight and single plant yield per plant. Regarding boll weight, TCH 1822 and C 10-8 were good general combiners with significantly high *per se* performance than other parents selected. The parent Anjali for the number of bolls per plant and GSHV 173 and CPD 1501 for seed index and lint index respectively showed better expression for high *per se* and gca effects(**Table 2 & 3**). These parents were found to be recorded as good general combiners for different characters should be extensively used in hybridization programme.

The specific combining ability effects are usually used to identify the best cross combinations for hybrid production. In the present study, based on *per se* performance, the cross TCH 1822 x RAHC 1017 recorded a high *per se* for the number of bolls, boll weight and single plant yield.

Table 2. Mean performance of different characters in *Gossypium hirsutum* parents

Parents	Days to 50 % flowering	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight (g)	Lint index	Seed index
Lines								
TCH 1822	58.5	130	0.0	11.5	15.0	5.2	5.4	8.6
TCH 1819	57.5	102	0.0	11.5	17.5	4.1	5.8	9.3
TCH 1926	60.5	94	0.0	9.5	16.0	3.9	5.0	8.2
C 10-8	58.5	77.5	1.0	11.0	25.5	5.2	5.9	10.3
343-1-1	60.0	112.5	1.0	9.5	18.5	3.4	3.7	8.4
Anjali	54.5	99	2.0	12.5	25.5	4.5	6.7	11.0
Mean	**58.3**	**102.5**	**0.67**	**10.9**	**20.0**	**4.4**	**5.4**	**9.3**
SE	**0.47**	**3.07**	**0.07**	**0.82**	**0.28**	**0.06**	**0.19**	**0.16**
CD (5%)	**0.98**	**6.35**	**0.15**	**1.70**	**0.57**	**0.13**	**0.40**	**0.33**
Testers								
GSHV 173	58.5	160	2.0	17.5	23.5	5.1	6.5	11.8
CPD 1501	54.5	112.5	1.0	14/5	20.0	4.1	6.0	10.3
RAHC 1917	54.5	121.5	1.0	15.5	23.0	5.4	5.5	9.6
RS 2821	57.5	153.5	1.0	18.5	28.5	5.1	4.6	9.1
Mean	**56.3**	**136.9**	**1.3**	**16.5**	**24.0**	**4.9**	**5.7**	**10.2**
SE	**0.39**	**2.50**	**0.06**	**0.67**	**0.23**	**0.05**	**0.16**	**0.13**
CD (5%)	**0.80**	**5.18**	**0.12**	**1.40**	**0.47**	**0.11**	**0.33**	**0.27**

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Parents	Ginning outturn %	Single plant yield per plant (g)	2.5 % span length (mm)	Fibre strength (g/ tex)	Micronaire value	Uniformity ratio	Elongation percentage
Lines							
TCH 1822	38.7	57.5	26.4	22.2	4.8	52.5	5.9
TCH 1819	38.6	55.9	26.3	21.5	4.3	51.5	5.9
TCH 1926	37.7	64.6	26.9	20.6	4.8	49.1	5.8
C 10-8	36.4	91.6	27.8	22.3	4.5	50.1	5.9
343-1-1	30.3	54.7	29.6	23.5	4.4	47.6	5.9
Anjali	37.8	89.3	30.0	23.4	4.1	46.2	6.0
Mean	**36.6**	**68.9**	**27.8**	**22.2**	**4.7**	**49.5**	**5.9**
SE	**0.96**	**0.92**	**0.84**	**1.03**	**0.19**	**0.91**	**0.05**
CD (5%)	**2.00**	**1.90**	**1.74**	**2.13**	**0.40**	**1.89**	**0.11**
Testers							
GSHV 173	35.6	45.1	32.3	24.5	4.7	45.3	5.9
CPD 1501	36.8	92.1	28.4	21.6	4.1	47.2	5.8
RAHC 1917	36.5	107.3	26.1	21.3	4.7	51.1	5.8
RS 2821	33.6	68.4	25.6	18.9	3.3	47.5	5.9
Mean	**34.6**	**78.2**	**28.1**	**21.6**	**4.2**	**47.8**	**5.8**
SE	**0.79**	**0.75**	**0.69**	**0.84**	**0.16**	**0.74**	**0.04**
CD (5%)	**1.63**	**1.55**	**1.41**	**1.74**	**0.32**	**1.54**	**0.09**

The cross TCH 1926 x RS 2821 recorded a high *per se* for fibre strength, ginning out turn and single plant yield. The cross C 10-8 x RAHC 1017 recorded high *per se* for 2.5 % span length, boll weight and single plant yield. The cross Anjali x CPD 1501 recorded a high *per se* for boll weight and lint index. The two crosses TCH 1819 x RAHC 1017 and Anjali x RS 2821 recorded high *per se* for the number of bolls and single plant yield. The cross 343-1-1 x RAHC 1017 recorded a high *per se* for seed index and single plant yield. The crosses TCH 1819 x GSHV 173 and C-10-8 x GSHV 173 recorded high *per se* for seed index. Hence based on yield and component characters, the

Table 3. Estimates of general combining ability (GCA) for lines and testers

Parents	Days to 50 % flowering	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight (g)	Lint index	Seed index
Lines								
TCH 1822	0.29	-9.13**	-0.23**	-0.98	1.21**	0.17**	-0.13	-0.61**
TCH 1819	-0.83*	12.75**	-0.10	-0.85	0.96**	0.08	-0.18	-0.40**
TCH 1926	1.67**	-7.00**	0.27	1.52*	-2.04**	-0.38**	-0.22	-1.05**
C 10-8	-0.83*	-12.63**	0.02	1.40*	-1.42**	0.51**	0.27	1.06**
343-1-1	-0.83	8.25**	0.02	0.65	-2.29**	-0.25**	0.11	0.23
Anjali	0.54	7.75**	0.02	-1.73**	3.58**	-0.13	0.14	0.78
SE (gca for lines)	0.34	2.17	0.05	0.58	0.19	0.04	0.14	0.11
SE (Between gca lines)	0.47	3.07	0.07	0.82	0.28	0.06	0.19	0.16
Testers								
GSHV 173	-0.00	4.96*	0.19	-0.15	0.13	-0.05	-0.04	0.78**
CPD 1501	0.42	-4.71*	0.02	-0.40	-0.46**	0.10*	0.36**	1.04**
RAHC 1917	-0.42	-3.29	0.10*	-0.15	1.63**	0.10*	-0.07	-0.54**
RS 2821	-0.00	3.04	-0.31**	0.69	-1.29**	-0.15**	-0.25*	-1.28**
SE (gca for testers)	0.27	1.77	0.04	0.47	0.16	0.04	0.11	0.10
SE (Between gca of testers)	0.39	2.50	0.06	0.67	0.22	0.05	0.16	0.13

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Parents	Ginning outturn %	Single plant yield per plant (g)	2.5 % span length (mm)	Fibre strength (g/tex)	Micronaire value	Uniformity ratio	Elongation percentage
Lines							
TCH 1822	0.80	-7.51**	-0.37	0.22	-0.23	0.37	0.04
TCH 1819	0.22	10.03**	-0.63	-1.14	0.11	-0.61	-0.05
TCH 1926	1.46*	5.29**	-0.28	0.94	0.16	2.04**	0.04
C 10-8	-1.07	4.33**	0.78	-0.27	-0.17	-1.41*	-0.06
343-1-1	-0.16	-4.96**	0.32	-0.29	0.44**	-0.33	0.01
Anjali	-1.24	-7.18**	0.17	0.54	-0.30*	-0.06	0.01
SE (gca for lines)	0.68	0.65	0.60	0.73	0.13	0.64	0.04
SE (Between gca of lines)	0.96	0.92	0.84	1.03	0.19	0.91	0.05
Testers							
GSHV 173	-2.04**	-17.77**	0.10	0.39	-0.11	0.02	0.03
CPD 1501	-0.78	-2.62**	-0.04	0.03	0.04	0.08	-0.01
RAHC 1917	0.76	20.91**	1.49**	0.75	0.01	-1.21*	0.02
RS 2821	2.07**	-0.52	-1.55	-1.17	0.05	1.11*	-0.04
SE (gca for testers)	0.56	0.53	0.48	0.59	0.11	0.52	0.03
SE (Between gca of testers)	0.79	0.75	0.68	0.84	0.16	0.74	0.04

Table 4. Mean performance of different characters in Gossypium hirsutum hybrids

Hybrids	Days to 50 % flowering	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight (g)	Lint index	Seed index
TCH 1822 x GSHV 173	58	125.0	2.0	14.5	33.5	5.02	5.2	9.7
TCH 1822 x CPD 1501	57	88.0	1.0	14.0	36.0	5.27	5.6	10.3
TCH 1822 x RAHC 1017	57	113.0	1.0	14.0	32.5	4.03	4.5	8.7
TCH 1822 x RS 2821	58	108.0	1.0	16.5	28.0	4.92	4.5	7.5
TCH 1819 x GSHV 173	57	128.0	1.0	15.5	27.0	4.63	5.8	12.2
TCH 1819 x CPD 1501	56	118.0	2.0	13.5	31.5	4.27	5.1	9.2
TCH 1819 x RAHC 1017	57	138.0	1.5	14.5	36.5	4.94	4.4	8.1
TCH 1819 x RS 2821	57	137.5	1.0	16.0	34.0	5.05	4.2	7.5
TCH 1926 x GSHV 173	59	102.5	2.0	21.5	32.0	4.39	4.3	9.0
TCH 1926 x CPD 1501	60	115.0	1.0	17.0	30.0	4.63	5.2	8.8
TCH 1926 x RAHC 1017	59	117.5	2.0	16.0	26.0	4.16	5.1	9.2
TCH 1926 x RS 2821	58	107.5	2.0	14.5	29.0	3.89	4.8	7.4
C 10-8 x GSHV 173	57	112.5	2.0	16.5	34.0	5.27	5.2	11.6
C 10-8 x CPD 1501	58	97.5	2.0	16.0	26.0	5.34	4.8	12.3
C 10-8 x RAHC 1017	56	92.5	1.0	18.0	31.5	5.37	5.8	10.4
C 10-8 x RS 2821	55	117.5	1.0	18.0	28.0	4.63	5.5	8.5
343-1-1 x GSHV 173	55	135.0	1.0	13.0	32.0	4.52	4.9	10.2
343-1-1 x CPD 1501	57	122.5	2.0	18.0	27.0	3.92	5.6	11.2
343-1-1 x RAHC 1017	57	125.0	2.0	17.0	31.0	5.09	5.4	9.7
343-1-1 x RS 2821	58	121.0	1.0	17.5	26.0	4.02	4.8	8.4
Anjali x GSHV 173	58	132.5	2.0	12.5	30.0	3.72	4.8	9.9
Anjali x CPD 1501	59	136.5	1.0	13.5	34.5	5.02	6.2	12.4
Anjali x RAHC 1017	56	100.0	2.0	14.0	40.0	4.89	4.7	8.5
Anjali x RS 2821	58	132.5	1.0	16.0	35.0	4.44	5.0	10.9
Mean	57.1	117.6	1.5	15.7	31.3	4.6	5.1	9.6
SE	0.95	6.13	0.14	1.65	0.55	0.13	0.39	0.31
CD (5%)	1.96	12.69	0.30	3.41	1.14	0.27	0.80	0.65

Table 5. Mean performance of different characters in *Gossypium hirsutum* hybrids

Hybrids	Ginning outturn %	Single plant yield per plant (g)	2.5 % span length (mm)	Fibre strength (g/tex)	Micronaire value	Uniformity ratio	Elongation percentage
TCH 1822 x GSHV 173	34.8	73.1	28.9	24.3	4.0	48.7	6.0
TCH 1822 x CPD 1501	35.3	74.7	30.7	26.7	3.9	48.7	6.0
TCH 1822 x RAHC 1017	33.8	154.6	28.4	22.9	3.7	47.0	5.9
TCH 1822 x RS 2821	37.7	110.5	27.3	22.3	4.1	51.1	5.9
TCH 1819 x GSHV 173	32.2	95.2	29.7	24.7	4.1	48.0	5.9
TCH 1819 x CPD 1501	35.6	125.1	29.8	23.3	5.0	47.2	6.0
TCH 1819 x RAHC 1017	35.3	136.2	28.5	21.5	4.0	46.6	5.8
TCH 1819 x RS 2821	36.1	126.5	26.3	21.3	3.8	49.7	5.8
TCH 1926 x GSHV 173	32.4	90.9	29.4	24.1	4.2	49.3	6.0
TCH 1926 x CPD 1501	37.1	103.9	24.7	20.5	4.7	54.0	5.8
TCH 1926 x RAHC 1017	35.5	131.1	31.0	26.8	4.3	48.8	6.1
TCH 1926 x RS 2821	39.3	138.1	30.6	27.7	3.9	50.0	6.0
C 10-8 x GSHV 173	30.9	121.6	30.9	24.7	4.0	47.7	5.9
C 10-8 x CPD 1501	28.1	129.8	30.1	24.3	3.2	46.8	5.8
C 10-8 x RAHC 1017	35.8	116.0	32.5	24.8	4.3	45.6	5.9
C 10-8 x RS 2821	39.2	92.8	26.5	20.4	4.3	48.3	5.8
343-1-1 x GSHV 173	32.2	83.9	27.6	21.4	4.3	47.9	5.9
343-1-1 x CPD 1501	33.4	110.6	29.0	23.6	4.6	47.6	5.9
343-1-1 x RAHC 1017	35.9	149.8	31.8	25.2	5.3	48.3	6.0
343-1-1 x RS 2821	36.2	78.7	29.7	24.0	4.1	48.8	6.0
Anjali x GSHV 173	32.7	92.0	29.3	26.1	3.5	49.5	6.0
Anjali x CPD 1501	33.4	104.6	30.7	24.8	3.6	47.1	6.0
Anjali x RAHC 1017	35.8	102.1	31.9	26.3	3.2	47.4	6.0
Anjali x RS 2821	31.5	114.6	25.5	20.3	4.9	49.8	5.8
Mean	34.6	110.7	29.2	23.8	4.1	48.5	5.9
SE	1.92	1.83	1.68	2.05	0.38	1.82	0.11
CD (5%)	3.98	3.80	3.47	4.25	0.79	3.77	0.22

Table 6. Estimates of specific combining ability (SCA) of crosses for different characters

Hybrids	Days to 50 % flowering	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight (g)	Lint index	Seed index
TCH 1822 x GSHV 173	0.63	11.54*	0.56**	-0.10	0.87*	0.26**	0.26	-0.16
TCH 1822 x CPD 1501	-0.79	-15.79**	-0.27*	-0.35	3.96**	0.36**	0.31	0.21
TCH 1822 x RAHC 1017	-0.46	7.79	-0.35**	-0.60	-1.63**	-0.88**	-0.42	0.22
TCH 1822 x RS 2821	0.63	-3.54	0.06	1.06	-3.21**	0.26**	-0.14	-0.27
TCH 1819 x GSHV 173	0.25	-7.33	-0.56**	0.77	-5.38**	-0.04	0.97**	2.19**
TCH 1819 x CPD 1501	-1.17	-7.67	0.60**	-0.98	-0.29	-0.55**	-0.16	-1.09**
TCH 1819 x RAHC 1017	0.67	10.92*	0.02	-0.23	2.63**	0.12	-0.38	-0.59*
TCH 1819 x RS 2821	0.25	4.08	-0.06	0.44	3.04**	0.48**	-0.43	-0.51*
TCH 1926 x GSHV 173	0.25	-13.08**	0.06	4.40**	2.63**	0.18	-0.52	-0.42
TCH 1926 x CPD 1501	0.83	9.08*	-0.77**	0.15	1.21**	0.26**	0.01	-0.82**
TCH 1926 x RAHC 1017	0.17	10.17*	0.15	-1.10	-4.88**	-0.22*	0.30	1.13**
TCH 1926 x RS 2821	-1.25	-6.17	0.56**	-3.44**	1.04*	-0.22*	0.21	0.10
C 10-8 x GSHV 173	0.75	2.54	0.31**	-0.48	4.00**	0.16	-0.12	0.09
C 10-8 x CPD 1501	0.83	-2.79	0.48**	-0.73	-3.42**	0.09	-0.88**	0.53*
C 10-8 x RAHC 1017	0.17	-9.21*	-0.60**	1.02	-0.00	0.12	0.55	0.27
C 10-8 x RS 2821	-1.75*	9.46*	-0.19**	0.19	-0.58	-0.37**	0.44	-0.89**
343-1-1 x GSHV 173	-1.75*	4.17	-0.69**	-3.23*	2.88**	0.18	-0.26	-0.42
343-1-1 x CPD 1501	-0.17	1.33	0.48**	2.02	-1.54**	-0.56**	0.07	0.24
343-1-1 x RAHC 1017	0.67	2.42	0.40**	0.77	0.38	0.60**	0.33	0.36
343-1-1 x RS 2821	1.25	-7.92	-0.19	0.44	-1.71**	-0.21*	-0.14	-0.19
Anjali x GSHV 173	-0.13	2.17	0.31**	-1.35	-5.00**	-0.74**	-0.33	-1.29**
Anjali x CPD 1501	0.46	15.83**	-0.52**	-0.10	0.08	0.40**	0.65*	0.93**
Anjali x RAHC 1017	-1.21	-22.08**	0.40**	0.15	3.50**	0.27**	-0.38	-1.39**
Anjali x RS 2821	0.88	4.08	-0.19	1.31	1.42**	0.07	0.07	1.75**
SE (SCA effects)	0.67	4.34	0.10	1.16	0.39	0.09	0.27	0.22
SE(Between SCA effects)	0.95	6.13	0.14	1.65	0.55	0.13	0.39	0.31

Table 7. Estimates of specific combining ability (SCA) of crosses for different characters

Hybrids	Ginning outturn %	Single plant yield per plant (g)	2.5 % span length (mm)	Fibre strength (g/ tex)	Micronaire value	Uniformity ratio	Elongation percentage
TCH 1822 x GSHV 173	1.47	-.12.33**	-0.02	-0.08	0.18	-0.21	0.04
TCH 1822 x CPD 1501	0.65	-25.91**	1.87	2.63	-0.07	-0.27	0.07
TCH 1822 x RAHC 1017	-2.35	20.47**	-1.90	-1.94	-0.24	-0.62	-0.11
TCH 1822 x RS 2821	0.22	7.76**	0.04	-0.62	0.14	1.10	0.00
TCH 1819 x GSHV 173	-0.54	-7.80**	1.05	1.59	-0.00	0.12	0.02
TCH 1819 x CPD 1501	1.59	6.98**	1.24	0.55	0.74*	-0.74	0.11
TCH 1819 x RAHC 1017	-0.24	-5.46**	-1.54	-1.93	-0.23	-0.10	-0.12
TCH 1819 x RS 2821	-0.81	6.28**	-0.75	-0.20	-0.50	0.73	-0.01
TCH 1926 x GSHV 173	-1.64	-7.29**	0.40	-1.04	0.04	-1.23	-0.01
TCH 1926 x CPD 1501	1.81	-9.25**	-4.21**	-4.33**	0.42	3.36*	-0.13
TCH 1926 x RAHC 1017	-1.32	-5.82**	0.56	1.30	0.01	-0.50	0.09
TCH 1926 x RS 2821	1.15	22.62**	3.25*	4.07*	-0.46	-1.63	0.05
C 10-8 x GSHV 173	-0.56	24.36**	0.78	0.73	0.18	0.57	0.04
C 10-8 x CPD 1501	-4.60**	17.33**	0.17	0.73	-0.79**	-0.34	-0.03
C 10-8 x RAHC 1017	1.50	-19.96**	1.00	0.51	0.31	-0.30	0.04
C 10-8 x RS 2821	3.67*	-21.73**	-1.96	-1.97	0.30	0.07	-0.05
343-1-1 x GSHV 173	-0.15	-4.07**	-2.05	-2.51	-0.18	-0.26	-0.09
343-1-1 x CPD 1501	-0.25	7.47**	-0.46	0.05	-0.05	-0.62	-0.06
343-1-1 x RAHC 1017	0.73	23.12**	0.81	0.87	0.76**	1.38	0.07
343-1-1 x RS 2821	-0.32	-26.51**	1.70	1.60	-0.53	-0.50	0.08
Anjali x GSHV 173	1.43	7.13**	-0.15	1.31	-0.22	1.02	0.01
Anjali x CPD 1501	0.80	3.64**	1.39	0.37	-0.24	-1.39	0.04
Anjali x RAHC 1017	1.68	-22.36**	1.06	1.20	-0.61*	0.15	0.02
Anjali x RS 2821	-3.91**	11.59**	-2.30	-2.88	1.06**	0.23	-0.07
SE(SCA effects)	1.36	1.30	1.19	1.45	0.27	1.29	0.75
SE (Between SCA effects)	1.92	1.83	1.68	2.05	0.38	1.82	0.11

crosses TCH 1822 x RAHC 1017, TCH 1926 x RS 2821, C 10-8 x RAHC 1017, Anjali x CPD 1501, TCH 1819 x RAHC 1017, Anjali x RS 2821 and 343-1-1 x RAHC 1017 were considered as desirable crosses (**Table 4 & 5**).

Among twenty four hybrids, the following twelve hybrids, TCH 1822 x RAHC 1017, TCH 1822 x RS 2821, TCH 1819 x CPD 1501, TCH 1819 x RS 2821, TCH 1926 x RS 2821, C 10-8 x GSHV 173, C 10-8 x CPD 1501, 343-3-1-1 x CPD 1501, 343-3-1-1 x RAHC 1017, Anjali x GSHV 173, Anjali x CPD 1501 and Anjali x RS 2821 showed positive and significant sca effect for seed cotton yield. Similar findings was reported by Dhamayanthi (2011), Bayyapu Reddy (2017). Out of these, Anjali x GSHV 173 ranked first for seed cotton yield per plant. Among the twelve hybrids, the cross combination TCH 1822 x RAHC 1017 was found to be compact plant type, one of the parent RAHC 1017 of this hybrid were also possess high sca for seed cotton yield per plant. The cross TCH 1819 x RS 2821 showed a positive and significant sca effect for the number of bolls, boll weight and seed cotton yield. The cross Anjali x CPD 1501 showed a positive and significant sca effect for boll weight, lint index, seed index and seed cotton yield (**Table 6 & 7**). These observations are in conformity with the findings obtained by Saravanan *et al.* (2010), Senthil kumar *et al.* (2013), Kumar *et al.* (2014) and Bayyapu Reddy (2017). The cross TCH 1926 x RS 2821 exhibited a positive significant sca for the number of bolls, 2.5 % span length and fibre strength, however both parents of this hybrid were not good general combiners for fibre quality traits, hence the influence of epistatic mechanism should have contributed to the positive expression and the cross should be followed up for deriving useful lines. The specific combining ability effect alone may not be the appropriate choice for exploitation of heterosis, because the hybrid with low mean value may also possess high sca effect. Hence, the cross having significant sca effects should be tested across the years and locations prior to recommendation for commercial exploitation.

REFERENCE

Bayyapu Reddy, K., Chenga Reddy, V., Lal Ahmed, M., Naidu,T.C.M., and Srinivasarao, V. 2017. Combining ability analysis for seed cotton yield and quality traits in upland cotton. (*Gossypium hirsutum* L.). *Electronic Journal of Plant Breeding,* **8**(1): 142-152. [Cross Ref]

Bilwal, B.B., Vadodariya, K.V., Rajkumar, B.K., Lahane, G.R., Shihare, N.D. 2018. Combining ability analysis for seed cotton yield and its component traits in cotton. (*Gossypium hirsutum* L.). *Int.J.Curr. Microbiol.App. Sci.* **7**(7): 3005-3010. [Cross Ref]

Chinchane, V.N., K.Duomani and H.V. Kalpande. 2018. Combining ability studies for yield and its components in desi cotton. *Journal of Pharmacognosy and Phytochemistry.* **7**(5):3406-3408. [Cross Ref]

Dhamayanthi KPM. 2011. Study of interspecific hybrids (*Gossypium hirsutum* x *Gossypium barbadense*) for heterosis and combining ability. World Cotton Research Conference-5., Mumbai, India, 2011, 51-55.

Kempthorne O. An introduction to Genetic Statistics New York, John Wiley and Sons, 1st Edn. 1957, 456-471.

Kumar K.S., Ashok Kumar K., Ravikesavan R. 2014. Genetic effects for combining ability studies for yield and fibre quality traits in diallel crosses of (*Gossypium hirsutum* L.). *Academic Journals.* **13**(1): 119-126. [Cross Ref]

Punitha, D., T.S.Raveendaran and M.Kavitha. 1999. Combining ability for seed cotton yield and quality traits in interspecific coloured linted cotton (*Gossypium hirsutum* x *Gossypium barbadense*). *PKV Res.J.*, **23**;14-16.

Rajamani, S., Gopinath, M. and Reddy, K.H.P. 2014. Combining ability for seed cotton yield and fibre characters in upland cotton (*Gossypium hirsutum* L.). *J.Cotton.Res.Dev.*, **28**(2):207-210.

Saravanan, N.A., Ravikesavan, R., and Raveendran, T.S. 2010. Combining ability for seed cotton yield and fibre quality parameters in intraspecific hybrids of *Gossypium hirsutum* L. *Electronic Journal of Plant Breeding,* **1**(4): 856-863.

Senthil Kumar, K., Ashok Kumar, K. and Ravikeasavan, R. 2013.Genetic effects of combining ability studies for yield and fibre quality traits in diallel crosses of upland cotton (*Gossypium hirsutum* L.). *African J. Biotech.,* **13**(1):119-126. [Cross Ref]

Shinde, A.V., D.B. Deosarkar, BR Chavan, V.N. Chinchane and A.S.Kalambe. 2018. Combining ability studies for yield and its components in desi cotton (*Gossypium arboreum* L.). *Journal of Pharmacognosy and Phytochemistry.* **7**(5):435-438.

Swetha, S.,Nidagundi, J.M., Diwan, J.R., Lokesha, R., Hosmani, A.C.and Asifn Hadimani. 2018. Combining ability studies in cotton (*Gossypium barbadense* L.). *Journal of Pharmacognosy and Phytochemistry*. **7**(1):638-642.