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RESEARCH ARTICLE

GENE ACTION FOR YIELD AND QUALITY TRAITS IN WHEAT (*Triticum aestivum* L.)

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ABSTRACT

The components of variance and other genetic parameters were analyzed, through a 10x10 parent diallel cross excluding reciprocals, for 1000-grain weight, seed hardness, harvest index, protein content, phenol colour reaction and grain yield/plant. Genetic component analyses revealed that both additive and non-additive type of gene action were responsible for the inheritance of 1000-grain weight, protein content and grain yield per plant in both F_1 and F_2 generations at all three locations. The non-additive components $(\hat{H}_1 \text{ and } \hat{H}_2)$ were predominant for all most the characters in both the generations at all the locations. Over dominance effects and asymmetrical distribution of positive and negative alleles were responsible for allele interactions in respect of all the characters in both the generations at all the locations. The dominant genes were more frequent than recessive genes for all the traits except number of grains/spike in both the generations at all the locations. The component analysis revealed the presence of both additive and non-additive genetic components; therefore, biparental mating/diallel selective mating followed by pedigree method of selection would be worthwhile for the improvement of grain yield and quality traits in wheat

Key **W**ords : Genetic components, diallel analysis and wheat.

Wheat is the most important and widely cultivated cereal crop throughout the world. India has tremendous progress in the food grain production, especially wheat. It is grown in India over an area of about 29.1 million hectare with a production of about 84.27 million tones, still maintaining second position in the world (Agriculture Ministry, Govt. of India, 2011). The national productivity is about 2.9 tones/ hectare, while in China and US is about 4.7 and 3.1 tones/ hectare, respectively (Chakarbarti, 2011). With all these achievements, the issues ahead are even more challenging. The population of India is growing at 1.8% per year, it is necessary to further increase the productivity level to meet the requirement of 109 million tones up to 2020 (Nagarajan 2002). It is used in the form of *chapatti, bread, naan, tandori, rumali roti, puri, pudding, bhatore, bran* and *fodder* etc. In India wheat grain is used by human beings mainly in the form of chapatti, hence wheat cultivars with high baking quality will be preferred. The medium hard, medium grain size and appearance is preferred for non-fermented flat Indian bread *(Chapatti)* and a number of other ethnic food preparations such as *naan, tandori, rumali roti, puri, bhatore* etc. The protein content is a chief component of nutritional quality. Therefore, the improvements in characters related to produce quality along-with grain yield is very essential. For this, the appropriate breeding strategy is needed to enhance the genetic potential of new cultivar. For developing sound breeding strategy, the knowledge of components of variance involved in the inheritance of yield and quality traits is of paramount importance. Therefore, the present study was undertaken to study the nature and magnitude of gene action at different locations.

MATERIALS AND METHODS

Ten diverse genotypes of wheat; *viz*., K 68, DL 784-3, K

9107, K 8027, C 306, K7903, GW 373, K123, HP 1633 and K 9644 were crossed in all possible combinations excluding reciprocals during *Rabi* 2005-06. Half of the seeds of each cross was advanced in off season nursery at Wellington (Neelgiri hills), Tamil Nadu to raise F_1 population in order to get the seeds for raising F_2 population. The ten parents and their 45 F_1s and 45 F_2s were grown in Randomized Block Design with three replications at three locations; *viz.*, Crop Research Farm, Nawabganj (Kanpur), Mauranipur (Jhansi) and Etawah, of C.S.A. University of Agriculture and Technology, Kanpur (U.P.). The plots of parents and F_1s consisted single row of 3 m length, while each plot of F_2 consisted of three rows of 3 m length with inter and intra row distance of 25 and 15 cm, respectively. The usual cultural practices were applied to raise a good crop. The observations were recorded in each plot on 10 randomly selected plants in parents and F_1 generation and 20 plants in F_2 generation for grain yield and quality traits; namely, 1000-grain weight (g), seed hardness (kg/seed), harvest index (%), protein content (%), phenol colour reaction (score) and grain yield/plant (g). The components of variance in diallel cross were computed by the use of equation given by Hayman, (1954a).

RESULTS AND DISCUSSION

Component analysis revealed highly significant value for additive genetic component (D) at all the locations in both the generations for 1000-grain weight, protein content and grain yield per plant whereas, it was highly significant for harvest index at Kanpur and Etawah in both F_1 and F_2 generations and phenol colour reaction at Kanpur and Mauranipur in F_2 generation indicating the role of additive gene action in controlling the expression of all these traits. The dominant components $(\hat{H}_1 \text{ and } \hat{H}_2)$ indicated highly significant values for all the characters in both the generations whereas $\hat{H}_2$ was significant for phenol colour reaction at all the three location in F_1s exhibiting role of non-additive gene action or dominance gene action in the inheritance of these attributes. Yadav *et al*. (2005) and Ahmad *et al*. (2007) also reported additive as well as dominance genetic variance for yield and quality traits in wheat.

The positive and significant values of $\hat{F}$ component were recorded for 1000-grain weight in both the generations at all the locations; grain yield per plant in both F_1 and F_2 generations at Kanpur indicating the distribution of dominant genes was frequent than the recessive genes in the parents.

The value of $\hat{h}^2$ revealed significant and positive for 1000-grain weight, seed hardness, harvest index and phenol colour reaction in F_1s and F_2s at all three locations; grain yield in both the generations at Kanpur symbolizing that there was preponderance of dominant genes in the consistent nature.

Significant and positive estimates of $\hat{E}$ component were reported for 1000-grain weight, seed hardness, harvest index, phenol colour reaction and grain yield per plant in both F_1 and F_2 generations at all the three locations; protein content in F_1 and F_2 progenies at Mauranipur and Etawah reflecting substantial degree of environmental effects in the expression of these characters.

The values of mean degree of dominance $(\hat{H}_1/\hat{D})^{1/2}$ reflected over dominance for 1000-grain weight, seed hardness, harvest index, protein content, phenol colour reaction and grain yield in both the generations at all the locations. Similar findings were reported by Singh and Rai (1991), Prodanovic (1993) and Sameena *et al*. (2000) for grain yield.

The proportion of genes with positive and negative effects $(\hat{H}_2/4\hat{H}_1)$ was less than the theoretical value (0.25) for all the characters in F_1 and F_2 generation at all the locations showing asymmetrical distribution of positive and negative genes among the parents. Sharma *et al*. (1991) and Nayeem (1994) were reported similar findings for grain yield and its related traits.

The ratio of dominant and recessive gene $[(4\hat{D}\hat{H}_1)^{1/2} + F/(4\hat{D}\hat{H}_1)^{1/2} - F)]$ was observed more than unity for all the traits except phenol colour reaction in both the generations' at all three locations indicating that dominant genes were more frequent than recessive genes.

The values of $\hat{h}^2/H_2$ were found more than unity for 1000-grain weight and harvest index in F_1 generation at Kanpur and Mauranipur and grain yield in both F_1 and F_2 generations at Kanpur indicating that inheritance of these characters was governed by more than one major gene group, rest of characters in their respective generations and locations governed by one major gene group.

The coefficient of correlation between parental order of dominance and parental measurement was found to be positive 1000-grain weight and phenol colour reaction in both F_1 and F_2 generations at all the three locations; harvest index in F_1 at Kanpur and Mauranipur; protein content in F_1 generation at all the locations and in F_2 progeny at Kanpur and Mauranipur showing that the negative genes were responsible to express these characters. On the other hand, negative values of correlation coefficient were recorded for rest of the attributes in their respective generations and locations indicating that positive genes were mostly predominant for the expression of these traits.

CONCLUSION

The component analysis revealed the presence of both additive and non-additive genetic components as well as

Table 1: Estimates of $\hat{D}$, $\hat{H}_1$, $\hat{H}_2$, $\hat{F}$, $\hat{h}^2$ and E components and related statistics for 6 attributes in F_1 and F_2 generations of wheat at three locations

Attributes			$\hat{D}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{F}$	$\hat{h}^2$	$\hat{E}$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	$\frac{(4\hat{D}\hat{H}_1)^{1/2}+\hat{F}}{(4\hat{D}\hat{H}_1)^{1/2}-\hat{F}}$	$\hat{h}^2/\hat{H}_2$	r
1000-grain	F_1	L_1	20.74**± 0.61	23.91**± 1.29	12.16**± 1.10	26.15**± 5.40	28.57**± 0.74	1.04**±0.18	1.07	0.13	3.84	2.35	0.86
weight (g)		L_2	17.55**± 0.50	20.09**± 1.06	11.25**± 0.90	21.46**± 4.15	49.19**± 0.60	1.16**±0.15	1.07	0.14	4.08	4.37	0.98
		L_3	19.28**± 0.19	28.67**± 4.67	15.64**± 3.97	30.96**± 5.06	11.46**± 2.66	1.48**±0.66	1.22	0.14	4.86	0.73	0.93
	F_2	L_1	20.73**± 2.08	141.68**± 17.68	88.13**± 15.02	62.43**± 9.58	9.59**± 2.51	1.05**±0.33	2.61	0.16	3.72	0.11	0.87
		L_2	17.77**± 1.41	110.01**± 12.00	72.25**± 10.20	47.78**± 6.50	8.82**± 1.71	0.94**±0.42	2.49	0.16	3.35	0.12	0.86
		L_3	19.63**± 1.64	127.36**± 13.97	74.57**± 11.87	61.79**± 7.57	11.57**± 1.99	1.13**±0.29	2.55	0.15	4.23	0.15	0.86
	F_1	L_2	0.27**+ 0.06	1.05**+ 0.30	0.81**+ 0.21	0.39+ 0.34	0.38**+ 0.10	0.21**+0.04	1.97	0.18	2.16	0.47	-0.16
		L_3	0.37**± 0.08	1.35**± 0.37	1.16**± 0.31	0.28± 0.40	3.10**± 0.21	0.24**±0.05	1.91	0.21	1.50	2.67	0.45
Seed	F_2	L_1	0.22**± 0.06	5.07**± 1.09	5.13**± 0.92	0.80± 0.59	3.75**± 0.15	0.23**±0.04	4.80	0.25	1.44	0.73	-0.27
hardness		L_2	0.28**± 0.08	5.58**± 1.63	4.11**± 1.39	0.51± 0.89	0.95**± 0.23	0.21**±0.06	4.46	0.18	1.18	0.17	0.25
(kg/seed)		L_3	0.38**± 0.09	6.51**± 1.46	5.10**± 1.24	0.82**± 0.79	3.09**± 0.21	0.22**±0.05	4.14	0.20	1.18	0.47	0.47
Attributes			$\hat{D}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{F}$	$\hat{h}^2$	$\hat{E}$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	$\frac{(4\hat{D}\hat{H}_1)^{1/2}+\hat{F}}{(4\hat{D}\hat{H}_1)^{1/2}-\hat{F}}$	$\hat{h}^2/\hat{H}_2$	r
Harvest	F_1	L_1	1.23**± 0.28	2.26**± 0.59	2.05**± 0.50	0.85± 0.64	11.46**± 0.34	1.01**±0.08	1.36	0.23	1.69	5.59	0.90
index		L_2	0.23± 0.45	2.60**± 0.77	1.90**± 0.52	0.64± 1.05	4.93**± 0.55	0.73**±0.14	3.22	0.17	2.50	2.59	0.49
(per cent)		L_3	1.47**± 0.31	3.82**± 0.66	3.06**± 0.56	1.65± 0.82	2.78**± 0.38	0.65**±0.09	1.61	0.20	2.17	0.91	-0.41
	F_2	L_1	1.57**± 0.35	13.80**± 2.97	12.25**± 2.53	2.46± 1.61	4.12**± 0.42	0.66**±0.11	2.96	0.22	1.72	1-4 0.34	-0.29
		L_2	0.42± 0.47	31.19**± 4.01	29.20**± 3.40	0.27± 2.17	0.61**± 0.15	0.54**±0.14	8.60	0.23	1.08	0.02	-0.76
		L_3	1.58**± 0.45	18.34**± 3.82	15.77**± 3.25	2.98**± 2.07	2.88**± 0.54	0.55**±0.14	3.41	0.21	1.77	0.18	-0.32
	F_1	L_1	0.40**± 0.11	0.74**± 0.18	0.61**± 0.16	0.30± 0.26	0.60± 0.34	0.06± 0.04	1.30	0.20	1.76	0.98	0.46
		L_2	0.36**± 0.10	1.00**± 0.20	0.80**± 0.17	0.44± 0.22	0.25± 0.12	0.21**±0.03	1.68	0.20	2.16	0.31	0.69
		L_3	0.40**± 0.09	0.52**± 0.12	0.43**± 0.12	0.26± 0.21	0.15± 0.11	0.20**±0.03	1.06	0.21	1.80	0.35	0.02
Protein	F_2	L_1	0.39**± 0.11	303**± 0.57	2.58**± 0.43	0.54± 0.53	0.15± 0.14	0.08± 0.04	2.61	0.21	1.72	0.06	0.26
content		L_2	0.38**± 0.09	2.19**± 0.42	1.91**± 0.47	0.33± 0.55	0.13± 0.15	0.21**±0.04	2.13	0.24	1.57	0.07	0.35
(per cent)		L_3	0.39**± 0.10	1.92**± 0.34	166**± 0.31	0.42± 0.45	0.14± 0.12	0.21**±0.03	1.91	0.22	1.78	0.08	-0.03
Attributes			$\hat{D}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{F}$	$\hat{h}^2$	$\hat{E}$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	$\frac{(4\hat{D}\hat{H}_1)^{1/2}+\hat{F}}{(4\hat{D}\hat{H}_1)^{1/2}-\hat{F}}$	$\hat{h}^2/\hat{H}_2$	r
Phenol	F_1	L_1	0.04± 0.02	0.17**± 0.05	0.11*± 0.04	-0.09± 0.05	0.06*± 0.02	0.16**±0.01	2.06	0.16	0.30	0.54	0.07
colour		L_2	0.09± 0.05	0.29**± 0.08	0.16*± 0.07	-0.19± 0.12	0.05*± 0.02	0.18**±0.02	1.80	0.12	0.25	0.31	0.58
reaction		L_3	0.03± 0.02	0.22**± 0.06	0.21*± 0.08	-0.03± 0.10	0.12*± 0.04	0.20**±0.01	1.41	0.23	0.69	0.57	0.03
(score)	F_2	L_1	0.09**± 0.02	1.20**± 0.16	0.94**± 0.13	-0.29*± 0.09	0.06*± 0.08	0.22**±0.01	3.65	0.19	0.39	0.06	0.81
		L_2	0.17**± 0.02	1.93**± 0.14	1.34**± 0.12	-0.64**± 0.08	0.08*± 0.03	0.27**±0.01	3.37	0.17	0.28	0.07	0.68
		L_3	0.02± 0.02	0.94**± 0.21	0.85**± 0.18	-0.03± 0.11	0.09*± 0.03	0.23**±0.01	6.85	0.23	0.80	0.11	0.71
	F_1	L_1	3.44**± 0.33	3.56**± 0.50	1.75**± 0.50	4.71**± 0.76	7.40**± 0.40	0.91**±0.10	1.02	0.12	5.51	4.23	-0.98
		L_2	0.80**± 0.22	0.89**± 0.25	0.68**± 0.15	1.14± 0.52	0.05± 0.27	1.23**±0.07	1.05	0.19	5.22	0.07	-0.32
		L_3	0.57**± 0.15	1.57**± 0.43	1.17**± 0.25	0.79± 0.57	0.10± 0.30	0.92**±0.07	1.65	0.18	2.43	0.09	-0.58
	F_2	L_1	3.58**± 0.34	16.13**± 2.88	9.30**± 2.44	9.83**± 1.56	14.66**± 0.41	0.77**±0.10	2.12	0.14	4.66	1.58	-0.99
Grain yield		L_2	0.87**± 0.25	2.76**± 0.49	2.32**± 0.66	1.45± 1.35	0.75± 0.35	1.25**±0.09	1.78	0.21	2.76	0.32	-0.68
per plant (g)		L_3	0.38**± 0.10	4.62**± 0.83	4.70**± 0.96	0.78**± 0.61	0.14**± 0.16	1.18**±0.04	3.37	0.25	1.88	0.03	-0.33

* and ** Indicate significance of values at P=0.05 and 0.01, respectively, L_1= Kanpur; L_2 = Mauranipur (Jhansi); L_3 = Etawah

preponderance of non additive gene action. Therefore, biparental mating/diallel selective mating followed by pedigree method of selection would be worthwhile for the improvement of grain yield and quality traits in wheat.

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