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COMBINING ABILITY IN BREADWHEAT

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ABSTRACT

Heterosis was examined in relation to combining ability effects in a 8×8 diallel cross experiment in wheat. Highest heterosis of 33.22, 12.72, 22.32, 66.61, 52.94, 189.89 and 5.07% was observed over economic parent for protein content, tryptophan content, seed hardness, coleoptile length, radicle length, root spread area and grain yield, respectively. The results of mean performance of the crosses agreed well with the overall status of the specific combining ability effects, indicating that selection of the crosses based on heterotic response is equally effective. High × high, high × low, and low × low general combiners could cause heterosis in the best crosses.

Key words: Combining ability, quality and seedling traits, breadwheat.

In countries like India, the basic problem of nutrition is linked with protein shortage and its poor quality. Tryptophan plays a fundamental role in biosynthesis of nicotinamide (vit. B_6) and determines the nutritive value of protein. Seed hardness plays a substantial role in determining the *chapati* making quality of wheat. Coleoptile length, a character of seedling vigour, can effectively determine the plant height status from the early stage of plant life [1]. Radicle length and root area traits may be considered good for saline and moisture stress conditions. The rarity of promising lines with good combining ability in respect of these important traits necessitates information on heterosis and combining ability, as the heterotic response of a cross combination depends on combining ability of its parents.

MATERIALS AND METHODS

An 8 × 8 diallel set was prepared by crossing eight wheat genotypes, viz., K8302, HD2285, K8301, B1252, K78, K8103, K8144, and K68 in all possible combinations (excluding reciprocals). Eight parents along with 28 F_1 were grown in randomized block design with three replications keeping single row of each F_1 and

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parent. The protein content of grains was determined by the Biuret method [2]. Tryptophan content was estimated by the colorimetric method [3, 4]. Seed hardness (kg pressure) was determined using O.S.K. 201 Seed Hardness Tester Type-E of 50 kg pressure capacity.

For seedling traits, grains were raised in moist folded germination paper adjusted in aluminium template and these, in turn, were placed in trays containing water up to the level just touching the lower edges of the germination paper. These were placed in the germination chamber at 20°C and final observations recorded on 6th day of the experiment. Root spread area (cm^2 was calculated by multiplying the length of radicle and width taken by spreading rootlets).

Heterosis (%) was calculated over economic parent. Combining ability was based on the procedure of Griffing [5].

RESULTS AND DISCUSSION

ANOVA for the traits studied showed significant differences among parents and F_1. The gca and sca mean squares were also significant for all the traits. The crosses which have shown high heterosis and sca effects are presented in Table 1. The highest heterosis for protein content was observed in K8302 × K78 (33.2%), followed by K78 × K8144 and K8302 × B1252. Similarly, highest heterosis for tryptophan content was observed in K8302 × K78 (12.7%). The other crosses, K8301 × B1252 and K78 × K68, were also equally good in heterotic response. For seed hardness, cross B1252 × K78 exhibited maximum heterosis (22.3%), followed by K8144 × K68, B1252 × K68, and K78 × K68. Cross K8301 × K8103 showed highest heterotic response (66.6%), followed by K8302 × K78 and K8302 × B1252 for coleoptile length. The highest heterosis for radicle length was observed in cross K8302 × K8301 (52.9%), followed by K8302 × K78, and K8302 × B1252. For root spread area cross K8302 × HD2285 showed maximum heterosis (189.9%), followed by K8302 × K68. Cross K8302 × K8144 expressed mild heterosis (5.1%) over the economic parent for grain yield.

The F_1 heterosis is of direct interest for developing hybrids in cross-pollinated crops, but it is also of importance in self-pollinated crops. Such heterotic crosses may produce desirable transgressive segregants in advanced generations. Thus, when an initial choice of parents has to be made to obtain heterosis, it is important to ascertain the level of parental combining ability status.

To explain heterosis, data on sca effects indicated that most of the heterotic crosses had high sca effects. The overall heterotic response showed that the heterotic crosses had either high sca or possessed heterosis for only one trait. Cross K8302 × K78 was common for protein and tryptophan content and coleoptile and radicle length.

The mean performance of crosses showed significant association with sca effects, indicating that selection of the cross combinations on the basis of heterotic response may be reliable.

Table 1. Best crosses selected on the basis of heterotic effect and sca effect along with gca effects of the parents involved in such crosses

Character	Heterotic cross	gca	Mean performance	Specific combiner	gca	Common cross	gca	r value
Protein content	K 8302 × K 78	(H × H)	17.1	K 78 × K 8144	(H × L)	K 8302 × K 78	(H × H)	0.91**
	K 78 × K 8144	(H × L)	16.8	K 8103 × K 68	(L × L)	K 78 × K 8144	(H × L)	
	K 8302 × B 1252	(H × L)	16.6	K 8302 × K 78	(H × L)	K 8302 × B 1252	(H × L)	
	K 8103 × K 68	(L × L)	15.7	K 8302 × B 1252	(H × L)	K 8103 × 68	(L × L)	
	HD 2285 × K 78	(L × H)	15.7	K 8301 × K 8144	(L × L)			
Tryptophan content	K 8302 × K 78	(L × H)	1.7	K 8302 × K 78	(L × H)	K 8302 × K 78	(L × H)	0.87**
	K 8301 × B 1252	(H × L)	1.8	K 8301 × B 1252	(H × L)	K 8301 × B 1252	(L × H)	
	K 78 × K 68	(H × L)	1.8	HD 2285 × B 1252	(H × L)	HD 2285 × B 1252	(H × L)	
	HD 2285 × B 1252	(H × L)	1.8	B 1252 × K 68	(L × L)	B 1252 × K 68	(L × L)	
	B 1252 × K 68	(L × L)	1.8	K 8302 × B 1252	(L × L)			
Seed hardness	B 1252 × K 78	(L × H)	1.7	HD 1285 × K 8103	(L × L)			0.79**
	K 8144 × K 68	(L × H)	1.7	B 1252 × K 8144	(L × L)	HD 2285 × K 8103	(H× L)	
	B 1252 × K 68	(L × H)	1.8	K 78 × K 68	(H × H)	K 78 × K 68	(H × L)	
	K 78 × K 68	(L × H)	1.8	K 8301 × K 68	(L × H)			
	HD 2285 × K 8103	(L × L)	1.7	K 8302 × K 8103	(H × L)			
Coleoptile length	K 8301 × K 8103	(H × L)	9.8	K 8302 × K 78	(H × L)	K 8301 × K 8103	(H × L)	0.69**
	K 8302 × K 78	(H × L)	9.8	K 8301 × K 8103	(H × L)	K 8302 × K 78	(L × L)	
	K 8302 × B 1252	(H × L)	9.0	K 8301 × K 68	(H × L)			
	K 8302 × K 8103	(H × L)	8.9					
	K 8302 × K 8301	(H × L)	8.7					
Radicle length	K 8302 × K 8301	(H × H)	11.7	K 8302 × K 78	(H × L)			0.73**
	K 8302 × K 78	(H × L)	10.9	K 8301 × K 68	(H × L)	K 8302 × K 78	(H × L)	
	K 8302 × B 1252	(H × L)	10.9	K 8302 × K 8301	(H × H)	K 8302 × K 8301	(H × H)	
	K 8302 × K 8103	(H × L)	10.4	K 8302 × K 2285	(H × L)			
Root area spread	K 8302 × HD 2285	(H × L)	50.5					0.73**
	K 8302 × K 68	(H × L)	43.7	K 8302 × HD 2285	(H × L)	K 8302 × HD 2285	(H × L)	
	K 8302 × K 8103	(H × L)	38.6	K 8302 × K 68	(H × L)	K 8302 × K 68	(H × L)	
	K 8302 × K 78	(H × L)	35.5	K 8301 × K 68	(L × L)			
	K 8302 × K 8301	(H × L)	34.5					
Grain yield	K 8302 × K 8144	(H × L)	118.1	K 8302 × K 8144	(H × L)	K 8302 × K 8144	(H × L)	0.89**
						K 8302 × K 8103	(H × L)	

r value—association of mean performance of crosses with sca effects.
H—high, L—low general combiner.
**Significant at 1% level.

When the magnitude of heterosis was substantial for a trait, the parents had, in general, other contrasting attributes like high vs low sca status. In almost all the crosses with high heterosis there was involvement of either one low gca and one high gca parent or parents of high/high gca effects. High × high general combiners exhibited desirable results in heterotic cross combinations like K8302 × K78 for protein content and K8302 × K8301 for radicle length. They can be explained in self-pollinated crops like wheat because the presence of additive gene effects in them is fixable generation after generation.

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