Identification of Superior Parents and Cross Combination in Wheat (*Triticum aestivum* L.) For Seed Yield and Its Attributing Traits

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Abstract- Current study was aimed to study the general combining ability (GCA) and specific combing ability (SCA) of 32 wheat hybrids and estimation of average heterosis, heterobeltiosis and standard heterosis. 8 Testers viz., AKAW 4630, AKAW 4739, AKAW 4731, AKAW 4498, AKAW 4800, AKAW 4730, AKAW 5077, AKAW 4924 along with the standard check HI 1418 were crossed with 4 lines viz., AKAW 3717, AKAW 2865, AKAW 2956, HI 1418 and 32 hybrids were developed which were evaluated in randomized block design during rabi 2018-2019. Among various tested lines only AKAW 3717 recorded positive and significant gca effects while among testers AKAW 4630, AKAW 4731, AKAW 4730 have positive and significant gca effects for seed yield and other yield contributing traits. The line HI 1418 and tester AKAW 4731 was the best combiner for days to maturity and other yield contributing traits. The line AKAW 2865 and the tester AKAW 4630 was the best combiner for grain weight per spike other yield contributing traits. Similarly, positive significant sca effect was exhibited by AKAW 3717 x AKAW 4731 (15.47) followed by AKAW 3717 x AKAW 4730 (14.09) for seed yield. Improvement methods which exploit both additive and non-additive gene effects could be useful for the characters included in the present study.

Indexed Terms- Bread wheat, GCA, Heterosis, Line x Tester, SCA.

I. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop for the majority of world's populations. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995). Wheat is an annual plant of family gramineae (Sub family poaceae) belongs to the genus Triticum grown in tropical, subtropical as well as temperate zones. Wheat is naturally self-pollinated crop and is a native of Southwestern Asia. In India, it is the second most important food crop after rice in terms of both area and production, India contributes 12 per cent to the world wheat production. Carbohydrate and protein are two main constituents of wheat. On an average wheat contains 11-12% protein, the kernel contains 12 percent water, 70 percent carbohydrates, 2 percent fat, 1.8 percent minerals, and 2.2 percent crude fibers.

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) defined combining ability term and divided it in to general and specific combining ability. In general combining ability, genes with additive effects are more important, while specific combining ability is more dependent on genes with dominance and epistatic effects. 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 32 wheat direct crosses made among twelve bread wheat genotypes using line x tester mating design.

II. MATERIALS AND METHODS

The study was carried out during the rabi season of 2018-2019 at the experimental field of Dr. PDKV Wheat Research Unit in Akola. The experimental material consists of four lines: AKAW-3717, AKAW-2865, AKAW-2956, and HI-1418, and eight testers. AKAW-4630, AKAW-4739, AKAW-4731, AKAW-4498, AKAW-4800, AKAW-4730, AKAW-507, AKAW-4924. According to Kempthorne's line tester mating design, four lines and eight testers were crossed to create 32 F1 hybrids. In a randomized block design with three replications, F1 plants were sown in the field along with their parents. Each entry was planted in a single row of 1m length keeping a distance of 20 cm between rows and 5 cm between plants within the row. To ensure a healthy crop, all of the recommended practises were followed. The observation was recorded on five randomly selected plants in each replication of each treatment. Data were collected on five randomly selected plants for days to heading, days to maturity, plant height, effective tillers per plant, spike length, grains per spike, 1000 grain weight, grain weight per spike, and grain yield per plant. The recorded data was subjected to analysis of variance to determine significant differences between genotypes.

III. RESULTS AND DISCUSSION

- Analysis of variance

The analysis of variance for combining ability for the characters studied in a Line x Tester analysis of 32 crosses obtained by crossing four lines with eight testers was carried out and the total variance due to crosses was partitioned into portions attributable to females (lines), males (testers), interactions; female x male (line x tester) and error sources. The analysis of variance for combining ability is presented in (Table 1). The variance due to crosses was significant for all the characters except days to heading. The mean squares due to lines (females) were found to be significant for days to maturity, effective tillers per plant, spike length, grains per spike, 1000 grain weight and grain yield per plant. The mean squares due to testers (males) were highly significant for days to heading, grains per spike and grain yield per plant. The variance due to lines x testers was highly significant for all the characters except days to heading and days to maturity. Significant variance indicated the presence of substantial amount of genetic variability among the parents and crosses for respective characters.

- General combining ability (GCA)

Estimates of general combining ability effects for each parent are presented in (Table 2). In wheat positive gca effects are desirable for all the characters studied except days to heading, days to maturity and plant height for which negative gca effects are desirable. Results indicated that the parents HI 1418 and AKAW 4731 were good general combiners for early maturity. AKAW 4739 was identified as good combiner for plant height. AKAW 2865 was identified as good combiner for effective tillers per plant. Besides AKAW 2956 was good general combiner for spike length and grains per spike. While AKAW 4731 was good combiner for 1000 grain weight. Similar results were earlier reported by Kumar *et al.*, (2011) and Singh *et al*,. (2010). AKAW 2865 and AKAW 4630 were identified as good combiners for grain weight per spike. Parents AKAW 3717, AKAW 4630, AKAW 4731 and AKAW 4730 were identified as good combiners for grain yield per plant.

- 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. The crosses AKAW 2956 x AKAW 4739 and AKAW 3717 x AKAW 4731 exhibited negative and significant specific combining ability effects for plant height. The crosses AKAW 2865 X AKAW 4630, AKAW 3717 x AKAW 4498 and AKAW 2956 X AKAW 4800 exhibited significant positive specific combining ability effects for effective tillers per plant. The cross AKAW 2956 X AKAW 5077 followed by HI 1418 x AKAW 4800 and HI 1418 x AKAW 4498 showed positive significant sca effects for Spike length. AKAW 3717 x AKAW 4731 recorded positive significant sca effects for grain weight per spike. The crosses viz., AKAW 3717 X AKAW 4730, AKAW 3717 x AKAW 4731 and AKAW 2956 X AKAW 4731 are found promising for grain yield improvement as they exhibited high specific combining ability effects. Similar finding were also reported by earlier workers Mavi *et al.,* (2003), Siddique *et al.,* (2004), Dhayal and Sastry (2003), Desai *et al.,* (2005), Chowdhary *et al.,* (2007), Sami *et al.,* (2010) and Zahid *et al.,* (2011). 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.

Table 1: Analysis of variance for combining ability

Sources of variation	df	Days to heading	Days to maturity	Plant height (cm)	Effective tillers per plant	Spike length(cm)	Grains per spike	1000 grain weight	Grain weight per spike	Grain yield per plant
		1	2	3	4	5	6	7	8	9
Replications	2	2.44	47.00	65.53	1.21	0.023	7.01	23.52	0.051	8.11
Crosses	31	34.49**	197.93**	169.09**	8.98**	2.127**	134.18**	51.94**	0.694**	356.09**
Females (lines)	3	27.86	461.92*	133.18	10.60*	7.103*	242.46*	25.59*	0.626	1330.68*
Males (testers)	7	80.80**	236.32	107.94	4.43	0.584	107.93*	67.80	0.309	255.28*
Females Vs Males	21	20.00	147.42	194.60**	10.26**	1.931**	127.46**	50.42**	0.832**	250.46**
Error	62	22.56	110.18	66.76	2.14	0.286	33.69	33.75	0.107	11.06

Note: * Significant at 5% level of significance.
** Significant at 1% level of significance

Table 2: Estimation of general combining ability effects of parents for yield and other yield contributing traits

Parents	Days to heading	Days to maturity	Plant height (cm)	Effective tillers per plant	Spike length(cm)	Grains per spike	1000 grain weight (g)	Grain weight per spike (g)	Grain yield per plant (g)
	1	2	3	4	5	6	7	8	9
Line (Female)									
AKAW 3717	1.01	3.76	0.41	-0.61*	-0.50**	-3.98**	0.75	-0.07	10.35**
AKAW 2865	0.84	2.35	3.17	0.94**	-0.05	0.62	0.66	0.24**	0.42
AKAW 2956	-0.91	0.04	-1.79	-0.20	0.76**	3.72**	-1.47	-0.09	-4.77**
HI 1418	-0.94	-6.16**	-1.79	-0.12	-0.20	-0.372	0.05	-0.08	-6.00**
SE (gi)	1.03	1.95	1.78	0.27	0.15	1.16	1.14	0.07	0.63
CD at 5 %	2.07	3.91	3.55	0.55	0.31	2.33	2.29	0.14	1.27
CD at 1%	2.75	5.20	4.73	0.73	0.42	3.09	3.04	0.18	1.69
Testers (Male)									
AKAW 4630	-2.47	-1.46	0.65	0.39	-0.08	0.02	-1.78	0.25*	5.91**
AKAW 4739	5.64**	3.20	-5.04*	0.59	0.17	2.88	-1.24	-0.12	0.72
AKAW 4731	0.22	-8.09**	-2.03	-0.63	-0.13	2.91	3.46*	0.15	4.89**

AKAW 4498	-0.76	-2.48	2.63	-0.01	0.07	-5.47**	3.16	-0.05	-6.78**
AKAW 4800	-1.96	2.77	0.13	-0.02	0.18	-0.28	1.11	0.04	-5.94**
AKAW 4730	0.95	5.53	5.00	0.62	-0.10	1.85	-1.88	0.02	2.14*
AKAW 5077	0.30	7.36	-0.80	-1.11**	0.27	-3.28	-2.83	-0.26*	-1.70
AKAW 4924	-1.92	-1.46	-0.54	0.18	-0.39	1.37	-0.006	-0.04	0.76
SE (gi)	1.46	3.20	2.51	0.39	0.22	1.64	1.62	0.10	0.9
CD at 5 %	2.93	-8.09 **	5.03	0.78	0.44	3.29	3.24	0.20	1.79
CD at 1%	3.89	-2.48	6.69	1.04	0.59	4.38	4.30	0.26	2.39

Note: * Significant at 5% level of significance.
** Significant at 1% level of significance

Table 3: Estimation of specific combining ability effects of crosses for yield and other yield contributing traits.

Sr. No.	Crosses	Days to heading	Days to maturity	Plant height (cm)	Effective tillers per plant	Spike length (cm)	Grains per spike	1000 grain weight (g)	Grain wight per spike (g)	Grain yield per plant (g)
		1	2	3	4	5	6	7	8	9
1	AKAW 3717 × AKAW 4630	-1.78	-6.86	0.29	0.006	0.45	54.86	-4.96	-1.03**	-4.04*
2	AKAW 3717 × AKAW 4739	-2.39	-2.65	10.72 *	0.19	0.36	52.66	4.66	0.40	-5.46 **
3	AKAW 3717 × AKAW 4731	-2.64	-2.53	-15.25 **	-1.50	0.70	63	7.99 *	0.73**	14.0**
4	AKAW 3717 × AKAW 4498	-0.59	1.14	-3.45	2.00*	-0.29	39.6	-4.84	-0.19	-7.09**
5	AKAW 3717 × AKAW 4800	5.40	-0.56	0.77	-3.21 **	-0.11	44.26	2.26	-0.03	-12.2 **
6	AKAW 3717 ×	2.75	-1.90	2.20	2.17 **	-0.38	53.7	-0.13	0.61**	15.47 **

	AKAW 4730									
7	AKAW 3717 × AKAW 5077	-1.33	9.39	2.81	-1.58 *	- 1.03 *	47.73	-4.01	-0.34	-4.18 *
8	AKAW 3717 × AKAW 4924	0.56	3.98	1.89	1.91 *	0.30	55.13	-0.97	-0.13	3.48
9	AKAW 2865 × AKAW 4630	-0.11	-1.31	-0.69	2.28 **	0.86	56.76	0.62	0.58**	6.34**
10	AKAW 2956 × AKAW 4630	1.23	-7.56	8.13	-0.96	0.009	45.3	-3.34	- 0.90**	4.13 *
11	AKAW 2865 × AKAW 4731	0.71	-3.78	-1.81	-0.49	-0.74	61.66	-3.78	-0.25	- 10.81**
12	AKAW 2865 × AKAW 4498	2.36	2.56	4.48	-0.75	-0.01	55.73	1.54	0.32	-5.27 **
13	AKAW 2865 × AKAW 4800	-3.76	1.04	-3.51	0.26	-0.43	61.76	-0.24	0.46 *	1.07
14	AKAW 2865 × AKAW 4730	0.51	-0.61	-5.21	-0.51	0.02	53.06	2.26	- 0.46 *	1.92
15	AKAW 2865 × AKAW 5077	1.83	10.81	-2.27	1.29	-0.25	54.4	1.74	0.11	9.12**
16	AKAW 2865 × AKAW 4924	-2.79	-1.13	0.87	-1.11	0.55	59.16	1.18	0.13	-6.50**
17	AKAW 2956 × AKAW 4630	1.65	0.99	3.46	-0.51	-0.51	52.16	3.63	0.15	-2.40
18	AKAW 2956 ×	1.73	1.07	- 15.30**	1.41	0.95*	72.33	-0.26	0.17	-0.42

	AKAW 4739									
19	AKAW 2956 × AKAW 4731	2.95	4.45	14.45**	0.45	-0.29	55.43	-2.80	-0.14	10.22**
20	AKAW 2956 × AKAW 4498	-0.06	-4.12	2.15	-2.40**	-0.73	50.63	-0.91	-0.13	8.75**
21	AKAW 2956 × AKAW 4800	-1.33	-0.84	2.75	2.11 **	-0.51	60.43	-5.93	-0.78**	3.94*
22	AKAW 2956 × AKAW 4730	-4.91	1.82	-0.91	0.89	0.27	70.7	2.20	0.35	-10.35**
23	AKAW 2956 × AKAW 5077	-1.13	1.12	-1.97	0.76	1.42**	54.23	5.38	0.40 *	-7.22**
24	AKAW 2956 × AKAW 4924	1.10	-4.49	2.76	-0.39	-0.59	56.73	-1.30	-0.02	-2.50
25	HI 1418 × AKAW 4630	0.21	7.19	-3.06	0.55	-0.80	57.73	0.70	0.30	0.10
26	HI 1418 × AKAW 4739	-0.57	9.14	3.83	-0.65	-1.33**	62.66	-1.06	0.32	1.75
27	HI 1418 × AKAW 4731	-1.02	1.86	2.61	1.54	0.34	52.96	-1.40	-0.32	-13.5**
28	HI 1418 × AKAW 4498	-1.70	0.41	-3.18	1.15	1.04*	53.56	4.21	0.004	3.61*
29	HI 1418 × AKAW 4800	-0.30	0.36	-0.01	0.83	1.05*	53.8	3.90	0.35	7.26**
30	HI 1418 ×	1.64	0.69	3.91	-2.54**	0.08	51.36	-4.33	-0.50 *	-7.04**

	AKAW 4730									
31	HI 1418 × AKAW 5077	0.62	-2.42	1.42	-0.47	-0.13	51.9	-3.11	-0.18	2.28
32	HI 1418 × AKAW 4924	1.12	1.64	-5.53	-0.40	-0.25	55.86	1.09	0.02	5.53**
	SE(D)±	2.93	5.54	5.03	0.78	0.44	3.29	3.24	0.20	1.80
	CD 5%	5.86	11.074	10.06	1.57	0.89	6.59	6.48	0.40	3.59

Note: * Significant at 5% level of significance.
** Significant at 1% level of significance

CONCLUSION

In conclusion, line AKAW 3717 and testers AKAW 4630, AKAW 4731, AKAW 4730 were the best general combiner for seed yield and other yield contributing traits. The line HI 1418 and tester AKAW 4731 was the best combiner for days to maturity and other yield contributing traits. The line AKAW 2865 and the tester AKAW 4630 was the best combiner for grain weight per spike other yield contributing traits, hence these genotypes were recognized as the good parent material among the available genotypes for their exploitation in wheat breeding programmes. The highest significant sca effect for seed yield was recorded by the cross AKAW 3717 x AKAW 4731 followed by AKAW 3717 x AKAW 4730. Present results may be useful to wheat breeder in making the selection of parents for future crossing programme.

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