INHERITANCE OF GRAIN WEIGHT PER PLANT IN RICE

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ABSTRACT

This paper examined the mode of inheritance and the influence of genes on weight of grains per plant in F_1 and F_2 generations in 7x7 half diallel crosses of rice. On both studied generations most combinations have dominant mode of inheritance of analyzed property. The results of the analysis of combining ability show significant activity of genes with additive and genes with non-additive action. Data of components of genetic variance and regression analysis indicate a greater role of the dominant component in the inheritance and absence of inter allelic interaction.

Key words: *inheritance, combining ability, components of genetic variance, regression analysis, additive and non-additive gene action*

INTRODUCTION

The mass of grains of individual plants directly determines the yield of a population. As a final product of the interaction between a lot of fisiological and biochemical processes in the plants, the mass of grains from plant depends of several propreties, such as the number of panicles per plant, number of grains per panicle and weight of grain. Changing any of these properties result whit change of the grain yield per plant. The link of this proprety whit other components of yield indirectly contributes to its high variability. Therefore the stady of the genetic nature can lead to faster and more reliable success in plant breeding for this purpose.

Method of diallel analysis is relatively reliable mechanism for determining the gentic system and the activity of genes involved in the expression of individual properties. The results of this stady indicate on combining abilities and the mode of inheritance and the effect of genes on the mass of grains per plant. Knowledge of these parameters can be used for giude and improvement the breeding of rice in the country.

MATERIAL AND METHODS

Seven rice varieties (*Oryza sativa* L.), type japonica and the F_1 and F_2 hybrid progenies obtained by their diallel crossing (without reciprocal combinations) were used as a trial material in this experiment. Two of the crossed varieties are domestic (Biser-2 and Ranka) and five are introduced (Medusa, S-136, Arborio Bjanko, Baldo and Loto). The experiment was conducted on areas of Rice Department – Kocani, by using randomized block design in three replications. The length of the rows was 1 m with 17 cm space in the rows and 20 cm space within rows. The results were analyzed by analysis of variance method. The mode of inheritance in F_1 and F_2 generations was evaluated by the test of significance of the mean values of the hybrid generation according to parental ones (Borojevic, 1965). The analysis of the general combining ability (GCA) and specific combining ability (SCA) was carried out according Griffing (1956), method II, model I, and the components of genetic variance and regression analysis were analyzed by using methods of Jinks (1954), Hayman (1954) and Mather and Jinks (1971).

RESULTS AND DISCUSSION

The results obtained from the examination of the mass of grains per plant showed that in the both studied generations the most combinations have dominant mode of inheritance for this property. At the hybrids from F_1 generation the dominance occurs in 11combinations, whereupon, to the parent with the greater mass of grains in 7 combinations, and to the weaker parent in 4 combinations. Positive heterozis was obtained in 6 combinations and in 4 combinations there was no significant differences between mean values of hybrids and their parents. In the F_2 generation the mass of grains of the whole plant is dominantly inherited in 13 combinations, of which at 8 to the better parent and at 5 to weaker. Positive heterozis occurs in combination Medusa x Baldo, and negative at S-136 x Loto. The combination Biser-2 x Loto has an intermediate mode of inheritance. Between the mean value of hybrids and their parents are no significant differences in 5 hybrid combinations (Tab.1).

Positive heterozis which was the result of the action of dominant genes received Chauhan et al. (1993) and Rany and Murthy (1994).

Table 1. Mean values (g) and the inheritance of grains weight per plant

Parents and F_1								LSD	
Parents	Biser-2	Medusa	S-136	A. bjanko	Ranka	Baldo	Loto	0,05	0,01
Biser-2	38,31	38,28^{+d}	25,17^{-d}	34,48^{+d}	27,35^{-d}	43,53^{+d}	34,38^{+d}	4,66	6,20
Medusa		23,94	20,00^{-d}	29,58^{+h*}	26,55	32,30^{+h}	40,25^{+h}		
S-136			27,33	38,08^{+h}	32,13^{+d}	27,77	28,78^{+d}		
A.Bjanko				23,17	33,02^{+d}	32,23^{+h}	19,90		
Ranka					29,88	35,25^{+h*}	24,85^{+d*}		
Baldo						23,94	24,37		
Loto							22,52		
Parents and F_2									
Biser-2	38,31	41,96^{+d}	31,16^{-d}	37,98^{+d}	34,53^{+d*}	37,61^{+d}	30,21^{i}	4,40	5,86
Medusa		23,94	26,21	27,04^{+d}	21,36^{-d}	31,58^{+h}	24,99		
S-136			27,33	20,92^{-d}	25,60^{-d}	25,34	18,80^{-h}		
A.Bjanko				23,17	25,49^{-d}	25,42	26,17^{+d}		
Ranka					29,88	27,90^{+d}	30,93^{+d}		
Baldo						23,94	24,79		
Loto							22,52		

d –dominant; h –heterosis; i –intermedijar

The results of the analysis of variance (Tab. 2) show higt significant values for GCA and for SCA, which means activity on additive and non additive component of variance. In the F_1 generation, the values of GCA and SCA are quite close. It can be seen from the value of the ratio GCA/SCA which is greater than 1 and indicates slightly greater role of recessive genes, but not negligible role of dominant genes. The results for the F_2 generation showed more appreciable advantage on additive component of variance. The value of the ratio GCA/SCA indicates that in this generation participation of additive component is nearly 8 times greater than the participation of the dominant component.

Table 2. ANOVA for combining ability in the F_1 and F_2

Sources of variance	Degrees of freedom	F_e	
		F_1	F_2
GCA	6	16,40**	42,68**
SCA	21	13,96**	5,36**
E	54		
GCA/SCA		1,18	7,97

Highly significant values for GCA and SCA and greater value for GCA received Chakraborty et al. (2009), Bagheri et al. (2008), Akram et al. (2007). In the results of Kumar and Chandrappa (1994) and Geetha et al. (1994) greater value had a variance of SCA. Roy and Panwar (1993) obtained significant dominant and not significant additive effect in inheritance of this property.

Ranked first in both genetarions is the variety Biser-2 and only its values are highly significant (Tab. 3).

Table 3. General combining ability of the parents

Parents	GCA- F_1	Range	GCA- F_2	Range
Biser-2	4,60**	1	7,31**	1
Medusa	-0,52	4	-0,37	3
Y-136	-1,31	6	-2,40	6
A,bjanko	-0,66	5	-1,66	5
Ranka	-0,07	3	0,14	2
Baldo	0,42	2	-0,42	4
Loto	-2,44	7	-2,60	7
LSD 0,05 0,01	1,55 2,07		1,47 1,95	

Specific combining ability for each combination particular is given in Table 4. Highly significant SCA values in F_1 have combinations Medusa x Loto, S-136 x Arborio bjanko and Biser-2 x Baldo, and significant combinations Arborio bjanko x Baldo, Ranka x Baldo and Biser-2 x Medusa. All these combinations except the combination Ranka x Baldo include one parent with bad or medium GCA and one whit medium or good GCA. In combination Ranka x Baldo both parents have medium GCA for this property. In the F_2 generation highly significant SCA values are obtained for combinations Biser-2 x Medusa and Ranka x Loto and significant for Medusa x Baldo and Biser-2 x Arborio bjanko. These combinations were obtained by parents crossing with different genetic value. Only in combination Medusa x Baldo both parents are with medium GCA. Best combination in both generations is Biser-2 x Medusa.

Table 4. Specific combining ability of the hybrid combinations for height of stem

F_1							LSD	
Parents	Medusa	S-136	A. bjanko	Ranka	Baldo	Loto	0,05	0,01
Biser-2	4,26*	-6,93	0,60	-7,12	8,57**	2,28	4,11	5,47
Medusa		-8,11	0,82	-2,80	2,46	13,27**		
S-136			10,11**	3,58	-1,28	2,60		
A.Bjanko				3,80	5,39*	-6,94		
Ranka					4,96*	-2,58		
Baldo						-3,55		
F_2								
Biser-2	6,98**	-1,78	4,29*	-0,96	2,68	-2,54	3,88	5,17
Medusa		0,94	1,03	-6,45	4,33*	-0,09		
S-136			-3,06	-0,18	0,13	-4,24		
A.Bjanko				-1,02	1,64	2,39		
Ranka					0,14	5,35**		
Baldo						-0,23		

Inheriting the mass of grains from whole plant, analyzed by components of genetic variance is shown in Table 5. The components of variance (H_1 and H_2) resulting from dominant gene action in

F_1 and in F_2 generations are greater than the variance component D, which is result of their additive action. In the F_1 generation interaction F has positive value which is a sign of dominance of genes of the better parents, while in F_2 dominated genes from parents with less weight of grains per plant because interaction F has a negative value.

Values from expression $H_2/4H_1$ show that in F_1 generation the dominant and recessive alleles are more symmetrically distributed than to their distibution in F_2 generation. This conclusion derives from the values of dominant (u) and recessive (v) alleles. In the F_1 generation the frequency of the dominant allele is 1,7 times greater than the frequency of recessive alleles, and in F_2 generation 3 times. The average degree of dominance ($\sqrt{H_1/D}$) in both generations has values greater than 1 which means superdominance in the inheritance of property. The ratio of the total number of dominant against recessive alleles (Kd/Kr) in the F_1 generation is greater than 1, indicating the presence of more dominant alleles in inheritance of the proprety. In the F_2 generation this ratio has a value less than 1, which means greater representation of recessive alleles.

Larger values of H_1 and H_2 in terms of D received Chaturvedi et al. (2010) and Akram et al. (2007).

Table 5. Gentic components of variation for weight of grains per plant

Components	Values	
	F_1	F_2
D	28,92	29,22
H_1	145,26	53,03
H_2	133,94	39,56
F	21,62	-10,10
E	2,72	2,42
$H_2/4H_1$	0,23	0,19
u	0,64	0,75
v	0,36	0,25
$\sqrt{H_1/D}$	2,24	1,35
Kd/Kr	1,40	0,77

According to figure 1, the regression line in the F_1 generation cut ordinate under the coordination beginning, and its slope is not different from the slope of the line of regression with coefficient b = 1. This means that non allele genes for this property acted independently, respectively between them is no interaction. The distance of the line of regression of limited parable shows a greater role of the dominant component in inheritance. The intersection of the expected regression line with the ordinate is below the starting point of coordinate system and indicates that the inheritance as a whole is superdominant.

Regression analysis in the F_2 generation (Fig. 2 A) shows that regression coefficient does not differ significantly from 1 though it has a low value ($b = 0,493 \pm 0,238$). The resulting position of the expected regression line and limited parable confirms that inheritance of this property is quite complex. In order to increase the accuracy of the results, it was made another dialelle analysis (5 x 5) which does not include the values of varieties Ranka and Loto and their cross (Fig. 2 B). Again, the regression coefficients from this analysis ($b = 0,851 \pm 0,293$) did not differ significantly from 1 and shows the absence of interalelle interaction and the distance of the line of regression of limited parable confirms the greater role of dominant genes. The expected regression line cuts the Wr - ordinate under the starting point which indicate superdominant mode of inheritance. The results coincide with the results obtained of analysis of the genetic variance.

Dispose of the breaking points in diagrams show genetic divergence of parental varieties. The varieties S-136 and Biser-2 have more dominant genes and varieties A. bjanko and Medusa more recessive genes. In the variety Baldo in small advantage are additive genes (Fig. 2 B).

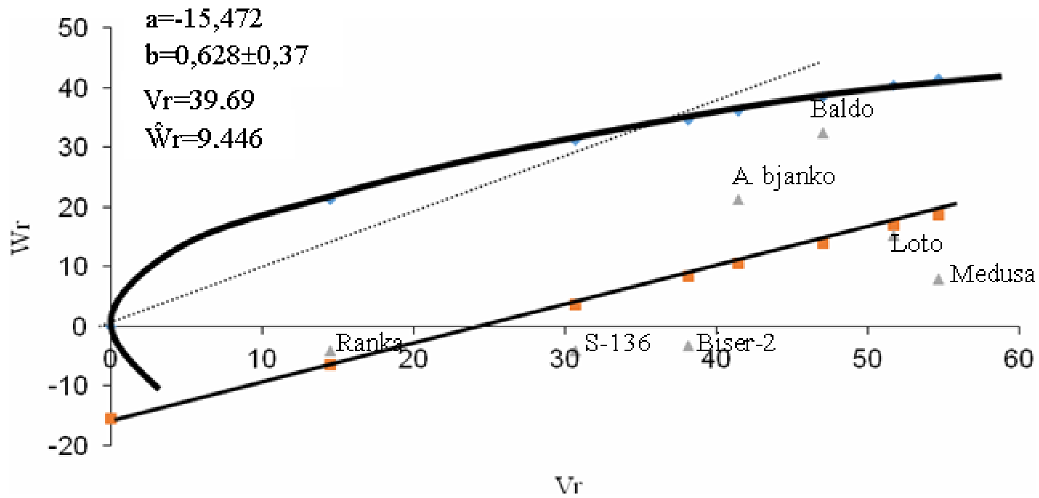

Figure 1. Vr/Wr graph for grains weight per plant in rice in the F_1 generation

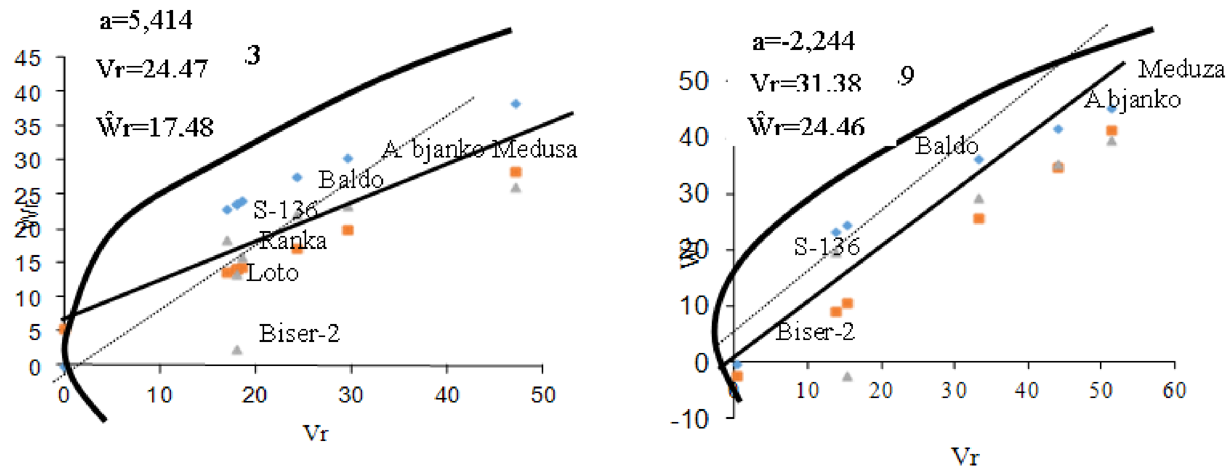

Figure 2. Vr/Wr graph for grains weight per plant in rice in the F_2 generation (A- from diallel set 7x7, B-from diallel set 5x5)

CONCLUSIONS

- Major role in the inheritance of grains weight per plant of selected rice genotypes has dominant component. In the inheritance appears positive heterozis.
- Varieties S-136 and Biser-2 have more dominant genes and varieties Arborio bjanko and Medusa mostly recessive genes. In the variety Baldo insignificant advantage are additive genes.
- Best combiner used from parental genotypes is variety Biser-2, which can be reliably used as a parent in the future breeding programme for higher yield in rice.

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