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Genetic Variability, Heritability and Genetic Advance of Grain Quality in Hybrid Rice

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The present investigation was under taken to study the extent of variability and genetic parameters in 15 rice hybrids and five checks for seventeen qualitative traits along with grain yield. The magnitude of difference between PCV and GCV was relatively low for all the traits, indicating less environmental influence. High (> 20 %) GCV and PCV were recorded for gelatinization temperature and gel consistency. Heritability estimates were found to be high (> 61%) for all the characters except breadth-wise expansion. High heritability coupled with high genetic advance was observed for Kernel breadth, Kernel length/breadth ratio, Kernel breadth after cooking, Kernel length/breadth ratio after cooking, Gel consistency, volume expansion ratio, gelatinization temperature, amylose content and grain yield.

Key words: Rice, quality traits, amylose and variability.

Knowledge of nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and quality characters are essential for effecting genetic improvement. Improving rice quality has now become prime objective of most of the breeding programmes. Fine varieties of rice with superior milling, cooking and eating quality traits get a premium prize in the market. Rice quality is influenced by characteristics under genetic control, environmental conditions and processing techniques. In the latter case, characteristics are principally a function of handling, storage and distribution. Selection for improved milling, cooking, eating and processing qualities are essential component of breeding programs designed to meet industry standards or taste and cooking characteristics preferred by consumers in export market. Increasing demand in quality rice's in the local as well as in international market has paid great attention on quality breeding programmes.

Materials and methods

Experimental material for this study consists of fifteen hybrids and five checks. They were raised at department of Plant Breeding and Genetics, Bhavanisagar, Tamil Nadu Agricultural University evaluated for milling traits viz., hulling percentage, milling percentage and head rice recovery, physical traits like grain length, grain breadth, grain length/breadth ratio and cooking quality traits Kernel length, Kernel breadth, Kernel length/breadth ratio, Gel consistency, Kernel breadth after cooking, Linear elongation ratio, breadth-wise expansion ratio, water uptake, volume expansion and amylose content were evaluated. Details of the hybrids and their parentage are furnished below.

Entries	Parentage
BRH 0601	IR 68897 x IR 59673
BRH 0602	IR 68897 x IR 68926
BRH 0603	IR 68897 x IR 62036
BRH 0604	IR 68888 x IR 68926
BRH 0605	IR 68888 x IR 72865
BRH 0606	IR 68888 x ADO 1259
BRH 0607	IR 68888 x IR 62037
BRH 0608	IR 68888 x W 216
BRH 0609	IR 68888 x IR 62161
BRH 0610	IR 68888 x IR 3883
BRH 0611	IR 68886 x IR 68427

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BRH 0612	IR 68886 x W 216
BRH 0613	IR 68886 x IR 3883
BRH 0614	IR 68886 x IR 62171
BRH 0615	CRMS 32 x WCR 21
ADT 39	IR 8 / IR 20
CORH 2	IR 58025 A x C 20 R
CORH 3	TNAU CMS 32A x CB 87 R
BPT 5204	GEB 24 / TN 1 / Mahsuri
I. W. Ponni	Taichung 65 / Mayang EPOS 80

Information on the nature of inheritance and associations of quality traits with grain yield is scanty in rice and is helpful in order to formulate effective breeding programmes. Hence, the present study made an attempt to study the variability, heritability and genetic advance of quality traits with grain yield in rice hybrids.

Results and Discussion

Selection of parents is an important criterion for the successful breeding programme. Such an attempt was also made in the present study to identify suitable parents for utilizing in hybrid rice breeding programme. The mean performance of twenty genotypes revealed that certain genotypes exhibited their superiority over others for different traits. In India the qualities sought in rice are the fineness of the kernel, attractive colour and flavour, moderate water absorption, high volume expansion, retention of kernel shapes, absence of kernel splitting during cooking and dry and fluffy nature of cooked rice.

The hybrid combinations viz., BRH 0601 (5330 Kg/ ha), BRH 0613 (5105 Kg/ ha) and BRH 0608 (4947 Kg/ ha) were recorded significantly superior garin yield than the high yielding check BPT 5204 (4503 Kg/ ha). Besides grain yield kg/ ha, all the hybrids had higher milling per cent (>55 %) except BRH 603. with this high milling percentage, the hybrid BRH 601 had high head rice recovery followed by BRH 613, BRH 608, BRH BRH 604 and BRH 612 than the checks. This is in accordance with the suggestion of Shobha Rani *et al*. (2002) to choose parents with high milling yield for producing hybrids with high milling quality. Preferences for grain size and shape vary from one group of consumer to another. Length breadth ratio decides the shape of the kernel. In general, medium to long grains are preferred under Indian condition. Eight hybrids had medium slender and other hybrids are short slender (Table 1).

In general, minimum breadth wise expansion on cooking is preferred by the consumers. In the study, all the hybrids exhibited lower breadth wise expansion (<1.3) except BRH 606 which may be due to the involvement of maternal parents with low breadth wise expansion. These hybrids resulted from the parents with low x low, low x medium, low x high and medium x medium combinations. The results are similar to the results reported by Banumathy (2001).

Amylose content, gelatinization temperature and gel consistency are the important starch properties which influence cooking and eating characteristics. A complex relationship however exists, between chemical characters and quality. Intermediate amylose rice (20-25 %) is preferred in most of the rice growing areas of the world. The study on cooking quality of 15 hybrids revealed that 7 hybrids had intermediate amylose content as that of the check varieties. In the present study, 8 hybrids displayed intermediate alkali spreading value (Score 3-5) The hybrids with intermediate GT includes of 70-74^{0}C. To isolate hybrids with intermediate GT, it is important to select especially male parent to have intermediate GT (Shivani *et al*., 2002).

Medium and soft gel consistency types of rice varieties/ hybrids are generally preferred. In the present study, all the hybrids showed soft gel consistency of more than 60 mm with values ranging from 91.50 mm to 142.50 mm. Volume expansion is another important cooking parameter of consumer preference. Three hybrids registered higher volume expansion after cooking over the checks CORH 2, ADT 39, BPT 5204 and I.W.Ponni. Higher volume expansion after cooking was recorded by the hybrid BRH 601, BRH 608 and BRH 613.

Table 1. Mean performance of 15 hybrids and checks of rice for quality traits

Genotypes	HL%	ML%	HR%	GL	GB	L/B	LAC	Grain shape
BRH 601	72.89	65.07	55.10	6.17	1.67	3.71	9.55	MS
BRH 602	69.79	58.63	45.86	6.48	1.42	4.58	8.54	MS
BRH 603	64.15	52.42	49.18	6.11	1.41	4.34	7.48	MS
BRH 604	67.35	59.56	51.20	6.18	1.70	3.64	7.74	MS
BRH 605	65.05	61.98	47.00	6.09	1.42	4.29	7.65	MS
BRH 606	63.53	56.02	35.78	6.34	1.52	4.16	8.00	MS
BRH 607	71.55	64.19	49.97	6.43	1.58	4.07	8.30	MS
BRH 608	71.21	65.15	51.19	5.40	1.65	3.24	7.44	MS
BRH 610	69.92	61.94	48.74	6.35	1.58	4.04	7.76	SS
BRH 609	61.52	46.84	39.54	5.37	1.61	3.32	7.64	SS
BRH 610	61.50	57.02	47.31	6.12	1.61	3.79	7.28	SS
BRH 611	70.03	61.05	47.55	6.13	1.49	4.12	8.33	SS
BRH 612	71.36	65.35	50.51	6.21	1.59	3.89	8.82	SS
BRH 613	69.48	66.41	54.89	6.22	1.70	3.66	8.10	SS
RH 614	68.33	62.10	49.84	6.02	1.60	3.75	7.75	SS
BRH 615	58.42	42.65	47.23	5.38	1.65	3.26	7.25	SS
CORH 2	67.37	64.59	50.69	6.04	2.19	2.75	7.35	SS
CORH 3	67.24	60.88	49.82	6.20	1.81	3.42	9.25	MS
ADT 39	70.09	61.31	48.22	6.01	1.59	3.77	8.68	SS
BPT 5204	74.55	63.45	48.03	5.34	1.77	3.01	7.17	MS
I.W.PONNI	72.25	59.35	49.62	5.73	1.84	3.11	7.69	SS
GM	**68.46**	**60.67**	**48.51**	**6.05**	**1.64**	**3.74**	**8.03**	

	BAC	LER	BWE	L/BAC	GT	GC	WU	VE	AMY	YLD
BRH 601	1.89	1.33	1.14	5.04	3.00	104.00	2.58	4.26	25.15	5329.50
BRH 602	1.75	1.31	1.23	4.87	2.50	134.00	2.07	2.50	26.85	4504.50
BRH 603	1.61	1.22	1.14	4.67	3.50	96.50	2.30	2.34	23.05	4679.50
BRH 604	2.03	1.25	1.19	3.81	2.00	141.00	2.46	3.39	28.00	3881.50
BRH 605	1.83	1.26	1.29	4.17	2.00	160.00	2.38	2.60	23.10	4303.50
BRH 606	2.07	1.26	1.36	3.86	1.00	92.50	2.41	3.29	29.60	4510.00
BRH 607	2.00	1.29	1.26	4.15	1.00	111.00	2.28	2.54	23.15	4798.00
BRH 608	1.98	1.37	1.18	3.77	1.00	96.50	2.29	4.21	27.90	4946.50
BRH 609	1.80	1.21	1.13	4.31	3.00	91.50	2.39	3.51	25.97	3891.50
BRH 610	1.97	1.33	1.22	3.87	2.50	116.50	2.37	3.12	19.05	3308.00
BRH 611	1.96	1.19	1.22	3.72	3.00	134.50	2.43	3.07	31.32	3992.50
BRH 612	1.74	1.28	1.17	4.79	4.50	102.00	2.31	3.58	31.05	3707.50
BRH 613	1.72	1.39	1.08	5.13	6.00	191.00	2.26	4.35	25.90	5105.00
BRH 614	2.09	1.30	1.23	3.88	5.50	142.50	2.47	2.89	23.10	4234.00
BRH 615	2.02	1.28	1.26	3.84	3.00	132.00	2.29	3.40	29.95	4474.00
CORH 2	2.66	1.21	1.22	2.76	5.00	76.50	1.95	3.13	23.05	3521.50
CORH 3	2.23	1.53	1.23	4.14	4.50	101.50	2.19	4.17	23.05	4121.50
ADT 39	2.06	1.44	1.29	4.21	4.00	86.00	2.27	3.82	24.05	4353.50
BPT 5204	2.19	1.34	1.23	3.28	5.00	119.50	2.17	3.99	20.75	4503.00
I.W Ponni	2.21	1.33	1.11	3.48	5.00	87.50	1.89	3.53	23.67	4137.50
GM	1.99	1.31	1.21	4.09	3.35	115.83	2.29	3.39	25.39	4315.13

HL - Hulling percentage: ML%- Milling percentage: HR %- Head rice recovery %: GL-Grain length (mm): GB- Grain breadth (mm) :L/B - L/B ratio: MS: medium slender: SS: Short slender: LAC - Length after cooking (mm): BAC- Breadth after cooking (mm): LER - Linear elongation ratio:

BWE - Breadth wise expansion raio: L/B AC - L/B after cooking ratio: GT - Gelatinization temperature: GC- Gel consistency (cm): WU -Water uptake: VE-Volume expansion ratio: AMY- Amylose content (%): Grain yield (Kg).

Table 2. Estimates of variability and genetic parameters of 15 hybrid and checks rice

S.No.	Characters	Grand mean	GCV %	PCV %	CD (%)	Hertability%	GA % of mean
1	Hulling percentage	68.46	4.89	5.91	4.75	68.52	8.34
2	Milling percentage	60.67	7.76	8.06	2.79	92.57	15.37
3	Head rice recovery %	48.51	8.29	9.81	5.31	71.57	14.46
4	Grain length (mm)	6.05	5.54	5.59	0.09	98.31	11.31
5	Grain breadth (mm)	1.64	10.85	10.97	0.05	97.98	22.13
6	L/B ratio	3.74	12.77	12.89	0.14	98.05	26.04
7	Length after cooking(mm)	8.03	8.21	8.32	0.23	97.39	16.69
8	Breadth after cooking (mm)	1.99	11.44	11.93	0.14	92.04	22.61
9	Linear elongation ratio	1.31	5.86	6.90	0.10	72.06	10.25
10	Breadth wise expansion raio	1.21	4.82	6.26	0.10	59.32	7.65
11	L/B after cooking ratio	4.09	14.35	14.95	0.36	92.16	28.37
12	Gelatinization temperature	3.35	45.19	46.72	0.83	93.56	90.05
13	Gel consistency (cm)	115.83	24.59	24.86	8.69	97.92	50.14
14	Water uptake	2.29	7.13	7.76	0.15	84.32	13.48
15	Volume expansion ratio	3.39	17.34	18.90	0.53	84.15	32.77
16	Amylose content (%)	25.39	13.29	13.54	1.39	96.28	26.86
17	Grain yield (g)	4315.13	11.98	12.06	124.96	98.68	24.52

Analysis of variance was carried out statistically utilizing the mean values for all characters under study. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated using the formula as suggested by Johnson *et al.* (1955). Heritability in broad sense was calculated following the method advocated by Lush (1940) and expressed in percentage. The range of Genetic advance was classified as suggested by Johnson *et al.* (1955). The mean, GCV, PCV, heritability and genetic advance as percentage of mean are presented in table 2.

PCV was higher than GCV for all the 17 characters studied. PCV ranged from 5.59 % for grain length to 46.72 % for gelatinization temperature. PCV and GCV was low (< 10 %) for hulling percentage, milling percentage, head rice recovery, grain length, length after cooking, linear elongation ratio, breadth wise expansion and water uptake. Similar findings of low GCV and PCV were reported earlier for kernel breadth, linear elongation ratio, milled kernel breadth and amylose content (Verma *et al.,* 2000, Shivani and Sree Rama Reddy, 2000 and Kamalagar, 2003).

Moderate GCV and PCV were recorded for grain breadth, L/B ratio, Breadth after cooking, L/B ratio after cooking, volume expansion ratio, amylase content %, grain yield. Moderate level of GCV indicating considerable amount of variability expressed for these characters. Moderate level of variability was earlier observed for kernel length, kernel length/breadth ratio, milled kernel length, kernel length after cooking, kernel breadth after cooking, and breadth-wise expansion ratio (Kamalagar, 2003) and high (> 20 %) GCV and PCV were recorded for gelatinization temperature and gel consistency. Karim *et al.* (1992) reported high GCV values with respect to gel consistency. These traits showing high genotypic variability offer greater scope for genetic improvement through selection. All the characters showed little

difference between PCV and GCV indicating lesser influence by environment.

Heritability estimates were found to be high (> 61%) for all the characters except breadth-wise expansion. High heritability indicates the predominance of additive gene effects in controlling these traits. Such high heritability estimates were earlier reported by Verma *et al.* (2001). Mishra and Verma (2002) observed high heritable values for kernel length after cooking, kernel breadth after cooking, and kernel elongation.

High heritability coupled with high genetic advance was more useful for predicting the resultant effect of selecting the best individual than either of them above. The estimates of GA expressed as % of mean were high along with high heritability for Kernel breadth, Kernel length/ breadth ratio, Kernel breadth after cooking, Kernel length/breadth ratio after cooking, Gel consistency, volume expansion ratio, gelatinization temperature, amylose content and grain yield. Low GA was recorded for hulling percentage and breadth–wise expansion ratio, this is due to dominance and epistatic effects (Paramasivan, 1986).

Such high heritability coupled with high genetic advance was reported grain yield per plant (Michael Gomez and Rangasamy, 2002), Kernel length/breadth ratio (Verma *et al.,* 2000), kernel length after cooking (Mishra and Verma, 2002). High heritability with low GA for hulling percentage and breadth-wise expansion suggested that both additive and non-addtive gene effects may be operating in the determination of these traits. High heritability with low genetic advance was reported by Hussain *et al.* (1987) for amylose content.

The study revealed that the traits, grain breadth, Breadth after cooking, volume expansion ratio, amylase content %, grain yield, gel consistency and gelatinization temperature exhibited less influence by environment and high heritability coupled with moderate / high GA, implying predominance of additive gene action: selection for these traits based on phenotypic values would be more convenient in advanced generations.

Thus the hybrids BRH 601, BRG 606, BRH 608, BRH 612 and BRH 613 which showed superior performance for important quality traits may serve as ideal hybrids for developing new genotypes with desirable grain quality.

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