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COMBINING ABILITY ANALYSIS OF PHYSIOLOGICAL AND ECONOMIC TRAITS IN BREADWHEAT (*TRITICUM AESTIVUM L.*) OVER ENVIRONMENTS

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ABSTRACT

Combining ability analysis of physiological and economic traits was conducted involving nine diverse parents of breadwheat in all possible combinations excluding reciprocals. The mean squares for both general combining ability (gca) and specific combining ability (sca) were significant for all the characters studied in each analysis. This indicated the involvement of both additive and nonadditive gene actions in the inheritance of characters. In general, high magnitudes of gca variance depicted the greater importance of additive gene action in the inheritance of traits under study. The environment played a significant role in the expression of almost all the traits. The gca x year interaction exhibited greater sensitivity in most cases except net assimilation rate, biological yield, and grain yield than sca x year interaction. Cvs. Lok-1 and WH 147 emerged as desirable general combiners. The crosses, Sonalika x HD 2402, Sonalika x J 405, Sonalika x K 8470, HUW 234 x JWJ 80-4, HI 1148 x Lok-1, and WH 147 x K 8470 were the most desirable specific combinations for grain yield and other physiological and economic traits.

Key words: Combining ability, breadwheat, physiological traits, economic traits.

Breeding on the basis of economic traits is well established and fully exploited in wheat. Now it is obvious that yields of the present semidwarf wheat have reached a plateau. At present, there is need to study the genetic architecture of important physiological traits affecting growth and photosynthesis, shift in biomass, regulatory process and their environmental responses. Simultaneous studies of physiological and economic traits over environments are very few. Hence, the present investigation has been undertaken to identify the most suitable genetic material to be used as parents of cultivars in future and to more efficiently finalize the breeding programmes. The combining ability analysis was performed involving 9 x 9 diallel cross combinations over environments (years).

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MATERIALS AND METHODS

Nine diverse wheat varieties, viz., Sonalika, HUW 234, HI 1148, WH 147, JWJ 80-4, HD 2402, Lok-1, J 405 and K 8470, were crossed in all possible combinations excluding reciprocals. The parents and their 36 crosses were grown in randomized block design with three replications at the farm of the R.A.K. College of Agriculture, Sehore, under the J.N.K.V.V., Jabalpur (M.P.) during rabi seasons of 1987-88 and 1988-89. Each genotype was grown in a single row, 2 m long, 30 cm apart, with plant-to-plant distance of 10 cm. The recommended package of practices for high fertility irrigated conditions were followed.

Three plants per plot were taken from each replication on 50th and 70th days after sowing to estimate net assimilation rate (NAR) and crop growth rate (CGR) by employing the techniques discussed by Gragory [1] and Watson [2], respectively. Five competitive plants from each progeny were randomly taken from each replication for recording observations on flag leaf area, spikes per plant, grains per spike, 1000-grain weight, harvest index (HI), biological yield per plant, and grain yield per plant. The combining ability estimates were calculated according to the procedure proposed by Griffing [3] using Method II, Model I for each year and pooled over the environments.

RESULTS AND DISCUSSION

The mean squares for both gca and sca (Tables 1, 2) were highly significant for all the characters studied in each analysis except CGR in 1988-89 for sca, which was significant at 5% level only. This indicated the importance of both additive and nonadditive gene effects

Table 1. Analysis of variance for combining ability under two different environments in wheat

Source	d.f.	Environment (year)	Mean squares								
			NAR	CGR	flag leaf area	spikes per plant	grains per spike	1000-grain weight	harvest index	biological yield per plant	grain yield per plant
Gca	8	1987-88	0.028**	33.4**	51.4**	7.80**	130.0**	53.7**	15.8**	154.4**	64.1**
		1988-89	0.025**	17.0**	56.4**	5.85**	93.9**	36.2**	16.5**	35.2**	21.5**
Sca	36	1987-88	0.012**	25.7**	3.5**	2.21**	7.0**	2.5**	0.9**	78.4**	20.1**
		1988-89	0.009**	7.5*	6.2**	1.89**	7.7**	3.1**	2.4**	48.5**	13.8**
Error	88	1987-88	0.003	3.0	0.8	0.64	1.4	0.3	0.2	19.1	4.7
		1988-89	0.002	4.3	1.1	0.63	2.7	0.7	0.6	13.6	3.3

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

Table 2. Analysis of variance for combining ability in wheat pooled over two environments

Source	d.f.	Mean squares								
		NAR	CGR	flag leaf area	spikes per plant	grains per spike	1000-grain weight	harvest index	biological yield per plant	grain yield per plant
Gca	8	0.048**	34.9**	98.7**	11.0**	218.5**	88.4**	30.7**	145.6**	70.2**
Sca	36	0.012**	19.9**	4.4**	1.9**	9.5**	4.5**	2.0**	58.5**	16.0**
Year	1	0.005	105.5**	1288.5**	4.0**	1410.3**	7.0**	74.0**	1568.1**	626.6**
Gca x year	8	0.005	15.5**	9.1**	2.6*	5.3**	1.6**	1.6**	43.9**	15.4**
Sca x year	36	0.008**	13.4**	5.3**	2.2**	5.14**	1.1**	1.3**	68.4**	17.9**
Error	136	0.002	3.6	1.0	0.6	2.0	0.5	0.4	16.3	4.0

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

in their inheritance. In general, the variance due to gca were higher than due to sca, showing a greater importance of additive gene action in the inheritance of traits except for biological yield in 1988-89, where higher magnitude of sca indicated greater importance of nonadditive gene action. Similar findings were reported by earlier workers [4–9]. However, report of Dasgupta and Mondal [10] are not in agreement with the present findings. In pooled analysis of gca x year and sca x year interactions gave significant differences for all the traits except for gca x year for NAR. The gca x year interaction showed greater sensitivity in most of the cases except NAR, biological yield, and grain yield. This is in agreement with the earlier findings [5–7, 11]. While greater sensitivity of sca x year interaction was reported by Dasgupta and Mondal [10], it appears from both the earlier and present findings that additive genetic variances were no less constant from one environment to another than nonadditive genetic variances.

The estimates of gca effects (Table 3) revealed that none of the parents had good general combining ability for all the traits studied. Out of nine parents, var. Lok-1was the best general combiner for NAR, CGR, spikes/plant, 1000-grain weight, HI, and grain yield. Var. WH 147 was a good general combiner for flag leaf area, spikes/plant, grains/spike, HI, and grain yield. Var. HUW 234 was identified as a superior general combiner for NAR, flag leaf area, grains/spike, HI, biological yield, and grain yield.

The crosses showing positive and significant sca effects for various traits are listed in Table 4. None of the cross combinations was observed superior for all the traits under investigation. Six crosses Sonalika x HD 2402, Sonalika x J 405, HUW 234 x JWJ 80-4, Sonalika

Table 3. Estimates of gca effects of the parent varieties under two environments in wheat

Parent variety	Environ-ment (year)	NAR	CGR	Flag leaf area	Spikes per plant	Grains per spike	1000-grain weight	Harvest index	Biolo-gical yield per plant	Grain yield per plant
Sonalika	1987-88	0.08**	–1.82**	–3.54**	–0.57*	–3.60**	1.71**	–0.55**	–4.48**	–2.65**
	1988-89	0.08**	1.86**	–3.64**	0.20	–3.38**	1.01**	0.43	–2.09*	–0.76
	Pooled	0.08**	0.02	–3.60**	–0.18	–3.49**	1.36**	–0.06	–3.29**	–1.70**
HUW 234	1987-88	0.04*	1.05*	0.65*	0.30	3.48**	–0.42**	0.97**	4.50**	2.98**
	1988-89	0.01	–0.26	0.27	0.23	2.05**	–0.66**	0.19	2.83**	1.38**
	Pooled	0.02	0.39	0.46*	0.27	2.77**	–0.54**	0.58**	3.67**	2.18**
HI 1148	1987-88	–0.02	–1.01*	0.45	0.46*	0.86*	–0.11	0.51**	3.01*	1.83**
	1988-89	–0.03*	–0.71	0.46	–0.38	0.98*	0.08	–0.18	–0.42	–0.31
	Pooled	–0.02*	–0.86*	0.45*	0.04	0.92**	–0.01	0.16	1.29	0.76
WH 147	1987-88	–0.01	0.15	3.20**	–0.03	1.74**	–0.23	1.60**	0.18	1.03
	1988-89	–0.03**	–1.33*	1.23**	0.76**	0.79	–0.25	1.76**	2.65*	2.34**
	Pooled	–0.02*	–0.59	2.22**	0.36*	1.27**	–0.24	1.68**	1.41	1.69**
JWJ 80-4	1987-88	–0.09**	–0.35	1.31**	0.36	–0.16	–1.29**	–0.35*	0.20	–0.12
	1988-89	–0.04**	0.43	1.22**	0.13	–0.02	–1.30**	–0.27	–0.47	–0.41
	Pooled	–0.06**	0.04	1.26**	0.25	–0.09	–1.30**	–0.31*	–0.13	–0.26
HD 2402	1987-88	0.02	0.94	–1.37**	–0.10	–0.90**	–1.21**	–0.97**	–1.60	–1.46*
	1988-89	–0.02	0.03	0.00	0.28	–1.54**	–1.14**	–0.55*	–0.57	–0.61
	Pooled	–0.00	0.49	–0.68**	0.09	–1.22**	–1.17**	–0.76**	–0.08	–1.04*
Lok-1	1987-88	0.03	3.66**	–1.23**	0.70**	–6.94**	5.03**	1.44**	0.26	0.99
	1988-89	0.07**	2.06**	–2.99**	0.78**	–5.30**	4.24**	1.56**	0.41	1.10*
	Pooled	–0.05**	2.86**	–2.11**	0.73**	–6.12**	4.63**	1.45**	0.34	1.05*
J 405	1987-88	–0.05**	–0.61	–1.83**	0.82**	1.96**	–2.58**	–0.50**	4.35**	1.84**
	1988-89	–0.05**	–0.99	–0.47	–0.41**	3.17**	–1.96**	–0.61**	–0.03	–0.36
	Pooled	–0.05**	–0.80*	–1.15**	0.21**	2.56**	–2.27**	–0.55**	2.16**	0.74
K 8470	1987-88	0.00	–2.02**	2.36**	–1.93**	3.57**	–0.89**	–2.07**	–6.42**	–4.45**
	1988-89	0.01	–1.07	3.91**	–1.60**	3.25**	–0.03	–2.33**	–2.31*	–2.38**
	Pooled	0.00	–1.54**	3.13**	–1.77**	3.41**	–0.46**	–2.20**	–4.36**	–3.41**
SE (gi)	1987-88	0.02	0.49	0.25	0.23	0.34	0.15	0.13	1.24	0.62
	1988-89	0.01	0.59	0.30	0.22	0.46	0.23	0.22	1.05	0.52
	Pooled	0.01	0.38	0.20	0.16	0.29	0.14	0.13	0.81	0.40

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

Table 4. Crosses showing significant positive sca effects for different characters in 1987-88 (E_1) and 1988-89 (E_2) and pooled (P) over environments (years)

Character	Crosses								
NAR	P1 x P3 (E_1, E_2 & P)	P1 x P4 (E_2 & P)	P1 x P6 (E_2)	P1 x P8 (E_1)	P2 x P4 (E_1, E_2 & P)	P2 x P7 (E_2 & P)	P2 x P8 (E_1 & P)	P2 x P9 (E_2)	
	P3 x P7 (E_1)	P4 x P7 (E_2)	P5 x P7 (E_1)	P5 x P8 (E_2 & P)	P6 x P7 (E_1, E_2 & P)				
CGR	P1 x P8 (E_1 & P)	P2 x P8 (E_1 & P)	P2 x P9 (E_2 & P)	P3 x P6 (E_1)	P4 x P7 (E_1 & P)	P4 x P9 (E_1)	P5 x P7 (E_1 & P)	P5 x P8 (P)	P6 x P7 (E_1 & P)
Flag leaf area	P1 x P7 (E_2)	P1 x P4 (E_2)	P1 x P5 (E_1, E_2 & P)	P2 x P4 (E_2)	P2 x P8 (E_2 & P)	P3 x P6 (E_2 & P)	P3 x P8 (E_2)	P4 x P7 (E_1)	
	P4 x P8 (E_2 & P)	P4 x P9 (E_1)	P5 x P7 (E_1, E_2 & P)						
Spikes/plant	P1 x P5 (E_1)	P1 x P6 (E_1 & P)	P1 x P8 (E_2)	P1 x P9 (E_1 & P)	P2 x P5 (P)	P3 x P6 (E_2 & P)	P4 x P5 (E_2)	P4 x P9 (E_1 & P)	P5 x P8 (E_1)
Grains/spike	P1 x P3 (E_1)	P1 x P7 (E_1)	P1 x P8 (E_2 & P)	P1 x P9 (E_2 & P)	P2 x P3 (E_2 & P)	P2 x P5 (E_1)	P2 x P6 (E_1 & P)	P2 x P7 (E_1)	
	P3 x P5 (E_1, E_2 & P)	P5 x P8 (E_1)	P8 x P9 (P)						
1000-grain wt.	P1 x P2 (E_1, E_2 & P)	P1 x P4 (E_2)	P1 x P7 (E_2)	P2 x P5 (E_1)	P2 x P7 (E_1 & P)	P2 x P8 (E_2 & P)	P3 x P8 (E_2)	P3 x P9 (E_1 & P)	
	P4 x P5 (E_1, E_2 & P)	P4 x P6 (E_1 & P)	P5 x P7 (E_1 & P)	P5 x P8 (E_2 & P)	P5 x P9 (E_1, E_2 & P)	P6 x P7 (E_2 & P)	P6 x P8 (E_1 & P)	P6 x P9 (E_1)	P8 x P9 (E_1, E_2 & P)
Harvest index	P1 x P8 (E_1, E_2 & P)	P1 x P9 (E_2 & P)	P2 x P3 (E_1, E_2 & P)	P2 x P4 (E_2)	P2 x P5 (E_1)	P3 x P5 (E_2 & P)	P3 x P8 (E_2 & P)	P3 x P9 (E_2 & P)	
	P5 x P6 (E_1)	P5 x P8 (E_1)							
Biological yield per plant	P1 x P6 (E_1 & P)	P1 x P8 (E_2)	P1 x P9 (E_2 & P)	P2 x P5 (E_1 & P)	P3 x P6 (P)	P3 x P7 (E_2 & P)	P4 x P5 (E_2)	P4 x P9 (E_1 & P)	
	P5 x P8 (E_1 & P)	P7 x P8 (E_1)	P8 x P9 (E_2)						
Grain yield per plant	P1 x P6 (E_1 & P)	P1 x P8 (E_2 & P)	P1 x P9 (E_2 & P)	P2 x P5 (E_1 & P)	P3 x P6 (P)	P3 x P7 (E_2 & P)	P4 x P5 (E_2)	P4 x P9 (E_1 & P)	
	P5 x P8 (E_2 & P)	P7 x P8 (E_1)	P8 x P9 (E_2)						

Variety symbols: P_1—Sonalika, P_2—HUW 234, P_3—HI 1148, P_4—Wh 147, P_5—JWJ 80-4, P_6—HD 2402, P_7—Lok-1, P_8—J 405 and P_9—K 8470.

x K 8470, HI 1148 x Lok-1 and WH 147 x K 8470, showed significant sca effects for grain yield along with some other important physiological and economic traits.

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