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ASSESSMENT OF HETEROSIS AND INBREEDING DEPRESSION IN COTTON (*GOSSYPIUM HIRSUTUM* L.)

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ABSTRACT

Six generation of four crosses *viz*., G.Cot 12 × MR 786, G.Cot 16 × GIHV 95 – 145, G.Cot 20 × GJHV 503 and 76 IH 20 × GBHV 148 derived from eight genotypes were evaluated to study heterosis and inbreeding depression for seed cotton yield and its component traits. For seed cotton yield and its component traits crosses *viz*., G.Cot 20 × GJHV 503 and 76 IH 20 × GBHV 148 showed significant positive heterosis over better parent along with significant positive inbreeding depression. The crosses, G.Cot 20 × GJHV 503 and 76 IH 20 × GBHV 148 also recorded significant positive heterobeltiosis for number of bolls per plant as well as boll weight with significant positive inbreeding depression. The present study reveals good scope for isolation of pure lines from the progenies of heterotic F_2s and significant positive inbreeding depression as well as commercial exploitation of heterosis in cotton.

INTRODUCTION

Cotton is the most important fibre crop of India. Despite the increasing production of synthetic fibre, cotton has its reputation as king of fibres due to its inherent properties. The production of cotton in the country is not making a striding increase. Conversely, the yield potential is the cotton productivity can be broken by identifying suitable high yielding hybrids exhibiting high economic heterosis. The low production of cotton can be increased by increasing area under hybrid cultivation. Hybrids are not only important in their high productivity but are generally good for stability for production also. They hold the key for making breakthrough in production of cotton and therefore,should be given more attention. (Khadi *et al*., 2010). For commercial exploitation of heterosis, the magnitude of heterosis provides a basis for genetic diversity and is a guide to the choice of desirable parents for developing superior F_1 hybrid so as to exploit hybrid vigour or building the better gene pool after growing is subsequent generation (Kumar *et al*., 2013). Heterosis and inbreeding depression are complementary to each other and the two phenomenons are usually observed in the same study. Thus a character, which show high heterosis due to dominant allelic factors proportionally show high inbreeding depression because of fixation of allelic gene with increased homozygosity. Considerable success in developing superior cotton hybrids has been achived by releasing cotton hybrids viz., Hybrid 4, G. Cot. Hy.-6. G. Cot Hy.-8, 10, 12. (Singh *et al*., 2014). Both positive and negative heterotic values have been detected, demonstrating potential of hybrid combination for traits improving in breeding programme (Geddam *et al*., 2011, Panni *et al*., 2012.). Keeping in view the objective of present study was to assess the extent of heterosis and inbreeding depression in cotton crosses.

MATERIALS AND METHODS

The experimental material comprised of four crosses namely,G.Cot 12 × MR 786, G.Cot 16 × GIHV 95 - 145, G.Cot 20 × GJHV 503 and 76 IH 20 × GBHV 148 each having six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2). The conventional hand emasculation and pollination method develop by Dock (1934) was followed. F_2population was developed by selfing the F_1s. The experiment was laid out in compact family block design with three replication during kharif 2013 at Cotton Research Station, Junagadh Agricultural University, Junagadh. All the generations of a cross were sown at 120 x 45 cm spacing. Data were recorded on randomly selected plant in each replication for seed cotton yield per plant and its contributing characters (5 plant for parents and crosses and 20 plants for F_2 generation.). Heterosis was estimated over better parent (BP) as per standard procedure of Fonseca and Patterson (1968) and inbreeding depression as per standard method suggested by Hallauer and Miranda (1988).

RESULTS AND DISCUSSION

The analysis of variance among progenies within each family indicated significance differences among six generation means for seed cotton yield per plant and its contributing characters in all the crosses (Table 1) except days to flowering in G.Cot

Table 1: Analysis of variance (mean square) between crosses and between generations within cross of six generations for different characters in cotton

Source of variation	d.f.	Days to flowering	Days to 50% boll bursting	Plant height	Number of monopodia per plant	Number of sympodia per plant	Number of boll per plant	Boll weight	Seed cotton yield per plant	Ginning %	Seed index	Lint index	Oil content (%)
	Analysis of variance between crosses												
Replication	2	0.96	0.005	2.80	0.0	0.09	3.89	0.01	1.67	0.28	0.03	0.002	0.002
Crosses	3	44.02**	137.89**	64.18**	3.20**	2.22**	174.39**	0.92**	902.23**	5.15**	1.72*	0.99**	0.006
Error	6	0.97	2.21	2.46	0.02	0.27	3.58	0.02	53.45	0.38	0.04	0.01	0.014
X^2 test	3	S	S	NS	NS	NS	NS	NS	NS	S	NS	NS	S
	Analysis of variance between generations within cross												
		G. Cot 12 x MR 786											
Replication	2	0.79	11.21	9.58	0.09	1.82	18.16	0.03	250.09	2.17	0.27	0.001	0.17**
Generations	5	10.47**	228.35**	1025.11**	9.44**	5.48**	182.26**	0.06	2195.16**	16.72	1.37**	0.39**	0.05*
Error	10	0.64	4.11	8.58	0.10	0.58	8.83	0.02	94.45	5.89	0.12	0.04	0.02
		G. Cot 16 x GIHV 95-145											
Replication	2	12.29	2.62*	1.40	0.05	0.32	9.64	0.03	149.31	0.90	0.32**	0.10*	0.04
Generations	5	24.48*	62.59**	158.08**	0.71	13.71**	19.89	0.16**	363.86*	14.51*	0.18*	0.34**	0.01
Error	10	7.28	0.47	6.45	0.29	0.55	12.42	0.02	96.48	0.36	0.04	0.02	0.01
		G. Cot 20 x GJHV 503											
Replication	2	0.43	25.72	32.46	0.22	1.59	21.29	0.22**	234.42	0.15	0.11*	0.03	0.02
Generations	5	7.54**	114.52*	186.40**	0.18	8.61**	150.18*	0.20**	3211.39**	3.16**	0.68**	0.29**	0.08*
Error	10	0.47	22.18	12.94	0.19	0.72	31.38	0.02	154.58	0.25	0.03	0.01	0.01
		76 IH 20 x GBHV 148											
Replication	2	9.74	0.18	17.61	0.11	1.63*	38.72	0.04	338.31	5.22	0.26*	0.12*	0.04
Generations	5	4.04	1.51**	316.68**	0.99*	2.73**	69.67*	0.09*	903.55*	12.87	1.42**	0.30**	0.10*
Error	10	7.81	0.09	16.30	0.22	0.28	17.10	0.02	168.98	7.16	0.06	0.01	0.03

12 × MR 786, number of monopodia per plant in G.Cot 16 × GIHV 95 – 145 and G.Cot 20 × GJHV 503 and oil content in G.Cot 16 × GIHV 95 – 145. The result and discussion pertaining heterosis and inbreeding depression of twelve characters are grouped into plant morphological traits, yield and yield attributing traits and economic traits. Heterobeltiosis and inbreeding depression for twelve characters is presented in Table 2 and 3. The result indicated that the phenomenon of heterosis and inbreeding depression were of a general occurance for almost all the characters under study. However the magnitude of heterosis and inbreeding depression varied with characters.

Plant morphological characters

The cross G.Cot 16 × GIHV 95 – 145 exhibited maximum heterosis (10.2%) for plant height while maximum inbreeding depression (1.38%) was recorded in cross G.Cot 12 × MR 786 for days to flowering. The highest (6.63%) heterobeltiosis for days to 50% boll bursting was recorded in cross G.Cot 20 × GJHV 503 and same cross also showed highest (1.20%) inbreeding depression.The results are in accordance with Kaushik and Sastry (2011)and also reported that days to flowering and days to 50% boll bursting are important morphological characters which determines the earliness of a genotypes.

Plant height is an important morphological trait in cotton which provides the seat for nodes and internodes ultimately determining total yielding potential of a genotype. The cross G.Cot 20 × GJHV 503 showed highest (14.45%) heterobeltiosis for plant height and the some crosses also exhibited highest (18.23%) inbreeding depression. The heterobeltiosis ranged from -29.95% (G.Cot 12 × MR 786) to 14.45% (G.Cot 20 × GJHV 503) while inbreeding depression ranged from -3.98% (G.Cot 12 × MR 786) to 18.23% (G.Cot 20 × GJHV 503). The results are akin to the findings of Panni *et al.* (2012) and found that plant height was positively correlated with seed cotton yield, if lodging doesn't occur.

The heterobeltiosis for number of monopods per plant was very high and highest (457.14%) in cross G.Cot 12 × MR 786, however this cross showed non-significant inbreeding depression. The cross combination, 76 IH 20 × GBHV 148 showed significant and positive heterobeltiosis and inbreeding depression indicating the true heterozygosity and on selfing homozygosity reduces performance of progenies. The result are in accordance to the findings of Geddem *et al.* (2011) for heterosis and Mehetre *et al.* (2004) for inbreeding depression.

The heterosis and inbreeding depression for number of sympodia per plant ranged from -11.34% to -0.42% and 4.64% to 18.45%, respectively. The heterosis over better parent was negative in all four crosses for this traits indicating reduction in number of sympodia per plant on hybridization. The highest (18.45%)

Table 2: Heterosis over batter parent (BP) and inbreeding depression (ID) for days to flowering, days to 50% boll bursting, plant height, number of monopodia per plant, number of sympodia per plant and number of boll per plant of four crosses in cotton

	Heterosis (%) over BP Days to flowering			ID (%)			Heterosis (%) over BP Days to 50% boll bursting			ID (%)		
G.Cot 12 x MR 786 (Cross 1)	4.10**	±	0.5	1.38*	±	0.4	3.83**	±	0.4	-9.01**	±	0.9
G.Cot 16 x GIHV 95-145 (Cross 2)	10.2**	±	0.4	-1.25	±	0.6	0.63	±	0.5	-8.14**	±	0.7
G.Cot 20 x GJHV 503 (Cross 3)	-0.58	±	1.1	0.18	±	1.1	6.63**	±	0.5	1.20*	±	0.8
76 IH 20 x GBHV 148 (Cross 4)	(- -)		(- -)	0.79*	±	0.4	-0.31	±	0.4			
	Plant height						Number of monopodia per plant					
G.Cot 12 x MR 786 (Cross 1)	-29.95**	±	1	-3.98*	±	1.5	457.14**	±	0.2	13.68	±	0.2
G.Cot 16 x GIHV 95-145 (Cross 2)	4.75**	±	1.1	13.39**	±	1.8	(- -)		(- -)			
G.Cot 20 x GJHV 503 (Cross 3)	14.45**	±	0.8	18.23**	±	1.6	(- -)		(- -)			
76 IH 20 x GBHV 148 (Cross 4)	-10.39**	±	0.9	11.51**	±	1.7	244.44**	±	0.3	33.33**	±	0.3
	Number of sympodia per plant						Number of boll per plant					
G.Cot 12 x MR 786 (Cross 1)	-11.34**	±	0.4	4.64	±	0.5	68.09**	±	0.7	7.23	±	2.5
G.Cot 16 x GIHV 95-145 (Cross 2)	-7.61**	±	0.4	16.93**	±	0.4	(- -)		(- -)			
G.Cot 20 x GJHV 503 (Cross 3)	-1.32	±	0.5	18.45**	±	0.5	31.95**	±	0.9	34.11**	±	1.8
76 IH 20 x GBHV 148 (Cross 4)	-0.42	±	0.6	13.5	±	0.5	40.57**	±	0.8	24.56**	±	1.2

*, ** Significant at 5 % and 1 % levels, respectively

Table 3: Heterosis over batter parent (BP) and inbreeding depression (ID) for boll weight (g), seed cotton yield per plant (g), ginning %, seed index, lint index and oil content(%) of four crosses in cotton

	Heterosis (%) over BP Boll weight					ID (%)	Heterosis (%) over BP Seed cotton yield per plant		ID (%)			
G.Cot 12 x MR 786 (Cross 1)	(- -)	(- -)		47.67**	±		0.9		25.43**		±	4.85
G.Cot 16 x GIHV 95-145 (Cross 2)	4.09	±	0.1	15.56**	±	0.1	2.06	±	1.1	11.96**	±	4.55
G.Cot 20 x GJHV 503 (Cross 3)	15.5**	±	0.1	10.75**	±	0.1	52.27**	±	1.27	45.50**	±	4.98
76 IH 20 x GBHV 148 (Cross 4)	5.31	±	0.1	3.43	±	0.1	53.86**	±	1.09	29.59**	±	3.44
	Ginning %						Seed index					
G.Cot 12 x MR 786 (Cross 1)	(- -)			(- -)			-13.99**	±	0.23	3.30*	±	0.13
G.Cot 16 x GIHV 95-145 (Cross 2)	8.35**	±	0.2	0.15	±	0.5	-5.43**	±	0.09	-5.44**	±	0.13
G.Cot 20 x GJHV 503 (Cross 3)	-5.06**	±	0.3	0.46	±	0.3	12.92**	±	0.13	8.71**	±	0.13
76 IH 20 x GBHV 148 (Cross 4)	(- -)			(- -)			-11.75**	±	0.13	-8.20**	±	0.15
	Lint index						Oil content (%)					
G.Cot 12 x MR 786 (Cross 1)	-1.57	±	0.1	3.11	±	0.1	0.49	±	0.14	1.92**	±	0.11
G.Cot 16 x GIHV 95-145 (Cross 2)	13.60**	±	0	-8.00**	±	0.1	(- -)		(- -)			
G.Cot 20 x GJHV 503 (Cross 3)	5.91**	±	0.1	8.85**	±	0.1	2.16**	±	0.14	1.62*	±	0.13
76 IH 20 x GBHV 148 (Cross 4)	5.75*	±	0.1	0.79	±	0.1	-0.66	±	0.14	1.48*	±	0.14

*, ** Significant at 5 % and 1 % levels, respectively

inbreeding depression was recorded in cross (G.Cot 20 × GJHV 503). Similar finding were recorded earlier by Kaushik and Sastry (2011).

Yield and yield attributing characters

The seed cotton yield of cotton is generally contributed by boll number and boll weight in interspecific hybrids (Solanki *et al*., 2014). Therefore in present study, the result of three traits *viz*., seed cotton yield, number of bolls and boll weight are discussed below.

For number of boll per plant, heterobeltiosis ranged from 31.95% to 68.09% and highest heterobeltiosis was recorded in cross G.Cot 12 × MR 786. The inbreeding depression ranged from 7.23% to 34.11% and highest in cross G.Cot 20 × GJHV 503. Significantly high heterobeltiosis along with non-significant inbreeding depression indicated true heterozygote advance. The high heterotic response for number of bolls per plant would be ultimately resulted in higher seed cotton yield. Geddam *et al*. (2011), Kaushik and Sastry (2011) and Panni *et al*. (2012) reported similar results and indicated that significant variability for boll per plant among different cotton cultivar and their F_1 and F_2 populations.

In case of boll weight, the hybrid G.Cot 20 × GJHV 503 depicted the highest significant positive heterobeltiosis of 15.5 per cent. Two crosses *viz*., G.Cot 16 × GIHV 95 - 145 and, G.Cot 20 × GJHV 503 recorded significant positive inbreeding depression (15.56% and 10.75% respectively). The results are akin to the findings of Mehetre *et al*. (2004), Khan *et al*. (2010) and Solanki *et al*. (2014) and found that boll weight is an important yield contributing trait and has direct impact on seed cotton yield. Therefore, during selection due attention should be paid to boll weight.

The result of heterobeltiosis for seed cotton yield per plant varied from 2.06% to 53.86%. Three hybrids *viz*., 76 IH 20 × GBHV 148 (53.86%), G.Cot 20 × GJHV 503 (52.27%) and G.Cot 12 × MR 786 (47.67%) showed significant positive heterobeltiosis. All the four crosses showed significant positive inbreeding depression, highest (45.50%) in cross G.Cot 20 × GJHV 503 and lowest (11.96%) in cross G.Cot 16 × GIHV 95 -145. The result are in agreement with earlier worker Mehetre *et al*. (2004), Khan *et al*. (2010), Kaushik and Sastry (2011), Panni *et al.* (2012), Solanki *et al.* (2014) and Choudhary *et al.* (2014).

Economic traits

The economic traits included in the present study are ginning percentage, seed index, lint index and oil content. Among these four economic traits, ginning percentage primarily depends upon seed weight and lint weight. Lint index represents the absolute weight of lint produced per seed and this trait is more important in breeding work than ginning percentage as it is highly correlated with the lint yield. Similarly oil content is correlated with seed index and high seed index along with high seed cotton yield given more oil yield.

Highest significant positive heterobeltiosis was observed in G.Cot 16 × GIHV 95 – 145 (8.35%) for ginning percentage, in G.Cot 20 × GJHV 503 (12.92%) for seed index, in G.Cot 16 × GIHV 95 – 145 (13.60%) for lint index and in G.Cot 20 × GJHV 503 (2.16%) for oil content. The inbreeding depression was nonsignificant for ginning percentage while it was highest and significant positive in G.Cot 16 × GIHV 95 – 145 (8.71%) for seed index, in G.Cot 20 × GJHV 503 (8.85%) for lint index and in G.Cot 20 × GJHV 503 (2.16%) for oil content. Heterosis of lint index was generally concomitant to heterosis for seed index (Abro *et al.*, 2009). Similar results were recorded by Mehetre *et al.* (2004), Khan *et al.* (2010), Geddam *et al.* (2011), Kaushik and Sastry (2011), Panni *et al.* (2012) and Choudhary *et al.* (2014).

To conclude, among the crosses, G.Cot 20 × GJHV 503 and 76 IH 20 × GBHV 148 appeared to be more promising for seed cotton yield per plant due to more number of boll per plant and high boll weight. So the crosses could be tested for stability performance before exploitation of hybrid vigour for commercial cultivation.

REFERENCES

Abro, S., Kandhro, M. M., Laghari, S. and Deho, Z. A. 2009. Combining ability and heterosis for yield contributing traits in upland cotton. (Gossypium hirsutum L.). *Pak. J. Bot.* **41:** 17689-17674.

Choudhary, R., Solanki, B. G., Choudhary, R., Singh, A. K. and Vikashandelwal 2014. Heterosis in single cross inter and intra specific hbrids of desi cotton in relation to seed cotton yield and it's contributing characters. *The Bioscan.* **9(2):** 839-843

Dock, C. C.1934. A new technique in cotton hybridizing. suggested changing in exhisting method of emasculation and bagging cotton flowers. *J. heredity.* **25:** 187-194.

Fonseca, S. and Patterson, F. L. 1968. Hybrid vigour in seven parental diallel cross in common winter wheat (*Triticum aestivum* L.). *Crop Sci.* **8:** 85-88.

Geddam, S., Khadi, B. M., Mogali, S., Patil, R. S., Katageri, I. S., Nadaf, H. L. and Patil, B. C. 2011. Study of heterosis in genetic male sterility based diploid cotton hybrids for yield, yield component and fibre quality characters (*Gossypium hirsutum* L.). *Karnataka J. Agric. Sci.* **24(2):** 118-124.

Hallauer, A. R. and Miranda-Fith, J. B. 1988. Quantitative genetics in maize breeding. *2nd Ed., Iowa State Univ. Press.*

Kaushik, S. K. and Sastry, E. V. D. 2011. Heterosis and inbreeding depression in *Gossypium hirsutum* L. *SABRAO J. Br. Genet.* **43(2):** 107-121.

Khadi, B. M., Santhy, V. and Yadav, M. S. 2010. Cotton: An Introduction. In: Cotton - Biotechnological advances, Zehr and Usha Basrwale (Eds). *Springer.* pp. 1-14.

Khan, N. U., Basal, and Hassan, G. 2010. Cotton seed oil and yield assessment via economic heterosis and heritability in intra specific cotton population. *African J. Biotech.* **9(44):** 7418-7428.

Kumar, M., Nirania, K. S., Sangwan, R. S., Yadav, N. K. and Somprakash. 2013. Heterosis for seed cotton yield and its contributing traits in upland cotton (Gossypium hirsutum L.). *J. Cotton Res. Dev.*, **27(1):** 11-15.

Mehetre, S. S., Rajput, H. J., Mokate, A. S. and Shinde, G. C. 2004. Inbreeding depression for seed cotton yield of intraspecific hybrids. *Advances Plant Sci.***17(1):** 317-321.

Panni, M. K., Khan, N. U., Sundas, F. B. and Maryam, B. 2012. Heterotic studies and inbreeding depression in F_2 populations of upland cotton. *Pak. J. Bot.* **44(3):** 1013-1020.

Singh P., Kairon, M. S. and Singh, S. B. 2014. CICR Technical Bulltein: 14, CICR, Nagpur.

Solanki, H. V., Meheta, D. R., Rathod, V. B. and Valu, M. G. 2014. Heterosis for seed cotton yield and its contributing characters in cotton (*Gossypium hirsutum* L.). *Elec. J. Pl. Br.* **5(1):** 124-130.