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Identification of superior combiners and combinations of stay green lines against high rgr testers of cotton (*Gossypium hirsutum* L.)

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Abstract
Formation and exploitation of heterotic groups has helped in enhancing heterosis level in cross-pollinated crops. The principles of heterotic grouping and its exploitation by reciprocal selection can be applied for self pollinated crop like cotton with modifications suitable for mating system of cotton. At ARS Dharwad, continuous studies on series of hybrids helped in understand complementation patterns between different plant types; on the basis of these, different heterotic groups like Stay Green, High RGR, Compact etc., were made. In the present study broad based heterotic box was formed by using four elite combiner parents from Stay Green heterotic group. An attempt was made to follow recurrent selection for combining ability for exploiting the Stay Green group and improving performance of cotton hybrids. Twenty double cross F_3 lines of Stay Green group were used as base material for practicing recurrent selection against three high RGR testers producing 60 derived F_1s. The derived F_1s were evaluated during *kharif* 2018. Analysis of variance for combining ability revealed significance of mean sum of square due to crosses for all the characters. The lines SG 13 and SG 12 were identified as good general combiners for most of the yield and yield attributing traits like seed cotton yield, lint yield, number of bolls per plant, boll weight and lint index. The derived F_1s SG14 × RCR-4 and SG16 × RCR-4 were best specific combiners for yield and yield attributing traits like seed cotton yield, Lint yield, number of bolls per plant, boll weight and lint yield.

Keywords: Heterotic group, heterotic box, stay green group, derived F_1s

Introduction

The improvement in the cotton productivity in the recent decades is mainly contributed by cultivation of hybrids and adoption of Bt technology. In India hybrid cotton is cultivated in an area of 31.80 million hectares (Anon., 2017) [1] accounting for over 95 % of total cotton area, indicating the predominance and acceptance of hybrid cotton by Indian farmers. The commercial exploitation of heterosis in cotton has taken place at a revolutionary scale which is parallel to success of hybrid breeding in maize, but unfortunately this is not supported by development of hybrid oriented populations and their exploitation by following population improvement procedures as seen in case of cross pollinated crops like maize. There are no systematic procedures of hybrid development in any self-pollinated crop. Breeding procedures aimed at developing better hybrids in cotton must focus on identifying diverse groups of genotypes which are known to give better hybrids between them; once such groups are made the elite combiners of each group can be recombined for creating variability for ability to combine with opposite groups (Patil *et al.*, 2007) [2].

In conventional reciprocal recurrent selection schemes defined for cross pollinated crop like maize, random mating opposite populations are used as base material for practicing reciprocal selection. Since cotton is predominantly self pollinated crop, naturally random mating populations do not exist in cotton but segregating populations based on varietal lines representing opposite heterotic groups can be developed. Unlike in maize, segregating lines of cotton can be subjected to selfing without any inbreeding depression. The segregating lines from opposite populations can be used as base population for practicing reciprocal selection for combining ability. Hence, the principles of formation of heterotic groups and their exploitation by following population improvement schemes can also be applied to self pollinated crop like cotton with required modifications to suit the mating system of cotton (Patil and Patil, 2003) [3].

In this regard at ARS, Dharwad, Continuous studies on series of hybrids helped in understanding complementation patterns between different plant types; on the basis of these complementation patterns, different heterotic groups like Stay Green, High RGR, Compact, Robust *etc.*, were made and heterotic patterns of these groups were identified.

Once the opposite groups are identified they can be exploited by forming heterotic boxes (elite lines of a group selected to create variability for combining ability by recombination). In the present study four elite combiner lines of Stay Green group were utilized for creating variability for combining ability by forming heterotic box against testers of High RGR group.

Material and methods

In the present study Stay Green heterotic box was formed by using double cross (four parent based) F_1 (SG 102 × SG 109) × (SG 16 × SG 358). This double cross F_1 was advanced to F_3 generation where 20 double cross F_3 lines were selected for testing combining ability against testers from High RGR group. Three testers SG 102, SG 109 and SSG 2 from High RGR group were used for testing combining ability of the derived F_3 lines of Stay Green group. The 20 double cross F_3 lines of Stay Green group were crossed to three testers from high RGR group in a Line × Tester fashion producing sixty derived F_1s.

These sixty derived F_1s were evaluated during *Kharif* 2018-19 at Botany garden, Main Agricultural Research Station, UAS, Dharwad. The derived F_1s were raised in randomized block design with two replications per each entry. Fertilizers at recommended doses were applied and other cultural practices were carried out at regular intervals. Plant protection measures were taken up at appropriate times to control pests and diseases. Observations were recorded on following thirteen quantitative characters viz., seed cotton yield, lint yield, number of bolls, boll weight, ginning outturn, lint index, seed index, sympodial length, plant height, inter boll distance, Inter branch distance, number of sympodia and number of monopodia. Observations on these characters were subjected to Line × Tester analysis given by Kempthorne (1957) [4].

Results and Discussion

The analysis of variance (ANOVA) for combining ability for different traits is presented in Table 1. Combining ability analysis of derived F_1s of Stay Green group revealed that the difference between the crosses was significant for all the characters. The mean sum of square due to line effect was significant for the characters number of monopodia per plant and number of bolls. Mean squares due to tester effect were significant for the characters, number of monopodia and inter branch distance. Line × Tester mean sum of square was significant for all the characters except for ginning outturn. The magnitude of SCA variance was more than GCA variance for all the characters except for number of monopodia indicating preponderance of non additive gene action. Similar results were observed by Yanal *et al.* (2013) [5], Kencharaddi *et al.* (2015) [6], Girish and patil (2017) [7], Rajeev *et al.* (2018) [8] and Rajeev and Patil (2018) [9].

The estimates of general combining ability effects of Stay Green lines are presented in table 2 and the estimates of sca effects of derived F_1s are presented in table3. The results revealed that, out of twenty lines, five lines showed positive significant gca and seven lines showed negative significant gca effects for seed cotton yield. The lines SG 13, SG 12, SG 8, SG 19 and SG 6 were identified as good general combiners for seed cotton yield. Out of three testers, RGR 2572 (117.885) was the only tester which showed positive significant gca effect for seed cotton yield. The sca effects for seed cotton yield were significant for twenty hybrids, out of which ten were positively significant and ten were negatively significant. SG14 × RCR-4, SG16 × RCR-4, SG17 × RB2F2-15, SG2 × RGR 2572 and SG3 × RB2F2- 15 were the top five derived F_1s with highest positive sca effects for seed cotton yield. Similar findings were observed by Rajeev and Patil (2018) [9] and Thiyagu *et al.* (2019) [10].

For lint yield, four lines SG 13, SG 12, SG 8, and SG 19 were having positive significant gca effects and these lines were considered as good general combiners. Among the testers RGR 2572 (53.198) was having positive significant gca effect. Out of sixty derived F_1s, nine were having positive significant sca and eight were having negative significant sca. The hybrids SG16 × RCR-4 (330.485) and SG19 × RCR-4 (-265.706) have shown highest and lowest significant sca effects, respectively. SG16 × RCR-4 (330.485), SG17 × RB2F2- 15 (318.125) and SG14 × RCR-4(313.815) were the top three hybrids with highest sca effects. Similar results were observed by Kencharaddi *et al.* (2015) [6] and Rajeev and Patil (2018) [9].

For ginning outturn two lines showed positive significant gca and two lines showed negative significant gca effect. The best combiner lines identified were SG 3 (1.618), SG 10 (1.265). Out of sixty derived F_1s, none of the F_1s showed significant sca effects. For the character number of bolls per plant four lines revealed positive significant gca effects. The top three best combiners were SG 13 (6.179), SG 1 (5.962) and SG 6 (3.701). Among the testers RGR 2572 (1.729) showed positive significant gca effect. The sca effects were positively significant for three hybrids and negatively significant for one hybrid. SG14 × RCR-4(8.169), SG17 × RB2F2 15 (8.15) and SG16 × RCR-4 (7.119) were the top three hybrids with positive sca effects. Similar findings were reported by Girish and patil (2017) [7], Rajeev *et al.* (2018) [8], Rajeev and Patil (2018) [9] and Thiyagu *et al.* (2019) [10].

For boll weight, three lines showed positive significant gca and two lines showed negative significant gca. The top three best combiners for boll weight were SG 13 (1.01), SG 12 (0.508) and SG 11 (0.432). The sca effects were significant for eleven hybrids, out of which six were positively significant. The top three hybrids with highest sca effects were SG2 × RGR 2572 (1.406), SG14 × RCR-4 (1.356) and SG11 × RB2F2- 15 (1.287). Similar findings were reported by Kencharaddi *et al.* (2015) [6], Girish and patil (2017) [7], Rajeev and Patil (2018) [9] and Thiyagu *et al.* (2019) [10].

The lines SG 13 and SG 12 were good general combiners for most of the yield attributing traits like seed cotton yield, lint yield, number of bolls per plant, boll weight and lint index. Hence these two lines are most useful lines for developing hybrids with High RGR group testers. Among the derived F_1s SG14 × RCR-4 and SG16 × RCR-4 were best specific combiners for yield attributing traits like seed cotton yield, Lint yield, number of bolls, boll weight and lint yield. The combining ability status of most productive crosses and their parents in this study can be utilized for drawing the inference about handling the best crosses identified in the present study. The potential derived hybrids identified can be promoted for multi location trials. The elite combiner lines identified can be recombined to create a improved version of base population, the improved version of base population can be utilized for practicing another cycle of recurrent selection against high RGR testers.

Table 1: ANOVA for combining ability involving crosses of Stay Green F_3 lines with High RGR testers

	DF	Number of monopodia	Number of sympodia	Number of bolls	Plant height (cm)	Sympodial length (cm)	Inter boll distance (cm)	Interbranch distance (cm)	Seed cotton yield (kg/ha)	Seed index (g)	Boll weight (g)	Ginning outturn (%)	Lint index (g)	Lint yield (kg/ha)
Replicates	1	0.963*	59.038**	3.224	272.767**	4.343	3.759**	1.853	560803.50**	0.133	2.002**	144.058**	8.840**	243853.00**
Crosses	59	0.752**	7.770**	48.977**	244.309**	57.331**	1.294**	5.176**	393513.50**	3.014**	0.946**	3.677*	1.331**	60433.59**
Line Effect	19	0.897**	9.073	71.688*	320.582	76.957	1.346	4.517	479273.7	2.972	0.997	4.215	1.573	70380.24
Tester Effect	2	6.749**	13.136	92.944	527.99	27.971	2.181	36.838**	447040.2	4.8	0.696	7.623	2.715	85611.6
Line x Tester Eff.	38	0.364**	6.836**	35.307**	191.243**	49.064**	1.221**	3.840**	347816.20**	2.940**	0.934**	3.2	1.137**	54135.10**
Error	59	0.162	1.72	17.121	24.268	14.21	0.317	1.666	45941.92	0.455	0.241	2.295	0.327	7916.561
Total	119	0.462	5.201	32.798	135.452	35.507	0.83	3.408	222593.9	1.721	0.606	4.172	0.896	35937.07
s^2gca		0.16	0.41	2.83	17.39	1.66	0.06	0.83	18139.78	0.15	0.03	0.16	0.08	3046.93
s^2sca		0.10	2.56	9.09	83.49	17.43	0.45	1.09	150937.13	1.24	0.35	0.45	0.41	23109.27

Table 2: General combining ability effects of Stay Green F_3 lines against High RGR testers

S. No.		Number of monopodia	Number of sympodia	Number of bolls	Plant height (cm)	Sympodial length (cm)	Inter boll distance (cm)	Inter branch distance (cm)	Seed cotton yield (kg/ha)	Seed index (g)	Boll weight (g)	Ginning outturn (%)	Lint index (g)	Lint yield (kg/ha)
1	SG 1	-0.284	-2.219**	5.962***	-8.309***	-0.093	0.299	-0.101	159.763	-0.067	-0.132	-0.367	-0.114	61.221
2	SG 2	-0.492**	0.156	0.272	-2.462	-3.676*	-0.824***	0.219	120.655	-0.567*	0.066	-0.218	-0.396	45.451
3	SG 3	-0.409*	-1.344*	-1.793	-3.142	0.49	0.463*	0.524	-35.54	-0.067	-0.227	1.618*	0.313	10.028
4	SG 4	0.216	-0.386	-4.579**	-2.809	0.574	-0.106	0.149	-385.818***	1.933***	-0.322	0.953	1.528***	-140.215***
5	SG 5	-0.117	-0.511	-3.636*	12.892***	-4.093*	-0.519*	-0.892	-312.913***	0.1	-0.530*	0.03	0.036	-122.507**
6	SG 6	0.841***	0.156	3.526*	-2.309	3.657*	-0.079	-0.559	188.587*	0.600*	0.432*	-1.440*	0.068	51.493
7	SG 7	0.049	-1.178*	-2.063	2.941	5.990***	-0.394	0.191	-351.517***	-0.067	-0.339	0.177	0.011	-136.295***
8	SG 8	0.424*	-1.053	2.947	-7.392***	-0.135	0.398	2.108***	294.997**	-0.233	0.183	-1.763**	-0.551*	83.075*
9	SG 9	0.341*	-0.553	3.172	0.274	-1.051	0.753**	0.733	167.488	0.933**	0.262	-0.707	0.463	55.715
10	SG 10	-0.076	-1.719**	-1.713	13.101***	-1.635	-0.617**	-0.309	-175.703*	0.1	0.081	1.265*	0.341	-49.312
11	SG 11	-0.034	0.822	-2.466	0.566	2.907	-0.514*	-1.101*	-315.192***	-1.400***	0.393	0.495	-0.847***	-116.810**
12	SG 12	-0.159	-0.594	3.701*	-1.517	2.824	0.276	-0.559	339.548***	-0.233	0.508*	-0.138	-0.181	134.023***
13	SG 13	0.091	1.447**	6.179***	13.816***	3.240*	-0.289	1.149*	591.683***	0.767**	1.010***	-0.072	0.486*	234.776***
14	SG 14	0.578***	-0.511	-0.958	4.191*	-4.718**	-0.269	-1.267*	-66.76	-0.233	-0.189	-0.873	-0.357	-47.895
15	SG 15	0.049	1.281*	2.192	-1.642	-6.010***	-0.239	-1.309*	152.378	-0.067	0.222	0.367	0.063	71.675
16	SG 16	-0.006	1.586**	1.477	8.358***	-6.606***	-0.314	0.553	168.628	-0.567*	-0.33	-0.12	-0.437	51.13
17	SG 17	-0.867***	-0.261	-4.708**	0.233	-0.76	0.346	-0.559	-164.902	0.433	-0.353	-0.238	0.229	-65.14
18	SG 18	-0.034	1.822**	-3.271	6.941**	3.824*	0.603*	0.399	-247.978**	-0.567*	-0.303	-0.232	-0.424	-100.657**
19	SG 19	0.216	1.822**	-0.138	12.066***	3.574*	0.321	0.858	257.908**	-0.067	0.205	0.973	0.176	126.651***
20	SG 20	-0.326	1.239*	-4.108*	6.191**	1.699	0.703**	-0.226	-385.313***	-0.733**	-0.637**	0.29	-0.407	-146.407***
	SE (g_i)	0.16	0.54	1.69	2.01	1.54	0.23	0.53	87.50	0.28	0.20	0.62	0.23	36.32
	C.D. (g_i) 5 %	0.33	1.07	3.38	4.02	3.08	0.46	1.05	175.10	0.55	0.40	1.24	0.47	72.68
	C.D. (g_i) 1 %	0.44	1.43	4.50	5.35	4.10	0.61	1.40	232.92	0.73	0.53	1.65	0.62	96.69
	SEd (g_i - g_j)	0.23	0.76	2.39	2.84	2.18	0.33	0.75	123.75	0.39	0.28	0.87	0.33	51.37
1	RGR T1	-0.463***	0.445*	1.729*	-2.111**	-0.895	-0.146	-0.784***	117.885***	-0.2	-0.151	0.351	-0.045	53.198***
2	RGR T2	0.320***	0.201	-0.579	-2.084**	0.761	-0.124	-0.286	-31.494	-0.2	0.094	-0.489*	-0.235*	-22.387
3	RGR T3	0.143*	-0.647**	-1.15	4.195***	0.134	0.269**	1.070***	-86.391*	0.400***	0.057	0.138	0.280**	-30.811*
	SE (g_i)	0.06	0.21	0.65	0.78	0.60	0.09	0.20	33.89	0.11	0.08	0.24	0.09	14.07
	C.D. (g_i) 5 %	0.13	0.41	1.31	1.56	1.19	0.18	0.41	67.81	0.21	0.16	0.48	0.18	28.15
	C.D. (g_i) 1 %	0.17	0.55	1.74	2.07	1.59	0.24	0.54	90.21	0.28	0.16	0.64	0.24	37.45
	SEd (g_i - g_j)	0.09	0.29	0.93	1.10	0.84	0.13	0.54	47.93	0.15	0.11	0.34	0.13	19.90

Table 3: Specific combining ability effects of derived F_1s of Stay Green F_3 lines against High RGR testers

S. No.	Derived F_1	Number of monopodia	Number of sympodia	Number of bolls	Plant height (cm)	Sympodial length (cm)	Inter boll distance (cm)	Inter branch distance (cm)	Seed cotton yield (kg/ha)	Seed index (g)	Boll weight (g)	Ginning outturn (%)	Lint index (g)	Lint yield (kg/ha)
1	SG1 × RGR 2572	0.13	-3.487**	1.916	-9.222*	-4.813	0.464	-0.049	479.639**	0.867	0.954**	0.926	0.776	207.273**
2	SG1 × RCR-4	-0.028	3.007**	-1.231	6.376	1.656	-0.458	0.453	-190.943	-0.133	-0.301	0.161	-0.068	-79.431
3	SG1 × RB2F2- 15	-0.101	0.48	-0.685	2.847	3.158	-0.006	-0.404	-288.696	-0.733	-0.653	-1.087	-0.708	-127.842*
4	SG2 × RGR 2572	0.463	2.263*	3.916	1.431	2.27	1.357**	1.256	593.557***	0.867	1.406***	-0.302	0.563	231.493***
5	SG2 × RCR-4	-0.07	-3.493***	-2.826	-4.181	-8.136**	-0.920*	0.343	-364.859*	-0.633	-1.044**	1.572	-0.121	-122.661
6	SG2 × RB2F2- 15	-0.393	1.23	-1.09	2.75	5.866*	-0.438	-1.599	-228.698	-0.233	-0.362	-1.27	-0.442	-108.832
7	SG3 × RGR 2572	0.005	-2.362*	-1.484	4.611	-0.897	0.576	0.951	-219.823	0.867	0.194	-1.844	0.175	-117.343
8	SG3 × RCR-4	0.097	2.257*	-3.261	-0.041	-3.178	-0.466	-0.047	-356.759*	-1.133*	-0.241	2.066	-0.355	-116.183
9	SG3 × RB2F2- 15	-0.101	0.105	4.745	-4.57	4.074	-0.109	-0.904	576.582***	0.267	0.047	-0.222	0.18	233.526***
10	SG4 × RGR 2572	-0.12	1.18	0.503	2.403	3.52	-0.521	1.701	86.79	-1.633**	0.274	0.541	-0.955*	40.905
11	SG4 × RCR-4	0.722*	1.174	-2.5	11.126**	-0.886	0.127	-0.672	-128.371	1.367**	-0.461	1.201	1.275**	-34.11
12	SG4 × RB2F2- 15	-0.601*	-2.353*	1.997	-13.529***	-2.634	0.394	-1.029	41.581	0.267	0.187	-1.742	-0.32	-6.795
13	SG5 × RGR 2572	0.338	0.68	-0.011	-14.514***	7.062*	1.282**	0.617	-140.29	-1.300**	-0.048	1.235	-0.594	-40.023
14	SG5 × RCR-4	-0.32	-0.826	1.632	5.959	-4.719	-0.23	1.744	58.074	0.2	-0.233	-0.201	0.102	22.922
15	SG5 × RB2F2- 15	-0.018	0.147	-1.621	8.555*	-2.342	-1.053*	-2.362*	82.216	1.100*	0.28	-1.034	0.492	17.101
16	SG6 × RGR 2572	-0.245	0.138	0.088	10.903**	0.937	0.027	-0.591	99.575	0.2	-0.659	0.965	0.39	54.877
17	SG6 × RCR-4	0.722*	-0.618	1.57	-1.124	-3.719	0.870*	0.786	201.614	0.7	0.141	0.719	0.575	89.772
18	SG6 × RB2F2- 15	-0.476	0.48	-1.658	-9.779**	2.783	-0.898*	-0.195	-301.189	-0.9	0.519	-1.684	-0.965*	-144.649*
19	SG7 × RGR 2572	-0.829**	1.097	-0.514	-3.847	-2.647	-0.003	0.409	-250.156	0.367	-0.214	-0.522	0.076	-106.475
20	SG7 × RCR-4	0.763**	-1.910*	4.459	-7.874*	1.697	0.44	-0.589	278.947	-2.133***	0.361	-0.068	-1.413***	113.115
21	SG7 × RB2F2- 15	0.065	0.813	-3.945	11.722**	0.949	-0.438	0.18	-28.791	1.767***	-0.147	0.59	1.337**	-6.64
22	SG8 × RGR 2572	0.172	-0.654	0.016	-17.014***	-1.522	0.121	-1.008	-124.545	0.533	-0.511	-1.552	-0.007	-78.22
23	SG8 × RCR-4	-0.487	0.59	-0.086	11.834**	4.572	-0.301	0.619	-178.076	-1.967***	0.304	1.222	-0.956*	-45.04
24	SG8 × RB2F2- 15	0.315	0.063	0.07	5.18	-3.051	0.181	0.388	302.621	1.433**	0.207	0.33	0.963*	123.26
25	SG9 × RGR 2572	0.255	-0.154	1.426	-5.681	-1.48	0.191	-0.758	334.079*	-0.633	-0.349	-0.369	-0.485	122.305
26	SG9 × RCR-4	-0.153	0.09	3.489	-15.083***	-1.761	-0.906*	-0.256	18.917	-0.633	0.186	0.076	-0.385	13.285
27	SG9 × RB2F2- 15	-0.101	0.063	-4.915	20.763***	3.241	0.716	1.013	-352.996*	1.267*	0.164	0.293	0.870*	-135.590*
28	SG10 × RGR 2572	-0.204	1.263	-1.239	0.944	1.229	-0.469	0.909	-11.31	-0.8	0.231	1.715	-0.179	19.687
29	SG10 × RCR-4	-0.112	0.382	2.984	-7.833*	-1.803	-0.306	-2.464**	196.929	0.2	-0.224	-1.721	-0.278	59.082
30	SG10 × RB2F2- 15	0.315	-1.645	-1.745	6.888	0.574	0.776	1.555	-185.619	0.6	-0.007	0.007	0.457	-78.769
31	SG11 × RGR 2572	0.005	1.722	1.754	11.153**	2.187	0.257	-2.049*	54.514	-0.3	-0.241	-0.006	-0.225	23.54
32	SG11 × RCR-4	-0.278	-0.535	-3.178	-0.624	5.156	0.11	1.828*	-135.208	1.700***	-1.046**	-0.066	1.120**	-51.725
33	SG11 × RB2F2- 15	0.274	-1.187	1.424	-10.529**	-7.342**	-0.368	0.222	80.694	-1.400**	1.287***	0.072	-0.895*	28.185
34	SG12 × RGR 2572	0.255	-0.737	-1.112	-0.014	-3.355	-0.098	1.659	-109.106	0.033	-0.756*	0.198	0.043	-40.008
35	SG12 × RCR-4	-0.278	0.882	-4.545	0.084	5.739*	0.745	-2.339*	-188.073	-0.467	-0.426	0.022	-0.281	-71.138
36	SG12 × RB2F2- 15	0.024	-0.145	5.657	-0.07	-2.384	-0.648	0.68	297.179	0.433	1.182**	-0.22	0.238	111.146
37	SG13 × RGR 2572	-0.495	-0.529	-3.591	-5.222	-0.897	-0.918*	-2.174*	-320.366*	-0.967*	-0.163	0.266	-0.549	-113.597
38	SG13 × RCR-4	0.097	0.465	0.727	5.876	0.447	-0.19	-0.422	453.547**	1.533**	0.217	-1.384	0.632	145.269*

39	SG13 × RB2F2- 15	0.399	0.063	2.864	-0.654	0.449	1.107**	2.597**	-133.181	-0.567	-0.055	1.118	-0.083	-31.672
40	SG14 × RGR 2572	-0.397	-0.945	-5.594	-0.597	-10.188***	-1.773***	-2.258*	-556.178***	-1.467**	-0.484	0.068	-0.950*	-209.675**
41	SG14 × RCR-4	0.235	0.299	8.169**	6.876	8.156**	1.345**	1.619	876.561***	0.533	1.356***	-1.173	0.07	313.815***
42	SG14 × RB2F2- 15	0.162	0.647	-2.575	-6.279	2.033	0.427	0.638	-320.383*	0.933	-0.871*	1.105	0.880*	-104.14
43	SG15 × RGR 2572	0.047	1.638	0.371	11.361**	4.854	-0.043	-0.466	1.224	0.367	-0.649	0.708	0.415	14.79
44	SG15 × RCR-4	-0.237	-2.618**	1.264	-8.666*	-4.928	-0.22	-0.339	-105.713	0.367	0.406	-1.288	-0.045	-61.83
45	SG15 × RB2F2- 15	0.19	0.98	-1.635	-2.695	0.074	0.262	0.805	104.489	-0.733	0.243	0.58	-0.37	47.04

Contd......

S. No.	Derived F_1	Number of monopodia	Number of sympodia	Number of bolls	Plant height (cm)	Sympodial length (cm)	Inter boll distance (cm)	Inter branch distance (cm)	Seed cotton yield (kg/ha)	Seed index (g)	Boll weight (g)	Ginning outturn (%)	Lint index (g)	Lint yield (kg/ha)
46	SG16 × RGR 2572	0.352	0.833	-3.974	10.986**	-7.175**	-0.993*	0.672	-238.171	1.367**	0.032	-2.105	0.455	-140.940*
47	SG16 × RCR-4	-0.182	2.202*	7.119*	-5.666	0.169	0.285	-0.701	809.897***	0.867	0.797*	0.029	0.61	330.485***
48	SG16 × RB2F2- 15	-0.17	-3.035**	-3.145	-5.32	7.006*	0.707	0.028	-571.726***	-2.233***	-0.830*	2.076	-1.065*	-189.545**
49	SG17 × RGR 2572	-0.162	0.555	-5.189	0.361	5.354*	0.087	0.284	-439.051**	0.367	0.036	-1.292	-0.082	-192.880**
50	SG17 × RCR-4	-0.570*	-2.951**	-2.961	-6.291	-1.178	-0.165	0.161	-342.073*	-0.133	-0.049	0.687	0.079	-125.245
51	SG17 × RB2F2- 15	0.732*	2.397*	8.150**	5.93	-4.176	0.077	-0.445	781.124***	-0.233	0.014	0.605	0.003	318.125***
52	SG18 × RGR 2572	0.005	-1.779	4.969	2.653	3.52	-0.214	0.451	338.165*	0.867	0.486	-0.194	0.541	128.252*
53	SG18 × RCR-4	-0.153	0.59	-2.183	1.626	-1.386	0.464	-0.047	-195.581	0.367	-0.149	-0.894	0.047	-83.053
54	SG18 × RB2F2- 15	0.149	1.188	-2.786	-4.279	-2.134	-0.249	-0.404	-142.584	-1.233*	-0.336	1.088	-0.588	-45.199
55	SG19 × RGR 2572	0.005	-1.029	4.826	2.153	2.395	0.577	0.242	320.744*	-0.133	0.227	0.706	0.061	145.083*
56	SG19 × RCR-4	0.347	1.715	-6.441*	-3.749	-0.761	-0.655	0.244	-624.003***	0.367	-0.008	-0.889	0.032	-265.706***
57	SG19 × RB2F2- 15	-0.351	-0.687	1.615	1.597	-1.634	0.077	-0.487	303.259	-0.233	-0.22	0.183	-0.093	120.623
58	SG20 × RGR 2572	0.422	0.305	2.921	-2.847	-0.355	0.091	0.201	100.71	0.533	0.234	0.859	0.53	50.957
59	SG20 × RCR-4	-0.112	-0.701	-2.196	11.376**	4.864	0.429	0.078	-84.831	-0.967*	0.414	-0.071	-0.64	-31.623
60	SG20 × RB2F2- 15	-0.31	0.397	-0.725	-8.529*	-4.509	-0.519	-0.279	-15.879	0.433	-0.648	-0.788	0.11	-19.334
	SE (ij)	0.28	0.40	2.93	3.48	2.67	0.40	0.91	151.56	0.48	0.35	1.07	0.40	0.57
	C.D. @ 5 %	0.57	1.86	5.86	6.97	5.33	0.80	1.83	303.27	0.96	0.70	2.14	0.81	125.89
	C.D. @ 1 %	0.76	2.47	7.79	9.27	7.10	1.06	2.43	403.42	1.27	0.92	2.85	1.08	167.46
	SEd (Sij- Skl)	0.40	2.47	4.14	4.93	3.77	0.56	1.29	214.34	0.67	0.49	1.52	0.57	88.98

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