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Combining ability analysis for yield and yield components in bread wheat

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Abstract
Combining ability analysis was studied in a twelve parents of bread wheat (*Triticum aestivum* L.). Which were crossed in a diallel fashion (without reciprocals) and their 66F_1's were grown in a field experiment at Wheat Research Unit, Dr. P.D.K.V., Akola during in 2017-18 to study the combining ability for grain yield and its component traits. The gca and sca components of variances were significant for all studied characters. The (gca/sca) variances below unity in the generation showed the predominance of non-additive gene actions effects for all the traits. On the basis of general combining ability (gca) effect and per se performance, parents AKAW-5014 and AKAW-4924 emerged as good general combiners for grain yield per plant and average to high combiners for almost all the traits under study. Parent AKW-1071 was good general combiner for number of tiller/ plant and parents AKAW-5014 and AKAW-4924 also exhibited positive gca effects for days to 50% flowering, days to maturity, plant height, number of seed/earhead and grain yield. On the basis of sca effects, the crosses AKW-1071 xHPBW-01, AKAW-5017 x AKAW5014, AKAW-4924 x GW-322 and AKAW-5014 x WB-2 emerged as good specific cross combinations for grain yield per plot. Hybridization scheme for wheat improvement, such as multiple crossing or bi-parental mating could be useful in further manipulation of genes for economic purposes.

Keywords: Bread wheat, combining ability (GCA and SCA), diallel, additive, non-additive

Introduction

Wheat (*Triticum aestivum* L.) occupies a pivotal position among cereal crops. It is a leading grain crop of the temperate climate of the world, just like rice in the tropics. It is the dietary mainstay for millions of people. It is a chief source of caloric and other valuable nutritive materials notably protein requirements of our people. To increase the yield potential of the wheat varieties information on the genetic mechanisms, like combining ability is of major importance. Sprague and Tatum (1942) [16] defined combining ability term and divided it in to general and specific combining ability. Combining ability analysis developed by Griffing (1956) [8] has been extensively used to derive such information in F_1 generation. Its method I, and model II is the best in that it also gives the information for the effects of reciprocals.

The main objectives of this study are to detect the magnitude of both general and specific combining ability (GCA and SCA variance) for grain yield and some agronomic characters in 66 wheat direct crosses made among twelve bread wheat genotypes using one-way diallel crosses.

Materials and Methods

The present study was carried out during the two successive seasons 2016-17 and 2017-18 at the Wheat Research Unit, Dr. P.D.K.V., Akola (M.S). The aim of this research was to study the direct crosses for general (GCA) and specific (SCA) combining ability variance and effect through diallel mating of different wheat varieties. In 2016-17 seasons, the twelve parental genotypes were planted and all possible crosses without reciprocals between each two of the twelve parents were done to produce 66 F_1 hybrids. In 2017-18 season, seeds of the sixty-six F_1 (direct) crosses and twelve parents were sown in randomized block design (RBD) with three replications. Each plot consisted of one rows of parents and their F_1. Each row was 2 m long and 20 cm apart, and the seeds within row were spaced 10 cm apart. All recommended cultural practices were considered. Data were recorded on 5 individual guarded plants chosen at random from each row.

The studied characters were number of days to 50% flowering, number of days to maturity, plant height (cm), number of effective tiller plant^{-1}, number of grains earhead^{-1}, grain weight earhead^{-1} (g), 1000-grain weight (g) and grain yield plot^{-1} (kg). Data analysis was done according to Singh and Chaudhari (1977) [17], General and specific combining ability estimates were obtained by employing Griffing diallel cross analysis, model II (Random model) method I (Griffing, 1956) [8].

Results and Discussion
Analysis of variance
The analysis of variance for number of days to 50% flowering, number of days to maturity, plant height (cm), number of effective tiller plant^{-1}, number of grains earhead^{-1}, grain weight earhead^{-1}(g), 1000-grain weight (g) and grain yield plot^{-1} (kg) are presented in table 1. The results reflected that the mean sum of squares due to GCA, SCA due to direct crosses were highly significant for all the traits.

The significant variances due to both general and specific combining abilities reflect the importance of both additive and non-additive types of gene actions. However, general combining ability effects are which were of low magnitude suggested the predominant role of non-additive gene action. Therefore, selection in the early generation could be successfully practiced to improve these characters.

These results are agreement with Muhammad Akbar *et al.* (2009) [12], Cifci and Yagdi (2010) [5], Gami *et al.* (2010) [7], Burungale *et al.* (2011) [4], Jain and Sastry (2012) [10].

Genotypic performance
The mean performance of the twelve wheat parental genotypes revealed that AKAW-5014 genotype was the shortest cultivar. It was early in maturity and harvest more number of grain earhead^{-1}, grain weight earhead^{-1} and 1000 grain weight. Whereas, genotype AKAW-4925 and HPBW-01 are the tallest genotype among the parents. AKAW-4924 ranked first as highest productive cultivar. Genotypes AKAW-5014 and AKAW-4627 were intermediate for all studied characters.

The mean performance of sixty-six direct crosses indicated that for plant height, the tallest three crosses are AKAW-4924 x HPBW-01, AKAW-5014 x AKAW-4627, and AKAW-4627 x GW-322 and AKAW-4925 x K-0307and AKAW-4924 x AKAW-4627 are the earliest in maturity. While two crosses *viz*., AKAW-5017 x AKAW-4925 and AKAW-4210-6 x AKW-1071 possessed the highest number of effective tillers plant^{-1}, while four crosses *viz*., AKAW-4924 x MACS-6222, MACS-6222 x WB-2, MACS-6222 x GW-322 and AKAW-5014 x AKAW-4627 exhibited highest number of grain earhead^{-1}.

For 1000 grain weight, the best three crosses are *viz*., AKAW-4627 x AKW-1071, AKAW-4627 x AKAW-4210-6 and K-0307 x HPBW-01 and highest grain yield plant^{-1} (g) are AKAW-5014 x GW-322, MACS-6222 x HPBW-01, MACS-6222 x WB-2 and AKAW-5017 x AKAW-5014. Similar results are reported by Barot *et al.* (2014) [2], Baloch *et al.* (2013) 2016 [3], Kalhoro *et al.* (2015) [11], Ismail (2015) [9].

General combining ability (GCA)
Estimates of general combining ability effects for each parent are presented in table 2. High positive values would be of great interest in all studied characters except plant height, days to 50% flowering and days to maturity which if had negative values become more useful from the breeder's point of view. Results indicated that the cultivar AKAW-5014 proved to be a good combiner for grain yield/plant followed by AKW-1071, AKAW-4924 and AKAW-4925, but the other parents exhibited negative SCA for this character. AKAW-4925 exhibited positive GCA for flowering, maturity, number of effective tillers plant^{-1}, grain weight plant^{-1}, 1000 grain weight and grain yield plot^{-1}. The crosses involving such good general combiners should produce promising sergeants with higher mean performance of those character. Consequently, the results of the average performance of the respective characters are in agreement with those reported by Ankita Singh *et al.* (2012) [1], Raj Preeti and Kandalkar (2013) [14], Dholariya *et al.* (2014) [6], Patel (2015) [13], Raiyani *et al.* (2015) [15], Uzair *et al.* (2016) [18].

Specific combining ability effects
Specific combining ability effects for each cross are presented in table 3. Specific combining ability effects can be defined as the magnitude of deviation exhibited by the parental line in the cross from its expected performance on the basis of its general combining ability (GCA) effects. A significant deviation from zero in cross would indicate especially high or low specific combining ability (SCA) according to the sign whether positive or negative. The crosses AKAW-5014 x AKAW-4210-6, AKAW-4925 x WB-2 and AKAW-4925 x GW-322 exhibited significant specific combining ability effects for early maturity. AKAW-5017 x AKAW-4627, AKAW-5017 x K-0307, AKAW-5014 x AKAW-4627, AKAW-4924 x MACS-6222 and AKW-1027 x MACS-6222 crosses exhibited significant positive specific combining ability effects for number of effective tillers plant^{-1}, number of grains earhead^{-1}, grain weight earhead^{-1}, and grain yield plot^{-1}. The crosses *viz*., AKAW-5017 x AKAW-5014, AKAW-5014 x WB-2, AKAW-4924 x GW-322, AKAW-4925 x K-0307, AKW-1071 x HPBW-01 and AKW-1071 x GW-322 are found promising for grain yield improvement as they exhibited high specific combining ability effects. These crosses could account for the highest average performance of the respective characters. In such hybrids, desirable transgressive segregates would be expected in the subsequent generations. Similar results were obtained by Raj Preeti and Kandalkar (2013) [14], Dholariya *et al.* (2014) [6], Patel (2015) [13], Raiyani *et al.* (2015) [15], Uzair *et al.* (2016) [18].

Table 1: Analysis of variance for combining ability in a 12 parent- diallel cross (parents and their F_1s) among the studied characters in bread wheat.

Sources of variation	df	Days to 50% flowering	Number of days to maturity	Plant height (cm)	No. of effective tillers/plant	Number of grains / earhead	Grain weight / earhead (g)	1000 Grain weight (g)	Grain yield (Kg/plot)
GCA	11	12.961**	10.629**	32.196**	0.889**	89.608**	0.122**	40.551**	54.288**
SCA crosses	66	7.104**	9.105**	26.807**	1.034**	47.576**	0.073**	17.082**	23.614**
Error	286	0.678	0.497	3.907	0.079	1.394	0.005	1.602	1.120
GCA Vs. SCA		0.080	0.049	0.051	0.035	0.080	0.072	0.105	0.098

Significance Levels* = <.05,**= <.01

Table 2: Estimates of general combining ability effects for the studied characters.

S.N.	Parents	Days to 50% flowering	Number of days to maturity	Plant height (cm)	No. of effective tillers/ plant	Number of grains / earhead	Grain weight / earhead (g)	1000 Grain weight (g)	Grain yield (Kg/plot)
1	AKAW-5017	-0.391	-0.146	0.500	0.068	-2.991**	-0.124**	-0.869**	-0.003
2	AKAW-5014	-0.502*	-0.979**	1.937**	0.149*	0.797**	0.049**	1.175**	0.015**
3	AKAW-4924	-0.905**	-0.757**	1.123*	-0.132	-2.494**	-0.108**	1.427**	0.006**
4	AKAW-4925	1.164**	0.118	-0.326	0.117	2.573**	0.101**	0.725*	0.005**
5	AKAW-4627	0.567**	0.826**	-1.217*	-0.059	-0.310	-0.047*	0.298	0.000
6	AKAW-4210-6	-1.391**	-0.576**	-1.877**	-0.343**	-2.075**	-0.039*	0.977**	-0.010**
7	AKW-1071	-0.447*	-0.632**	1.242*	0.316**	1.387**	0.049**	0.782*	0.010**
8	K-307	0.456*	-0.118	0.075	-0.025	0.697*	0.037	1.136**	0.001
9	MACS-6222	0.581*	1.049**	0.118	0.156*	-1.748**	-0.046*	-1.139**	-0.003*
10	HPBW-01	0.123	0.840**	0.139	0.000	0.906**	0.016	-2.354**	-0.010**
11	WB-2	0.553**	0.201	-0.042	0.068	2.781**	0.069**	-2.022**	0.000
12	GW-322	0.192	0.174	-1.672**	-0.315**	0.476	0.043*	-0.137	-0.012**
	SE (gi)±	0.161	0.138	0.386	0.055	0.231	0.014	0.247	0.001
	C.D.5%	0.523	0.448	1.256	0.179	0.750	0.047	0.804	0.003
	C.D.1%	0.738	0.632	1.772	0.252	1.059	0.066	1.135	0.005

Significance Levels* = <.05,**= <.01

Table 3: Estimates of specific combining ability effects for 66 direct crosses (F_1).

S. N.	Genotypes	Days to 50% flowering	Number of days to maturity	Plant height (cm)	No. of effective tillers/plant	Number of grains / earhead	Grain weight / earhead (g)	1000 Grain weight (g)	Grain yield (Kg/plot)
1	AKAW-5017 x AKAW-5014	-3.067**	2.521**	2.494	0.600*	3.523**	0.370**	5.573**	0.054**
2	AKAW-5017 x AKAW-4924	1.836*	0.299	-1.565	0.197	5.380**	0.065	-2.843**	0.001
3	AKAW-5017 x AKAW-4925	-4.567**	-1.576*	3.271	0.232	-6.187**	-0.234**	0.877	0.001
4	AKAW-5017 x AKAW-4627	0.363	-0.285	1.279	1.408**	-5.170**	-0.279**	-1.170	-0.006
5	AKAW-5017 x AKAW-4210-6	-0.512	-3.215**	-2.323	0.308	-9.122**	-0.110	-0.074	-0.010*
6	AKAW-5017 x AKW-1071	-1.456*	-3.493**	7.983**	-1.200**	3.299**	0.092	0.036	-0.026**
7	AKAW-5017 x K-0307	1.308	1.326*	-4.774**	1.173**	2.556*	0.034	-2.441*	0.014**
8	AKAW-5017 x MACS-6222	1.183	1.326*	0.002	-0.441	1.767	0.017	-0.692	-0.022**
9	AKAW-5017 x HPBW-01	-0.859	0.035	-2.153	-0.085	1.246	0.045	-0.108	-0.002
10	AKAW-5017 x WB-2	2.544**	2.507**	1.367	-0.570*	-4.329**	-0.150*	-0.303	-0.023**
11	AKAW-5017 x GW-322	1.572*	-0.465	-0.060	-0.286	6.094**	0.275**	0.132	0.025**
12	AKAW-5014 x AKAW-4924	-0.387	-1.368*	-3.971*	0.383	2.592*	-0.004	-7.295**	-0.028**
13	AKAW-5014 x AKAW-4925	-2.123**	-0.743	-0.876	-0.366	6.559**	0.042	-3.851**	-0.024**
14	AKAW-5014 x AKAW-4627	0.308	2.715**	-0.221	1.511**	-6.725**	-0.339**	-1.901	0.003
15	AKAW-5014 x AKAW-4210-6	-1.900**	-7.049**	3.528*	0.228	3.607**	0.119	-1.940	0.021**
16	AKAW-5014 x AKW-1071	0.155	-0.493	-0.212	-1.014**	-7.388**	-0.091	2.957**	-0.010*
17	AKAW-5014 x K-0307	2.586**	-0.340	-2.579	-0.941**	-3.848**	-0.355**	-3.475**	-0.023**
18	AKAW-5014 x MACS-6222	0.127	-2.340**	3.685*	-0.504*	0.180	-0.006	0.711	-0.013**
19	AKAW-5014 x HPBW-01	2.086**	2.035**	-1.236	-0.332	1.659	0.051	0.691	-0.013**
20	AKAW-5014 x WB-2	1.155	0.840	2.775	0.766**	-1.950	0.108	-0.646	0.036**
21	AKAW-5014 x GW-322	2.516**	2.201**	0.725	-0.034	0.389	-0.111	0.043	-0.028**
22	AKAW-4924 x AKAW-4925	1.113	2.201**	-4.535**	0.048	2.716**	-0.038	-4.023**	-0.021**
23	AKAW-4924 x AKAW-4627	-1.289	-0.340	-1.541	0.025	1.699	0.051	-1.163	-0.022**
24	AKAW-4924 x AKAW-4210-6	1.502*	3.396**	-0.218	0.275	7.764**	0.101	-0.415	0.001
25	AKAW-4924 x AKW-1071	-1.942**	-2.215**	6.187**	-0.734**	0.369	0.074	1.808	-0.042**
26	AKAW-4924 x K-0307	1.322	-2.563**	3.180	-0.977**	-3.641**	-0.143*	-0.376	-0.067**
27	AKAW-4924 x MACS-6222	-1.137	1.271*	-0.812	1.359**	-3.330**	-0.111	1.054	0.028**
28	AKAW-4924 x HPBW-01	-1.178	-1.188	-0.887	-0.502*	-1.151	0.089	4.247**	0.011*
29	AKAW-4924 x WB-2	-0.775	-0.215	5.167**	0.197	4.307**	0.195**	2.252	0.024**
30	AKAW-4924 x GW-322	-2.081**	-2.521**	3.797*	0.264	1.313	0.206**	4.465**	0.051**
31	AKAW-4925 x AKAW-4627	-0.192	0.451	-1.723	-0.674**	-3.768**	-0.002	4.426**	-0.010*
32	AKAW-4925 x AKAW-4210-6	3.433**	3.187**	2.226	-0.074	2.198*	0.132*	1.365	0.005
33	AKAW-4925 x AKW-1071	1.822*	1.243*	-2.342	0.218	-1.898	0.020	2.214*	-0.006
34	AKAW-4925 x K-0307	0.586	1.063	4.233*	0.891**	5.359**	0.294**	1.027	0.042**
35	AKAW-4925 x MACS-6222	1.127	-0.271	-4.101*	0.544*	3.637**	0.207***	2.183	0.033**
36	AKAW-4925 x HPBW-01	-0.581	-0.563	-0.893	0.416	1.049	0.070	-3.310**	0.030**
37	AKAW-4925 x WB-2	-0.512	-4.090**	2.025	-0.485	-1.826	-0.161*	-0.204	-0.022**
38	AKAW-4925 x GW-322	1.016	-3.729**	-0.811	-0.885**	0.446	-0.084	-3.120**	-0.030**
39	AKAW-4627 x AKAW-4210-6	2.530**	0.813	6.892**	-0.664**	-1.952	-0.045	-2.875**	-0.040**
40	AKAW-4627 x AKW-1071	0.419	2.701**	-0.704	1.144**	-6.048**	-0.416**	-1.686	0.013**
41	AKAW-4627 x K-0307	1.183	-2.979**	4.424*	-1.216**	5.175**	0.179**	-0.408	0.004
42	AKAW-4627 x MACS-6222	0.225	-3.479**	3.932*	-1.029**	1.887	0.066	-0.217	0.000
43	AKAW-4627 x HPBW-01	1.516*	-0.104	-2.913	0.193	3.032**	0.139*	-0.953	0.018**
44	AKAW-4627 x WB-2	-0.581	1.368*	-7.672**	-0.309	4.791**	0.109	1.323	-0.001

45	AKAW-4627 x GW-322	-3.887**	-0.938	-6.199**	-0.675**	-3.270**	0.003	0.498	-0.020**
46	AKAW-4210-6 x AKW-1071	0.711	1.104	-6.194**	-0.039	4.717**	0.150*	-1.344	0.023**
47	AKAW-4210-6 x K-0307	-1.025	1.924**	-0.801	0.301	7.007**	0.249**	0.187	0.027**
48	AKAW-4210-6 x MACS-6222	-0.484	-0.576	-1.392	0.504*	0.852	0.104	-1.426	0.025**
49	AKAW-4210-6 x HPBW-01	-1.859**	1.299*	-4.298*	-0.374	-7.269**	-0.416**	-0.890	-0.049**
50	AKAW-4210-6 x WB-2	-2.289**	-3.396**	-2.132	0.591*	1.189	0.062	-1.422	0.006
51	AKAW-4210-6 x GW-322	-1.762*	-0.035	-0.121	0.158	1.795	0.038	-1.780	-0.011*
52	AKW-1071 x K-0307	-1.637*	0.479	-7.192**	-0.707**	-3.855**	-0.009	-0.698	-0.041**
53	AKW-1071 x MACS-6222	-0.928	1.146	-1.247	1.229**	-1.094	-0.268**	-1.651	0.027**
54	AKW-1071 x HPBW-01	-3.303**	-2.979**	8.653**	1.001**	10.702**	0.271**	1.439	0.056**
55	AKW-1071 x WB-2	2.266**	-0.840	-0.218	-0.167	4.027**	0.106	-0.861	0.010*
56	AKW-1071 x GW-322	-1.206	-0.313	0.487	0.900**	5.549**	0.289**	3.581**	0.045**
57	K-0307 x MACS-6222	-2.164**	-0.201	1.737	0.236	2.946**	0.103	5.160**	0.028**
58	K-0307 x HPBW-01	-2.539**	-1.493*	3.806*	0.558*	-0.008	-0.030	1.739	0.024**
59	K-0307 x WB-2	0.530	-0.354	0.524	0.523*	1.250	0.032	3.037**	0.024**
60	K-0307 x GW-322	0.558	1.840**	-2.418	-0.493*	-5.744**	-0.167**	2.506*	-0.010*
61	MACS-6222 x HPBW-01	1.502*	-0.493	-1.172	0.128	-2.630*	0.013	3.168**	-0.010*
62	MACS-6222 x WB-2	-0.262	0.646	3.128	-0.591*	0.028	0.086	-1.232	-0.018**
63	MACS-6222 x GW-322	0.766	0.674	1.260	-0.324	-1.333	-0.178**	-2.142	-0.036**
64	HPBW-01 x WB-2	-0.803	0.854	-3.092	-0.568*	-1.559	-0.067	-0.748	-0.035**
65	HPBW-01 x GW-322	0.725	0.215	0.220	-0.135	-1.320	-0.080	-0.263	-0.018**
66	WB-2 x GW-322	-1.706*	0.687	2.298	1.280**	-7.962**	-0.316**	1.588	0.021**
	SE (Sij)	0.536	0.459	1.287	0.183	0.768	0.048	0.824	0.004
	SE (Sij-Skl)	0.752	0.643	1.804	0.257	1.078	0.067	1.155	0.005

Significance Levels* = <.05,**= <.01

Conclusion

In conclusion, genotype AKAW-5014 was the good combiner for early flowering, maturity, plant height and 1000 grain weight and genotype AKAW-4924 was good combiner for number of grain earhead^{-1} and high grain yield plot^{-1}. Besides genotype AKW-1071 was found good combiner for number of effective tillers per plant. Five crosses *viz*., AKAW-5017 x AKAW-5014, AKAW-4924 x GW-322, AKAW-4925 x K-0307, AKW-1071 x HPBW-01 and AKAW-5014 x WB-2 are found promising for grain yield improvement as they showed high specific combining ability effects. Present results may be useful to wheat breeder in making the selection of parents for future crossing programme.

References

1. Ankita Singh, Anil Kumar, E Ahmad, Swati, JP Jaiswal. Combining Ability and Gene Action Studies for Seed Yield, Its Components and Quality Traits in Bread Wheat (*Triticum aestivum* L. EmThell.). Electronic Journal of Plant Breeding 2012;3(4):964-972.
2. Barot HG, Patel MS, Sheikh WA, Patel LP, Allam CR. Heterosis and combiningabilityanalysis for yield and its componenttraits in wheat (*Triticum aestivum*L.). Electr. J. Plant Breed 2014;5(3):350-359.
3. Baloch Muhammad JTA, Rajper WA Jatoi, NF Vaseer. Identification of Superior Parents and Hybrids from Diallel Crosses of Bread Wheat (*Triticum aestivum* L.). Pak. J. Ind. Res. Ser. B: Boil. Sci 2013;56(2):59-64.
4. Burungale SV, RM Chauhan, RA Gami, DM Thakor, PT Patel. Combining Ability Analysis for Yield, its Components and Quality Traits in Bread Wheat (*Triticum aestivum* L.). Crop Res 2011;42(1-2-3):241-245.
5. Cifi EA, Yagdi K. The research ofcombining ability of agronomic traitsof breed wheat in F1 and F2generation. J. Agric. Fac. UlvdogUnvi 2010;24(2):85 92.
6. Dholariya ND, VR Akabari, JV Patel, VP Chovatia. Combining Ability and Gene Action Study for Grain Yield and Its Attributing Traits in Bread Wheat. Electronic Journal of Plant Breeding 2014;5(3):402-407.
7. Gami RA, CJ Tank, RM Chauhan, HN Patel, SV Burungale. Genetic analysis for grain yield and quality parameter in durum wheat (*Triticum durum* Desf.) under late sown condition. Trends in Biosciences, 3(2):140-142.
8. Griffing B. 1956. Concept of General and Specific Combining Ability in Relation to Diallel Crossing Systems. Australian Journal of Biological Sciences 2010(a);9:463-493.
9. Ismail SKA. Heterosis and Combining Ability Analysis for Yield and Its Components in Bread Wheat (*Triticum aestivum* L.). International Journal of Current Microbiology and Applied Sciences 2015;4(8):1-9.
10. Jain SK, EVD Sastry. Heterosis and Combining Ability for Grain Yield and Its Contributing Traits in Bread Wheat (*Triticum aestivum* L.). Journal of Agriculture and Allied Sciences 2012;1(1):17-22.
11. Kalhoro FA, AA Rajpur, SA Kalhoro, A Mahar, A Ali, SA Otho, *et al*. Heterosis and Combining Ability in F_1 Population of Hexaploid Wheat (*Triticum aestivum* L.). American Journal of Plant Sciences 2015;6:1011-1026.
12. Muhammad Akbar J, Anwar M Hussain, MH Qureshi, S Khan. Line×Tester Analysis in Bread Wheat (*Triticum aestivum* L.). J. Agric. Res 2009;47(1).
13. Patel HN. Genetic Analysis for Grain Yield and Quality Parameters in Aestivum Wheat (*Triticum aestivum* L.) Under Late Sown Condition. International Journal of Retailing and Rural Business Perspectives 2015;4(2):1543-1545.
14. Raj Preeti, VS Kandalkar. Combining Ability and Heterosis Analysis for Grain Yield and Its Components in Wheat. J. Wheat Res 2013;5(1):45-49.
15. Raiyani AM, DA Patel, VN Kapadia, MC Boghara, HC Sisara. Combining Ability and Gene Action for Different Characters in bread Wheat (*Triticum aestivum* L.). The Bioscan 2015;10(4):2159-2169.
16. Sprague GF, LA Tatum. General Vs. Specific Combining Ability in Single Crosses of Conr. J Amer. Soc. Agron 1942;34:923-932.

17. Singh RK, BD Chaudhary. Biometrical methods in quantitative genetic analysis, Kalyani Publishers, New Delhi 1977, pp. 57-58.
18. Uzair M, Z Ali, T Mahmood, I Karim, U Akram, N Mahmood, *et al.* Genetic Basis of Some Yield Related Traits in Wheat (*Triticum aestivum* L.) under Drought Conditions. Imperial Journal of Interdisciplinary Research 2016;2(11):444-449.