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Combining Ability in Wheat (*Triticum aestivum* L.)*

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ABSTRACT

Studies on combining ability were conducted in wheat using 8 x 8 diallel set in three environments. Yield and its component characters were studied. The mean squares due to GCA x environments and SCA x environments were highly significant for all the characters studied in all the generations. The estimates of GCA x environment variances were generally higher than those of the SCA x environment Variances. It showed that the additive variance x environment interaction was more as compared to the non-additive variance x environment interaction. Raj 1777 was good combiner for grain yield/plant, productive tillers/plant, length of main spike, number of spikelets/spike and number of grains/spike. The crosses pitic 62/Raj 1777 and Pitic 62/GW 496 exhibited positive sca effects for grain yield/plant and other yield attributing characters over generations. Diverse good combiners should be used for hybridization and the resultant material should be exposed to different environments for identifying the stable high yielding genotypes.

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INTRODUCTION

It is being realised that the genetic potential of present day cultivars of wheat appears to be fast reaching plateau. . Thus there is need to improve the yield potential of wheat varieties. Therefore, testing of new segregants and lines from germplasm for their usefulness in breeding programme would be the first step leading to development of superior varieties. The success of a breeding procedure is determined by the useful gene combinations organised in the form of high combining lines isolated from germplasm. Therefore, information on general and specific combining ability would be very useful to the plant breeders.

MATERIALS AND METHODS

Eight parents namely, K 65, Pitic 62, Raj 1777, HD 2189, GW 173, GW 496, HI 1077 and Lok 1 were crossed in all possible combinations excluding reciprocals to make a diallel set during 1992-93. A few F_1 seeds of each of the crosses were grown at Wellington, Nilgiris, Tamil Nadu in off season wheat nursery during Summer 1993 for generation advancement. Eight parental lines, their 28 F_{1s} and 28 F_{2s} were studied during *Rabi* 1993-94, under three environments as follows :

Environment 1 : Early sown (1st November, 1993)

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Environment 2 : Timely sown (15th November, 1993)

Environment 3 : Late sown (1st December, 1993)

The experiment was laid out in randomised complete block design (RBD), with three replications under each environment. Each plot of homogeneous (Parents and F_{1s}) and segregating (F_{2s}) material was consisted of 2.5 m long single and four row respectively. The row-to-row and plant-to-plant distances were kept at 22.5 cm and 5 cm, respectively. Five competitive plants from parental lines and F_{1s} and 20 plants from each F_{2s} were randomly selected for recording observations. The combining ability analysis was carried out according to the procedure given by Griffing (1956, Moel I, Method 2) which was further extended by Singh (1973) for pooled analysis.

RESULTS AND DISCUSSION

Pooled analysis for combining ability for parents and F_1S as well as parents and F_2S was carried out separately. The variances due to general and specific combining abilities were significant for all the characters in both the generations. This indicated that both additive and non-additive gene effects played important role in the inheritance of the characters. The GCA x environment interaction was significant for all the characters in F_1 and F_2 except 1000-grain weight in F_2 generation. The SCA x environment interaction was significant for most of the characters in both the generations except productive tillers/plant and 1000-grain weight in F_2 generation (Table 1). The mean squares due to GCA x environment were higher than the SCA x environment for most of the characters. The higher value of GCA x environment over SCA x environment for majority of the cases suggested that GCA was more susceptible to environmental changes. Significant sensitivity of GCA x environment and SCA x environment interactions for different traits have also been reported earlier by Narula (1987) and Srivastava (1992).

General Combining Ability Effects

Significant negative GCA effects revealed that GW 173, Lok 1, GW 496 and HI 1077 were good general combiners for early flowering and maturity in both the generations (Table 2). The parents K 65, HD 2189, Raj 1777 and Pitic 62 were desirable combiners for tallness, while parents GW 173, Lok 1, GW 496 and HI 1077 were desirable combiners for dwarfness, Raj 1777 recorded to be good general combiner for productive tillers/plant in both the generations. HD 2189 and Pitic 62 in F_1 generation and Pitic 62 in F_2 generation were identified as good general combiners for productive tillers/plant. In respect of length of main spike, number of grains/spike and number of spikelets/spike, Raj 1777, HD 2189 and Pitic 62 were identified as good general combiners over both the generations. Lok 1 and K 65 over both the generations were identified as good general combiners for 1000-grain weight. HD 2189 and Pitic 62 in F_1 generation and K 65 in F_2 generation were identified as good general combiners for grain yield/plant. Raj 1777 was good general combiner for grain yield/plant, which means that these parents transmitted additive genes for yield and component characters in their progeny.

Specific Combining Ability Effects

Specific combining ability effects (SCA) presented in Table 3 revealed that out of 28 crosses only six crosses over generations were significant for sca effects for grain yield/plant. In the present study none of the

TABLE 1

Analysis of variance for combining ability over environments in wheat.

Item	d.f.	Days to flowering		Days to maturity		Plant height		Productive tillers per plant	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
GCA	7	492.14**	398.63**	268.03**	470.56**	1030.06**	1123.29**	7.79**	4.18**
SCA	28	24.61**	24.33**	29.49**	20.86**	22.15**	17.36**	7.74**	1.47**
Environment (E)	2	203.78**	30.41*	723.85**	648.65**	405.61**	411.08**	26.38**	2.69
GCA x E	14	109.08**	13.24**	23.94**	42.31**	32.68**	22.06**	3.17**	1.35**
SCA x E	56	6.36**	36.30*	11.34**	5.12**	10.99**	15.85**	2.22**	0.34
Error	210	0.38	1.02	0.44	0.90	1.04	2.83	0.19	0.25

Item	d.f.	Length of main spike		No.of spiklets per spike		No. of grains per spike		1000 grain weight		Grain yield per plant	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
GCA	7	17.15**	11.99**	53.62**	39.86**	654.21**	412.71**	229.26**	177.90**	39.85**	12.72**
SCA	28	0.92**	0.23**	2.06**	0.94**	104.68**	17.61**	18.83**	11.43**	23.76**	5.73**
Environment (E)	2	9.42**	7.78*	11.62*	27.21*	64.05*	23.25	1.71	11.95	100.12**	8.40
GCA x E	14	0.89**	0.59**	3.49**	1.69**	24.98**	11.89*	4.42**	3.89	16.20**	2.85**
SCA x E	56	0.17**	0.28**	0.71**	1.05**	7.54**	8.45**	4.25**	2.86	12.40**	1.17**
Error	210	0.07	0.10	0.16	0.30	1.63	4.12	0.35	2.13	0.19	0.54

*, ** Significant at 5% and 1% levels, respectively.

TABLE 2

Estimates of the general combining ability effects for different characters studied in wheat.

Parents	Days to flowering		Daysto maturity		Plant height		Productive tillers per plant		Length of main spike	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
K 65	3.51**	4.34**	3.04**	6.47**	9.06**	8.67**	0.01	0.50**	0.42**	0.62**
Pitic 62	2.56**	2.35**	2.31**	1.89**	1.91**	2.51**	0.32**	0.02	0.60**	0.45**
Raj 1777	6.56**	5.22**	4.37**	3.62**	2.91**	3.51**	0.86**	0.55**	0.50**	0.22**
HD 2189	0.13	-0.69**	0.33**	-0.71**	4.39**	5.14**	0.33**	-0.15	0.59**	0.46**
GW 173	-5.88**	-5.23**	-3.80**	-6.41**	-10.13**	-10.09**	-0.77**	-0.48**	-1.49**	-1.16**
GW 496	-2.09**	-2.29**	-1.96**	-2.52**	-3.06**	-3.97**	-0.21**	-0.37**	-0.04	-0.12*
HI 1077	-1.26**	-0.96**	-1.37**	-0.63**	-1.55**	-0.91**	-0.04	-0.16*	0.19**	0.26**
Lok 1	-3.53**	-2.73**	-2.93**	-1.73**	-3.52**	04.86**	-0.49**	0.08	-0.77**	-0.73**
SE (gi) ±	0.11	0.17	0.11	0.16	0.17	0.29	0.07	0.08	0.05	0.05
SE (gi — gj) ±	0.16	0.26	0.17	0.24	0.26	0.43	0.11	0.13	0.07	0.08

Parents	No. of spikelets per spike		No. of grain per spike		1000 grain weight		Grain yield per plant	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
K 65	0.62**	0.80**	-1.15**	0.45	1.47**	1.37**	0.03	0.86**
Pitic 62	1.16**	1.03**	1.62**	1.13**	0.88**	1.24**	0.41**	0.21
Raj 1777	1.71**	1.06**	7.75**	5.12**	-4.13**	-3.60	1.44**	0.75**
HD 2189	1.14**	1.06**	4.50**	3.77**	0.20*	-0.15	1.48**	0.16
GW 173	-1.82**	-1.47**	-6.40**	-4.51**	-3.30**	-2.89**	-2.02**	-1.06**
GW 496	-0.67**	-0.80**	-1.10**	-1.24**	-0.03	-0.34	-0.59**	-0.64**
HI 1077	-0.54**	-0.08	-0.03	0.90**	0.16	0.31	-0.06	-0.10
Lok 1	-1.59**	-1.60**	-5.54**	-5.62**	4.75**	4.06**	-0.67**	-0.18
SE (gi) ±	0.07	0.09	0.22	0.34	0.10	0.25	0.07	0.12
SE (gi—gj) ±	0.10	0.14	0.33	0.52	0.15	0.38	0.11	0.20

*, ** Significant at 5% and 1% levels, respectively.

TABLE 3

Specific combining ability effects for different traits in wheat.

Genotypes	Days to flowering		Days to maturity		Plant height		Productive tillers per plant		Length of main spike	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
K 65/HD/2189	0.34	1.63**	1.82**	2.99**	-0.86	-0.19	2.58**	1.57**	-0.21	0.28
Pitic 62/Raj 1777	-3.57**	-2.62**	0.40	-1.75**	-3.48**	7.31**	0.35	-0.15	0.63**	0.47**
Pitic 62/GW-496	-0.15	1.78**	0.29	1.94**	1.41**	0.35	1.53**	0.59*	0.40**	0.35*
Pitic 62/HI 1077	2.69**	1.00	0.37	2.83**	1.62**	0.94	1.62**	0.61*	0.24	-0.20
Raj 1777/HD 2189	2.97**	0.09	-0.18	-0.37	2.34**	-0.21	1.00**	1.08**	0.36**	0.10
Raj 1777/GW 496	-0.26	-0.42	1.56**	1.21*	-0.86	-0.54	1.90**	0.52*	0.27*	-0.04
SE (Sij) ±	0.32	0.53	0.35	0.50	0.53	0.88	00.23	0.26	0.14	0.17
SE (Sij-Sik) ±	0.48	0.78	0.51	0.74	0.79	1.30	0.34	0.37	0.20	0.25

Genotypes	No. of spikelets per spike		No. of grains per spike		1000 grain weight		Grain yield per plant	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
K 65/HD 2189	0.25	-0.45	-0.32	1.80	0.94**	0.13	1.93**	3.13**
Pitic 62/Raj 1777	0.35	0.19	4.77*	2.60*	1.01**	1.12	2.43**	0.77**
Pitic 62/GW 496	0.92**	0.71*	5.45**	3.30**	1.30**	0.92	1.11**	1.28**
Pitic 62/HI 1077	0.27	-0.01	2.36**	0.62	0.29	0.76	3.80**	1.16**
Raj 1777/HD 2189	0.59**	-0.24	5.51**	4.40**	1.21**	1.27	3.16**	1.57**
Raj 1777/GW 496	0.95**	0.09	5.56**	-0.08	0.60*	0.22	5.70**	0.77**
SE (Sij) ±	0.21	0.28	0.67	1.06	0.31	0.76	0.23	0.38
SE (Sij-Sik) ±	0.31	0.42	0.99	1.57	0.46	1.13	0.34	0.57

*, ** Significant at 5% and 1% levels, respectively.

crosses showed significant positive sca effects for all the traits in both the generations. The cross Pitic 62/Raj 1777 showed desirable spacific combining ability for early flowering in both the generations. Crosses Pitic 62/Raj 1777 and Pitic 62/GW 496 exhibited significant and positive sca effects for grain yield/plant over generations with positive sca effects for length of main spike, number of spikelets/spike, number of grains/spike and 1000-grain weight (Table 3). The inconsistency in sca effects observed over generations can be attributed to dominance x dominance interaction and genotype x environment interaction. Most of the cross combinations in F_1 and F_2 generations which exhibited high sca effects for different traits involved one good general combiner as either parent, it is expected that such a cross combination would throw transgressive segregants in later generations.

Keeping in view the findings of present investigation it is concluded that the choice of the parents to be used in breeding programme should be based on the combining ability tests over different environments. In a wheat breeding programme aiming to improve yield and other traits, a three-way or complex crosses involving good combiners should be produced and resulting material should be handled through intermating (biparental crosses) of the selects in the early generation.

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