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COMBINING ABILITY IN WHEAT IN NORMAL AND SODIC SOILS

K. N. SINGH

Central Soil Salinity Research Institute
Karnal 132001

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ABSTRACT

The present investigation revealed that not only additive but nonadditive genetic effects were also important for different characters in wheat (*Triticum aestivum* L. emend. Thell). Varieties HD 2009, WH 157 and WL 711 were the best general combiners in normal soil and WH 157 and Kharchia 65 in alkali (sodic) soils. Most of the crosses showing significant sca effects involved low×low or high×low general combiners. The best crosses for seed yield were HD 2009×Kharchia 65, HD 2009×WL 711, and HD 1553×Kharchia 65. They were also good for 1000-grain weight.

Key words: Wheat, combining ability, sodic soils.

To initiate a sound breeding programme for any specific environment, the information on gene action of the characters that require improvement is essential. Selection of parents based on their combining ability in the hybrid is important, as it may give good segregants to select. Hence, a study was conducted to get some information on the combining ability and the nature of gene action involved in the inheritance of its grain yield and other attributes of economic importance in wheat (*Triticum aestivum* L. emend. Thell) under normal and sodic (alkali) soil conditions.

MATERIALS AND METHODS

The material consisted of 6 cultivars of wheat (HD 1982 HD 1553, HD 2009, Kharchia 65, WH 157 and WL 711). All possible crosses among them including reciprocals were made. The parents, F_1 and reciprocals were grown in randomized block design with 3 replications at the farm of Central Soil Salinity Research Institute, Karnal, in two soil conditions, where the soil status of the experimental plot for sodic (alkali) soil conditions was pH 9.1, ESP 23, ECe 2.5 dS/m, and for nonsaline, nonalkali normal soil pH 7.8, ESP 8 and ECe 0.9 dS/m at 25°C. Each treatment had 1.5 m long row, the spacing between and within lines being 25 and 10 cm, respectively. Observations were recorded on 5 randomly selected plants for eight characters (Table 1). The combining ability analysis was done following Model I and Method I of Griffing [1].

RESULTS AND DISCUSSION

The analysis of variance indicated highly significant variation for all the characters studied in two soil conditions. The general and specific combining ability (gca, sca)

variances were significant for all characters in both soil conditions (Table 1). For most characters, gca variances were larger than the corresponding sca variances. The gca: sca ratio was larger for plant height, spikelets/ear, grains/ear, grain weight/ear, 1000-grain weight, and grain yield/plant under both soil conditions. Reciprocal effects were significant in few crosses for some of the characters studied.

The gca effects in both soil types are presented in Table 2. Highly significant and positive gca effects for plant height were recorded in var. Kharchia 65 in both the soil conditions, whereas it was positive only in alkali soil in var WH 157. Kharchia 65 showed significant positive gca effects for all other characters in alkali soils, but under normal soil condition it was negative for most of the characters, except plant height and tillers/plant. Apart from Kharchia 65, WH 157 was the only parent which showed significant and positive gca effect in alkali soil for all the 8 characters studied. The other parents with desirable effects were HD 2009 for ear length in alkali soil and number of ears/plant in normal soil; and WL 711 for ear length, spikelets/ear, grains/ear, grain weight/ear, 1000-grain weight, and grain yield/plant under both the soil conditions. HD 1982 and HD 1553 were poor combiners for most characters, as indicated by the analysis in both the soil conditions, except for 1000-grain weight and grain weight/ear under normal soil condition.

The gca effects showed that none of the parents was a good general combiner for all the desirable characters simultaneously. However, the parents showing high gca effects for individual characters may be utilized for further breeding programme for improving these traits of some otherwise good varieties.

The specific combining ability effects for plant height were significant and negative in only two crosses, HD 2009 × Kharchia 65, and WH 157 × Kharchia 65, while four crosses i.e., HD 1982 × Kharchia 65, HD 1553 × Kharchia 65, HD 2009 × WL 711, and HD 1553 × WL 711 revealed significant and positive sca effects in both soil environments. The cross HD, 1553 × WL 711 showed significant and positive sca effect and three crosses, HD 1982 × HD 1553, HD 1553 × WH 157, and Kharchia 65 × WL 711, showed significant negative sca effect in alkali

Table 1. Analysis of variance of gca, sca and reciprocal effects

Source of variation	d.f.	Soil	Plant height	Ears per plant	Ear length	Spike-lets per ear	Grains per ear	Grain weight per ear	1000-grain wt.	Grain yield per plant
gca	5	Normal	462.5**	1.47**	1.30**	3.80**	86.7**	0.9**	102.9**	130.9**
		Alkali	779.8**	2.58**	4.23**	1.68**	56.2**	0.37**	88.2**	20.9**
sca	15	Normal	13.9**	1.21**	0.39**	0.60**	16.4**	0.09**	7.0**	21.1**
		Alkali	77.5**	0.53**	0.73**	0.60**	1.7**	0.01**	14.1**	2.06**
Reciprocals	15	Normal	18.9**	1.56**	0.40**	0.96**	17.1**	0.11**	19.2**	33.3**
		Alkali	31.1**	0.31**	0.61**	0.65**	5.9**	0.05**	17.4	2.71**
Error	432	Normal	0.5	0.12	0.03	0.12	0.4	0.002	0.2	0.98
		Alkali	1.6	0.07	0.02	0.08	0.6	0.001	0.2	0.2

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

Table 2. Estimates of gca effects in a 6×6 diallel for eight characters in two types of soils

Parent	Soil	Plant height	Ears per plant	Ear length	Spikelets per ear	Grains per ear	Grain weight per ear	1000-grain weight	Grain yield per plant
HD 1982	Normal	−1.30**	−0.20*	−0.14**	0.01	−2.34**	−0.09	0.78**	−0.63**
	Alkali	−4.47**	−0.24**	−0.83**	−0.30	−1.90**	−0.21**	−4.21**	−1.27**
HD 1553	Normal	0.26**	−0.46**	0.12*	−0.65**	−0.87**	0.04**	1.35**	−1.20**
	Alkali	−5.02**	−0.49**	−0.58**	−0.51**	−3.14**	−0.15**	−0.48**	−1.37**
HD 2009	Normal	−6.35**	0.18**	−0.04	−0.42**	0.22	−0.19**	−3.31**	2.02**
	Alkali	−7.09**	−0.09	0.38**	−0.15	−0.04	−0.04**	−0.82**	−0.46**
WH 157	Normal	−1.04**	−0.19*	0.27**	0.49**	3.08**	0.38**	3.67**	3.86**
	Alkali	4.23**	0.47**	0.72**	0.41**	2.58**	0.26**	3.87**	1.94**
Kharchia 65	Normal	11.76**	0.17**	−0.57**	−0.25**	−3.13**	−0.36**	−3.74**	−4.09**
	Alkali	14.39**	0.66**	0.16**	0.24	1.01**	0.02**	−0.14**	1.12**
WL 711	Normal	−3.32**	0.50**	0.33**	0.81**	3.24**	0.23**	1.15**	4.10**
	Alkali	−2.03**	−0.31**	0.15**	0.30	1.49**	0.12**	1.75**	0.05
S.E.(g_i)	Normal	0.18	0.09	0.05	0.09	0.17	0.01	0.13	0.24
	Alkali	0.34	0.07	0.04	0.17	0.20	0.01	0.03	0.12

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

soil condition. Highly significant and positive sca effect for ears/plant have been noted in only one cross, namely, HD 2009 × Kharchia 65, in both types of soils. The cross WH 157 × WL 711 showed significant positive sca effect only in alkali soil. None of the crosses exhibited significant positive sca effects for ear length in any soil environment. Three crosses in normal soil and four crosses in alkali soil had significant positive sca effects for this character. For number of spikelets/ear, there were only two crosses (HD 2009 × Kharchia 65 and HD 2009 × WL 711) which expressed consistent significant positive sca effect in both soil environments. For number of grains/ear, most of the crosses expressed average sca effects. For grain weight/ear, there were only two crosses, i.e., HD 1982 × HD 1553 and HD 1982 × HD 2009, which exhibited significant positive sca effects in both soil conditions, whereas eight crosses in normal and three crosses and in alkali soils had positive sca effects for this character. Out of 15 cross combinations, crosses HD 1982 × HD 2009, HD 1982 × Kharchia 65, and Wh 157 × Kharchia 65 recorded significant positive sca effect in both soil environments for 1000-grain weight. In four crosses, it was significantly positive in normal soil, whereas crosses HD 1982 × HD 1553, HD 2009 × WH 157, WH 157 × Kharchia 65, and Kharchia 65 × WL 711 recorded significant negative sca in alkali soil. For grain yield/plant, none of the crosses gave consistently significant sca effects in both soil environments, except cross HD 2009 × Kharchia 65. Six crosses in normal soil and four crosses (HD 1553 × Kharchia 65, HD 1553 × WL 711, HD 209 × WL 711, and WH 157 × WL 711) in alkali soil had significant positive sca effects for this character.

Majority of the crosses, where sca effects were high, involved at least one good combiner. This may be ascribed to the less genetic diversity among the concerned parents and some degree of internal cancellation for favourable factors, as suggested by Jinks and Jones [2]. The most outstanding parents for grain yield in sodic soil was Kharchia 65, followed by WH 157. The best cross with the highest sca estimates for grain yield under sodic soil was HD 2009 × Kharchia 65 between low × high general combiners. Of the remaining 3 crosses having high sca effects in sodic soil, HD 1553 × Kharchia 65 was between low × high, HD 2009 × WL 711 between low × low, and WH 157 × WL 711 was between high × low general combiners. These four best crosses for grain yield under sodic soil conditions were also good for 1000-grain weight. The crosses involving low × low general combiners and giving high sca effects revealed that a combination of two best general combiners may not be the best combination and low × low cross may not be poor. The poor combining parents lacked the additive effects of the good combining parents but were highly responsive to heterozygosity due to nonadditive effects [3]. Crosses between high × low combiners along with high sca effects may give transgressive segregants in the next generations [4].

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