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Combining ability studies for yield and its attributes in *Triticum durum*

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Abstract : Combining ability effects were estimated in line x tester crossing programme for fifteen characters involving ten lines and four testers in *Triticum durum*. It revealed preponderance of non-additive gene action for grain yield / plant along with other character like grain number / spike, 1000 grain weight, protein content, sedimentation value and β-carotene, which suggests scope for improvement of these characters through heterosis breeding and transgressive segregants for evolving high yielding superior genotypes. HI 8591, HI 8596 and HD 4692 among lines and Bij Red and HG 110 among testers were evaluated as good general combiners. Among hybrids, HD 4694 x Bij Red, HI 8381 x MPO 215, HI 8591 x MPO 215, HI 8591 xHG 110, HI 8596x MPO 215 and HI 8653 x Bij Red were the most promising ones as they had high SCA effect and *per se* performance for grain yield / plant and its component characters. An attempt of multiple crosses with the use of all the above good general combiners would lead to obtain transgressive segregants for grain yield in advanced generations.

Key words : Combining ability, T.durum, line x tester, Gene action.

Introduction

India is one the major producers of durum wheat with a total output of 2.5 million tones, which is mainly grown in Central India and Punjab. The knowledge on nature and magnitude of gene action determines the selection of parents which, when crossed will result in heterotic hybrids or higher proportions of transgressive segregants. Combining ability study finds out the good general combiners for yield and its components, promising cross combinations, nature and magnitude of gene action governing the expression of yield and yield components which inturn helps in identification of proper breeding methodology. The present investigation was undertaken to get the information on the nature of combining ability operative in the inheritance of grain yield and its related characters through line x tester mating design involving ten lines and four testers of durum wheat.

Materials and Methods

The experimental materials comprised of ten pure lines of durum wheat viz., HD 4694, HI 8498, HI 8381, HI 8596, HD 4672, HD 4692, HI 8591, HD 4695, HI 8651 and HI 8653 were used as females crossed with four male parents *viz.*, Bijaga Red, HG 110, IWP 5019 and MPO 215, which were also resistant to black rust to develop forty F1 crosses using line x tester mating design during *rabi* 2000-01. The F1 crosses along with their parents were raised in a randomized block design with three replications during 2001-02 at Indian Agricultural Research Station - Regional Station, Indore. Plot size comprised of a single row of 2 m length spaced 30 cm apart. Seeds were dibbled 10 cm apart with in a row. All the recommended package of practices were followed to a raise a good crop.

Observations were recorded on five randomly selected competitive plants in each entry and in each replication for days to 50% flowering, days to maturity, plant height, number of tillers/plant, spike length, spikelets/spike, grain number/ spike, grain yield / spike, grain yield / plant, 1000 grain weight, biological

Table 1. Estiamtes of general combining ability effects of 14 parents in wheat *(Triticum durum)*

S.N	Parents	Characters														
		Days to 50% flowering	Days to matu-ring	Plant height (cm)	No.of tillers/ plant	Spike length (cm)	No.of grains /spike	Grain yield/ spike(g)	Grain yield/ plant(g)	1000-grain wt.(g)	Biolog-cat yield (g)	Spike-lets/ spike	Pro-tein (%)	Sedimen-tation (ml)	β-carotene (ppm)	Harvest index (%)
1	HD 4694	1.06*	0.40	1.89*	0.12	-0.08	-0.61	-0.15*	-0.99*	-3.89**	-2.47*	0.61*	0.45**	-4.06**	1.00**	0.01*
2	HI 8591	2.72**	1.15	-0.56	0.20	0.17	4.24**	0.23**	1.45**	0.15	2.58**	0.77**	-0.20**	-7.39**	-0.15**	-0.01*
3	HI 8653	2.47**	2.98**	-0.13	-0.29	0.02	-1.48	-0.05	-0.68	-0.18	-1.12	0.04	-0.38**	2.86**	-0.58**	0.00
4	HI 8596	-0.19	0.15	1.60	0.55**	-0.30*	-1.21	-0.10	0.67	-0.47	1.43	-0.44	0.55**	1.03**	0.56**	0.01
5	HD 4692	0.89	1.32	1.46	0.05	-0.17	2.52*	0.08	0.75*	0.41	1.32	0.22	-0.12**	5.11**	-0.09	0.03**
6	HD 4672	-2.36*	-0.18	2.32**	-0.04	0.19	0.66	0.06	0.42	1.26*	-0.81	-0.48	0.03	-1.73**	0.06	0.01
7	HI 8498	-1.36*	-0.18	-1.59	-0.35*	0.06	1.54	0.19**	0.06	1.90**	-0.48	-0.09	-0.12**	1.53**	-0.12	0.01
8	HI 8381	-0.03	-1.68*	-0.19	-0.16	0.32**	2.27	0.11	0.21	0.97	-0.57	0.12	-0.22*	-2.39**	-0.55**	0.01
9	HD 4695	-1.86**	-3.10**	-3.25**	-0.04	-0.52**	-5.97**	-0.45**	-1.58**	-3.08**	-1.70	-0.93**	-0.06	3.28**	0.53**	-0.03**
10	HI 8651	1.36**	-0.85	-1.54	-0.04	0.31**	-1.98	0.08	-0.31	2.93**	1.83	0.19	0.07	1.78*8	-0.67**	-0.03**
	SE(gi)+_	0.54	0.75	0.96	0.16	0.12	1.19	0.07	0.36	0.55	0.97	0.29	0.05	0.21	0.07	0.01
Testers (Males)																
1.	MPO215	6.01**	4.88**	-8.69**	-0.07	-0.03	0.85	-0.11**	-0.60**	-2.13**	0.80	1.10**	-0.09**	-1.86**	0.58**	-0.03
2	BIJ Red	-0.43	-2.48**	12.76**	0.18*	0.58**	1.07	0.06	0.91**	0.35	0.66	0.02	0.02	-2.62**	-0.45**	0.02
3	IWP 5019	-5.29**	-3.38**	-9.08**	-9.01	-0.63**	-4.20**	-0.19**	-1.46**	0.14	-4.21**	-1.08**	0.02	3.81**	-0.18**	0.01
4	HG110	-0.29	0.98	5.01**	-0.09	0.08	2.28**	0.23**	1.16**	1.63**	2.76**	-0.04	0.05	0.67**	0.05	0.00
	S.E. ((gj))+	0.31	0.43	0.56	0.09	0.07	0.69	0.04	0.21	0.32	0.56	0.17	0.12	0.12	0.04	0.01

* Significant at 5% level, and ** Significant at 1% level, respecively.

Table 2. Best cross combinations for yield and related characters (SCA effects) in wheat (*Triticum durum*)

SN	Cross combinations		Days to 50% flowering	Plant height (cm)	No.of tillers/ plant	Grain number/ spike	Grain yield/ (g)	Grain yield/ plant(g)	1000- grain weight (g)	Harvest index (%)
1	HD 4694 x Bij Red	L x H	**	-ve	*	**	**	**	+ve	+ve
2	HI 8381 x MPO 215	L x L	-	-ve	+ve	*	*	*	-	+ve
3	HI 8591 x MPO 215	H x L	-ve	-	+ve	+ve	+ve	*	-	+ve
4	HI 8591 x HG 110	H x H	-	-ve	*	+ve	+ve	*	+ve	-
5	HI 8596 x MPO 215	H x L	-	-	+ve	+ve	+ve	*	-	+ve
6	HI 8653 x BIJ Red	L x H	**	**	+ve	+ve	*	*	+ve	+ve

* Significant at 5%
** Significant at 1%
\- Undesirable

yield, protein content (%), sedimentation value (ml), β-carotene (ppm) and harvest index. The combining ability analysis was carried out as per the method given by Kempthorne (1957).

Results and discussion

The analysis of variance revealed that the mean square of F1's were highly significant for all the characters, suggesting significant genetic differences in the generated material. Significant differences were also observed among the testers for days to 50% flowering, days to maturity, plant height, spike length, grain yield/spike, biological yield, spikelets/spike, whereas, for spike length, grain yield / spike, 1000 grain weight, protein content, sedimentation value and β-carotene among the lines. Significant differences were observed for line xtesters for all the characters, except plant height, no.of tillers / plant, spike length, spikelets / spike, biological yield and harvest index.

The specific combining ability variance was greater than that of general combining ability for the characters like grain number / spike, grain yield / plant, 1000 grain weight, protein content, sedimentation value and β-carotene. Hence, the relative estimates of General Combining Ability (GCA) and Specific Combining Ability (SCA) variances indicated that the variances due to SCA effect were predominant for the above characters and in turn it indicated the preponderance of non-additive gene action. For grain yield / plant, the additive and non-additive variance found almost of similar magnitude. Thus the value of σ_D^2 / σ^2A is approximately equal to unity, which indicated complete dominance for this character and it can be improved by both heterosis breeding and by selection of superior segregants. Whereas, additive gene action is predominant for all the remaining characters under study. The characters controlled by non-additive gene action indicates the scope of improvement of these characters though heterosis breeding for evolving high yielding superior

genotypes. Similar results were reported by Ranvir Singh *et al.* (1982), Yadav *et al.* (1988) and Singh *et al.* (1990).

The GCA effects of parents (Table 1) suggested that HI 8591, HI 8596 and HD 4692 among lines and Bij. Red and HG 110 among testers were good general combiners for grain yield /plant. The good general combiners for grain yield / plant were also found to be good general combiners for different yield components *viz.* high GCA effects were exhibited for four characters in HI 8591 (spikelets / spike, no. of grains / spike, grain yield / spike and biological yield). HI 8596 for no. of tillers / plant and quality characters like protein, sedimentation and β carotene content. While, HD 4692 showed high GCA effects for three characters like no. of grains / spike, sedimentation value and harvest index. Among the testers, Bij. Red exhibited high GCA for four characters other than grian yield i.e., days to maturity,, no. of tillers / plant, test weight and biological yield, while, HG 110 showed for 6 characters i.e., no. of grains / spike, grain yield / spike, test weight, biological yield, sedimentation value and β - carotene. This direct relationships between GCA effects of grain yield with that of yield components was probably due to close association between grain yield and yield components. So, these parents may thus be used in the hybridization programme to get transgressive segregants in early generations. As none of the parents was found to be general combiners for all the characters, there is need to attempt multiple crosses for component breeding for improvement of grain yield. Parents HI 8591, HI 8596 and HD 4692 among lines and Bij. Red and HG 110 among testers should be given importance in the choice of parents because of their good *SCA* for yield. Multiple crosses followed by intermating among the desired selected plants in later segregating generations may also be of much use for simultaneous improvement of grain yield (Patil *et al.* 1995).

The estimates of specific combining ability effects revealed that none of the crosses were found to be superior for all the characters under study. However, the significant and positive SCA effect for grain yield / plant exhibited by 6 crosses viz., HD 4694 x Bij Red, HI 8381 x MPO 215, HI 8591 x MPO215, HI 8591 x HG 110, HI 8596 x MPO 215 and HI 8653 x Bij. Red in ascending order of magnitude. These crosses also recorded significant and desirable positive SCA effects for one or more yield components.

All the superior specific combiners (Table 2) involved high x high, high x low, low x high and low x low general combiners. It shows that the desirable SCA effect of any cross combination need not necessarily depend on the level of GCA effects of the parents involved (Rajaram and Maheswari, 1996). It indicated that the role of additive and non-additive gene action for the characters studied and also signify the importance of both the types of gene action for improvement of grain yield. The promising crosses resulted from the combination of high x low or low x high GCA parents could be possibly due to complementary action of divergent genes in the F_1s and additive type of gene interaction which may yield transgressive segregants in later generations, if the allelic genetic systems are present in good combinations and epistatic effects present in the cross act unidirectional to maximize the expression of the characters under selection.

As a conclusion, it was observed that the parents HI 8591, HI 8596 and HD 492 among lines and Bij. Red and HG 110 among testers were the good general combiners and these parents can be used advantageously in the crossing programme of practical plant breeding like pedigree breeding etc., for the development of superior durum wheat varieties. Based on mean performance and SCA effects, six hybrid combinations i.e., HD 4694 x Bij Red, HI

8381 x MPO 215, HI 8591 x MPO 215, HI 8591 x HG 110, HI 8596 x MPO 215 and HI 8653 x Bij. Red were found to be the best hybrid combinations for grain yield and other contributing characters and these F_1s can be utilized for heterotic breeding for exploitation of heterosis and it is possible to select a superior genotype in the subsequent generations.

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