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HETEROSIS AND COMBINING ABILITY ANALYSIS FOR FEW COLD TOLERANT RICE GERMPLASM LINES AT THEIR SEEDLING STAGE

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ABSTRACT

Rice yields are low during *rabi* season when compared to kharif due to cold effect at seedling stage. In the present study, 4 lines and 4 testers were crossed with 4 testers in L X T mating design. The resultant 16 F_1s were used to determine the heterosis. IR-64, Ujala Depama and MALIDA are identified as good general combiners. IR64 X Ujala Depama, IR64 X Malida and MTU-1010 X Ujala Depama are good specific combinations . IR64 X Ujala Depama, IR64 X Malida and Krishna Hamsa X Parwa Panki are the best heterotic lines for the character under study.

INTRODUCTION

Rice has been one of the world's most important food crops, and staple food for 65% of the global population and forms the cheapest source of food, energy and protein (Khush, 1997). In India, rice is cultivated by different methods under diverse environmental conditions To meet the food demand of the growing population and to achieve food security in the country, the present production levels need to be increased by 2 million tones every year, which is possible through heterosis breeding and other innovative breeding approaches. Heterosis in rice was first reported by Jones (1926). Rice yields are low in Telangana region during *rabi* season due to cold effect. In Telangana region the low temperature vary from 8°C to 16°C starting from December to first fortnight of February. In general, positive heterosis is desired for yield and negative heterosis for early maturity (Nuruzzaman *et al*., 2002). From a practical point of view, standard heterosis is the most important of the two levels of heterosis because it is aimed at developing desirable hybrids superior to the existing high yielding commercial varieties (Chaudhary, 1984). Breeding strategies based on hybrid production require a high level of heterosis as well as the specific combining ability (SCA) of crosses.

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Line X Tester analysis is one of the most powerful tools for estimating the general combining ability (GCA) of parents and selecting of desirable parents and crosses with high SCA for the exploitation of heterosis (Salgotra *et al*., 2009). The general combining ability (GCA) identifies superior parental genotypes while specific combining ability (SCA) helps in identification of good hybrid combinations which may ultimately lead to the development of hybrids (Saleem *et al*., 2008). Line x Tester (Kempthorne, 1957) analysis is one of the most powerful tools for estimating the GCA of parents and selection of desirable parents and crosses with high SCA for the exploitation of heterosis (Tiwari *et al*., 2011). The values ranged from 18-59%, 5-42% and 7-35% for mid-parent, better parent and standard heterosis, respectively. Significant GCA and SCA for yield and yield components were also reported by Borgohain and Sarma (1998). Seedling stage is the most sensitivity one at the whole rice growth stages to cold stress, which severely affects rice yields. The objectives of this study were to evaluate GCA and SCA in rice cultivars and heterosis of different traits for identifying desirable cultivars with cold tolerance at the seedling stage.

MATERIALS AND METHODS

In the present study, 4 lines were crossed with 4 testers in L X T mating design and the resultant 16 F_1s were used to determine the heterosis, combining ability as well as the gene action on yield and yield components (Roy and Mandal

(2001). The parents used as lines were IR-64, vikas, Krishna Hamsa, MTU1010. Testers were Malida, Ujala Depama, Bhurma bhuki, Parwa Panki. In 2010 *Rabi* season, the F1 hybrids along with parents were grown in trays in green house conditions up to 30 days seedlings to study the effect of cold on Rice seedlings. The seedlings were exposed to cold stress at 8^0C to 10^0C in green house conditions. Observations were recorded on five competitive plants of each plot for five morphological parameters viz. germination %, coleoptile length, seedling growth, radical length and seed vigor. The mean data were recorded on five randomly selected plants from parents and F1's from each replication. Heterosis was estimated from mean values according to the Fehr (1987). The significance of different types of heterosis was carried out by adopting 't test' as suggested by Nadarajan and Gunasekaran (2005) as given below:

$$\text{Mid parent (relative heterosis)} = \frac{\overline{F_1}-\overline{MP}}{\overline{MP}} \times 100$$

$$\text{Better parent (heterobeltiosis)} = \frac{\overline{F_1}-\overline{BP}}{\overline{BP}} \times 100$$

Where: Fij-F1 cross of i and j parent, MP- mean mid parental performance same cross, BP-Mean performance of better parent and CV- mean performance of commercial variety. However, combining ability analysis was done using line × tester method (Kempthorne, 1957). The variances 91for general combining ability (GCA) and specific combining ability (SCA) were tested against their respective error variances derived from ANOVA reduced to mean level. Significance test for GCA and SCA effects were performed using t-test.

Significance of GCA effects of lines is tested as $t = g_i / SE(g_i)$

Significance of GCA effects of testers is tested as $t = g_j / SE(g_j)$

Significance of SCA effects of hybrids is tested as $t = Sij / SE(Sij)$

RESULTS AND DISCUSSION

The analysis of variance for combining ability of all the traits under study is presented in the (Table 1) which showed that variances due to treatments (parents+ crosses), parents, hybrids were highly significant for all the characters. The variance due to parent vs. hybrids was also found highly significant for almost all the characters (Rahimi *et al*., 2010).

The significant differences between lines x testers interaction indicates that SCA attributed heavily in the expression of these traits and demonstrates the importance of dominance or non additive variances for all the traits. (Sanghera and Hussain, 2012). Significant variances due to lines x testers interaction for all the characters suggested the presence of significant variances for SCA among the hybrids (Table 2). Estimates of highly significant GCA and SCA variances for all the characters indicated the importance of both additive and non additive gene action in the expression of the characters. The ratio of σ2 gca/σ2 sca was less than unity for all the characters and this also indicated pre- ponderence of non- additive genetic variance. It suggested greater importance of non-additive gene action in their expression and indicated very good prospect for the exploitation of non- additive genetic variation for grain and its component characters through hybrid breeding. IR-64, Ujala Depama and Malida are identified as good general combiners for the germination %. IR64 X Ujala Depama, IR64 X Malida and Krishna Hamsa X Bhurma Bhuqi are recorded as good specific combiners for the character germination%. IR64 X Ujala Depama, IR64 X Malida and Vikas X Bhurma Bhuqi are good heterotic combinations for the character germination %. These results are in accordance with Changrong Ye *et al* (2008).

Krishna Hamsa, MTU1010 and Parwa Panki are recognized as good general combiners for coleoptile length. IR64 X Parwa Panki, IR64 X Bhurma Bhuqi and Vikas X Malida are identified as good specific combiners for the character coleoptile length. Krishna Hamsa X Ujala Depama, Krishna Hamsa X Parwa Panki and MTU-1010 X Ujala Depama are the best heterotic combinations for the character coleoptile length. These results follows the Rahimi *et al* (2010). Ujala Depama, IR-64 and Krishna Hamsa are good general combiners for the character seedling growth. IR64 X Ujala Depama, Krishna Hamsa X Parwa Panki and MTU1010 X Bhurma Bhuqi are identified as good specific combiners for the character seedling growth. Krishna Hamsa X Ujala Depama, IR64 X Ujala Depama and IR64 X Malida are the best heterotic combinations for seedling growth and results are found in accordance with Vanaja *et al* (2000). MTU1010, Krishna Hamsa and Parwa Panki are good general combiners for the character radical length. IR64 X Parwa Panki, IR64 X Bhurma Bhuqi and Vikas X Ujala Depama are good specific combinations for the character radical length. MTU-1010 X Malida, MTU-1010 X Ujala Depama and IR64X Bhurma Bhuqi are identified as best heterotic combinations for the character radical length. These results are in accordance with Muhammad Rashid *et al* (2007).

Table 1. Analysis of variance for line × tester and combining ability

Source of variation	d.f	Germination %	Coleoptile length	Seedling growth	Radical lengthg	Seed vigor
replications	2	159.3	84.02	40.01	49153.6	299698.9
treatments	23	983.2	168.4	61.9	3499564.9	1280121.7
Crosses	15	1451.7	240.2	92.7	4962511.4	1873969.5
Line	3	2163.9	843.1	141.6	4250557.00	3998226.05
Tester	3	1295.00	122.5	158.5	1666740.8	1343698.5
LXT	9	1266.6	81.8	54.5	2965086.4	1342641.00
error	46	163.10	43.2	22.00	167016.1	368766.4

Table 2. Good general combiners, good specific combinations and gca effects of parents involved and heterotic combinations for the characters related to cold tolerance

Character	Good general combiner	Good specific combinations	Gca effects	Heterotic combinations (Standard heterosis)
Germination %	IR-64	IR64 X Ujala Depama	20.04	IR64 X Ujala Depama
	Ujala Depama	IR64 X Malida	12.96	IR64 X Malida
	Malida	Krishna Hamsa X Bhurma Bhuqi	3.80	Vikas X Bhurma Bhuqi
Coleoptile length	Krishna Hamsa	IR64 X Parwa Panki	7.36	Krishna Hamsa X Ujala Depama
	MTU1010	IR64 X Bhurma Bhuqi	4.19	Krishna Hamsa X Parwa Panki
	Parwa Panki	Vikas X Malida	2.75	MTU-1010 X Ujala Depama
Seedling growth	Ujala Depama	IR64X Ujala Depama	5.23	Krishna Hamsa X Ujala Depama
	IR-64	Krishna Hamsa X Parwa Panki	4.81	IR64 X Ujala Depama
	Krishna Hamsa	MTU1010 X Bhurma Bhuqi	0.03	IR64 X Malida
Radical length	MTU1010	IR64 X Parwa Panki	711.42	MTU-1010 X Malida
	Krishna Hamsa	IR64 X Bhurma Bhuqi	518.69	MTU-1010 X Ujala Depama
	Parwa Panki	Vikas X Ujala Depama	434.85	IR64 X Bhurma Bhuqi
Seed vigor	IR-64	IR64 X Ujala Depama	865.83	IR64 X Ujala Depama
	Ujala Depama	IR64 X Malida	324.17	IR64 X Malida
	MALIDA	MTU-1010 X Ujala Depama	253.25	Krishna Hamsa X Parwa Panki

Conclusion

IR-64, Ujala Depama and MALIDA are identified as good general combiners for the character seed vigor. IR64 X Ujala Depama, IR64 X Malida and MTU-1010 X Ujala Depama are good specific combinations for the character seed vigor. IR64 X Ujala Depama, IR64 X Malida and Krishna Hamsa X Parwa Panki are the best heterotic lines for the character seed vigor.

REFERENCES

Borgohain, R. and Sarma, N. K. 1998. Combining Ability for Grain Yield and Its Component Characters in Deepwater Rice. Crop Res. Hisar, 16(2): 215-219.

Changrong Ye., Shu Fukai., Russell Reinke., Ian Godwin., Peter Snell and Jaya Basnayake. 2001. Screening rice genetic resources for cold tolerance at different growth stages. Proceeding of the 10th Australian Agronomy Conference, Hobart, Australia, 28 January 28- 1 February.

Chaudhary, R. C. 1984. Introduction to Plant Breeding. New Delhi, Oxford and IBH.

Fehr WR (1987). Heterosis, 115 p. In: Principles of cultivar development: Theory and Techniques (Vol.1). Macmillan Publishing Company. New York.

Jones, J. W. 1926. Hybrid Vigour in Rice. J. Am. Soc. Agron., 18: 423-428.

Khush GS (1997). Breaking the yield barrier of rice. Geo J 35:329-332.

Muhammad Rashid., Akbar Ali Cheema and Muhammad Ashraf. 2007. Line x tester analysis in basmati rice. Pak. J. Bot., 39(6): 2035-2042.

Nadarajan N, Gunasekaran M (2005). Quantitative genetics and biometrical techniques in plant breeding. Kalyani publishers, New Delhi, 57-60 p.

Nuruzzaman, M., Alam, M. F., Ahmed, M. G., Shohael, A. M., Biswas, M. K., Amin, M. R. and Hossain, M. M. 2002. Studies on Parental Variability and Heterosis in Rice. Pakistan J. Biol. Sci., 5(10): 1006-1009.

Rahimi,M., Rabiei, B., Samizadeh, H and Kafi Ghasemi, A. 2010. Combining Ability and Heterosis in Rice (Oryza sativa L.) Cultivars. Journal of Agr. Sci. Tech. Vol. 12: 223-231.

Roy, B. and A.B. Mandal. 2001. Combining ability of some quantitative traits in rice. Ind. J. Genet., 61(2): 162-164.

Salgotra RK, Gupta BB, Praveen S (2009). Combining ability studies for yield and yield components in basmati rice. Oryza 46(1):12-16.

Sanghera GS, Hussain W (2012). Heterosis and combining ability estimates using line x tester analysis to develop rice hybrids for temperate conditions. Not Sci Biol 4(3):131-142.

Tiwari DK, Pandey P, Giri SP, Dwivedi JL (2011). Heterosis studies for yield and its components in rice hybrids using CMS system. Asian J Plant Sci 10:29-42.

Vanaja, T., Luckins, C., Babu., Radhakrishnan, V.V and Pushkaran, K. 2003. Combining ability analysis for yield and yield components in rice varieties of diverse origin. Journal of Tropical Agriculture 41: 7-15.

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