Combining ability of grain weight per spike in spring barley varieties

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Abstract
The study was conducted during on the parents and F1 hybrids of spring barley obtained from full diallel combination. For parents were used Scarlett, Fink, Barke, Zernogradskij 73, Bitrana and line - 3717C-60. The general and specific combining ability of parental components were studied for the indicator grain weight per spike. It was found that variety Scarlett has good combining ability and can be used in crosses to obtain hybrids of high grain weight per spike. The SCA variances were high for parents Zernogradskij 73, Fink and Barke. They are not reliable in combinatory selection as they are also the varieties with the lowest phenotypic manifestation of the trait.

Key words: spring barley; combining ability; grain weight per spike

INTRODUCTION

The methods of genetic analyses of quantitative traits are often used by crop breeders to increase the efficiency of the breeding selection work. The study of combining ability begins to be implemented in heterogeneous selection of self-pollinated crops and in the studies for establishing genetic similarity or difference between groups of varieties and lines. It is gradually becoming a much used method in combinative breeding. Combining ability is a property of the self-pollinated lines when crossing with other lines to produce offspring better than the parental components (Knaish & Noric, 1973; Atanasov, 2001; Atanasov et al., 2005; Mersinkov et al., 2002). The combining ability of various accessions is determined by crossing and assessing the hybrid generations (Turbin et al., 1974). Hayes & Johnson (1939) and Green (1948) established that the combining ability is a genetically determined property, which is passed on to the offspring, and lines of higher-yielding combining ability produce higher yielding hybrids. When combining a variety with other varieties, the studied trait manifests in different ways. For objective assessment of the combining ability of a given variety it is better to include larger number of accessions (Boroevich, 1984).

The aim of this study was to establish the combining ability of spring barley varieties by the trait grain weight per spike.

MATERIAL AND METHODS

In the period of 2009-2011, at the Institute of Agriculture in Karnobat, Bulgaria, was conducted a breeding-genetic study to obtain information about the type of inheritability by grain weight per spike. It was performed in full diallel combination of the type n^2 described by Hayman (1954) and the Ognyanova's guidelines (1972). As parental components were used 5 varieties of two-row spring barley – Scarlett, Fink, Barke, Zernogradskij 73, Bitrana, and one spring line - 3717C-60. In a hybridization nursery for a period of three years were made 30 diallel crosses. Biometrics were taken annually from the parents and hybrids in the three replications to determine the values of grain weight per spike. The analysis of combining ability was performed by the method of Griffing (1956) and Turbin et al. (1966).

RESULTS AND DISCUSSION

The diallel combination included 6 parents of spring barley which are contrasting in the studied trait and can be conditionally divided into three groups. The first group included variety Scarlett, which formed heavy spikes with weight ranging from 1.22 g to 1.68 g. The second group included varieties Barke, Bitrana and 3717C-60. The average weight of their spikes for the studied period ranged from 1.29 g for variety Barke to 1.34 g for Bitrana. The third group included varieties of low grain weight per spike – Fink and Zernogradskij 73 - 1.25 g and 1.27 g, respectively.

Table 1 presents data from the analysis of variance performed on the diallel scheme, which showed significant genotype effect throughout the whole studied period. The parents participating in the hybrid combination had significant genetic differences, which allowed the performance of an objective analysis on their combining ability. In 2009 and 2010 were proven both GCA, and SCA mean squares. In 2011, GCA was highly significant, whereas the SCA mean squares were not proven. Regarding the variance of GCA to SCA, it was observed that in 2009 and 2011 prevailing were the negative gene effects (σ^2_g/σ^2_s=0.941 for 2009 and σ^2_g/σ^2_s=0.460 for 2011), whereas in 2010 the correlation between the GCA and SCA variances was higher than one (σ^2_g/σ^2_s=1.286). In the specific diallel combination, stronger influence on the heritability of the trait grain weight per spike was observed for the non-additive genetic effects and the selection by this trait should be conducted in later generations.

Table 2 shows the GCA effects and the SCA variances for the trait grain weight per spike. It is significant for the selection to juxtapose the values of GCA effects and SCA variances. The results show that in the three years and mean for the period the highest positive values of GCA were observed for Scarlett. This is also the parent with the highest values of grain weight per spike in the three years of the study. The behavior of Scarlett proved the statement of Boroevich (1984) that the parents with the highest phenotypic manifestation of the trait also had the highest GCA effects. The other parents in the diallel combination had negative average values of GCA for the period. In the individual years, their GCA effects were not constant, which was probably due to the genotype-environment interaction. The SCA variances were high for parents Zernogradskij 73, Scarlett, Fink and Barke. Only variety Scarlett had high GCA and SCA values, which makes it a good general combinator. The other three varieties had low GCA effects. They

Table 1. Analysis of variance of the combining ability of grain weight per spike

Year	Source of variation	F_1				
		SS	DF	MS	F e	F tabl.
2009	Genotypes	0.20114	14	0.01437	30.61288***	**5 % -** 2.06
	GCA	0.05708	5	0.01142	72.97847***	2.56
	SCA	0.01017	9	0.00113	7.22318***	2.24
	E	0.00438	28	0.00016		
	σ^2_g/σ^2_s	0.941				
2010	Genotypes	0.07976	14	0.00570	10.59369***	**1 % -** 2.80
	GCA	0.02100	5	0.00420	23.43149***	3.76
	SCA	0.00548	9	0.00061	3.39570**	3.11
	E	0.00502	28	0.00018		
	σ^2_g/σ^2_s	1.286				
2011	Genotypes	0.10835	14	0.00774	13.55573***	**0.1 %** -3.96
	GCA	0.03092	5	0.00618	32.49258***	5.66
	SCA	0.00338	9	0.00038	1.97322	4.50
	E	0.00533	28	0.00019		
	σ^2_g/σ^2_s	0.460				

Table 2. GCA effects and SCA variance for the trait grain weight per spike

Parents	F_1			Average for the period
	2009	2010	2011	
GCA effects				
Scarlett	0.07300	0.035200	0.057600	0.055267
Fink	-0.05200	0.00620	-0.03140	-0.02573
Barke	-0.0550	0.0147	0.0346	-0.0019
Zernogradskij 73	-0.0320	0.0197	-0.0459	-0.0194
Bitrana	0.02400	-0.02180	-0.00470	-0.00083
3717C-60	0.04100	-0.05380	-0.01020	-0.00767
SCA variance				
Scarlett	0.001070	0.000041	0.000200	0.000437
Fink	0.000670	0.000462	0.000148	0.000427
Barke	0.000750	0.000292	0.000200	0.000414
Zernogradskij 73	0.000980	0.000349	0.000037	0.000455
Bitrana	0.000430	0.000111	0.000212	0.000251
3717C-60	0.000480	0.000670	0.000030	0.000393
Average	0.000730	0.000321	0.000138	0.000396

are not reliable in combinatory selection as they are also the varieties with the lowest phenotypic manifestation of the trait. Many research scientists recommend that such source forms should be combined with parents with high GCA to achieve higher results for the studied trait (Phogat et al., 1995; Verma et al., 2007; Patial et al., 2016; Pesaraklu et al., 2016). Variety Bitrana and line 3717C-60 were not good combinators by grain weight per spike as their GCA effects and SCA variance were low.

CONCLUSIONS

To increase the grain weight per spike it is suitable to use parent Scarlett in selection, which is a good combinator, with average specific combinatory ability.

The SCA variances were high for parents Zernogradskij 73, Fink and Barke. They are not reliable in combinatory selection as they are also the varieties with the lowest phenotypic manifestation of the trait.

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