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COMBINING ABILITY ANALYSIS OF SOME YIELD COMPONENTS IN RICE (ORYZA SATIVA L.)

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Abstract

With diallel cross of seven varieties of rice (Biser-2, Ranka, Medusa, S-136, Arborio Bjanko, Baldo and Loto) was conducted an analisys of their combining abilities for panicle length, number of grains per panicle and grain mass per panicle. Highly significant values on general (GCA) and specific combining abilities (SCA) in the F_1 and F_2 generations were found for all analyzed traits. Biser-2, Ranka and S-136 are the best combiners for panicle length, Biser-2 and Ranka for number of grains per panicle and Biser-2 for grains mass per panicle. Superior hybrid combinations were obtained in which one parental variety has good and the other one has bad to medium general combining ability.

Key words: rice, combining ability, diallel analysis

Introduction

Potential for yield of modern rice varieties usually varies because the properties of panicle, as length of panicle, number of primary and secondary branches in panicle, number of grains per panicle, size of grains in panicle, grains mass per panicle etc. The rice plant these properties cannot reach its maximum at the same time. But it can be determine the most favorable relationship between them which will result in a high yield of panicle and in proper combination with other components to yield to give a maximum yield of grain. Besides the variety, great influence on the properties of panicle have external conditions. Hence, the selection to improve these properties requires knowledge of their genetic basis. Diallel analysis is one of the most exploited and still current technique used for this purpose. The genetic character of diallel hybrids commonly associated with the study of general and specific combining ability of the initial population from which they are derived. The application of this method in the literature is found in different cultures and different material for hybridization, because the results obtained of the analysis of certain genetic material cannot be accepted as a general for assessment of other genetic material, or the same material grown in different environmental conditions. In this research is studied the effect of general and specific combining ability of some rice varieties for length of panicle, number of grains per panicle and grains mass per panicle in order to facilitate the selection of parental varieties for future domestic breeding programs for rice.

Materials and Methods

The experiment for this research was conducted on the area of rice Department - Kocani. Experimental material for the study of combinative capabilities for length of panicle , number of grains per panicle and grains mass per panicle with diallel method were seven varieties of rice, type japonica (Biser-2, Medusa, S-136, Arborio Bjanko, Ranka, Baldo and Loto) and their hybrid progenies of F_1 and F_2 generations obtained with their diallel crossing (without reciprocal combinations). The material was placed by using randomized block design in three replications. The length of the row was 1 m with 17 cm space in the rows and 20 cm space within rows. The standard growing measures were applied during the vegetation. After the harvest, 48 plants of each parental variety, 30 plants of each F_1 combinations and 99 plants of each F_2 combinations were analyzed in laboratory conditions. The obtained results were analyzed by analysis of variance method and calculated standard error. Diallel analysis for general and specific combining ability was carried out according Griffing (1956) metod 2, model I.

Results and discussion

Length of panicle. – In both generation (Tab.1) analysis of variance shows that are obtained high significant differences, for general combining ability (GCA) and for specific combining ability (SCA) for this property. In addition, additive component of variance has a dominant role, because in the F_1 generation the ratio GCA / SCA is 4.19 times greater in favor of the GCA, and in F_2 11.62 times, while the influence of the dominant component of variance is as the same times smaller. These results are consistent with the results of Sabouri et al. (2013), Saleem et al. (2010), Chakraborty et al. (2009), Akram et al. (2007), Torres and Geraldi (2007), Das et al. (2005),

while in the results of El-Rawainy et al. (2011), Akter et al. (2010) and Vanaja et al. (2003) the SCA value was greater than values of GCA.

Positive highly significant values for GCA were obtained in varieties Y-136, Ranka and Biser-2 in both hybrid generations (Tab. 2). Hence it can be concluded that these varieties have good GCA and are good combinatorial for length of panicle. In both generations with a positive value, but not significant, was characterized Baldo variety. Other varieties have shown negative effect in F_1 and F_2 generations and are rated as poor general combinatorial for this property. As a weakest combinatorial was show variety Lotto, which panicle is the shortest in terms of panicle of parental varieties used. Perspective for breeding programs of this property are varieties with significant positive values of GCA.

Table 1. ANOVA for combining ability in the F_1 and F_2

Sources of variance	Degrees of freedom	F_e					
		Panicle length		Number of grains per panicle		Grain mass per panicle	
		F_1	F_2	F_1	F_2	F_1	F_2
GCA	6	59.55**	63.28**	8.60**	28.28**	20.53**	53.26**
SCA	21	14.20**	5.45**	7.45**	5.53**	6.51**	5.34**
E	54						
GCA/SCA		4.19	11.62	1.15	5.12	3.15	9.98

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

From the tested combinations positive effect for SCA have 11 in F_1 and 8 in F_2 generation (Tab 3). In most of the combinations whose values for SCA are positive, one parent is Baldo variety, which has a mean GCA. High significant positive value have only combinations Arborio bjanko x Loto and Ranka x Baldo in F_1 and Arborio bjanko x Baldo and Ranka x Loto in the F_2 generation. The parental varieties involved in these combinations only variety Ranka has good GCA, Baldo medium and Arborio bjanko and Loto have bad GCA.

Hybrids from combination of Biser-2 x Baldo and Medusa x Loto in F_1 have significant positive SCA value, and negative in F_2 generation. The worst SCA in F_1 generation has a combination Medusa x Baldo, and F_2 Medusa x Y-136. In the results of Rahimi et al. (2010) also important part of combinations with significant SCA value were obtained with crossing of one good and one bad general combinatorial.

Table 2. General combining ability of the parents

Parents	Panicle length		Number of grains per panicle		Grains mass per panicle	
	F_1	F_2	F_1	F_2	F_1	F_2
Biser-2	0.46**	0.75**	2.21	10.76**	0.48**	0.81**
Medusa	-1.04	-0.30	-2.03	2.44	-0.21	0.02
S-136	1.04**	0.65**	6.03*	0.97	0.06	-0.15
A. bjanko	-0.04	-0.28	-10.89	-15.63	-0.05	-0.20
Ranka	0.57**	0.48**	3.21	7.69**	-0.11	-0.10
Baldo	0.17	0.16	4.54	-0.65	0.28**	0.16*
Loto	-1.17	-1.47	-3.08	-5.59	-0.44	-0.55
LSD 0.05	0.30	0.14	5.63	4.65	0.19	0.16
0.01	0.40	0.27	7.48	6.18	0.26	0.22

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

Number of grains per panicle. – Based on the results of the analysis of variance for combinative ability in both studied generations can be concluded that there are high significant differences for GCA and SCA. (Tab 1). That means that in the inheritance of the number of grains per panicle acted genes with additive and genes with non-additive effect.

Higher GCA values, especially in F_2 generation means dominance of recessive genes in inheritance of this property. Because the values of GCA and SCA in

F_1 generation are very close, implies that additive and the dominant component had almost equal influence in inheritance of the number of grains per panicle. The role of recessive and dominant genes can be seen from the ratio GCA/ SCA. He is slightly higher than 1 in F_1 generation, which indicates approximately equal impact on both the others, and in F_2 is 5.12 which indicates that the participation of recessive genes is 5.12 times greater than the participation of the dominant genes.

Table 3. Specific combining ability of the hybrid combinations for panicle length, number of grains per panicle and grains mass per panicle

Combinations	Panicle length		Number of grains per panicle		Grains mass per panicle	
	F_1	F_2	F_1	F_2	F_1	F_2
Biser-2 x Medusa	-1.34	-0.59	18.15*	21.15**	0.20	0.53*
Biser-2 x S-136	-0.59	0.08	-17.31	-3.40	-0.68	-0.39
Biser-2 x A.Bjanko	-0.07	-0.44	1.47	14.46*	0.31	0.65**
Biser-2 x Ranka	-0.04	0.68	-21.26	-6.57	-0.77	-0.27
Biser-2 x Baldo	1.05*	-0.10	-1.45	-7.12	0.18	0.29
Biser-2 x Loto	-1.51	-0.89	4.26	1.32	-0.15	-0.21
Medusa x S-136	-1.26	-0.95	-28.24	-11.45	-0.77	-0.14
Medusa x A.Bjanko	-0.81	0.38	10.31	10.09	0.00	0.37
Medusa x Ranka	-065	-0.50	-15.89	-5.71	-0.48	-0.35
Medusa x Baldo	-2.45	-0.76	-1.25	5.13	-0.25	0.04
Medusa x Loto	0.98*	-0.07	26.00**	9.50	0.82**	0.16
S-136 x A.Bjanko	0.68	-0.77	11.05	-3.41	0.51*	-0.16
S-136 x Ranka	0.41	-0.34	15.26*	6.82	0.53*	0.17
S-136 x Baldo	0.40	0.70	-7.90	-7.02	-0.39	-0.31
S-136 x Loto	0.10	-0.46	21.61**	-5.53	0.58*	-0.09
A.Bjanko x Ranka	0.55	0.61	9.41	1.30	0.23	-0.13
A.Bjanko x Baldo	0.45	1.69**	24.03**	9.71	1.16**	0.67**
A.Bjanko x Loto	1.12**	-0.16	-11.77	-7.52	-0.64	-0.30
Ranka x Baldo	1.48**	-0.18	17.15*	1.36	0.47	0.05
Ranka x Loto	-0.25	0.99**	-4.47	22.70**	0.28	1.00**
Baldo x Loto	0.24	0.14	1.74	8.60	0.20	0.25
LSD 0.05 0.01	0.80 1.06	0.73 0.97	14.89 19.80	12.29 16.35	0.51 0.68	0.43 0.57

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

Highly significant values for both combining capabilities and greater GCA value received Sabouri et al. (2013), Saleem et al. (2010), Chakraborty et al. (2009), Torres and Geraldi (2007). In studies of Akter et al. (2010), Jagadeesan and Ganesan (2006), Vanaja et al. (2003) the values for GCA and SCA were also highly significant, but this authors proved a greater role of the dominant component, which means higher SCA values.

In the F_1 generation, as the best combinatorial for the number of grains per panicle is variety Y-136 and its only GCA value is significantly different (Tab 2). The varieties Baldo, Ranka and Biser-2 have positive values, but not significant. The other three parental varieties (Medusa, Loto and Arborio bjanko) have negative GCA values. However the weakest combinatorial for this property in F_1 and F_2 is the variety Arborio bjanko.

In the F_2 generation highly significant positive GCA values are obtained in varieties Biser-2 and Ranka. Positive, but not significant values were obtained for varieties Medusa and Y-136. Bad GCA showed Baldo, Loto and Arborio bjanko.

The results of the specific combining ability of the tested combinations are presented in Tab 3. In the F_1 generation 9 of 21 combinations are with negative and 12 with positive value, of which 3 are highly significant and 3 significant. The highest SCA values, highly significant have varieties Medusa x Loto (26.00), Arborio bjanko x Baldo (24.03) and Y-136 x Loto (21.61). In the first combination, both parents have bad GCA and in the other two combinations as

parents participate one variety with good GCA (Y-136 and Baldo) and one with bad GCA (Loto and Arborio bjanko).

In the F_2 generation positive SCA value is also in 9 combinations, but highly significant values were only 2 of them (Ranka x Loto and Biser x Medusa), and in one occur a significant difference. These combinations include one parent with good and one with poor to medium GCA for the number of grains per panicle. Chakraborty et al. (2009) also report that there is no direct correlation between the effect of GCA at parents and the effect of SCA in hybrid combinations.

Grains mass per panicle. - The values obtained from the analysis of variance of combining ability for grains mass per panicle show that there are highly significant differences for GCA and SCA and the same are an indicator of the impact of additive and non-additive genes in inheritance of this property. Higher GCA values from the SCA values show that in both studied generations the dominance belongs to the recessive genes.

In the F_1 generation their role is 3.15, and in F_2 9.98 times higher than the role of dominant genes. GCA and SCA values were significant in the results of Sabouri et al. (2013), that declared more power of additive genes, while in the results of Akter et al. (2010) the source of the variability of this property were the dominant genes.

The effect of general combining ability of parents can be seen from the values presented in Tab 2. In both generations, as the best combinatorial for the grains mass per panicle is rang the variety Biser-2, and immediately thereafter variety Baldo. Highly significant are only the values from the effect of GCA of those two varieties. In F_1 with positive but not significant GCA value is variety Y-136, and in F_2, variety Medusa.

However, the weakest combinatorial for this property in F_1 and F_2 generations proved variety Lotto.

Combining ability of each crossing separately is expressed through the SCA values, shown in Tab 3.

The highest SCA values, highly significant in F_1 generation have combinations Arborio bjanko x Baldo (1.16) and Medusa x Loto (0.82). In the first combination Arborio bjanko has bad GCA, while Baldo is the second rank, and in the second combinations both parents have bad GCA. With positive significant SCA values are featured combinations Y-136 x Loto, Y-136 x Ranka and Y-136 x Arborio bjanko. In all these combinations one parent is with good medium, and the other with bad GCA.

In the F_2 generation of all tested combinations, 11 were with positive SCA values. The same highly significant differ compared to the other at 3 of these combinations and significant in one. With the highest SCA value is combination Ranka x Loto, whose parents have bad GCA. That means that good combination between this parental pair refers specifically to this combination. The other two combinations Arborio bjanko x Baldo and Biser-2 x Arborio bjanko have highly significant SCA values. Both combinations were obtained by hybridization of one parent with good and one with bad GCA. One parent with good and one with bad are creators of the combination Biser-2 x Medusa, which SCA value is significant.

Conclusion

All examined properties have highly significant values for general and specific combining ability in both studied generations. According to this, in expression of the properties are involved additive and non-additive genes.

General combining ability of parental varieties used for surveyed properties is different. The best general combinatorial for length of panicle in both generations is the variety Biser-2, and also as the number of grains per panicle and mass of grains in panicle in the F_2 generation. Variety Ranka usually is second or third rank, followed by Y-136 as the best general combinatorial for length of panicle and the number of grains per panicle in the F_1 generation. That means that the variety Biser-2 can be reliably used as a parent in the future breeding programs to increase rice yield.

In the F_1 generation superior hybrids were obtained with combinations Arborio bjanko x Loto and Ranka x Baldo for length of panicle, and Medusa x Loto, Y-136 x Loto and Arborio bjanko x Baldo for number of grains per panicle. Combinations Medusa x Loto and Arborio bjanko x Baldo are promising for further monitoring and selection in relation to the mass of grains per panicle.

In the F_2 generation most promising hybrid combinations are Ranka x Loto, whose units are superior to all tested properties, Arborio bjanko x Baldo for length of panicle and mass of grains per panicle, and Biser-2 x Arborio bjanko for number of grains per panicle and mass of grains per panicle. At most of these combinations one parent has good and the other parent has bad to average GCA.

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