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Original Article

Analysis of Combining Ability in Rice Varieties for Quantitative Traits

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Abstract

Rice is staple food in Iran. Despite of high quality of local rice, their grain yield is low. In hybridization breeding programs, selection of suitable parents is an essential role for developing new combinations with broadens genetic diversity. Combining ability of local rice varieties namely 'Hashemi', 'Sang Jo' and 'Tarom Deylamani' and 'Nemat' was evaluated in a partial diallele analysis for agronomic traits in a randomized complete block design at Sari Agricultural Sciences and Natural Resources University. General combining ability (GCA) and specific combining ability (SCA) variances showed predominated role of additive gene effects in the inheritance of grain length. Both additive and non-additive components of genetic variances were important in the inheritance of traits like grain yield, plant height, panicle length, total grains per panicle, grain length and grain length to width. However, non-additive gene effects were seen for tiller number. Results showed that 'Nemat' was the best general combiner for most of characters followed by 'Tarom Deylamani'. The cross of 'Hashemi' × 'Tarom Deylamani' was suggested to exploitation of heterosis breeding for increasing yield and its components in rice breeding programs.

Keywords: combining ability; diallele analysis; gene action; quantitative; rice traits

Introduction

Rice is one of the world's most important foods for more than half of the world population. Rice is staple food in Iran and the country still largely depends on rice imports to meet the domestic consumer's demand (Nematzadeh *et al.*, 2006).

Agronomic characteristics such as yield are inherited as quantitative traits. The knowledge of inheritance of such quantitative traits helps breeders to employ desirable breeding method for improvement of traits. Breeders use combining ability analysis to test the performance of genotypes in different cross combinations and characterize the nature and magnitude of gene effects in the expression of yield and yield components. Diallele analysis have widely used in plant breeding as practical means for the evaluation of combining ability and heterotic patterns of varieties or inbred lines in cross combinations (Huang *et al.*, 2015).

Classical quantitative genetics is useful in practical rice improvement. Estimation of genetic parameters such as heterosis and combing ability gives inferences about the predominant action of the genes, indicates the appropriate selection strategy to be applied in the breeding program and allows the identification of the best parents.

Aromatic rice has narrow genetic base, scarcity of donor parents for grain quality and poor combining ability response. It is therefore necessary to focus breeding efforts on exploration of good combiners which can efficiently be hybridized to produce superior genotypes without loss of eating and cooking quality. So, success of breeding efforts mainly dependent on properly choice of parents, understanding of genetic control of yield and it components and adoption of desirable breeding method (Saleem *et al.*, 2010).

The aim of this study was to identify the best varieties on the basis of their general and specific combining ability for agronomic traits for yield improvement in rice.

Materials and Methods

This study involved four varieties namely 'Hashemi', 'Nemat', 'Sang Jo' and 'Tarom Deylamani'. 'Hashemi', 'Sang Jo' and 'Tarom Deylamani' are high quality land race varieties and 'Nemat' is high yielding improved variety derived from cross between 'Sang Tarom' and 'Amol3'. Crosses between parents, except reciprocals, were made in cropping season of 2015 and in the next year, six F1 hybrids and their parents (10 treatments) were grown in a randomized complete block design with three replications at Sari University of Agricultural Sciences and Natural Resources, Sari, Iran. Plots consisted of two rows of 20 plants each, with 20 x 20 cm planting pattern. Data were recorded on five randomly selected plants. Normal cultural practices were followed during the experiments. Data on plant height (cm), tiller number, panicle length(cm), total grains per panicle, grain length (mm), grain width (mm), grain length to width and grain yield (gr/plant) were

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recorded. Data were analysed by analysis of variance technique (Steel and Torrie, 1980) to determine genetic differences. Analysis of combining ability effects were performed by method II model I as described by Griffing (1956).

Results and Discussion

Analysis of variance carried out for studied traits and there are significant differences between genotypes for all of traits, except grain width, hence later analysis for combining ability was possible. The total genetic variability was partitioned to general combining ability (GCA) and specific combining ability (SCA). GCA and SCA variances showed predominated role of additive gene effects in the inheritance of grain length revealing important role of additive gene effects. This finding is in line with Asfaliza *et al.* (2012). Both additive and non-additive components of genetic variance were important in the inheritance of grain yield, plant height, panicle length, total grains per panicle, grain length and grain length to width (Table 1), which are well supported by other works (Pradhan *et al.*, 2006; Kumar *et al.*, 2007; Rahimi *et al.*, 2010). Therefore, these traits can be improved by selection method. Non-additive genetic effects (dominance & epitasis) were seen for tiller number, so production of hybrid varieties for heterosis exploration can be suitable breeding strategy for this trait. Non-additive genetic effects were also reported for tiller number by Bagheri and Jelodar (2010) and Mirarab *et al.* (2011).

The GCA effect, which determines the average performance of a parent in crosses, and is an estimate of its breeding value was estimated for each variety (Table 2). None of the parents was excellent general combiner for all the characters studied. This suggested use of multiple parent participation through multiple crossing to effect substantial improvement in yield and yield components. As regards to estimates for GCA (Table 2), variety of 'Nemat' appeared to be the best general combiner for most of traits like panicle length, total grains per panicle, grain length, grain width and grain length to width. Whereas, 'Tarom Deylamani' was the best general combiner for plant height, tiller number and grain yield.

SCA effect was further calculated for the judgment of the usefulness a particular cross in exploiting heterosis. The result was given in Table 3. Based on the results of SCA effects all hybrids, except 'Hashemi' × 'Sang Jo', had positive and significant SCA effect for plant height. Hybrids 'Hashemi' × 'Sang Jo', 'Hashemi' × 'Tarom Deylamani', 'Nemat' × 'Sang Jo' and 'Nemat' × 'Tarom Deylamani' were the best specific combinations for panicle length. Hybrid 'Hashemi' × 'Tarom Deylamani' and 'Nemat' × 'Sang Jo' had significant SCA effects for total grains per panicle. Hybrid 'Hashemi' × 'Tarom Deylamani' performed better for grain yield as well as for most important agronomic traits including tiller number, panicle length, total grains per panicle, grain length and grain length to width ratio.

Table 1. Mean performance of parents and hybrids for studied traits

Parent/hybrid	Height (cm)	Tiller No.	Panicle length (cm)	Total grain no.	Grain length (mm)	Grain width (mm)	Length: width ratio	Yield (gr/plant)
'Hashemi'	138.37	8.12	29.25	107.12	10.06	2.01	5.00	29.39
'Nemat'	114.72	16.25	30.69	161.50	11.89	2.02	5.88	34.26
'Sang jo'	128.50	10.00	26.56	111.12	10.06	1.99	5.06	25.87
'Tarom Deylamani'	143.00	13.37	27.81	141.37	10.18	2.00	5.08	35.38
'Hashemi'/'Nemat'	140.50	11.25	29.62	134.00	10.30	2.01	5.12	36.45
'Hashemi'/'Sang Jo'	134.25	11.00	30.81	127.87	10.03	1.99	5.05	31.34
'Hashemi'/'Tarom Deylamani'	172.12	22.12	34.56	155.87	10.88	1.98	5.48	57.24
'Nemat'/'Sang Jo'	167.75	15.12	31.59	179.75	10.80	2.09	5.17	30.76
'Nemat'/'Tarom Deylamani'	165.37	15.50	32.25	155.00	10.74	2.04	5.26	33.32
'Sang Jo'/'Tarom Deylamani'	154.62	11.37	29.56	150.00	10.10	1.97	5.12	30.11
$LSD_{0.05}$	6.15	4.97	1.44	21.30	0.46	0.05	0.24	11.37

Table 2. Analysis of variance for studied traits

Source of variation	Degree of freedom	Height (cm)	Tiller No.	Panicle length (cm)	Total grain no.	Grain length (mm)	Grain width (mm)	Length: width ratio	Yield (gr/plant)
Treatment	9	1388.2**	64.67**	20.58**	2072.42**	1.39**	0.005	0.29**	296.49*
Block	3	48.66	8.18	0.586	368.49	0.91	0.003	0.006	351.70
Error	27	26.12	17.06	1.44	312.77	0.144	0.002	0.040	89.16
CV (%)		3.5	30.8	4.0	12.4	3.6	2.2	3.8	27.4

*, ** are significant and high significant at 0.05 and 0.01 statistical levels, respectively

Table 3. Analysis of variance for combining ability

Source of variation	Degree of freedom	Height (cm)	Tiller No.	Panicle length (cm)	Total grain no.	Grain length (mm)	Grain width (mm)	Length: width ratio	Yield (gr/plant)
GCA	3	743.67**	58.18	12.53**	3287.13**	2.98**	0.005	0.458**	291.67*
SCA	6	1710.55**	3.98*	24.61**	1465.07**	0.598**	0.005	0.202**	298.91*
Error	27	26.12	17.06	1.44	312.77	0.144	0.002	0.040	89.16
MSGCA/MSSCA		0.43ns		0.51ns	2.24ns	4.98*		2.27ns	0.98ns

Ns, *, ** are non-significant, significant and high significant at 0.05 and 0.01 statistical levels, respectively

Table 4. Estimation of GCA effects for studied traits

Cultivar	Height (cm)	Tiller No.	Panicle length (cm)	Total grain no.	Grain length (mm)	Grain width (mm)	Length: width ratio	Yield (gr/plant)
'Hashemi'	-1.00	-1.07	0.357	-13.30**	-0.20**	-0.007	-0.08*	1.96
'Nemat'	-4.42**	1.22	0.581**	13.32**	0.52**	0.022**	0.20**	-0.50
'Sang Jo'	-2.67**	-1.59*	-1.045**	-5.32	-0.25**	-0.006	-0.11**	-4.68**
'Tarom Deylamani'	8.08**	1.45*	0.107	5.30	-0.07	-0.009	-0.01	3.23*
S.E. GCA	0.903	0.730	0.212	3.13	0.067	0.008	0.036	1.67

Ns, *, ** are non-significant, significant and high significant at 0.05 and 0.01 statistical levels, respectively

Table 5. Estimation of SCA effects for studied traits

Hybrid	Height (cm)	Tiller No.	Panicle length (cm)	Total grain no.	Grain length (mm)	Grain width (mm)	Length: width ratio	Yield (gr/plant)
'Hashemi'/'Nemat'	-0.008	-2.31*	-1.58**	-8.38	-0.521**	-0.01	-0.223**	0.58
'Hashemi'/'Sang Jo'	-8.01**	0.25	1.23**	4.14	-0.028	-0.01	0.015	-0.34
'Hashemi'/'Tarom Deylamani'	19.12**	8.34**	3/83**	21.51**	0.644**	-0.01	0.350**	17.64**
'Nemat'/'Sang Jo'	28.91**	2.09	1.78**	29.39**	0.023	0.06**	-0.145*	1.54
'Nemat'/'Tarom Deylamani'	15.78**	-0.58	1.29**	-5.99	-0.207*	0.02	-0.149*	-3.82
'Sang Jo'/ 'Tarom Deylamani'	3.28*	-1.89	0.23	7.66	-0.082	-0.02	0.023	-2.84
S.E. SCA	1.616	1.306	0.379	5.593	0.120	0.014	0.064	2.99

*, ** are significant and high significant at 0.05 and 0.01 statistical levels, respectively

Conclusions

'Nemat' was found to be the best general combiner with 5 characters followed by 'Tarom Deylamani' with 3 characters. The cross of 'Hashemi' × 'Tarom Deylamani' can be exploited by heterosis breeding for increasing yield and its components.

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Conflict of Interest

The author declares that there are no conflicts of interest related to this article.

References

Asfaliza R, Rafii MY, Saleh G, Omar O, Puteh A (2012). Combining ability and heritability of selected rice varieties for grain quality traits. Australian Journal of Crop Science 6(12):1718-1723.

Bagheri N, Jelodar NB (2010). Heterosis and combining ability analysis for yield and related-yield traits in hybrid rice. International Journal of Biology 2(2):222-231.

Griffing B (1956). Concept of general and specific combining ability in relation to diallel crossing system. Australian Journal of Biological Sciences 9(4):463-493.

Huang M, Chen LY, Chen ZQ (2015). Diallel analysis of combining ability and heterosis for yield and yield components in rice by using positive loci. Euphytica 205(1):37-50.

Kumar ST, Narasimman R, Eswaran R, Kumar CPS, Thangavel P (2007). Studies on the relationship among per se performance, combining ability effects and heterosis in rice (*Oryza sativa* L.). International Journal of Plant Sciences 2(1):195-198.

Mirarab M, Ahmadikhah A, Pahlavani MH (2011). Study on combining ability, heterosis and genetic parameters of yield traits in rice. African Journal of Biotechnology 10(59):12512-12519.

Nematzadeh GA, Ali AJ, Sattari M, Valizadeh A, Alinejad E, Nouri MZ (2006). Relationship between different allogamic associated trait characteristics of the five newly developed cytoplasmic male sterile (CMS) lines in rice. Journal of Central European Agriculture 7(1):49-56.

Pradhan SK, Bose LK, Meher J (2006). Studies on gene action and combining ability analysis in Basmati rice. Journal of Central European Agriculture 7(2):267-272.

Rahimi M, Rabiei B, Samizadeh H, Kafi Ghasemi A (2010). Combining ability and heterosis in rice (*Oryza sativa* L.) cultivars. Journal of Agricultural Sciences and Technology 12(2):223-231.

Saleem MY, Mirza JI, Haq MA (2010). Combining ability analysis for yield and related traits in basmati rice (*Oryza sativa* L.). Pakistan Journal of Botany 42(1):627-637.

Steel RGD, Torrie JH (1980). Principles and procedures of statistics: a biometrical approach (2nd ed). McGraw-Hill Inc New York.