Short Communication **Oryza Vol. 46. No.2, 2009 (152-155)**

Combining ability for grain quality characters in *indica/indica* hybrids of rice

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ABSTRACT

Eighteen indica/indica hybrids developed by crossing three lines with six testers were screened for various grain quality traits to assess the combining ability of the parents. For head rice recovery, the crosses involving IR 58025A with MTU 9992 and KMR-3, IR 62829A with MTU 9992 and IR 29723 and IR 68886A with IR 40750R and IR 21567 showed significant positive specefic combining ability (sca) effects. For kernel length, IR 58025A and IR 68886A among lines and MTU 9992 and IR 21567 among testers showed positive significant general combining ability (gca) effects. The magnitude of s2gca/s2sca revealed the predominance of non-additive genetic variance for most of the quality characters. For gel consistency, IR 62829A among lines and Ajaya R and IR 40750 R among testers registered significant positive gca effects indicating them to be good general combiners for obtaining hybrids with soft gel consistency. The predominance of non-additive component for most of the quality characters of economic importance offers considerable scope for exploitation of hybrid vigour through heterosis or hybridization and selection.

Key words: *Rice hybrid, combining ability, quality characters*

Hybrid technology is one of the most important approaches to realize higher yields in rice. The high yield potential of *indica*/*indica* hybrids is yet to be fully tapped by utilizing the genetically diverse material. The parents should have good combining ability to express better yield potential. The combining ability of parents in terms of quality traits should be good so as to get hybrids with desirable quality attributes for consumer preference. This requires identification of parents with good general combining ability (gca) and superior cross combinations for various grain and cooking quality attributes. Therefore, the present investigation was undertakne for assessment of combining ability of indica parents based on the performance of their hybrids as a tool for the breeders in identifying those parents and their hybrids that have desirable yield and quality components.

Three CMS lines and six restorers were grown and crosses were attempted to get 18 *indica*/*indica* hybrids following line x tester design (Kempthorne, 1957). The F_1s were grown and the produce was used for quality analysis for hulling percentage (HP), milling percentage (MP), head rice recovery (HRR), kernel length (KL), kernel breadth (KB), L/B ratio, kernel length after cooking (KLAC), elongation ratio (ER), water uptake (WU), volume expansion ratio (VER), alkali spreading value (ASV), gel consistency (GC) and amylose content (AC).The of the parents and specific combining ability (*sca*) of the hybrids for grain and cooking quality traits were worked out to identify desirable parental and hybrid combinations in respect of these quality attributes.

None of the lines showed significant *gca* effects while MTU 9992 and KMR 3 among the testers showed significant positive (2.14) and negative (-1.60) *gca* effects for milling percentage (Table 1). For head rice recovery, the crosses involving IR 58025A with MTU 9992 (6.48) and KMR 3 (7.43), IR 62829A with MTU 9992 (5.18) and IR 29723 (4.95) and IR 68886A with IR 40750R (4.32) and IR 21567 (5.46) showed significant positive *sca* effects (Table 2). For kernel length, IR 58025A and IR 68886A among lines and MTU 9992 and IR 21567 among testers showed positive significant *gca* effects. However, only one cross viz., IR 58025A x Ajaya R showed positive *sca* effect (0.18) involving parents with high x low *gca*. The choice of hybrids for this trait depends upon regional preference. In areas where longer kernels are preferred,

Table 1. Estimates of general combining ability effects of parents involved in *indica*/*indica* crosses for different quality traits

Parents	Hulling (%)	Milling (%)	HRR (%)	KL (mm)	KB (mm)	L/B ratio	KLAC (mm)	ER	WU (ml)	VER	ASV	GC (mm)	AC (%)
Lines													
IR 58025A	0.32	0.39	1.83*	0.24**	-0.04**	0.19**	0.31**	-0.01	16.11**	-0.03	1.48	-5.36**	-2.41**
IR 62829A	-0.49	-0.60	0.13	-0.33**	0.02	-0.19**	-0.65**	-0.02	6.11*	-0.01	0.17	10.47**	0.91**
IR 68886A	0.16	0.21	-1.96*	0.09**	0.02	0.005	0.33**	0.03	-22.22**	0.05	-1.66*	-5.11**	1.49**
Testers													
Ajaya R	-0.58	-0.40	4.27**	-0.08	-0.05**	0.03	0.26*	0.07**	19.44**	0.17	0.70**	9.22**	1.50**
MTU 9992	1.81	2.14**	-16.79**	0.11*	-0.03*	0.11**	0.23*	0.01	-5.55	0.12	-1.49**	-7.94**	-1.14**
KMR 3	-1.44	-1.60*	-0.19	-0.25**	0.11**	-0.28**	-0.46**	-0.01	-22.22**	0.39*	-1.22**	-6.94**	0.55**
IR 40750R	0.85	1.27	4.40**	-0.09*	-0.05*	0.04	-0.20	-0.008	-0.55	-0.04	-0.88**	4.55**	-2.41*
IR 29723	1.00	0.52	5.13**	0.05	-0.005	0.02	0.20	0.01	7.77*	-0.38*	2.33**	0.55	0.98**
IR 21567	-1.64	-1.92	3.17**	0.26**	0.04*	0.06*	-0.03	-0.07**	1.11	-0.25	0.56**	0.55	0.50**
SE (gi) line	0.459	0.490	0.733	0.031	0.012	0.021	0.077	0.016	2.615	0.109	0.072	1.262	0.111
SE (gj) tester	0.649	0.693	1.037	0.044	0.017	0.030	0.109	0.023	3.698	0.155	0.102	1.785	0.157
SE (gi-gj) line	0.649	0.693	1.037	0.044	0.017	0.030	0.109	0.023	3.698	0.155	0.102	1.785	0.157
SE (gi-gj) tester	0.919	0.980	1.467	0.063	0.024	0.043	0.154	0.033	5.230	0.219	0.144	2.525	0.223

* Significant at 5% level
** Significant at 1% level

Table 2. Estimates of specific combining ability effects of *indica*/*indica* hybrids for various quality traits

Cross combinations	Hulling (%)	Milling (%)	HRR (%)	KL (mm)	KB (mm)	L/B ratio	KLAC (mm)	ER	WU (ml)	VER	ASV	GC (mm)	AC (%)
IR 58025A x Ajaya R	0.08	0.84	-4.08*	0.18*	0.17**	-0.18**	-0.31	-0.10**	-16.11*	-0.005	0.06	-0.13	1.09**
IR 58025A x MTU 9992	*-0.46*	*-1.75*	*6.48***	*0.09*	*-0.03*	*0.10*	*0.21*	*0.008*	*-11.11*	*-0.04*	*0.51***	*3.02*	*0.34*
IR 58025A x KMR 3	-2.44*	-2.60*	7.43**	-0.15	0.003	-0.10	0.11	0.06	20.55**	-0.06	1.04**	-5.47	1.89**
IR 58025A x IR 40750R	0.005	0.50	-0.36	-0.12	-0.15**	0.18**	-0.35	-0.02	23.88**	-0.31	0.23	10.02**	-3.03**
IR 58025A x IR 29723	1.20	1.20	-3.39	-0.10	0.02	-0.09	-0.15	-0.001	-19.44**	0.38	-1.81**	-5.97	0.46
IR 58025A x IR 21567	1.60	1.80	-6.08**	0.10	-0.02	0.08	0.48*	0.05	2.22	0.03	-0.04	-1.47	-0.75*
IR 62829A x Ajaya R	-1.88	-3.00	1.76	-0.04	-0.17**	0.23**	0.35	0.07	-6.11	-0.49	1.46**	3.52	-1.63**
IR 62829A x MTU 9992	0.56	1.69	5.18**	-0.0006	0.04	-0.07	0.28	0.05	13.88*	0.01	-1.17**	-9.30**	0.96**
IR 62829A x KMR 3	0.83	1.29	-8.56**	0.008	0.05	-0.04	-0.51*	-0.10	-4.44	0.24	-1.44**	-1.30	1.06
IR 62829A x IR 40750R	1.43	0.008	-3.96*	0.07	0.15**	-0.20**	0.31	0.03	13.88*	-0.05	-0.28	-17.30**	2.33**
IR 62829A x IR 29723	-1.46	-0.79	4.95*	-0.10	-0.10**	0.09	-0.38	-0.03	-14.44*	-0.01	-0.007	20.69**	-1.86**
IR 62829A x IR 21567	0.53	0.80	0.61	0.06	0.01	0.003	-0.05	-0.02	-2.77	0.30	1.43**	3.69	-0.88**
IR 68886A x Ajaya R	1.79	2.16	2.31	-0.13	-0.009	-0.05	-0.03	0.02	22.22**	0.49	-1.53**	-3.38	0.53
IR 68886A x MTU 9992	-0.10	0.06	-11.67**	-0.09	-0.009	-0.03	-0.50*	-0.06	-2.77	0.02	0.66	6.27	-1.31**
IR 68886A x KMR 3	1.61	1.31	1.12	0.14	-0.05	0.15**	0.40*	0.03	-16.11*	-0.18	0.39	6.77*	-2.96**
IR 68886A x IR 40750R	-1.43	-0.51	4.32*	0.04	-0.004	0.01	0.03	-0.006	-37.77**	0.36	0.05	7.27*	0.70**
IR 68886A x IR 29723	0.26	-0.41	-1.55	0.20	0.07*	0.002	0.53**	0.03	33.88**	-0.36	1.82**	-14.72**	1.40**
IR 68886A x IR 21567	-2.13	-2.61*	5.46**	-0.16	0.003	-0.08	-0.43*	-0.03	0.55	-0.34	-1.39**	-2.22	1.63**
SE (sij)	1.125	1.201	1.797	0.077	0.030	0.053	0.188	0.040	6.405	0.268	0.177	3.093	0.273
SE (sij- sjk)	1.591	1.699	2.541	0.109	0.042	0.075	0.267	0.057	9.058	0.380	0.250	4.374	0.386

* Significant at 5% level
**Significantat1%level

the parents with high *gca* and those crosses with positive *sca* are desirable. For cooking quality traits like kernel length after cooking, three crosses viz., IR 68886A x IR 29723 (0.53) followed by IR 58025A x IR 21567 (0.48) and IR 68886A x KMR 3 (0.40) showed significant positive *sca* effects involving parents with high x average and high x low combining ability. Statistically significant negative *gca* effects were recorded by IR 68886A and KMR 3 for water uptake while for volume expansion ratio, none of the lines showed significant *gca* estimates while KMR 3 and IR 29723 among the testers registered significant positive and negative *gca* effects. However, none of the *indica/indica* crosses registered significant *sca* effects for volume expansion. The magnitude of s2*gca*/s2*sca* revealed the predominance of non-additive genetic variance for most of the quality characters. Sharma and Mani (1997) observed additive and non-additive gene effects to be predominant for kernel elongation and volume expansion ratio.

As regards gel consistency, IR 62829A (10.47) among lines and Ajaya R (9.22) and IR 40750 R (4.55) among testers registered significant positive *gca* effects indicating them to be good general combiners for obtaining hybrids with soft gel consistency. For amylose content, among 18 *indica/indica* crosses, seven crosses showed significant negative *sca* effects. The predominance of non-additive component for most of the quality characters of economic importance offers considerable scope for exploitation of hybrid vigour through heterosis or hybridization and selection. These results are in accordance with those reported by Pooni *et al.,* (1993), Singh and Singh (1993) and Xu *et al.,* (1997).

For milling traits like hulling percentage, milling percentage and head rice recovery, parents with higher *gca* are desirable. Heterotic crosses showing high *sca* effects for these traits were derived from parents possessing high x high and low x high *gca*. However, for grain quality traits like kernel length, kernel breadth, L/B ratio and kernel length after cooking, the choice of parents for developing specific hybrids depends on regional preference. For northern parts of the country where long kernels are preferred, the parents having good *gca* and heterotic crosses showing high *sca* effects for kernel length, L/B ratio and kernel length after cooking are preferred, whereas in other parts of the country where medium slender and short slender grain types are preferred, the parents with average *gca* are desirable.

For cooking quality traits like water uptake and volume expansion ratio, the hybrids with intermediate values are preferred. Hence, parents with average or moderate combining ability with average *sca* effects are to be crossed to obtain desirable hybrids. For physico-chemical traits like gelatilization temperature, gel consistency and amylose content also, intermediate values are preferred and in this case also to obtain hybrids with intermediate gelatinization temperature and amylose content and medium to soft gel consistency, the parents with average combining ability are preferred which would yield crosses with average *sca* effects for these traits.

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