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Short Communication

Combining ability for germination and seedling establishment characters in bread wheat (*Triticum aestivum* L.) under normal and saline environments

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The material for the present study was developed by crossing seven genetically diverse lines of bread wheat namely Kalyansona, Kharchia 65, KRL 1-4, Raj 1114, Raj 3077, Wt 222 and Wt 245 in half-diallel fashion. The resultant F_1s and F_2s along with the parents were evaluated in laboratory for their response to salinity. For this purpose, 10 seeds of each parent/F_1/F_2 were sown per petridish which was layered with Whatman filter paper 40 and sterilised. Three such dishes for each parent and F_1 and six for each F_2 were prepared. The dishes were irrigated with Hoagland's solution [1]. The entire experiment was replicated 3 times and was evaluated in two environments created by supplementing Hoagland's solution with 0 and 10 g NaCl 1^{-1}. The corresponding ECe values were 1.8 dSm^{-1} and 15.5 dSm^{-1}. The entire set was maintained for 10 days in growth chambers at 25°C. For the first 3 days, the dishes were kept under dark, later-on in bright light for 12 h daily. On the 11th day the seedlings were harvested and observations were recorded in each petridish/replications/environment for germination percentage, coleoptile length (cm), seedling height (cm), and fresh and dry weights of seedling (g). F_1 means were used to analyse the combining ability as per Griffing's method II model [2].

The analysis of variance for combining ability indicated that mean squares due to general combining ability and specific combining ability were highly significant (Table 1) for all the characters under both the environments revealing the importance of both the additive and non-additive gene effects in the inheritance of these characters. These results are in line with the earlier observation [3].

Classification of parents based on their desirable gca effects over all the characters has shown that Kharchia 65 was the best followed by Raj 3077 in both saline and non saline environments (Table 2). KRL-1-4 was found to be best general combiner under saline environment. This is expected as Kharchia 65, Raj 3077 and KRL-1-4 are the recognised lines for saline environments [4]. Their superiority in saline environments is probably because of their ability to withstand the saline stress at the early stages of growth [5].

Table 1 Analysis of variance for combining ability for germination and seedling establishment under two environment in Bread wheat

Source	df	Environment	Mean squares				
			Germination %	Coleoptile length	Seedling length	Fresh weight of seedlings	Dry weight of seadling
GCA	6	Normal	52.20**	1.50**	1.71**	3.50**	0.49**
		Saline	140.00**	1.44**	1.06**	4.68**	0.79**
SCA	21	Normal	24.88**	0.11	0.19**	2.71**	0.44**
		Saline	41.03**	0.41**	0.024**	1.95**	0.29**
Error	54	Normal	4.03	0.002	0.001	0.13	0.02
		Saline	9.01	0.004	0.0002	0.3	0.002

*Significant at p = 0.05 and **significant at p = 0.01

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Table 2. GCA effects and best crosses selected on the basis of SCA effects and *per se* performance of germination and seedling establishment characters in wheat

Character	Environment	Good GCA	Crosses selected on the basis of		
			Desirable SCA	*Per se* performance in	
				F_1	F_2
Germination percentage	Normal	Kharchia 65*	-	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-14, Raj 3077 × KRL-1-4	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × Wt 222
	Saline	Kharchia 65* KRL-1-4	-	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × KRL-1-4	Kharchia 65 × KRL-1-4, Kharchia 65 × Raj 3077, Raj 3077× KRL-1-4
Coleoptile length	Normal	Kharchia 65* Raj 3077, Wt 222, Wt 245	Wt 222 × Wt 245, Raj 1114 × Raj 3077, Kharchia 65 × Wt 245	Kharchia 65 × Wt 345, Wt 222 × Wt 245, Kharchia 65 × Kalyansona	Kharchia 65 × Wt 245, Kharchia 65 × Wt 222, W 222 × Wt 245
	Saline	Kharchia 65, Raj 3077	Kharchia 65 × Wt 222, Kharchia 65 × Wt 245, Kalyansona × KRL-1-4	Kharchia 65 × Wt 245, Kharchia 65 × Wt 222, Kharchia 65 × Raj 3077	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Wt 222 × Wt 245
Seedling length	Normal	Kharchia 65, Raj 3077	Kharchia 65 × Raj 1114, Kharchia 65 × Raj 3077, Kharchia 65 × Kalyansona	Kharchia 65 × KRL-1-4, Kharchia 65 × KRL-1-4, Kharchia 65 × Wt 245	Kharchia 65 × KRL-1-4, Kharchia 65 × Wt 222, Kharchia 65 × Raj 3077
	Saline	Kharchia 65, Raj 3077 KRL-1-4	Wt 222 × Wt 245, Raj 3077 × KRL-1-4, Raj 1114 × Wt 222	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × KRL-1-4	Kharchia 65 × KRL-1-4, Kharchia 65 × Raj 3077, Raj 3077 × KRL-1-4
Fresh weight of seedlings	Normal	Kharchia 65, Raj 3077	Raj 3077 × Wt 245, Kharchia 65 × Raj 3077, Wt 222 × Wt 245	Kharchia 65 × Raj 3077, Raj 3077 × Wt 245, Kharchia 65 × KRL-1-4	Wt 222 × Wt 245, Raj 1114 × Raj 3077, Kharchia 65 × KRL-1-4
	Saline	Kharchia 65, Raj 1114, Raj 3077, KRL-1-4		Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4	Raj 3077 × KRL-1-4, Kharchia 65 × KRL-1-4, Kharchia 65 × Raj 3077
Dry weight of seedlings	Normal	Kharchia 65, Raj 3077, KRL-1-4	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × KRL-1-4	Kharchia 65 × KRL-1-4, Kharchia 65 × Raj 3077, Raj 3077 × KRL-1-4	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × KRL-1-4
	Saline	Kharchia 65, Raj 3077, KRL-1-4	Wt 222 × Wt 245, Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × KRL-1-4	Kharchia 65 × Raj 3077, Kharchia 65 × KRL-1-4, Raj 3077 × KRL-1-4

*Only those lines which exhibited significant GCA effects are listed.

The sca effects for three best crosses are presented in Table 1 along with *per se* performance in F_1 and F_2 generations and environments. The crosses having significant and highly desirable SCA effects in general had involved atleast one good general combiner. Crosses Kharchia 65 × Raj 3077 followed by Kharchia 65 × KRL 14 had high mean values for most of the traits under salinity. Among these, the first one also had desirable sca effect for most of the traits indicating that its parents had high concentration of genes which promote salinity tolerance and this is expected as both the parental lines are bred for salinity tolerance. Wt 22 × Wt 245 had shown desirable sca effects under salinity, though both parents had undesirable gca effects and mean values.

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