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Estimation of Heterosis and Heterobeltiosis in F_1 Hybrids of Upland Cotton

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Abstract
The present study was performed to evaluate the expression per se performance and heterosis effect for quantitative traits of 12hybrid involving seven varieties as testers in line x tester analysis. Experiment was grown under field conditions during 2012-2013 at experimental farm of Nuclear Institute of Agriculture, Tando Jam. It is noticed that the crosses involving genotypes Chandi-95, Bt-703, Bt-802 and Sadori exhibited higher performance mean and positive heterosis over mid parent and better parent heterosis for yield contributing characters like for plant height, sympodial branches, boll weight, bolls per plant and seedcotton well . Therefore transgressive F1 hybrids and heterosis can be exploited to create genetic variability followed by the selection of high yielding genotypes of cotton and establish lines with superior features and improved through subsidiaries to bring income seedcotton, however, segregating generations the degree of heterosis is a key factor for use
Keywords: Cotton, Heterosis, Heterobeltiosis, Line x tester analysis

Introduction

Cotton is the main cash crop of Pakistan; it is commonly called "white gold". Cotton crop contributes an important role in the national economy of Pakistan. Pakistan is the fifth largest producer of cotton around the world, the third largest exporter of raw cotton, the fourth largest consumer of cotton, and the largest exporter of cotton yarn. Cotton hybrid seed development has been undertaken in many countries like China, India, Vietnam and Myanmar. About 90% area in India and 40% in China has come under hybrid cotton cultivation. In China, field experiments on hybrid cotton have brought about 20-30% increase in production (Ansari, 2011). Hybrid cotton seed offer many advantages over the conventional variety seed such as increase in productivity, tolerance to abiotic stresses (drought, heat, cold) and is highly responsive to inputs (Ali, 2011).

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

Cotton breeders are trying to develop varieties those well adapt to our environmental conditions and produce higher yields, higher ginning outturn percentage, better fiber quality and respond to higher fertilizer doses along with increased tolerance to complexes diseases and insect pest. For breeding program, parents must be genetically superior, physiologically efficient, possess better general and specific combining ability so that they could be utilized for both variety development and commercial exploitation of heterosis for hybrid crop development.

Heterosis is the superiority of the hybrid over the mid-parent or better parent values. It is the allelic or non-allelic interaction of genes under the influence of particular environment. Heterosis has been observed in many crop species and has been the objective of considerable importance as mean of increasing productivity of crop plants. It is now well established fact that heterosis does occur with proper combination of parents

MATERIALS AND METHOD

The trial was conducted at experimental farm of Nuclear Institute of Agriculture (NIA) Tandojam to estimate the heterosis for quantitative traits in upland cotton (*Gossypium hirsutum* L). The experimental material i.e. seeds of F_1 hybrid along with their parents were sown in the Randomized Complete Block Design during kharif season 2012. The experimental matetial comprised four lines (Chandi-95, Sohni, Sadori and NIA Ufaq) and three tester (BT.802, BT.703 and BT.A1) and their 12 F_1 hybrids. The trait studied were Plant height (cm), Sympodial branches plant$^{-1,}$ Boll plant$^{-1,}$ Boll weight (g), Seed cotton yield plant^{-1}, GOT %, Seed index (g), Staple length (mm).

The collected data was be subjected to the statistical analysis (ANOVA) after Gomez and Gomez (1989).The heterosis and heterobeltiosis after (Falconer, 1989)

$$\text{Mid parent heterosis \%} = \frac{F_1 - MP}{MP} \times 100$$

Mid parent value = $\frac{P_1 + P_2}{2}$ x 100

Heterobeltiosis = $\frac{F_1 - BP}{BP}$ x 100

Results and Discussion

Mean squares of parents (lines and testers) including their crosses and the mean performance of parents and their 12 F_1 hybrids is presented in Table-1&2 respectively. Table-1 reveals that genotypes were highly significant at 0.01 level of probability for plant height, number of sympodial plant^{-1}, number of bolls plant^{-1}, boll weight, seedcotton yield plant^{-1}, which states that there were considerable variation among parents and their F_1 hybrids.

For the character plant height, the parent Sadori had tall plant(121cm) and Sohni showed Dwarf plant(98.9). While the cross Sadori x BT A-1 had highest value (126.87) fallowed by Chandi-95 x Bt-802 (126.87) exhibited highest positive significant value for relative heterosis, heterobeltiosis. This shows that these crosses are best combiners for the taller plant while Sohni x BT A-1, and Sadori x BT 802 had highest negative value suggesting for the dwarf plants. In case of sympodia plant^{-1}, the cross NIA-Ufuaq x BT 802 (23.56) and NIA-Ufuaq x BT 703 (23.19) had highest mean value and positive value for mid parent and better parent.It indicated that these parents were used for increasing sympodial branches per plant. For the character number of bolls plant^{-1} parent Sadori (37.18) and Bt-703 (32.77)gave more number of bolls per plant while crosses Chandi-95 x BT 802, Chandi-95 x BT 703, , Sadori x BT 802, Sadori x BT 703, showed more number bolls and highly significant positive relative heterosis, heterobeltiosis. These crosses are good combiner by producing highest number of bolls plant^{-1} . For the character boll weight, five crosses showed positive heterosis and heterobeltiosis. Among the cross NIA Ufaq x BT A-1 had highest value for relative heterosis and heterobeltiosis fallowed by cross Chandi-95xBt-A1, while the parent Chandi-95 (3.26g) showed maximum boll weight among the parents.Yield is polygenic character had the highest value of mid parent and better parent shown by Chandi-95 x BT 802 followed by Chandi-95 x BT 703. Seven crosses showed positive mid parent and better parent for the character seedcotton yield plant^{-1}. In many instances F_1 hybrids of cotton were found to out yield their parents. This encourages heterosis from wide arrange of parental combinations. The increased vigour of F_1s is mainly due to accumulation of favorable genes (complementary epistatic). Therefore, these crosses with desirable segregates to select for yield improvement (Table 2&3). These results are in accordance with the findings of Mukhtar and Khan (2000), Ansari and Soomro (2005), Abdel-Hafez *et al.* (2007), Reddy *et al.* (2008), Saravanan and Koodalingam (2011) Mustungi and Ansari (2011) Larik *et al.* (2004) El-Adl *et al.* (2001), Chang *et al.* .(2001 a) Chang *et al.* (2001 b) Chang *et al.* (2001 c) Baber *et al.* (2001b) Baloch (2002) Khan *et al.* (2002) Solangi *et al.* (2002) Saira *et al*. (2002) Potdukhe *et al.* (2003), Kandhro *et al.* (2004) Soomro and Baloch (2005) Jesus Rafael *et al.* (2007) Naqib Ullah Khan *et al.* (2007) Khan *et al*. (2009) Campbell and Bowman (2010) Patil *et al.* (2011) Arshad *et al*. (2001) Iqbal *et al.* (2008) Soomro, *et al*. (2005).

Conclusion

It is noticed that the crosses involving genotypes Chandi-95, Bt-703, Bt-802 and Sadori exhibited higher performance mean and positive heterosis over mid parent and better parent heterosis for yield contributing characters like for plant height, sympodial branches, boll weight, bolls per plant and seedcotton well . Therefore transgressive F1 hybrids and heterosis can be exploited to create genetic variability followed by the selection of high yielding genotypes of cotton and establish lines with superior features and improved through subsidiaries to bring income seedcotton, however, segregating generations the degree of heterosis is a key factor for use

Table 1. Mean squares for seedcotton yield and its components of Upland cotton.

Source of variance	D.F	P.H (cm)	Sym/Pl (No.)	Bolls/pl (No.)	Boll Weight (g)	Seed cotton yield/pl (g)
Replication	2	5.632	2.05114	28.4418	0.93123	23.084
Genotype	18	167.556**	8.91597**	99.4521**	0.11118**	647.522**
Parents	6	252.016**	4.23964**	27.711**	0.11175**	153.366**
P vs.C	1	822.4**	2.1*	112.0**	0.2**	703.2**
Crosses	11	61.9571**	12.0904**	137.444**	0.10596**	911.997**
Lines (female)	3	43.6909**	28.9559**	365.196**	0.26542^{NS}	2659.67**
Tester (male)	2	29.9297*	1.6138^{ns}	62.622*	0.01593 ^{NS}	366.94**
Line xTester	6	81.766**	7.1498**	48.509**	0.05625 ^{NS}	219.85**
Pooled error	36	0.55	0.34176	1.5802	0.02155	0.195

* = Significant at 5% level of Probability, ** = Significant at 1% level of Probability , NS = Non Significant

Table 2. Mean Performance of parents and their hybrids for seed cotton yield yield and its components of Upland cotton

Genotype	P.H (cm)		Sym/Pl (No.)		Bolls/pl (No.)		Boll Weight(g)		Seed cotton yield/pl (g)	
Chandi-95	113.54	h	22.097	cd	29.97	gh	3.2667	a	92.68	k
Sohni	98.9	j	21.197	def	33.34	de	2.8333	cdef	92.63	k
Sadori	121.49	d	23.57	ab	37.18	bc	2.8133	def	106.86	c
NIA Ufaq	115.64	g	21.997	cd	32.777	ef	2.8167	def	90.43	l
BT-802	118.69	ef	20.863	efg	30.127	gh	3.1767	ab	92.85	jk
BT-703	121.78	d	22.763	bc	33.693	de	3.0833	abc	98.31	h
BT-A-1	102.2	i	20.053	gh	28.017	h	3.1433	ab	83.75	n
Chandi-95 x BT 802	126.87	a	23.667	ab	47.66	a	2.66	f	131.85	a
Chandi-95 x BT 703	123.77	c	23.887	a	46.333	a	2.84	cdef	131.49	a
Chandi-95 x BT A-1	115.48	g	20.56	fg	34.547	de	3.05	abcd	103.37	e
Sohni x BT 802	112.98	h	18.647	i	24.657	i	2.9633	bcde	75.8	p
Sohni x BT 703	120.91	d	18.293	i	28.43	h	2.7233	ef	85.44	m
Sohni x BT.A-1	119.51	e	20.123	gh	28.71	h	2.7533	ef	80.37	o
Sadori x BT.802	117.67	f	19.197	hi	34.237	de	2.82	def	93.45	j
Sadori x BT.703	120.9	d	21.877	cde	36.78	bc	2.8233	def	101.44	f
Sadori x BT.A-1	126.52	a	21.94	cd	35.443	bcd	2.7667	ef	99.46	g
NIA Ufaq x BT.802	124.62	bc	23.563	ab	37.513	b	3.0833	abc	108.82	b
NIA Ufaq x BT.703	125.71	ab	23.19	ab	35.323	cd	3.18	ab	105.6	d
NIA Ufaq x BT-A-1	117.66	f	21.83	cde	31.127	fg	3.2267	a	97.43	i

Table 3. Mean performance of parents, F_1 hybrids and percentage increase (+) or decrease (-) over mid parent (relative heterosis) and better parent (heterobeltiosis).

F_1 hybrids	Plant height (cm)		Sympodia/ plant (No.)		Bolls/plant (No.)		Boll weight (g)		Seedcotton yield (g/plant)	
	Percentage									
	MPH	HB	MPH	HB	MPH	HB	MPH	HB	MPH	HB
Chandi-95 x BT 802	9.52	6.25	14.52	11.25	65.38	64.88	-8.11	-10.15	42.14	42.00
Chandi-95 x BT 703	5.71	1.82	11.56	8.18	50.82	42.97	-4.57	-7.30	37.70	33.75
Chandi-95 x BT A-1	7.79	2.67	-2.50	-7.12	24.32	20.17	-2.24	-3.19	17.57	11.90
Sohni x BT 802	7.10	-2.22	-1.07	-1.16	-18.03	-22.49	1.02	-1.98	-18.28	-18.36
Sohni x BT 703	9.66	-0.55	0.85	0.34	-9.94	-9.97	0.34	-1.68	-10.52	-13.09
Sohni x BT.A-1	19.06	17.29	-1.68	-3.69	-5.55	-13.13	-2.35	-6.45	-8.85	-13.22
Sadori x BT.802	-2.42	-3.16	-8.52	-11.98	1.31	-8.95	-2.72	-5.29	-6.41	-12.55
Sadori x BT.703	1.16	1.14	0.93	-3.06	4.36	-1.09	-1.71	-3.36	-1.10	-5.06
Sadori x BT.A-1	13.15	4.00	1.47	-4.23	8.95	-4.73	-1.00	-4.83	4.35	-6.93
Nia Ufaq x BT.802	5.44	4.12	10.05	7.15	19.90	14.88	4.09	0.99	18.76	17.17
Nia Ufaq x BT.703	5.56	3.47	11.82	8.67	6.48	7.99	9.96	7.74	11.91	7.41
Nia Ufaq x BT-A-1	7.69	0.85	2.41	-2.21	1.89	-5.22	11.44	6.77	11.13	7.03

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