Int.J.Curr.Microbiol.App.Sci (2018) *7*(10): 1357-1370

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 10 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.710.151

Combining Ability Studies for Yield, its Component Traits and Fibre Properties through Line X Tester Mating Design in Upland Cotton (*Gossypium hirsutum* L.)

H.B. Kumbhalkar[1*], V.L. Gawande[2], Vinita Gotmare[3] and T.H. Rathod[4]

[1]*Department of Agricultural Botany, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444104, Maharashtra, India*
[2]*Agriculture Botany Section, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444104, Maharashtra, India*
[3]*Division of Crop Improvement, ICAR-Central Institute for Cotton Research, Nagpur, India*
[4]*Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444104, Maharashtra, India*

**Corresponding author*

A B S T R A C T

The experiment was undertaken to assess the magnitude of combining ability for yield, its components and fibre properties in upland cotton. The experimental material i.e. 52 genotypes (15 parents, 36 crosses and 1 check) produced from line x tester mating design were evaluated for fifteen characters in randomized block design with three replications across 3 environments at *viz.*, Cotton Research Unit, Dr. PDKV, Akola, Regional Research Centre, Amravati and ICAR-Central Institute for Cotton Research, Nagpur during *kharif*, 2017-18. Analysis of variance revealed that there was presence of substantial genetic variability for all the studied characters at all 3 environments. The pooled analysis, showed highly significant differences for all the characters indicating the validity of conduct of experiment in these environments. Further, there was significant G x E interaction for all the traits studied. The parents *viz.*, DHY 286, AKH 9916 and AKH 10-5 were the best general combiners over 3 environments for seed cotton yield and its components. Among the hybrids, AKH 081 x AKH 09-5, AKH 8828 x AKH 2006-2, AKH 8828 x AKH 9916 were the best combinations based on higher and significant sca effects with highest standard heterosis and *per se* performance over the environments. These hybrids were also found promising for other yield contributing and fibre quality traits, hence, can be exploited for heterosis breeding. Whereas, the hybrid, AKH 8828 x DHY 286 may be exploited for development of varieties through transgressive segregation due to its non-significant sca and involving parents with high gca.

Keywords

Combining ability, line x tester, G x E, Seed cotton yield, gca and sca effects

Article Info

Accepted:
12 September 2018
Available Online:
10 October 2018

Introduction

Cotton (*Gossypium spp*.) the white gold is the world's leading natural textile fibre and also known as "King of fibres" is one of the best gifts that nature bestowed on mankind. Cotton contributes to 35.0 *per cent* of the global fabric needs and 60.0 *per cent* clothing in

India. Cotton is cultivated by about 80 countries in the world. In India, cotton occupies 122.35 lakh hectare area with the production of 377 lakh lint bales and productivity 524 kg lint/hectare (Anonymous, 2017). In cotton, now the yield levels have reached a plateau. So, the increased productivity of cotton could be achieved in developing countries like India by adopting hybrid cotton cultivars and exploitation of hybrid vigour and selection of parents on the basis of combining ability effects have opened a new line of approach in crop improvement. Application of biometrical techniques like line x tester analysis has appeared to be the best and vastly useful breeding tool, which gives generalized picture of genetics of the characters under study. Combining ability analysis provides the information for selection of the desirable parents and cross combinations for its exploitation (Sprague and Tatum, 1942).

Information on relative importance of general and specific combining ability is of value in the development of efficient breeding programme in species, which are amenable to commercial production of F_1 seed such as cotton. Besides its use in selection of parents, it indicates the nature and magnitude of various types of gene action involved in the expression of quantitative characters. Such information is of potential use in formulating and executing an efficient breeding programme for achieving maximum genetic gain with minimum resources and time.

Study of gene action involved is very crucial for choosing of best parents and crosses for cotton yield improvement and has been reported by many researchers *viz.,* Pavasia *et al.,* (1999), Palve (2009), Karademir *et al.,* (2009) and Babu *et al.,* (2017). Hence, the present investigation was undertaken to assess the combining ability of parents and crosses over the environments for yield potential, its components traits and fibre properties and to identify the best suitable parents and cross combinations which can be utilized for exploitation of heterosis in upland cotton.

Materials and Methods

In the present study, fifteen parents, among which three lines *viz.*, AKH 84635, AKH 8828 and AKH 081 and twelve testers *viz.*, AKH 10-2, AKH 10-5, AKH 10-10, AKH 11-7, AKH 2006-2, AKH 2012-8, AKH 2012-9, AKH 09-5, AKH 976, AKH 9916, DHY 286 and SURAJ were selected for crossing. Each of the line was crossed with all the twelve testers individually in a line x tester mating design (Kempthorne, 1957) to develop 36 hybrids during *kharif*, 2016 at Cotton Research Unit, Dr. PDKV, Akola. The 15 parents and the 36 hybrids along with 1 check (PKV Hy 2) were evaluated for combining ability in randomized block design with three replications across 3 environments *viz.*, at Cotton Research Unit, Dr. PDKV, Akola, Regional Research Centre, Amravati and ICAR-Central Institute for Cotton Research, Nagpur during *kharif*, 2017-18. The spacing of 60 cm between row to row and 60 cm between plants to plant was adopted for all the three environments.

The observations on five randomly selected plants in each genotype from three replications were recorded for days to 50 % flowering, plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, seed index, ginning percentage, seed cotton yield per plant, lint index, 2.5 % span length, fibre strength, fibre fineness, uniformity index and elongation percentage. The mean sum of squares from line x tester mating design and the general combining ability (gca) and specific combining ability (sca) effects were calculated according to the procedure developed by Kempthorne (1957).

Results and Discussion

The mean sum of squares due to different sources of variation were estimated over the three environments and presented as a pooled analysis of variance for combining ability in Table 1.

Significant differences were found among the environments and crosses for all the traits indicating sufficient variability among environments and crosses, respectively. Mean sum of squares due to males were non-significant for all the characters, except number of monopodia/plant, which indicates less variability for general combining ability amongst the males studied. Mean sum of squares due to females were also found non-significant for most of the characters. It was found significant for characters *viz.,* days to 50% flowering, plant height and number of monopodia/plant indicating substantial genetic variability for general combining ability among females for concerned traits.

Mean sum of squares due to males x females interaction were significant for all the characters under study which indicated genetic variability among the crosses for specific combining ability. The variance due to environments x crosses interaction was found to be significant for all the characters under study indicating considerable amount of interaction between the crosses and environments. The environments x males interaction were significant only for one character i.e. number of monopodia/plant indicating significant environment x male variance for this trait only and considerable amount of interaction between environments and general combining ability among males. The environments x females interaction were found to be non- significant for all the characters under study, which indicates negligible interaction between environments and general combining ability among females.

Environments x males x females interaction was also found to be significant for all the characters which indicated variability for specific combining ability among the crosses to the environments for these traits. Tuteja *et al.,* (2006), Shinde *et al.,* (2009), Singh *et al.,* (2014), Patil *et al.,* (2017) and Patil *et al.,* (2018) also reported significant variation for genotypes and genotypes x environments interaction over the environments. Among female parents, none of the parents exhibited significant gca effects over the environments for seed cotton yield. However, AKH 081 exhibited significant and desirable gca effects for days to 50 % flowering, seed index, lint index, 2.5 % span length, fibre strength and fibre fineness while, AKH 8828 recorded gca effects for plant height, number of bolls/plant, seed index and elongation percentage (Table 2).

Among male parents, DHY 286 (9.59) could exhibit significantly high gca effects for seed cotton yield, its related traits and fibre properties. It showed significant and desirable gca effects for seed cotton yield/plant, number of bolls/plant, seed index, fibre strength and elongation percentage. Similarly, the parent AKH 9916 (9.43) also exhibited significant gca effect for seed cotton yield/plant, ginning percentage and fibre strength. Similarly, the parent AKH 10-5 (9.35) exhibited significant and desirable gca effects for seed cotton yield and elongation percentage.

In the present study, among 15 studied parents, 3 parents *viz.,* DHY 286, AKH 9916 and AKH 081 were found to be the good general combiners besides high mean *per se* for seed cotton yield and other yield contributing traits (Table 2). Parent AKH 9916 exhibited high mean performance for seed cotton yield, number of bolls/plant and elongation percentage with highly significant gca effect for seed cotton yield/plant, ginning percentage and fibre strength.

Table.1 Pooled analysis of variance for combining ability over the three environments

Sources of variation	d.f.	Mean sum of squares								
		Days to 50 % flowering	Plant height	Number of monopodia	Number of sympodia	Number of bolls/plant	Boll weight	Seed index	Ginning percentage	Seed cotton yield/plant
Environments	2	212.74**	4044.51**	3.21**	194.27**	24676.46**	5.99**	17.51**	175.19**	263074.14**
Crosses	35	30.02**	211.50**	0.58**	7.99**	118.59**	0.75**	3.33**	32.23**	1749.83**
Females	2	101.97*	1164.58**	1.67*	3.79	274.41	0.05	4.49	5.21	236.17
Males	11	22.73	119.58	0.89*	11.65	106.50	0.71	5.13	41.39	1078.80
Males x females	22	27.13**	170.82**	0.32**	6.53**	110.47**	0.84**	2.33**	30.10**	2222.96**
Environments x crosses	70	13.92**	105.58**	0.26**	4.60**	70.34**	0.34**	1.20**	10.75**	1187.45**
Environments x females	4	3.32	155.79	0.22	2.28	38.58	0.21	2.41	24.84	776.55
Environments x males	22	17.47	107.31	0.41*	5.28	81.98	0.42	0.89	8.28	1280.73
Environments x males x females	44	13.10**	100.15**	0.18	4.47**	67.40**	0.31**	1.25**	10.71**	1178.16**
Error	210	4.46	49.31	0.16	2.45	26.62	0.08	0.27	1.84	224.70

Sources of variation	d.f.	Mean sum of squares					
		Lint index	2.5 % span length	Fibre strength	Fibre fineness	Uniformity index	Elongation percentage
Environments	2	3.19**	90.95**	817.42**	35.17**	122.60**	15.87**
Crosses	35	2.32**	11.73**	20.65**	0.63**	7.44**	0.85**
Females	2	1.35	30.95	42.88	1.13	1.06	0.44
Males	11	3.04	12.34	16.24	0.82	9.38	0.75
Males x females	22	2.05**	9.68**	20.84**	0.50**	7.05**	0.94**
Environments x crosses	70	0.57**	4.84**	7.40**	0.49**	5.15**	0.90**
Environments x females	4	0.47	9.29	6.25	0.48	3.63	1.54
Environments x males	22	0.68	4.39	3.94	0.65	6.17	0.62
Environments x males x females	44	0.53**	4.67**	9.23**	0.41*	4.78**	0.99**
Error	210	0.12	0.10	0.25	0.01	0.75	0.01

*****- Significant at 5 % level of significance ******- Significant at 1 % level of significance

Table.2 General combining ability effects of the parents for different characters over the three environments

Sr. No.	Genotypes	Days to 50 % flowering	Plant height	Number of monopodia	Number of sympodia	Number of bolls /plant	Boll weight	Seed index	Ginning percentage	Seed cotton yield/plant
	Females									
1	AKH 84635	0.707**	0.417	-0.140**	0.013	-0.010	0.008	0.055	-0.248	1.289
2	AKH 8828	0.401*	3.056**	0.097*	0.181	1.599**	0.017	-0.226**	0.077	0.325
3	AKH 081	-1.108**	-3.472**	0.043	-0.194	-1.589**	-0.025	0.171**	0.171	1.614
	SE(gi)±	**0.203**	**0.676**	**0.039**	**0.151**	**0.497**	**0.027**	**0.050**	**0.131**	**1.442**
	CD (5%)	**0.401**	**1.332**	**0.077**	**0.297**	**0.979**	**0.054**	**0.098**	**0.257**	**2.844**
	CD (1%)	**0.529**	**1.756**	**0.101**	**0.391**	**1.291**	**0.071**	**0.129**	**0.339**	**3.749**
	Males									
1	AKH 10-2	-0.340	1.111	-0.142	-0.153	-1.696	-0.181**	0.263**	1.120**	-4.789
2	AKH 10-5	0.290	-2.370	-0.060	-0.849**	-2.255*	0.016	-0.190	-0.266	-9.345**
3	AKH 10-10	1.068**	2.852*	0.117	1.388**	-0.792	-0.024	0.385**	0.976**	-3.498
4	AKH 11-7	0.920*	-2.333	0.132	-0.338	-1.122	0.056	0.083	-1.168**	-2.920
5	AKH 2006-2	0.068	-0.259	0.080	-0.986**	0.201	0.060	-0.099	-0.154	-7.167*
6	AKH 2012-8	-0.858*	1.037	0.065	-0.323	-0.918	0.106	0.369**	1.672**	4.178
7	AKH 2012-9	0.290	0.296	-0.046	0.188	-0.070	-0.151**	-0.504**	0.141	-3.276
8	AKH 09-5	-0.340	-4.074**	-0.120	-0.390	-0.903	0.343**	0.379**	-0.551*	1.693
9	AKH 976	-1.747**	-0.667	-0.186*	0.410	2.112*	-0.043	-0.994**	-0.361	4.978
10	AKH 9916	-0.080	0.815	0.140	0.166	0.775	-0.238**	-0.311**	1.337**	9.434**
11	DHY 286	1.549**	0.593	0.347**	0.677*	5.152**	-0.107*	0.381**	-2.855**	9.588**
12	SURAJ	-0.821*	3.000*	-0.327**	0.210	-0.485	0.163**	0.240*	0.109	4.511
	SE(gj)±	**0.407**	**1.351**	**0.078**	**0.301**	**0.993**	**0.054**	**0.099**	**0.261**	**2.885**
	CD (5%)	**0.802**	**2.664**	**0.153**	**0.593**	**1.957**	**0.107**	**0.196**	**0.515**	**5.687**
	CD (1%)	**1.057**	**3.513**	**0.202**	**0.782**	**2.581**	**0.141**	**0.258**	**0.678**	**7.499**

*****- Significant at 5 % level of significance ******- Significant at 1 % level of significance

Cont…

Sr. No.	Genotypes	Lint index	2.5 % span length	Fibre strength	Fibre fineness	Uniformity index	Elongation percentage
	Females						
1	AKH 84635	-0.010	-0.528**	-0.255**	0.108**	0.114	-0.006
2	AKH 8828	-0.106**	-0.014	-0.463**	-0.014	-0.062	0.067**
3	AKH 081	0.117**	0.542**	0.718**	-0.094**	-0.052	-0.060**
	SE(gi)±	**0.034**	**0.031**	**0.048**	**0.011**	**0.084**	**0.011**
	CD (5%)	**0.066**	**0.060**	**0.095**	**0.021**	**0.165**	**0.022**
	CD (1%)	**0.087**	**0.079**	**0.126**	**0.027**	**0.217**	**0.029**
	Males						
1	AKH 10-2	0.369**	-0.319**	-0.365**	0.061**	-0.015	-0.155**
2	AKH 10-5	-0.185**	-0.875**	0.113	0.235**	-0.238	0.112**
3	AKH 10-10	0.443**	0.770**	-0.057	-0.028	0.503**	0.094**
4	AKH 11-7	-0.175*	-0.204**	0.813**	-0.180**	0.466**	0.038
5	AKH 2006-2	-0.089	-0.386**	-1.457**	0.172**	-0.941**	0.271**
6	AKH 2012-8	0.501**	0.214**	0.869**	-0.157**	0.281	0.023
7	AKH 2012-9	-0.270**	-0.408**	-0.269**	-0.135**	0.355*	-0.166**
8	AKH 09-5	0.106	1.159**	0.517**	-0.165**	0.948**	0.008
9	AKH 976	-0.615**	0.262**	-1.376**	-0.120**	-0.015	-0.340**
10	AKH 9916	0.097	-0.456**	0.754**	0.091**	-0.497**	0.019
11	DHY 286	-0.310**	-0.749**	0.331**	0.328**	-1.015**	0.186**
12	SURAJ	0.127	0.992**	0.128	-0.102**	0.170	-0.092**
	SE(gj)±	**0.067**	**0.061**	**0.097**	**0.021**	**0.167**	**0.022**
	CD (5%)	**0.133**	**0.120**	**0.191**	**0.041**	**0.329**	**0.044**
	CD (1%)	**0.175**	**0.158**	**0.252**	**0.055**	**0.434**	**0.058**

*****- Significant at 5 % level of significance ******- Significant at 1 % level of significance

Table.3 Specific combining ability effects of the crosses for different characters over the three environments

Sr. No.	Crosses	Days to 50% flowering	Plant height	Number of monopodia	Number of sympodia	Number of bolls/ plant	Boll weight	Seed index	Ginning percentage	Seed cotton yield/plant
1	AKH 84635 X AKH 10-2	-1.114	-3.120	0.148	0.735	3.273	0.196*	0.216	2.031**	7.195
2	AKH 84635 X AKH 10-5	0.478	-0.639	-0.134	-1.391**	-0.279	-0.092	-0.028	0.888	-5.177
3	AKH 84635 X AKH 10-10	1.145	-4.083	-0.156	-0.517	-0.942	-0.139	-0.351*	0.339	-9.430
4	AKH 84635 X AKH 11-7	-0.485	6.102**	0.318*	1.276*	2.765	0.150	0.456**	2.425**	13.659**
5	AKH 84635 X AKH 2006-2	-0.522	0.917	-0.208	-1.087*	-2.779	-0.172	-0.207	-1.294**	-13.896**
6	AKH 84635 X AKH 2012-8	-0.707	6.398**	0.029	1.061*	2.117	0.201*	0.296	1.204**	10.919*
7	AKH 84635 X AKH 2012-9	2.367**	-0.639	0.007	0.172	3.158	0.050	0.013	-1.826**	7.585
8	AKH 84635 X AKH 09-5	-0.003	2.731	-0.164	-0.294	-4.398*	-0.363**	-0.842**	-2.237**	-14.556**
9	AKH 84635 X AKH 976	-0.151	-1.676	-0.052	-0.650	-3.124	0.030	-0.021	1.399**	9.411
10	AKH 84635 X AKH 9916	0.071	-2.602	0.133	0.394	-0.953	-0.235*	-0.012	0.523	6.272
11	AKH 84635 X DHY 286	-0.670	0.843	0.036	0.772	-2.653	0.191*	-0.364*	-2.251**	-10.548*
12	AKH 84635 X SURAJ	-0.410	-4.231	0.044	-0.472	3.817*	0.183	0.845**	-1.202**	12.955*
13	AKH 8828 X AKH 10-2	1.969**	-4.870*	-0.090	-0.477	-5.625**	-0.407**	-0.519**	-2.721**	-5.131
14	AKH 8828 X AKH 10-5	-0.216	0.278	-0.193	0.553	-1.788	-0.229*	0.111	-0.772	-12.539*
15	AKH 8828 X AKH 10-10	-2.105**	1.389	-0.038	-0.306	2.572	0.078	0.109	-1.514**	8.949
16	AKH 8828 X AKH 11-7	-2.290**	-4.315	-0.164	-0.603	-1.110	0.005	0.426*	-0.306	-9.801
17	AKH 8828 X AKH 2006-2	2.562**	1.167	0.222	1.134*	6.135**	0.371**	0.558**	0.653	25.156**
18	AKH 8828 X AKH 2012-8	2.599**	-4.130	0.014	-0.818	-0.747	-0.335**	-0.418*	0.137	-7.422
19	AKH 8828 X AKH 2012-9	-0.772	2.167	-0.008	0.227	0.972	0.214*	0.004	0.098	7.732
20	AKH 8828 X AKH 09-5	-0.698	-4.241	0.088	-0.195	0.183	-0.030	-0.128	2.018**	-11.825*
21	AKH 8828 X AKH 976	-1.068	3.907	-0.001	-0.106	-0.954	0.488**	0.198	-1.274**	-15.097**
22	AKH 8828 X AKH 9916	-0.512	-0.241	0.229	0.182	1.627	0.140	0.114	0.474	17.604**
23	AKH 8828 X DHY 286	1.414*	1.426	0.044	0.316	0.916	-0.020	-0.064	3.249**	7.487

Cont…

Sr. No.	Crosses	Days to 50 % flowering	Plant height	Number of monopodia	Number of sympodia	No. of bolls/ plant	Boll weight	Seed index	Ginning percentage	Seed cotton yield/plant
24	AKH 8828 X SURAJ	-0.883	7.463**	-0.104	0.094	-2.180	-0.277**	-0.391*	-0.042	-5.112
25	AKH 081 X AKH 10-2	-0.855	7.991**	-0.058	-0.258	2.352	0.211*	0.303	0.690	12.326*
26	AKH 081 X AKH 10-5	-0.262	0.361	0.327*	0.838	2.067	0.321**	-0.083	-0.116	17.716**
27	AKH 081 X AKH 10-10	0.960	2.694	0.194	0.823	-1.629	0.061	0.242	1.174*	0.481
28	AKH 081 X AKH 11-7	2.775**	-1.787	-0.154	-0.673	-1.655	-0.155	-0.882**	-2.119**	-3.858
29	AKH 081 X AKH 2006-2	-2.040**	-2.083	-0.014	-0.047	-3.355	-0.200*	-0.351*	0.640	-11.259*
30	AKH 081 X AKH 2012-8	-1.892**	-2.269	-0.043	-0.244	-1.370	0.133	0.122	-1.341**	-3.497
31	AKH 081 X AKH 2012-9	-1.596*	-1.528	0.001	-0.399	-4.129*	-0.264**	-0.017	1.729**	-15.317**
32	AKH 081 X AKH 09-5	0.701	1.509	0.075	0.490	4.215*	0.393**	0.969**	0.220	26.382**
33	AKH 081 X AKH 976	1.219	-2.231	0.053	0.756	4.078*	-0.518**	-0.177	-0.125	5.686
34	AKH 081 X AKH 9916	0.441	2.843	-0.362**	-0.577	-0.674	0.095	-0.102	-0.997*	-23.876**
35	AKH 081 X DHY 286	-0.744	-2.269	-0.080	-1.088*	1.737	-0.171	0.428*	-0.998*	3.061
36	AKH 081 X SURAJ	1.293	-3.231	0.060	0.379	-1.637	0.094	-0.454**	1.244**	-7.844
	SE(Sij)±	**0.704**	**2.341**	**0.135**	**0.521**	**1.720**	**0.094**	**0.172**	**0.452**	**4.997**
	CD (5%)	**1.388**	**4.614**	**0.265**	**1.028**	**3.390**	**0.185**	**0.339**	**0.891**	**9.850**
	CD (1%)	**1.831**	**6.084**	**0.350**	**1.355**	**4.471**	**0.244**	**0.447**	**1.175**	**12.988**

*****- Significant at 5 % level of significance ******- Significant at 1 % level of significance

Cont…

Sr. No.	Crosses	Lint index	2.5 % span length	Fibre strength	Fibre fineness	Uniformity index	Elongation percentage
1	AKH 84635 X AKH 10-2	0.472**	-0.142	0.073	-0.001	-0.336	-0.186**
2	AKH 84635 X AKH 10-5	0.074	0.425**	0.018	0.214**	0.441	0.047
3	AKH 84635 X AKH 10-10	-0.100	-1.153**	-1.590**	-0.212**	-1.188**	-0.179**
4	AKH 84635 X AKH 11-7	0.682**	0.199	0.584**	-0.238**	0.182	-0.068
5	AKH 84635 X AKH 2006-2	-0.340**	-0.686**	-0.501**	0.066	-0.855**	-0.423**
6	AKH 84635 X AKH 2012-8	0.464**	1.514**	-0.005	-0.094*	0.145	0.181**
7	AKH 84635 X AKH 2012-9	-0.311**	-1.142**	0.699**	0.206**	0.293	0.147**
8	AKH 84635 X AKH 09-5	-0.865**	1.236**	-1.586**	-0.375**	0.367	0.295**
9	AKH 84635 X AKH 976	0.196	0.943**	-0.549**	0.025	0.219	-0.001
10	AKH 84635 X AKH 9916	0.123	-0.083	-0.001	0.214**	-0.522	-0.071
11	AKH 84635 X DHY 286	-0.568**	-0.957**	0.232	0.144**	-0.003	0.151**
12	AKH 84635 X SURAJ	0.173	-0.153	2.625**	0.051	1.256**	0.106**
13	AKH 8828 X AKH 10-2	-0.743**	-1.146**	-0.074	0.144**	-0.605*	-0.193**
14	AKH 8828 X AKH 10-5	-0.058	-1.157**	-1.496**	-0.275**	-1.605**	-0.148**
15	AKH 8828 X AKH 10-10	-0.273*	0.577**	-1.048**	0.210**	0.432	-0.330**
16	AKH 8828 X AKH 11-7	0.129	0.428**	0.004	0.251**	0.136	-0.030
17	AKH 8828 X AKH 2006-2	0.410**	1.421**	2.085**	-0.290**	1.543**	0.693**
18	AKH 8828 X AKH 2012-8	-0.201	-1.135**	-0.674**	0.040	-0.346	0.085*
19	AKH 8828 X AKH 2012-9	0.037	-0.012	-1.448**	-0.049	-0.420	0.041
20	AKH 8828 X AKH 09-5	0.315**	0.110	0.322	0.269**	-0.346	-0.378**
21	AKH 8828 X AKH 976	-0.115	-0.105	1.215**	0.192**	0.840**	-0.207**
22	AKH 8828 X AKH 9916	0.128	0.380**	1.619**	0.025	0.654*	0.133**
23	AKH 8828 X DHY 286	0.560**	0.484**	0.874**	-0.290**	0.284	0.333**
24	AKH 8828 X SURAJ	-0.189	0.154	-1.378**	-0.227**	-0.568	0.000
25	AKH 081 X AKH 10-2	0.271*	1.288**	0.001	-0.143**	0.941**	0.379**

Cont…

Sr. No.	Crosses	Lint index	2.5 % span length	Fibre strength	Fibre fineness	Uniformity index	Elongation percentage
26	AKH 081 X AKH 10-5	-0.016	0.732**	1.479**	0.061	1.164**	0.101**
27	AKH 081 X AKH 10-10	0.374**	0.577**	2.638**	0.002	0.756**	0.508**
28	AKH 081 X AKH 11-7	-0.812**	-0.627**	-0.588**	-0.013	-0.318	0.097*
29	AKH 081 X AKH 2006-2	-0.070	-0.735**	-1.584**	0.224**	-0.688*	-0.269**
30	AKH 081 X AKH 2012-8	-0.263*	-0.379**	0.679**	0.054	0.201	-0.266**
31	AKH 081 X AKH 2012-9	0.274*	1.154**	0.749**	-0.157**	0.127	-0.188**
32	AKH 081 X AKH 09-5	0.550**	-1.346**	1.264**	0.106**	-0.022	0.082*
33	AKH 081 X AKH 976	-0.081	-0.838**	-0.666**	-0.217**	-1.059**	0.208**
34	AKH 081 X AKH 9916	-0.251*	-0.298**	-1.618**	-0.239**	-0.133	-0.062
35	AKH 081 X DHY 286	0.008	0.473**	-1.106**	0.146**	-0.281	-0.484**
36	AKH 081 X SURAJ	0.016	-0.001	-1.247**	0.176**	-0.688*	-0.106**
	SE(Sij)±	**0.117**	**0.106**	**0.168**	**0.036**	**0.289**	**0.038**
	CD (5%)	**0.230**	**0.208**	**0.331**	**0.072**	**0.570**	**0.076**
	CD (1%)	**0.303**	**0.274**	**0.436**	**0.094**	**0.752**	**0.100**

*****- Significant at 5 % level of significance ******- Significant at 1 % level of significance

Table.4 Mean yield performance, standard heterosis (H_3) and SCA effects of the promising crosses over the environments

S N	Crosses	Seed cotton yield/plant (g)	Standard heterosis (H_3) for seed cotton yield (%)	SCA effects for seed cotton yield per plant	GCA effects of parents for seed cotton yield	Significant SCA effects for other characters in desirable direction
1	AKH 8828 x AKH 9916	110.09**	60.30**	17.61**	0.33 x 9.43**	11,12,14,15
2	AKH 081 x AKH 09-5	105.80**	54.05**	26.38**	1.61 x 1.69	5,6,7,10,12,15
3	AKH 84635 x SURAJ	101.48**	47.76**	12.96*	1.29 x 4.51	5,7,12,14,15
4	AKH 8828 x AKH 2006-2	101.04**	47.12**	25.16**	0.33 x -7.17*	4,5,6,7,10,11,12,13,14,15
5	AKH 8828 x DHY 286	100.09**	45.79**	7.49	0.33 x 9.59**	8,10,11,12,13,15

*****- Significant at 5 % level of significance ******- Significant at 1 % level of significance

1: Days to 50 % flowering; 2: Plant height; 3: Number of monopodia/plant
4: Number of sympodia/plant; 5: Number of bolls/plant; 6: Boll weight
7: Seed index; 8: Ginning percentage; 9: Seed cotton yield/plant
10: Lint index; 11: 2.5 % span length; 12: Fibre strength
13: Fibre fineness; 14: Uniformity index; 15: Elongation percentage

Thus, above promising male parents having high gca effects for seed cotton yield, yield related traits and fibre parameters can be suitably used in the hybridization programmes over the environments under study for improvement of individual trait *per se*. The high gca effects among males and females for seed cotton yield, its components traits and fibre quality parameters have also been reported by other workers *viz.*, Pavasia *et al.*, (1999), Dheva *et al.*, (2002) Ahuja and Dhayal (2007), Dhamayanthi *et al.*, (2008), Palve (2009), Saravanan *et al.*, (2010), Alkuddsi *et al.*, (2013), Sawarkar *et al.*, (2015), Usharani *et al.*, (2016), Monicashree *et al.*, (2017) and Anjum *et al.*, (2018).

Similarly, female parent AKH 081 though exhibited non-significant gca effect for seed cotton yield, but recorded high mean performance for seed cotton yield (81.65 g) and other yield contributing traits with highly significant gca effects for days to 50 % flowering, seed index, lint index, 2.5 % span length, fibre strength and fibre fineness. Hence, can be used in recombination breeding to obtain more favourable gene recombination for seed cotton yield and also for improvement of yield and associated characters. Saravanan *et al.*, (2010) reported similar results in which they found that parent KC 2, MCU 5 and MCU 12 were good general combiners besides high mean *per se* for single plant yield. Similar results were also reported by Alkuddsi *et al.*, (2013) for the parent RAH 146.

The specific combining ability effect is indicative of heterosis and also non- additive gene action which is presented in Table 3. The hybrid, AKH 081 x AKH 09-5 exhibited highest and significant sca effects for seed cotton yield/plant with other yield contributing and fibre quality traits in desirable direction *viz.*, number of bolls/plant, boll weight, seed index, lint index, fibre strength and elongation percentage. Further, AKH 8828 x AKH 2006-2 also showed desirable significant sca effects for seed cotton yield with other 10 traits *viz.*, number of sympodia/plant, number of bolls/plant, boll weight, seed index, lint index, 2.5 % span length, fibre strength, fibre fineness, uniformity index and elongation percentage. The third hybrid, AKH 8828 x AKH 9916 recorded desirable and high sca effects for seed cotton yield with 4 fibre quality traits namely, 2.5 % span length, fibre strength, uniformity index and elongation percentage. These hybrids also exhibited superior *per se* performance and significant standard heterosis in combination with high sca effects. The results indicated the preponderance of non-additive genetic variation in the inheritance of these characters which was in accordance with the results obtained by Preetha and Raveendran (2008).

These hybrids also recorded significant heterosis in desirable direction over check for seed cotton yield/plant. Out of these, 5 hybrids, AKH 8828 x AKH 9916 and AKH 8828 x DHY 286 were combinations involving parents with low x high gca effect, whereas, AKH 081 x AKH 09-5 was combination of medium x high gca effect, AKH 8828 x AKH 2006-2 was combination of high x low gca effect and AKH 84635 x SURAJ was combination of low x medium gca effect of the parents involved in respective hybrid (Table 4).

The hybrid AKH 8828 x DHY 286 recorded high *per se* performance, significant standard heterosis and highly significant gca effects for one of the parents for seed cotton yield but non-significant sca effect for seed cotton yield may be due to the lack of co-adaptation between favourable alleles of the parents involved for this trait. Similar findings were also recorded by Kannan and Saravanan (2016) in the CG 67 x CG 45 SB cross combination. This cross also exhibited significant sca effect for 6 yield contributing and fibre quality characters. By exploiting this cross the best transgressive segregants for yield, other yield contributing traits and fibre quality parameters can be selected in further generations. Similar results were also recorded by Preetha and Raveendran (2008), Palve (2009), Hussain *et al.,* (2010), Khan *et al.,* (2015), Sawarkar *et al.*, (2015), Solanki *et al.,* (2015), Usharani *et al.,* (2016), Babu *et al.,* (2017), Monicashree *et al.,* (2017), Anjum *et al.,* (2018) and Munir *et al.,* (2018). Similarly, the hybrid AKH 84635 x SURAJ exhibited positive and significant sca effects for seed cotton yield (12.96). However, both the parents of this hybrid were not good general combiners for seed cotton yield evidently the influence of epistatic gene action mechanism should have been contributed to the positive yield expression. Thus, this cross should be cautiously followed up for deriving useful lines. Similar findings were also reported by Saravanan *et al.,* (2010) in SRT 1 x MCU 7 cross combination in their study.

Thus, out of 36 hybrids, 3 hybrids *viz.,* AKH 081 x AKH 09-5, AKH 8828 x AKH 2006-2 and AKH 8828 x AKH 9916 are expected to be promising over the environments under study which can be exploited for heterosis breeding programme after further testing at other locations. Similarly, the hybrid, *viz.,* AKH 8828 x DHY 286 which showed desirable gca effects for most of the yield contributing and fibre quality traits but exhibited non-significant sca effect for seed cotton yield. Therefore, this hybrid can be exploited for varietal development programme in further generations.

Acknowledgement

I wish to express my sincere thanks to Dr. T. H. Rathod, Senior Research Scientist, Cotton Research Unir, Dr. PDKV, Akola, Dr. V. N. Waghmare, Director, ICAR-Central Institute for Cotton Research, Nagpur and Dr. A. S. Thakre, Head, Regional Research Centre, Amravati for providing the necessary facilities to conduct my research experiment and their all staff members for constant assurance, help and aspiration during the course of my research work.

References

Ahuja, S. L. and Dhayal, L. S. 2007. Combining ability estimates for yield and fibre quality traits in 4 × 13 line × tester crosses of *Gossypium hirsutum*. *Euphytica*, 153: 87–98.

Alkuddsi Yanal A., M. R. Gururaja Rao, S. S. Patil, T. H. Gowda and Joshi, Mukund. 2013. Combining ability analysis for seed cotton yield (kapas yield) and its components in intra hirsutum hybrids and forming heterotic boxes for exploitation in cotton, *Genomics and Applied Biology*., Vol.4, No.5, 35-49.

Anjum, R., M. J. Baloch, G. M. Baloch and Chachar, Q. 2018. Combining ability estimates for yield and fibre quality traits in Bt and non-Bt upland cotton genotypes. *Pure and Applied Biology.,* Vol. 7(1): 389-399.

Anonymous. 2017. A report of Cotton Advisory Board (CAB), Ministry of Textile, Government of India.

Babu, B. J., Y. Satish, M. L. Ahamed and Rao, V. S. 2017. Combining ability analysis for yield and fibre quality traits in cotton (*Gossypium hirsutum* L.). *J. Res. Angrau*, 45(4): 33-43.

Dhamayanthi, K. P. M. 2008. Study of Interspecific Hybrids (*Gossypium hirsutum* x *G. barbadense*) for heterosis and combining ability. World Cotton Research Conference on Technologies for Prosperity.

Dheva, N., N. R. Potdukhe and Patil, V. T. 2002. Heterosis for seed cotton yield and other morphological characters in *Gossypium hirsutum* L. *J. Cotton Res. Dev*., 16(2):165-167.

Hussain, A., F. M. Azhar, M. A. Ali, S. Ahmad and Mahmood, K. 2010. Genetic studies of fiber quality characters in upland cotton. *J. Anim. Plant Sci*., 20(4): 234-238.

Kannan, N. and Saravanan, K. 2016. Heterosis and combining ability analysis in tetraploid Cotton (*G.hirsutum* and *G.barbadense* L.). *Electronic Journal of Plant Breeding*, 7(2): 341-351.

Karademir, C., E. Karademir, R. Ekinci and Gencer, O. 2009. Combining ability estimates and heterosis for yield and fiber quality of cotton in line x tester design. *Bot. Hort. Agrobot. Cluj.*, 37(2): 228-231.

Kempthorne, O. 1957. An introduction to genetic statistics, John Wiley and Son Inc. New york, Champman and Hall Ltd. London, pp., 468-470.

Khan, S. A., N. U. Khan, R. Gul, Z. Bibi, I. U. Khan, S. Gul, S. Ali, and Baloch, M. 2015. Combining ability studies for yield and fiber traits in upland cotton. *The Journal of Animal & Plant Sciences*, 25(3): 698-707.

Monicashree, C., P. Amala Balu and Gunasekaran, M. 2017. Combining ability and heterosis studies on yield and fibre quality traits in upland cotton (*Gossypium hirsutum* L.). *Int.J.Curr. Microbiol.App.Sci.*, 6(8): 912-927.

Munir S., M. K. Qureshi, A. N. Shahzad, H. Manzoor, M. A. Shahzad, K. Aslam and Athar, H. 2018. Assessment of gene action and combining ability for fibre and yield contributing trais in interspecific and intraspecific hybrids of cotton. *Czech J. Genet. Plant Breed. pp*: 1-7.

Palve, S. M. 2009. Heterosis and combining ability for fibre properties in upland cotton (*Gossypium hirsutum*). *Indian Journal of Agricultural Sciences,* 79(9): 66-68.

Patil, A. E., D. B. Deosarkar and Kalyankar, S. V. 2017. Impact of genotype x environment interaction on the heterosis and stability for seed-cotton yield on heterozygous and homozygous genotypes in cotton (*Gossypium hirsutum* L.). *Indian J. Genet*., 77(1): 119-125.

Patil, A. E., D. B. Deosarkar and Puttawar, M. R. 2018. Environmental impact on the stability of gene action for seed cotton yield in cotton (*Gossypium hirsutum* L.). *Int. J. Curr. Microbiol. App. Sci.*, 7(1): 1319-1329.

Pavasia, M. J., P. T. Shukla and Patel, U. G. 1999. Combining ability analysis over environments for fibre characters in upland cotton. *Indian J. Genet.*, 59(1): 77-81.

Preetha, S. and Raveendran, T. S. 2008. Combining ability and heterosis for yield and fiber quality traits in line x tester crosses of upland cotton. *Int. J. of Plant Breeding and Gene.*, 2: 64-74.

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

Sawarkar, M., A, Solanke, G. S. Mhasal and Deshmukh, S. B. 2015. Combining ability and heterosis for seed cotton yield, its components and quality traits in *Gossypium hirsutum* L. *Indian Journal of Agricultural Research*, 49(2): 154-159.

Shinde, G. C., S. S. Mehetre and Jagtap, P. K. 2009. Stability analysis of CGMS based hybrids and their parents for seed cotton yield in cotton (*Gossypium hirsutum* L.). *J. Cotton Res. Dev.*, 23(2): 188-192.

Singh, S., V. V. Singh and Chaudhary, A. D. 2014. Genotype x environment interaction and yield stability analysis in Multienvironment. *Tropical and Subtropical Agroecosystems*, 17: 477-482.

Solanki, H. V., D. R. Mehta, V. B. Rathod and Vavdiya, P. A. 2015. Heterosis and combining ability for earliness and its related traits in cotton (*Gossypium hirsutum* L.). *The Bioscan*, 10(4): 2075-2079.

Sprague, G. F. and Tatum, L. A. 1942. General Vs. specific combining ability in a single cross corn. *J. Amer. Soc. Agron.*, 34: 923-932.

Tuteja, O. P., M. Singh and Verma, S. K. 2006. Stability analysis for seed cotton yield and its component traits in interspecific hybrids of *Gossypium hirsutum*. *J. Cotton Res. Dev.*, 20(2):171-173.

Usharani, C. V., S. M. Manjula and Patil S. S. 2016. Estimating combining ability through line × tester analysis in upland cotton. *Research in Environment and Life Sciences*, 9(5): 628-633.

How to cite this article:

Kumbhalkar, H.B., V.L. Gawande, Vinita Gotmare and Rathod, T.H. 2018. Combining Ability Studies for Yield, its Component Traits and Fibre Properties through Line X Tester Mating Design in Upland Cotton (*Gossypium hirsutum* L.). *Int.J.Curr.Microbiol.App.Sci.* 7(10): 1357-1370. doi: https://doi.org/10.20546/ijcmas.2018.710.151