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Research Article

Heterosis and Inbreeding Depression for economic traits in *desi* cotton

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Abstract

Seven parents in five cross combinations were studied for heterosis in F_1 and inbreeding depression in F_2 populations for number of bolls per plant, boll weight, halo length, ginning outturn and seed cotton yield per plant. In F1 hybrids, maximum heterosis was observed for seed cotton yield per plant followed by bolls per plant. Majority of the F2 population displayed inbreeding depression and it was high for seed cotton yield per plant followed by bolls per plant. Inbreeding depression was higher in Blach-1 x DLSA-17 cross followed by the hybrid DD-8NLE x MDL 2582 and in remaining hybrids it was lower. In F1 generation, heterosis over better parent ranged from 172.82 to 127.94 % for seed cotton yield per plant. The inbreeding depression was lower when RDC 88 and 9749 was used as male parents in combination with MDL 2582 and MDL 2601 as male parents.

Key words: Heterosis, Cross combination, Hybrids, Inbreeding depression and *Des*i cotton.

Introduction

Heterosis works as a basic tool for improved production of crops in the form of F1 hybrids. The phenomenon of heterosis of F1 hybrids can reflect their own specific combining ability (SCA) and the general combining ability (GCA) of parental lines. Hence, heterotic studies can provide the basis for exploitation of valuable hybrid combinations and their commercial utilization in future breeding programmes. Crosses between inbred lines show vigour and productiveness in F1 generation (Shull, 1908), but with increasing homozygosity due to selfing, vigour and productiveness is reduced by 50% in each generation because of inbreeding depression (Falconer, 1989). Heterosis and inbreeding depression are complementary to each other and two phenomenons are usually observed in the same studies. Thus, the character, which shows high heterosis due to dominant allelic factors proportionally show high inbreeding depression because of fixation of allelic genes with, increased homozygosity. Soomro and Kalhoro (2000) and Khan (2007) reported that high heterosis was generally associated with high inbreeding depression. Cook (1909) was the first to utilize hybrid vigour in interspecific hybrids (G. *barbadense x G. hirsutum*) and after that a number of workers all over the world are still supporting his contention. Hybrid cotton is a good approach for significant improvement in genetic potential for yield and fibre quality traits and has attracted attention of cotton breeders for commercial growing of hybrid generations. However, the efforts have not delivered the expected results due to self pollination in cotton which has some different implications on hybrid seed production in comparison to cross pollinated crops (Salam, 1991 and Arshad, 1991). In countries, however, like India and China, where labour is cheaper, the successful hybrid cotton are produced

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on large scale since 1960s as reported by Khan *et al*. (1999). In view of the economic importance of hybrid cotton cultivation, and the importance of selected hybrids in segregating generations, a study was made to evaluate the manifestation of heterosis in F1 hybrids and inbreeding depression in F2 population for bolls per plant, seed cotton yield per plant, boll weight, ginning out turn % and halo length in desi cotton.

Materials and Methods

The experimental material formed part of the material under staff research project in the Department of Genetics and Plant Breeding, University of Agriculture Sciences, Dharwad. The material for the present investigation was generated by involving four genotypes *viz.,* DD-8NLE, Blach-1, RDC-88 and 9749 belonging to *Gossypium herbaceum* which were used as a female parents and three genotypes of *G. arboreum viz.,* MDL 2582, DLSA-17 and MDL-2601 which were used as male parents (Table1). Using the above parents five crosses were made for the present investigation to generate breeding material. All the five single crosses (F_1s) *viz*., DD-8NLE x MDL 2582, Blach-1 x DLSA-17, RDC 88 x MDL 2601, 9749 x MDL 2601 and RDC 88 x MDL 2582 were sown during *kharif,* 2005 and data were recorded on agronomic and quality parameters. Heterosis (%) over better parent for each character was computed. To find out the inbreeding depression, an experiment was conducted without replications as it was segregating material. The sowing was done on July 2006 with a spacing of 30 cm between plants and 90 cm between rows with row length of 5.1 meters. Each F_2 was raised with minimum of 500 plant population. And all standard agronomic practices were followed to raise a good crop. At the time of harvest, observations were recorded on randomly selected 100 plants in all the populations for the following traits i) number of bolls per plant , ii) boll weight (g), iii) halo length (mm) iv), ginning out turn per cent and v) yield of seed cotton per plant (g). The data were utilized to estimate the inbreeding depression.

Results and Discussion

Mean performance:

The mean performance of F_1 hybrids, F_2 populations and their parents has been furnished in Table 2. The mean squares from the analysis of variance demonstrate significant difference between F_1 and parents for all the traits under investigation, except for boll weight and ginning outturn. For the mean performance, all the five F_1 hybrids set more bolls, recorded higher boll weight, gave higher seed cotton yield, ginned better and gave longer fiber than their respective parents, where as majority but not all the F_2s were superior to their respective parents for these traits. These results are in line with the earlier reports of Soomro and Kalhoro (2000). In general the mean performance of F_1 hybrid RDC-88 x MDL-2582 was high for all traits studied except for boll number followed by the F_1 hybrid DD-8 NLE x MDL-2582 which recorded the highest boll number than other hybrids under study. This shows superior combining ability of this male parent than other male parents for hybrid combination.

Heterosis and Inbreeding depression

The data of heterosis in the F_1 and the percentage of inbreeding depression in F_2 for all the traits are furnished in Table 3 and discussed here under.

Bolls per plant: For number of boll per plant the maximum heterosis of 120.67% was shown by the cross RDC-88 x MDL 2601 followed by the cross DD-8NLE x MDL 2582 119.33%. F_2 population of the cross Blach-1 x DLSA -17 showed the maximum inbreeding depression of -59.07 followed by DD-8NLE x MDL 2582 (-52.66). It is also interesting to note that combination Blach-1 x DLSA-17 manifested the third best heterosis for no of bolls per plant and also suffered from the maximum inbreeding depression. Our results, that high heterosis was generally associated with high inbreeding depression, were in conformity with those of Khan (2007) and Wang and Pan (1991). The association of heterosis and inbreeding depression suggested that dominant and over dominant genes are responsible for number of bolls. Majority of the F_1s has shown above 50% of heterosis suggesting that these hybrids can be useful for hybrid cotton development. High inbreeding depression for number of bolls in F_2 could be explained by abnormal segregation at meiosis due to dissociation of favorable dominant factor due to selfing.

Boll Weight: The better parent heterosis values ranged from 6.25% (DD-8NLE x MDL 2582) to 28.57 to (Blach-1 x DLSA-17) to over better parents, respectively. However all hybrids recorded non-significant differences among themselves for boll weight. All the F2 genotypes displayed inbreeding depression for boll weight and the observed inbreeding depression was -11.68. to -48.82%. However, none of the genotypes displayed positive values of inbreeding depression. The results showed that in F2 even after inbreeding depression, some promising segregants exhibited good performance and positive selection in such crosses can lead to further improvement. Due to high inbreeding depression for boll weight as compared to other yield related traits, the selection for yield in F2 generation is mostly dependent on boll weight and bolls per plant, which ultimately control the seed cotton yield.

Halo length: - In F1 generation, all the hybrids showed positive heterosis and the heterosis for halo length ranged from 17.72 (RDC-88 x MDL 2601) to 23.40% (Blach-1 x DLSA-17) over the better parent. All the crosses showed significant heterosis for staple length over better parent (17.72 to +23.40%). All the F2 population depicted inbreeding depression for staple length and the observed inbreeding depression ranged from -6.29 to -59.42%.

Ginning out turn: For ginning out turn, four crosses expressed positive heterosis over their better parent but the cross Blach-1 x DLSA -17 exhibited negative heterosis of -0.84% and the degree of heterosis ranged from 0.29 (RDC-88 x MDL 2601) to 10.76% (RDC-88 x MDL 2582). Almost all the F2 population displayed inbreeding depression for ginning out turn except the cross RDC-88 x MDL 2582 which displayed positive values of 6.67% due to transgressive recombination and the observed inbreeding depression was ranging from -0.19 to -5.94%.

Seed cotton yield: In F1 generation**,** all F1 hybrids had positive heterosis for seed cotton yield per plant and the heterosis ranged from 127.94 (DD-8NLE x MDL 2582) to 175.85% (Blach-1 x DLSA-17). The crosses of the cultivar MDL 2601and MDL 2582 with all the other cultivars (except as a maternal parent with DD-8NLE) manifested high heterosis over better parent (+132.05 to 154.60%). All the F2 genotypes showed inbreeding depression for seed cotton yield per plant and the observed inbreeding depression ranged from -9.49 to -60.81%.

The results in F2 generation provide good ground for further study in segregating generations. It is suggested that yield of the F1 did not predict the yield of the bulks in the advanced generations and the combined performance of the hybrids in the F1 and F2 generation could be a good indicator to identify the most promising populations to be utilized either as F2 hybrids or as a source population for further selection in advanced generations.

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Table 1. Salient features of parents used in the present study.

Parents	Salient features
	Female parents (*Gossypium herbaceum* L.)
DD-8 NLE	Variety received from ARS, Viramgam, Gujarat and used as donor parent for boll number and boll weight
Blach-1	Variety received from ARS, Viramgam, Gujarat and used as donor parent for boll weight
9749	Variety received from ARS, Viramgam, Gujarat and used as donor parent for boll weight and boll number
RDC-88	Pre breeding line from RRS, Raichur and used as donor parent for fibre length
	Male parents (*Gossypium arboretum* L.)
MDL-2582	Genotypes from ARS, Mudhol, Andhra Pradesh and used as donor parent for boll number and boll weight
MDL-2601	Genotypes from ARS, Mudhol, Andhra Pradesh and used as donor parent for boll number and boll weight
DLSA-17	Genotype released from UAS, Dharwad with high seed cotton yield coupled with fibre length and strength

Table 2: Mean performance of parental genotypes, their F_1 hybrids and F_2 population for productivity and quality trait in *desi* cotton.

Parent/check/hybrid	Gene ration	Boll number per plant	Boll weight (g)	GOT (%)	Halo length (mm)	Seed cotton yield per plant (g)
DD-8NLE	-	34.20	1.25	34.00	21.20	40.50
Blach-1	-	30.00	1.50	35.80	21.60	41.40
9749	-	33.30	1.40	34.50	22.50	43.50
RDC 8	-	28.50	1.30	33.30	23.70	33.60
MDL 2582	-	34.40	1.60	34.40	20.70	54.40
MDL 2601	-	30.00	1.55	32.30	20.10	43.50
DLSA-17	-	24.20	1.40	30.70	23.50	30.20
Jayadhar	-	25.50	1.45	32.00	23.00	33.50
DD-8NLE x MDL 2582	F1	75.45	1.70	36.00	26.00	124.00
DD-8NLE x MDL 2582	F2	35.72	1.48	31.49	21.15	50.75
RDC 88 x MDL 2582	F1	74.50	1.90	38.10	28.20	138.50
RDC 88 x MDL 2582	F2	44.21	1.67	33.65	20.50	70.89
RDC 88 x MDL 2601	F1	66.20	1.69	34.50	27.90	109.80
RDC 88 x MDL 2601	F2	31.71	1.41	32.33	18.98	44.56
9749 x MDL 2601	F1	64.32	1.65	33.00	26.50	102.10
9749 x MDL 2601	F2	32.43	1.76	32.83	18.44	58.75
Blach-1 x DLSA-17	F1	65.46	1.80	35.50	29.00	114.20
Blach-1 x DLSA-17	F2	31.50	1.43	32.13	19.91	44.75

Table 3: Estimation of heterosis in F_1 hybrid and inbreeding depression in F_2 population for productivity and quality trait in desi cotton.

Cross	Parameter	Boll number per plant	Boll weight (g)	Halo length (mm)	GOT (%)	Seed cotton yield per plant (g)
DD-8NLE x MDL 2582	H	119.33	6.25	22.64	4.65	127.94
	IB	-52.66	-40.66	-52.1	-49.58	-51.88
RDC 88 x MDL 2582	H	116.57	18.75	18.99	10.76	154.6
	IB	-12.94	-12.11	-16.57	6.67	-20.56
RDC 88 x MDL 2601	H	120.67	9.03	17.72	0.29	152.41
	IB	-18.65	-27.3	-31.97	-30.42	-31.34
9749 x MDL 2601	H	93.15	6.45	17.78	1.45	132.05
	IB	-12.53	-11.68	-6.29	-6.2	-9.49
Blach-1 x DLSA-17	H	118.2	28.57	23.4	-0.84	175.85
	IB	-59.07	-48.82	-59.42	-42.46	-60.81

Note: H- Heterosis in F_1; IB- Inbreeding depression in F_2