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HETEROSIS AND COMBINING ABILITY IN BREAD WHEAT

M. S. DUDHAT, B. S. JADON[1] and K. B. KATHIRIA

Seven diverse cultivars of wheat (*Triticum aestivum* Linn. emend. thell) were crossed in diallel and parents and F1s evaluated for seven quantitative characters. Yield heterosis to the extent of 64.34% over mid parent and 54.63% over better parent was recorded. Both general and specific combining ability were important for all the trait studied. However, non additive gene effects were predominant in the inheritance of grain yield and its direct components. 'WL 711', 'NP 824', and 'J 391' for grain yield and it components and 'Lok 1' for earliness and dwarfness had high gca effects. 'WL 711' Lok 1' and 'NP 824', x 'UP 301', having highest heterosis, mean performance and desirable sca effects need to be exploited for higher grain yield.

Combining ability studies are useful in classifying parental lines in terms of their hybird performance. In self pollinated crops, such studies are useful in assessing the nicking ability of the parents and thus aid in selecting the parents, which when crossed would give rise to more desirable segregants. Several high yielding varieties of wheat have been developed in recent years which need evaluation for their parental usefulness in further research Programmes to stabilize and expand the yield ceiling of this crop. The present investigation, 7x7 diallel set was, therefore, conducted to determine heterosis, obtain relative combining ability effects among parents and determine components of genetic variance for grain yield and components of yield in order to choose parents for hybridization and to plan effective breeding programme.

MATERIALS AND METHODS

Seven diverse wheat varities (Five released for different production conditions in different wheat growing zones of India) and their 21 possible non-reciprocal single crosses were grown in randomized block design with four replications during winter 1983 - 84. Each entry was represented by a single row of 25 plants spaced at 30 cm X 15 cm. Observations on five competitive plants were recorded for grain yield/plant (g), tillers/plant, grain yield/spike (g), grains/spike, 1000 grain weight (g), plant height (cm) and days to flowering. The means of replications were used to estimate heterosis expressed as percentage increase or decrease of the F1s over their mid parents and better parents. Combining ability analysis was conducted according to Model-I, method-2 of Griffing (1956).

RESULTS AND DISCUSSION

Significant differences among parents as well as hybrids for all the characters were noticed. Parents vs hybrids comparison was significant for grain yield/plant and 1000 grain weight. Heterosis to the extent of 64.34% for grain yield/plant, 35.25% for grain yield/spike, 21.00% for 1000 grain weight and 19.68% for grains/spike was

Wheat Research Station, Gujarat Agril. University, Junagadh-362 001

1 Research Scientist (Wheat), Wheat Research Station, Gujarat Agricultural University, Vijapur.

Table 1 : Range of heterosis and top three hybrids with heterosis (%) over mid-parent (MP) and better parent (BP), their sca, mean performance and rank for eight characters in wheat

Characters	Range		Best crosses	Heterosis*		Sca effects	*Per se* Perfor-mance	Rank	C.D. (5%) for heterosis	
	Mid-parent	Better parent		Mid-parent	Better parent				Mid-parent	Better parent
Grain yield/plant	−36.17	−43.14	'WL 711 x Lok 1'	64.34	54.3	10.30	30.37	1		
	to	to	'VP 301 x J 420'	42.08	—	—	16.29	18	3.22	3.70
	64.34	54.63	'NP 824 x UP 301'	36.25		5.05	23.68	2		
Tillers/plant	−29.59	−38.97	'WL 711 x Lok 1'	24.69	10 32	—	11.97	1	2.19	2.53
	to	to								
	24.69	10.32								
Grain yield/Spike	− 7.96	− 8.87	'NP 824 x J 420'	35.26	—	0.27	2.38	4		
	to	to	'NP 824 x UP 301	32.45	26.13	0.36	2.51	1	0.37	0.42
	35.25	26.13	'UP 301 x J 420'	30.33	—	—	2.17	7		
Grains/Spike	−15.34	−23.63	'WL 711 x Lok 1'	19.68	—	—	56.38	4		
	to	to	'NP 824 x UP 301'	17.97	15.16	—	59.09	1	8.55	9.88
	19.68	15.16								
1000 grain weight	− 0.65	−12.07	'WL 711 x NP 824'	21.08	10.87	4.38	44.46	6		
	to	to	'NP 834 x UP 301'	12.80	—	1.93	42.40	10	2.18	2.51
	21.08	10.87	'Lok 1 x NP 824'	11.63	—	2.60	51 19	1		
Plant height	− 14.58	− 1.55	'Lok 1 x NP 824'	−14.58	− 9.88	−8.69	65.60	13	4.32	4.99
	to	to								
	4.14	31.15								
Days to flowering	− 7.69	− 2.19	'Lok 1 x J 391'	− 7.69	—	−3.08	55.50	4		
	to	to	'WL 711 x NP 824'	− 6.46	—	−4.30	67.00	17	2.41	2.79
	12.02	25.35	'Lok 1 x NP 824'	− 5.88	—	−2.14	58.00	6		

*P = 0.01 : ———, Crosses with desired significant heterosis were not available.

recorded (Table 1). Seven crosses displayed significant positive heterosis for grain yield/plant, highest being in 'WL' 711 x Lok 1' followed by 'UP 301 x J 420' end NP 824 x UP 301' Highest postive heterosis for grain yield/plant in 'WL 711 x Lok 1' and NP 824 x UP' 301' was accompanied with high positive heterosis for grain yield/spike, grains/spike, 1000 grain weight and tillers/plant. High heterosis for grain yield in UP' 301 x J 420' with poor mean performance was not accompained with heterosis for any other traits except grain yield/spike. Heterosis for plant height and days to flowering was of low magnitude. 'Lok 1 x J 391', 'WL 711 x NP 824' for dwarfnes exhibited heterosis. There was some degree of correspondence between *per se* performance, heterosis and sca effect for all the seven characters (Table 1). W L 711 x Lox 1' and 'NP 824 x UP 301' having highest *per se* performance, significant sca effects and highest heterosis for grain yield and majority of component traits need to be exploited. Relative higher estimates of heterosis and sca effects were recorded in those crosses which involved diverse parents viz., 'WL 711' and 'Lok 1' and 'NP 824' and UP 301', as determined by phenotype, pedigree and place of origin

Combining ability :

Both gca and sca variances were significant for all the characters studied except gca for grain yield/spike and sca for grains/spike and tillers/plant indicating the importance of additive and non additive genetic variance (Table 2), However, the ratio δ^2 gca/δ^2 sca indicated the preponderance of non additive gene

Table 2 : Analysis of varience for combining ability in a 7 x 7 diallel cross in wheat

Source	df	Mean squares						
		Grain yield/ plant	Tillers/ plant	Grain yield/ spike	Grains/ Spike	1000-grain weight	Plant height	Days to flowering
Gca	6	24.00*	6.36*	0.01	96.03*	81.67*	313.31*	130.19**
Sca	21	12.64*	1.32	0.06*	18.26	3.95*	7.03*	5.05*
Error	81	1.73	0.81	0.02	12.30	0.80	3.14	0.88
δ^2gca/δ^2sca		0.06	0.34	—	0.44	0.81	2.53	1.08

* Significant at P = 0.01.

effects for all the characters except plant height and days to flowering for which additive gene effects were more important confirming the results reported by Yadav and Murty (1976), Sharma *et al.* (1978). Jatasra and Paroda (1979) and Sharma and Ahmed (1980). This suggests that breeding methods enabling the simultaneous exploitation of both additive and non-additive gene effects should be adopted in developing superior wheat varieties.

The relative magnitude and sign of gca effects of parents (Table 3)

Table 3 : General combining ability effect of parents and mean performance (in parentheses) in a 7 x 7 diallel cross in wheat

Source	Grain yield/ plant	Tillers/ plant	Grain yield/ spike	Grains/ spike	1000-grain weight	Plant height	Days to flowering
WL 711	2.11**	1.14**	−0.01	2.77*	−2.60**	0.05	6.57**
	(19.64)	(10.85)	(1.83)	(54.90)	(33.34)	(68.40)	(74.75)
Lok 1	−0.07	0.16	0.01	−6.40**	5.87**	- 5.32	−4.59**
	(17.32)	(8.32)	(2.03)	(39.32)	(51.61)	(59.70)	(54.75)
NP 824	1.16**	0.45	0.06	−0.03	1.14**	11.96**	3.16**
	(22.16)	(11.25)	(1.99)	(48.87)	(40.10)	(93.90)	(68.50)
J 391	0.87*	0.60*	−0.02	1.75	−2.08**	1.85**	1.60**
	(18.25)	(9.75)	(1.93)	(52.46)	(37.21)	(71.70)	(65.50)
UP 301	−0.57	−0.18	−0.01	2.19	2.26**	−4.92**	- 2.62**
	(12.60)	(7.15)	(1.80)	(51.31)	(35.08)	(58.10)	(54.75)
HD 2236	−0.52	−0.37	0.02	1.77	- 1.13**	−3.05**	−1.53**
	(15.96)	(7.75)	(2.05)	(54.47)	(36.72)	(60.40)	(56.00)
J 420	−2.97**	−1.47**	−0.05	−2.07	1.06**	- 0.58	−2.59**
	(10.33)	(5.60)	(1.53)	(42.60)	(43.92)	(64.40)	(54.25)
S. E. (gi)	±0.40	±0.27	—	±1.08	±0.27	±0.54	±0.30

*, ** Significant at P=0.05 and P=0.01, respectively.

revealed that 'WL 711', 'NP 824' and 'J 391' were good general combiner for grain yield/plant. 'WL 711' was good general combiner for tillers/plant and grains/spike also. 'NP 824' for 1000 grain weight and 'J 391' for tillers/plant showed higher gca effect. 'Lok 1', 'UP 301' and 'HD 2236' had more favourable genes for dwarfness and earliness. Of these, 'Lok 1' exhibited highest gca effect for 1000 grain weight, the character for which importance has been emphasized by Sharma and Knott (1964) and Knott and Talukdar (1971). In the present study, significant positive association between *per se* performance of parents and their gca effects for all the characters (r varying from 0.81** to 0.99**) was observed indicating the importance of *per se* performance while selecting parents for hybridization. High gca effects are related to additive genetic effects or additive x additive interaction effects which represents the fixable genetic components of variation. In view of this, parents 'WL 711' 'NP 824', 'J 391' and 'Lok 1' appear to be worthy of exploitation in varietal improvement programme It is suggested that population involving these lines in a multiple crossing programme by putting them into central gene pool may be developed for isolating high yielding lines. Further, the varieties/ lines showing good gca for particular components may be utilized in components breeding for improvement in particular components, thereby seeking improvement in yield.

Out of 21 crosses, 8 had significant sca effects for grain yield/plant. In contrast to gca effects, sca effects represent dominance and epistasis components of variation which are not fixable. But if the crosses showing high sca involve both the parents which are also good general combiners they could be exploited for varietal improvement programme. In the present study 'WL 711 x Lok 1' and 'NP 824 x UP 301' gave significant positive sca effects for grain yield/plant, grain yield/spike and grains/spike. They were high x average combinations which showed presence of considerable additive x additive interaction variance. Further, these two crosses having exhibited highest heterosis and mean performance for yield and majority of yield components can provide transgressive segregantes and therefore, be utilized in further breeding programme to isolate high yielding lines in advance generations

For characters like days to flowering and plant height, additive genetic variance was predominant, therefore, pedigree method can be used for improvement of these characters. Yield and its most important components have shown preponderence of non additive gene action, though they also exhibited considerable amount of additive genetic variance. Thus, improvement of such characters should be based on the simultaneous exploitation of both additive and non-additive components of genetic variance. Sharma and Singh (1976) and Sharma *et al.* (1978) suggested population breeding in the form of biparental mating between selected recombinants and mating of selected segregants between crosses in early segregating generations to exploit the additive and non additive gene action in *aestivum* what. Many workers have recently emphasized the application of recurrent selection as substitute to conventional selection technique in autogamous crops.

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