

Genetic Variability, Heritability and Genetic Advance for Grain Yield, its Components and Quality Traits in Rice (*Oryza sativa* L.)

B Hari Ram Kumar, P V Satyanarayana, D Ratna Babu, N Chamundeswari, V Srinivasa Rao and S Krishnam Raju

Department of Genetics and Plant Breeding, Agricultural College, Bapatla, A.P. - 522 101.

ABSTRACT

An investigation was carried out to assess the variability, heritability and genetic advance for twenty four characters. High PCV and GCV for alkali spreading value was recorded, while number of grains per panicle, test weight, leaf area index at maximum tillering stage, kernel breadth after cooking, water uptake, gel consistency recorded moderate variability (*i.e.*, moderate PCV and GCV). High heritability accompanied with high genetic advance had shown by the characters *viz.*, number of ear bearing tillers per plant, number of grains per panicle, test weight, leaf area index at maximum tillering stage, water uptake, gel consistency and alkali spreading value indicating the preponderance of additive gene action which may be exploited through pedigree method, mass selection, ear-to-row method, etc. are to be followed to improve these traits.

Key words: Genetic advance, Heritability, Rice, Variability

Rice (Oryza sativa L.) was one of the staple cereal food crops of India. About 90% of the world's rice is grown and consumed in Asia. According to the projections made by the Population Foundation of India, the country's population will be 1546 million by the end of 2030 and 1824 million by the end of 2050. It is estimated that the demand for rice will be 121.2 million tonnes by the year 2030 and 137.3 million tonnes by the year 2050. (CRRI -VISION 2050). Due to various socioeconomic constraints, a chance of bringing more area under rice cultivation is very remote. In view of the current situation of food insecurity, a number of limiting factors such as population growth in most of the Asian countries continues to be around 2% per year. Hence to achieve the target of increased rice production, it requires raising the production per unit area by creating the high yielding varieties, which requires a thorough knowledge of genetic variation in yield contributing characters. Observed variability is a combined estimate of genetic and environmental causes whereas genetic variability alone is heritable. Moreover, estimates of genetic variability across different environments helps to exploit complete genetic variability to exercise selection for development of yield contributing traits.

However, the success of any breeding programme depends upon the quantum of genetic variability present in the population. Wider range of genetic variability helps in selecting desired genotypes. In addition to the genetic variability, knowledge on heritability and genetic advance helps the breeder to employ the suitable breeding strategy. Therefore, it is necessary to have knowledge of genetic variability, heritability and genetic advance present in the available genetic material.

MATERIAL AND METHODS

Twenty varieties were grown during *kharif*, 2014 at Andhra Pradesh Rice Research Institute (APRRI) and Regional Agricultural Research Institute (RARS) in a Randomized Complete Block Design (RCBD) with three replications. Observations were recorded on ten randomly chosen plants for twenty four quantitative characters viz., twenty four characters of consisting of 10 yield attributing characters *viz.*, days to 50% flowering, days to maturity, plant height (cm), total number of tillers per plant, number of ear bearing tillers per plant, panicle length per plant (cm), number of grains per panicle, test weight (gm), leaf area index at maximum tillering stage, grain yield

per plant; 6 physical traits such as hulling per cent, milling per cent, head rice recovery per cent, kernel length (mm), kernel breadth (mm), L/B ratio; and 8 cooking quality traits such as kernel length after cooking (mm), kernel breadth after cooking (mm), kernel elongation ratio, volume expansion ratio, water uptake value (ml), gel consistency, alkali digestion value (mm) and amylose. The data were subjected to statistical analysis and various genetic parameters such as PCV, GCV, heritability and genetic advance were worked out as per Johnson *et al.* (1955) and Hanson (1963).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among all the 20 varieties for all the characters studied, indicating a high degree of variability in the material (Table 1). In the present study, the variation among genotypes was estimated as coefficient of variation (Table 2). The phenotypic coefficient of variance (PCV) was slightly higher in magnitude than genotypic coefficient of variance (GCV) for all the characters studied indicating the influence of environment on expression of these traits. Highest PCV and GCV (32.342 and 32.079) were exhibited by akali spreading value, whereas Moderate PCV and GCV was recorded for total number of tillers per plant, number of ear bearing tillers per plant, number of grains per panicle, test weight, leaf area index at maximum tillering stage, kernel breadth after cooking, water uptake and gel consistency. While grain yield per plant exhibited moderate PCV and low GCV. Low PCV and GCV was recorded by days to 50% flowering, days to maturity, plant height, panicle length per plant, hulling per cent, milling per cent, head rice recovery, kernel length, kernel breadth, L/B ratio, kernel length after cooking, kernel elongation ratio, volume expansion ratio, and amylose content. The results are in accordance with by Allam et al. (2015), Navin Kumar et al. (2015), Sameera et al. (2015), Arpita et al. (2014), Lingaiah et al. (2014), Thirumala Rao et al. (2014), Aditya Kumar et al. (2013), Paikhomba et al. (2013) and Shiva Prasad et al. (2013).

Heritability estimates along with genetic advance are more helpful in predicting the gain under selection than heritability estimates alone. The estimates of heritability and genetic advance as per cent of mean were high for number of ear bearing tillers per plant, number of grains per panicle, test weight, LAI at maximum tillering stage, water uptake, gel consistency and alkali spreading value indicating that these characters were less influenced by environment and governed by additive gene action which may be exploited through breeding methods involving simple selection like pedigree method, mass selection, ear-to-row method, etc. These findings were in agreement with Keya *et al.* (2015), Sameera *et al.* (2015), Gokulakrishnan *et al.* (2014), Atif and Khalid (2013), Awaneet Kumar and Senapati (2013) and Gangashetty *et al.* (2013)

High heritability coupled with moderate genetic advance as per cent of mean was observed for days to 50% flowering, days to maturity, plant height, total number of tillers per plant, panicle length per plant, head rice recovery, kernel length, kernel breadth, L/B ratio, kernel length after cooking, kernel breadth after cooking, kernel elongation ratio and volume expansion ratio. Whereas hulling per cent, milling per cent and amylose content expressed high heritability accompanied with low genetic advance indicating the role of both additive and non-additive gene actions in the inheritance of these traits and can be improved either by population improvement methods or even heterosis breeding methods like production of hybrids and synthetics. While moderate heritability coupled with low genetic advance as per cent of mean was observed for milling per cent, whereas grain yield per plant exhibited moderate PCV and GCV indicating the role of non-additive gene action and can be improved by population improvement methods involving selection, intermating among selected ones and reselection may help to improve these traits besides exploiting the methods of heterosis breeding. These findings are corroborated by Vijay Kumar et al. (2015) and Mulugeta et al. (2012).

LITERATURE CITED

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C87.661 049.1067 0.0400 0.0334 0.032 0.0400 0.020 0.0400 0.020 0.0400 0.0200 0.0200 0.0200 0.0200 0.0200 0.0200	Replications Treatments Error Total		0.000 0.272** 0.002 0.275	0.001 0.087** 0.001 0.089	$\begin{array}{c} 0.001 \\ 0.088^{**} \\ 0.001 \\ 0.091 \end{array}$	0.003 1.654** 0.029 1.686	*	lean sum of 0.000 0.031** 0.001 0.032		25.350 2875.448** 50.648 2951.446	0.284 191.629** 2.071 193.985		0.034 5.939** 0.611 6.584	0.530 12.056** 2.769 15.354
** Significant at 1% level * Significant at	*	Signif	icant at 1%	level								Significant at 5% level	5% level	

Table: 2. Estimates of variability, heritability and genetic advance as per cent of mean for grain yield, yield components and quality traits of 20 varieties in rice (Oryza sativa L.)

Ig 112.37 96.33 122.33 6.997 Ig 142.83 126.00 152.33 5.596 Ig tillers plant ¹ 1182 8.67 14.00 12.822 1 Ig tillers plant ¹ 11.82 8.67 141.00 12.822 1 Int (cm) 25.10 21.34 28.14 6.958 1 Int (cm) 25.10 21.34 28.14 6.958 1 Ilering stage 25.10 21.34 28.14 6.958 1 192.6 15.07 25.54 13.635 1 1 192.6 15.07 25.54 13.635 1 1 2 0% 65.05 57.78 71.03 5.925 3 3 467 0% 65.05 57.78 71.03 5.925 3 3 467 0% 65.05 57.78 71.03 5.925 3 3 467 10.01 2.3.00 164 2.30 8 8 8 1 10 6.04 <t< th=""><th>S.No</th><th>Characters</th><th>Mean</th><th>Range Min</th><th>ge Max</th><th>Coefficient of varition PCV GC (%) (%</th><th>nt of on GCV (%)</th><th>Heritability (broad sense)</th><th>Genetic advancement</th><th>Genetic advance as percent of mean</th></t<>	S.No	Characters	Mean	Range Min	ge Max	Coefficient of varition PCV GC (%) (%	nt of on GCV (%)	Heritability (broad sense)	Genetic advancement	Genetic advance as percent of mean
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Number of grains per panicle199.30158.00242.0014.663Test weight (g)Test weight (g)19.2615.0725.5413.635LAI at max tillering tillering tillering tillering stage 2.84 2.30 3.47 14.242Grain yield plant ⁻¹ (g) 80.29 77.46 82.24 11.261 Hulling (%) 73.29 68.09 76.60 3.467 Milling (%) 73.29 68.09 76.60 3.467 Head rice recovery (%) 5.60 4.98 6.11 5.421 Kernel length (mm) 5.60 4.98 6.11 5.421 Kernel breadth (mm) 2.75 2.53 3.04 6.341 Kernel breadth Ratio 2.75 2.53 3.04 6.341 Kernel breadth after cooking (mm) 2.75 2.53 3.04 6.167 Yolume expansion ratio 2.75 2.53 3.04 6.167 Volume expansion ratio 2.75 2.53 3.04 6.167 Mater uptake (ml) 5.84 40.23 6.02 9.079 Mater uptake (ml) 5.84 40.23 6.02 3.342 Alkali spreading value (mm) 4.45 3.70 5.06 9.079 Mater uptake (ml) 5.84 40.23 6.72 32.342 Alkali spreading value (mm) 4.45 3.70 5.06 9.079 Alkali spreading value (mm) 4.21 2.06 6.167 3.342	9	Panicle length per plant (cm)	25.10	21.34	28.14	6.958	5.991	74.10	2.668	10.626
Test weight (g)19.2615.0725.5413.635LAI at max tillering tillering stage 2.84 2.30 3.47 14.242 Grain yield plant $^{-1}$ (g) 2.151 18.12 25.66 11.261 Hulling (%) 80.29 77.46 82.24 $1.8.63$ Milling (%) 77.46 82.24 1.863 Milling (%) 5.05 57.78 71.03 5.925 Kernel length (mm) 2.04 1.64 2.30 8.439 Length/Breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel length after cooking (mm) 2.75 2.53 3.04 6.167 Volume expansion ratio 2.75 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 2.86 9.079 Water uptake (ml) 5.78 2.15 3.47 12.488 Mater uptake (ml) 5.84 40.23 6.02 9.079 Mater uptake (ml) 5.84 40.23 6.72 32.342 Alkali spreading value (mm) 4.45 3.70 5.06	7	Number of grains per panicle	199.30	158.00	242.00	14.663	13.803	88.60	53.342	26.765
LAI at max tillering tillering stage 2.84 2.30 3.47 14.242 Grain yield plant $^{-1}(g)$ Grain yield plant $^{-1}(g)$ 80.29 77.46 82.24 11.261 Hulling (%) 80.29 77.46 82.24 1.863 Milling (%) 73.29 68.09 76.60 3.467 Head rice recovery (%) 55.05 57.78 71.03 5.925 Kernel length (mm) 5.60 4.98 6.11 5.421 Kernel length (mm) 2.04 1.64 2.30 8.439 Length/Breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Breadth after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Brogation Ratio 1.70 1.64 8.081 8.439 Kernel Elongation Ratio 1.70 1.60 2.366 9.079 Water uptake (ml) 2.78 2.15 3.47 12.488 Mater uptake (ml) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 4.21 2.06 6.72 32.342 Alkali spreading value (mm) 4.21 2.06 6.72 32.342	8	Test weight (g)	19.26	15.07	25.54	13.635	13.422	96.90	5.241	27.216
Grain yield plant $^{-1}$ (g) 21.51 18.12 25.66 11.261 Hulling (%)Milling (%) 80.29 77.46 82.24 1.863 Milling (%) 73.29 68.09 76.60 3.467 Mead rice recovery (%) 5.05 57.78 71.03 5.925 Kernel length (mm) 5.60 4.98 6.11 5.421 Kernel breadth (mm) 5.04 1.64 2.30 8.439 Kernel breadth Ratio 2.75 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel Elongation Ratio 2.78 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 55.84 40.23 68.08 14.467	6	LAI at max tillering tillering stage	2.84	2.30	3.47	14.242	14.123	98.30	0.821	28.848
Hulling (%)Hulling (%)Milling (%)Milling (%)Milling (%)Milling (%)Milling (%)Milling (%)Head rice recovery (%) 73.29 Kernel length (mm) 5.05 Kernel length (mm) 5.60 Kernel length (mm) 5.60 Kernel length (mm) 2.04 Length/Breadth Ratio 2.04 Length/Breadth Ratio 2.75 Kernel length after cooking (mm) 9.35 To lune expansion ratio 2.78 Volume expansion ratio 1.70 Water uptake (ml) 55.84 Alkali spreading value (mm) 7.200 Mikeli spreading val	10	Grain yield plant ⁻¹ (g)	21.51	18.12	25.66	11.261	8.181	52.80	2.633	12.245
Milling (%)Milling (%)73.29 68.09 76.60 3.467 Head rice recovery (%) 65.05 57.78 71.03 5.925 Kernel length (mm) 5.60 4.98 6.11 5.421 Kernel breadth (mm) 5.60 4.98 6.11 5.421 Kernel length after 2.04 1.64 2.30 8.439 Length/Breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel breadth after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 55.84 40.23 68.08 14.467	11	Hulling (%)	80.29	77.46	82.24	1.863	1.453	60.80	1.875	2.335
Head rice recovery (%) 65.05 57.78 71.03 5.925 Kernel length (mm) 5.60 4.98 6.11 5.421 Kernel breadth (mm) 2.04 1.64 2.30 8.439 Kernel breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel breadth after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 55.84 40.23 6.72 32.342	12	Milling (%)	73.29	68.09	76.60	3.467	2.648	58.30	3.053	4.166
Kernel length (mm) 5.60 4.98 6.11 5.421 Kernel breadth (mm) 2.04 1.64 2.30 8.439 Length/Breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel breadth after cooking (mm) 9.35 7.91 10.45 8.081 Kernel Brongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 1.70 1.50 1.88 6.167 Water uptake (ml) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 55.84 40.23 66.72 32.342	13	Head rice recovery (%)	65.05	57.78	71.03	5.925	5.553	87.80	6.975	10.722
Kernel breadth (mm) 2.04 1.64 2.30 8.439 Length/Breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel breadth after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 200.05 145.00 285.00 15.746 Alkali spreading value (mm) 55.84 40.23 68.08 14.467	14	Kernel length (mm)	5.60	4.98	6.11	5.421	5.355	97.60	0.611	10.899
Length/Breadth Ratio 2.75 2.53 3.04 6.341 Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel breadth after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 200.05 145.00 285.00 15.746 Gel consistency (mm) 55.84 40.23 68.08 14.467	15	Kernel breadth (mm)	2.04	1.64	2.30	8.439	8.313	97.00	0.345	16.869
Kernel length after cooking (mm) 9.35 7.91 10.45 8.081 Kernel breadth after cooking (mm) 2.78 2.15 3.47 12.488 Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 200.05 145.00 285.00 15.746 Gel consistency (mm) 55.84 40.23 68.08 14.467	16	Length/Breadth Ratio	2.75	2.53	3.04	6.341	6.188	95.30	0.342	12.442
Kernel breadth after cooking (mm)2.782.153.4712.488Kernel Elongation Ratio1.701.501.886.167Volume expansion ratio4.453.705.069.079Water uptake (ml)200.05145.00285.0015.746Gel consistency (mm)55.8440.2368.0814.467Alkali spreading value (mm)4.212.066.7232.342	17	Kernel length after cooking (mm)	9.35	7.91	10.45	8.081	7.870	94.90	1.477	15.79
Kernel Elongation Ratio 1.70 1.50 1.88 6.167 Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 200.05 145.00 285.00 15.746 Gel consistency (mm) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 4.21 2.06 6.72 32.342	18	Kernel breadth after cooking (mm)	2.78	2.15	3.47	12.488	10.208	66.80	0.478	17.19
Volume expansion ratio 4.45 3.70 5.06 9.079 Water uptake (ml) 200.05 145.00 285.00 15.746 Gel consistency (mm) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 4.21 2.06 6.72 32.342	19	Kernel Elongation Ratio	1.70	1.50	1.88	6.167	5.885	91.10	0.197	11.57
Water uptake (ml) 200.05 145.00 285.00 15.746 Gel consistency (mm) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 4.21 2.06 6.72 32.342	20	Volume expansion ratio	4.45	3.70	5.06	9.079	7.906	75.80	0.631	14.183
Gel consistency (mm) 55.84 40.23 68.08 14.467 Alkali spreading value (mm) 4.21 2.06 6.72 32.342	21	Water uptake (ml)	200.05	145.00	285.00	15.746	15.339	94.90	61.578	30.781
Alkali spreading value (mm) 4.21 2.06 6.72 32.342	22	Gel consistency (mm)	55.84	40.23	68.08	14.467	14.236	96.80	16.113	28.856
	23	Alkali spreading value (mm)	4.21	2.06	6.72	32.342	32.079	98.40	2.757	65.544
23.77 21.34 26.86 6.501	24	Amylose content (%)	23.77	21.34	26.86	6.501	5.607	74.40	2.368	9.964

PCV = Phenotypic coefficient of variation

GCV = Genotypic coefficient of variation

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