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EXPRESSION. OF HYBRID VIGOUR AND DOMINANCE IN INTERVARIETAL CROSSES OF COTTON

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Level of hybrid vigour and dominance estimates for six quantitative and qualitative parameters were examined in intervarietal crosses of nine cultivars of cotton. Results demonstrated that the parents and their F_1 hybrids differed significantly ($P < 0.01$) for all the traits studied indicating manifestation of heterosis for all the traits in at least one or more crosses. Highest average heterosis (32.41%), heterobeltiosis (16.37%) and dominance estimates (4.93) were found for number of bolls per plant. The extent of heterotic effects was appreciably influenced by the hybrid genotype, the direction of cross and the trait concerned. The cross Qalandri x Allepo-I may be selected as the superior hybrid combination which could be exploited in cotton breeding programme for developing new high yielding cotton varieties for commercial production.

Key words: cotton, dominance, hybrid vigour, intervarietal crosses

INTRODUCTION

Despite the fact that cotton breeders all over the world have been making continuous efforts for the improvement of yield and quality of cotton crop, yet these efforts in Pakistan have not proved to be good enough to achieve the yield average to a level of other cotton growing countries of the world. Apart from other exigencies, one of the most conspicuous reasons for low productivity could be inferior genotypes of local cotton plants. Improvement in both quantitative and qualitative traits can only be established when the nature of genetic effects for heterosis such as dominant and overdominant are thoroughly studied (Bruce, 1910). Nevertheless, the extent of heterosis largely depends on genetic divergence of parental lines. The lines are considered diverse if they manifest relatively high heterosis than those that manifest little (Yadava et al., 1985; Baloch et al., 1993).

Heterosis and dominance estimates are very useful as they help the breeder to choose parents or crosses for studies of particular nature and also provide information on gene action. In cotton *(Gossypium hirsutum* L.), heterosis indicates that yield and its components are controlled by both additive and non-additive genes (Ansari and Larik, 1992; Larik et al., 1992; Baloch et al., 1993; Kerio et al., 1996; Soomro et al., 1996). In present experiment six quantitative and qualitative traits in F_1 hybrids of *Gossypium hirsutum* L. were analysed and discussed for heterosis and dominance estimates. These provide information on the type of gene action involved so that breeding methodology could be directed accordingly.

MATERIAL AND METHODS

Seeds of eight intervarietal crosses obtained through the courtesy of Cotton Botanist, A.R.I., Tandojam were raised as F_1 along with their respective parents in randomized complete block design with four replications. The details of the crosses are: TH-1174 x Qalandri, Qalandri x Allepo-I, TH-1174 x IM-216, TH-3/83 x G 115-7, Rehmani x Mic Naire 3150, SLD x TH-3/83, Rehmani x IM-216 and TH-3/83 x Mic Naire 3150. The sowing was done by dibbling in rows of 15 meters long. The standard distance between row to row and within rows was 25 and 70 cm respectively so as to let the plants express themselves into the environment with full potential. All recommended cultural practices were carried out in the experiment. Twenty plants at random from each replication were tagged and treated as index plants for recording the data on six quantitative and qualitative traits (Table 1). Analysis of variance according to Steel and Tome (1980) was adopted to figure out the statistical differences among the genotypes for various traits. Two types of heterosis, the average heterosis and heterobeltiosis were determined according to the formula suggested by Fehr (1987):

$$\text{Average heterosis (\%)} = 100\ \frac{(F_1 - MP)}{MP}$$

$$\text{Heterobeltiosis (\%)} = 100\ \frac{(F_1 - HP)}{HP}$$

The dominance estimates were computed using "Potence ratio" method:

$$D.E. = \frac{(F_1 - MP)}{BP - MP}$$

where D.E. is the dominance estimate, Fp MP and BP are observed mean values of F_I, mid parent and better parent respectively.

RESULTS AND DISCUSSION

Plant Height: Mean performance of F_I hybrids and their parents (Table 1) indicated that generally the F_I hybrids showed increased height over their parents. ANOVA (Table 2) demonstrated that there existed highly significant differences (P<O.OI) among genotypes for this trait.. Of eight hybrids, six showed positive average heterosis and heterobeltiosis (Table 3). Three hybrids viz. TH-3/83 x G 115-7, Rehmani x Mic Naire and TH-3/83 x Mic Naire gave remarkable average heterosis of 34.67, 30.55 and 38.80% and hybrid TH-1174 x Qalandri gave 13.41% heterobeltiosis in plant height. The data revealed that parents TH-3/83, G 115-7, Rehmani, Mic Nai~e, TH-1174 and Qalandri involved in the F_I hybnds transmitted . superior genes for plant height. Increased height, complementary growth genes for tallness and these hybrids could be exploited for developing tall varieties. Similar results were also reported by Ansari and Larik (1992), Kerio et al, (1996) and Soomro et al. (1996). All the hybrids displayed more than one potence values except hybrid TH-1174 x IM-216, exhibiting overdominance and indicated the presence of transgressive segregates in the population for this trait (Ansari and Larik, 1992).

Sympodial Branches per Plant: All the F_I hybrids showed better performance than their respective parents (Table 1). An increase of 10.87% and 8.14% in number of sympodial branches per plant was noticed over mid and better parents, respectively. ANOVA indicated significant differences among the genotypes for this trait (Table 2). Of eight F_I hybrids, seven revealed positive average heterosis (MP) and five F_I hybrids exhibited heterobeltiosis (BP). Maximum average heterosis (21.69%) and heterobeltiosis (15.68%) were shown by the hybrid SLD x TH-3/83 (Table 3) for this character. Baloch et al. (1993) also reported similar results while evaluating six hirsutum F_I hybrids. Dominance estimates were greater than one for all the crosses except Rehmani x IM-216. These results indicate the scope for conducting selection from the population (Ansari and Larik, 1992; Soomro et al., 1996.)

Number of BoIls per Plant: The mean performance of parents and F_I hybrids (Table 1) indicated that all the F_I hybrids set more boIls per plant as compared to their respective parents. ANOVA (Table 2) showed that there were highly significant differences (P<O.OI)among the genotypes for this character. All the FI hybrids manifested positive average heterosis and heterobeltiosis which ranged from 3.73-32.41%· and 0.29-16.37%, respectively. The expression of both types of heterosis suggested that this trait is under the control of dominant as well as overdominant genes. In F_I hybrids, the maximum heterosis of 32,41% respectively over mid and better parents expressed by the cross TH-3/83 x G 115-7 and Rehmani x Mic Naire, demonstrated that the parents of these crosses are genetically more diverse than the parents of other crosses. Significant superiority of F_I hybrids over their respective parents indicated the involvement of dominant gene action for this trait (Ansari and Larik, 1992 and Baloch et al., 1993). Azhar et al. (1983) also reported that non-additive genes were responsible for the expression of boIls per plant in FI hybrids. All the F_I hybrids displayed more than one potence value, exhibiting overdominance and the presence of transgressive segregants in the population for this trait (Ansari and Larik, 1992).

Ginning Out Turn Percentage (G.O.T.%): Data in Table 1 showed that generally all the F_I hybrids produced more lint percentage. Highly significant («0.01) differences among genotypes are indicative of the significant genetic variability for this character. Results further illustrated (Table 3) that seven FIts exhibited positive average heterosis that varied from 2.33 to 4.93% and heterobeltiosis from 0,43 to 2.94%, indicating clearly an overdominant gene. action for this trait. The hybrid TH-3/83 x G 115-7 displayed negative mid parent heterosis (-4.93%) and heterobeltiosis (-5.32%). Similar negative mid parent and better parent heterosis has been reported by Balochet al. (1993) in F_I hybrids of cotton. In F_I hybrids, maximum heterosis of 4.34 and 2.12% respectively over both parents was expressed by the cross TH-3/83 x Mic Naire which demonstrated that the parents of this cross were genetically more diverse than the parents of other crosses (Baloch et al., 1993). Potence values of more than one also confirmed the overdominant gene action and the

Table 1. Mean performance of F, hybrids and their parents for six quantitative and qualitative traits in *Gossypium hirsutum* L.

Parents/F t hybrids	Plant height (cm)	Sympodial branches/ plant	Bolls per plant	G.O.T. (%)	Staple length	Seed cotton yield/plant (g)
TH-1174	126.35	13.25	51,57	34.12	30.75	128.25
Qalandri	115.22	12.00	44.02	33.50	28.50	120.00
Allepo-I	57.15	11,75	41,10	34.00	26.65	125.50
TH-3/83	122.87	12.75	38.80	33.80	28.35	134.25
G 115-7	82,40	13.50	45.16	33.52	29.00	104.00
Rehmani	123.62	12.25	44,47	34.60	27.50	131,50
Mic Naire	76.07	12.50	37.10	35.30	27.25	119.50
SLD	120.42	11,50	40.05	32.15	29.37	124.50
IM-216	112.85	11,25	40.57	33.32	26.75	138.50
TH-117 x Qalandri	143.30	14.00	53.17	34.75	31,10	136.00
Qalandri x Allepo- I	122.80	12.50	44.15	35.00	29.00	143.75
TIl-1174 x IM-216	116.85	14.50	56.22	34.57	29.17	145.00
TH-3/83 x G 115-7	138.22	11.50	59.80	32.00	29.92	136.00
Rehmani x Mic Naire	130.35	14.25	51,75	35.90	28,47	133.00
SLD x TH-3/83	95.62	14.75	58.97	34.10	29.75	142.25
Rehmani x IM-216	123.70	12.00	51,45	34.75	28.00	140.75
TH-3/83 x Mic Naire	138.07	12.75	53.65	36.05	28.75	141,25
LSD at 5%	30.87	2.10	7.10	0.90	0,41	10.32

Table 2. Mean squares of different quantitative and qualitative characters of Ft generation of cotton *Gossypium hirsutum* L.

Source	D.F	Plant height	No. of sympodial branches per plant	No. of bolls/plant	Seed cotton yield per plant	G.O.T. (%)	Staple length
Replications	3	67.66	1,57"	117.50	14.29	0.13	0.28
Genotype	16	1371,58**	5.89	206.51**	474.33**	5.56**	5.54*"
Error	48	567.98	2.28	29.97	63,42	0.50	0.11
S.E.±		11.92	0.75	2.74	3.98	0.35	0.16
CV%		20.07	11,82	11,32	6.02	2.06	1,15
ce,		33.87	2.14	7.78	11,32	1,00	0,47
ea,		45.16	-	10.38	15.09	1,34	0.62

Table 3. Heterosis (%) values over mid parent (MP), heterobeltiosis (BP) and dominance estimates (D.E) for six quantitative and qualitative traits in *Gossypium hirsutum* L.

Cross	Genetic parameter	Plant height	No. of sympodial branches! plant	Bolls per plant	G.O.T. (%)	Staple length	Yield of seed cotton per plant
TH-1174 x Qalandri	MP BP DE	+ 18.64 + 13.41 + 4.04	+ 10.93 + 5.66 + 2.10	+ 11.25 + 3.10 + 1.42	+ 2.78 + 1.85 :.. 3.03	+ 5.00 + 1.14 + 1.31	+ 9.57 + 6.04 + 2.78
Qalandri x Allepo-I	MP BP DE	+ 1.65 + 6.57 + 1.26	+ 5.31 + 4.16 + 4.84	+ 3.73 + 0.29 + 1.09	+ 3.70 + 2.94 + 5.00	+ 5.19 + 1.75 + 1.53	+ 17.11 + 14.54 + 3.70
TH-1174 x IM-216	MP BP DE	- 2.30 - 7.52 - 0.40	+ 18.36 + 9.43 + 2.25	+ 22.03 + 9.01 + 1.84	+ 2.52 + 1.32 + 2.12	+ 1.46 - 5.14 + 0.21	+ 8.72 + 4.69 + 2.52
TH-3/83 x G 115-7	MP BP DE	+ 34.67 + 12.49 + 1.75	- 12.34 - 14.18 - 4.37	+ 32.41 + 13.86 + 4.97	- 4.93 - 5.32 -11.85	+ 4.35 + 3.17 + 3.78	+ 14.17 + 1.30 - 4.93
Rehmani x Mic Naire	MP BP DE	+ 30.55 + 5.44 + 1.25	+ 15.19 + 14.00 + 14.46	+ 26.90 + 16.37 + 2.97	+ 2.72 + 1.70 + 2.71	+ 4.01 + 3.53 + 8.46	+ 8.13 + 1.14 + 2.72
SLD x TH-3/83	MP BP DE	- 21.39 - 22.17 - 19.33	+ 21.69 + 15.68 + 4.17	+ 27.42 + 12.28 + 2.03	+ 3.43 + 0.88 + 1.36	+ 3.08 + 1.29 + 1.74	+ 5.95 + 5.95 + 3.43
Rehmani x IM-216	MP BP DE	+ 4.62 + 0.06 + 1.01	+ 2.13 - 2.06 + 0.50	+ 21.00 + 15.69 + 4.57	+ 2.33 + 0.43 + 1.23	+ 3.24 + 1.82 + 2.31	+ 4.26 + 1.62 + 2.33
TH-3/83 x Mic Naire	MP BP DE	+ 38.80 + 12.73 + 1.66	+ 1.03 0.00 + 1.00	+ 19.72 + 2.15 + 1.14	+ 4.34 + 2.12 + 2.00	+ 3.42 + 1.41 + 1.92	+ 11.33 + 5.21 + 4.34

presence of transgressive segregants in the population for this trait (Ansari and Larik, 1992).

Staple Length: Parents and F_1 hybrids were highly significantly (P<0.01) different in producing fibre length (Table 2). All the F_1 hybrids had more staple length than respective mid parents, whereas seven out of eight hybrids manifested positive heterobeltiosis. Among the F_1 hybrids, Qalandri x Allepo-I expressed maximum average heterosis (5.19%), whereas hybrid Rehmani x Mic Naire manifested the highest (3.53%) heterobeltiosis. Superiority of these hybrids suggested that these could be more useful than other hybrids. The superiority of F_1 hybrids over both parents may be attributed to both dominant and overdominant types of gene action (Ansari and Larik, 1992; Baloch et al., 1993).

Yield of Seed Cotton per Plant: The mean performance of the genotypes (Table 1) illustrated that all the F_1 hybrids produced more yield than their respective parents. Highly significant differences (P < 0.01) among genotypes were observed (Table 2), indicating the presence of genetic variability for yield of seed cotton. The average heterosis (Table 3) of F_1 hybrids ranged from 4.26 to 17.11%, whereas heterobeltiosis varied from 1.14 to

14.54%. Among the F_1 hybrids, the cross Qalandri x Allepo-I, however, expressed the maximum average heterosis (17.11%) and hetetobeltiosis (14.54%). Expression of positive average heterosis and heterobeltiosis in all the F_1 hybrids indicated that dominant and overdominant genes were controlling the yield. The present fmdings that non-additive genes were responsible for the yield are in conformity with the results of Khan et al. (1985) and Tiwari et al. (1987). Potence ratio also confirms the overdominant gene action for this trait (Ansari and Lank et al,, 1992).

Keeping all the parameters in view, it may be concluded that the heterosis and dominance values were appreciably influenced by the genotype and the direction of the cross. The cross Qalandri x Allepo-I may be singled out as the better hybrid combination since it exhibited high parent heterosis in all the six parameters studied. This hybrid can be successfully exploited for the development of a future cotton variety.

REFERENCES

~sari, BA and AS. Larik. 1992. Heterosis in intraspecific crosses of cotton *(Gossypium hirsutum* L,). Pakphyton, 4: 157-163.

Azhar, F.M., M.D. Khan and M.A Khan. 1983. Combining ability in diallel crosses of some *(Gossypium hirsutum* L.) cultivars. The Pak. Cottons, 27(4): 259-265.

Baloch, M.J., G.H. Tunio and AR Lakho. 1993. Performance of F_1 hybrids from intrahirsutum crosses of upland cotton. Pak, J. Sci. Ind. Res. 36(1): 38-40.

Bruce, AB. 1910. The Mendelian theory of heredity and the augmentation of vigour. Science, 32: 627-628.

Fehr, W.R 1987. Principles of cultivar development. Theory and Technique. Macmillan Publishing Company, Inc., New York: 115-119.

Kerio, M.D., M.S. Kalware, M.I. Memon and M.J. Baloch. 1996. Estimates of economic heterosis for some metrical traits of *Gossypium hirsutum* L. The Pak. Cottons, 40(3&4): 42-46.

Khan, LA, M.A Khan and M. Iqbal. 1985. Study of heterosis and combining ability in cotton *(Gossypium hirsutum* L.). The Pak. Cottons, 29: 77-84.:

Larik, AS., H.M.I. Hafiz, M.I. Lashari and H. Sethar. 1992. Hybrid vigour and combining ability in barley *(Hordeum vulgare* L.). Pakphyton, 4: 87-96.

Soomro, AR, G.H. Nachnanc, AW. Soomro and A.D. Kalhoro. 1996. Heterosis for yield in tetraploid cotton hybrids and their reciprocals. The Pak. Cottons, 40(3-4): 18-23.

Steel, RG.D, and J.H. Torrie. 1980. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., New York.

Tiwari, V.N., KC. Mandloi and S.K Rao. 1987. Heterosis and inbreeding depression in intraspecific crosses of upland cotton. Ind. J. Agri. Sci. 337(5): 313-317.

Yadava, T.P., K Parkash, S.K Thakral and AK Yadava. 1985. Genetic divergence, its relationship with heterosis and character association among seed yield and its component traits in Indian mustard. J. Oilseed Res. 2: 163-173.