Madras Agric. J. 90 (1-3) : 37-40 January-March 2003

Combining ability for yield and different quality traits in rice

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Abstract: Combining ability studies in rice for kernel quality traits revealed non-additive gene action for all the characters. Based on *per se* performance and *gca* effects, ADT-38, Improved White Ponni, Pusa Basmati 1 and Taraori Basmati were the best parents for improvement of quality traits besides grain yield. ADT-38/Pusa Basmati 1 and Improved White Ponni/Pusa Basmati 1 were suitable for recombination breeding, while Improved White Ponni / Taraori Basmati and Improved White Ponni / Pusa Basmati 1 may be exploited for heterosis breeding.

Key Words: Rice, Kernel quality, Combining ability.

Introduction

For a systematic breeding programme, it is essential to identify the parents and crosses for further genetic improvement. Combining ability of the parents gives useful genetic information regarding the selection of parents in terms of the performance of their hybrids. Even though many studies have been made on the combining ability for yield and component traits in rice, information on the combining ability for kernel quality traits is limited. Hence, an attempt was made to study the combining ability of kernel quality characters through line x tester analysis.

Materials and Methods

Five high yielding cosmopolitan rice varieties, *viz.* ASD 19, ADT 38, ADT 39, CO 43 and Improved White Ponni (Lines) were crossed with three Basmati varieties *viz.* Taraori Basmati, Pusa Basmati 1 and Basmati 370 (Testers). The resultant 15 hybrids along with 8 parents were raised during the Kuruvai 1996 (May – Sept) at the Plant Breeding Farm, Department of Agricultural Botany, Faculty of Agriculture, Annamalai University, Annamalai Nagar, in randomised block design in two rows of 3m length adopting a spacing of 30 x 20 cm. Observations were recorded on ten randomly selected plants per replication both in parents and in hybrids for kernel length, kernel L/B ratio, kernel length after cooking, kernel elongation, elongation index and grain yield. Analysis of combining ability was done as per Kempthorne (1957).

Results and Discussion

The variance due to lines and testers and the interaction effects between lines and testers were significant for all the characters. The variance due to *sca* were of greater in

Table 1. Analysis of variance for combining ability

Source of variation	df	Kernel length	Kernel L/B ratio	Kernel length after cooking	Kernel elongation	Elongation index	Grain yield
Line (L)	4	0.638**	0.308**	4.435**	0.047**	0.067**	214.913**
Tester (T)	2	0.119**	0.063**	0.469**	0.059**	0.043**	246.060**
L x T	8	0.056**	0.033**	0.199**	0.014*	0.007**	84.160**
GCA		0.006	0.003	0.044	0.001	0.0002	2.138
SCA		0.013	0.011	0.046	0.003	0.0017	26.230

* Significant at 5 per cent level; ** Significant at 1 per cent level

Table 2. Mean performance and general combining ability effects for kernel traits

Parent	Kernel length		Kernel L/B ratio		Kernel length after cooking		Kernel elongation		Elongation		Grain yield	
	Mean (mm)	*gca*	Mean	*gca*	Mean (mm)	*gca*	Mean	*gca*	Mean	gca	Mean (g)	*gca*
Line												
ASD 19	5.34	-0.42*	2.39	-0.22*	7.77	-1.08*	1.61	-0.01	1.13	0.01	25.43	-2.38*
ADT 38	6.39*	0.31*	3.29	0.23*	8.57	0.82*	1.43	0.07*	0.93	0.01	28.09	-2.09*
ADT 39	5.48	0.05	2.56	-0.01	7.99	0.00	1.48	-0.01	0.99	-0.02*	38.44*	4.56*
CO 43	5.58	0.10*	2.43	-0.13*	8.28	-0.09	1.49	-0.11*	1.19	-0.03*	24.09	-5.74*
IW Ponni @	5.44	-0.04	2.85	0.13*	8.08	0.35*	1.53	0.07*	1.03	0.04*	33.03*	5.64*
SE		0.04		0.01		0.08		0.02		0.01		0.78
Tester												
T.B. @	7.66*	0.10*	4.51*	0.07*	12.91*	0.06	2.06*	-0.02*	1.35*	-0.02*	26.04	4.66*
P.B.1@	7.45*	-0.07*	4.46*	-0.03*	12.20*	0.14*	2.10*	0.07*	1.41*	0.06*	24.98	-2.65*
B.370 @	7.54*	-0.03	4.46*	-0.04*	11.80*	-0.20*	1.96*	-0.05*	1.22	-0.04*	15.11	-2.01*
SE	0.07	0.03	0.02	0.01	0.14	0.06	0.04	0.02	0.02	0.01	1.35	0.60

* Significant at 5 per cent level

@ I.W. Ponni - Improved White Ponni, T.B. - Taraori Basmati, P.B. 1 - Pusa Basmati 1, B. 370 - Basmati 370

magnitude than *gca* for all the characters indicating non-additive gene action for these characters (Table 1). Preponderance of non-additive gene action was reported by Singh *et al.* (1993) and Ganesan (1995) for kernel length, Sarawgi *et al.* (1991) for kernel L/B ratio, Siddiq (1980) and Sood *et al.* (1983) for kernel elongation. Additive gene effect for kernel length, kernel L/B ratio and kernel elongation was reported by Vivekanandan and Giridharan (1997).

High mean value was the main selection criterion among the breeding for a long time. Gilbert (1958) suggested that parents with good *per se* performance would result in better genotypes. Further, the parents having high *gca* effects could be useful since the *gca* effect is due to additive gene action and is fixable. Hence the parents were evaluated based on *per se* performance and *gca* effects (Table 2).

Among the lines studies ADT 39 and Improved White Ponni recorded significantly desirable mean performance for grain yield and ADT 38 for kernel length. Among the testers Pusa Basmati 1 and Taraori Basmati had desirable mean value for all the quality characters. The *gca* effects of the lines, Improved White Ponni and ADT 38 were in high order for the traits kernel L/B ratio, kernel length after cooking and kernel elongation. In addition, Improved White Ponni had high *gca* effects for grain yield and elongation index, while ADT 38 for kernel length.

Table 3. Promising hybrids selected based on *gca* and *sca* effects for recombination breeding

Character	Cross	*sca* effect	Selected hybrid
Kernel length	ADT 38/Taraori Basmati	-0.21*	CO 43/Taraori Basmati
	CO 43/Taraori Basmati	-0.02	
Kernel L/B ratio	ADT 38/ Taraori Basmati	-0.12*	
	Improved White ponni/ Taraori Basmati	0.08*	
Kernel length after cooking	ADT 38/Pusa Basmati 1	0.06	ADT 38/Pusa Basmati 1
	Improved White Ponni/ Pusa Basmati 1	-0.08	Improved White Ponni/ Pusa Basmati 1
Kernel elongation	ADT 38/ Taraori Basmati	0.05	ADT 38/ Taraori Basmati
	Improved White Ponni/ Pusa Basmati 1	0.01	Improved White Ponni/ Pusa Basmati
Elongation index	Improved White Ponni/ Pusa Basmati 1	0.01	Improved White Ponni/ Pusa Basmati 1
Grain yield	ADT 39/ Taraori Basmati	-2.21	ADT 39/ Taraori Basmati
	Improved White Ponni/ Taraori Basmati	-3.55*	

* Significant at 5 per cent level.

Table 4. Hybrids identified based on mean performance, *sca* effects and heterosis

Mean performance	*sca* effects	Heterosis
ADT 38 / T.B. (3)	ASD 19 / T.B. (6)	None of the hybrids identified
ADT 38 / P.B. 1 (5)	CO 43 / P.B. 1 (4)	
ADT 38 / Basmati 370 (3)	I.W. Ponni / T.B. (3)	
I.W. Ponni / T.B. (5)		
I.W. Ponni / P.B. 1. (4)		

Figures in parenthesis indicate suitability of hybrids for number of characters.
I.W. Ponni : Improved White Ponni, T.B. : Taraori Basmati, P.B. 1 : Pusa Basmati 1.

Considering the *per se* performance and *gca* effects, ADT 38 had desirable mean and *gca* effects for kernel length, while Improved White Ponni for grain yield. Pusa Basmati 1 was the best parent for the traits kernel length after cooking, kernel elongation and elongation index followed by Taraori Basmati for kernel length and kernel L/B ratio. Therefore, crosses involving ADT 38, Improved White Ponni, Pusa Basmati 1 and Taraori Basmati would result in identification of superior segregants with favourable genes for the quality traits besides grain yield.

Hybrids for recombination breeding

The criterion for the selection of hybrids for recombination breeding is that the parents should have significant *gca* effects and the hybrids with non-significant *sca* effects. Based

on this, the hybrids were evaluated (Table 3). The parents Improved White Ponni, ADT 38 and Pusa Basmati 1 possessed favourable and significant *gca* effects for kernel length after cooking, kernel elongation and elongation index and the resultant hybrids involving these parents had non-significant *sca* effects.

Hybrids for heterosis breeding

Exploitation of hybrids for heterosis breeding is best judged by mean performance, *sca* effects and magnitude of heterosis. Evaluation of hybrids on the above basis revealed no similarity in the identification of best hybrids (Table 4). High *sca* effects may not be the appropriate choice for heterosis exploitation because hybrids with low mean value may also possess high *sca* effects, if the *gca* effects of the parents were very low or even negative. Further more, heterosis value alone may also mislead the identity of superior hybrids because heterosis of the hybrids tend to be high when the parental means are low and *vice versa*. The mean performance being the actual realised value, but the *sca* effects and heterosis being estimates the former should be given preference. Based on the above, Improved White Ponni / Taraori Basmati and Improved White Ponni / Pusa Basmati 1 are the two hybrids identified for heterosis breeding which combine grain traits and grain yield.

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(Received : August 2000; Revised : February 2003)