To Estimates Heterosis and Heterobeltosis of Yield and Quality Traits in Upland Cotton

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Abstract:
The research studies were carried out to enhance the incorporation of genes for high yield improved fibre quality endowed with disease resistant/ tolerance. The study was conducted at the experimental farm of the Nuclear Institute of Agriculture, Tando Jam, during 2009-10. Three cotton lines were crossed with two testers in line x tester pattern to draw genetic information. Result indicated that the crosses involving genotypes Okra, and NIA-Bt exhibited superior and positive heterosis over mid parent and heterobeltiosis over better parent for yield contributing characters such as sympodial branches and bolls per plant and seed cotton yield as well. This aims to develop new ideotypes/genetic stock endowed with high yield, improved fibre quality and resistant/ tolerance to CLCuV disease. Release of a variety and development of genetic stock for cross breeding programme are the main objectives of these studies.
Key words: Cotton, Heterosis, Heterobeltiosis, Line x tester analysis.

Introduction:
The hybrid vigour in respect of yield is generally defined as increase in the yield over the mean of the two parents or over the better parents. Useful heterosis is an increase in yield of hybrid over the standard commercial check (Meredith and Bridge, 1972). Heterosis works like a basic tool for the improvement of crops in the form of F_1 generation. The feasibility of economic heterosis in inter and intra - crosses of *Gossypium* is emphasized where manpower is cheaper (Khan and Khan, 1979, Salam, 1991, Altaf *et al*. (1996) and Keerio *e. al*. (1996) conducted such studies for monopodial and sympodial branches per plant and reported promising heterosis and inheritance for these morphological traits. Through heterosis, seed cotton along with quality traits can be improved significantly (Naquibullah *et. al*., 2000).
In crop breeding programme to achieve high degree of heterotic response, it is essential to have knowledge about performance of desirable parents; the heterotic studies are helpful in having such information. A research project was therefore, undertaken to evaluate the manifestation of heterosis and heterobeltiosis in F_1 hybrids of *Gossypium hirsutum L* in single crosses.

Materials and Methods:
The study was conducted at the experimental farm of the Nuclear Institute of Agriculture, Tando Jam, during 2009-10. Three cotton lines were crossed with two testers viz. NIA-Ufaq, NIA-78 and Okra (as lines) LRA-5166 and NIA-Bt (as testers) in line x tester pattern to draw genetic information. Six F_1 hybrids along with five parents were field evaluated using Randomised Complete Block Design (RCBD) with three replications. This experiment was maintained properly with 75 cm row to row and 30 cm plant to plant distance in three replications. All the agronomical practices were maintained according the recommendations when ever needed. The field observations of 5 plants from each genotype per replication were randomly tagged and data on plant height of the main stem, sympodial branches, bolls per plant, seed cotton yield per plant and staple length were recorded at maturity. The data were analysed as suggested by Steel and Torrie (1980). Heterosis and heterobeltiosis were estimated by formulae suggested by Miller and Marani (1963).
Heterosis was calculated in term of percent increase (+) or decrease (-) of hybrid against its mid-parent values. While heterobeltiosis was estimated in term of percent increase (+) or decrease (-) of hybrid over its better parent.
Mid-parent heterosis (MPH,)= (F1- MP)/MP
Heterobeltiosis, (HB,)= (F1- BP)/BP, where MP (P1 + P2/2)= mid-parent and BP= better parent.

Results and Discussion:
The analysis of variance (ANOVA) of parents and their hybrids for the traits under study is present in Table-1. It reveals that traits were highly significant at 0.01 level of probability which indicate considerable distance among genotypes.
The mean performance of parents and their hybrids for various traits under study is reproduced in table -2. Which reveals that the NIA-78 as seed parents and LRA-5166 as pollen parent proved to be the tallest, while remaining lines as well as tester displayed comparatively short plant height (Table 2). The hybrids NIA-78 x NIA-Bt and Okra x NIA-Bt manifested highly significant mid-parent heterosis (15.48 and 15.48%, respectively) and heterobeltiosis 5.49 and 5.47%, respectively) for plant height. The hybrids NIA-Ufaq x LRA-5166 manifested pronounced increase of 13.68% over mid parent (Table-3). These findings are supported by previous

researchers like Khan *et al.* (1999) and Sayal *et al.* (1999) who also reported fair degree of heterosis and heterobeltiosis for plant height.

The seed parents NIA-78 and NIA-Ufaq as a pollen parent possessed the highest number of sympodia per plant, while the remaining lines as well as tester displayed lesser number of sympodia per plant. All crosses produced the highest number of sympodia (Table 2).

The highest heterotic performance was recorded in cross Okra X NIA-Bt and NIA-Ufaqx NIA-Bt which surpassed its mid parent by (+26.05and 20.06 respectivily) and same crosses showed vigour over better parent (Table 3). The previous workers like Keerio *et al.* (1996), Soomro and Kalhoro (2000) and Khan *et al.* (2000) have reported heterotic and heterobeltiotic values and suggested number of sympodia per plant as suitable criteria for selection of high yielding hybrids.

The seed parents NIA-Ufaq produced the highest number of bolls per plant, while the varieties used as pollen parents displayed the less number of bolls. As regards hybrids, three out of six crosses exhibited higher number of bolls with few insignificant differences and among three top crosses, the cross NIA-Ufaq x NIA- Bt produced higher number of bolls per plant (Table 2). All the high yield brids showed increase over mid parent ranging from 6.07 to 25.71%. Only one combination Okra x NIA-Bt showed more heterbeltosis with increase of 20.77% and showed transgression. The hybrid Okra x NIA-Bt achieved 24.35% more bolls and remained superior among all crosses. Therefore, bolls per plant being the most important and direct yield contributing trait can be exploited from this cross combination (Soomro, 2000; Mukhtar and Khan, 2000; Chang *et al*., 2001a, b & c; Solangi *et al*. 2001; Solangi *et al.* 2002).

The male parents showed the lowest mean value for seedcotton yield per plant. The F_1 hybrids NIA-Ufaq x NIA-Bt produced higher seedcotton yield than their respective parent varieties (Table 2). All hybrids exhibited hybrid vigour over mid parent and the heterosis ranged from 6.69% (NIA-Ufaq x LRA-5166) to 28.70% (Okra x NIA-Bt). The hybrids Okra x NIA-Bt and NIA-Ufaq x NIA-Bt showed significantly better heterotic values (18.8 and 13.86%) over better parents respectively. Maximum heterosis was observed for the cross Okra x Bt (28.70%) which suggested that this cross combination can be used in future hybridization programme for the exploitation of heterosis followed by selection to boost the seed cotton yield (Soomro and Kalhoro, 2000; Mukhtar and Khan, 2000 and Chang *et al*., 2001c).

Regarding to staple length pollen parent LRA-5166 gave long staple length (29.5mm) while among the hybrids crosses NIA-Ufaqx LRA-5166 and NIA-78X LRA-5166 produced long staple length (29.15mm and 29.20mm respectively) table-2.

NIA-78 x NIA-Bt and OkraxBt showed heterosis (+ 1.81 and 1.11 respectively) when compared with mid-parent value, which suggested that both cross combination can be used in future hybridization programme for the exploitation of heterosis followed by selection for staple length. . The results are in concurrence to the findings of S. Ahmed,et al (1996), A.S. Larik et al (1997) and M.S. Kalwar et al (1998). While parent LRA-5166 involving in crosses that produced resistance/tolerant against CLCuV**.**

Conclusion:

It is noticed that the crosses involving genotypes Okra, and NIA-Bt exhibited superior and positive heterosis over mid parent and heterobeltiosis over better parent for yield contributing characters such as sympodial branches and bolls per plant and seedcotton yield as well. While parent LRA-5166 involving in crosses that produced resistance/tolerant against CLCuV. Therefore F_1 transgressive and heterotic hybrids can be exploited to create genetic variability followed by selection of high yielding genotypes in cotton and to establish strains with superior and improved characteristics through segregating filial generations to bring forth seedcotton yield, however the degree of heterosis is a key factor for its utilization.

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Table-1: Analysis of variance (Mean squares) of genotypes for various traits in Upland cotton.

Source of variance	D.F	P.H (cm)	Sympodia (No.)	Boll/plant (No.)	SCY/pl (g)	GOT (%)	SL (mm)
Replication	2	13.857	11.6129	12.8629	12.852	12.2545	12.5220
Genotype	10	453.777ns	22.1004**	34.7450**	387.720**	0.4926**	2.2326**
Error	20	0.047	77.18	0.2864	0.191	0.1837	0.1907

Table 2: Means for plant height, sympodia/plant, bolls/plant, seedcotton yield/plant and GOT% of cotton parents and their F_1 hybrids evaluated during 2009-10.

Genotypes		Plant height (cm)	Sympodia/ plant (No.)	Bolls/plant (No.)	Seed cotton yield (g/plant)	Staple length (mm)	CLCV Incidence (%)
Lines	NIA-Ufaq	95.2 j	19.6 bc	34.2 bc	112.86 f	28.5 b	0.00 c
	NIA-78	127.4 a	20.8 ab	32.4 d	110.16 g	28.5 b	0.00 c
	Okra	109.6 h	16.8 d	25.8 g	82.56 j	27.5 c	0.00 c
Te ste	LRA-5166	118.2 g	18.6 c	30.2 e	105.7 h	29.5 a	0.00 c
	Bt	90.6 k	16.2 d	28.4 f	102.2 i	26.5 d	62.66 a
F_1 hybrids	NIA-Ufaq x LRA-5166	121.3 e	21.4 a	34.8 bc	116.6 c	29.15 a	0.00 c
	NIA-78 x LRA-5166	124.5 c	21.4 a	33.2 cd	115.8 d	29.20 a	0.00 c
	Okra x LRA-5166	120.4 f	20.8 ab	35.2 b	114.4 e	28.50 b	0.00 c
	NIA-Ufaq x Bt	103.5 i	21.6 a	38.7 a	128.52 a	27.40 c	26.00 b
	NIA-78 x Bt	123.7 d	21.2 a	33.9 cd	115.3 d	28.0 b	31.00 b
	Okra x Bt	125.6 b	20.8 ab	34.3 bc	121.5 b	27.3 c	28.00 b

Table 3: Percent increase (+) or decrease (-) over mid and better parents of F_1 hybrids of cotton for plant height, sympodia/plant, bolls/plant, seedcotton yield/plant and Staple length evaluated during 2009-10.

F_1 hybrids	Plant height (cm)		Sympodia/ plant (No.)		Bolls/plant (No.)		Seedcotton yield (g/plant)		Staple Length (mm)	
	Percentage									
	MPH	HB	MPH	HB	MPH	HB	MPH	HB	MPH	HB
NIA-Ufaq x LRA-5166	13.68	2.62	10.99	8.16	6.21	1.75	6.69	3.31	0.5	-1.18
NIA-78 x LRA-5166	1.38	-2.27	8.62	2.88	6.07	2.46	7.29	5.11	0.69	-1.16
Okra x LRA-5166	5.70	1.86	17.51	11.82	25.71	16.55	21.53	8.23	0.00	-3.38
NIA-Ufaq x Bt	11.41	8.71	20.06	10.20	24.03	13.15	19. 49	13.86	-0.36	-3.85
NIA-78 x Bt	15.48	5.49	14.94	1.92	11.51	4.63	8.56	4.66	1.81	-1.75
Okra x Bt	15.48	5.47	26.05	23.08	24.35	20.77	28.70	18.83	1.11	-0.72