Indian J. Genet., **65**(2): 123-124 (2005)

Short Communication

Combining ability and gene action for quality characters in Basmati rice (*Oryza sativa* L.)

Ram Kumar Sharma[1] and S. C. Mani

Department of Genetics & Plant Breeding, G.B. Pant University of Agril. & Tech., Pantnagar 263 601

(Received: September 2004; Revised: February 2005; Accepted: February 2005)

Six diverse genotypes of Basmati rice (Bas. 370, Bas. C 622, Bas. 5853, Kasturi, Pusa Bas. 1 and Haryana Bas. 1) were crossed with three parents (UPR 85-71-8-1, TN 1 and Pant Dhan 11) in line x tester fashion to evaluate the type of gene action involved in Basmati rice for quality characters by applying line × tester analysis. Thirty-days old seedlings of 18 F_1 and 9 parents were transplanted in a well-puddled field using RBD with three replications. A random sample of 100 g of oven dried rough rice taken from the bulk harvest of each plot was hulled and milled by Stake Rice Huller and Kelt T2 Polisher, respectively. Observations were recorded on grain length (mm), grain breadth (mm), length and breadth (L/B ratio), milling and head rice recovery percent as per standard procedures [1]. Milled samples were used to record alkali digestion value, kernel elongation ratio, water uptake number, volume expansion and gel consistency using standard procedure. The estimates of combining ability and variances were estimated using method outlined by Kempthorne [2].

Mean squares due to hybrids and parents were highly significant for all the traits indicating sufficient genetic variation in parental lines and hybrids for all the characters. Mean squares due to lines (except volume expansion) and testers (except milling recovery percent) were significant for all the traits. Partitioning of combining ability variances into additive and non-additive genetic variances indicated that both additive and non-additive-gene actions play considerable role in inheritance of these traits. The interaction components due to line × tester was of lower magnitude either due to lines or testers and more than unity ratio of *gca* : *sca* variance for alkali digestion value indicating that additive gene action play a primary role in governing this trait. Similar result for this trait was reported earlier [3]. The higher magnitude of line × tester interaction either due to lines or testers and lower ratio for *gca* : *sca* variance for grain length, L/B ratio, milling and head rice recovery percent, water uptake and gel consistency suggesting involvement of non-additive gene action in the expression of these traits. Preponderance of non-additive gene action has also been reported for grain length and L/B ratio [4], for milling and head rice recovery percent [5] and for water uptake [6]. Preponderance of non-additive genetic effects offers good scope for exploitation of heterosis in improving these attributes. The unity ratio of *gca* : *sca* variance for grain breadth, kernel elongation ratio and volume expansion suggesting equal importance of both additive and non-additive gene effects for these traits. Similar results were reported earlier [6]. Any approach that facilitates simultaneous exploitation of additive and non-additive gene effects would be appropriate for improvement of these traits. Based on the general combining ability (*gca*) effects (Table 1) improved varieties *viz.*, Kasturi and Haryana Bas. 1 among the lines were found as good general combiners for five characters. Kasturi showed significant *gca* effects in desired direction for grain length, grain breadth, head rice recovery and gel consistency, while Haryana Basmati-1 exhibited positively significant *gca* effects for alkali digestion value, water uptake, gel consistency, kernel elongation and volume expansion. Similarly, Pusa Bas. 1 (for L/B ratio, milling recovery percent and gel consistency) and Bas. 370 (for alkali digestion value and volume expansion) were found to be good general combiners. Bas. C 622 and Bas. 5853, both from Pakistan origin, showed high *gca* effects for gel consistency. Among the testers, Pant Dhan 11 for grain breadth, gel consistency and volume expansion, UPR 85-71-8-1 for grain length and L/B ratio and TN 1 for alkali digestion value recorded positively significant *gca* effects. However, none of the parents possessed the gca effects for all the quality traits. Being the common parent in the parentage of Kasturi (Bas. 370 × CR 88-17-15) and Haryana Bas. 1 (Sona × Bas. 370), Bas. 370 probably contributed desirable quality traits in both of them. Assessment of *gca* effects of the parents revealed that Kasturi and Haryana Bas. 1 followed by Pusa Bas. 1 and Bas. 370 were superior

[1]Present address: Division of Genetics, Indian Agricultural Research Institute, New Delhi 110 012

Table 1. Estimates of *gca* effects of Line × Tester analysis for grain yield and associated traits in Basmati rice

Parents	Kernel length	Kernel breadth	L/B ratio	Milling recovery (%)	Head rice recovery (%)	Alkali digestion value	Water uptake number	Gel consistency	Kernel elongation ratio	Volume expansion
Lines										
Bas. C 622	0.05	0.05	−0.04	0.45	−2.62**	−0.31	40.41**	11.33**	−0.06*	−0.02*
Kasturi	0.16**	0.08**	−0.06	−0.94	2.44**	−1.31**	24.30	11.33**	0.03	−0.03**
Bas. 5853	0.03	0.04	−0.04	−1.23	0.56	−0.10	3.19	7.00**	−0.05	−0.01
Haryana Bas. 1	−2.20**	−0.04	−0.02	−0.47	−3.52**	1.05**	42.63**	4.66*	−0.08**	0.03**
Pusa Bas. 1	0.07	−0.07*	0.14**	2.36	1.89	−0.96**	4.85	9.66**	0.01	0.01
Bas. 370	−0.11	−0.05	0.01	−0.16	1.76	1.63**	−115.37**	−43.99**	0.01	0.02
SE(gi)	0.06	0.03	0.06	0.74	1.08	0.23	14.62	2.18	0.03	0.01
SE (gi-gi)	0.09	0.04	0.09	1.05	1.52	0.33	20.68	3.09	0.04	0.02
Testers										
Pant Dhan 11	−0.01	0.10**	−0.11**	0.27	1.79*	−0.60**	11.24	11.05**	0.02	0.04**
TN 1	−0.07	−0.02	−0.01	−0.10	−1.65*	0.92**	9.57	−6.32**	−0.04*	−0.03**
UPR 85-71-8-1	0.08*	−0.08**	0.11**	−0.17	0.14	−0.32	−20.81	−4.73**	0.02	−0.01
SE (gi)	0.04	0.02	0.04	0.50	0.76	0.17	10.34	1.54	0.02	0.01
SE (gi-gi)	0.06	0.03	0.06	0.74	1.08	0.23	14.62	2.18	0.03	0.01

*,**Significant at 5% and 1% level of significance, respectively

to rest of the genotypes. Involving these parents in recombination breeding for quality traits the breeders would be able to isolate genotypes having quality traits in desired direction. The specific combining ability (*sca*) effects of hybrids (Table 2) revealed the importance of both additive and non-additive gene action. Two crosses *viz.*, L4 × T3 and L5 × T2 not only showed positively significant *sca* effects together for alkali digestion value and gel consistency but also for kernel elongation ratio and milling recovery percent, respectively. Similarly, three crosses L3 × T2, L2 × T1 and L5 × T3 together showed significant *sca* effects for volume expansion and separately for head rice recovery percent, alkali digestion value and water uptake, respectively. For kernel breadth and water uptake number L2 × T2 and L1 × T2; for head rice recovery and water uptake L4 × T1 and L6 × T2 for L/B ratio and water uptake recorded significant *sca* effects. Other superior combinations were L1 × T3 (head rice recovery percent), L3 × T1 (L/B ratio), L3 × T3 (gel consistency) and L4 × T2 (kernel length) exhibited positively significant *sca* effects.

The perusal of different crosses with significant *sca* effects and *gca* effects of respective parents revealed that 12 out of 24 crosses involved at least one parent with good *gca* effects indicated the presence of additive × additive and/or additive × dominance genetic interaction in sizeable amount among these crosses. The remaining crosses involved parents with average × average (6), poor × average (5) and poor × poor (1) *gca* effects. It appears that high *sca* effects of any cross does not necessarily dependent upon the *gca* effects of the parents involved. The superiority of these crosses may be due to complementary type of gene interaction, which can be exploited in the subsequent generations. In such crosses where non-additive gene effects played a predominant role in association with additive component, the recurrent selection and reciprocal recurrent selection can be used to exploit simultaneously both the components. With the available systems of cytoplasmic genetic male sterility and restoration, the exploitation of such crosses for heterosis breeding is no more a difficult task.

Table 2. Hybrid combinations with significant positive specific combining ability effects in Basmati rice

Characters	Cross combinations
Kernel length	L4 × T2
Kernel breadth	L1 × T2, L2 × T2
Length/breadth ratio	L3 × T1, L6 × T2
Milling recovery %	L5 × T2
Head rice recovery %	L1 × T3, L3 × T2, L4 ×T1
Alkali digestion value	L2 × T1, L4 × T3, L5 × T2
Water uptake number	L1 × T2, L2 × T2, L4 × T1,L 5 × T3, L6 × T2
Volume expansion	L2 × T1, L3 × T2, L5 × T3
Kernel elongation ratio	L4 × T3
Gel consistency	L3 × T3, L4 × T3, L5 × T2

(L = lines, T = tester)

References

1. **Anonymous.** 1988. Standard Evaluation System for Rice. International Rice Testing Programme, The IRRI, Los Banos, Philippines.
2. **Kempthorne O.** 1957. An Introduction to Genetic Statistics. John Wiley & Sons Inc, New York, USA. 458-471
3. **Puri R. P. and Siddiq E. A.** 1983. Studies on cooking and nutritive qualities of cultivated rice (*Oryza sativa* L.) IV. Quantitative genetic analysis of gelatinization temperature. Genetic Agraria, **37**: 335-343.
4. **Singh N. B. and Singh H. G.** 1985. Heterosis & combining ability for kernel size in rice. Indian J. Genet., **45**: 81-85.
5. **Manhot M. K., Sarawgi A. K. and Rastogi N. K.** 2000 Gene action and combining ability for yield, grain quality and other releated traits in rice . Oryza, **37**: 1-6.
6. **Sharma R. K. and Mani S. C.** 1997. Combining ability for cooking quality characters in basmati rice (*Oryza sativa* L.). Crop Improv., **24**: 93-97.