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Short Communication

Combining ability in bread wheat (*Triticum aestivum* L.) under salinity and normal conditions

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Breeding for salt tolerance in wheat would depend on intensive hybridization using salt tolerant donors and high yielding commercial cultivars. Presently, information on the combining ability for various traits in bread wheat under normal condition is abundant but under salinity, the information is meager. The present investigation was therefore conducted to generate information on combining ability and the nature of gene action involved in the inheritance of grain yield and other component traits in wheat under salinity and normal conditions.

Ten genetically diverse varieties of wheat (*Triticum aestivum* L.) namely: PBW-343, UP-2338, Job-666, WH-542, HD-2687, Raj-3777, KRL 1-4, Lok-1, K-65 and Raj-3077, selected on the basis of salt tolerance and ecogeographic origin, were crossed in all possible combinations excluding reciprocals. All the genotypes (10 parents and 45 F_1s) were evaluated in randomized block design with three replications in normal (pH-8.00, ECe 1.04 dSm^{-1}) and saline field (pH-8.50, ECe 6.40 dSm^{-1}) during rabi 2000-01. In each environment, and in each replication, each genotype (parent/F_1) was grown in a plot of 2 rows of 2m length spaced 25 cm apart keeping 10 cm distance between plant to plant. Non experimental rows were planted all around the experimental material to avoid any possible boarder effects. The data was recorded on days to ear emergence (taken on whole plot basis), plant height (cm), number of productive tillers/plant, number of grains/ear, grain weight/ear (g), grain yield/plant (g) and 1000 grain weight (g) on a sample of 10 plants/replication/environment in each genotype. Combining ability effects and their variances were estimated using method 2 model I as given by Griffing [1].

Pooled analysis of variance indicated significant differences among genotypes, environment as well as interactions between genotype × environment. As the genotype × environment interaction was highly significant, the combining ability analysis was conducted in each environment individually.

The mean squares due to *gca* and *sca* were comparable among the environments indicating that these parameters were relatively less sensitive to change of environments. The significant sum of squares due to *gca* and *sca* further indicated that both additive as well as non additive components contributed to the inheritance, although, preponderance of additive components was observed for days to ear emergence, plant height and 1000 grain weight in both the environments, number of productive tillers per plant and grain yield under saline environment, while nonadditive gene effects was observed for rest of the characters as indicated by the *gca/sca* variance ratio.

Perusal of the results of *gca* indicated that the change between the environments particularly the change in direction of *gca* was not noted. This indicates that the *gca* effects were in general stable across the environments. From the results of the *gca* effects in both the environments, none of the parents was observed to be a good general combiner for all the desirable traits (Table 2). Parent K-65 followed by Raj-3077 had desirable *gca* effects in both the environments for maximum number of cases. Lok-1 and KRL 1-4 also showed desirable *gca* effects for grain yield under normal and saline environment, respectively. Parents which showed desirable *gca* effects for grain yield also showed desirable *gca* effects either for days to ear emergence, number of productive tillers/plant, grain weight/ear and 1000-grain weight indicating the importance of these characters in the yield improvement. This is a common observation. Earlier Dubey *et al.* [2] also observed similar findings. Perusal of Table 2 also indicated that the crosses Job-666 × KRL 1-4, PBW-343 × Lok-1 and Raj-3777 × Raj-3077 had high *sca* effects for grain yield under normal as well as salinity conditions coupled with high per se performance. No cross had high *sca* effects for all the characters

Table 1. ANOVA for combining ability in F_1 generation for various morphological characteristics in wheat evaluated in normal (N) and saline (S) environments

Characters	Env.	Mean sum squares			gca/sca variance ratio
		gca (9)†	*sca* (45)	Error (108)	
Days to ear emergence	N	45.17**	2.03**	1.31	5.07
	S	60.74**	1.74**	0.51	4.08
Plant height	N	402.34**	3.59**	2.57	1.58
	S	254. 10**	29.86	1.08	0.73
No. of prod. tillers/plant	N	2.48	2.38	1.75	0.10
	S	5.68**	0.48**	0.04	1.07
No. of grains/ear	N	92.85**	60.67**	1.00	0.13
	S	29.23**	28.40**	0.89	0.08
Grain weight/ear	N	0.08**	0.04**	0.02	0.17
	S	0.37**	0.08**	0.02	0.39
Grain yield/plant	N	22.94**	16.40**	0.65	0.12
	S	45.97**	4.93**	0.22	0.81
1000 grain weight	N	57.45**	8.79**	0.03	0.54
	S	3.59**	10.05**	0.22	0.79

*and **significant at 5% and 1% level of significance respectively.
†the figures in parenthesis indicate degrees of freedom

although, the cross, PBW-343 × Lok-1 also had high *sca* effects for number of productive tillers per plant, number of grains per ear and grain weight per ear under normal condition while the cross Raj-3777 × Raj-3077 had high *sca* effects for number of grains per ear, grain weight per ear and 1000 grain weight under salinity condition most of the crosses with high *sca* for grain yield had atleast one high *gca* parent.

The results signify the importance of exploitation of both additive and non-additive genetic effects for attaining maximum improvement in grain yield and yield attributes. It is also suggested that high *gca* parents for grain yield and its components, like K-65 followed by Raj-3077 were used as a donor parent for the development of salt tolerant varieties. Cross PBW-343 × Lok-1 and Raj-3777 × Raj-3077 should be given due consideration in developing superior varieties for normal and saline environment, respectively.

Table 2. Top two parents and crosses for grain yield and other related traits in wheat grown under normal (N) and saline (S) environments

Character	Env.	Best parents based on		Best crosses based on
		per se performance	*gca*	*sca*
Days to ear emergence	N	Raj-3077	Lok-1	HD-2687×Raj-3777
		Lok-1	Raj-3077	--
	S	Lok-1	Lok-1	UP-2338×Job-666
		K-65	K-65	KRL 1-4 × K-65
Plant height	N	PBW-343	PBW-343	KRL 1-4 × Lok-1
		HD-2687	HD-2687	KRL 1-4 ×Raj-3077
	S	K-65	K-65	PBW-343 × K-65
		Raj-3077	Raj-3077	UP-2338 × KRL 1-4
No. of prod. tillers/plant	N	Rai-3077	K-65	HD-2687×Raj-3077
		K-65	Job-666	PBW-343 × Lok-1
	S	K-65	K-65	UP-2338×Raj-3077
		Job-666	Job-666	WH-542 × K-65
No. of grains/ear	N	HD-2687	HD-2687	PBW-343 × KRL1-4
		UP-2338	UP-2338	UP-2338×Raj-3077
	S	Job-666	KRL 1-4	Raj-3777×Raj-3077
		KRL 1-4	PBW-343	UP-2338 × K-65
Grain weight/ear	N	Lok-1	Lok-1	Job-666 × KRL 1-4
		Job-666	PBW-343	PBW-343 × Lok-1
	S	K-65	K-65	Raj-3777×Raj-3077
		KRL 1-4	KRL 1-4	PBW-343 × Lok-1
Grain yield/plant	N	Lok-1	K-65	HD-2687×Raj-3077
		Raj-3077	Lok-1	PBW-343 × Lok-1
	S	K-65	K-65	Raj-3777×Raj-3077
		Job-666	Raj-3077	Raj-3777 × K-65
1000-grain weight	N	Lok-1	Lok-1	PBW-343×UP-2338
		Raj-3077	Raj-3077	K-65 × Raj-3077
	S	K-65	K-65	Raj-3777 × K-65
		Lok-1	Raj-3077	Raj-3777×Raj-3077

References

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