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Combining Ability Estimates for Yield and Fibre Quality Traits in Line X Tester Crosses of Intra-Hirsutum Hybrids of Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Combining ability analysis involving 84 hybrids derived from crossing 12 lines and 7 testers in line × tester fashion were evaluated along with two checks during *kharif* 2010-11 at students' farm, Agricultural college, Bapatla for 21 qualitative and quantitative traits. Estimates of variance due to *gca* and *sca* and their ratios revealed the predominance of non-additive gene action for all the traits studied. The lines RAC 99152, RAH 178-4, NAWAB and RAH 97-612 and in testers SC 68 followed by SC 7-IPS and SC 40 were identified as potential general combiners for important yield component traits. Based on *per se* performance, high *sca* and standard heterosis , the top specific cross combinations detected for seed cotton yield and other traits were RAH 370 X SC 31 and RAH 178 X SC 40. This suggested the possibility of direct utilization of their hybrids for commercial exploitation after through testing over larger number of diversified environments and seasons. The progeny of these crosses may be further advanced to isolate superior recombinants.

Key words : Cotton, General combining ability, Line × tester analysis, Specific combining ability.

Cotton is an important fibre crop of global important and also referred as "white gold". It is providing employment to 60 million people either directly or indirectly in its production, processing and marketing. The economy of many countries depends on production, processing, utilization and export of cotton. In India hybrids have played a significant role in achieving self sufficiency in cotton production to some extent. The concept of combining ability plays a significant role in crop improvement and helps in selection of superior parents in exploitation of heterosis.

MATERIAL AND METHODS

In the present study, twelve *Gossypium hirsutum* lines RAH 100-32, SC 7, RAH 370, Gcot 16, RAH 178-4,RACH 99-152, SM-1, RAH 97-612, RAH 111, NAWAB, RAH 178, RAC 99152 and semi compact to compact plant types viz., SC 68, SC 7 IPS, SC 40, SC 79, C 11, NAWAB 8 and SC 31were used as testers. Each of the line was crossed with all the seven testers individually in a line x tester fashion (Kempthorne, 1957) to develop eighty four intra-hirsutum hybrids. The eighty four intra-hirsutum hybrids along with two checks were raised in randomized Block Design with two replications during *kharif* 2010-11 at students' farm, Agricultural college, Bapatla. They were sown in one row of 7.2 m length spaced at 90 cm between the rows and 60 cm with in the row. Recommended agronomic practices and need based plant protection measures were followed. Five randomly selected plants were tagged for recording the observations viz., plant height (cm), days to 50% flowering, number of monopodia per plant, number of sympodia per plant, relative water content (%), specific leaf weight (mg cm^{-2}), crop growth rate at peak flowering stage (g m^{-2} day^{-1}), crop growth rate at boll formation stage (g m^{-2} day^{-1}), crop growth rate at maturity stage (g m^{-2} day^{-1}), number of bolls per plant, boll weight (g), ginning out-turn (%), seed index (g), lint index (g), 2.5% span length (mm), micronaire value (10^{-6} g $inch^{-1}$), bundle strength (g tex^{-1}), uniformity ratio, fibre elongation (%), lint yield per plant (g) and seed cotton yield per plant (g).

The mean of five plants was used for statistical analysis. The data was subjected to combining ability analysis following the method suggested by Kempthorne (1957). The ratio of GCA/SCA was worked out for each character to find out the predominance of additive or non-additive gene action. Standard heterosis was worked out as percent mean deviation of the mean F_1 performance over the mean performance of the standard check hybrids Mallika Bt.

Table 1. Analysis of variance for combining ability for 21 traits in cotton.

Source of variation	d.f	Mean sum of squares										
		Plant height (cm)	Days to 50% flowering	No. of mono podia plant^{-1}	No. of sympodia plant^{-1}	Relative water content (%)	Specific leaf weight (mg cm^{-2})	C.G.R at peak flowering (g m^{-2} day^{-1})	C.G.R at boll formation (g m^{-2} day^{-1})	C.G.R at maturity (g m^{-2} day^{-1})	No. of bolls plant^{-1}	Boll weight (g)
Replication	1	7.671	1.006	0.004	0.229	2.713	0.002	0.0431	0.104	0.023	15.972	0.004
Crosses	83	656.175**	8.247**	0.091**	17.577**	134.761**	5.769**	0.859**	2.114**	0.379**	39.594**	0.466**
Line effect	11	484.141	7.461	0.055	16.493	165.199	3.766	0.695	1.898	0.306	19.567	0.310
Tester effect	6	407.961	13.770	0.077	4.222	82.987	7.091	1.046	1.379	0.706	34.189	0.412
Line X Tester effect	66	707.412**	7.876**	0.099**	18.972**	134.394**	5.983**	0.870**	2.216**	0.361**	43.423**	0.498**
Error	83	12.606	0.922	0.026	1.073	2.293	0.008	0.033	0.043	0.013	10.722	0.006

Table 1.(cont.)

Source of variation	d.f	Mean sum of squares									
		Ginning out-turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire (10^{-6} g inch^{-1})	Bundle strength (g tex^{-1})	Uniformity ratio	Fibre elongation (%)	Lint yield plant^{-1} (g)	Seed cotton yield plant^{-1} (g)
Replication	1	0.137	0.037	0.005	0.337	0.036	0.017	0.054	0.037	3.661	16.406
Crosses	83	9.743**	2.380**	1.294**	4.052**	0.356**	2.506**	5.727**	0.096**	76.683**	435.936**
Line effect	11	4.211	1.140	0.791	2.450	0.251	2.032	2.602	0.094	43.979	430.816
Tester effect	6	7.456	1.126	0.239	3.410	0.661	1.940	7.118	0.054	53.201	209.792
Line X Tester effect	66	10.873**	2.701**	1.474**	4.377**	0.346**	2.637**	6.121**	0.100**	84.269**	457.348**
Error	83	0.202	0.023	0.005	0.547	0.025	0.803	1.306	0.017	19.546	141.538

*, ** Significant at 5% and 1% level, respectively.

Table 2. Estimates of general combining ability (*gca*) effects of lines and testers for 21 traits in cotton.

Parents	Plant height (cm)	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	Relative water content (%)	Specific leaf weight (mg cm^{-2})	C.G.R at peak flowering (g m^{-2} day^{-1})	C.G.R at boll formation (g m^{-2} day^{-1})	C.G.R at maturity (g m^{-2} day^{-1})
						Lines			
RAH 100-32	9.222 **	0.113	0.082	0.843**	-0.399	-0.003	0.013	-0.142*	-0.007
SC 7	-5.249**	-1.030**	-0.004	-0.636*	3.586**	-0.639**	-0.154**	-0.464**	-0.000
RAH 370	4.322 **	-0.030	-0.004	-0.414	3.535**	-0.250**	-0.017	-0.231**	0.197**
GCOT 16	3.122**	0.899**	0.039	-0.086	-2.369**	-0.898**	-0.123*	-0.490**	-0.149**
RAH 178-4	0.822	0.399	-0.075	0.029	2.781**	0.376**	-0.089	-0.082	0.267**
RACH 99-152	3.915**	-0.101	-0.061	-0.493	-1.756**	-0.308**	0.077	0.235**	0.038**
SM 1	-4.578**	0.399	-0.004	1.557**	-5.685**	0.794**	-0.177**	0.232**	-0.100**
RAH 97-612	3.508**	-1.101**	-0.089*	-0.743**	-5.334**	0.117**	0.609**	0.552**	0.198**
RAH 111	-6.878**	0.470	-0.004	-2.300**	-1.544**	0.769**	0.076	0.690**	-0.164**
NAWAB	1.293	1.185**	0.111*	0.671*	3.517**	0.211**	-0.185**	-0.240**	-0.117**
RAH 178	-11.678**	-0.387	0.054	-0.071	3.508**	0.190**	-0.174**	-0.092	-0.123**
RAC 99152	2.179**	-0.815**	-0.046	1.643**	0.161	-0.359**	0.144**	0.033	-0.039
SE (gi)	0.949	0.257	0.043	0.277	0.405	0.024	0.048	0.055	0.030
CD at 5%	1.887	0.510	0.085	0.551	0.805	0.047	0.096	0.110	0.060
						Testers			
SC 68	4.858**	1.661**	0.113**	-0.733**	1.326**	0.409**	0.055	0.023	0.283**
SC7 IPS	-0.959	-0.339	0.021	0.113	0.433	-0.389**	0.326**	0.229**	0.131**
SC 40	-4.726**	0.077	-0.037	0.442*	0.919**	-0.053**	-0.223**	-0.441**	-0.184**
SC 79	1.708*	-0.381	-0.020	0.383	-2.401**	0.784**	0.064	-0.040	0.084**
C 11	4.345**	-0.131	-0.045	-0.383	2.736**	-0.222**	-0.250**	-0.086*	-0.044
NAWAB 8	-5.751**	-0.381	-0.045	0.092	-1.795**	0.304**	0.148**	0.297**	-0.144**
SC 31	0.524	-0.506*	0.013	0.088	-1.218**	-0.833**	-0.119**	0.018	-0.126**
SE (gj)	0.725	0.196	0.033	0.212	0.309	0.018	0.037	0.042	0.023
CD at 5%	1.442	0.390	0.065	0.421	0.615	0.036	0.074	0.084	0.046

Table 2 (cont.)

Parents	No. of bolls plant^{-1}	Boll weight (g)	Ginning out-turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire (10^{-6} g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Lint yield plant^{-1} (g)	Seed cotton yield plant^{-1} (g)
Lines												
RAH 100-32	-0.600	0.185**	-0.281*	0.121**	0.024	-0.133	0.010	0.068	-0.315	-0.058	1.228	3.888
SC 7	-0.521	-0.034	0.176	-0.006	-0.112**	0.214	-0.039	-0.003	-0.101	0.064	-0.588	-3.284
RAH 370	-0.164	0.134**	-0.838**	0.006	-0.209**	-0.447*	0.279**	-0.239	-0.173	-0.079*	1.101	6.045
GCOT 16	0.714	-0.011	-0.481**	-0.705**	-0.585**	0.026	-0.055	-0.010	-0.680*	-0.115**	0.672	4.416
RAH 178-4	-1.043	0.201**	-0.181	0.355**	0.204**	0.362	0.094*	-0.153	0.220	0.157**	0.572	2.730
RACH 99-152	0.229	0.122**	-0.331**	0.034	-0.020	-0.386	-0.245**	-0.103	0.820**	-0.093**	0.401	2.687
SM 1	0.986	-0.041	-0.002	0.168**	0.098**	-0.370	0.009	-0.617*	0.292	0.014	0.190	1.102
RAH 97-612	-1.114	-0.212**	-0.217	-0.004	0.001	-0.175	0.063	0.097	-0.365	-0.043	-4.208**	-11.213**
RAH 111	-1.757*	-0.115**	0.798**	0.046	0.191**	-0.503*	0.103*	-0.517*	-0.008	-0.015	-2.672*	-9.770**
NAWAB	-0.143	-0.009	1.190**	-0.006	0.307**	0.703**	-0.063	0.326	-0.451	0.057	1.490	-0.334
RAH 178	0.729	0.049*	0.019	-0.341**	-0.082**	0.028	0.010	0.768**	0.449	0.085*	1.855	4.359
RAC 99152	2.686**	-0.269**	0.148	0.332**	0.184**	0.682**	-0.166**	0.383	0.313	0.028	-0.041	-0.627
SE (gi)	0.875	0.021	0.120	0.040	0.019	0.198	0.042	0.239	0.305	0.035	1.182	3.180
CD at 5%	1.741	0.042	0.239	0.080	0.037	0.393	0.084	0.476	0.607	0.069	2.350	6.324
Testers												
SC 68	-1.911**	0.197**	-0.520**	0.213**	-0.008	-0.373*	0.134**	-0.360	0.477*	-0.017	-0.588	-0.995
SC7 IPS	-0.269	0.063**	0.230*	-0.201**	-0.038**	0.255	0.169**	0.536**	0.702**	0.049	0.844	1.647
SC 40	-0.348	0.097**	0.868**	0.076*	0.187**	0.176	0.033	0.128	0.418	-0.092**	2.423**	3.751
SC 79	1.873**	-0.152**	0.172	-0.167**	-0.037*	0.418**	-0.054	-0.193	-0.632**	0.029	0.420	0.880
C 11	-0.182	-0.148**	-0.015	-0.234**	-0.142**	0.137	-0.146**	0.045	-0.661**	0.020	-2.255*	-5.803*
NAWAB 8	-0.219	0.017	0.126	-0.014	0.043**	-0.650**	0.136**	-0.089	-0.115	0.029	0.193	0.047
SC 31	1.056	-0.075**	-0.861**	0.328**	-0.005	0.037	-0.273**	-0.068	-0.190	-0.017	-1.036	0.472
SE (gj)	0.668	0.016	0.092	0.031	0.014	0.151	0.032	0.183	0.233	0.026	0.902	2.429
CD at 5%	1.329	0.032	0.183	0.061	0.028	0.300	0.064	0.364	0.464	0.053	1.795	4.830

Table 3. Estimates of specific combining ability (*sca*) effects of crosses for 21 traits in cotton.

Crosses	Plant height (cm)	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	Relative water content (%)	Specific leaf weight (mg cm^{-2})	C.G.R at peak flowering (g m^{-2} day^{-1})	C.G.R at boll formation (g m^{-2} day^{-1})	C.G.R at maturity (g m^{-2} day^{-1})	No. of bolls plant^{-1}	Boll weight (g)
L1*T1	-8.872**	-0.446	0.201	0.190	1.962	2.003**	-0.486**	-0.337*	-0.437**	0.175	0.089
L1*T2	12.845**	1.054	-0.007	3.545**	0.265	2.856**	-0.087	-0.043	0.064	4.783*	0.242**
L1*T3	30.411**	4.137**	0.251*	0.615	-15.321**	-2.681**	0.651**	0.072	0.130	-0.837	0.448**
L1*T4	15.978**	-0.905	-0.065	-0.526	-6.811**	-2.688**	-0.625**	-0.250	-0.229**	-0.058	-0.462**
L1*T5	-10.160**	-2.155**	-0.240*	0.040	1.876	0.929**	0.459**	0.387**	-0.210*	2.646	-0.547**
L1*T6	-10.564**	-0.405	0.160	1.165	11.453**	-1.678**	0.031	0.064	0.500**	0.383	-0.162**
L1*T7	-29.639**	-1.280	-0.299**	-5.030**	6.576**	1.260**	0.058	0.107	0.181*	-7.092**	0.391**
L2*T1	3.599	-0.304	-0.013	0.069	3.672**	0.704*	0.321*	0.575**	0.216**	3.396	-0.452**
L2*T2	-3.384	-0.304	-0.221	0.623	-3.480**	-1.788**	-0.470**	-0.682**	-0.433**	5.855*	-0.589**
L2*T3	-7.117**	-0.220	0.137	2.094**	7.974**	0.996**	0.078	0.063	0.003	1.134	0.447**
L2*T4	27.449**	-0.262	0.320**	0.152	7.869**	0.758**	0.282*	0.537**	0.504**	-6.087*	0.626**
L2*T5	-28.488**	-0.012	-0.055	-0.081	-14.414**	-1.805**	0.136	-0.167	-0.107	-0.333	-0.098
L2*T6	19.408 **	0.738	0.045	-2.356**	-4.897**	2.738**	-0.292*	0.020	-0.117	-0.545	0.007
L2*T7	-11.467**	0.363	-0.213	-0.502	3.276**	-1.604**	-0.055	-0.346*	-0.066	-3.420	0.059
L3*T1	14.328**	-1.304	-0.113	-2.152**	3.928**	2.470**	-0.276*	-0.363*	0.269**	-1.611	-0.229**
L3*T2	-10.755**	-0.304	0.079	1.602*	-3.914**	-1.227**	0.133	0.195	-0.165*	0.648	-0.016
L3*T3	21.111**	0.280	0.037	2.073**	-5.845**	0.616**	0.251	0.940**	0.421**	-2.623	0.170**
L3*T4	-25.422**	1.238	0.220	-4.869**	0.465	-1.921**	-0.195	-0.336*	-0.243**	-8.094**	0.329**
L3*T5	7.440**	-0.512	-0.055	-3.502**	-0.628	0.986**	0.089	0.171	-0.214**	1.360	-0.355**
L3*T6	-19.264**	-1.762*	-0.355**	0.223	-0.687	-0.661**	-0.149	-0.732**	-0.174*	2.998	-0.130*
L3*T7	12.561**	2.363**	0.187	6.627**	6.681**	-0.263**	0.148	0.126	0.107	7.323**	0.232**
L4*T1	31.428**	-2.732**	-0.056	2.119**	6.647**	-2.047**	-0.321*	0.140	0.300**	9.611**	-0.345**
L4*T2	7.145**	3.768**	0.236*	-3.427**	-4.220**	-1.359**	-0.161	0.149	0.246**	-6.281**	0.018
L4*T3	-24.289**	-1.149	-0.006	4.544**	6.644**	0.484**	0.077	-0.311*	-0.174*	-1.302	0.294**
L4*T4	25.178**	2.310**	-0.123	-0.198	-18.341**	-0.893**	-0.060	-0.538**	-0.507**	-4.273	0.723**
L4*T5	8.140**	-0.940	-0.198	-2.231**	3.551**	3.954**	-0.386**	0.119	-0.189*	-1.418	0.049
L4*T6	-32.064**	1.310	-0.098	3.694**	-1.662	-2.013**	0.417**	0.176	-0.109	2.619	-0.426**

Table 3. (cont.)

Crosses	Plant height (cm)	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	Relative water content (%)	Specific leaf weight (mg cm^{-2})	C.G.R at peak flowering (g m^{-2} day^{-1})	C.G.R at boll formation (g m^{-2} day^{-1})	C.G.R at maturity (g m^{-2} day^{-1})	No. of bolls plant^{-1}	Boll weight (g)
L4*T7	-15.539**	-2.565**	0.244*	-4.502**	7.381**	1.875**	0.434**	0.265	0.433**	1.044	-0.313**
L5*T1	2.828	-0.232	-0.242*	4.005**	1.632	-2.081**	0.815**	1.083**	0.499**	-0.132	0.323**
L5*T2	7.445**	1.768*	0.350**	-2.441**	-4.815**	-0.064	-0.626**	-1.053**	-0.900**	-6.224**	0.297**
L5*T3	-7.289**	-2.649**	-0.292*	-2.470**	3.334**	-1.160**	-0.487**	0.187	-0.244**	-1.145	-0.237**
L5*T4	-2.522	-2.190**	-0.308**	3.088**	4.069**	1.003**	-0.434**	-0.235	0.677**	9.935**	-0.898**
L5*T5	-10.260**	4.560**	0.617**	-1.545*	0.821	-0.161*	0.440**	0.402**	0.426**	-5.411**	0.898**
L5*T6	-5.264*	-1.190	0.017	-5.020**	-5.497**	1.263**	-0.048	-0.021	-0.354**	-0.024	-0.307**
L5*T7	15.061**	-0.065	-0.142	4.384**	0.456	1.200**	0.339**	-0.363*	-0.103	3.001	-0.075
L6*T1	-18.165**	4.268**	0.344**	-3.274**	2.068	-0.227**	-0.311*	-0.279	0.743**	-4.454	0.772**
L6*T2	-26.848**	-0.732	-0.064	-0.470	-12.048**	0.661**	-0.791**	-0.281	-0.091	-3.495	0.335**
L6*T3	16.118**	-1.149	-0.006	-1.249	6.466**	-0.326**	0.057	-0.391**	-0.355**	0.284	-0.379**
L6*T4	2.985	-1.690*	-0.123	-2.190**	8.015**	0.427**	1.410**	2.378**	0.466**	3.463	-0.740**
L6*T5	7.498**	-1.440*	-0.198	4.976**	4.613**	-1.556**	-0.046	-0.390**	-0.375**	7.117**	-0.624**
L6*T6	-4.857	-1.190	-0.198	-0.499	5.794**	0.357**	0.097	-0.428**	0.185*	-0.595	0.351**
L6*T7	23.268**	1.935**	0.244*	2.705**	-14.908**	0.665**	-0.416**	-0.610**	-0.574**	-2.320	0.284**
L7*T1	-16.972**	4.768**	0.387**	-1.724*	6.268**	1.911**	1.054**	0.769**	0.406**	-7.961**	1.215**
L7*T2	20.045**	-1.732*	-0.121	3.430**	-2.289*	-0.581**	-0.567**	-1.328**	-0.373**	4.748*	0.138*
L7*T3	-5.389*	-0.149	0.037	-5.299**	-4.280**	0.293**	0.101	-0.313*	0.013	-0.623	-0.306**
L7*T4	-9.522**	-1.690*	-0.280*	1.960**	-4.575**	-0.404**	-0.005	0.001	-0.046	6.006*	-0.527**
L7*T5	2.840	-0.440	-0.055	-2.874**	11.947**	-0.998**	0.339**	-0.112	0.213**	-4.090	-0.091
L7*T6	6.636**	0.310	0.045	3.451**	3.298**	0.116	-0.459**	-1.180**	-0.257**	0.648	-0.056
L7*T7	2.361	-1.065	-0.013	1.055	-10.369**	-0.337**	-0.462**	2.163**	0.044	1.273	-0.373**
L8*T1	-18.458**	-2.232**	-0.227*	0.776	-12.003**	1.518**	-0.532**	-1.211**	-0.933**	-1.661	-0.634**
L8*T2	6.659**	2.268**	0.064	-0.670	14.345**	-2.579**	3.487**	4.787**	1.299**	-2.402	0.490**
L8*T3	-23.074**	-0.149	0.123	-2.199**	4.089**	0.589**	-0.684**	-0.468**	-0.346**	-6.373**	0.505**
L8*T4	9.392**	0.310	0.306**	1.860*	7.634**	0.592**	-0.601**	-0.659**	-0.244**	-0.144	0.405**
L8*T5	20.555**	0.560	0.031	1.026	-0.874	1.109**	-0.687**	-0.707**	0.484**	-0.440	0.250**
L8*T6	-3.349	-0.190	0.031	-1.749*	-0.717	-1.468**	-0.625**	-0.965**	-0.096	1.348	-0.355**
L8*T7	8.276**	-0.565	-0.327**	0.955	-12.474**	0.240**	-0.358**	-0.777**	-0.164*	9.673**	-0.662**
L9*T1	19.828**	1.696*	-0.113	1.733*	4.751**	-1.614**	-0.459**	-0.869**	-0.670**	-1.518	0.209**

Table 3. (cont.)

Crosses	Plant height (cm)	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	Relative water content (%)	Specific leaf weight (mg cm^{-2})	C.G.R at peak flowering (g m^{-2} day^{-1})	C.G.R at boll formation (g m^{-2} day^{-1})	C.G.R at maturity (g m^{-2} day^{-1})	No. of bolls plant^{-1}	Boll weight (g)
L9*T2	-23.155**	-1.804**	-0.021	-0.112	1.609	2.444**	-0.550**	-1.096**	-0.258**	1.640	-0.408**
L9*T3	3.911	1.780*	0.137	-3.242**	9.324**	-0.723**	-0.062	-0.366*	0.077	-1.780	0.368**
L9*T4	-23.722**	0.738	0.020	2.417**	6.988**	2.440**	0.182	-0.667**	-0.211*	0.149	0.108
L9*T5	6.640**	-1.512*	0.045	1.383	-12.989**	-1.683**	-0.374**	0.305*	0.617**	3.303	-0.317**
L9*T6	17.736**	0.238	0.145	-1.092	-11.908**	0.320**	1.548**	4.057**	0.617**	-2.010	0.188**
L9*T7	-1.239	-1.137	-0.213	-1.088	2.225*	-1.183**	-0.285*	-1.365**	-0.171*	0.215	-0.149**
L10*T1	-7.543**	-2.018**	-0.227*	-3.838**	-7.225**	-0.496**	0.602**	0.500**	-0.117	2.068	-0.547**
L10*T2	36.673**	-1.518*	0.064	2.716**	3.609**	-0.738**	-0.749**	-0.756**	0.714**	3.826	-0.003
L10*T3	-27.360**	-3.435**	-0.277*	-1.613*	-10.832**	-1.084**	0.389**	0.624**	0.120	-1.345	-0.747**
L10*T4	-14.593**	1.024	0.206	-1.155	8.058**	1.468**	-0.178	-0.238	-0.179*	-2.215	0.412**
L10*T5	0.769	1.274	-0.169	0.612	7.745**	-0.785**	0.137	0.549**	-0.310**	-0.811	0.068
L10*T6	33.565**	3.524**	0.231*	4.737**	-2.744*	1.098**	-0.266*	-0.789**	-0.340**	1.326	0.603**
L10*T7	-21.510**	1.149	0.173	-1.459*	1.389	0.536**	0.066	0.110	0.111	-2.849	0.215**
L11*T1	-23.772**	-2.946**	0.030	-1.095	-11.790**	-0.125*	-0.459**	-0.077	-0.391**	1.096	-0.825**
L11*T2	-15.255**	-1.446*	-0.279*	-3.341**	7.498**	1.233**	0.350**	0.087	0.030	1.955	-0.822**
L11*T3	23.411**	1.137	-0.220	3.730**	-1.373	2.941**	-0.092	0.447**	0.546**	9.634**	-0.096
L11*T4	-6.422*	2.095**	0.163	-0.412	1.402	-2.571**	0.272*	-0.135	-0.053	-2.537	0.403**
L11*T5	8.840**	1.345	0.188	4.955**	-3.746**	-1.354**	-0.064	-0.633**	-0.464**	-1.833	0.839**
L11*T6	-0.164	-0.405	-0.012	0.880	8.301**	2.309**	-0.152	-0.016	0.196*	1.305	-0.036
L11*T7	13.361**	0.220	0.130	-4.716**	-0.292	-2.433**	0.145	0.327*	0.137	-9.620**	0.537**
L12*T1	21.771**	1.482*	0.030	3.190**	0.091	-2.016**	0.052	0.068	0.115	0.989	0.423**
L12*T2	-11.413**	-1.018	-0.079	-1.455	3.439**	1.142**	0.031	0.022	-0.134	-5.052*	0.317**
L12*T3	-0.446	1.565*	0.080	3.015**	-0.181	0.056	-0.280*	-0.483**	-0.189*	4.977*	-0.467**
L12*T4	1.221	-0.976	-0.337**	-0.126	-14.772**	1.788**	-0.047	0.140	0.063	3.856	-0.378**
L12*T5	-13.817**	-0.726	0.088	-2.760**	2.096	1.365**	-0.043	0.077	0.131	-0.090	-0.072
L12*T6	-1.821	-0.976	-0.012	-3.435**	-0.733	-2.382**	-0.101	-0.186	-0.049	-7.452**	0.323**
L12*T7	4.504	0.649	0.230*	1.570*	10.060**	0.046	0.386**	0.362*	0.063	2.773	-0.145*
SE (s_{ij})	2.511	0.679	0.113	0.733	1.071	0.063	0.128	0.146	0.080	2.315	0.056
CD at 5%	4.993	1.350	0.225	1.457	2.130	0.125	0.255	0.291	0.160	4.605	0.112

Table 3. (cont.)

Crosses	Ginning out-turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire (10^{-6} g inch^{-1})	Bundle strength (g tex^{-1})	Uniformity ratio	Fibre elongation (%)	Lint yield plant^{-1}(g)	Seed cotton yield plant^{-1} (g)
L1*T1	0.327	1.280**	0.745**	1.119*	0.305**	-0.398	-3.105**	-0.076	1.724	5.537
L1*T2	3.427**	-0.146	0.685**	-1.613**	0.500**	0.257	2.620**	0.208*	15.487**	27.996**
L1*T3	0.189	1.037**	0.580**	-0.255	0.611**	-1.085	-1.047	-0.051	3.973	10.392
L1*T4	-3.265**	-0.790**	-1.086**	0.878	-0.761**	1.236	-0.147	-0.071	-9.634**	-15.838
L1*T5	1.873**	-1.823**	-0.731**	-2.150**	-0.380**	-1.102	0.632	-0.313**	-1.319	-9.254
L1*T6	-1.569**	0.667**	0.145**	2.757**	-0.617**	1.182	-1.564	0.229*	-3.847**	-4.404
L1*T7	-0.982**	-0.225*	-0.338**	-0.736	0.342**	-0.089	2.611**	0.074	-6.383*	-14.429
L2*T1	-0.180	0.347**	0.311**	-1.013	0.274*	-1.976**	1.980*	0.103	1.990	-1.191
L2*T2	-0.130	-1.959**	-1.079**	-2.570**	-0.886**	-0.522	2.405**	-0.514**	-2.026	-3.933
L2*T3	-1.818**	0.844**	-0.994**	1.523**	-0.270*	0.936	-2.861**	0.078	3.859	18.363*
L2*T4	0.128	0.927**	0.639**	-0.644	0.223*	-1.043	0.239	0.357**	0.277	1.334
L2*T5	2.565**	0.954**	1.694**	-0.953	0.045	0.920	2.018*	-0.035	0.672	-5.183
L2*T6	0.724*	-1.136**	-0.450**	0.090	0.437**	-0.897	-0.328	-0.093	-0.011	-1.133
L2*T7	-1.289**	0.022	-0.122*	3.567**	0.176	2.582**	-3.453**	0.103	-4.762	-8.258
L3*T1	-0.366	0.404**	0.088	0.248	-0.109	-0.890	-0.098	0.396**	-4.894	-11.120
L3*T2	-1.166**	-0.592**	-0.572**	-1.360*	0.076	-0.186	1.077	-0.121	-0.286	3.939
L3*T3	2.596**	-0.908**	0.113*	0.604	-0.378**	-0.978	-1.140	-0.029	1.175	-6.065
L3*T4	-2.558**	1.484**	0.207**	2.582**	0.100	2.293**	0.760	0.100	-9.692**	-18.995*
L3*T5	-1.370**	-0.379**	-0.498**	0.218	0.227*	0.655	-1.211	0.108	-4.372	-7.911
L3*T6	1.888**	0.171**	0.567**	-2.750**	0.279*	-1.411*	1.293	-0.300**	3.570	3.039
L3*T7	0.976**	-0.181**	0.095	0.458	-0.196	0.518	-0.682	-0.154	14.499**	37.114**
L4*T1	2.027**	-1.114**	-0.206**	-1.295*	-0.275*	-0.719	-0.591	-0.168	9.700**	19.409*
L4*T2	2.177**	-0.801**	-0.086	0.357	-0.260*	-0.615	0.134	-0.035	-6.071	-24.233**
L4*T3	-3.561**	-0.367**	-0.931**	0.431	-0.384**	0.543	0.417	0.057	1.074	16.663
L4*T4	-4.865**	-0.354**	-1.068**	-0.261	0.199	0.364	-0.783	-0.064	-2.428	11.734

Table 3. (cont.)

Crosses	Ginning out-turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire (10^{-6} g inch^{-1})	Bundle strength (g tex^{-1})	Uniformity ratio	Fibre elongation (%)	Lint yield plant^{-1} (g)	Seed cotton yield plant^{-1} (g)
L5*T1	2.277**	0.836**	0.895**	-0.317	0.206	-0.276	0.109	-0.190*	6.370*	9.895
L5*T2	2.827**	-0.631**	0.355**	1.266*	0.036	-0.072	2.184**	0.193*	-2.041	-15.147
L5*T3	1.239**	-0.587**	0.010	-2.235**	0.037	-0.514	0.067	-0.115	-1.121	-7.851
L5*T4	1.235**	0.026	0.284**	0.128	-0.480**	-0.243	-1.233	0.114	2.457	1.720
L5*T5	-3.127**	-0.277*	-0.851**	2.649**	0.442**	2.420**	-2.004*	0.073	0.337	11.903
L5*T6	-1.069**	0.383**	0.015	1.066*	0.019	-0.397	-0.299	-0.086	-5.431	-11.847
L5*T7	-3.382**	0.251*	-0.708**	-2.557**	-0.261*	-0.918	1.176	0.010	-0.572	11.328
L6*T1	0.627	0.577**	0.480**	-0.023	0.000	-0.226	1.259	0.110	2.531	5.838
L6*T2	-1.173**	-0.469**	-0.530**	1.610**	0.115	2.978**	-3.166**	0.293**	-0.686	1.996
L6*T3	-0.161	0.154	0.155**	0.093	0.396**	0.536	1.217	0.085	-3.520	-9.408
L6*T4	1.635**	0.267*	0.438**	0.551	0.319**	-0.493	-0.233	-0.186*	-2.652	-13.137
L6*T5	2.723**	-0.136	0.633**	-1.223*	-0.200	-2.180**	0.196	-0.027	3.213	-1.654
L6*T6	-2.069**	0.034	-0.501**	-1.460**	-0.052	-0.197	1.801*	-0.086	1.865	13.096
L6*T7	-1.582**	-0.428**	-0.674**	0.452	-0.578**	-0.418	-1.074	-0.190*	-0.751	3.271
L7*T1	1.348**	0.603**	0.831**	0.066	-0.014	0.938	-1.962*	-0.147	2.412	2.623
L7*T2	-2.652**	0.666**	-0.269**	1.098*	-0.539**	0.642	-2.087*	-0.164	6.116	27.582**
L7*T3	1.561**	1.000**	1.236**	1.577**	-0.053	0.651	2.946**	0.078	-2.333	-11.923
L7*T4	0.457	-1.297**	-0.761**	-1.600**	-0.195	-1.429*	0.196	-0.243**	0.119	-2.052
L7*T5	1.244**	-2.070**	-1.166**	1.471**	0.147	0.584	2.075*	0.115	-3.620	-14.468
L7*T6	-0.448	0.740**	0.340**	0.113	0.204	0.617	-1.021	0.057	0.866	3.682
L7*T7	-1.510**	0.358**	-0.212**	-2.724**	0.449**	-2.004**	-0.146	0.303**	-3.560	-5.443
L8*T1	-3.238**	-1.396**	-1.402**	-0.744	0.233*	0.524	2.995**	-0.040	-12.080**	-24.263**
L8*T2	-0.238	2.308**	1.218**	0.719	0.358**	-0.572	-0.280	0.243**	2.829	8.896
L8*T3	1.975**	-1.008**	-0.117*	-0.162	-0.701**	-0.214	-1.597	-0.215*	-1.541	-9.508
L8*T4	0.871**	0.994**	0.717**	-0.260	0.392**	-1.043	-2.247**	-0.186*	6.107	14.063
L8*T5	-0.742*	0.301**	-0.058	-1.173*	0.243*	-1.030	0.532	0.073	3.017	10.946
L8*T6	-1.833**	-1.909**	-1.543**	-0.231	-0.899**	2.053**	-1.014	0.014	-4.961	-7.604
L8*T7	3.204**	0.709**	1.185**	1.851**	0.375**	0.282	1.611*	0.110	6.628*	7.471
L9*T1	-1.752**	1.014**	-0.102*	0.999	0.298**	-0.562	0.638	-0.068	-0.826	4.495
L9*T2	-0.152	-0.852**	-0.482**	-1.053*	0.303**	-0.408	1.512	-0.385**	-3.338	-8.647
L9*T3	-1.389**	1.152**	0.573**	1.690**	0.199	0.701	1.646*	-0.043	-1.047	1.749

Table 3. (cont.)

Crosses	Ginning out-turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire (10^{-6} g/inch)	Bundle strength (g/tex)	Uniformity ratio	Fibre elongation (%)	Lint yield plant^{-1} (g)	Seed cotton yield plant^{-1} (g)
L9*T4	3.557**	-0.326**	0.767**	-0.937	-0.288*	1.121	-0.554	-0.114	5.811	3.620
L9*T5	1.744**	-0.889**	-0.288**	0.205	-0.392**	-0.866	-2.625**	-0.356**	2.371	0.803
L9*T6	-2.448**	1.041**	0.027	-0.403	0.431**	-0.433	-0.321	0.686**	-2.382	1.453
L9*T7	0.440	-1.141**	-0.495**	-0.501	-0.550**	0.446	-0.296	0.282**	-0.588	-3.472
L10*T1	0.955**	-1.043**	-0.388**	1.478**	-0.866**	1.645*	-0.370	-0.040	-3.438	-10.541
L10*T2	1.655**	2.190**	1.743**	0.115	0.394**	-0.251	-1.095	0.493**	7.650*	14.317
L10*T3	-2.782**	-1.231**	-1.323**	-0.926	0.229*	0.358	-1.111	0.135	-15.214**	-32.437**
L10*T4	2.464**	-0.453**	0.251**	0.477	0.297*	0.329	0.589	0.064	5.633	6.284
L10*T5	-3.049**	-0.507**	-1.084**	-1.522**	-0.686**	-0.859	1.568	-0.327**	-3.726	0.167
L10*T6	0.260	1.523**	1.012**	-0.455	0.366**	-0.876	0.122	-0.036	9.645**	25.217**
L10*T7	0.497	-0.478**	-0.211**	0.833	0.266*	-0.346	0.297	-0.290**	-0.550	-3.008
L11*T1	-2.423**	-1.948**	-1.629**	0.003	0.016	0.852	0.430	0.032	-11.938**	-23.934**
L11*T2	-0.973**	-1.605**	-1.199**	0.825	-0.474**	-0.343	-3.445**	-0.135	-10.220**	-24.376**
L11*T3	2.389**	1.409**	1.426**	-0.996	0.327**	-0.185	-0.611	0.007	15.526**	31.620**
L11*T4	-2.815**	0.352**	-0.511**	-0.583	0.094	-0.314	3.439**	0.186*	-0.347	10.491
L11*T5	0.423	1.208**	0.924**	0.523	0.006	0.098	0.468	0.144	7.734*	20.174*
L11*T6	4.831**	-0.482**	0.820**	-1.260*	0.199	-0.668	1.222	-0.164	6.630*	1.424
L11*T7	-1.432**	1.067**	0.168**	1.488**	-0.167	0.561	-1.503	-0.068	-7.385*	-15.401
L12*T1	0.398	0.439**	0.375**	-0.521	-0.069	1.088	-1.284	0.089	8.448**	23.252**
L12*T2	-3.602**	1.892**	0.215**	0.607	0.376**	-0.908	0.141	-0.078	-7.414*	-8.390
L12*T3	-0.239	-1.494**	-0.730**	-1.345*	-0.013	-0.749	2.074*	0.014	-0.833	-1.594
L12*T4	3.157**	-0.831**	0.124*	-0.332	0.100	-0.779	-0.026	0.043	4.350	0.777
L12*T5	-0.756*	1.235**	0.449**	0.870	-0.043	1.084	-1.996*	0.201*	-1.745	-2.440
L12*T6	-1.148**	-0.475**	-0.455**	2.647**	-0.556**	1.517*	-0.642	-0.107	-6.503*	-13.990
L12*T7	2.190**	-0.766**	0.022	-1.926**	0.204	-1.254	1.733*	-0.161	3.696	2.385
SE (s_{ij})	0.318	0.107	0.049	0.523	0.111	0.634	0.808	0.091	3.126	8.412
CD at 5%	0.633	0.212	0.098	1.040	0.221	1.260	1.607	0.182	6.218	16.732

L1 = RAH 100-32 , L2 = SC 7, L3 = RAH 370, L4 = GCOT 16, L5 = RAH 178-4, L6 = RACH 99- 152, L7 = SM 1, L8 = RAH 97-612,
L9 = RAH 111, L10 = NAWAB, L11 = RAH 178, L12 = RAC 99152.
T1 = SC 68, T2 = SC7 IPS, T3 = SC 40, T4 = SC 79, T5 = C 11, T6 = NAWAB 8, T7 = SC 31.

RESULTS AND DISCUSSION

The analysis of variance shown in Table1 revealed significant differences among hybrids indicated the existence of variability among the cross combinations for all 21 characters studied. The line x tester component also exhibited significant variability for all characters studied.The line x tester component had the maximum share of genetic variance in all the characters studied. The GCA/ SCA ratio was less than unity for all the traits studied suggesting that these characters were governed predominantly by non-additive components. These components can be exploited by heterosis breeding programme. These findings support earlier observations of Senthilkumar *et al.,* (2010) and Ashok Kumar *et al.,* (2010) for plant height, days to 50% flowering, number of sympodia per plant, number of bolls per plant, 2.5% span length and seed cotton yield per plant. Senthilkumar *et al.,* (2010) and Saravanam *et al.,* (2010) for boll weight and ginning out-turn, Ashok Kumar (2010) and Saravanam *et al.,* (2010) for seed index, lint index, micronaire, bundle strength ,fibre strength and Saravanam *et al.,* (2010)for uniformity ratio.

In the present study combining ability effects were studied Table 2 in which line RAC 99152 followed by RAH 178-4 and NAWAB were and among testers, SC 68 followed by SC 7-IPS and SC 40 were identified as good general combiners for majority of the traits studied . These may serve as potent general combiners in future breeding programmes for improvement of different traits. In the present study, there was no relationship between *per se* performance of hybrids and *gca* effects of parents which indicated the presence of epistatic interaction also. Further studied through generation mean analysis or triple test cross analysis may bring out useful information on the nature of gene interaction in the material

The crosses RAH 370 x SC 31, RAH 178 x SC 40, RAH 100-32 x SC 7-IPS and SM 1x SC 7-IPS exhibited significant standard heterosis over standard check hybrid Mallika Bt. The results suggested that high yield does not necessarily depend on high heterotic expression of all yield components (Preetha and Raveendran 2008). Thus from the above study based on the overall performance (*per se* performance, high *sca* effect and significant standard heterosis) Table 3. The crosses RAH 370 x SC 31 (Low x Low) and RAH 178 x SC 40 (Low x Low) were identified as promising hybrids for heterosis breeding. Superiority of low x low combiners may be due to nicking ability/genetic diversity of the parents involved in the cross combinations. This suggested the possibility of direct exploitation of these hybrids for commercial exploitation after thorough testing over larger number of diversified environments and seasons. Further these hybrids may also be utilized in basic breeding programmes. The study also indicated the possibility of developing compact to semi-compact hybrids with high seed cotton yield and acceptable fibre qualities through heterosis breeding.

LITERATURE CITED

Ashok Kumar K, Ravikesavan R and Kirubakaran Silvas Jebakumar Prince 2010 Combining ability estimates for yield and fibre quality traits in line x tester crosses of upland cotton (*Gossypium hirsutum* L.) *International Journal of Biology,* 2 (1) : 179-183.

Kempthorne O 1957 An Introduction to Genetic Statastics. *John Wiley and sons Inc*, New York pp: 458-471.

Preetha S and Raveendran T S 2008 Combining ability studies for yield and fibre quality traits in line x tester crosses of upland cotton (*Gossypium hirsutum* L.). *International Journal of Plant Breeding and Genetics*, 2(2): 64-67.

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

Senthilkumar R, Ravikesavan R, Punitha D, Rajarathinam S 2010 Genetic analysis in cotton. *Electronic Journal of Plant Breeding,* 1(4): 846-851

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