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STUDY OF HETEROSIS AND HETEROBELTIOSIS IN UPLAND COTTON

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ABSTRACT

The study was conducted at Halani District Naushehro Feroze during the kharif season 2013-14, to investigate the heterosis and heterobeltiosis of five parents through diallel cross combination to evaluate the superior parents and cross combinations for knowing the potential to produce F_1 hybrids for hybrid crop development. *The analysis of variance revealed that significant difference among the parents and genotypes, which suggested that the occurrence of extensive amount of genetic variability for all the characters studied.* For number of bolls per plant hybrid MNH-886 X CIM-511 recorded more bolls over mid parent, while CRIS-134 X MNH-886 was given highest number of bolls over the better parent. The hybrid MNH-886 X CIM-506 obtained highest heterosis for boll weight and seed cotton yield per plant over mid and better parents. Whereas hybrid CRIS-134 X BH-36 produced maximum seed index heterosis over mid parent and hybrid CRIS-134 X CIM-511 for better parent. The maximum heterosis of GOT was obtained by hybrid (CRIS-134 X CIM-506 and MNH-886 X CIM-506) CRIS-134 X CIM-506 over mid parent and MNH-886 X CIM-506 for better parent. Therefore results suggested that hybrids may be exploited in hybrid seed production.

Keywords: Heterosis, heterobeltiosis, hybrid vigor, upland cotton.

INTRODUCTION

Heterosis is the superiority of the F_1 hybrid over the mid-parent or better parent and is the result of allelic and non-allelic interaction of genes under the influence of particular environment. Heterosis in any breeding programmes refers to the superiority of F1 hybrids over the parental performance Wu *et al*. (2004). For development of hybrid cotton, the significance of heterosis should be at adequate level. In cotton, heterosis of 50% over the commercial variety and 20% over the commercial hybrid is considered useful for hybrid development Singh *et al*. (2012). Patil *et al*. (2011) reported that some hybrids exhibited significant heterosis in boll number and boll weight which were associated with increased seed cotton yield, thus suggested that such crosses could be considered for exploitation of hybrid vigor in cotton. In intra and inter- specific Heterosis , yield increase over mid and better parent or greater than commercial cultivar (useful Heterosis) have been documented (Khan *et al*., 2007; Khan 2011 and Maria Khanpanni *et al*., 2012).

Cotton breeders are keenly interested in evolving new cotton varieties; those well adapt to the environmental conditions and produce higher yields, higher ginning outturn percentage, better fiber quality and higher fertilizer response along with increased tolerance to complexes of diseases and insect pests. Keeping in view the importance of cotton crop, the present research was conducted to investigate the information on heterosis and heterobeltiosis for various quantitative traits in cotton which can be used for commercial exploitation of heterosis for hybrid crop development.

MATERIALS AND METHODS

The experiment was conducted at Halani, district Naushehro Feroze during kharif season 2013-14. The experimental material consisted of five parents (CRIS-134, BH-36, MNH-886, CIM-506 & CIM-511) and 10 F_1 hybrids to study effects of heterosis and heterobeltiosis for some quantitative traits in upland cotton (*Gossypium hirsutum L.*). The F_1 seed of 10 hybrids was produced by crossing 5 cultivars, in half diallel crossing fashion.

The 5x5 diallel crosses which included the parents and one set of the hybrids, thus formed a total of 15 genotypes (10 F_1 hybrids and 5 parents) were studied. The F_1 hybrids seed of 10 crosses and 5 parents were planted in a Randomized Complete Block Design. Plant to plant distance was kept at 9 inches and row to row at 2.5 feet. Normal inputs were used whenever required. For recording the data, 15 plants of each genotype from each replication were randomly tagged. The traits were studied viz. number of bolls per plant, boll weight, seed cotton yield per plant, seed index and ginning outturn percentage. Heterosis was calculated in terms of percent increase/decrease of populations over its mid and better parent values (Fehr, 1987).

Mid Parent Heterosis

When the heterosis is estimated over the mid parent i.e. mean value or average of the two parents is known as mid parent heterosis. It is also known as average heterosis or relative heterosis and calculated by using formula.

$$\text{Mid Parent Heterosis} = \frac{F1 - MP}{MP} \times 100$$

F1 is First Filial Generation (after cross of two varieties result is F1)
MP = Mid Parent (two varieties average is called MP for comparing)

Better Parent Heterosis

When the heterosis is estimated over the better parent is known as better parent heterosis. It is also known as heterobeltiosis and calculated by using formula:

$$\text{Heterobeltiosis} = \frac{F1 - BP}{BP} \times 100$$

F1 is First Filial Generation (after cross of two varieties result is F1)
BP = Better Parent (compared with best parent if there is one parent high and other is low)

RESULTS AND DISCUSSIONS

The analysis of variance (mean square values) of studied traits are presented in Table 1. It revealed that mean squares genotypes were highly significant; as well as parents and hybrids individually were also significant for all the traits studied. The mean values of traits for parents and hybrids are presented in Table 2 which showed that among the parents CIM-506 and MNH-886 produced maximum bolls per plant, whereas in hybrid CRIS-134 X MNH-886 and MNH-886 X CIM-506 given highest number of bolls. For boll weight parents CIM-506 and MNH-886 results, while among the hybrids CRIS-134 X MNH-886 and CRIS-134 X CIM-506 yielded maximum boll weight. As regards to the seed cotton yield MNH-886 and BH-36 were maximum yield parents, though CRIS-134 X MNH-886 and CRIS-134 X CIM-506 found to be the best yield potential hybrids for seed cotton yield per plant. For the trait seed index BH-36 and CIM-506 proven to be the best parents and given highest values, however hybrids BH-36 X MNH-886 and CRIS-134 X BH-36 produced maximum seed index in cross combinations. Among the parents CIM-506 and MNH-886 produced the maximum lint percentage, at the same time among cross combinations hybrids MNH-886 X CIM-506 and CRIS-134 X CIM-506 produced the maximum ginning outturn percentage.

Table 1. Analysis of variance (mean squares) values of yield attributing traits and GOT in upland cotton.

Source of variance	D.F	Number of bolls per plant	Boll weight	Seed cotton yield/plant	Seed Index	GOT %
Replication	3	2.745	1.874	36.824	0.037	0.814
Genotypes	14	112.45**	0.52**	19207.18**	1.43**	7.15**
Hybrids	9	89.87**	0.47**	1322.41**	0.89**	6.12**
Parents	4	21.45**	0.07**	298.51**	3.21**	8.27**
Error	42	0.978	0.016	9.751	0.098	0.319

Heterosis and Heterobeltiosis

The result of heterotic effects are depicted in Table 3 which indicated that for the number of bolls per plant all the F_1 hybrids produced positive heterosis over mid parent value, which range from 13.53 to 49.41% increase over mid parent. The highest number of bolls were recorded in cross MNH-886 X CIM-511 followed by BH-36 X MNH-886. Whereas result of heterobeltiosis 03 crosses given negative values out of 10. The heterobeltiosis ranged was observed from 9.46 to 28.17% respectively. The highest number of bolls for heterobeltiosis was recorded in cross CRIS-134 X MNH-886 followed by MNH-886 X CIM-511. For boll weight all the F_1 hybrids showed positive heterosis over mid and better parent except two which expressed negative heterosis over mid and better parent value. The maximum boll weight was exhibited by cross MNH-886 X CIM-506 over mid parent (23.21%) and better parent (21.13%) respectively. The heterotic effect of seed cotton yield ranged from 16.17 up to 47.33%. All the hybrids given positive heterosis over mid and better parent. The maximum seed cotton yield manifested by cross MNH-886 X CIM-506 over mid parent (47.33%) and better parent (40.87%) respectively. The seed index results showed that among the hybrids eight crosses obtained positive heterosis over mid parent and two were produced negative heterosis. Whilst six hybrids given positive heterosis over better parent and four were given negative heterosis.

Table 2. Mean performance of hybrids and parents for yield attributing traits and GOT in upland cotton.

Parents and F_1 hybrids	TRAITS				
	Number of bolls per plant	Boll weight (g)	Seed cotton yield/pl. (g)	Seed Index (g)	GOT %
Parents					
CRIS-134	43.81	3.18	78.82	8.21	37.16
BH-36	34.18	3.37	91.57	10.91	32.47
MNH-886	47.81	3.43	98.12	9.73	38.91
CIM-506	49.16	3.55	89.51	9.82	40.21
CIM-511	31.34	3.25	75.8	8.47	34.8
F_1 Hybrids					
CRIS-134 X BH-36	51.36	3.21	108.23	11.21	37.51
CRIS-134 X MNH-886	61.28	3.51	116.12	9.26	36.28
CRIS-134 X CIM-506	53.81	3.75	121.81	8.78	42.12
CRIS-134 X CIM-511	41.67	3.31	100.25	9.67	38.11
BH-36 X MNH-886	56.17	3.71	110.18	11.89	35.61
BH-36 X CIM-506	47.31	3.64	107.36	10.92	36.57
BH-36 X CIM-511	39.22	3.29	96.47	9.51	33.27
MNH-886 X CIM-506	59.57	4.30	138.22	10.12	42.21
MNH-886 X CIM-511	59.13	3.61	108.99	9.67	38.45
CIM-506 X CIM-511	47.11	3.46	105.75	9.87	38.57
LSD (5%)	2.11	0.21	3.78	0.27	0.72

Table 3. Heterotic effects of F_1 % increase (+) or decrease (-) over mid and better parent for yield attributing traits and GOT in upland cotton.

Hybrid	Number of Bolls Per Plant		Boll Weight		Seed Cotton yield per plant		Seed Index		GOT	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
CRIS-134 X BH-36	31.71	17.23	-1.98	-4.75	27.04	18.19	17.26	2.75	7.74	0.94
CRIS-134 X MNH-886	33.77	28.17	6.20	2.33	31.25	18.34	3.23	-4.83	-4.61	-6.76
CRIS-134 X CIM-506	15.76	9.46	11.44	5.63	44.73	36.09	-2.61	-10.59	8.88	4.75
CRIS-134 X CIM-511	10.90	-4.88	2.95	1.85	29.67	27.19	7.27	14.17	5.92	2.56
BH-36 X MNH-886	37.02	17.49	9.12	8.16	16.17	12.29	15.21	8.98	-0.22	-8.48
BH-36 X CIM-506	13.53	-3.76	5.20	2.54	18.58	19.94	5.35	0.09	0.63	-9.05
BH-36 X CIM-511	19.72	14.75	-0.60	-2.37	15.28	5.35	-1.86	-12.83	-1.09	-4.40
MNH-886 X CIM-506	22.86	21.18	23.21	21.13	47.33	40.87	3.53	3.05	6.70	4.97
MNH-886 X CIM-511	49.41	23.68	8.08	5.25	25.33	11.08	6.26	-0.62	4.33	-1.18
CIM-506 X CIM-511	17.04	-4.17	1.76	-2.54	27.94	18.14	7.93	0.51	2.84	-4.08

(MP = Mid Parent) and (BP = Better Parent)

The highest seed index was recorded by cross CRIS-134 X BH-36 over mid parent (17.26%), while the cross CRIS-134 X CIM-511 produced maximum heterosis over better parent (14.17%). For the trait GOT all the hybrids produce positive heterosis over mid parent except three which given negative heterosis, while over the better parent four hybrids given negative heterosis out of ten. The maximum heterosis for GOT was produced by hybrid CRIS-134 X CIM-506 over mid parent, whereas hybrid MNH-886 X CIM-506 gave the highest heterosis over better parent for the trait GOT. The heterotic effects thus indicated that the potential hybrids can be exploited for hybrid crop development for the traits like number of bolls per plant, boll weight, seed cotton yield per plant, seed index and GOT. Therefore inevitably over-dominance pattern of genetic determination governed their inheritance. These finds are in agreement with those of Nidagundi *et al*. (2011), Patil *et al*. (2011), Solanki *et al*. (2014), Mastungi and Ansari (2015) and Muhammad *et al*. (2015) who also obtained high positive heterosis and heterobeltiosis effects.

Conclusion

The study was conducted to evaluate the parents in cross combinations for knowing the potential to produce F_1 hybrids for hybrid crop development. The parents MNH-886, CIM-506 and CRIS-134 proved to be the best for cross combination for the traits viz. number of bolls per plant, boll weight, seed cotton yield per plant, seed index and GOT and these parents can be utilized in hybrid crop development program. The hybrids MNH-886 X CIM-511, CRIS-134 X MNH-886, MNH-886 X CIM-506, CRIS-134 X BH-36 performed better exhibited significant heterosis for yield and yield contributing characters and ginning outturn percentage.

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