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Research Article

Combining ability analysis in bread wheat

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Abstract

Combining ability analysis was studied in a 10 × 10 half diallel set of bread wheat (*Triticum aestivum* L.). The analysis of variance for combining ability revealed that the mean squares due to both general combining ability (GCA) and specific combining ability (SCA) were highly significant for number of effective tillers per plant, length of spike, number of spikelets per spike, peduncle length of spike, number of grains per spike, grain weight per spike, 100-grain weight and grain yield per plant. This indicated that both additive and non-additive genetics variances played a vital role in the inheritance of all these eight traits.The GCA and SCA ratio (σ^2GCA/σ^2SCA) was less than unity for all the traits indicated that non-additive component play relatively greater role in the inheritance of all the eight traits.The line, HW 5018 and HI 1544 were good general combiners for grain yield per plant and some of its component traits. Nine crosses exhibited significant and positive SCA effects for grain yield per plant. The highest SCA effect for grain yield per plant was exhibited by the cross HW 5018 x K 604 followed by RAJ 4136 x UAS 281, KYZ 300 x RAJ 4136, KYZ 300 x HW 5018 and GW 173 x RAJ 4136. The cross KYZ 300 x RAJ 4136 was found most promising having high SCA effect together with *per se* performance for grain yield per plant, number of effective tillers per plant, grain weight per spike and 100-grain weight which could be further exploited in practical plant breeding programme.

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

1. Introduction

The choice of suitable parents for evolving better varieties/hybrids is a matter of concern to the plant breeders. For these purpose, the combining ability is a powerful tool to discriminate good as well as poor combiners for choosing appropriate parental materials for a particular character in the plant breeding programme. At the same time, it also 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 with desirable characteristics having good general combining ability effects for grain yield and its components and high estimates of specific combining ability effects are essential. These estimates will help in formulating sound, efficient and effective breeding procedure to bring about rapid and purposeful improvement in this crop. The present investigation was, therefore, planned to study combining ability and genetic architecture of grain yield and its components in bread wheat crosses obtained from 10 x 10 half diallel mating design.

2. Materials and methods

Ten genotypes/varieties of bread wheat *viz.,* GW 496, GW 322, LOK 1, GW 173, KYZ 300, RAJ 4136, HW 5018, K 604, UAS 281 and HI 1544 were crossed in all possible combinations using diallel mating design excluding reciprocal during Rabi 2010-11 at Wheat Research Station, Junagadh Agricultural University, Junagadh, Gujarat. A set of 55 entries (10 parents and 45 crosses) were sown in randomized block design with three replications during *Rabi* 2011-12. Each entry was sown in a single row plot of 2.5 meter long keeping row-to-row and plant-to-plant distance of 22.5 and 10 centimetres, respectively.

Five competitive plants per genotype in each replication were selected randomly for recording observations on eight characters *viz*., number of effective tillers per plant, length of main spike (cm), number of spikelets per main spike, peduncle length of main spike (cm), number of grains per main spike, grain weight per main spike (g), 100-grain weight (g) and grain yield per plant (g). The analysis of variance for GCA and SCA were carried out according to Griffing's (1956) model-1, method 2.

3. Results and discussion

The analysis of variance for combining ability revealed that the variances due to GCA and SCA were highly significant for all the eight characters (Table 1). This indicated involvement of both additive and non-additive gene effects in the inheritance of these traits. The magnitude of SCA variances was higher than their respective GCA variances for all the characters revealed preponderance of non additive gene action. The ratio of σ^2GCA/σ^2SCA was less than unity for all the traits indicated non-additive component played relatively greater role in the inheritance of these traits. Similar findings were also reported by Vanpariya *et al* (2006); Seboka *et al.* (2009) and Zahid *et al.* (2011).

Table 1. Analysis of variance for various characters in bread wheat

Source	DF	Effective tillers / plant	Length of spike	Spikelets / spike	Peduncle length of spike	Grains / spike	Grain weight / spike	100-grain weight	Grain yield / plant
GCA	9	2.41**	0.303**	2.08**	8.74**	74.28**	0.16**	0.23**	4.46**
SCA	45	1.68**	0.715**	2.24**	3.73**	29.74**	0.025**	0.10**	5.69**
Error	108	0.28	0.099	0.18	0.51	01.46	0.007	0.013	1.37
σ^2GCA		0.18	0.017	0.16	0.69	06.07	0.013	0.018	0.26
σ^2SCA		1.39	0.616	2.06	3.22	28.28	0.017	0.090	4.31
σ^2GCA/σ^2SCA		0.13	0.028	0.077	0.21	00.21	0.74	0.20	0.06

*,** Significant at 5 and 1per cent levels, respectively

Table 2. Estimates of general combining ability effects for different characters in bread wheat

Parents	Effective tillers / plant	Length of spike	Spikelets /spike	Peduncle length of spike	Number of grains / spike	Grain weight /spike	100-grain weight	Grain yield / plant
GW 496	-0.45**	0.07	0.38**	-1.55**	1.88**	-0.083**	-0.11**	-0.42
GW 322	-0.13	-0.04	0.33**	-0.84**	2.52**	0.004	0.04	-1.10**
LOK 1	0.15	-0.28**	-0.78**	0.61**	-1.82**	-0.008	0.31**	-0.10
GW 173	0.58**	0.11	-0.65**	-1.05**	-5.93**	-0.25**	-0.11**	-0.43
KYZ 300	-0.009	0.04	0.38**	0.38	0.12	-0.009	-0.07*	-0.06
RAJ 4136	-0.016	0.32**	-0.06	0.16	-1.22**	-0.50*	0.05	0.15
HW 5018	0.13	-0.02	0.18	0.79**	1.90**	0.17**	0.08*	0.92**
K 604	-0.80**	-0.16	0.22	-0.03	1.10**	0.13**	-0.007	-0.08
UAS 281	0.75**	0.01	-0.16	0.79**	0.66*	0.06*	0.005	0.20
HI 1544	0.09	-0.04	0.16	0.74**	0.81*	0.03	-0.18**	0.92**
SE(gi) ±	0.15	0.09	0.12	0.20	0.33	0.01	0.03	0.32
SE(gi-gj) ±	0.22	0.13	0.18	0.29	0.49	0.04	0.04	0.47

*,** Significant at 5 and 1per cent levels, respectively

The estimate of GCA effects (Table 2) revealed that two parents *viz*, HW 5018 and HI 1544 were good general combiners for grain yield per plant and number of grains per spike. Besides, HW 5018 was also good general combiner for grain weight per spike and 100-grain weight. Similarly, GW 322 was good general combiner for number of spikelets per spike and number of grains per spike, while Lok 1 possessed good GCA effect for 100-grain weight. GW 173 was found good general combiner for number of effective tillers per plant, peduncle length of spike, while KYZ 300 was good general combiner for number of spikelets per spike. RAJ 4136 was good general combiner for length of spike. The parent K 604 was good general combiner for number of grain per spike, grain weight per n spike, while UAS 281 was good general combiner for number of effective tillers per plant, number of grains per spike, grain weight per spike.

As regards the specific combining ability effects, nine crosses exhibited significant and positive SCA effects for grain yield per plant. The cross combination HW 5018 x K 604 (good x poor) recorded the highest SCA effect (4.64) followed by RAJ 4136 x UAS 281 (4.33, average x average), KYZ 300 x RAJ 4136 (2.97, average x average), KYZ 300 x HW 5018 (2.81, average x good) and GW 173 x RAJ 4136 (2.97, average x average) and were rated as good specific cross combinations for this trait. Similar results were reported by Singh *et al.* (1990) and Mavi*et al.* (2003). The cross combination HW 5018 x HI 1544 (2.38 sca effect) involving both good combining parents offer still better possibilities of exploitation as this is expected to yield stable segregants in the advance generations and need further exploitation in the practical plant breeding programme.

Only eight hybrids exhibited significant and positive SCA effects, therefore, they were considered as the best specific combinations for number of effective tillers per plant. Hybrid Lok 1 x UAS 281 showed maximum SCA effect (2.74) followed by RAJ 4136 × HI 1544, RAJ 4136 x K 604, KYZ 300 x RAJ 4136 and GW 173 x HI 1544. Ten cross combinations showed significant and positive SCA effects for length of spike with highest SCA effect in GW 173 x RAJ 4136 (2.29) followed by GW-196 x HW 5018, GW 173 x HI 1544 and K 604 x UAS 281 and were found to be best specific combinations.

Fourteen out of 45 crosses showed significant and positive SCA effects for number of spikelets per spike. Out of which cross K 604 x UAS 281 ranked first for SCA effect (2.28) followed by RAJ 4136 x HW 5018, GW 496 x KYZ 300 and GW 173 x UAS 281.Of the nineteen crosses producing significant SCA effects for peduncle length of spike, only ten crosses were in desired direction.

The cross combinations GW 322 x Lok 1 had maximum SCA effect (-3.51) followed by Lok 1 x HW 5018 and GW 173 x HW 5018 which showed significant and negative SCA effects for peduncle length of spike. Nineteen cross combinations showed significant and positive SCA effects for more number of grains per spike with the highest SCA effects in GW 173 x HI 1544 (11.28) followed by GW 322 x GW 173, KYZ 300 x K 604 and KYZ 300 x UAS 281.Among twenty-five crosses producing significant SCA effects for grain weight per spike, eleven were in desired direction. The cross combination GW 173 x K 604 ranked first for SCA effect (0.35) followed by HW 5018 x K 604, HW 5018 x UAS 281 and Lok 1 x GW 173 for grain weight per spike. Ten hybrids were identified as the best specific cross combinations as they exhibited significant and positive SCA effects for 100-grain weight. The maximum SCA effect was observed in HW 5018 x UAS 281 (0.69) followed by KYZ 300 x RAJ 4136, GW 322 x K 604 and GW 173 x K 604 for 100-grain weight.

Considering the desired SCA effects, the best cross combinations were HW 5018 x K 604 for grain yield per plant and grain weight per spike; RAJ 4136 x K 604 for grain yield per plant and number of effective tillers per plant; KYZ 300 x RAJ 4136 for grain yield per plant, number of effective tillers per plant and 100-grain weight; GW 173 x RAJ 4136 for high grain yield per plant and length of spike; HW 5018 x UAS 281 for grain weight per spike and 100-grain weight; and GW 173 x HI 1544 for number of effective tillers per plant, length of spike and number of grains per spike.

In majority of cases, the best specific combinations for different characters were either good x poor, average x average, average x good and *vice versa* general combiners. This suggested that information on GCA effects should be supplemented by SCA effects and hybrid performance of cross combinations to predict the transgressive type possibly made available in segregating generations. The GCA effects of the parents and SCA effect of their crosses indicated that the crosses between two high general combiners were not always best specific combiners.

A comparison between mean performance of hybrids and their SCA effects (Table 3) revealed that high *per se* performance of crosses was related with their significant SCA effects in majority of characters studied. For example, out of three crosses, two crosses common for number of spikelets per spike, grain weight per spike, 100-grain weight, grain yield per plant. For length of spike, all the three crosses were similar in both the comparison.

Table 3. Three best crosses selected on the basis of best performing parents, good general combiners, *per se* performance, SCA effects for different characters in bread wheat

Character	Rank	Best performing parents	Good general combiners	Best performing crosses	Best specific crosses
Effective tillers/ plant	I	GW 173	UAS 281	RAJ 4136 x UAS 281	Lok 1 × UAS 281
	II	HI 1544	GW 173	RAJ 4136 x HI 1544	RAJ 4136 × HI 1544
	III	KYZ 300	-	HW 5018 x UAS 281	RAJ 4136 × K 604
Length of spike	I	KYZ 300	RAJ 4136	GW 173 x RAJ 4136	GW 173 × RAJ 4136
	II	RAJ 4136	-	GW 173 x HI 1544	GW 496 × HW 5018
	III	GW 496	-	GW 496 x HW 5018	GW 173 × HI 1544
Spikelets/ spike	I	K 604	GW 322	GW 496 x KYZ 300	K 604 × UAS 281
	II	GW 322	GW 496	RAJ 4136 x HW 5018	RAJ 4136×HW 5018
	III	HW 5018	KYZ 300	KYZ 300 x UAS 281	GW 496 × KYZ 300
Peduncle length	I	GW 322	GW 496	GW 496 x GW 322	GW 322 × LOK 1
	II	KYZ 300	GW 322	GW 322 x LOK 1	Lok 1 × HW 5018
	III	GW 496	-	GW 173 x RAJ 4136	GW 173 × HW 5018
Grains spike	I	UAS 281	GW 322	GW 496 x HW 5018	GW 173 × HI 1544
	II	K 604	HW 5018	HW 5018 x HI 1544	GW 322 × GW 173
	III	HW 5018	GW 496	KYZ 300 x K 604	KYZ 300 × K 604
Grain weight/ spike	I	HW 5018	HW 5018	HW 5018 x K 604	GW 173 × K 604
	II	K 604	K 604	HW 5018 x UAS 281	HW 5018 × K 604
	III	KYZ 300	UAS 281	HW 5018 x HI 1544	HW 5018 ×UAS 281
100-grain weight	I	LOK 1	LOK 1	HW 5018 x UAS 281	HW 5018 ×UAS 281
	II	HW 5018	HW 5018	GW 322 x K 604	KYZ 300 ×RAJ 4136
	III	GW 496	-	Lok 1 x RAJ 4136	GW 322 × K 604
Grain yield/ plant	I	LOK 1	HW 5018	HW 5018 x K 604	HW 5018 x K 604
	II	GW 496	HI 1544	RAJ 4136 x UAS 281	RAJ 4136 × UAS 281
	III	HI 1544	-	HW 5018 x HI 1544	KYZ 300 × RAJ 4136

It can be concluded that information on GCA effects should be supplemented by SCA effects and hybrid performance of cross combinations to predict the transgressive type possibly made available in segregating generations. Seed yield is complex, polygenically controlled quantitative character and due to predominance of non-additive gene action, it would be worthwhile to resort to breeding methodologies, such as biparental mating, recurrent selection and diallel selective mating than to use of conventional pedigree or backcross techniques.

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