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ESTIMATION OF HETEROSIS, POTENCE RATIO AND COMBINING ABILITY IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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Heterosis, potence ratio and combining ability for seven quantitative traits were examined in F_1 generation of intervarietal crosses of four wheat genotypes using randomized block design. Results demonstrated that the parents and their F_1 hybrids differed significantly (P> 0.05) for four out of seven traits studied, indicating substantial variation within parents and their hybrids. Manifestation of heterosis was observed for all the traits in at least one or more crosses. The highest MP heterosis (31.12%), heterobeltiosis (23.31%) and potence ratio (4.91) were displayed by the hybrid Koh-i-noor-83 x Mehran-89 for tillers per plant followed by yield per plant. Heterotic effects were appreciably influenced by the hybrid genotype, the direction of cross and the trait concerned. General combining ability analysis indicated that the large portion of total genetic variation for four out of seven traits was associated with genes which were additive in their effect. Specific combining ability was non-significant for all the traits indicating absence of epistasis and dominant gene effects. Parent Jauhar-78 was the best general combiner having positive GCA effects for six out of seven traits. Cross Koh-i-noor-83 x Mehran-89 was the best cross combination followed by Yecora x Jauhar-78 since these crosses exhibited high parent heterosis in at least five out of seven traits. GCA effects were more pronounced than SCA effects for all the traits except grains per spike. Therefore, selection has been advocated on the basis of GCA's of the parents which can be exploited through conventional breeding programme.

Key words: bread wheat, combining ability, heterosis, potence ratio

INTRODUCTION

Increased yields of crops had been a prime concern in breeding programmes. Wheat breeders all over the world have been utilizing the available genetic resources for this purpose. An understanding of the genetic factors that govern the yield components is necessary because breeding for yield depends largely upon genetic manipulation of the components along with yield. These characters are polygenic and exhibit additive and non-additive genetic variation. Parents with significant GCA effects are useful for exploitation through conventional crossing programme, and those with significant SCA effect are suitable for hybrid variety development. Today, it has become amply clear that self-pollinated crops can exhibit similar extent of heterosis as in case of cross-pollinated crops (Larik et al., 1988, 1992, 1995). In this context, the present study was undertaken to determine hybrid vigour, potence ratio (dominance estimates) and combining ability for yield and its components in bread wheat.

MATERIAL AND METHODS

Four varieties of wheat i.e. Jauhar-78, Mehran-89 (M-89), Yecora and Koh-i-noor-83 crossed in a complete diallel system with reciprocals were studied in randomized block design with three replications during 1990-91 at the Department of Plant Breeding and Genetics, Sindh Agriculture University, Tandojam, Pakistan. Each entry was represented by a row 1.5 cm long, 30 cm apart, with 15 cm distance between plants. The data were recorded for seven quantitative traits from 10 competitive plants selected from each row. The data thus recorded were subjected to statistical analysis and comparison of means as per design was carried out after Steel and Torrie (1980). Two types of heterosis, the average heterosis and heterobeltiosis were determined according to the formulae suggested by Fehr (1987). The dominance estimates were computed using "potence ratio" method (Griffing, 1950).

$$D.E. = \frac{F1-MP}{BP-MP}$$

Where D.E. is the dominance estimate, F1 MP and BP are observed mean values of F_1, mid parent and better parent respectively.

RESULTS AND DISCUSSION

Mean performance of 12 F1 hybrids along with their parents is presented in Table 1. Analysis of variance for combining ability is given in Table 3. Data revealed significant differences for plant height, spike length, grains per spike and 1000-grain weight indicating thereby the presence of considerable amount of variability.

Hybrid Vigour: Heterotic effects and dominance estimates for seven characters are given in Table 2. Data demonstrated that the degree of heterosis was variable in different traits and is appreciably affected by direction of the cross (Larik et al., 1992, 1995) and that the heterosis in grain yield was associated with increase in one or more of the characters such as tillers per plant, spike length, spikelets per spike, grains per ear and 1000-grain weight (Larik et al., 1988). For plant height 4 out of 12 hybrids showed negative heterosis over both parents. Hybrid Koh-i-noor-83 x Mehran-89 produced shorter plants with the highest negative heterosis (-11.4% and -16.31%) over mid and better parents respectively which can be exploited to produce dwarf hybrids which are likely to resist lodging and respond to high fertilizer inputs (Larik et al., 1995). The expression of positive heterosis by Yecora x Jauhar-78 over both parents indicates overdominance of additive gene action (Liu et al., 1989). Five F_1 hybrids expressed positive heterosis over both parents for spike length with maximum hybrid vigour of 11.09% by the hybrid Koh-i-noor-83 x Mehran-89 over MP. Spikelets per spike displayed almost *low* positive heterosis in four out of twelve hybrids, while for grains per spike hybrid Jauhar-78 x Yecora showed the highest positive heterosis Over MP (10.01%) and BP (8.23%) respectively. For 1000-grain weight hybrid Jauhar-78 x Mehran-89 exhibited the highest positive heterosis over both parents.

Yield heterosis of the F_1 hybrids Over mid and BP ranged from 1.73 to 27.12% and 11.88 to 18.21%. Hybrid Koh-i-noor-83 x Mehran-89 displayed maximum heterosis of27.12 and 18.21% over MP and BP respectively, and heterosis values tended to increase in cross between parents of increasing diversity. Therefore cross Koh-i-noor-83 x Mehran-89, Yecora x Koh-i-noor-83 and their reciprocals can be picked up as the best potential combination and may be a good starting material for initiating hybrid breeding programme.

Combining Ability: Analysis of variance for general combining ability (GCA) and specific combining ability (SCA) as well as GCA-SCA ratios are presented in Table 4. Variances due to GCA were significant for four out of seven traits and were higher than those of SCA (Table 3) which suggested that the major portion of genetic variance in the base population was additive in nature.

Direct comparison of GCA performance of individual parent with corresponding standard error for each trait (Table 4) indicated that parent,huh.ctY.7C }t,?cl significant GCA effects for tallness and was a good general combiner for this trait, while Yecora and Koh-i-noor-83 showed highest GCA effects for dwarfness and can be exploited. for breeding dwarf genotypes. For tillers per plant parent Koh-i-noor-83 and Yecora displayed superiority by exhibiting maximum positive GCA effects and proved good general combiners for this trait. F_1 hybrids I{ch--i-r..oor-83x MehraJ:l.-89 b"d high positive SCA effects than other hybrids and proved to be a promising genotype for improvement of yield components. For spike length and spikelets per spike, parent Jauhar-78 exhibited positive GCA effects and proved a good general combiner. The highest positive SCA effect (+0.65) was shown by the hybrid Koh-i-noor-83 x Mehran-89 for spike *length.* Hybrid Jauhar-78 x Mehran-89, showed positive significant SCA effect for spikelets per spike, indicating that non-additive gene action controlled a portion of genetic variance associated with this trait (Larik et al., 1995). In case of grains per spike, parent Mehran-89 and Koh-i-noor-83 showed positive GCA effects in this order of merit proving good general combiners for this trait, whereas hybrids Mehran-89 x Jauhar-78 and Koh-i-noor-83 x Mehran-89 had the highest positive SCA values. For seed index parent Jauhar-78 had the highest positive GCA effects, whereas hybrid JaUhar x Koh-i-noor displayed highest positive SCA effects (Table 4).

Grain yield per plant revealed non-significant GCA and SCA variance indicating that non-additive gene action was predominant for this trait (Singh et al., 1982). Parent Jauhar-78 and Koh-i-noor-83 displayed significant positive GCA values suggesting that these parents are the good general combiners. Of the 12 F_1 hybrids. *only* five showed significant SCA effects for this trait (Table 4) and suggested that these potential parental combinations may have to be tested to obtain the desirable level6fhybrid vigour in bread wheat.

It is, therefore, concluded that the parent Jauhar-78 was the best general combiner having GCA effects in positive direction for six out of seven quantitative traits followed by Mehran-89. As regards SCA, Koh-i-noor-83 x Mehran-89 was the best cross combination followed by hybrid Yecora x Jauhar-78.

Table 1. Mean performance and ANOVA(mean squares) for 12 F_1 hybrids and their parents

Parent/cross hybrids	Plant height (cm)	Fertile tillers/ plant	Spike length	Spikelets/ spike	Grains/ spike	1000-grain weight (g)	Yield/ plant (g)
Jauhar-78	93.70 ef	21,18	12,43 d	19.28	50.06 ab	50.70 cdef	39.54
Mehran -89(M-89)	93.91 ef	17.80	11.01 abc	18.96	57.04 cde	50.67 cdef	35.79
Yecora	67.05 a	19.89	10.89 ab	17.67	48,44 a	49.70 cde	30.53
Koh-i-noor-83	83.55 bcdef	15.68	10.62 a	17.75	57.11 a	44,49 a	30.31
Jauhar-78 x M-89	94.99 f	19.77	12.38 cd	19.67	53.88 abed	55.61 i	37.12
Jauhar-78 x Yecora	94.87 f	19.37	12.25 cd	19.08	5'4.18 abed	55.00 hi	33.18
Jauhar-78 x Koh-i-noor-83	92.04 def	21,38	12.21 bed	18.73	52.83 abc	52.64 efgh	39.05
M-89 x Jauhar-78	95.03 f	16,44	12.28 cd	19.52	60.23 de	54.82 ghi	36,47
M·89 x Yecora	81.96bcdef	18.33	11.33 abcd	18.58	55.27 bcde	53.33fghi	33.46
M-89 x Koh-i-noor-83	84.81 bcdef	16.35	11,16 abcd	17.77	53.96 abed	47.87 be	28.68
Yecora x M-89	88.07 cdef	19.3	10.69 a	18.17	57.37 cde	50.95 defg	33.81
Yecora x Koh-i-noor-83	73.36 ab	20.25	11.08 abcd	18.38	57.07 cde	44.77 a	34.26
Yecora x Jauhar-78	80.13 bcde	20.85	12.35 cd	19.09	53.07 abc	54.88 hi	39,41
Koh-i-noor-83 x Jauhar-78	90.84 def	19.22	11,66 abcd	18.66	53.56 abed	51,20 defg	36.99
Koh-i-noor-83 x M-89	78.59 abc	21,95	12.02 bed	18.57	61,96 e	48,46 bed	41,67
Koh-i-noor-83 x Yecora	75.87	20.06	11.27 abcd	18.2	5'5.60 bcde	45.67 ab	34.04
ANOVA							
Replications 2	6.315	84.35	1,66	3.35	18,49	4.71	117.22
Genotypes 15	232.61 **	9.75 n.s	1,31*	1,14*	38.78*	40.20**	40.24 n.s
Error 30	55.83	13.84	0.55	0.77	14.21	2.75	66.89

*,**Denote significant at 5% and 1% level of probability; n.s = non-significant.

Table 2. Dominance estimates (D.E) and heterosis (%) values over mid parrent (MP) and better parent (BP) for seven quantitative traits in *Triticum aestivum* L. crosses

Crosses		Plant height	No. of productive tillers	Spike length	Spike-*letsl* spike	Grains per spike	1000-grain weight	Yield per plant
Jauhar-78 x M-89	MP	+1,27	+1,44	+5.63	+2.88	+0.62	+9.71	-0.72
	BP	+1,15	-6.66	-0,40	+2.02	-5.54	+9.68	-6.10
	DF	+3.63	+0.16	+0.93	+3,43	+0.09	+49.20	-0.13
Jauhar-78 x Yecora	MP	+18.03	-5.72	+7.38	+3.25	+10.01	+9.56	-5.28
	BP	+ 1,25	-8.56	-1,45	-1,04	+8.23	+8,48	-16.06
	DE	+ 1.08	+1,84	+0.76	+0.75	+6.08	+9.60	-0,41
Jauhar-78 x Koh-i-noor-83	MP	+4.16	+15.98	+5.90	+1,13	-1,42	+10.59	+11.83
	BP	-1,77	+0.93	-1,77	-2.85	-7,49	+3.83	-1,21
	DE	+0.69	+1,06	+0.75	+0.27	+0.88	+1,62	+0.89
M-89 x Jauhar-78	MP	+1,30	-15.80	+4.78	+2.09	+12,47	+8.15	-2,46
	BP	+1,19	-22.52	-1,21	+1,24	+5.59	+8.13	-7.74
	DE	+12.20	+1.82	+0.78	+2.50	+1.91	+41.30	-0.43
M-89 x Yecora	MP	+1,47	-2.76	+3,47	+1,42	+10.52	+6.26	+1,73
	BP	-13.04	-7.87	+2.91	-2.00	+2.19	+5.25	+5.08
	DE	+0.08	-0.52	+6.33	+0,41	+1,29	+6.54	+0.24
M-89 x Koh-i-noor-83	MP	-4.42	-2.33	+3.14	-3.21	-5,47	+0.61	-12.51
	BP	-9.69	-8.15	+1,36	-6.28	-5.52	-5.53	-18.64
	DE	-0.76	-0.36	+1,78	-0.98	-14.00	+0.09	-1,18
Yecora x M-89	MP	+9.34	+2.39	-2.37	-0.82	-2.60	+1,51	+2.80
	BP	-6.22	-3.00	-2.91	-4.17	-9.94	+0.55	-4.09
	DE	+0.56	+0,43	+4.33	-0.23	-0.32	+1,58	+0.38
Yecora x Koh-i-noor-83	MP	-2.52	+13.81	+2.97	+3.76	+8.13	-4.95	+12.96
	BP	-12.20	+1,76	+1,74	+3.55	-0.07	-9.92	+12.95
	DE	-0.23	+1,17	+2,46	+17.25	+0.99	-0.89	
Yecora x Jauhar-78	MP	-0.31	+1,51	+5.92	+3.30	+7.76	+9.32	+12.50
	BP	-14,48	-1,56	-0.64	-0.99	+6.01	+8.24	-0.30
	DE	cO.02	+0;48-	+D:B7	+0.'16	+~.71	+9.36	+0.97
Koh-i-noor-83 x Jauhar-78	MP	+2,49	+4.29	+1,13	+0.76	-0.06	+7.56	+5.93
	BP	-3.05	-9.25	-6.19	-3.22	-6.22	+0.99	-6,43
	DE	+0,43	-0.44	+0.14	+0.18	-0.01	+1,16	+0,46
Koh-i-noor-83 x M-89	MP	-11,43	+31,12	+11,09	+1,14	+8.55	+1,85	+27.1£
	BP	-16.31	+23.31	+9.17	-2.06	+E1.49	-4.36	+18.21
	DE	-1,95	+4.91	+6.31	+0.35	+16.26	+0.28	+3.60
Koh-i-noor-83 x Yecora	MP	+0.76	+12.76	+4.74	+2.77	+5.34	-3.04	+12.23
	BP	-9.19	+0.82	+3,49	+2.54	-2.64	-8.11	+12.16
	DE	+0.07	+1,36	+3.92	+12.25	+0.65	-0.55	+37.10

Table 3. Analysis of variance (mean squares) for combining ability

Source of variation	D.F	Plant height	No. of productive tillers	Spike length	Spike-lets! spike	Grains! spike	1000-grain weight	Yield! plant
GCA	3	164.27**	2,46n.s	0.898**	0.881*	7.33n.s	48.62**	9.06n.s
SCA	6	5.303n.s	0.099n.s	0.035n.s	0.06n.s	2,483n.s	1.127n.s	0.041n.s
Reciprocals	6	25.39n.s	4.21n.s	0.13n.s	0.07n.s	13.00*	0.79n.s	17.73n.s
Error	30	18.6	4.61	0.18	0.26	0.74	0.92	22,29

Table 4. Estimation of general and specific combining ability effects for seven traits of *Triticum aestivum* L.

Parent/cross	Plant height	Tillers/ plant	Spike length	Spike-lets/ spike	Grains per spike	1000-grain weight	Grain yield! plant
GCAeffects							
Jauhar-78	+8.20	+0.09	+0.70	+0.63	-1,28	+4.14	+0.02
Mehran-89	+2.01	-1,13	-0.12	+0.02	+1,71	+0.86	-0.71
Yeoora	-5.29	+0.38	-0.31	-0.17	-0.82	-0.75	-1.47
Koh-i-noor-83	-4.90	+0.64	-0.23	-0,42	+0.54	-4.25	+0.14
S.E	:t3.01	:1.52	:to.30	:1:0.35	:1:1.54	:1:0.68	:t3.34
SCAeffeds							
Jauhar-78 x M-89	-1,08	+1,37	+0.08	+0.32	-2.03	-0.66	+0.14
Jauhar-78 x Yecora	-4.64	+1,10	+0.30	-2.00	-,41	+.35	+2.60
Jauhar-78 x Koh-i-noor-83	+2.88	+1,21	+0.02	-1,13	-1,91	+1,48	+1,22
M-89 x Jauhar-78	-1,04	+1,99	-0.02	+0.17	+4.32	-1,45	-0.51
M-89 x Yecora	-0.92	-0.56	+0.07	-0.97	+1,92	-1,95	-0.03
M-89 x Koh-I-noor-83	+1,84	-2.60	-0.21	-1,48	-3.77	-0.01	-6,42
Yecora x Jauhar-78	-8.64	+0.94	+0.27	-1,07	-0.31	+0.22	+3.19
Yecora x M-89	+5,49	+0.61	-0.57	-1,38	-5.00	-0,43	+0.32
Yecora x Koh-i-noor-83	-2.31	-0.21	-0.07.	-0.68	+1,87	-1,50	-0.08
Koh-i-noor-83 x Jauhar-78	+1,68	-0.95	-0.53	-1,20	-1,18	+0.04	-0.93
Koh-i-noor-83 x M-89	-4.38	+3.00	+0.65	-0.68	+4.23	+0.58	+6.57
Koh-i-noor-83 x Yecora	+0.20	-0,40	+0.12	-0.86	+0,40	-0.60	-0.30
S.E	±3.01	±1,52	±0.30	±0.35	±1,54	±0.68	±3.34

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