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Variability and Genetic Parameters for Grain Quality Attributes in Elite Rice Genotypes

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ABSTRACT

The present investigation was under taken to study the extent of variability and genetic parameters in 31elite rice (*Oryza sativa* L.) genotypes for sixteen kernel quality characters during. 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 the characters gelatinization temperature and gel consistency. Heritability estimates were found to be high (> 61 %) for all the characters. High heritability coupled with high genetic advance was observed for gelatinization temperature, gel consistency, amylose content, kernel L/B ratio, kernel breadth and kernel length indicating that most likely the heritability is due to additive gene effects and selection may be effective for these characters.

Key words : Genetic advance,Heritability, Rice, Variability.

A paradigm shift in the rice (*Oryza sativa* L.) breeding strategies from quantity centered approach to quality oriented effort was inevitable, since India has not only become self sufficient in food grain production but also is the second largest exporter of quality rice in the world (Sreedhar *et al.,*2005). Improvement in grain quality that does not lower yield is the need of hour at present context in order to benefit all rice growers and consumers. Like grain yield, quality is not easily amenable to selection due to its complex nature. Lack of clear cut perception regarding the component traits of good quality rice is one of the important reasons for the tardy progress in breeding for quality rice varieties. For the development of high yielding varieties with good quality the information on variability and genetic parameters of grain quality attributes and their association with each other including grain yield is necessary to formulate suitable breeding strategies for grain quality improvement. In the present investigation, an attempt has been made to elucidate information on nature and magnitude of genetic variation observed for grain quality attributes in certain elite genotypes of rice.

MATERIAL AND METHODS

A field experiment was conducted with 31 elite rice (*Oryza sativa* L.) genotypes grown in a completely randomized block design with three replications at S.V Agricultural College, Tirupati during 2010. Twenty one days old seedlings of each genotype were transplanted in three rows of 2.0 m length by adopting a spacing of 22.5 cm between rows and 10 cm between plants with in rows at the rate of 20 plants per row. The crop was grown with the application of fertilizer N, P and K at the rate of 120, 60 and 60 kg ha^{-1}, respectively. Standard agronomic practices were followed to raise a good crop. A composite sample of 10 plants from the middle row was used to record observations on hulling percentage, milling percentage, head rice recovery percentage, kernel length, kernel breadth, kernel length / breadth ratio, kernel length after cooking, kernel breadth after cooking, kernel linear elongation ratio, kernel breadth wise expansion ratio, kernel length/breadth ratio after cooking, water uptake, volume expansion ratio, amylose content, gelatinization temperature and gel consistency. The quality characters were estimated as per the standard evaluation system in rice. Gelatinization temperature was estimated following the method of Little *et al.,* (1958), Gel consistency was analyzed based on the method described by Cagampange *et al.,* (1973) and amylose content by Juliano (1979) and Webb (1985). Water uptake was estimated following the standard method of Beachell and Stansel (1963) and volume expansion ratio by Shahidullah *et al.,* (2009). The kernel length and breadth after cooking was measured using grain vernier.

Table 1. Analysis of variance for kernel qualty characters in 31 elite rice genotypes.

S.No.	Character	Source of Variation		
		Replications (df=2)	Genotypes (df=30)	Error (df=60)
1.	Hulling percentage	0.052	1.229**	0.151
2.	Milling percentage	0.538	3.091**	0.370
3.	Head rice recovery (%)	9.295	72.238**	5.749
4.	Kernel length (mm)	0.005	1.024**	0.002
5.	Kernel breadth (mm)	0.001	0.165**	0.001
6.	Kernel L/B ratio	0.001	0.309**	0.003
7.	Kernel length after cooking (mm)	0.010	1.060**	0.001
8.	Kernel breadth after cooking (mm)	0.010	0.142**	0.005
9.	Kernel linear elongation ratio	0.001	0.017**	0.001
10.	Kernel breadth wise expansion ratio	0.003	0.015**	0.001
11.	Kernel L / B after cooking	0.013	0.181**	0.008
12.	Water uptake (ml/10g)	0.002	0.129**	0.001
13.	Volume expansion ratio	0.062	0.444**	0.036
14.	Gelatinization temperature	0.011	7.300**	0.333
15.	Amylose content (%)	0.427	30.484**	0.544
16.	Gel consistency (mm)	6.656	658.513**	7.434

*, ** Significant at 5% and 1% levels, respectively.

The data recorded for all the characters were subjected to analysis of variance technique on the basis of model proposed by Panse and Sukhatme (1961). The genotypic and phenotypic variances as well as the genotypic (GCV) and phenotypic (PCV) coefficient of variation were calculated by the formulae given by Burton (1952). Heritability in broad sense [$h^2_{(b)}$] and genetic advance (GA) were estimated by the following formula given by Johnson *et al.,* (1955).

RESULTS AND DISCUSSION

Analysis of variance revealed the significant differences among the genotypes for all the kernel quality attributes (Table 1). A wide range of variation was observed among the elite genotypes for all the traits (Table 2). In the present study the genotype NLR-9993 had recorded the highest mean value for both hulling and milling percentage whereas NLR-34303, BPT-1235 and JGL-384 recorded the higher head rice recovery percentage which can be utilized as potential donors for improvement in head rice yield (Table 2). Kernel length was maximum in BPT-1235, IR 64, NLR-145 and MTU-1010. Kernel breadth was minimum in BPT-5204, ADT-43, NDLR-8, JGL-1798, JGL-384 and NLR-34449. More is the kernel L/B ratio, finer is the grain quality. Kernel L/B ratio was maximum in MTU-1010, IR-64, NLR-145 and BPT-1235 and these genotypes can be identified as best entries for improvement of quality in rice. NLR-34449, NLR-30491, BPT-1235 and JGL-384 have recorded higher volume expansion ratio.

Intermediate amylose rice (20-25%) is preferred in most of the rice growing areas of the world. More over intermediate amylose content rice shows the fluffiness and remain soft after cooling. In the present study, NLR-34449, NDLR-8, NLR-33358 and BPT-5204 were the varieties with intermediate amylose content.

A perusal of genetic variability parameters indicated that PCV estimates were higher than GCV for all the traits, indicating the influence of environment in the expression of these traits (Table 3). The difference between PCV and GCV estimates were relatively low for all the traits indicating less environmental influence on these traits.

Gelatinization temperature and gel consistency showed higher estimates of GCV and

Table 2. Mean performance of 31 rice genotypes for 16 kernel quality characters.

S.No.	Genotype	HL %	ML %	HRR %	KL (mm)	KB (mm)	L/B	KLAC (mm)	KBAC (mm)	KLER	KBER	L/BAC	WU (ml/10g)	VER	GT	AC (%)	GC (mm)
1.	NLR-33654	77.33	71.40	52.84	6.09	2.22	2.74	7.96	2.84	1.30	1.28	2.79	3.49	3.67	1.67	23.26	65.47
2.	Vasundhara	76.53	71.50	54.33	6.01	2.60	2.31	7.90	3.08	1.31	1.19	2.56	3.13	3.67	4.33	18.11	86.50
3.	NLR-34303	77.17	71.30	59.39	5.47	2.03	2.69	7.64	2.98	1.39	1.46	2.57	3.41	3.38	4.67	19.93	35.30
4.	TN-1	76.90	69.30	52.09	5.28	2.62	2.02	7.30	3.10	1.38	1.19	2.35	3.60	4.00	6.33	17.36	56.53
5.	IET-8585	77.30	70.13	48.46	6.12	2.39	2.56	8.01	3.08	1.31	1.29	2.61	3.06	3.84	6.67	19.19	75.90
6.	BPT-1235	76.13	71.63	56.95	6.69	2.20	3.05	8.25	3.05	1.23	1.39	2.70	3.14	4.44	4.67	23.66	75.53
7.	IR-64	76.40	70.27	41.56	6.69	2.15	3.12	8.77	2.69	1.31	1.26	3.28	3.33	3.67	4.33	22.89	78.23
8.	NLR-34449	77.13	71.73	51.92	5.29	1.92	2.76	6.97	2.61	1.32	1.36	2.67	3.29	4.90	1.33	24.74	72.27
9.	Salivahana	76.07	69.73	55.41	5.69	2.65	2.15	7.52	3.01	1.32	1.14	2.50	3.43	3.27	4.33	14.78	73.37
10.	NLR-33059	77.37	72.30	54.86	6.51	2.20	2.96	7.74	2.83	1.19	1.23	2.73	3.17	3.63	4.67	15.88	53.70
11.	CRMR-1523	76.73	69.50	51.46	5.86	2.52	2.32	7.56	2.94	1.29	1.17	2.57	3.63	4.43	3.67	16.25	47.17
12.	TKM-6	77.27	71.10	51.83	5.41	2.00	2.71	7.76	2.67	1.43	1.34	2.91	3.09	3.66	2.33	21.42	63.70
13.	ADT-43	76.53	70.47	40.34	5.58	1.89	2.95	7.64	2.62	1.37	1.38	2.92	2.93	3.42	2.67	18.45	79.27
14.	JGL-384	77.60	70.63	56.92	5.37	1.91	2.82	6.76	2.46	1.26	1.29	2.74	3.06	4.44	5.33	22.53	73.77
15.	NLR-145	77.27	69.87	55.41	6.59	2.15	3.07	8.03	2.70	1.22	1.26	2.88	3.14	3.42	3.33	20.68	65.47
16.	NLR-33358	76.77	72.37	54.00	6.37	2.25	2.83	8.55	2.86	1.34	1.27	2.99	3.39	3.92	4.67	24.00	52.67
17.	NDLR-8	77.47	70.50	53.88	4.87	1.90	2.57	7.17	2.51	1.47	1.32	2.86	3.39	4.17	6.33	24.74	42.17
18.	NLR-33057	77.60	72.23	49.13	6.51	2.28	2.78	7.96	3.02	1.22	1.33	2.64	3.29	3.86	4.67	22.16	62.90
19.	Sasyashree	75.57	69.90	41.90	6.24	2.25	2.82	8.56	2.95	1.37	1.31	2.89	3.09	3.39	5.67	18.45	45.40
20.	ARC-6605	75.50	70.20	47.73	5.62	2.56	2.13	6.92	3.06	1.24	1.20	2.28	2.97	3.63	3.00	17.72	84.73
21.	MTU-1006	75.30	72.00	46.61	5.92	2.35	2.52	7.27	2.97	1.23	1.27	2.45	3.36	4.00	4.33	18.84	74.97
22.	MTU-1010	76.63	68.93	54.08	6.56	2.01	3.21	8.67	2.70	1.33	1.32	3.22	3.38	4.17	4.33	15.51	66.87
23.	MTU-1001	76.53	69.70	55.74	6.26	2.33	2.69	7.66	2.78	1.23	1.20	2.76	3.09	3.80	4.67	16.62	85.60
24.	NLR-30491	76.20	71.23	50.26	6.49	2.21	2.93	8.34	3.01	1.29	1.36	2.15	3.71	4.47	1.67	17.36	87.87
25.	ADT-37	77.47	70.80	52.14	4.68	2.49	1.89	6.77	3.14	1.44	1.27	2.72	3.28	4.17	3.33	20.31	85.10
26.	Mahsuri	76.53	72.27	43.30	5.45	2.17	2.51	7.49	2.76	1.37	1.27	2.77	3.34	3.86	2.33	16.99	42.93
27.	NLR-33359	76.63	70.37	51.16	6.31	2.31	2.72	7.81	2.82	1.24	1.22	2.74	2.89	3.67	4.33	26.22	47.13
28.	JGL-1798	76.60	71.50	42.89	5.05	1.90	2.66	6.65	2.42	1.31	1.27	2.76	3.30	3.92	1.67	21.79	53.67
29.	BPT-5204	76.70	72.17	51.63	5.01	1.88	2.66	6.82	2.32	1.36	1.24	2.94	3.23	3.84	1.33	24.00	66.07
30.	MTU-9993	77.63	72.37	53.72	6.25	2.43	2.56	7.42	2.86	1.19	1.23	2.52	2.99	3.43	6.67	16.62	56.43
31.	MTU-4870	76.00	71.40	51.99	5.38	2.21	2.43	6.99	2.83	1.31	1.28	2.48	3.05	3.84	4.33	20.31	65.37
	Mean	**76.74**	**70.93**	**51.09**	**5.86**	**2.22**	**2.65**	**7.64**	**2.83**	**1.31**	**1.28**	**2.71**	**3.25**	**3.87**	**3.99**	**20.03**	**65.23**
	C.V. (%)	0.51	0.86	4.69	0.84	1.50	2.10	0.43	2.62	1.19	2.99	3.23	0.77	4.93	14.46	3.68	4.18
	S.E	0.22	0.35	1.38	0.03	0.02	0.03	0.02	0.04	0.01	0.02	0.05	0.01	0.11	0.33	0.43	1.57

HL % : Hulling Percentage; ML %: Milling Percentage; HRR % : Head rice recovery Percentage; KL : Kernel Length ; KB : Kernel Breadth ; L/B : Kernel L/B ratio; KLAC : Kernel Length after Cooking ; KBAC : Kernel Breadth after Cooking ; KLER : Kernel Linear Elongation Ratio; KBER : Kernel Breadth wise Expansion Ratio; L/BAC : Kernel L / B after cooking; WU : Water Uptake ; VER : Volume Expansion Ratio; GT : Gelatinization Temperature; AC : Amylose Content; GC : Gel Consistency.

Table 3.Estimates of variability and genetic parameters for 16 kernel quality characters in rice

Sl. No.	Character	Mean	Range			Variance		Coefficient of variation(%)		Heritability in broad sense (h^2_b)	Genetic advance (GA)(%)	Genetic advance as per cent of mean (GAM)
						Genotypic (V_g)	Phenotypic (V_p)	Genotypic (GCV)	Phenotypic (PCV)			
1.	Hulling percentage	76.74	75.30	–	77.63	0.36	0.51	0.78	0.93	0.70	1.03	1.35
2.	Milling percentage	70.93	68.93	–	72.37	0.91	1.28	1.34	1.59	0.71	1.65	2.33
3.	Head rice recovery (%)	51.09	40.34	–	59.39	22.16	27.91	9.21	10.34	0.79	8.64	16.91
4.	Kernel length (mm)	5.86	4.68	–	6.69	0.34	0.34	9.96	10.00	0.99	1.19	20.45
5.	Kernel breadth (mm)	2.22	1.88	–	2.65	0.06	0.06	10.50	10.60	0.98	0.47	21.41
6.	Kernel L/B ratio	2.65	1.89	–	3.21	0.10	0.11	12.06	12.24	0.97	0.64	24.47
7.	Kernel length after Cooking (mm)	7.64	6.65	–	8.77	0.35	0.36	7.78	7.79	0.99	1.22	15.99
8.	Kernel breadth after Cooking (mm)	2.83	2.32	–	3.14	0.05	0.06	7.53	7.97	0.89	0.46	14.65
9.	Kernel linear elongation Ratio	1.31	1.19	–	1.47	0.01	0.01	5.63	5.76	0.96	0.42	11.35
10.	Kernel breadth wise Expansion ratio	1.28	1.14	–	1.46	0.01	0.01	5.33	6.11	0.76	0.67	9.58
11.	Kernel L / B after cooking	2.71	2.15	–	3.28	0.06	0.07	8.88	9.44	0.88	2.93	17.18
12.	Water uptake (ml/10g)	3.25	2.89	–	3.71	0.04	0.04	6.36	6.41	0.99	6.33	13.01
13.	Volume expansion ratio Gelatinization	3.87	3.27	–	4.90	0.14	0.17	9.53	10.73	0.79	29.84	17.44
14.	Temperature Amylose content (%)	3.99	1.33	–	6.67	2.32	2.66	38.20	40.85	0.88	7.59	73.59
15.	Gel consistency (mm)	20.03	14.78	–	26.22	9.98	10.52	15.78	16.20	0.95	1.036	31.65
16.		65.23	35.30	–	87.87	217.03	224.46	22.59	22.97	0.97	1.653	45.75

PCV indicating wide genetic variation among the genotypes under study and indicating further scope for improvement of these characters. This was in conformity with the findings of Veerabadhiran *et al.* (2009) and Asish *et al.,* (2007) for gelatinization temperature and gel consistency. Moderate estimates of PCV and GCV values were recorded for amylose content followed by kernel L/B ratio and kernel breadth. These results were in consonance with the findings of Veerabadhiran *et al.,* (2009) for amylose content, kernel L/B ratio and kernel breadth. However, other characters *viz.,* kernel length, volume expansion ratio, head rice recovery, kernel L/B ratio after cooking, kernel breadth after cooking, kernel length after cooking, water uptake, kernel linear elongation ratio, kernel breadth wise expansion ratio, milling percentage and hulling percentage registered low estimates of GCV and PCV indicating the low range of variation found in these characters, thus offers little scope for further improvement of these characters through selection. These results were in agreement with the reports of Vanaja *et al.,* (2006) for kernel length and kernel linear elongation ratio, Sanjukta Das *et al.,* (2007) for volume expansion ratio, head rice recovery, kernel linear elongation ratio, milling percentage and hulling percentage and Veerabadhiran *et al.,* (2009) for head rice recovery, kernel length, kernel length after cooking, kernel linear elongation ratio, kernel breadth wise expansion ratio and water uptake in rice.

High estimate of heritability was recorded for all the characters indicating the least influence of environment on the genotypes. These findings were in consonance with the reports made by Chakraborty *et al.,* (2009) for water uptake, gelatinization temperature, gel consistency, kernel linear elongation ratio and kernel breadth wise expansion ratio, Veerabadhiran *et al.,* (2009) for amylose content, kernel L/B after cooking, and kernel breadth after cooking, Sanjukta Das *et al.,* (2007) for hulling percentage, milling percentage and head rice recovery percentage and Asish *et al.,* (2007) for kernel length, kernel breadth and kernel L/B ratio.

High heritability coupled with high genetic advance as per cent of mean was recorded for gelatinization temperature, gel consistency, amylose content, kernel L/B ratio, kernel breadth and kernel length indicating that most likely the heritability is due to additive gene effects and selection may be effective for these characters. Similar kind of high estimates of heritability and genetic advance as percent of mean were reported by Chakraborty *et al.,* (2009) and Veerabadhiran *et al.,* (2009) for gelatinization temperature, gel consistency and amylose content, Sanjukta Das *et al.,* (2007) for kernel length and Vanaja *et al.,* (2006) for amylose content, kernel L/B ratio and kernel breadth and corroborated the results of the present study.

It is to conclude that, gelatinization temperature, gel consistency, amylose content, kernel L/B ratio, kernel breadth and kernel length were least influenced by environment in their expression. High heritability coupled with high genetic advance observed for these traits indicated that most likely the heritability is due to additive gene effects and selection may be effective for these characters based on phenotypic values by utilizing the present elite breeding lines of rice for further improvement of grain quality.

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