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ASSESSMENT OF HETEROTIC EFFECTS IN INTRA-HIRSUTUM CROSSES FOR YIELD AND FIBER TRAITS

Shabana Memon[†±], Sidra Nizamani[†], Sadaf Memon[†], Ghulam Hussain Jatoi[#], Liaquat Ali Bhutto[*] and Arshad Ali Kaleri[†]

[†]Department of Plant Breeding and Genetics, Sindh Agriculture University, Tando Jam, [*]Cotton Section, ARI, Tando Jam and [#]Ph.D. scholar, CAAS, Beijing, China. [#]Department of Plant Pathology Sindh Agriculture University, Tando Jam, Pakistan, Email[±]: sheeba.memon786@gmail.com

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ABSTRACT

The present study aimed to determine the heterotic effect in ten F_1 hybrids in upland cotton. The experiment was laid out in the experimental field of Botanical Garden, Sindh Agriculture University, Tando Jam with three replications during 2015. The hybrids Chandi-95 x CRIS-134 contributed positive heterosis for plant height (cm) and bolls plant^{-1}. NIAB-78 x Chandi provides better mid parent heterosis for plant height (cm), boll weight (g) and seed cotton yield. Heterobeltoisis seemed to be more in sympodial branches plant $^{-1}$ and seed index (g). However, the cross Chandi-95 x Haridost observed to produce relative heterosis and heterobeltoisis for G.O.T %. Hence, the heterotic information provides the better hybrid production in a gene pool.

Key Words: Cotton, Heterotic, Hirsutum, Yield.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) as a fiber crop occupies a pivotal position in the world in a normal and significant way in the Asian nation (Amjad et al., 2009). The cotton plant is perennial in nature and has an indeterminate growth habit, has adapted to the annual crop due to the monumental efforts of plant breeders (Ali et al., 2003; Rauf et al., 2005). The precocity of cotton is vital to alleviating late-season insect/pest risks (especially boll worms), disease, unfavorable climatic conditions and increased economic performance by reducing the value of inputs (Anderson et al., 1976). Another advantage of cultivating early maturing cotton cultivars is the provision of adequate time for the rotation of other crops, allowing the timely planting of wheat in the cotton-wheat-cotton cultivation system as in Pakistan (Ali et al., 2003). During FY2016, cotton production stood at 10,074 million bales compared to 13,960 million bales in fiscal year 2015 and recorded a drastic decrease of twenty-seven percent (Pakistan Economic Survey 2015-16).

Plant breeders crossbreed the genetic material to produce variation and to develop such varieties which are in accordance to their need. They intend to distinguish the parents and F_1 offspring from the developed hybrid combinations which have superior agronomic traits (Devi *et al.*, 2013). Utilization of best parents for crossing is the best strategy for the next generation of superior segregating populations to be picked up by selection (Valerio *et al.*, 2009). Heterosis and heterobeltiosis are directly proportional to selection i.e. if heterosis is more, effective will be selection (Kalimullah, 2011). Heterosis is the superiority of F_1 over the mean of the fogeys or over the superior parents or over quality discusses with relevance the useful agricultural traits. To maximize heterosis,there is a requirement to use breeding programs to constantly increase variability and increase genetic diversity among populations, which will be exploited by choosing to combine capacity among these many populations (Kumar, 2008). Hybrid vigor with respect to performance is generally defined as an increase in performance over the mean of the 2 elders or over the parent. Useful heterosis is explained as increasing the degree associated with the performance of the F_1 hybrid on quality business verification. Heterosis functions as a basic tool for the advancement of crops within the variety of F_1 hybrids. Emphasis is placed on the viability of economic heterosis in resting and intraspecies crossings of Gossypium where labor is cheaper (Khan and Khan 1979, Salam, 1991). Altaf et al., (1996) and Keerio et al., (1996) performed these studies for monopodial and sympodial branches per plant and reported promising heterosis. Khan et al., (2000) suggested that through heterosis, breeding for seed cotton yield along with quality traits can be greatly improved. To achieve a high degree of heterogeneous response, it is essential to have better data on the performance of the old fascinates in terms of hybrid combination; The unit of heterotic studies area useful for making such data. Heterosis is the superiorrity within the performance of the F_1/F_2 hybrids for specific traits (Khan et al., 2010). Several researchers have determined the vital amount of heterosis for varied traits, as Ashokkumar and Ravikesavan (2013) recorded positive heterotic effects for fiber elongation; Baloch et al. (2014) showed substantial effects of the heterobeltiosis for boll plant-^{1}, seed cotton production plant-^{1} and percentage of fluff.

Abro et al. (2014) noted considerable heterosis for sympodial branches per plant, capsules per plant and yield of seed cotton. Basal et al., (2011) suggested that the identification and choice of the best new F_1 hybrids should not be supported solely by GCA and SCA, but should be associated with an average yield. The present analysis was carried out with the aim of estimating the relative effects of heterotic and heterogeneous heterocycles on F_1 hybrids for seed cotton yield and fiber characteristics at intra-hirsutum crosses.

MATERIAL AND METHODS

The experiment was conducted at the experimental field of botanical garden at the Department of Plant Breeding and Genetics, Sindh Agriculture University, Tando Jam during Kharif season 2015. The seeds of five parental varieties (NIAB-78, Chandi-95, CRIS-134, Haridost and Shahbaz) and their F_1 hybrids were sown as half diallel fashion. Randomize complete block design (RCBD) with three replications. The analysis of variance was carried out according to the statistical methods of Gomez and Gomez (1984) and the percentages of heterosis relative to mid (MP) and better (BP) parents were calculated according to Fehr (1987) as follow:

$$\text{Heterosis} = \frac{\text{F1} - \text{MP}}{\text{MP}} X\, 100$$

$$\text{Heterobeltosis} = \frac{\text{F1} - \text{BP}}{\text{BP}} X\, 100$$

The statistical analysis was interpreted with the help of Statistix 8.1 computer software.

RESULTS AND DISCUSION

The occurrence of heterosis in plant species is variable according to the expression of genes. Heterobeltoisis is a valuable tool, which informs the comparison of the performance of the hybrid with that of the best parent in the cross. The present study was investigated to study the heterotic effects on different traits of cotton influencing yield (Table 1). The mean performance of parental lines and F_1 hybrids results revealed that among parents the genotype Haridost and Chandi-95 contributed to have taller height as compared to other parents (135 and 105 cm). Comparing with the different hybrids, the cross Haridost x Shahbaz attained maximum height (145 cm) and Chandi-95 x Shahbaz attained minimum height (100 cm), respectively. Sympodial branches plant^{-1} and number of bolls plant^{-1} was found to be more in CRIS-134 (23.3 and 44.4).

Table-1 Mean Performance of parents and hybrids for yield and qualitative traits in upland cotton.

Hybrids/Parents	Plant height (cm)	No. of sympodial branches	No. of bolls Plant-^{1}	Boll weight (g)	Seed cotton yield (g)	GOT %	Seed index (100 seed weight)	Staple length (mm)
NIAB-78	110.00d	18.90fg	42.00de	3.00efg	126.00ij	38.00c	6.00ab	28b
CHANDI-95	105.00d	20.30ef	40.35e	2.50gh	100.87j	37.50cd	37.50cd	28.5b
CRIS-134	130.00b	23.35de	44.40d	3.10efg	137.64ij	38.50c	5.50c	29a
HARIDOST	135.00ab	19.15fg	41.35e	3.40efg	140.59hi	36.50e	5.50c	27.5c
SHAHBAZ	120.00c	20.20ef	35.00fg	4.00ab	140.00hi	38.37c	5.80cd	28b
NIAB-78 X CHANDI-95	120.22c	22.00e	50.50c	3.50ef	170.52bc	39.33ab	5.50c	26d
NIAB-78 X CRIS-134	110.50d	28.00bc	48.34cd	3.30ef	159.52efg	41.00b	5.00c	28b
NIAB X HARIDOST	130.35b	25.50d	44.40d	3.80cd	168.72cd	35.00e	7.00b	28.5b
NIAB-78 X SHAHBAZ	125.00bc	20.15ef	54.50b	3.00efg	163.50cde	34.35ef	8.30a	26.8d
CHANDI-95 X CRIS-134	135.00ab	30.30bc	58.50a	3.00efg	175.50a	39.40ab	5.75cd	29a
CHANDI-95 X HARIDOST	110.00d	21.25ef	46.30cd	3.80cd	175.94a	42.00a	5.10c	27.5c
CHANDI-95 X SHAHBAZ	100.00d	18.19	40.14e	4.00ab	160.56ef	37.00cd	6.80ab	26.5d
CRIS-134 X HARIDOST	105.50d	23.75de	44.35d	3.35ef	148.57	38.5c	6.95ab	28.5b
CRIS-134 X SHAHBAZ	128.35bc	32.00ab	38.40ef	4.50a	172.80bc	35.70e	7.80b	26d
HARIDOST X SHAHBAZ	145.00a	34.50a	42.30de	4.10ab	173.43ab	34.50ef	8.50a	28.2b
LSD at 5%	1.45	1.05	1.82	0.45	3.35	1.35	0.95	0.35

However, the cross Chandi-95 x Shahbaz (18.2) to have more number of sympodial branches. CRIS -134 gave the highest number of sympodial branches plant^{-1}. While NIAB-78 recorded lowest sympodial branches plant $^{-1}$ (18.9). Maximum number of bolls were recorded in Chandi-95 x CRIS-134 (38.4). The parent Shahbaz contributed to have maximum boll weight and seed cotton yield plant^{-1} (4.0 g and 140.0 g). However, the hybrid NIAB-78 x Shahbaz revealed to have more boll weight (4.5g). Mukhtar *et al.,* (2000) also reported that as boll weight increased, the seed cotton yield also increased in the hybrids. Seed cotton yield plant^{-1} revealed to be more in Chandi-95 x Haridost, NIAB-78 x Chandi-95, Chandi-95 x CRIS-134, CRIS-134 x Shahbaz and Haridost x Shahbaz. Furthermore, the cross Chandi-95 x Haridost recorded highest G.O.T. % and the parent CRIS-134 gave maximum ginning outturn percent. The staple length was better in the cross Chandi x CRIS-134 and microniare value performed better as 4.5 and 4.6 ug/inch, whereas lowest microniare value shown by CRIS-134.

The information regarding heterosis for different trait is present in table-2. Maximum heterosis over mid parent was produced in the hybrids viz. Chandi-95 x CRIS-134, Haridost x Shahbaz and NIAB-78 x Chandi-95 having positive heterosis (12.9, 12.06 and 10.58%) for the trait plant height (cm). While, the hybrid NIAB-78 x Chandi-95 and Haridost x Shahbaz gave maximum heterobeltiosis (8.5 and 6.89%) for plant height. The heterotic effect for sympodial branches plant^{-1} contributed positive relative heterosis and heterobeltiosis (43.3 and 41.4%) in the cross Haridost x Shahbaz while NIAB-78 x Shahbaz recorded negative relative heterosis. Munir *et al*., and Soomro *et al.,* (2016) also observed positive heterosis and heterobeltiosis for the traits bolls/plant, monopodia plant^{-1}, sympodia plant^{-1}. For number of bolls plant^{-1} the heterosis revealed in NIAB-78 x Shahbaz (39.3%) was positive. However, CRIS-134 x Shahbaz influenced to have negative heterosis (-3.38%). Favorable heterosis was attributed for seed cotton yield and bolls plant^{-1}, boll weight, bolls plant^{-1}, sympodia plant $^{-1}$ and seed cotton yield^{-1} by different researchrers (Munir *et al.,* 2016; Katageri *et al.,* 1991; Haleem *et al.,* 2015). NIAB-78 x Chandi-95 was also found to have more heterotic effect for boll weight (14. 28), seed cotton yield (heterosis: 35.37) and (heterobeltoisis: 28.21). Alkuddsi *et al.,* (2013) and Abd-El-Haleem *et al.,* (2010) also reported the same results and found to have more boll weight with positive heterosis and heterobeltoisis effects. The relative heterosis for G.O.T%

was positive in the hybrid Chandi-95 x Haridost. However, NIAB-78 x Haridost, Chandi-95 x Shahbaz, CRIS-134 x Shahabz and Haridost x Shahbaz revealed to possess negative heterotic effects. Soomro *et al.,* (2010 and 2015) interpreted that ginning outturn percentage was better in different genotypes as having positive heterosis and heterobeltoisis. For the trait seed index, positive relative heterosis (36.4%) and hetrobeltoisis (31.7%) appeared to be in almost all the crosses except NIAB-78 x Chandi-95, NIAB x CRIS-134, Chandi x CRIS-134 and Chandi-95 x Haridost (-22.72, -15.00, -13.04 and -22.54%). The heterotic effect for microniare value also prevailed to have positive relative heterosis and heterbeltoisis for the hybrid Haridost x Shahbaz (7.29 and 5.85). Boleck *et al.,* (2010) also observed that different parents and crosses possessed high fiber quality and yield contributing positive heterosis and heterobeltoisis.

CONCLUSION

In the present study, the parents NIAB-78, Haridost and CRIS-134 performed better in the hybrids and can be used in different crosses. Whereas, Chandi-95 x CRIS-134 proved to have positive heterosis and heterobeltoisis for plant height and bolls plant^{-1}. Chandi-95 x Haridost and NIAB-78 x Chandi-95 exhibited significant heterosis for yield and yield contributing characters. Hence, the evaluated study suggests that different F_1 hybrids are useful to select potential genotypes and could be used for further useful breeding program.

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Table 2: Heterotic effects of F1% increase (+) or decrease (-) over their mid and better parents regarding different yield and qualitative traits.

Hybrids	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent	Mid Parent	Better parent
NIAB-78 x Shahbaz	8.00	4.00	2.907	-2.48	39.35	22.93	-16.66	-33.33	21.42	14.28	35.37	28.21	4.17	3.38	-22.72	-36.36	-8.65	-9.61
Chandi-95 x Haridost	-9.09	-22.72	7.15	4.47	11.77	10.69	22.36	10.52	7.75	6.06	17.36	13.71	6.63	6.09	-15.00	-20.00	-1.78	-3.57
Haridost x Shahbaz	12.06	6.89	43.33	41.41	9.76	2.24	9.75	2.43	15.78	10.52	20.99	16.67	-6.42	-8.57	21.42	14.28	2.63	1.75
Cris-134 x Haridost	-25.60	-27.96	10.52	.68	3.33	-0.11	2.98	-1.49	-16.66	-33.33	18.65	14.37	-11.14	-11.70	28.91	27.71	-4.47	-4.52
Chandi-95 x Shahbaz	-12.50	-20.00	-11.32	-11.62	6.15	-5.23	18.75	0.00	6.66	-3.33	32.05	21.57	3.55	2.28	-13.04	-30.43	0.86	0.00
NIAB-78 x Cris-134	-8.60	-17.64	24.45	16.60	10.63	8.15	7.75	6.06	22.36	10.52	31.38	20.92	11.90	10.71	-22.54	-47.05	-1.78	-3.63
Cris-134 x Shahbaz	2.36	-1.28	31.93	27.03	-3.38	-15.62	21.11	11.11	18.75	0.00	24.99	12.80	-2.51	-3.70	2.20	-10.29	-6.60	-7.54
NIAB-78 x Haridost	6.02	-3.56	25.41	24.90	6..21	5.40	15.78	10.52	2.98 v	-1.49	6.36	5.37	2.59	0.00	24.46	20.86	0.87	1.75
NIAB-78 x Chandi-95	10.58	8.50	10.90	7.72	17.90	16.25	21.42	14.28	21.11	11.11	19.66	18.98	-7.64	-7.84	27.56	25.64	-9.61	-11.53
Chandi-95 x Cris-134	12.96	3.70	27.98	22.93	27.57	24.10	6.66	-3.33	9.75	2.43	19.10	18.93	-8.49	-11.21	36.47	31.76	1.59	0.70