Biological Forum – An International Journal 13(3a): 830-834(2021)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Combining Ability and Gene Action for Grain Yield in Bread Wheat (*Triticum aestivum* L.)

Harshit Tripathi[1], *Bhupendra Kumar*[2*], *R.K. Yadav*[1], *H.C. Singh*[1] *and R.P. Vyas*[1]
[1]*Department of Genetics and Plant Breeding, C.S.A. University of Agriculture & Technology, Kanpur (Uttar Pradesh), India.*
[2]*Department of Genetics and Plant Breeding, Janta Mahavidyalay, Ajitmal, Auraiya (Uttar Pradesh), India.*

(Corresponding author: Bhupendra Kumar)*
(Received 06 July 2021, Accepted 28 September, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The selection of suitable genotypes/parents and their crosses is a prerequisite in order to formulate a systematic breeding programme for the improvement of crops. Combining ability analysis was studied in a half diallel set of 8 × 8 in bread wheat (*Triticum aestivum* L.). Variances for both general and specific combining abilities were found highly significant for all the characters which are indicative of the importance of both additive and non-additive gene effects. The ratios (σ^2GCA/σ^2SCA) of σ^2gca and σ^2sca estimates were observed less than unity for all the characters indicated that non-additive genetic components play relatively greater role in the inheritance of all the characters. The genotypes *viz.* PBW-343, K-307 and DBW-71 showed significant and positive gca effects for grain yield per plant which indicate their ability as good general combiners for the character. Ten cross combinations exhibited significant and positive SCA effects for the character grain yield per plant. The highest SCA effect for the character was exhibited by the cross combinations DBW71×PBW343, DBW14×K307 and K424×DBW71. The cross combination DBW-71×PBW-343 was found most promising as it showed high SCA effect together with *per se* performance for the characters *viz*., grain yield per plant, number of tillers per plant, weight of grain per spike and 1000-grain weight which could be further exploited in plant breeding programmes.

Keywords: Combining ability, gene action, grain yield, bread wheat.

INTRODUCTION

Wheat occupies first position among cereal crops both in context of its antiquity and use as a major source of human food. It is considered as a major staple food crop of the world after rice. Extensive references are available for wheat in ancient Indian scriptures. There in Atharva-Veda which supposed to have been written between 1500 B.C. and 500 B.C. refers to the wheat grain. India takes second rank both in area and production after China in the world. The share of India in world's wheat area and production is near to 13%. Thus, India has considered not only being self sufficient in wheat food grains but also in export to needy and friendly countries on a limited scale. Area under wheat crop at national level is 30.78 million hectare with the production of 107.86 million tonnes having a productivity of 3.5 metric tonnes per hectare (DACFW 2020). Contribution of wheat is about 34% of total food grain production of country. The plant breeders always have concern of the choice for suitable parents to evolve better varieties/hybrids. To discriminate good as well as poor combiners to choose appropriate parental materials for a particular character in the plant breeding programme the combining ability plays an important role. At the same time, the analysis of combining ability provides information about the nature of gene action involved in the inheritance of grain yield and its component characters. In a systematic breeding programme, selection of parents having good general combining ability effects for grain yield and its components and the estimates which are higher for specific combining ability effects are essential. With the help of these estimates formulation of sound, efficient and effective breeding procedure to bring about rapid and purposeful improvement is possible in the crop. The present investigation was, therefore, planned to study combining ability and genetic architecture of grain yield and its component characters in bread wheat crosses obtained from 8 × 8 half diallel mating design.

MATERIALS AND METHODS

For present investigation the experimental material comprised of 28 F_1s developed by crossing eight diverse lines *viz*., K 424, K 7903, WR 544, DBW 14, DBW 71, PBW 343, K 307 and K 9162 following half diallel mating design was carried out at Crop Research Farm, Nawabganj, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur- 208 002 (U.P.) during *Rabi season*, 2017-19.

The experimental material consisted of 36 genotypes (28 F_1s + 8 parents) were sown in Randomized Block Design with three replications after randomization in late sown (LS) condition. The lines/entries were sown in a 3 meter long single row plot with inter and intra-row spacing of 23 cm and 10 cm, respectively. For twelve characters *viz.* days to 50% heading, number of tillers per plant, plant height (cm), days to maturity, length of spike (cm), number of spikelet per spike, number of grains per spike, grain yield per plant (g), weight of grain per spike (g), 1000 grain weight (g), biological yield per plant (g) and harvest index %., observations were recorded from the five randomly selected plants in parents and their F_1s. Than the analysis of variance for GCA and SCA were carried out according to Griffing's (1956) model-1, method 2.

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) for combining ability showed that variances for both general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the characters which indicated that both additive and non-additive gene effects are important. The values of gca and sca ratio estimates were observed less than unity for all the characters indicated non-additive component played relatively greater role in the inheritance of the characters studied (Table 1). The magnitude of SCA variances was higher than their respective GCA variances for all the characters revealed preponderance of non additive gene action. Similar findings were also reported by Singh *et al.* (2014); Zahid *et al.* (2011); Ayoob (2020).

On the basis of *per se* performance and gca effects (Table 2) good general combiners were K424, K7903 and WR544 for days to heading , K424, K7903 and PBW343 for plant height, K424, K7903 and DBW71 for days to maturity, K 307, PBW343 and K9162 for number of tillers per plant, DBW14, K9162 and PBW343 for number of spikelets per spike, K9162 and K307 for spike length, PBW343, WR544 and K9162 for number of grain per spike, WR544 and PBW343 for 1000 grain weight, K7903 for weight of grain per spike, K307 and WR544 for biological yield per plant, PBW343, K307 and DBW71 for grain yield per plant PBW343 and DBW71 for harvest index. Genotype PBW343 was found good general combiner for the characters *viz.* plant height, number of tillers per plant, number of grains per spike, number of spikelets per spike, 1000 grain weight, and grain yield per plant and harvest index. In this study almost all the good general combiners showed the similar trend on the basis of gca effects and *per se* performance. Similar results were reported by Parveen *et al.* (2021).

Table 1: Analysis of variance (ANOVA) for combining ability for twelve characters in bread wheat.

Source of variance	d.f.	Days to heading	No. of tillers / plant	Plant height (cm)	Days to maturity	No. of spikelets / spike	Spike length (cm)	No. of grains/ spike	Grain weight /spike (g)	Biological yield/plant (g)	Grain yield / plant (g)	1000 grain weight (g)	Harvest index %
GCA	**7**	97.40**	19.36**	56.98**	63.43**	3.26**	1.88**	15.18**	0.038**	32.51**	18.26**	7.83**	60.26**
SCA	**28**	14.04**	6.65**	22.98**	12.06**	0.74**	0.66**	4.24**	0.084**	32.90**	5.31**	21.72**	21.58**
Error	**70**	0.25	0.187	1.203	0.212	0.104	0.101	0.409	0.007	1.171	0.184	0.153	0.207
δ^2g	-	9.71	1.91	5.58	6.32	0.32	0.18	1.48	0.003	3.31	1.81	0.77	6.006
δ^2s	-	13.794	6.47	21.78	11.85	0.64	0.55	3.84	0.78	31.73	5.13	21.57	21.37
δ^2g/ δ^2s	-	0.704	0.30	0.26	0.53	0.49	0.32	0.38	0.04	0.099	0.35	0.036	0.28
$(\delta^2 s/ \delta^2 g)^{0.5}$	-	1.19	1.84	1.97	1.37	1.41	1.75	1.60	16.13	3.10	1.68	5.29	1.89

*Significant at 5% level; **Significant at 1% level

Table 2: Estimates of GCA effects of parents for twelve characters in a set of eight parent's diallel cross in bread wheat.

Source of variance	Days to heading	No. of tillers/ plant	Plant height (cm)	Days to maturity	No. of spikelets/spike	Spike length (cm)	No. of grains/ spike	Grain weight /spike (g)	Biological yield (g)/ plant	Grain yield/ plant (g)	1000 grain weight (g)	Harvest index %
K-424	-1.68**	-1.27**	-3.28**	-3.41**	-0.78**	-0.19*	-0.99**	0.004	-1.93**	-1.21**	-0.15	-1.15**
K-7903	-4.62**	-1.23**	-2.18**	-3.21**	-0.32**	-0.06	-1.53**	0.024	-0.49	0.039	-0.033	0.189
WR-544	-2.52**	-0.74**	1.17**	-0.24	-0.097	-0.08	1.53**	-0.062*	1.29**	-0.35**	1.58**	-1.37**
DBW-14	-0.82**	-1.23**	0.69*	-0.37**	0.82**	-0.41**	-0.17	0.05	-0.32	-0.87**	-0.97**	-1.59**
DBW-71	2.55**	0.27*	-0.17	-0.57**	-0.48**	0.11	0.14	-0.012	0.178	1.19**	0.46**	2.69**
PBW-343	4.18**	0.95**	-2.09**	3.10**	0.44**	-0.59**	1.94**	0.11**	-0.49	1.87**	0.27*	4.42**
K-307	3.55**	2.65**	3.66**	1.56**	-0.21*	0.57**	-1.07**	-0.069**	3.64**	1.27**	-1.30**	-0.11
K-9162	-0.65**	0.60**	2.18**	3.16**	0.65**	0.65**	0.15	-0.046	-1.89**	-2.02**	0.14	-3.09**
SE(gi)	0.35	0.30	0.77	0.32	0.23	0.22	0.45	0.060	0.76	0.30	0.27	0.32

*Significant at 5% level; **Significant at 1% level

As regards the specific combining ability effects, ten cross combinations which exhibited significant and positive SCA effects for grain yield per plant. The cross combination DBW71×PBW343 (good × good) recorded the highest SCA effect (3.84) followed by DBW14×K307 (3.61, poor × good), K424×DBW71 (3.20, poor x good),K-7903×PBW-343 (3.19, average × good) and K-7903×K-307 (2.73, average × good) were rated as good specific cross combinations for this character (Table 3). Similar results were reported by Desale *et al.* (2014); Sharma *et al.* (2019).

Table 3: Ranking of top five cross combinations for grain yield in bread wheat.

Sr. No.	Cross Combinations	*per se*	SCA effect	GCA Status	
				P_1	P_2
1.	DBW71×PBW343	22.40	3.84	1.19	1.87
2.	DBW14×K307	19.50	3.61	-0.87	1.27
3.	K424×DBW71	18.77	3.20	-1.21	1.19
4.	K-7903×PBW-343	20.60	3.19	0.039	1.87
5.	K-7903×K-307	19.53	2.73	0.039	1.27

The specific combining ability effect for days to 50% heading varied from DBW14×K307 (-6.79) to DBW14× PBW343 (9.24) in F_1 generation. Out of twenty eight crosses nine crosses have negative and highly significant sca effect. Top five crosses DBW14×K307, K7903×K307, PBW343×K9162, WR544×K9162, K424×PBW343 and DBW71×K307 in F_1 generation showed highly significant value of sca effect.

The sca effect values for number of tillers per plants varied from PBW343×K307 (-3.31) to K7903×K9162 (4.524). Out of twenty eight crosses twelve cross combination showed highly positive and significant sca effect. The top three crosses in order of merit were K7903×K9162, DBW71×PBW343 and K424×DBW14 as good specific combiners.

In F_1 generation, the range of sca effect were found between K7903×K307 (-7.27) to K7903×PBW343 (14.14). The ten cross combinations showed negative and significant values of sca effect for desirable dwarfness. The first three crosses in order of merit were K7903×K307, K7903×WR544 and WR544×DBW14 with good specific combiners.

The value of sca effect for days to maturity ranged from DBW-71×K-307 (-4.81) to K-424×DBW-71 (7.16) in F_1 generation. Twelve cross combinations showed negative and highly significant sca effect, good specific combiners were *viz*. DBW71×K307, K7903×K9162, WR544×K307, PBW343×K307 and WR544×PBW343 showed highly significant negative value of sca effect.

The cross combinations for number of spikelets per spike have sca effect ranged from DBW14×K307 (-1.47) to K7903×DBW71 (1.130). Eight cross combinations exhibited positive and significant sca effect. The top three cross combinations were K7903×DBW71, K7903×K307 and K7903×K9162.

The values of sca effect varied from DBW71×K9162 (-1.09) to K424×DBW71 (1.42) in F_1 progeny for spike length. Eight cross combination out of twenty eight crosses showed positive and highly significant sca effect. The top three good cross combinations were K424×DBW71, K7903×K307 and DBW71×PBW343.

The values of sca effect for number of grains per main spike ranged from K424×DBW71 (-3.10) to DBW14×K9162 (3.01). Ten cross combinations showed positive and highly significant sca effect. The top three cross combinations were found good specific combiners DBW14×K9162, K424×K307 and K7903×PBW343.

The range of sca effect varied from PBW343×K9162 (-0.32) to DBW14×PBW343 (0.78) for grain yield per plant. Seven cross combinations were positive and highly significant for desirable sca effect in which top three are DBW14×PBW343, DBW71×PBW343 and K424×WR544.

The range of sca effect varied from K424×K307 (-7.96) to DBW71×K9162 (14.15) for biological yield per plant. Ten cross crosses showed positive and significant sca effect. The three best cross combinations were DBW71×K9162, DBW14×K307 and K424×PBW343 found good specific combiners.

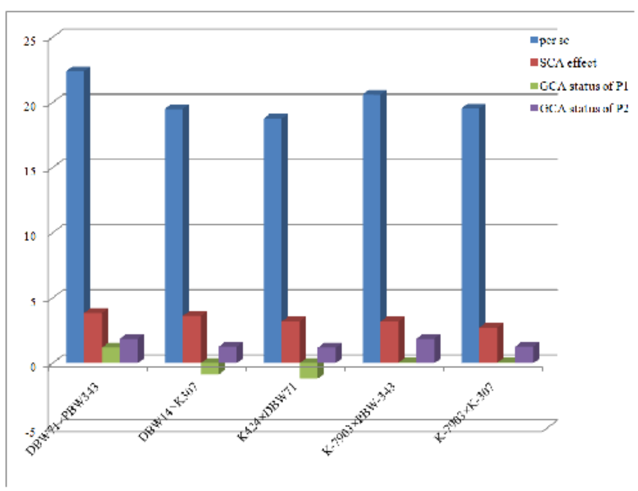
The range of sca effect for 1000 grain weight varied from K7903×DBW71 (-6.56) to K424×K9162 (8.55). Only ten cross combinations out of twenty eight crosses indicated positive and significant sca effect. Top three cross combinations were K424×K9162, K7903×K307 and DBW71×K9162.

The range of sca effect varied from DBW71×K9162 (-7.60) to WR544×PBW343 (9.08) for harvest index per plant. Twelve crosses showed positive and highly significant value for desirable sca effect. Fourteen cross combinations showed negative and significant for sca effect. The top three cross combinations were WR544×PBW343, DBW14×DBW71 and WR544×DBW1 as good specific combiners (Table 4).

A comparison between mean performance of hybrids and their SCA effects revealed that high *per se* performance of cross combinations was related with their significant SCA effects in majority of characters studied. Top five common cross combinations on the basis of *per se* performance and SCA effects were DBW71×PBW343, DBW14×K307, K424×DBW71, K-7903×PBW-343, and K-7903 × K-307 for grain yield per plant (Table 3). Best cross combiners for different characters were K-7903×WR-544 for plant height, DBW-71×PBW-343 for number of tillers per plant, K-7903×K-307 for spike length, DBW-71×K-9162 and K-424×K 9162 for 1000 grain weight. DBW-14×PBW-343 and DBW-71×PBW-343 for weight of grains per spike, DBW-71×K-9162 and DBW-14×K-307 for biological yield per plant and WR-544×PBW-343 for harvest index. Similar findings were also reported by Seboka *et al.* (2009); Tayade *et al*. (2020); Ayoob (2020).

Table 4: Ranking top three desirable cross combinations based on SCA effect and *per se* performance for twelve characters in bread wheat.

Characters	Superior specific combiners based on SCA effect	Best cross combinations on the basis of *per se* performance
Days to heading	DBW-14×K-307	K-424×K-7903
	K-7903×K-307	WR-544×K-9162
	PBW-343×K-9162	K-7903×WR-544
No. of tillers / plant	K-7903×K-9162	K-307×K-9162
	DBW-71×PBW-343	**DBW-71×PBW-343**
	K-424×DBW-14	K-424×K-307
Plant height(cm)	K-7903×K-307	K-424×PBW-343
	K-7903×WR-544	**K-7903×WR-544**
	WR-544×DBW-14	DBW-71×PBW-343
Days to maturity	DBW-71×K-307	K-424×K-7903
	PBW-343×K-307	K-424×DBW-14
	WR-544×PBW-343	K-7903×DBW-71
No. of spikelets/ spike	K-7903×DBW-71	DBW-14×K-9162
	K-7903×K-307	DBW-14×PBW-343
	WR-544×PBW-343	PBW-343×K-9162
Spike length (cm)	K-424×DBW-71	**K-7903×K-307**
	PBW-343×K-9162	WR-544×K-9162
	K-7903×K-307	DBW-14×K-9162
No .of grains/spike	DBW-14×K-9162	WR-544×PBW-343
	K-424×K-307	DBW-71×PBW-343
	K-7903×PBW-343	DBW-14×PBW-343
Weight of grain / spike(g)	**DBW-14×PBW-343**	**DBW-14×PBW-343**
	DBW-71×PBW-343	**DBW-71×PBW-343**
	K-424×K-307	K-424×DBW-14
Biological yield/plant (g)	**DBW-71×K-9162**	**DBW-14×K-307**
	DBW-14×K-307	**DBW-71×K-9162**
	K-424×PBW-343	WR-544×K-307
Grain yield /plant(g)	**DBW-71×PBW-343**	**DBW-71×PBW-343**
	DBW-14×K-307	K-7903×PBW-343
	K-424×DBW-71	WR-544×PBW-343
1000 grains weight(g)	**K-424×K-9162**	**DBW-71×K-9162**
	K-7903×K-307	**K-424×K-9162**
	DBW-71×K-9162	DBW-71×PBW-343
Harvest Index %	**WR-544×PBW-343**	**WR-544×PBW-343**
	DBW-14×DBW-71	DBW-71×PBW-343
	WR-544×DBW-71	K-7903×PBW343



Graph 1: Graphical representation of *per se*, SCA effect and comparison between GCA effects of the parents.

CONCLUSION

Form present investigation highly significant variances for both general and specific combining abilities were found for all the characters which indicated that both additive and non-additive gene effects are important. The values of GCA and SCA ratio estimates were observed less than unity for all the studied characters. The conclusion can be framed as information on GCA effects should be supplemented by SCA effects and performance of crosses to predict the transgressive segregants in segregating generations. Seed yield is polygenically controlled quantitative, complex character and due to predominance of non-additive gene action, it would be appreciable to resort to breeding methodologies, such as recurrent selection, biparental mating, and diallel selective mating than to use of backcross techniques or conventional pedigree method.

FUTURE SCOPE

Through the study of combining ability and gene action for grain yield in bread wheat good general combiners for different characters on the basis of both gca effect and *per se* performance which may be utilized in multiple crossing programme and the cross combinations which were good both in per se performance and sca effect can be used for improvement of respective characters by getting the transgressive segregants in the advance generations.

Acknowledgement. Present work was done by author for the thesis of post graduate at C. S. Azad University of Agriculture and Technology, Kanpur, U.P. The author is highly grateful for the research facilities provided by the university and sincerely acknowledge the support of Dr. R. K. Yadav, Professor and advisor for the support during complete research work

Conflict of interest. None.

REFERENCES

Ayoob, M. H. (2020). Combining ability analysis, estimation of heterosis and some genetic parameters using half diallel cross in bread wheat (*Triticum aestivum* L.). *Journal of Education and Science, 29* (1): 93-106.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. *Australian Journal of Biological Sciences, 9*: 463-493.

DAC & FW (2020). Directorate of Economics and Statics, Department of agriculture cooperation and farmers welfare.

Desale, C. S., Mehta, D. R. and Singh, A. P. (2014). Combining ability analysis in bread wheat. *Journal of Wheat Research*, 6(1): 25-28.

Parveen, S., Sibgha, N., Hussain, S. B., Naqqash, T. and Zubair, M. (2021). Combining ability analysis for its components in bread wheat (*Triticum aestivum* L.) using line × tester. *Int. J. of Multidisciplinary Res. and Development, 8*(9): 22-24.

Seboka, A. S. and Khan, A. S. (2009). Combining ability studies on yield related traits in wheat. *Pakistan Journal of Agricultural Sciences, 47*(4): 345-354.

Sharma, V., Dodiya, N. S., Dubey, R. B. and Khan, R. (2019). Combining ability analysis in bread wheat (*Triticum aestivum* L. Em. Thell) under different environmental conditions. *Bangladesh J. Bot., 48*(1): 85-93

Singh, M. K., Sharma, P. K., Tyagi, B. S. and Singh, G. (2014). Combining ability analysis for grain protein content in bread wheat (*Triticum aestivum). Indian Journal of Agricultural Science, 84* (3): 328-36.

Tayade, S. D., Potdukhe, N. R., Bharad, S., Phuke, R. M. and Tayade, N. R. (2020). Combining ability analysis for yield and yield components in bread wheat. *International Journal of Chemical Studies, 8*(6): 949-953.

Zahid, A., Saif, U. A., Khalid, S. K., Rahmatullah and Muhammad. (2011). Combining ability estimates of some yield and quality related traits in spring wheat (*Triticum aestivum* L.). *Pakistan Journal of Botany*, 43(1): 221-231.

How to cite this article: Harshit Tripathi, Bhupendra Kumar, R.K. Yadav, H.C. Singh and R.P. Vyas (2021). Combining Ability and Gene Action for Grain Yield in Bread Wheat (*Triticum aestivum* L.). *Biological Forum – An International Journal, 13*(3a): 830-834.