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GENETIC ANALYSIS OF WHEAT GENOTYPES HAVING DIFFERENT PHOTOTHERMAL GENETIC BACKGROUNDS

K. P. SINGH AND IQBAL SINGH

CCS Haryana Agricultural University, Hisar 125004

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ABSTRACT

Thermo-nonresponsive genotypes, Pavon 'S' and Harrier 'S' and photoperiod-responsive genotype Kalyan Sona exhibited positive gca effects for days to heading and grains/spike, and negative for grain weight and grain yield, while for temperature- responsive but photoperiod-neutral genotypes HD 2009 and WL 711 the situation was reversed. The positive gca effects of Chat 'S' in pooled analysis of all genotypes for days to heading, grains/spike and spike productivity changed into negative estimates in the analysis of the four CIMMYT genotypes. The hybrids exhibiting positive sca effects for grain yield involved parents differing in their photothermo responses.

Key words: Photothermal response, Vrn/Ppd genes, genetic background.

The specific adaptation of wheat crop (*Triticum aestivum* L.) under different environments is conferred by few major vernalization (Vrn) and photoperiodic (Ppd) genes [1]. It offers scope for planning genetic recombination that may enable breeders to produce well adapted and productive varieties for specific areas. In the present report, effort has been made to determine the influence of genetic background on combining abilities of wheat genotypes belonging to different geographical areas and having differential photothermal responses.

MATERIALS AND METHODS

Eight wheat genotypes belonging to two geographical areas of the world (Pavon 's', Harrier 's', Chat 'S' and Veery 's' of CIMMYT, and WH 147, HD 2009, WL 711 and Kalyan Sona from India) were crossed in all possible combinations, excluding reciprocals. The photo-thermo responses of these genotypes are presented in Table 1 as reported by Singh and Singh [2]. Single row plots of 3 m length spaced at 25 cm between rows and 10 cm within rows of 8 parents and their 28 hybrids were sown in randomized block design with three replications. Observations of ten competitive plants in each plot in each replication were

Table 1. Photothermal responses of the parents involved in hybridization

Parent	Origin	Probable Ppd/Vrn genes	Photothermal response
Pavon 's'	CIMMYT	vrn1, Vrn2, Vrn3, Ppd1	High temperature and photoperiod nonresponsive
Harrier 's'	-Do-	vrn1, vrn2, Vrn3, Ppd1	-Do-
Veery 's'	-Do-	Unknown	-Do-
Chat 'S'	-Do-	Vrn1, vrn2, vrn3, Ppd1	High temperature nonresponsive, photoperiod responsive
HD 2009	India	vrn1, Vrn2, Vrn3, Ppd1	Low temperature responsive, photoperiod nonresponsive
WL 711	-Do-	Vrn1, Vrn2, vrn3, Ppd1	High temperature responsive, photoperiod nonresponsive
WH 147	-Do-	Vrn1, Vrn2, vrn3, Ppd1	High temperature and photoperiod responsive
Kalyan Sona	-Do-	vrn1, Vrn2, Vrn3, Ppd1	-Do-

recorded for six quantitative traits. Plot means were used for statistical analysis. The combining ability analysis was performed as per Method 2 Model 1 of Griffing [3]. Separate analyses of four CIMMYT, four Indian and pooled analysis of both CIMMYT and Indian genotypes were carried out.

RESULTS AND DISCUSSION

High temperature-nonresponsive genotypes, Pavon 's' and Harrier 's' and photoperiod-responsive genotype Kalyan Sona [2] exhibited significant positive general combining ability (gca) effects for days to heading and grains/spike, and negative for 1000-grain weight and grain yield, while in case of temperature-responsive but photoperiod-nonresponsive genotypes WH 147, HD 2009 and WL 711 [2], the opposite situation was observed (Table 2). The results clearly showed the impact of genetic background on the combining ability of different genotypes. Similar influences of photothermal responses on different characters in wheat have been reported earlier [4–6].

Another interesting observation was in respect of changes in combining ability in the three different analyses of the CIMMYT, Indian and pooled genotypes for some characters. For instance, gca effects of Chat 's' in pooled analysis were positive for days to heading, grains/spike and spike productivity but negative for these traits in the CIMMYT genotypes (Table 2). Variations in combining ability effects of Pavon 's', WH 147 and Kalyan Sona for plant height and grains/spike of WH 147 were also evident in the pooled and 4-parent

Table 2. Estimates of general combining ability effects of wheat genotypes in 8-parent and 4-parent analyses

Parent	Analysis	Days to heading	Plant height	Grains per spike	1000-grain weight	Spike productivity	Grain yield per plant
Pavon 's'	Pooled	1.62**	1.16	2.11*	-1.16**	0.00	-0.93
	CIMMYT	0.03	-2.50**	1.12	-1.23*	-0.01	-0.12
Harrier 's'	Pooled	4.62**	3.13**	5.58**	-1.73**	0.09*	-0.20
	CIMMYT	3.92**	1.69*	4.34**	-1.38**	0.06	1.09
Chat 'S'	Pooled	2.72**	-0.31	0.67	-0.08	0.01	-0.93
	CIMMYT	-3.08**	-0.08	-3.25*	0.08	-0.15*	-1.21
Veery 's'	Pooled	1.88**	2.25**	-1.11	2.35**	0.18**	0.31
	CIMMYT	-0.86	0.89	-2.20	2.53**	0.10	0.24
WH 147	Pooled	-2.65**	-1.42*	-2.26**	1.63**	-0.02	0.71
	Indian	-0.67	0.50	0.39	1.06	0.01	-0.15
HD 2009	Pooled	-6.18**	-4.22**	-5.29**	0.09	-0.14**	0.49
	Indian	-2.06**	-2.03*	-3.32**	-0.8	-0.07	2.70**
WL 711	Pooled	-5.78**	1.35*	-1.24	1.00**	-0.06	1.81**
	Indian	-3.39**	1.17	-1.35	0.77	-0.10*	0.28
Kalyan Sona	Pooled	3.78**	-1.94**	1.52	-2.11**	-0.06	-1.26**
	Indian	6.11**	0.36	4.28**	-1.75**	0.15**	-2.39**
SE ($\hat{g}_i$)	Pooled	0.49	0.62	0.87	0.38	0.04	0.49
	CIMMYT	0.55	0.67	1.46	0.46	0.06	0.62
	Indian	0.71	0.75	0.66	0.55	0.04	0.48

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

analyses. In general, the magnitude of estimates in pooled analysis was higher than that of separate analyses of the CIMMYT and the Indian genotypes. Thus, the combining ability estimates of the genetically similar CIMMYT and Indian genotypes of specific regions differed from that of pooled analysis when genotypes of both the regions with different genetic backgrounds [2] were considered together.

The hybrids exhibiting significant positive specific combining ability (sca) effects for grain yield are listed in Table 3. Interestingly, all these hybrids involved parents which differed in their photothermal responses. The genotypes Harrier 's' and Chat 'S' contained maximum recessive alleles of the Vrn and Ppd genes, while other genotypes like Pavon 's', WL 711 and Kalyan Sona had variable number of dominant Ppd and Vrn alleles [7]. The hybrids involving Harrier 's' or Chat 'S' as one of the parents exhibited positive sca effects for days to heading and grains/spike and negative for 1000-grain weight, while those of WL 711, Pavon 's' and Kalyan Sona showed positive sca effects for 1000-grain weight but for

Table 3. Estimates of specific combining ability effects of some wheat hybrids

Cross	Analysis	Days to heading	Plant height	Grains per spike	1000-grain weight	Spike productivity	Grain yield per plant
Pavon 's' x Veery 's'	Pooled	- 0.48	- 1.43	13.10**	0.00	0.53**	9.86**
	CIMMYT	- 1.47	0.61	10.93**	1.31	0.53**	10.19**
Harrier 's' x Chat 'S'	Pooled	3.02*	3.65	0.92	- 0.93	0.06	4.38**
	CIMMYT	4.20**	1.89	1.83	- 0.02	0.18	4.44**
Harrier 's' x Veery 's'	Pooled	5.52**	- 4.07*	4.73	- 1.10	0.11	6.64**
	CIMMYT	3.64*	- 4.25*	2.82	- 0.20	0.14	6.49**
WH 147 x WL 711	Pooled	- 5.88**	8.22**	13.07**	- 0.77	- 0.10	2.18
	Indian	- 4.74*	9.73**	13.54**	0.83	0.11	3.89**
HD 2009 x WL 711	Pooled	5.32**	- 2.15	0.70	2.84*	0.11	6.16**
	Indian	4.31*	- 0.91	1.85	4.04**	0.28*	5.24**
HD 2009 x Kalyan Sona	Pooled	- 2.58	7.47**	- 0.49	0.28	0.18	6.09**
	Indian	- 3.52	6.23**	- 2.21	0.90	0.10	4.77**
Pavon 's' x WL 711	Pooled	- 3.48*	12.80**	- 1.03	1.75	0.13	3.88**
Pavon 's' x Kalyan Sona	Pooled	1.29	3.75*	3.01	3.73**	0.07	6.22**
Chat 'S' x WH 147	Pooled	4.29**	0.37	2.16	- 0.19	0.16	4.73**
Chat 'S' x WL 711	Pooled	6.75**	- 2.56	8.35**	1.18	0.55**	3.14*
Veery 's' x WH 147	Pooled	1.79	3.65	0.94	3.11**	0.24	7.40**
SE ($\hat{S}_{ij}$)	Pooled	1.51	1.91	2.67	1.17	0.13	1.50
	CIMMYT	1.34	1.60	3.53	1.12	0.14	1.50
	Indian	1.71	1.83	1.59	1.34	0.11	1.16

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

days to heading and grains/spike both positive and negative estimates were obtained.

The genotypes having low temperature and photoperiodic responses produce more grains/spike but their grain weight is low, and often a negative correlation exists between these traits [2]. The present study has shown that favourable sca effects for grains/spike and grain weight lead to positive sca effects for grain yield.

Thus, it is evident that combining abilities and their estimates differ among genotypes with similar and different genetic backgrounds. Therefore, caution may be observed while interpreting the results of inheritance in different materials. Some characters like days to heading and grain number are governed by a few major genes [1] whose penetrance and

expressivity differ in different environments. Therefore, results will be applicable only to specific environments under which experiments are conducted. However, even if a character is governed by major genes, the composition of minor genes of genotypes can be improved in favourable direction through hybridization of genotypes having different genetic backgrounds.

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