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HETEROSIS STUDIES IN INTRASPECIFIC CROSSES OF *GOSSYPIUM HIRSUTUM* L.

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Studies on heterosis were carried out in five intraspecific hybrids of tetraploid cotton *Gossypium hirsutum* L. All hybrids manifested positive heterosis over mid-parent and control variety Qalandri regarding yield per plant. The extent of heterosis recorded was 60.2% and 94.3% over mid-parent and check variety Qalandri respectively. For boll weight the heterosis ranged from -1.52 to + 49.5%, for plant height from -7.40 to + 39.22%, for sympodia per plant from + 0.99 to + 2.70% and for staple length from + 1.82 to + 4.0%.

Key words: Heterosis, *Gossypium hirsutum*, Intraspecific hybrids.

Introduction

Information on the extent of heterosis which seems to play an important role for both developmental and economic characters in cotton, is an important pre-requisite for hybrid cotton breeding. Earlier White and Richmond (1963) reported heterosis in intraspecific crosses of upland cotton for yield, boll size and final height. Marani (1964) observed remarkable hybrid vigor in F_1 hybrids for sympodial and monopodial branches and plant height. Aslam (1975) noted a high degree of heterosis for yield, ginning outturn percent and staple length. Baker and Verhalen (1975) studied heterosis and combining ability for several agronomic and fiber characteristic among 10 upland varieties and reported heterosis in lint percent. Nasir (1976) reported an appreciable amount of heterosis for plant height and for the number of monopodial and sympodial branches Khan *et al* (1976) reported remarkable heterosis for yield, ginning outturn percentage and staple length. Chaudhry *et al* (1978) studied nine hybrids which all gave positive heterosis over both mid and better parent values in yield, ginning outturn percent and staple length. In their studies on *Gossypium hirsutum* L., Nasir *et al* (1978) observed considerable increase of hybrids over their respective mid-parent values for number of bolls per plant, boll weight, ginning outturn, yield and staple length. Sarwar *et al* (1979) studied six hybrids, two of which gave increase over their mid parent values in yield while three gave an increase in bolls per plant and boll weight. Khan *et al* (1980) worked on 12 hybrids, all of which showed heterosis over mid-parent values in yield and ginning outturn percentage. Eight showed heterosis in number of sympodial branches and staple length, ten manifested heterosis in boll weight, nine in number of bolls per plant and none in the number of monopodial branches. Soomro *et al* (1981) studied heterosis in six F_1 *Gossypium hirsutum* L. hybrids. Out of them five hybrids manifested hybrid vigor in yield, four in number of bolls per plant, boll weight, ginning outturn and staple length, three in number of sympodial branches, and two in number of monopodial branches over their respective mid-parents. Ahmed *et al* (1981) studied heterosis in seven F_1 hybrids of *Gossypium hirsutum* L. regarding plant height, number of monopodia and sympodia, mid lobe length and breadth, boll weigtht and boll diameter. All the hybrids manifested hybrid vigor over their mid-parent values in number of sympodia, mid lobe length and breadth. In respect of plant height, boll length, number of monopodia and boll diameter, three hybrids showed positive results over mid parent values while two hybrids showed negative heterosis as compared to mid-parent values. Genetic diversity between parental pairs has often become necessary for getting enhanced heterosis in several crops. The present study was carried out to evaluate the amount of heterosis in intraspecific crosses of *G. hirsutum* L.

Materials and Methods

Experimental studies were carried out during the 1987-88 crop season at Central Cotton research Institute, Sakrand on NIAB-78 x 79-IC-3, Rajhans x 407-26, Rajhans x DPL-70, NIAB-78 x DPL-70 and 407-26 x 79-IC-3 hybrids and their parents. The layout was Randomized Completed Block Design with four replications and plot size of 15' x 2.5'. The sowing was done by dibbling deeping plant to plant and row to row distance of 9 inches and 2.5 feet respectively.

Each of the hybrids was sown with its parent separately on the flat bed by dibbling two seeds per hill. When the plant attained the height of one foot, thinning was done maintaining only one plant per hill. Ten plants per hybrid and parent from each replication making the total of four hundred plants were selected for studies. Commercial variety Qalandri was also sown to assess the useful heterosis manifested by the hybrids.

Observations regarding seedcotton yield per plant, number of bolls per plant, boll weight, plant height, number of sympodial branches per plant, ginning outturn percent and staple length were recorded. The analysis of variance was done to bring out differences between mid-parent values involved in F_1 combinations and values of their hybrids. The percentage increase (+) or decrease (-) exhibited by the F_1 hybrids compared to their respective better and mid-parent values and commercial check Qalandri was calculated and interpreted as heterosis for all the crosses with respect to individual character.

Results and Discussion

Mid parents and hybrids indicated highly significant difference in respect of seed cotton yield (Table 2). The data presented in Table 1 indicated that all hybrids manifested positive heterosis ranging from 14.1 to 60.2 percent over mid-parent values. While comparing with control variety Qalandri, the hybrids also showed positive heterosis varying from 51.7 to 94.3 percent. These findings are in agreement with early work done by White and Richmond (1963), Aslam (1975), Khan *et al* (1976), Chaudhry *et al* (1978), Nasir *et al* (1978), Sarwar *et al* (1979), Khan *et al* (1980). When hybrids were compared with better parent, NIAB-78 x 79-IC-3, Rajhans x 407-26 and 407-26 x 79-IC-3 gave the positive heterotic effect of 37.3, 49.8 and 37.9 percent, whereas hybrids Rajhans x DPL-70 and NIAB-78 x DPL-70 indicated negative heterosis of 2.1 and 9.5 percent respectively.

The hybrids and mid-parent values indicated highly significant differences regarding number of bolls per plant (Table 2). The data presented in Table 1 revealed hat hybrids NIAB-78 x 79-IC-3, Rajhans x 407-26 and 407-26 x 79-IC-3 manifested positive hybrids vigor of 16.3, 14.5 and 7.40 percent, respectively. When compared with control variety Qalandri, all these hybrids showed positive heterosis ranging from 9.4 to 50.3 percent. These results are in accordance with the results obtained by Nasir *et al* (1978), Sarwar *et al* (1979), Khan *et al* (1978), Khan *et al* (1980) and Soomro *et al* (1981). Two hybrids Rajhans x DPL-70 and NIAB-78 x DPL-70 exhibited negative heterosis of 14.5 and 6.5 percent respectively when compared with mid-parent, while 31.5 and 6.5 percent, respectively, when compared with better parent. Table 2 indicated significant differences for boll weight. The data presented in Table 1 revealed that all the hybrids indicated positive heterosis over mid-parent values ranging from 1.2 to 41.2 percent. The hybrids also showed positive effect of 28.5 to 40.0 percent when compared with control variety. The results are in agreement with the findings of Nasir *et al* (1978), Sarwar *et al* (1979), Khan *et al* (1980) and Soomro *et al* (1981). While comparing with better parent, only one hybrid NIAB-78 x 79-IC-3 showed negative heterosis of 1.52 percent. Four remaining hybrids gave positive values ranging

Table 1

Performance of the hybrids, parents and the control variety qalandri, mid-parent values and heterosis estimates for different characters

Name of character	Hybrid	Mother parent	Pollen parent	Mid parent	Mean of F_1	% increase (+) or decrease (-) of F_1 over		
						Mid parent	Better parent	Qalandri
Yield per plant (g)	NIAB-78 x 79-IC-3	49.8	44.5	47.1	68.3	+45.0	+37.3	+94.3
	Rajhans x 407-26	37.7	43.3	40.5	64.9	+60.2	+49.8	+85.0
	Rajhans x DPL-70	38.9	63.3	51.1	62.0	+21.3	-2.1	+77.1
	NIAB-78 x DPL-70	41.1	70.1	55.6	63.5	+14.1	-9.5	+81.4
	407-26 x 79-IC-3	38.5	35.1	36.8	53.1	+44.2	+37.9	+51.7
Bolls per plant	NIAB-78 x 79-IC-3	20.1	17.1	18.6	26.3	+41.3	+30.7	+50.3
	Rajhans x 407-26	16.1	21.4	18.7	21.8	+16.3	+2.1	+24.5
	Rajhans x DPL-70	19.1	31.1	25.1	21.4	-14.5	-31.1	+22.5
	NIAB-78 x DPL-70	20.5	33.3	26.9	25.2	-6.5	-24.5	+43.7
	407-26 x 79-IC-3	18.5	17.2	17.8	19.2	+7.4	+3.5	+9.4
Boll weight (g)	NIAB-78 x 79-IC-3	2.5	2.6	2.6	2.6	+1.2	-1.5	+29.5
	Rajhans x 407-26	2.3	2.0	2.2	3.0	+36.5	+27.8	+49.5
	Rajhans x DPL-70	2.1	2.0	2.0	2.9	+41.2	+40.5	+44.0
	NIAB-78 x DPL-70	2.0	2.1	2.1	2.6	+24.8	+21.8	+28.5
	407-26 x 79-IC-3	2.1	2.1	2.1	2.8	+35.3	+34.6	+40.0

	NIAB-78 x 79-IC-3	88.0	82.5	85.3	118.7	+39.2	+34.9	-8.7
	Rajhans x 407-26	132.6	114.1	123.4	142.5	+15.5	+7.4	+9.6
Plant height (cm)	Rajhans x DPL-70	133.1	117.9	125.5	141.5	+12.7	+6.2	+8.8
	NIAB-78 x DPL-70	92.8	95.3	94.1	120.4	+28.0	+26.3	-7.4
	407-26 x 79-IC-3	106.3	91.4	98.8	112.5	+13.8	+5.8	-13.5
	NIAB-78 x 79-IC-3	14.1	13.6	13.9	17.5	+26.3	+24.1	+75.3
	Rajhans x 407-26	15.4	13.0	14.2	18.9	+33.1	+22.7	+89.8
Sympodia per plant	Rajhans x DPL-70	16.0	14.7	15.4	20.6	+34.1	+28.8	+106
	NIAB-78 x DPL-70	16.8	13.5	15.2	21.2	+34.8	+26.3	+112
	407-26 x 79-IC-3	14.9	14.8	14.8	18.6	+25.3	+24.9	+85.8
	NIAB-78 x 79-IC-3	33.5	33.6	33.6	34.1	+1.6	+1.5	+1.8
	Rajhans x 407-26	33.4	33.3	33.3	34.0	+2.1	+2.0	+1.6
Lint percent	Rajhans x DPL-70	33.4	33.3	33.3	34.2	+2.7	+2.6	+2.2
	NIAB-78 x DPL-70	33.3	33.4	33.4	34.1	+2.2	+2.0	+1.7
	407-26 x 79-IC-3	33.4	33.5	33.4	33.8	+1.2	+1.1	+1.0
	NIAB-78 x 79-IC-3	25.6	25.6	25.6	26.5	+3.6	+3.5	+2.0
	Rajhans x 407-26	26.0	26.0	26.0	26.8	+3.1	+3.1	+3.1
Staple length (mm)	Rajhans x DPL-70	26.2	26.1	26.1	27.0	+3.5	+3.3	+3.9
	NIAB-78 x DPL-70	26.1	26.0	26.1	27.1	+3.8	+3.6	+4.0
	407-26 x 79-IC-3	26.4	26.1	26.2	26.8	+2.4	+1.8	+3.2

Table2

Mean squares from the analysis of variance for seven characters in F_1 hybrid

Source of variation	Degree of freedom	Yield per plant (g)	Bolls per plant	Boll weight (g)	Plant height (cm)	Sympodia per plant	Ginning outturn (%)	Staple length (mm)
Replications	3	1197**	71**	.02 NS	85.6 NS	7.33 NS	.03 NS	0.7 NS
Entries	14	8876**	101.8	.48**	1533**	26.92**	0.45**	.88**
Error	42	4387.6	20.65	0.02	69.88	5.66	0.05	0.07
Cd i		16.79	7.65	0.33	13.69	3.91	0.33	0.47
Cd ii		19.50	8.65	0.38	15.90	4.54	0.38	1.78
C.V%		19.80	20.76	5.91	7.41	14.59	0.65	0.99
Analysis of variance after partitioning 'entries' into mid-parents and hybrids								
Replications	3	399.0	70.7*	.02 NS	85.5 NS	7.33 NS	.03 NS	.07 NS
Parents	9	544**	140**	.19 NS	1344**	5.46 NS	.04 NS	.21 NS
Hybirds	4	122.03	34.03	.13 NS	773**	9.04 NS	.09 NS	.17 NS
Error	43	183.3	20.72	0.13	214.23	12.30	0.18	0.29
Cd i (parents)		31.74	10.66	0.80	34.33	8.23	1.03	1.23
Cd ii (Parents)		41.65	13.98	1.05	45.05	10.79	1.35	1.62
Cd i (Hybrids)		29.54	9.92	0.74	31.96	7.66	0.96	1.15
Cd ii (Hybirds)		39.07	13.12	0.98	42.27	10.13	1.27	1.52
C.V% (Parents)		29.27	21.24	16.51	13.88	23.83	0.54	2.04
C.V% (Hybrids)		21.70	19.99	13.04	11.51	18.08	1.23	1.97

from 21.80 to 40.49 percent. The negative results for only one hybrid may be due to the environmental effect or any other unknown reason.

Highly significant differences in plant height existed between mid-parent and hybrid (Table 2). The results depicted in Table 1 indicated that all the hybrids manifested positive

hybrid vigor ranging from 1.27 to 39.2 and 5.8 to 34.9 percent when compared with mid-parent and better parent values, respectively. The findings are in agreement with the results of White and Richmond (1963), Marani (1964), Nasir (1976) and Ahmed *et al* (1981). While comparing with Control variety Qalandri, two hybrids Rajhans x 407-26 and Rajhans x DPL-70 responded positive hybrid vigor of 9.6 and 8.8 percent, whereas hybrids NIAB-78 x 79-IC-3, NIAB-78 x DPL-70 and 407-26 x 79-IC-3 showed negative values of 8.7, 7.4 and 13.5 percent respectively.

Highly significant differences in ginning outturn were recorded between hybrids and their respective parents (Table 2). The data presented in Table 1 showed that all the hybrids manifested positive heterosis ranging from 1.2 to 2.7, 1.1 to 2.6 and 1.0 to 2.2 percent when compared with mid-parent, better parent and check variety respectively. These findings are in agreement with Aslam (1975), Khan *et al* (1976), Chaudhry *et al* (1978), Nasir *et al* (1978), Khan *et al* (1980) and Soomro *et al* (1981).

Hybrids and mid-parents showed highly significant difference in staple length (Table 2). Data in Table 1 revealed that all the hybrids manifested positive hybrids vigor over mid-parent, better parent and check variety varying from 2.4 to 3.8, 1.8 to 3.6 and 2.0 to 4.0 percent, respectively. This positive vigor suggests that the staple length is much stable character for combining ability. Improvement in this character can be made through crossing. The positive heterosis of this character has also been confirmed previously by Aslam (1975), Khan *et al* (1976), Chaudhry *et al* (1978), Nasir *et al* (1978), Khan *et al* (1980) and Soomro *et al* (1981).

Conclusion

Heterosis studies were carried out in five F_1 hybrids *viz.*, NIAB-78 x 79-IC-3, Rajhans x 407-26, Rajhans x DPL-70, NIAB-78 x DPL-70 and 407-26 x 79-IC-3. The characters studies included yield per plant, bolls per plant, boll weight, plant height, sympodia per plant, monopodia per plant, ginning outturn percent and staple length. The average values of hybrids and mid-parents were analyzed statistically. Highly significant differences were found for yield per plant, bolls per plant, plant height, sympodia per plant, ginning outturn percent and staple length, while no significant differences existed for monopodia per plant. All hybrids studied manifested heterosis for yield per plant, boll weight, plant height, sympodia per plant, monopodia per plant, ginning outturn percent and staple length. Only in the case of the number of bolls per plant, out of five hybrids three showed positive and two exhibited negative heterosis over their respective mid-parent values.

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