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Combining Ability Analysis for Morphological and Yield Traits in Wheat (*Triticum aestivum*)

Research Article

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Abstract

The estimation of SCA variance was higher than GCA variance for all the characters under study which indicated that non additive genetic variance was higher than additive genetic variance for these characters. Diallel mating with recurrent selection could provide the better conditions for recombination and accumulation of desirable genes and it was recommended for such type of study. The parent "HD2888" exhibited desirable significance GCA effect for 1000 grain weight and the parent "C306" exhibited desirable significance GCA effect for 50% flowering, maturity, tillers per plant, grain yield per plant and 1000 grain weight. The best cross on the basis of SCA effect were DBW39 X PBW343 for tillers per plant, spike length, spikelet per spike, grain yield per plant and plant height and the cross C306 X K8027 for tillers per plant, spike length , spikelet per spike and grain yield per plant. These best parents and cross combinations could be effectively utilized in wheat breeding for the improvement of yield components and thus their incorporation in further breeding program was suggested.

Introduction

Wheat is the staple food for 40% of the world's population. It provides 21% of total food calories and 20% of the protein for more than 4.5 billion people in 94 developing countries. In India wheat production of 95.8 million tons during 2013-14 clearly indicates the strength of systematic and planed wheat research and extension in the country. Much concentrated efforts are necessary to increase its yield. Hence evaluation of the existing cultivars is essential since it depicts genetic diversity of loose materials on which the promise for further improvement depends.

Keeping all these aspects in view, the present study attempted to find out the nature of gene action on seed yield and yield attributes from 6x6 half diallel cross analysis in Indian wheat varieties.

Materials and Methods

Six promising lines of bread wheat varieties viz., HD2888, C306, DBW39, PBW-343, K8027 and HD3083 were used in the present investigation. These varieties were raised in a Rabi season by hand pollinations. These lines were crossed in all possible combinations excluding reciprocals in a diallel fashion to produce 15 F_1S constituted in experimental materials for this experiment. The experiment was laid out in randomized block design with 3 replications. The row to row distance was 22cm and plant to plant distance within row was 10 cm and two border rows were given on both sides of each block. Eight characters like days to 50% flowering, days to 50% maturity, plants height, tillers perplant, spike length, spikelet per spike, grain yield per plant and 1000-grain weight were recorded. 5 competitive plants from each replication were used.

Method 2 model I of Griffing was used for the analysis of combining ability [1].

Results

Analysis of variance for randomized block design revealed highly significant differences among the varieties and 15 crosses at 5% and

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1% level for all the eight characters studied and analysis of variance for GCA and SCA were highly significant at 5% and 1% level for all the characters (Table 1). The variance components of combining ability were presented in (Table 2). The estimation of component variances showed comparatively higher values than that of GCA variances for all the characters suggesting there by the influence of non-additive gene action in the expression of these characters. The additive variance component showed higher magnitude than the dominance components for days to 50% maturity. The magnitude of dominance variance was greater than the additive variance for rest of the characters. The estimates of heritability (in narrow sense) was highest in days to 50% maturity followed by 1000-grain weight, plant height, spikes per spike, spike length, grain yield, tillers per plant and days to 50% flowering.

Estimation of general combining ability effects

The estimation of GCA effect of 6 parental lines for all the characters is presented in Table 3. Parent HD2888 showed significant GCA effects for plant height and 1000 grain weight and showed significant negative GCA effect for spike length and spiked per spike and grain yield whereas rest of the characters showed average combiners. C306 showed significant GCA effect days to 50% flowering, maturity, tillers per plant, grain yield and 1000 grain weight whereas rest of the characters showed average GCA effect.

DBW39 exhibited significant negative GCA effects for days to maturity, tillers per plant, plant height and 1000-grain weight whereas rest of the characters exhibited average combiners. PBW343 exhibited significant negative GCA effects for tillers per plant and grain yield whereas rest of the characters showed average GCA effect. Similarly K8027 performed significant GCA effects for tillers per plant, plant height, spike length, spikelet per spike and grain yield whereas days to maturity and 50% flowering performed significant negative GCA effects. HD3083 exhibited significant positive GCA effects for 1000-grain weight only and significant negative GCA effects for days to flowering, plants height and spike length whereas rest of the characters showed average GCA effects.

Estimation of SCA effect

The estimation of SCA effects on 15 crosses for different characters has been presented in Table 4.

Days to 50% flowering

Cross C306 X HD3083 Showed significant positive SCA effect for days to flowering where as HD288 8XDBW39 and C306XPBB343 showed significant negative SCA effect. SCA variance was greater than GCA and non-additive component is greater than additive component indicating preponderance of non-additive gene action.

Days to 50% maturity

For days to maturity C306XHD3083 and DBW39XPBW343 showed significant positive SCA effect, crosses like HD2888XDBW39, C306XDBW39 and C306XPBW343 showed significant negative SCA effect. SCA variance was slightly greater than GCA variance. Additive gene action was greater than non-additive gene component indicating the preponderance of additive gene action.

Tillers perplant

Crosses like HD2888XC306, HD2888XDBW39, HD2888XK8027, HD2888XHD3083, C306XK8027, C306XHD3083, DBW39XPBW343 and DBW39XK8027 exhibited positive SCA effect. The magnitude of SCA variance is much greater than GCA variance. Non-additive gene action was greater than additive gene action indicating the preponderance non-additive gene.

Plant height

Crosses HD2888XC306, C306XDBW39 and C306XK8027 showed significant positive SCA effects whereas C306XPBW343 and

Table 1: Anova for combining ability for eight different characters in wheat.

Source	df	Days to 50% Flowering	Days to 50% Maturing	Tillers/ Plant	Plant Height (cm)	Spike Length (cm)	Spikelet/ Spike	Grain Yield/ Plant(g)	1000 grain Weight(g)
GCA	5	9.54**	29.63**	42.76**	103.47**	1.45**	2.65**	19.62**	37.35**
SCA	15	20.20**	4.78**	95.41**	70.13**	1.77**	2.80**	34.11**	10.66**
Error	40	2.38	0.95	1.71	8.61	0.14	0.34	1.10	0.70

*5% level of significance
**1% level of significance

Table 2: Estimation of variance components, genetic components for eight different characters in wheat.

Source	Days to 50% Flowering	Tillers /Plant	Days to 50% Maturity	Plant Height(cm)	Spike Length(cm)	Spikelet /Spike	Grain Yield/ Plant(g)	1000 Grain Weight (g)
σ^2 g	0.90	5.13	3.58	11.86	0.16	0.29	23.15	4.58
σ^2 s	17.82	93.70	3.83	61.52	1.63	2.46	330.08	9.96
σ^2 e	2.38	1.71	0.95	8.61	0.14	0.34	11.06	0.70
σ^2 A	1.79	10.26	7.17	23.71	0.33	0.58	46.30	9.16
σ^2 D	17.82	93.70	3.83	61.52	1.63	2.46	330.08	9.96
GCA/SCA Ratio	0.05	0.05	0.94	0.19	0.10	0.12	0.07	0.46

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Table 3: Estimation of GCA effects of parents for eight different characters in wheat.

Parents	Days to 50% Flowering	Days to 50% Maturity	Tillers /Plant	Plant Height (cm)	Spike Length(cm)	Spikelet/ Spike	Grain Yield/ Plant(g)	1000 grain Weight (g)
HD2888	0.42	0.58	0.50	4.46**	-0.44**	-0.69**	-87.83**	2.70**
C306	1.75**	3.50**	3.37**	1.42	0.06	-0.32	105.83**	1.34**
DBW 39	0.50	-2.08**	-1.75**	-5.83**	-0.19	0.31	-54.96	-3.25**
PBW 343	-0.62	-0.33	-2.96**	0.21	0.10	-0.32	-160.17**	0.21
K8027	-1.00	-1.04**	1.63**	1.96*	0.76**	0.93**	265.37**	-1.76**
HD3083	-1.04*	-0.62	-0.79	-2.21*	-0.28*	0.10	-68.25	0.76**

** 1% level of significance
*5% level of significance

Table 4: Estimation of SCA effect of Hybrids for eight different characters in wheat.

Hybrids	Days to 50% Flowering	Days to 50% Maturity	Tillers/ Plant	Plant Height (cm)	Spike length (cm)	Spike /Spikelet	Grain yield/ Plant (g)	1000 grain Weight (g)
HD2888 X C306	1.93	-0.65	7.12**	5.93*	0.02	0.79	-8.18	1.81*
HD2888 X DBW39	-3.82*	-2.40*	3.92**	-2.48	0.94*	0.50	18.19	-3.22**
HD2888 X PBW343	0.64	-0.15	2.13	1.81	0.65	0.79	23.19	-1.86*
HD2888 X K8027	-0.65	-0.11	3.54**	-1.61	-0.68	-0.79	15.67	-1.41
HD2888 X HD3083	0.05	1.47	7.96**	1.23	0.02	-0.29	46.96**	0.16
C306 X DBW39	-0.49	-4.65**	3.38*	6.56*	-0.23	-0.21	18.65	1.48
C306 X PBW343	-8.03**	-1.74	0.25	-9.15**	0.82*	-0.58	-14.11	-3.00**
C306 X K8027	0.68	0.97	12.67**	8.10**	3.15**	4.17**	99.37**	-0.98
C306 X HD3083	6.72**	3.22**	10.75**	-0.07	-0.81*	-1.00	79.23**	-1.83*
DBW 39 X PBW343	-1.11	2.51*	4.38**	-10.23*	1.07**	1.79**	52.69**	-1.72*
DBW 39 X K8027	0.26	-0.11	9.12**	-4.65	0.73*	0.54	52.04**	1.38
DBW 39 X HD3083	4.30	0.14	0.21	-14.82	0.11	1.71**	-29.83**	-3.39**
PBW343 X K8027	4.05	-2.20*	-0.67	-2.36	-0.23	0.17	30.39**	0.31
PBW343 X HD3083	-6.90	0.05	4.75	-3.52	0.82*	1.00	-23.6*	-5.53**
K8027 X HD3083	-7.20	0.43	-0.17	-2.61	0.82*	-0.58	16.04	3.95**

**1% Level of significance
*5% Level of significance

DBW39X PBW 343 showed significant negative SCA effects. It was observed that the variance due to SCA was higher in magnitude than GCA. Non-additive gene was also higher indicating the predominance of non-additive gene.

Spike length

Crosses like HD2888XDBW39, C306XPBW343, C306XK8027, DBW39XPBW343, DBW39XK8027, PBW343XHD3083 and K8027XHD3083 revealed significant positive SCA effects for this character whereas only one cross C306XHD3083 revealed significant negative SCA effects. The magnitude of SCA variance was higher than GCA variance. Non-additive gene action was greater than additive gene action expressing the preponderance of non-additive gene.

Spikelet per spike

C306XK8027, DBW39XPBW343 and DBW39XHW3083 showed significant positive SCA effects. Variance due to SCA was greater than GCA. Non-additive action was higher than additive gene action showing the predominance of non-additive gene.

Grain yield perplant

Crosses like HD2888XHD3083, C306XK8027, C306XHD3083, DBW39XPBW343, DBW39XK8027 and PBW343XK8027 revealed significant positive SCA effects whereas DBW 39XHD3083 andPBW343XHD3083 revealed significant negative SCA effects. It was seen that the magnitude due to SCA was greater than the GCA and non-additive component was higher in magnitude indicating the preponderance of non-additive gene.

1000-grain weight

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Crosses HD2888XC306 and K8027XHD3083 showed significant SCA positive effects whereas crosses like HD2888XDBW39, HD2888XPBW343, C306XPBW343, C306XHD3083, DBW39XPBW343, DBW39XPBW343 and DBW343XHD3083 showed significant negative SCA effect. The magnitude of SCA variance was higher than GCA. The non-additive gene component was also higher than additive gene component indicating the preponderance of non-additive gene.

Discussion

The analysis of variance for combining ability revealed that GCA and SCA were highly significant for all the characters studied. Javed et al. reported that and SCA variances were found highly significant for all the traits [2]. The magnitude of GCA variance was lower than SCA variance for all the characters indicating the predominance of non-additive gene action for all the characters studied. Here reciprocal recurrent selection may be suggested for population improvement.

Burangale et al. reported the ratio of GCA and SCA variances indicated that non-additive type of gene action was predominant in the expression of traits i.e. no of tillers perplant, grain yield perplant and 1000-grain weight [3]. Singh et al. reported that the preponderance of non-additive gene action in the controlling of days to 50% flowering, days to 50% maturity, plant height, spike length, spike lets per spike [4]. Singh and Singh supported the expression of non-additive gene action in the expression of non-additive gene action for the characters of days to 50% heading and maturity [5].

Zahid et al. revealed the expression that SCA was greater than GCA effect for plant height, spike length and 1000-grain weight [6].

Javed et al. revealed the expression of GCA and SCA variances for the characters like tillers per plant, spike length and 1000-grain weight. In bread wheat early flowering, early maturity, short plant height, high tillers per plant, longer spike length, high spike per spike, high grain yield and high 1000-grain weight ware considered to be the desirable characters [2].

HD2888 showed desirable positive significant for plant height and 1000-grain weight and so this parent was a good general combiner parent C-306 showed desirable general combiners, for all characters except for plant height, spike length and spikelet per spike. K8027 revealed good general combiners for all the characters except for days to 50% maturity and 1000-grain weight. HD3083 showed positive general combiner only for the characters 1000-grain weight.

The finding revealed that the variety K8027 showed the highest number of desirable significant GCA effects for tiller per plant, plant height, spike length, spikelet per spike and grain yield. Parent HD2888 was a good general combiner for plant height and 1000-grain weight. C306 is a good general combiner for days to flowering, days to maturity, days to flowering, tillers per plant, grain yield perplant and 1000-grain weight.

So it can be concluded that breeding materials are generated by using the parents HD2888, K8027, C306 and HD3083 would be promising for development of new variety.

A fair number of crosses showed the desirable SCA effects for each of the character under investigation. Out of the 15 crosses significant SCA effect was found in most of the crosses. Therefore, the crosses can be used as the breeding materials for developing a composite variety.

The best crosses on the basis of SCA effect were DBW39XPBW343 for maturity, tillers perplant, spike length, spike lets per spike and grain yield. The cross C306XK8027 for the tiller per plant, plant height, spike length, spikelet per spike and grain yield, DPW39XK8027 for tillers per plant, spike length, and yield per plant. The cross HD2888XDBW39 showed SCA effect for tillers per plant and spike length. The cross HD2888XC306 showed desirable SCA effect for tillers perplant, plant height and 1000-grain weight and the cross K8027XHD3083 for spike length and 1000 grain weight, the cross PBW343XK8027 showed desirable SCA effect for grain yield. The crosses C306XK8027 had both promising general and specific combiner. The cross was likely to throw transgressive segregates in advanced generations.

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