

COMBINING ABILITY ANALYSIS FOR EARLINESS IN BREADWHEAT (*TRITICUM AESTIVUM* L. EM. THELL) UNDER NORMAL AND SALT AFFECTED SOILS

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ABSTRACT

Eight breadwheat genotypes were crossed in half diallel fashion. Combining ability analysis for days to flowering and maturity was studied in F₁ and F₂ generations under normal, sodic and saline sodic soils. The variances due to gca and sca were significant, the former being much larger in magnitude than the latter in F₁ and F₂ under each environment as well as in pooled analysis. The gca x environment and sca x environment interaction variances were highly significant in F₁ and F₂ for both traits. The parents HW 452, Lok 1 and Raj 1972 were good general combiners for earliness in F₁ and F₂ under all environments. Amongst all the crosses, Kharchia 65 x Raj 1972 was most promising for earliness under each environment. Most crosses showing desirable significant sca effects involved either high x low or low x low general combiners.

Key words: Breadwheat, combining ability, diallel.

Earliness in wheat is desirable for normal as well as salt affected soils. Particularly in latter condition the crop is generally delayed due to late germination of seeds and slow vegetative growth in initial stages. The information on inheritance of earliness is available under normal soil conditions but it is less for salinity conditions. Therefore, the present study has been undertaken to determine the type of inheritance and the genetic constitution of a set of parents for earliness (days to flowering and days to maturity) under normal, sodic and saline sodic soil conditions.

MATERIALS AND METHODS

A set of eight breadwheat parents, namely, K 8565, HD 2009, CPAN 1992, Kharchia 65, Raj 1972, Raj 3077, Lok 1 and HW 452 and their half diallel 28 F₁s and 28 F₂s were studied

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under the three environments, viz. normal soil (pH 8.4, ECe 3.5 dS/m); sodic soil (pH 9.3, ECe 3.6 dS/m); and saline sodic soil (pH 9.1, ECe 8.6 dS/m).

The experiments were conducted in randomised block design, replicated thrice in each environment. Each entry of the nonsegregating materials (parents and F₁) and segregating materials (F₂) was raised in 1.5 m long single and four rows, respectively. The distance between row to row and plant to plant was 25 and 5 cm, respectively. Days to flowering and maturity were recorded from sowing to 50% plants attaining ear emergence and physiological maturity, respectively. Combining ability analysis was carried out following Method 2, Model 1 of Griffing [1] as further extended by Singh [2, 3] for pooled analysis.

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Tables 1, 2) in F₁ and F₂ generations under three environments and in pooled analysis showed that variances due to general combining ability (gca) and specific combining ability (sca) were highly significant for both the characters. The gca : sca ratio was high, which indicated importance of additive and nonadditive gene effects in the inheritance of these characters with the predominant role of additive gene effects. Similar results were obtained earlier for days to flowering [4] and maturity [5]. These observations suggest that in wheat breeding, recurrent selection, diallel selective mating or biparental mating, which exploit both additive as well as nonadditive components, should be employed for the improvement of such traits.

Table 1. ANOVA (MS) for combining ability in F₁ and F₂ under three environments in breadwheat

Character	Environment (soil type)	Generation	Source and degrees of freedom			
			gca (7)	sca (28)	error (70)	gca/sca ratio
Days to flowering	Normal	F ₁	43.68**	3.15**	0.28	13.9
		F ₂	35.79**	3.57**	0.22	10.0
	Sodic	F ₁	62.40**	3.35**	0.77	18.6
		F ₂	52.47**	4.94**	0.47	10.6
	Saline sodic	F ₁	25.47**	2.08**	0.27	12.2
		F ₂	2.89**	0.34*	0.25	8.5
Days to maturity	Normal	F ₁	26.05**	1.57**	0.21	16.6
		F ₂	31.08**	1.39**	0.17	22.4
	Sodic	F ₁	68.11**	8.05**	0.45	8.5
		F ₂	58.80**	8.80**	0.29	6.7
	Saline sodic	F ₁	21.67**	1.69**	0.13	12.8
		F ₂	21.14**	1.71**	0.19	12.4

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

Mean square due to gca x environment and sca x environment were significant in F₁ and F₂ for both the characters (Table 2) and indicated that additive and nonadditive gene effects were influenced by environments. The magnitude of gca x environment variance was higher than the corresponding sca x environment variance in all the cases which suggested that additive genetic variance was more sensitive to changing environments as compared to nonadditive genetic variance [6].

Table 2. ANOVA (MS) for combining ability pooled over three environments in breadwheat

Source	d.f	Days to flowering		Days to maturity	
		F ₁	F ₂	F ₁	F ₂
Gca	7	118.85**	111.95**	102.85**	100.59**
Sca	28	4.91**	5.38**	5.15**	4.40**
Environments (E)	2	1186.54**	879.42**	135.88**	229.65**
Gca x E	14	6.36**	5.07**	6.64**	5.21**
Sca x E	56	1.83**	2.94**	3.08**	3.75**
Error	210	0.73	0.57	0.35	0.42
Gca : sca ratio		24.21	20.81	19.97	22.86

**Significant at 1% level.

The high gca parents for early flowering and early maturity were HW 452, Lok 1, Raj 1972 (Table 3) in F₁ and F₂ generations under the three environments except Raj 1972 for days to flowering in F₂ under saline sodic soil. The parent K 8565 was a significantly superior combiner for early maturity only in F₁ generation under saline sodic soil. HD 2009, CPAN 1992 and Raj 3077 for both the characters and Kharchia 65 for days to maturity were consistently poor general combiners.

The magnitude and direction of sca effects was not consistent over generations and environments suggesting that the generations may be tested over different environments to evolve widely adapted variety. Nevertheless, the cross Kharchia 65 x Raj 1972 exhibited highly significant desirable sca effects for both characters under three environments, except for days to maturity in F₂ under normal soil. Significant desirable sca effect for days to flowering was also noted in the cross K 8565 x Raj 3077 in F₁ and F₂ under all environments. For days to flowering, the crosses K 8565 x HD 2009 in normal soil and Kharchia 65 x HW 452 in saline sodic soil expressed consistent significant negative sca effects in F₁ and F₂ generations. For days to maturity, the crosses HD 2009 x Raj 1972 and CPAN 1992 x Raj 1972 in sodic soil, HD 2009 x CPAN 1992 in normal soil, and Kharchia 65 x HW 452 and Raj 3077

Table 3. General combining ability effects of parents in F₁ and F₂ generations under three environments in breadwheat

Parent	Days to flowering						Days to maturity					
	normal soil		sodic soil		saline sodic soil		normal soil		sodic soil		saline sodic soil	
	F ₁	F ₂	F ₁	F ₂	F ₁	F ₂	F ₁	F ₂	F ₁	F ₂	F ₁	F ₂
K 8565	1.25**	0.16	0.33	0.73**	0.16	0.01	0.11	0.48**	1.65**	1.03**	-0.52**	0.13
HD 2009	2.34**	1.34**	2.33**	2.56**	0.92**	1.43**	1.57**	1.10**	1.53**	2.42**	2.42**	0.33**
CPAN 1992	1.47**	2.40**	3.23**	3.49**	2.38**	2.26**	1.21**	0.86**	0.63**	0.58**	1.29**	0.58**
Kharchia 65	1.49**	1.15**	1.56**	0.13	0.14	0.11	1.36**	1.95**	2.82**	2.51**	1.68**	1.78**
Raj 1972	-1.45**	-0.68**	-2.31**	-3.00**	-1.11**	0.28	-0.91**	-0.33**	-2.10**	-2.41**	-1.11**	-0.89**
Raj 3077	0.52**	0.96**	0.97**	0.70**	1.02**	1.29**	1.14**	1.13**	2.36**	1.84**	1.53**	1.83**
Lok 1	-2.15**	-2.20**	-2.52**	-2.18**	-2.42**	-3.11**	-1.94**	-1.87**	-2.83**	-2.38**	-1.75**	-1.75**
HW 452	-3.50**	-3.15**	-3.58**	-2.14**	-2.09**	-2.28**	-2.56**	-3.30**	-4.06**	-3.57**	-1.82**	-1.99**
SE (gi) ±	0.16	0.14	0.26	0.20	0.15	0.15	0.14	0.12	0.20	0.16	0.10	0.13

**Significant at 1% level.

x HW 452 in saline sodic soil exhibited consistent desirable significant sca effects in both generations.

A comparison of the five best crosses based on per se performance and sca effects in F₁ and F₂ generation under three environments is presented in Table 4. It revealed that the ranking of cross combinations based on these two criteria did not indicate any significant association between them. Similar results were also reported by Singh et al. [4] for ear emergence in breadwheat.

Estimation of sca effects further revealed that there was no definite trend regarding the gca effects of the parents of the high sca crosses (Table 4). The crosses with high sca effects involved all the three possible combinations between parents of high and low gca effects, i.e. high x high, high x low and low x low. However, most of the crosses showing high sca effects involved at least one high general combining parent, which may throw stable performing transgressive segregates. The crosses with high sca effects involving low x low gca parents revealed that the parents in such crosses lacked the additive gene effects of the high gca parents but were highly responsive to environment in heterozygous state due to nonadditive effects [7].

Table 4. Best five crosses on the basis of per se performance and sca effects for earliness in F₁ and F₂ generations under three environments in breadwheat

Environment	Per se performance		Sca effects			
	F ₁	F ₂	F ₁	gca of parents	F ₂	gca of parents
Days to flowering						
Normal soil	5 x 8	7 x 8	4 x 5	L x H	4 x 5	L x H
	3 x 7	5 x 8	3 x 7	L x H	1 x 4	L x L
	4 x 5	1 x 7	1 x 2	L x H	1 x 2	L x L
	6 x 8	5 x 8	2 x 3	L x L	2 x 4	L x L
	4 x 8	4 x 5	1 x 6	L x L	1 x 7	L x H
Sodic soil	7 x 8	5 x 8	2 x 5	L x H	4 x 5	L x H
	6 x 8	4 x 5	4 x 5	L x H	1 x 2	L x L
	1 x 8	5 x 7	6 x 8	L x H	3 x 6	L x L
	4 x 5	7 x 8	1 x 6	L x L	4 x 7	L x H
	5 x 8	4 x 7	3 x 5	L x H	2 x 3	L x L
Saline sodic soil	7 x 8	7 x 8	4 x 5	L x H	1 x 5	L x L
	4 x 8	4 x 7	4 x 8	L x H	6 x 8	L x H
	4 x 5	6 x 8	6 x 7	L x H	4 x 5	L x L
	6 x 7	1 x 5	3 x 4	L x L	4 x 7	L x H
	5 x 8	4 x 8	1 x 6	H x L	3 x 5	L x L
Days to maturity						
Normal soil	5 x 7	7 x 8	5 x 7	H x H	1 x 7	L x H
	7 x 8	5 x 8	4 x 5	L x H	2 x 3	L x L
	1 x 8	1 x 7	2 x 3	L x L	2 x 5	L x H
	5 x 8	6 x 8	3 x 6	L x L	5 x 8	H x H
	4 x 8	2 x 8	2 x 4	L x L	6 x 8	L x H
Sodic soil	7 x 8	5 x 8	4 x 5	L x H	2 x 5	L x H
	5 x 7	7 x 8	2 x 5	L x H	4 x 5	L x H
	4 x 5	3 x 8	3 x 5	L x H	1 x 7	L x H
	2 x 5	5 x 7	2 x 7	L x H	2 x 6	L x L
	3 x 5	2 x 5	7 x 8	H x H	5 x 8	H x H
Saline sodic soil	7 x 8	7 x 8	4 x 8	L x H	4 x 5	L x H
	5 x 8	5 x 7	4 x 5	L x H	3 x 5	L x H
	4 x 8	2 x 8	6 x 8	L x H	2 x 8	L x H
	1 x 8	3 x 5	2 x 5	L x H	6 x 8	L x H
	6 x 8	3 x 8	1 x 6	H x L	4 x 8	L x H

Enumeration of parent varieties:

1. K 8565

2. HD 2009

3. CPAN 1992

4. Kharchia 65

5. Raj 1972

6. Raj 3077

7. Lok 1

8. HW 452

H— High, L—low combiner.

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