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DIALLEL ANALYSIS OF THE NUMBER OF SPIKELETS PER SPIKE IN SPRING TRITICALE

I. G. GREBENNIKOVA[1], A. F. ALEYNIKOV[1] and P. I. STEPOCHKIN[2]
[1] *State Scientific Establishment Siberian Physical-Technical Institute of Agrarian Problems, Russian Academy of Agricultural Sciences, Novosibirsk, Russia*
[2] *State Scientific Establishment Siberian Research Institute of Plant Growing and Selection, Russian Academy of Agricultural Sciences, Novosibirsk, Russia*

Abstract

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There was developed a computer program for calculating the combining ability of spring triticale varieties and for carrying out the genetic analysis of parental quantitative traits. The program was tested on hybrids experimentally obtained as a result of crossing between four spring triticale varieties according to a complete diallel scheme. There was selected a variety perspective for the trait "the number of spikelets per spike" breeding.

Key words: triticale, diallel analysis, combining ability, program, genetic parameters

Introduction

Triticale is a new synthetic plant species which does not exist in natural populations. This culture is able to surpass the parental species in many aspects. Triticale is more resistant to cold and leaf diseases, than wheat and much more productive than rye. Like rye it can grow on salty and acid soil and give satisfactory grain yield. Its grain contains more lysine, than wheat. That is why breeders are interested in this species.

Triticale in Siberia is less studied than parental species wheat and rye. There is a necessity to work out genetic principles of optimization the methods of triticale breading, and to increase the efficiency of realization its genetic potential (Stepochkin, 2008; 2009). For this reason it is necessary to develop computer programs for triticale breeders.

Diallel analysis is one of the most effective methods to study the genetic control system of quantitative traits in plant growing (Cilke, 2003). On its basis it is possible to receive the information on character of inheritance of various traits in cereals. Using diallel crossing it is possible to get some information on the genetic parameters of parental varieties (Griffing, 1957) and their combining ability (Hayman, 1958).

The authors of the report have developed a computer program DIAS (Aleynikov et al., 2009), aimed at calculation of genetic parameters, combining ability of triticale varieties and the analysis of parental quantitative traits.

The program estimates the combining ability of parental forms, carries out a comparative analysis of parental varieties, paternal and maternal offspring integrated genetic parameters of the

e-mail: petstep@ngs.ru

investigated traits, specific and general combining ability. The results of the analysis of ***the number of spikelets per spike*** are reported in this article

Materials and Methods

Four spring varieties of different origin were involved in complete diallele crosses (Table 1).

As triticale cytogenetically less stable species in comparison with the parental ones because of the disturbances in meioses, its populations as well as hybrid plants can contain aneuploids with chromosome number less than 42. The phenotype of aneuploid plants may differ from that one of the plants with complete chromosome set. Most of them are depressed, less fertile and have shriveled grain. It tells on variability of quantitative features (Aleynikov et al., 2009). Organizing the genetic experiment on quantitative features we had to consider this peculiarity of the cultivar and exclude deviating depressive plants – putative aneuploids. It required more repetitions. The initial information for the computer program «DIAS» is the data about the parental forms, hybrids of the first generation, the number of repetitions of the experiment, and also about the chosen quantitative feature interesting for the researcher. For estimation of the initial material on general and specific combining ability it is necessary to choose one of four offered Griffing methods (Griffing, 1957).

Table 1
Origin and the most valuable features of four parental triticale varieties

Variety	Origin	Valuable features
Gabo	Poland	Filled grain, short stem, resistant to lodging
Sokol Kievskij	The Ukraine	Earliness, high grain productivity, large grain
Ukro	Russia	Filled grain, large spike
K-3881	Mexico	Short stem, resistant to lodging, dense spike

Results

The average meaning of the number of spikelets per spike in parental forms and their hybrids F_1 is shown in Figure 1.

Before estimating the general and specific combining ability we had established the significance of genetic differences between hybrids F_1. Experimental data were processed with help of variance analysis. Fisher's F-criterion showed that there were significant distinctions between studied plants (Table 2).

The analysis of the combining ability has shown that the lines with high general combining ability (GCA) can be used in breeding programs to improve the trait in their hybrids and further generations. The most valuable line is a Mexican variety that has a VIR register catalogue number K–3881. Hybrid combinations possessing high specific combinational ability (SCA) such as (Gabo × K–3881) can be used in heterosis selection (Table 3). Additive gene effects in Sokol play the major role to inherit the trait, as its GCA variance makes more contribution to general variance, than SCA one. Dominant and epistatic gene effect play considerable role in inheritance of the trait in other three varieties.

In Figure 2 are given the average meaning of the trait of parental forms and their hybrids which allows estimating the contribution of a paternal or maternal variety to their hybrid progeny.

The least differences are observed between reciprocal hybrids of K–3881. The tendency to increase this trait is shown.

Diallel analysis allows determining and estimating the genetic parameters of a quantitative trait (Hayman, 1958) such as the average degree and the domination direction in polymorphic loci, the distribution desirable and undesirable allele, to approximate the number of these loci, etc. The given parameters facilitate to choose the optimum breeding scheme of an economic valuable trait.

The diallel analysis (Table 4) shows that dominant alleles prevail in the varieties in the scheme

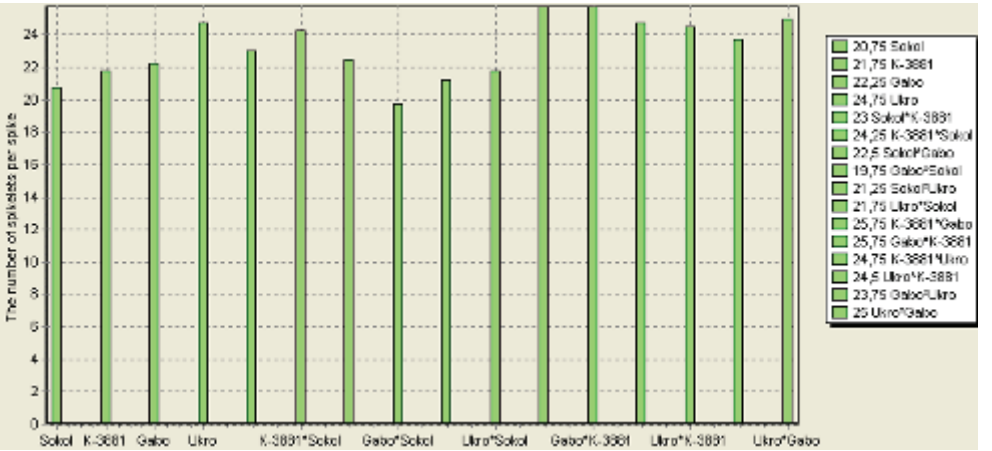

Fig. 1. The average meaning of the number of spikelets per spike in parental forms and their hybrids F1

Table 2

Results of the variance analysis

Variance	The sum of squares (SS)	Freedom degree (df)	Average square (Ms)	Ffact.	F0.05
General	296.94	63			
Variants	205.94	15	13.73	6.97	1.92
Repetitions	2.31	3	0.77	0.39	2.84
Casual	88.69	45	1.97		

Table 3

Results of variance analysis of the general and specific combining ability

Variety	The constant of SCA				Effects of GCA	The contribution of GCA to the general variance	The contribution of SCA to the general variance
	Sokol	K–3881	Gabo	Ukro			
Sokol					-1.47	2.07	0.88
K–3881	1.34				0.72	0.43	1.36
Gabo	0.61	2.74			0.16	0.06	1.17
Ukro	0.71	0.01	0.17		0.59	0.26	0.3

of inheritance of the trait «the number of spikelets per spike (the component of variability $F > 0$).

The regression analysis of the dispersions V_r on the covariance W_r illustrates the genetic control system of the trait on each variety, in particular the relative contribution of domination and recessive alleles (Figure 3).

As the regression line crosses the negative part of the axis W_r, it is possible to conclude that the effect of super domination occurs in all hybrids.

The coordinates of points defining the regression line show the average degree of domination. The position of the points of the parental varieties relatively to the regression line depends on the

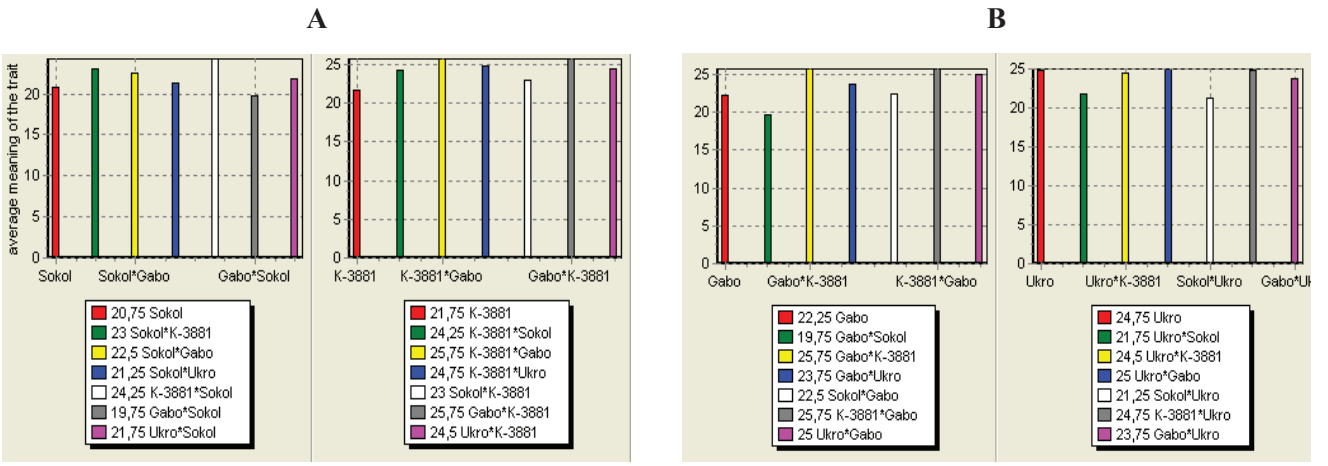

Fig. 2. The diagrams of average meanings of "spikelets per spike" of the parental varieties and their hybrids

Table 4
Variability components

Designation	Value	Essence
D	2,42*	Caused by additive genes
F	0.88	Reflects the dominant direction
H_1	8,53*	Reflects the positive effects of genes
H_2	6,24*	Reflects the negative effects of genes
h_2	2.49	The algebraic sum of the dominant effects of heterozygous loci of all hybrids
E	0.47	Reflects the dominant and additive effects for each line
* – parameters are significant		

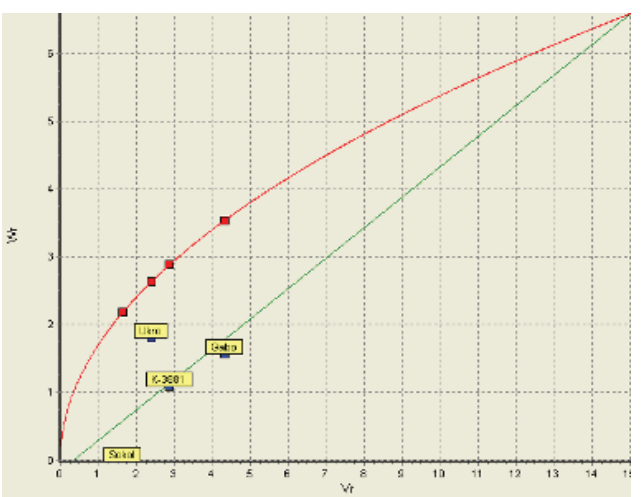

Fig. 3. The graph of regression W_r on V_r

relation of the number of dominant and recessive alleles that they contain. The variety Gabo has the highest means of dispersion and co variances, i.e. it bears the most amounts of recessive alleles.

The variety Sokol has least means of W_r and V_r. It possesses the most amounts of dominant alleles taking part in display of the trait in the heterozygote, and so is the most perspective for selection on the investigated trait ***the number of spikelets per spike***.

Conclusions

The computer program DIAS allows to define an estimation of the general and specific com-

bining ability of the lines (varieties) tested, the heritability of traits, the effects of genes (additive, domination, epistas), the ratio of the frequencies of dominant and recessive genes in a certain locus, the genetic nature of heterosis, etc.

The effect of super domination prevails in all loci of the genes, responsible for control of the trait ***the number of spikelets per spike.*** Gabo variety has the most number of recessive alleles, while Sokol variety is perspective in breeding of the trait ***the number of spikelets per spike.***

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