Plant Archives Vol. 15 No. 1, 2015 pp. 323-333 ***ISSN 0972-5210***

STUDIES ON HETEROSIS IN INTER HETEROTIC GROUP DERIVED COTTON HYBRIDS FOR LINT YIELD AND ITS COMPONENTS

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Abstract

Line × tester analysis was undertaken to assess the magnitude of heterosis in *Gossypium hirsutum* L. for lint yield and its attributing traits in 32 inter heterotic group derived hybrids of cotton developed by crossing four elite lines each from robust and stay green groups with four elite testers of high RGR group during *Kharif* 2012-13 at Main Agricultural Research Station, Dharwad. The Line × tester analysis consisting 32 intra hirsutum crosses along with three popular Bt hybrid checks (Kanaka, Mallika and RCH-2 *Bt*). The results revealed that the robust lines *viz.*, DSMR-10, DRAC-9565, DR-2 and stay green line *viz.*, DSG3-5 recorded highest mean lint yield. Among the high RGR testers, DRGR-32-100 and DRGR-24-100 recorded the highest lint yield. The between high RGR-stay green group and high RGR-robust groups crosses *viz.*, DSG-3-5 × DRGR-32-100, DRL-8 × DRGR- 24-178, DSMR-10 × DRGR-32-100, DSMR10 × DRGR-24-178 and DSG 3-5 × DRGR-24-178 exhibited highest mean lint yield. The robust/ stay green × high RGR derived crosses had the desirable features because of higher three dimensional space of robust plant type with high stay green nature and tall vertical fast growing habit coupled with high boll number and less biological mass in RGR types influenced the final phenotype of derived hybrids.

Key words : *Gossypium hirsutum* L., hybrid breeding program, relative growth rate (RGR), randomized block design (RBD).

Introduction

Cotton is one of the few often cross pollinated crop, which is accessible to development of homozygous genotypes as varieties and at the same time amenable for commercial exploitation of heterosis by exploitation of additive as well as non-additive genetic variance. India holds the distinction of being pioneer in the world in developing hybrids by conventional hand emasculation and pollination and commercial cultivation of hybrids. The development and release of world's first commercial intra-hirsutum hybrid H-4 and first inter specific hybrid, Varalaxmi during the seventies, respectively was an important milestone in the history of cotton improvement not only in India, but also in the world.

Heterosis is the superiority of the hybrid over the mid or better parent or over standard check and is the result of allelic or non-allelic interactions of genes under influence of particular environment. The basic formula on heterosis ($HF_1 = \Sigma dy^2$) explains how performance (heterosis) of hybrid depends on genetic diversity and extent of dominance existing at different yield influencing loci. It means heterosis can be enhanced either by increasing genetic distance or dominance. It is not possible to manipulate and enhance the degree of dominance and at best we may choose such population, which are differing for the allelic status of such yield influencing loci. If such populations are identified, which are diverse from each other, it means the plants belonging to the diverse populations in general differ for the allelic status of yield influencing loci (Falconer, 1981).

In cotton, attempts were made to exploit genetic diversity by forming heterotic groups. Heterotic group is a group of related or unrelated genotypes from the same or different populations, which display similar combining ability and heterotic response when crossed with genotypes from other genetically distinct germplasm groups. By comparison, the term heterotic pattern refers to a specific pair of two heterotic groups, which express high heterosis and consequently high hybrid performance in their cross. The concept of heterotic patterns includes the subdivision of germplasm available in a hybrid breeding program in at least two divergent populations, which can be improved with inter-population selection methods. Heterotic patterns have a strong impact in crop

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improvement because they predetermine to a large extent the type of germplasm used in a hybrid breeding program over a long period of time (Melchinger and Gumber, 1998).

Following this line of expectation, an attempt was made at Dharwad to understand in general the complementation pattern of parents contributing to heterosis. It was observed that parents representing different plant types like robust and physiological traits like stay green when crossed with high RGR (relative growth rate), reveal complementation of desirable features of two groups in the hybrid (Patil *et al*., 2011). The high RGR types combine well with stay green types and robust types, based on this information opposite heterotic groups are defined. The genetic diversity seen between robust, stay green and high RGR-types etc. are utilized in forming heterotic groups. There are some combinations where the exact reason for the superiority of the hybrids are still not clear. The parents may not differ much visibly but still give rise to heterotic hybrids and it only indicates that lot of intensive research is required to continue these efforts on forming heterotic groups and revising them through continued observation by different scientific teams working on exploitation of heterosis in cotton (Pranesh, 2014).

Materials and Methods

Present investigation was undertaken involving the elite lines of robust, stay green and high RGR heterotic groups. A set of four robust lines *viz*., DRL88, DR2, DRAC9565, DSMR10 and four stay green lines *viz*., DSG3-5, DSG79-61-2, DCSG 100 and DSG102 were crossed to a set of four high RGR testers *viz*., DRGR-32-100, DRGR-24-178, DRGR-257 and DRGR-041 to generate 32 inter heterotic group crosses in line × tester design. These crosses were evaluated during *kharif* - 2012 at Main Agricultural Research Station, Dharwad (Karnataka), India. This experiment was laid out in Randomized Block Design (RBD) with two replications. Each entry was sown in 3 row plots spaced at 90 × 60 cm with recommended dose of fertilizer, two-three seeds were dibbled per spot in each row and thinning was attended to retain one healthy plant per hill at 30 days after sowing. All the recommended package of practices were followed to raise a healthy crop.

Observations were recorded on twelve different quantitative characters *viz*., lint yield, number of bolls per plant, boll weight, plant height, number of monopodia, number of sympodia, sympodial length at 50 per cent plant height, number of reproductive points, inter boll distance, ginning out turn seed index and lint index from three randomly selected plants of each entry.

Results and Discussion

Line × tester study involving 12 parents (four lines from each robust and stay green group and four testers from high RGR group) and their 32 hybrids were evaluated with commercial Bt checks for confirming potentiality of identified heterotic box. This study was distinguished as Siya-HH trial and the results are as follows.

Analysis of variance was carried out for 12 yield and yield component traits using the data obtained from inter heterotic group line × tester study. 'F' test was carried out to examine the significance of variances. The values of mean sum of squares for 13 characters are presented in table 1. It was observed that variances among the genotypes for all 13 characters were significant. The mean sum of squares for parents was significant for most of the characters except lint index. The lines were showed significant differences for most of the characters except lint yield (Kg ha^{-1}) and ginning outturn (%). Among the testers significant differences were not observed for many characters except boll weight (g), plant height (cm), number of sympodia and interboll distance (cm). The interaction between lines and testers was significant for most of the characters except boll weight (g), number of sympodia per plant and lint index (g). The mean sum of squares with respect to hybrids were found to be significant for most of the characters, this depicts the presence of considerable differences among the hybrids. Variance arising from interaction between hybrids and parents were significant for all the characters except for sympodial length at 50 per cent plant height (cm), ginning outturn (%), seed index (g) and lint index (g). Differences due to replications were not significant for most of the characters under study except sympodia length at 50 per cent height (cm) and lint index (g).

A comparison of the mean value of the parents and hybrids in respect of different characters revealed that the range observed for lint yield (kg ha^{-1}) in case robust and stay green lines varied from 503 kg ha^{-1} to 723 kg ha^{-1} and in high RGR testers from 672 to 771 kg ha^{-1}. The lowest value was observed in stay green line DSG79-61-2 (503 kg ha^{-1}) and the highest mean value was in high RGR tester DRGR-32-100 (771 kg ha^{-1}). The mean of this character was observed to be higher in high RGR testers (717 kg ha^{-1}) compared to the stay green/ robust (558 kg ha^{-1}) lines. Among the inter heterotic group derived hybrids, DSG102 x DRGR-24-178 has recorded the lowest lint yield (925 kg ha^{-1}) and DSG 3-5 x DRGR-32-100 recorded the highest lint yield (1620 kg ha^{-1}) and the overall mean for the character was 1288.76 kg ha^{-1}.

Mid parent heterosis among the hybrids ranged from 49.07 (DSG102 × DRGR-24-178) to 144.62 (DSG 3-5 × DRGR-32-100) per cent with an overall mean of 102.25 per cent. All the 32 hybrids expressed significant positive heterosis over mid parent. The range of standard heterosis was from –16.22 (DSG102 × DRGR-24-178) to 46.72 (DSG 3-5 × DRGR-32-100) per cent with a mean of 16.68 per cent. Only one cross expressed significant negative heterosis and 19 hybrids revealed significant positive heterosis over commercial check. The inter group cross hybrids DSG 3-5 × DRGR-32-100 (46.72), DRL-88 × DRGR-24-178 (46.25) and DSMR10 × DRGR-32-100 (42.64) occupied top three positions with respect to useful heterosis. Presence of heterosis over mid parent and commercial check was reported by Somashekhar (2006), Deepakbabu (2007), Ramakrishna (2008) and Pranesh (2014).

The variation for number of bolls per plant trait among the lines of robust and stay green ranged from 16.66 to 24.35, which was relatively lesser than the range observed in high RGR testers (22.45 to 27.42). The lowest and highest number of bolls per plant was observed in stay green line DSG79-61-2 (16.66) and high RGR tester DRGR-32-100 (27.42), respectively. The mean of this character was observed to be higher in high RGR testers (27.40) than the stay green and robust lines (20.27). The variation for the trait among the inter group hybrids was from 24.94 (DSG79-61-2 × DRGR-32-100) to 44.95 (DSG 3-5 × DRGR-041) with an overall mean of 35.38. The hybrids DSG 3-5 × DRGR-041 (96.52) and DSG79-61-2 × DRGR-32-100 (3.77) exhibited the highest and the lowest mid parent heterosis in positive direction, respectively. The mean of mid parent heterosis was 59.13 per cent. All the 32 crosses depicted significant positive heterosis over mid parent. The heterosis over commercial check ranged from -26.09 (DSG79-61-2 × DRGR-32-100) to 33.22 (DSG 3-5 × DRGR-4) with an overall mean of 4.87 per cent. Ten crosses recorded significant positive heterosis over commercial check. Significant positive heterosis over mid parent was reported by Potdukhe (2002), Punitha and Ravikesavan (2004) and Saifullah *et al.* (2014). Heterosis over commercial check was reported by Neelima (2002), Maisuria *et al*. (2006), Tuteja *et al*. (2014) and Pranesh (2014).

Wide range of variation was observed among the lines of different heterotic groups. Boll weight ranged from 4.98 g to 6.26 g in case of robust and stay green lines and range among the high RGR testers was from 4.53 to 5.81 g. The lowest boll weight was observed in high RGR tester DRGR-32-100 (4.53 g) while, the highest boll weight was observed in robust line DRAC 9565 (6.26). The mean for this trait was higher in robust lines than stay green lines and high RGR testers. The mean value for boll weight ranged from 4.86 (DSG79-61-2 × DRGR-257) to 7.00 g (DR 2 × DRGR-257) with an overall mean of 5.90 g. The range of mid parent heterosis for the trait was from -8.18 (DSG79-61-2 × DRGR-257) to 24.22 (DR 2 × DRGR-257) per cent with a mean of 9.76. Out of 32 crosses, 21 crosses revealed significant positive heterosis. Heterosis over commercial check ranged from -19.22 (DSG79-61-2 × DRGR-257) to 16.47 (DR 2 × DRGR-257) per cent with a mean of -1.70. Four hybrids recorded significant positive heterosis over commercial check. Prevalence of significant heterosis for this trait was in accordance with the studies of Kajjidoni (1982), Reddy (2001), Deepakbabu (2007) Ramakrishna (2008) and Tuteja *et al.* (2014) and Pranesh (2014).

Among the lines of different groups, the mean value of reproductive points on sympodia ranged from 4.67 to 6.61 in case of robust and stay green lines. In case of high RGR testers, mean value ranged from 5.63 to 5.96. The lowest and highest reproductive points on sympodia was observed in stay green line DSG-3-5 (4.34) and robust line DR-2 (6.61), respectively. The overall mean for this trait was 5.53 in robust/stay green lines and 5.82 in the high RGR testers. The inter group hybrid DSG102 × DRGR-24-178 recorded the lowest mean value (4.17) and DSG 3-5 × DRGR-24-178 recorded the highest mean value (6.99) and the overall mean for the character was 5.31. Mid parent heterosis among the hybrids ranged from -21.96 (DSG102 × DRGR-24-178) to 37.16 (DSG 3-5 × DRGR-24-178) with an overall mean of -5.67 per cent. Five crosses expressed significant positive heterosis over mid parent. The range of standard heterosis was from -20.25 (DSG102 × DRGR-24-178) to 33.62 (DSG 3-5 × DRGR-24-178) per cent with a mean of 1.46. Five crosses exhibited significant positive heterosis over commercial check. Significant positive heterosis over mid parent and commercial check was reported by Mallikarjun (2005), Somashekhar (2006) and Deepakbabu (2007).

Wide range of variability was observed for the plant height among robust/stay green and high RGR testers. The range observed in case of robust and stay green lines was 125.79 (DSG3-5) to 167.95 cm (DR 2) while, it ranged from 108.34 (DRGR-257) to 153.79 cm (DRGR-24-178) in high RGR testers. The range observed between robust/stay green and high RGR lines was much wider indicating the presence of considerable amount of variability among the genotypes for the trait. The variation among the between group cross hybrids for *per se* performance was ranged from 121.00 (DSG102 ×

Table 1 : Analysis of variance of inter heterotic group line × tester study for confirming the potentiality of identified heterotic box.

Source of variation	Df	Lint yield (kg ha^{-1})	No. of bolls per plant	Boll weight (g)	Plant height (cm)	No. of mono podia per plant	No. of sympodia per plant
Replication	1	6710.75	11.11	0.01	26.33	0.02	3.86
Treatments	43	258807.31**	122.11**	0.68**	314.95**	1.06**	4.44**
Parents	11	19677.89**	20.09**	0.52**	481.65**	1.72**	5.90**
Parents vs Crosses	1	8010900.56**	330.08**	4.28**	179.26**	0.41**	24.35**
Crosses	31	9359.17**	55.69**	0.62**	260.18**	0.85**	3.28**
Lines	7	10074.22	13.98*	0.53**	333.15**	0.80*	7.14**
Testers	3	3725.42	11.30	0.61**	813.50**	0.52	4.88
Line × Tester	1	134760.99**	89.27**	0.11	523.50**	3.19**	0.23
Error	43	6243.75	4.63	0.05	34.36	0.08	1.18

Source of variation	df	Sympodial length at 50% height (cm)	Reproductive points on sympodia	Inter boll distance (cm)	Ginning outturn (%)	Seed index (g)	Lint index (g)
Replication	1	8.96**	0.69	0.02	4.07	0.33	0.88*
Treatments	43	76.97**	0.88**	2.24**	3.97**	1.65**	0.52**
Parents	11	154.41**	0.95**	1.97**	2.92**	0.94**	0.25
Parents vs Crosses	1	14.22	1.69**	7.64**	0.02	0.59	0.20
Crosses	31	51.52**	0.83**	2.16**	4.47**	1.94**	0.62**
Lines	7	205.43**	1.40**	1.61**	1.69	0.80*	0.36*
Testers	3	21.06	0.03	0.80**	1.04	0.52	0.07
Line × Tester	1	197.23**	0.45**	7.97**	17.14**	3.19**	0.003
Error	43	8.03	0.10	0.12	1.20	0.28	0.15

DRGR-257) to 159.71 cm (DR 2 × DRGR-041) with an overall mean of 149.29 cm. The heterosis over mid parent ranged from -2.23 (DSG102 × DRGR-257) to 12.24 (DRL88 × DRGR-257) per cent with an overall mean value of -0.91. Only two crosses exhibited significant positive heterosis over mid parent. It was also observed that five hybrids recorded significant positive heterosis over commercial check and the range of heterosis was from -14.98 (DSG102 × DRGR-257) to 12.22 cm (DR 2 × DRGR-041) per cent with a mean of -0.71. Significant positive heterosis over mid parent was reported by Bhatade *et al*. (1992) Maisuria *et al*. (2006), Deosarkar *et al*. (2009) and Pranesh (2014).

Significant difference was observed for the number of monopodia per plant among the different parental lines. Mean of robust (2.84) was found to be higher than high RGR testers (0.58). Narrow range of variation was observed for the trait within robust (1.50 to 2.84) and high RGR testers (0.17 to 0.84). The lowest values was observed in high RGR tester DRGR-32-100 (0.17) and highest value was observed in robust line DR-2 (2.84). Among the inter group cross hybrids, DCSG 100 × DRGR-24-178 recorded zero monopodia per plant and DRL88 × DRGR-24-178 recorded the highest mean value (2.67) with an overall mean of 1.56. Heterosis in negative direction is desirable for number of monopodia but only five inter group crosses revealed significant negative heterosis over mid parent and the range of heterosis varied from -100.00 (DCSG 100 × DRGR-24-178) to 116.50 (DSG 3-5 × DRGR-32-100) per cent with a mean of 13.60. With respect to useful heterosis, 21 crosses manifested significant negative heterosis and the heterosis values ranged from -86.80 (DSG79-61-2 × DRGR-257) to 100.00 (DCSG 100 × DRGR-24-178) with a mean of -37.51. Negative heterosis over mid parent and commercial check was reported by Shanmugavalli and Vijendradas (1995), Reddy (2001) and Punitha and Ravikesavan (2004). This negative heterosis for number of monopodia is highly desirable because increase in the monopodia makes the plant bushy and robust thus causing a wasteful increase in the space occupied by the plant.

Monopodia are vegetative branches which consume more photosynthete. Therefore, reduction in the number of monopodia is desirable.

The range observed for the character number of sympodia per plant was 14.83 to 20.80 and 15.76 to 19.11 in robust/stay green lines and high RGR testers, respectively. The lowest value was observed in stay green line DSG3-5 (14.83) and highest value in robust line DR-2 (20.80). The overall mean observed among robust lines (18.50) were relatively higher than stay green lines (16.50) and high RGR testers (17.70). Among the inter group cross hybrids, the mean value ranged from 14.17 (DSG102 × DRGR-32-100) to 18.90 (DSG79-61-2 × DRGR-32-100) with an overall mean of 16.39. The expression of heterosis over mid parent values in hybrids ranged from -9.67 (DRL88 × DRGR-32-100) to 24.40 (DRL88 × DRGR-24-178) per cent with a mean of –6.64. Nine crosses exhibited significant positive heterosis. In case of standard heterosis, eight crosses depicted significant positive heterosis and a minimum of -4.80 and maximum of 27.01 per cent was recorded by the crosses DSG102 × DRGR-32-100 and DSG79-61-2 × DRGR-32-100, respectively. The mean of standard heterosis was 10.14. Significant positive heterosis over mid parent was reported by Reddy (2001), Punitha and Ravikesavan (2004). Significant positive heterosis over commercial check was reported by Neelima (2002), Maisuria *et al.* (2006) and Saifullah *et al.* (2014).

The range observed for the trait sympodial length at 50 per cent plant height higher in robust lines (42.0 to 55.39 cm) than the stay green (27.89 to 41.61 cm) and RGR testers (33.96 to 41.45 cm). The mean for this trait was also higher in robust lines (50.80 cm) than high RGR testers (36.70 cm). The lowest and highest sympodial length at 50 per cent plant height was observed in stay green line DSG3-5 (27.89) and robust line DR-2 (53.39) respectively. The mean value for the character ranged from 31.90 (DSG79-61-

Table 2 : *Per se* performance of parental lines involved in inter heterotic group Line × Tester study.

S. no.	Lines	Group	Lint yield (kg ha^{-1})	Number of bolls per plant	Boll weight (g)	Rep. points on sympodia	Plant height (cm)	No. of Monopo-dia/plant	No. of Sympodia per plant	S L @ 50%	Interboll Distance (cm)	Ginning Out turn (%)	Seed index (g)	Lint index (g)
1.	DSG3-5	Stay green	553	23.31	5.21	4.34	125.79	1.84	14.83	27.89	6.50	36.63	11.65	6.75
2.	DSG79-61-2	Stay green	503	16.66	5.04	5.99	151.27	2.17	18.67	41.61	6.97	38.86	10.88	6.92
3.	DCSG 100	Stay green	521	17.34	4.98	4.67	138.50	2.50	15.75	34.23	7.33	39.35	10.89	7.07
4.	DSG102	Stay green	512	17.42	4.98	4.84	139.17	1.50	16.83	35.56	7.36	37.04	10.47	6.17
5.	DRL88	Robust	529	18.70	5.39	5.50	155.67	2.17	18.81	42.07	7.67	37.81	11.80	7.16
6.	DR2	Robust	547	21.57	5.73	6.61	167.95	2.84	20.80	53.55	8.12	38.62	11.65	7.34
7.	DRAC9565	Robust	575	18.83	6.26	6.40	153.50	2.59	17.54	52.54	8.25	37.65	12.08	7.30
8.	DSMR10	Robust	723	24.35	6.13	5.88	150.63	2.67	16.84	55.39	9.42	38.17	12.23	7.55
	Mean		**558.32**	**20.27**	**5.46**	**5.53**	**147.81**	**2.28**	**17.51**	**42.85**	**7.70**	**38.01**	**11.46**	**7.03**
	Min		503.00	16.66	4.98	4.34	125.79	1.50	14.83	27.89	6.50	36.63	10.47	6.75
	Max		723.91	24.35	6.26	6.61	167.95	2.84	20.80	55.55	9.42	39.35	12.23	7.55
	Testers													
1.	DRGR-32-100	High RGR	771	27.42	4.53	5.82	145.60	0.17	18.84	33.96	6.39	39.19	11.35	7.32
2.	DRGR-24-178	High RGR	728	25.08	5.38	5.87	153.79	0.84	19.11	35.63	6.07	40.36	10.20	6.89
3.	DRGR-257	High RGR	695	23.51	5.54	5.63	108.34	0.50	15.76	41.45	7.40	40.50	10.38	7.07
4.	DRGR-041	High RGR	672	22.45	5.81	5.96	143.81	0.84	17.17	36.06	6.05	39.17	10.80	6.94
	Mean		**717**	**24.36**	**5.31**	**5.82**	**137.88**	**0.58**	**17.72**	**36.77**	**6.48**	**39.81**	**10.68**	**7.05**
	Min		672	22.45	4.53	5.63	108.34	0.17	15.76	33.96	6.07	39.17	10.20	6.89
	Max		771	27.42	5.81	5.96	153.79	0.84	19.11	41.45	7.40	40.50	10.80	7.32

Table 3 : *Per se* performance and heterosis for lint yield, number of bolls per plant and boll weight in inter heterotic group Line × Tester study.

S. no.	Crosses	Inter group crosses	Lint yield (kg ha^{-1})			Number of bolls per plant			Boll weight (g)		
			Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)
1.	DSG 3-5 × DRCR-32-100	SG × RGR	1620	144.62**	46.72**	40.94	61.44**	21.32**	5.28	8.52*	-12.06**
2.	DSG 3-5 × DRGR-24-178	SG × RGR	1522	137.46**	37.81**	42.09	74.00**	24.73**	5.45	3.07	-9.23*
3.	DSG 3-5 × DRGR-257	SG × RGR	1410	125.88**	27.71**	37.78	64.94**	11.96	5.50	2.33	-8.49*
4.	DSG 3-5 × DRGR-041	SG × RGR	1438	134.70**	30.20**	44.95	96.52**	33.22**	5.53	0.36	-7.99*
5.	DSG79-61-2 × DRCR-32-100	SG × RGR	947	48.58**	-14.25	24.94	3.77	-26.09**	6.05	26.50**	0.67
6.	DSG79-61-2 × DRGR-24-178	SG × RGR	1053	71.07**	-4.59	30.90	35.14**	-8.43	5.05	-3.07	-16.06**
7.	DSG79-61-2 × DRGR-257	SG × RGR	1330	121.95**	20.46**	39.61	83.55**	17.38*	4.86	-8.18*	-19.22**
8.	DSG79-61-2 × DRGR-041	SG × RGR	1398	138.00**	26.64**	40.31	87.05**	19.45**	5.63	3.83	-6.32
9.	DCSG 100 × DRCR-32-100	SG × RGR	970	50.17**	-12.09	25.13	12.29	-25.54**	5.40	13.56**	-10.15*
10.	DCSG 100 × DRGR-24-178	SG × RGR	1029	64.62**	-6.83	32.25	52.09**	-4.43	5.60	8.16*	-6.82
11.	DCSG 100 × DRGR-257	SG × RGR	1428	134.68**	29.30**	39.16	96.61**	16.06*	5.40	2.66	-10.15*
12.	DCSG 100 × DRGR-041	SG × RGR	1209	102.73**	9.54	30.83	55.00**	-8.64	5.85	8.43*	-2.66
13.	DSG102 × DRCR-32-100	SG × RGR	1038	61.77**	-5.94	35.36	57.76**	4.80	5.00	5.21	-16.81**
14.	DSG102 × DRGR-24-178	SG × RGR	925	49.07**	-16.22*	25.30	19.07*	-25.03**	5.99	15.65**	-0.42
15.	DSG102 × DRGR-257	SG × RGR	1369	126.70**	24.01**	37.15	86.10**	10.09	6.08	15.55**	1.08
16.	DSG102 × DRGR-041	SG × RGR	1195	101.72**	8.20	34.09	71.05**	1.04	5.98	10.80**	-0.58
17.	DRL8 × DRCR-32-100	Rob × RGR	1439	121.28**	30.31**	43.02	86.58**	27.49**	5.45	9.93*	-9.32*
18.	DRL8 × DRGR-24-178	Rob × RGR	1615	156.81**	46.25**	37.57	71.65**	11.34	6.65	23.61**	10.65**
19.	DRL8 × DRGR-257	Rob × RGR	1501	145.10**	35.90**	39.15	90.03**	16.02*	6.40	17.16**	6.49
20.	DRL8 × DRGR-041	Rob × RGR	1075	78.96**	-2.67	36.27	76.28**	7.47	5.25	-6.21	-12.65**
21.	DR 2 × DRCR-32-100	Rob × RGR	1289	95.35**	16.71*	32.45	32.48**	-3.85	6.35	23.78**	5.66
22.	DR 2 × DRGR-24-178	Rob × RGR	1147	79.77**	3.91	28.10	20.48*	-16.74*	6.65	19.77**	10.65**
23.	DR 2 × DRGR-257	Rob × RGR	1392	123.94**	26.09**	32.87	49.17**	-2.59	7.00	24.22**	16.47**
24.	DR 2 × DRGR-041	Rob × RGR	1425	133.60**	29.04**	36.39	65.35**	7.82	6.25	8.32*	3.99
25.	DRAC9565 × DRCR-32-100	Rob × RGR	1080	60.30**	-2.19	31.00	34.08**	-8.13	6.34	17.48**	5.41
26.	DRAC9565 × DRGR-24-178	Rob × RGR	1101	68.84**	-0.26	33.32	51.82**	-1.24	6.34	9.03*	5.49
27.	DRAC9565 × DRGR-257	Rob × RGR	1344	111.48**	21.76**	35.82	73.36**	6.16	6.10	3.43	1.50
28.	DRAC9565 × DRGR-041	Rob × RGR	953	52.79**	-13.65	30.17	46.21**	-10.59	5.77	-4.27	-3.91
29.	DSMR10 × DRCR-32-100	Rob × RGR	1575	110.66**	42.64**	42.09	62.64**	24.73**	6.40	20.08**	6.49
30.	DSMR10 × DRGR-24-178	Rob × RGR	1570	116.13**	42.15**	38.59	56.17**	14.36*	6.75	17.34**	12.31**
31.	DSMR10 × DRGR-257	Rob × RGR	1422	100.35**	28.77**	37.99	62.18**	12.58	6.35	8.83*	5.66
32.	DSMR10 × DRGR-041	Rob × RGR	1418	103.18**	28.43**	36.85	57.51**	9.20	6.37	6.62*	5.91
	Mean		**1288.76**	**102.25**	**16.68**	**35.38**	**59.13**	**4.87**	**5.90**	**9.76**	**-1.70**
	Minimum		925.33	48.58	-16.22	24.94	3.77	-26.09	4.86	-8.18	-19.22
	Maximum		1620.49	156.81	48.72	44.95	96.61	33.22	7.00	26.50	16.47
	SEd			68.43	79.01		1.86	2.15		0.19	0.22
	CD, Heterosis at 5%			139.56	161.15		3.80	4.38		0.39	0.45
	CD, Heterosis at 1%			187.77	216.82		5.11	5.90		0.52	0.61

Table 4 : *Per se* performance and heterosis for reproductive points, plant height, no. of monopodia per plant and no. of sympodia per plant in inter heterotic group Line x Tester study.

S. no.	Crosses	Groups	Reproductive points on sympodia			Plant height (cm)			No. of Mono podia per Plant			No. of Sympodia per plant		
			Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)
1.	DSG 3-5 × DRCR-32-100	SG × RGR	4.43	-12.65*	-15.28*	129.00	-4.94	-9.36*	2.16	116.50**	-13.40	15.97	-5.15	7.26
2.	DSG 3-5 × DRGR-24-178	SG × RGR	6.99	37.16**	33.62**	145.26	3.92	2.07	1.50	12.36	-40.00**	18.00	6.09	20.93**
3.	DSG 3-5 × DRGR-257	SG × RGR	6.34	27.21**	21.01**	130.11	11.15*	-8.58*	1.83	57.17*	-26.60*	16.00	4.63	7.49
4.	DSG 3-5 × DRGR-041	SG × RGR	5.86	13.84*	11.94	134.17	-0.47	-5.73	0.50	-62.55**	-80.00**	15.83	-1.06	6.35
5.	DSG79-61-2 × DRCR-32-100	SG × RGR	5.66	-4.19	8.02	159.50	7.45*	12.08**	1.50	28.76	-40.00**	18.90	0.81	27.01**
6.	DSG79-61-2 × DRGR-24-178	SG × RGR	5.84	-1.43	11.56	151.50	-0.67	6.45	1.17	-22.33	-53.40**	17.59	-6.90	18.14*
7.	DSG79-61-2 × DRGR-257	SG × RGR	4.88	-16.02**	-6.88	138.67	6.83	-2.56	0.33	-75.23**	-86.80**	16.53	-3.99	11.02
8.	DSG79-61-2 × DRGR-041	SG × RGR	4.84	-19.05**	-7.64	142.50	-3.41	0.13	2.00	33.33*	-20.00	16.45	-8.20	10.51
9.	DCSG 100 × DRCR-32-100	SG × RGR	5.16	-1.48	-1.34	128.00	-9.89**	-10.06*	0.50	-62.48**	-80.00**	14.21	17.81**	-4.53
10.	DCSG 100 × DRGR-24-178	SG × RGR	6.51	23.65**	24.36**	123.00	-15.84**	-13.57**	0.00	-100.00**	100.00**	14.76	15.27**	-0.81
11.	DCSG 100 × DRGR-257	SG × RGR	6.50	26.34**	24.16**	138.00	11.81**	-3.03	1.17	-22.33	-53.40**	17.67	12.19*	18.71*
12.	DCSG 100 × DRGR-041	SG × RGR	4.65	-12.47*	-11.17	127.67	-9.56*	-10.29*	1.50	-10.04	-40.00**	15.33	-6.85	2.99
13.	DSG102 × DRCR-32-100	SG × RGR	4.85	-9.06	-7.45	130.33	-8.47*	-8.42*	1.50	80.18*	-40.00**	14.17	20.54**	-4.80
14.	DSG102 × DRGR-24-178	SG × RGR	4.17	-21.96**	-20.25**	138.00	-5.79	-3.03	1.50	28.48	-40.00**	16.47	-8.36	10.61
15.	DSG102 × DRGR-257	SG × RGR	5.34	2.10	2.01	121.00	-2.23	-14.98**	2.00	100.00**	-20.00	14.28	12.35*	-4.06
16.	DSG102 × DRGR-041	SG × RGR	5.26	-2.45	0.57	137.00	-3.17	-3.73	2.00	71.31**	-20.00	16.10	-5.29	8.16
17.	DRL88 × DRCR-32-100	Rob × RGR	4.87	-13.96**	-6.97	155.83	3.45	9.50*	2.16	85.84**	-13.40	17.00	-9.67	14.21
18.	DRL88 × DRGR-24-178	Rob × RGR	5.15	-9.37	-1.62	148.89	-3.77	4.62	2.67	78.00**	6.80	14.33	24.40**	-3.73
19.	DRL88 × DRGR-257	Rob × RGR	4.84	-12.99*	-7.55	148.16	12.24**	4.11	1.33	-0.19	-46.80**	14.50	16.09**	-2.59
20.	DRL88 × DRGR-041	Rob × RGR	5.21	-8.99	-0.38	143.67	-4.05	0.95	1.83	22.33	-26.60*	15.97	11.24*	7.26
21.	DR 2 × DRCR-32-100	Rob × RGR	4.63	-25.42**	-11.46	159.01	1.43	11.73**	2.34	55.67**	-6.60	18.00	-9.16	20.93**
22.	DR 2 × DRGR-24-178	Rob × RGR	5.67	-9.10*	8.31	150.00	-6.76*	5.40	1.50	-18.26	-40.00**	16.17	18.95**	8.63
23.	DR 2 × DRGR-257	Rob × RGR	5.45	-10.91*	4.11	141.33	2.31	-0.69	2.34	40.03*	-6.60	17.00	-6.98	14.21
24.	DR 2 × DRGR-041	Rob × RGR	5.88	-6.44	12.32*	159.71	2.46	12.22**	2.17	18.26	-13.20	17.77	-6.41	19.35*
25.	DRAC9565 × DRCR-32-100	Rob × RGR	5.16	-15.55**	-1.43	158.00	5.65	11.02*	1.33	-3.27	-46.80**	18.28	0.51	22.81**
26.	DRAC9565 × DRGR-24-178	Rob × RGR	4.92	-19.77**	-6.02	151.00	-1.72	6.10	1.50	-12.28	-40.00**	15.96	12.87*	7.26
27.	DRAC9565 × DRGR-257	Rob × RGR	5.35	-11.02*	2.20	127.50	-2.62	-10.41*	1.17	-24.47	-53.40**	16.85	1.25	13.23
28.	DRAC9565 × DRGR-041	Rob × RGR	4.83	-21.93**	-7.83	140.83	-5.26	-1.04	1.67	-2.34	-33.20**	16.17	-6.83	8.63
29.	DSMR10 × DRCR-32-100	Rob × RGR	5.50	-5.98	5.06	149.00	0.59	4.69	2.16	52.73**	-13.40	17.00	-4.70	14.21
30.	DSMR10 × DRGR-24-178	Rob × RGR	5.33	-9.24	1.81	150.67	-1.01	5.87	1.50	-14.69	-40.20**	17.84	-0.77	19.82*
31.	DSMR10 × DRGR-257	Rob × RGR	4.59	-20.21**	-12.32*	127.33	-1.66	-10.53*	0.67	-57.73**	-73.20**	17.00	4.31	14.21
32.	DSMR10 × DRGR-041	Rob × RGR	5.31	-10.30*	1.43	136.83	-7.05*	-3.85	2.50	42.65**	2.63	16.57	-2.56	11.32
	Mean		**5.31**	**-5.67**	**1.46**	**141.29**	**-0.90**	**-0.71**	**1.56**	**13.60**	**-37.50**	**16.39**	**-6.64**	**10.14**
	Minimum		4.17	-25.42	-20.25	121.00	-15.84	-14.98	0.00	-100.00	-100.00	14.39	-24.40	-4.80
	Maximum		6.99	37.16	33.62	159.71	12.24	12.22	2.67	116.50	6.80	18.90	12.19	27,01
	S.Ed.			0.26	0.31		5.07	5.86		0.24	0.28		0.93	0.08
	CD, heterosis @ 5%			0.54	0.63		10.35	12.95		0.49	0.57		1.91	2.21
	CD, heterosis @ 1%			0.73	0.85		13.93	16.08		0.66	0.77		2.57	2.97

Table 5 : *Per se* performance and heterosis for sympodial length, interboll distance, ginning outturn, seed index and lint index in inter heterotic group crosses.

S. no.	Crosses	Groups	Sympodial length at 50% plant height (cm)			Inter boll distance (cm)			Ginning outturn (%)			Seed index (g)			Lint index (g)		
			Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)	Mean	Hmp (%)	Hcc (%)
1.	DSG 3-5 × DRCR-32-100	SG × RGR	38.78	25.40**	-7.69	8.75	35.76**	12.18*	40.32	6.36*	11.60**	9.10	-20.87**	-9.45	6.14	-12.59*	8.00
2.	DSG 3-5 × DRGR-24-178	SG × RGR	38.74	21.98**	-7.78	5.61	-10.82*	-28.14**	38.44	-0.14	6.39*	9.65	-11.67**	-3.98	6.03	-11.55*	5.98
3.	DSG 3-5 × DRGR-257	SG × RGR	45.43	31.07**	8.17	7.18	3.38	-7.88	39.17	1.58	8.41**	8.50	-22.81**	-15.42**	5.48	-20.71**	-3.78
4.	DSG 3-5 × DRGR-041	SG × RGR	40.64	27.10**	-3.26	6.93	10.44*	-11.15*	37.58	-0.84	4.01	11.15	-0.67	10.95*	6.72	-1.86	18.01*
5.	DSG79-61-2 × DRCR-32-100	SG × RGR	43.64	15.52*	3.90	7.72	15.57**	-1.03	37.01	-5.16*	2.44	10.15	-8.66*	1.00	5.95	-16.30**	4.66
6.	DSG79-61-2 × DRGR-24-178	SG × RGR	38.32	-0.78	-8.78	6.57	0.69	-15.83**	40.29	1.72	11.51**	10.80	2.49	7.46	7.29	5.54	28.03**
7.	DSG79-61-2 × DRGR-257	SG × RGR	31.90	-23.20**	-24.07**	6.28	-12.60**	-19.49**	38.44	-3.12	6.39*	10.65	0.24	5.97	6.64	-4.94	16.78*
8.	DSG79-61-2 × DRGR-041	SG × RGR	33.07	-14.84*	-21.27**	7.63	17.28**	-2.12	37.79	-3.13	4.59	11.25	3.81	11.94*	6.84	-1.26	20.21**
9.	DCSG 100 × DRCR-32-100	SG × RGR	39.69	16.41*	-5.52	7.68	12.03**	-1.47	40.33	2.71	11.62**	10.20	-8.27	1.49	6.89	-4.14	21.18**
10.	DCSG 100 × DRGR-24-178	SG × RGR	37.94	8.63	-9.68	6.34	-5.45	-18.78**	36.96	-7.26**	2.30	11.46	8.68	14.03*	6.72	-3.72	18.10*
11.	DCSG 100 × DRGR-257	SG × RGR	36.66	-3.09	-12.71	6.67	-9.44*	-14.49**	39.32	-1.51	8.83**	11.40	7.22	13.43*	7.38	4.49	29.79**
12.	DCSG 100 × DRGR-041	SG × RGR	40.33	14.77*	-3.99	8.68	29.75**	11.28*	41.61	5.99*	15.17**	9.93	-8.44	-1.19	7.08	1.00	24.34**
13.	DSG102 × DRCR-32-100	SG × RGR	32.94	-5.21	-21.57**	6.61	-3.89	-15.32**	39.88	4.64	10.38**	11.35	4.03	12.94*	7.53	11.72*	32.34**
14.	DSG102 × DRGR-24-178	SG × RGR	35.33	-0.73	-15.89*	8.45	25.96**	8.40	37.00	-4.39	2.41	11.15	7.89	10.95*	6.56	0.50	15.29*
15.	DSG102 × DRGR-257	SG × RGR	37.50	-2.60	-10.72	7.03	-4.71	-9.87*	37.32	-3.73	3.29	12.30	18.01**	22.39**	7.33	10.73*	28.73**
16.	DSG102 × DRGR-041	SG × RGR	47.00	31.27**	11.89	8.16	21.82**	4.68	39.05	2.49	8.08*	11.85	11.42*	17.91**	7.59	15.76**	33.30**
17.	DRL88 × DRCR-32-100	Rob × RGR	45.94	20.87**	9.38	9.44	34.28**	21.03**	39.00	1.31	7.94*	11.80	1.94	17.41**	7.55	4.28	32.60**
18.	DRL88 × DRGR-24-178	Rob × RGR	43.93	13.10*	4.59	8.52	24.02**	9.23*	42.67	9.18**	18.10**	10.50	-4.55	4.48	7.81	11.21*	37.26**
19.	DRL88 × DRGR-257	Rob × RGR	42.11	0.84	0.25	8.70	15.53**	11.60*	39.67	1.32	9.80**	10.80	-2.59	7.46	7.11	0.00	24.96**
20.	DRL88 × DRGR-041	Rob × RGR	42.00	7.52	-0.01	8.05	17.35**	3.21	36.96	-3.97	2.30	10.25	-9.29*	1.99	6.01	-14.79**	5.54
21.	DR 2 × DRCR-32-100	Rob × RGR	35.39	-19.11**	-15.75*	7.64	5.34	-2.05	38.00	-2.32	5.18	11.35	-1.30	12.94*	6.98	-4.71	22.67**
22.	DR 2 × DRGR-24-178	Rob × RGR	46.16	3.54	9.90	7.50	5.75	-3.85	37.88	-4.07	4.84	12.60	15.33**	25.37**	7.68	7.98	34.97**
23.	DR 2 × DRGR-257	Rob × RGR	45.55	-4.08	8.45	8.36	7.70	7.12	38.00	-3.95	5.16	11.80	7.15	17.41**	7.22	0.28	26.89**
24.	DR 2 × DRGR-041	Rob × RGR	52.45	17.06**	24.85**	8.91	25.87**	14.29**	40.40	3.86	11.80**	10.70	-4.68	6.47	7.27	1.79	27.68**
25.	DRAC9565 × DRCR-32-100	Rob × RGR	43.83	1.35	4.34	8.50	16.16**	8.97	36.70	-4.48	1.58	12.40	5.85	23.38**	7.19	-1.51	26.45**
26.	DRAC9565 × DRGR-24-178	Rob × RGR	42.61	-3.33	1.44	8.66	20.92**	10.96*	36.99	-5.15*	2.39	12.75	14.45**	26.87**	7.49	5.60	31.63**
27.	DRAC9565 × DRGR-257	Rob × RGR	47.44	0.97	12.95	8.87	13.39**	13.72**	37.31	-4.52	3.27	12.10	7.77	20.40**	7.20	0.35	26.63**
28	DRAC9565 × DRGR-041	Rob × RGR	42.40	-4.29	0.93	8.79	22.98**	12.69**	37.91	-1.30	4.93	11.45	0.09	13.93*	6.99	-1.86	22.76**
29	DSMR10 × DRCR-32-100	Rob × RGR	46.54	4.19	10.80	8.47	7.15	8.59	39.20	1.35	8.50**	10.70	-9.23*	6.47	6.91	-7.00	21.44**
30	DSMR10 × DRGR-24-178	Rob × RGR	46.50	2.19	10.70	8.72	12.59**	11.79*	38.39	-2.23	6.24*	10.30	-8.14	2.49	6.40	-11.26*	12.57
31	DSMR10 × DRGR-257	Rob × RGR	44.83	-7.40	6.73	9.77	16.17**	25.26**	39.90	1.46	10.45**	10.40	-7.96	3.48	6.92	-5.20	21.70**
32	DSMR10 × DRGR-04	Rob × RGR	49.67	8.63	18.24*	9.35	20.88**	19.87**	37.15	-3.92	2.82	11.65	1.19	15.92**	6.88	-5.07	20.83**
	Mean		**41.72**	**5.74**	**-0.66**	**7.95**	**12.24**	**1.98**	**38.64**	**-0.66**	**6.96**	**11.01**	**-0.36**	**9.59**	**6.93**	**-1.47**	**21.79**
	Minimum		31.9	-23.20	-24.07	5.61	-12.60	-28.14	36.70	-7.26	1.58	8.50	-22.81	-15.42	5.48	-20.71	-3.78
	Maximum		52.45	31.27	24.85	9.77	35.76	25.26	42.67	9.18	18.10	12.75	18.01	26.87	7.81	15.76	37.26
	SEd			2.45	2.83		0.29	0.34		0.94	1.09		0.45	0.52		0.33	0.38
	CD, Heterosis @ 5%			5.00	5.78		0.61	0.70		1.93	2.23		0.92	1.06		0.68	0.79
	CD, Heterosis @ 1%			6.73	7.77		0.82	0.95		2.60	3.00		1.24	1.43		0.92	1.06

2 × DRGR-257) to 52.45 cm (DR 2 × DRGR-041) with a mean of 41.72 cm. Heterosis over mid parent exhibited by hybrids extended from –23.20 (DSG79-61-2 × DRGR-257) to 31.07 (DSG102 × DRGR-041) with a mean of 5.74. Eleven crosses showed significant positive heterosis. Heterosis values over commercial check ranged from -24.07 (DSG79-61-2 × DRGR-257) to 24.85 (DR 2 × DRGR-041) per cent with an overall mean of -0.66. Five and two hybrids exhibited significant negative and positive heterosis respectively for the trait. Significant positive heterosis over mid parent was reported by Mallikarjun (2005), Somashekhar (2006), Ramakrishna (2008) and Nidagundi (2010).

For inter boll distance robust genotypes revealed the range from 7.67 (DRL-88) to 9.42 cm (DSMR 10) and high RGR lines showed range from 6.05 (DRGR-041) to 7.40 cm (DRGR-257). The mean inter boll distance was observed to be higher in robust/stay green lines (7.70 cm) and high RGR testers (6.48cm). Variation for the trait among the crosses was from 5.61 (DSG 3-5 × DRGR-24-178) to 9.77 (DSMR10 × DRGR-257) with an overall mean of 7.95. The mid parent heterosis among the crosses ranged from -12.60 (DSG79-61-2 × DRGR-257) to 35.76 (DSG 3-5 × DRGR-32-100) with a mean of 12.24. Only three crosses exhibited significant negative heterosis. The crosses DSG 3-5 × DRGR-24-178 and DSMR10 × DRGR-257 recorded minimum (-28.14%) and maximum (25.26%) heterosis over commercial check, respectively. The mean heterosis was 1.98. Eight and twelve crosses exhibited significant negative and positive heterosis over commercial check respectively. Similar kind of negative heterosis over mid parent and commercial check was also narrated by Lavanyakumar (2004) and Rajeev (2011). Reduction in the inter boll distance gives more yield as it promote the better packing of boll number per plant, which leads to avoid of the unwanted space utilized by the plant with more robust growth then by increases the three dimensional space occupied by the plant for increases of seed cotton yield.

For ginning out turn among the robust and stay green lines, the range for trait varied from 36.63 (DSG3-5) to 39.35 (DCSG-100) per cent with an overall mean of 38.01 per cent, whereas, in high RGR lines the range was 39.19 (DRGR-32-100) per cent to 40.50 (DRGR-275) per cent having with the mean value of 39.81 per cent. Among the inter group cross hybrids the mean value ranged from 36.70 (DRAC9565 × DRGR-32-100) to 42.67 per cent (DRL88 × DRGR-24-178) with a mean of 38.64. The crosses DSG 100 × DRGR-24-178 and DRL-88 × DRGR-24-178 showed minimum (-7.26%) and maximum (9.18%) mid parent heterosis, respectively. The mean heterosis was -0.66. Only three crosses showed significant positive heterosis. In case of heterosis over commercial check, 17 crosses exhibited significant positive heterosis and it ranged from 1.58 (DRAC9565 × DRGR-32-100) to 18.10 (DRL-88 × DRGR-24-178) per cent with a mean of 6.96 per cent. Significant positive heterosis over mid parent and commercial check was reported by Potdukhe (2002), Neelima (2002), Maisuria *et al*. (2006) and Yenal (2013) reported heterosis over commercial check.

Among the robust and stay green genotypes, the range for the seed index varied from 10.47g to 12.23 g with the mean of 11.46 g. The lowest mean value was observed in the line DSG 102 (10.47 g) and the highest was in DSMR 10 (12.23 g). The range in RGR genotypes varied from 10.20 g (DRGR-24-178) to 10.80 g (DRGR-041) with an overall mean of 10.68 g. The mean value for the trait varied from 8.50 g in the cross DSG 3-5 x DRGR-257 to 12.75 g in DRAC 9565 × DRGR-24-178 with an overall mean of 11.01 g. The hybrids, DSG 3-5 × DRGR-257 and DR 2 × DRGR-24-178 showed the maximum mid parent heterosis in negative (-22.81) and positive (15.33) direction, respectively. The mean heterosis was -0.36. Four crosses showed significant positive heterosis over mid parent. With respect to heterosis over commercial check, 17 crosses recorded significant positive values. Maximum (26.87%) and minimum (-15.42) heterosis for the trait was registered by the crosses DRAC9565 × DRGR-24-178 and DSG 3-5 × DRGR-257 respectively. The mean of useful heterosis was 9.59 per cent. Similar kind of positive heterosis over mid parent and commercial check was also narrated by Kajjidoni (1982), Reddy (2001), Neelima (2002), Maisuria *et al.* (2006) and Pole *et al.* (2008) and Pranesh (2014).

For lint index the mean values among the robust and stay green genotypes ranged from 6.75 g (DSG3-5) to 7.55 g (DSMR10) with an overall mean of 7.03 g. The range of variation observed among the RGR testers were from 6.89 g (DRGR-24-178) to 7.32 g (DRGR-32-100) with an overall mean of 7.05g. The mean value for the trait among the crosses ranged from 5.48 (DSG 3-5 × DRGR-257) to 7.81 per cent (DRL88 × DRGR-24-178) with a mean of 6.93 per cent. The crosses DSG 3-5 × DRGR-257 and DSG102 × DRGR-041 exhibited minimum (-20.71%) and maximum (15.76%) mid parent heterosis, respectively. The mean heterosis was -1.47. Four crosses showed significant positive heterosis. In case of heterosis over commercial check, 26 crosses exhibited significant positive heterosis and it ranged from -3.78 (DSG 3-5 × DRGR-257) to 37.26 (DRL88 × DRGR-24-178) per cent with a mean of 21.79 per cent. Presence of high heterosis over mid parent was reported by Karande *et al.* (2004). Presence of low heterosis over commercial check for this trait was reported by Maisuria *et al.* (2006) and Yanal (2013).

Conclusion

The stay green/robust lines *viz.*, DSMR-10, DRAC-9565, DSG3-5 and DR-2 recorded highest mean lint yield. Among the high RGR testers, DRGR-32-100 and DRGR-24-100 noticed the highest mean lint yield. The hybrids exhibited wider variability for lint yield indicating the presence of variability for combining ability among the parents. The between high RGR-stay green group and high RGR- robust groups crosses *viz.*, DSMR10 × DRGR-24-178, DSG 3-5 × DRGR-32-100, DSMR10 × DRGR-32-100, DSG 3-5 × DRGR-24-178 and DSG 3-5 × DRGR-4 exhibited highest mean lint yield. All the crosses revealed significant positive heterosis over mid parent for lint yield. In general, majority of the inter heterotic group derived hybrids revealed positive heterosis over mid parent and commercial check for different characters under study. These between group crosses are in general more potential and the robust/ stay green × high RGR derived crosses had the desirable features because of higher three dimensional space of robust plant type with high stay green nature and tall vertical fast growing habit coupled with high boll number and less biological mass in RGR types influences final phenotype of resulting hybrids. The complementation of contrasting characters from robust/stay green and high RGR lines enabled them to exhibit superior performance. A comparison of inter and intra plant type crosses revealed that the robust × high RGR and stay green × high RGR crosses were highly productive and heterotic for lint yield. This was accompanied by heterosis for yield components as well.

Acknowledgment

The authors are grateful to the "Council For Scientific and Industrial Research (CSIR)" for their financial support of the presented research work.

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