The Andhra Agric. J 71 (3): 276-282, 2024
doi :10.61657/aaj.2024.130

Genetic variability studies for yield, quality and nutritional traits in slender grain rice genotypes (*Oryza sativa* L.)

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ABSTRACT

The studies on genetic variation and its understanding in cultivated rice can help in improving the crop yield. The present investigation was undertaken with 66 slender grain rice genotypes to study the variability and genetic parameters for yield and its components, quality and nutritional traits. The investigation revealed that the estimates of GCV for all the characters studied were slightly less than PCV estimates the indicating influence of environment on the genotype performance. High PCV and GCV were recorded for the traits *viz*., grains panicle^{-1}, iron and fat content. The traits, days to 50 per cent flowering, 1000-grain weight, grain yield plant^{-1}, kernel L/B ratio, water uptake, volume expansion ratio, protein and zinc content showed moderate variability. High heritability coupled with high genetic advance as per cent was observed for the traits viz., days to 50 per cent flowering, grains panicle^{-1}, 1000-grain weight, grain yield plant^{-1}, kernel L/B ratio, water uptake, volume expansion ratio, iron, zinc and fat contents indicating that these characters are governed by additive gene effects and simple selection procedures may be effective for improving these traits.

Keywords: *GCV, Genetic advance, Grain yield, Heritability, PCV and Rice*

Rice (*Oryza sativa* L., 2n=24) belongs to the order Cyperales and family Poaceae, is a self-pollinated cereal crop. Approximately three billion people (>60% population) around the world consume rice as a basic food which provides about 50 to 80% of their daily calories and 15% of protein. About 90% of the rice is produced and consumed in Asia only. India is the second largest producers of rice in the world, Eastern and South India are the by major rice growing regions of India. Rice occupies an area of 451.52 lakh hectares producing 1238.15 lakh tonnes with an average productivity of 2742 kg ha^{-1} (www.Indiastat.com, 2023-24). In Andhra Pradesh, it occupies an area of 19.70 lakh ha, with a production and productivity of 76.76 lakh tonnes and 3896 kg ha^{-1}, respectively (www.Indiastat.com, 2023-24). Owing to a burgeoning population in world, it is estimated that the demand for rice will be 121.2 million metric tonnes by the year 2030, 129.6 million metric tonnes by the year 2040 and 137.3 million metric tonnes by the year 2050. In view of the increasing demand of rice foreseen for the future, the production per unit area needs to be increased to the level of 3.4 tonnes per ha from the present 2.4 tonnes per ha assuming the rice area under plough remains at existing level (CRRI-VISION 2050). The present deceleration drift in production and yield is a cause of concern and has to be upturned to meet the growing demand. It is, therefore necessary to harness the available rice knowledge and exploit genetic resources to maximize production to ensure food security and prosperity for the country. Agronomic value of rice varieties are defined by several features and the most important features include high yielding ability, tolerance to diseases and pests, resistance to undesirable environmental factors, and appearance quality of the products. Appearance quality (AQ) directly defines increasing demand for quality grain rice in domestic and international markets. Grain shape (slender or bold) and grain length (short, medium or long) are the important appearance qualities of rice grain. So the current challenges are to feed the ever-growing population and to meet the market demand with diminishing natural resources and environmental fluctuations by developing rice varieties with acceptable grain qualities along with high yield. The presence of adequate genetic variability is regarded as the fundamental pre-requisite to conduct any crop improvement programme. Sometimes phenotypic selection based on their performance may not be effective because these genotypes may perform poor in further segregating generations, so it is essential to select the genotypes based on heritability and genetic advance. The genotypic coefficient of variation measures the magnitude of genetic variability and reflects the heritable portion of variability. Genetic variability along with heritability estimates would provide the amount of genetic gain expected out of selection (Burton, 1952) . Therefore, assessment of variability for grain yield, yield attributes, quality and nutritional parameters in slender grain rice genotypes is essential to formulate selection criteria for the constructive yield augmentation through breeding. The present investigation was undertaken in this context to elucidate information on variability, heritability and genetic advance in 66 slender rice genotypes to identify effective selection criteria for grain yield and quality improvement

MATERIAL AND METHODS

The present investigation was carried out during *kharif*, 2023 at Regional Agricultural Research Station, Maruteru. In the present study, 66 genotypes were assessed to know the variability and genetic parameters for yield, yield component traits, quality and nutritional traits. List of genotypes used in the present study is presented in Table 1. Each genotype was sown in two rows of 5 m length following a spacing of 20 cm between the rows and 15 cm between the plants in alpha lattice design (ALD) with two replications. Standard agronomic practices were performed uniformly for all the experimental units. Crop was raised by following recommended package of practices. Phenological data on days to 50% flowering, days to maturity was recorded on plots bases of each genotype. At maturity five plants from each accession were selected randomly for recording data on grain yield per plant; yield component traits, *viz*., plant height, number of tillers plant^{-1}, panicle length, grains panicle^{-1} and test weight; and quality characters, *viz*., head rice recovery per cent, kernel length, kernel breadth, kernel length/breadth (L/B) ratio, water uptake, volume expansion ratio, amylose content and nutritional traits *viz.,* protein content, iron content, zinc content, fat content, starch content and calories. In contrast, observations for test weight and all the quality and nutritional traits were obtained from a random grain sample drawn from each plot and replication using standard procedures. Mean performance of the genotypes were calculated and the genotypic (GCV) and phenotypic (PCV) coefficients of variation were estimated by using the formula given by Burton (1952) . The estimates of PCV and GCV were classified as low (0-10%), moderate (10-20%) and high (>20%) according to Sivasubramanian and Madhavamenon (1973). Heritability in broad sense (h^2b) was estimated according to the formula suggested by Johnson *et al.* (1955) and Hanson *et al.* (1956). Estimation of genetic advance was carried out following the formula given by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) revealed significant differences among the genotypes for all the characters, demonstrating the presence of significant amount of variability and intrinsic genetic variation in the genotypes studied. The results of analysis of variance are presented in Table 2. Coefficient of variation studies implied that the estimates of GCV for all the characters studied were slightly less than PCV estimates indicating slight influence of environment on the genotype performance. Similar finding was reported earlier by Harsharaj *et al*. (2024). The results of mean, variability, heritability and genetic advance of each trait in the present study are presented in Table 3. The PCV values ranged from 3.71 (calories) to 25.48 (grains panicle^{-1}); whereas, GCV valuesranged from 3.05 (calories) to 25.12 (grains panicle^{-1}). High PCV and GCV (Fig 1) were recorded for grains panicle^{-1} (25.48 and 25.12), iron content (25.22 and 24.69) and fat content (24.93 and 24.20) Similar results were reported by Bhargavi *et al.* (2021), Nath and Kole (2021), Deepthi *et al.* (2022), Devi *et al.* (2020), Suhana *et al.* (2023), Harsharaj *et al.* (2024) .Moderate PCV and GCV was observed for the traits days to 50% flowering (11.14 and 12.55), test weight

Table 1. Experimental material used in the investigation

S. No.	Genotype	S. No.	Genotype
1	MTU 2770-1-1-1	34	JMP 132
2	MTU 2776-29-1-1-1-2	35	JGL 384
3	RM 426-21-2-1	36	WGL 14
4	MTU 2896-58-1-1	37	WGL 44
5	MTU 2897-35-1-1	38	WGL 347
6	NIC 6-1-3B	39	WGL 962
7	BPT 3278	40	WGL 1119
8	NIC 5-1-2B	41	WGL 14377
9	BPT 2858	42	WGL 23985
10	BPT 3082	43	WGL 32100
11	BPT 3224	44	KNM 733
12	BPT 3238	45	KNM 1638
13	BPT 3263	46	GR-3
14	BPT 3284	47	GR-4
15	BPT 3354	48	GR-7
16	BPT 3372	49	GR-11
17	BPT 3411	50	GR-12
18	BPT 3431	51	GR-101
19	BPT 5204	52	GAR-1
20	BPT 3278-320-1-6-1-1-1	53	GAR-3
21	NLR 3354	54	GAR-13
22	NLR 3648	55	GAR-22
23	NLR 3693	56	Narmada
24	NLR 3784	57	Pusa Samba 1850
25	NLR 3791	58	Pusa Samba 1853
26	NDLR 7	59	Ankur Sona
27	NDLR 24	60	Annapurna
28	NDLR 25	61	Chintoo
29	NDLR 26	62	HMT Sona
30	NDLR 27	63	Jai Shriram
31	RGL 7033	64	RNR 15048
32	RGL 7035	65	DRR Dhan 48
33	RGL 7038	66	DRR Dhan 58

(18.67 and 18.45), grain yield plant^{-1} (16.75 and16.27), kernel L/B ratio (14.46 and 13.83), water uptake (17.65 and 17.23), volume expansion ratio (13.21 and 12.06), protein content (11.61 and 10.32) and zinc content (15.87 and 14.47). The results are in consonance with the findings of Lakshmi *et al.* (2021), Akhtar *et al.* (2022), Suhana *et al.* (2023), Singh *et al.* (2020) and Zayed *et al.* (2023). Low PCV and GCV were recorded for days to maturity (9.27 and 8.43); panicle length (9.98 and 9.25), head rice recovery per cent (9.80 and 9.00), head rice recovery (9.28 and 6.96), amylose content (7.73 and 5.16) and calories (3.71 and 3.05). Similar findings were reported by Bhargavi *et al.* (2021), Nath and Kole (2021), Deepthi *et al.* (2022), Devi *et al.* (2020) and Suhana *et al.* (2018).

In the present study values of PCV are higher for all characters than corresponding GCV indicating the influence of environment over the expression of these characters. The estimates of heritability ranged from 44.57 (amylose content) to 97.71 (test weight) whereas, genetic advance as per cent of mean values ranged from 5.16 (calories) to 50.99 (grains panicle^{-1}). Heritability and genetic advance (Fig.2 and 3) are two important selection parameters. Heritability (Fig.2) estimates along with genetic advance are more useful in predicting genetic gain under selection than heritability estimates alone. High heritability coupled with high genetic advance as per cent of mean was observed for the characters, days to 50 per cent flowering, grains panicle^{-1}, 1000-grain weight, grain yield plant^{-1}, kernel L/B ratio, water uptake, volume expansion ratio, iron zinc and fat contents indicating that these characters are governed by additive gene action. Hence, better response to selection can be attained for improvement of these traits. The results are in accordance with the reports of Bhargavi *et al.* (2021), Nath and Kole (2021), Deepthi *et al.* (2022), Devi *et al.* (2020) and Suhana *et al.* (2018). High heritability estimates coupled with moderate genetic advance was manifested by the traits viz., days to maturity, plant height, ear bearing tillers plant^{-1}, panicle length, head rice recovery, kernel length, kernel breadth, protein content and starch content indicating involvement of both additive and non-additive gene actions in the inheritance of these traits.

CONCLUSION

The study concluded that important yield attributing characters like days to 50 per cent flowering, plant height, grains panicle^{-1}, test weight, grain yield plant^{-1}, kernel breadth, L/B ratio, water uptake, iron content, zinc content and fat content showed moderate to high variability, high heritability coupled with high genetic advance as per cent of mean, indicated the predominant role of additive gene action. As a result, the present study revealed that substantial

Table 2: Analysis of variance for yield and its components, quality and nutritional traits in slen der grain rice

Source	Degrees of freedom	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Ear bearing tillers plant^{-1}	Panicle length (cm)	Grains per panicle	1000-grain weight (g)	Grain yield plant^{-1} (g)	Head rice recovery (%)	Kernel length	Kernel breadth
	Mean sum of squares											
Replication	1	32.76	0.71	0.08	0.0113	1.107	3	0.003	0.55	22.86	0.03	0.00121
Genotypes	65	276.77**	250.32**	280.53**	2.501**	11.32**	8370**	17.64**	38.84**	47.87**	0.495**	0.0646**
Blocks	20	35.7	17.5	16.76	0.2657	0.727	135	0.196	1.38	11	0.0455	0.00475
Error	45	31.47	26.43	23.64	0.1264	0.911	115	0.208	1.04	14.44	0.0405	0.00607

Source	Degrees of freedom	L/B ratio	Water uptake	Volume expansion ratio	Amylose content (%)	Protein content (%)	Fe content (ppm)	Zn content (ppm)	Starch content	Fat content	Calories
Mean sum of squares											
Replication	1	0.024	0	0.0189	0.035	0.0353	0.066	0.738	13.79	0.01241	22.81
Genotypes	65	0.3795**	3633**	0.7217**	4.819**	1.5863**	11.461**	17.216**	77.21**	0.1782**	281.3**
Blocks	20	0.022	75	0.0902	1.967	0.2898	0.275	1.873	16.7	0.00383	62.59
Error	45	0.0145	92	0.0549	1.795	0.1387	0.234	1.46	14.26	0.00598	50.7

d.f = **Degrees of freedom ** = Significant at**

Table 3: Mean, coefficient of variation, heritability (broad sense), genetic advance as per cent of mean for different characters in rice.

Sl.No.	characters	GCV	PCV	h2 (Broad Sense)	GA	GAM
1	Days to 50 per cent flowering	11.14	12.55	78.82	20.2	20.38
2	Days to maturity	8.43	9.27	82.71	19.94	15.8
3	Plant height (cm)	9.87	10.66	85.74	21.71	18.83
4	Ear bearing tillers per plant	9.61	10.28	87.32	2.08	18.49
5	Panicle length (cm)	9.25	9.98	85.96	4.37	17.67
6	No. of grains per panicle	25.12	25.48	97.14	130.39	50.99
7	1000-grain weight (g)	18.45	18.67	97.7	6.01	37.57
8	Grain yield per plant (g)	16.27	16.75	94.25	8.68	32.53
9	Kernel length (mm)	9	9.8	84.34	0.9	17.03
10	Kernel breadth (mm)	9.85	10.76	83.87	0.32	18.59
11	Kernel L/B Ratio	13.83	14.46	91.49	0.84	27.26
12	Water uptake (ml)	17.23	17.65	95.34	84.7	34.66
13	Volume expansion ratio	12.06	13.21	83.3	1.08	22.68
14	Head Rice Recovery (%)	6.96	9.28	56.31	6.42	10.76
15	Amylose Content (%)	5.16	7.73	44.57	1.68	7.1
16	Protein Content (%)	10.32	11.61	79.08	1.53	18.91
17	Iron content (ppm)	24.69	25.22	95.79	4.77	49.78
18	Zinc content (ppm)	14.47	15.87	83.12	5.25	27.18
19	Strach content	8.72	10.62	67.44	9.43	14.76
20	Fat content (%)	24.2	24.93	94.2	0.59	48.39
21	Calories	3.05	3.71	67.61	18.04	5.16

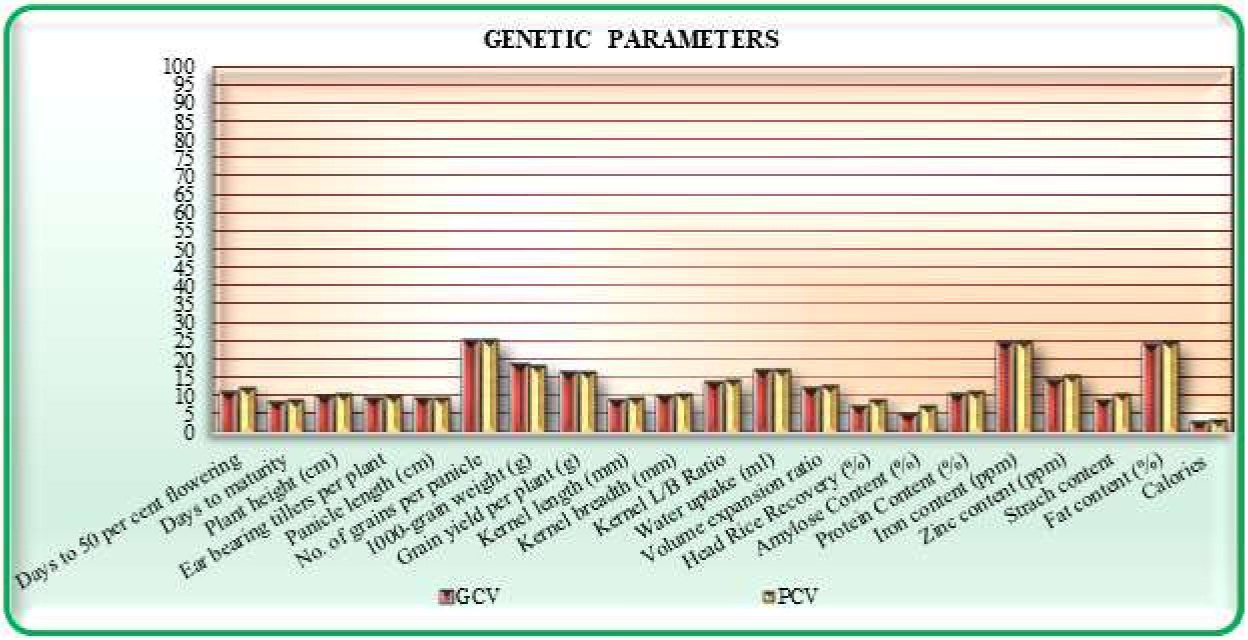

Fig 1: Variability parameters for yield and its components, quality and nutritional characters in rice

Fig 2: Heritability for yield and its components, quality and nutritional characters in rice

improvement in the expression of these characters over base population can be expected through simple selection.

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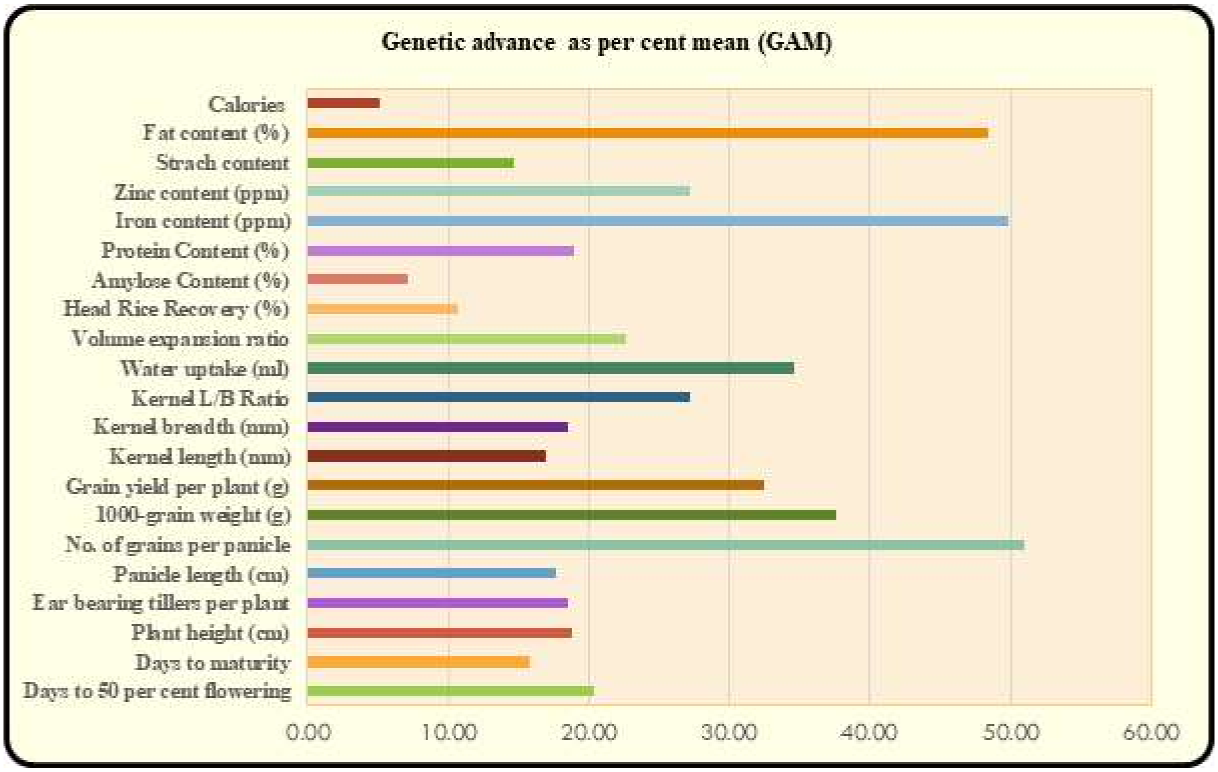

Fig 3: Genetic advance as per cent of mean for yield and its components, quality and nutritional characters in rice

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Received on 03.06.2024 and Accepted on 02.07.2024