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VARIABILITY AND GENETIC PARAMETERS FOR GRAIN YIELD AND ITS COMPONENTS AND KERNEL QUALITY ATTRIBURTES IN CMS BASED RICE HYBRIDS (ORYZA SATIVA L.)

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ABSTRACT: The present investigation was under taken to study the extent of variability and genetic parameters with 16 parents and 48 hybrids for nine yield and its components and twenty five quality characters. The magnitude of difference between PCV and GCV was relatively low for all the traits, indicating less environmental influence. High GCV and PCV were recorded for harvest index, total number of productive tillers per plant and gelatinization temperature in parents and for total number of productive tillers per plant, number of grains per panicle, gelatinization temperature and amylose content in hybrids. High heritability coupled with high genetic advance as per cent of mean were recorded for gelatinization temperature, harvest index, total number of productive tillers per plant, number of grains per panicle, kernel length, kernel L/B ratio and grain yield per plant in case of parents and for gelatinization temperature, amylose content, total number of productive tillers per plant, number of grains per panicle and harvest index in case of hybrids indicating the additive gene effects in the genetic control of these traits and can be improved by simple selection in the present breeding material.

Key words: Variability, heritability, genetic advance, hybrid rice

INTRODUCTION

Quantum jump in yield improvement has achieved in rice with the development of high yielding heterotic hybrids under commercial cultivation. However, being the staple food of the population in India, improving its productivity has become a crucial importance. The knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for effecting genetic improvement. It is important to evaluate the promising rice germplasm along with their hybrids for morphological characters and yield. 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 grower 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 yield and yield components and kernel quality attributes in certain parents and rice hybrids.

MATERIALS AND METHODS

The experimental material used in the study consisted of sixteen parents and 48 F_1 hybrid combinations of rice grown in a completely randomized block design with three replications at S.V Agricultural College, Tirupati. Twenty four 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 these plants for plant height, total number of productive tillers per plant, panicle length, number of grains per panicle, 200-kernel test weight, harvest index and grain yield per plant except days to 50 per cent flowering and days to maturity and for quality characters *viz.,* 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 Length/Breadth ratio after cooking, kernel linear elongation ratio, kernel breadth wise expansion ratio, water uptake, volume expansion ratio, amylose content, gelatinization temperature and gel consistency.

The treatment means 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 were calculated as per the formulae proposed by Burton (1952). The genotypic (GCV) and phenotypic (PCV) coefficient of variation was calculated by the formulae given by Burton (1952). Heritability in broad sense [$h^2_{(b)}$] was calculated by the formula given by Lush (1940) as suggested by Johnson *et al.* (1955). From the heritability estimates, the genetic advance (GA) was 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 traits indicating the sufficient scope for further improvement (Table 1and 2). The range of mean variation observed among yield components and kernel quality characters in parents revealed that highest range of mean variation was noticed for number of grains per panicle (141.51) and amylose content (8.65), whereas the range was found to least for 200-kernel test weight (1.91) and volume expansion ratio (0.08), respectively (Table 3 and 4). Similarly, the highest magnitude of genotypic and phenotypic variance was registered for number of grains per panicle and amylose content while least estimates were recorded for 200-kernel test weight and volume expansion ratio in case of parents (Table 5 and 6).

In case of hybrids, the range of mean variation observed for the characters revealed that highest range of mean variation was noted for number of grains per panicle (190.97) and gel consistency (29.42), whereas the range was found to be least for kernel L/B ratio (0.20) and volume expansion ratio (0.13). The highest magnitude of genotypic and phenotypic variance was noted for number of grains per panicle and gel consistency while the least estimates were recorded for kernel L/B ratio and volume expansion ratio

TABLE (1): ANALYSIS OF VARIENCE FOR GRAIN YIELD AND ITS CONTRIBUTINFG CHARACTERS IN RICE

Source of variation	df	DF	DM	PH	TPTP	PL	NGPP	GY	200-KTW	HI
Replications	2	1.03	0.38	0.49	2.88	1.07	1221.29	22.37	0.14	13.86
Genotypes	63	221.50**	160.61**	157.50**	9.35**	6.00**	5723.80**	22.66**	0.72**	104.65**
Error	126	0.42	0.36	0.39	0.07	0.16	118.96	1.23	0.01	0.58

* Significant at P = 0.05 level; ** Significant at P=0.01 level

DF: Days to 50% Flowering; DM: Days to Maturity; PH: Plant Height; TPTP: Total number of Productive Tillers per Plant; PL: Panicle Length; NGPP: Number of Grains Per Panicle; GY: Grain Yield per plant; 200 KTW: 200-Kernel Test Weight; HI: Harvest Index

TABLE (2): ANALYSIS OF VARIENCE FOR KERNEL QUALITY CHARACTERS IN RICE

Source of variation	df	HL%	ML%	HRR%	KL	KB	L/B	KLAC	KBAC
Replications	2	6.93	28.27	4.45	0.005	0.002	0.009	0.014	0.01
Genotypes	63	7.22**	24.12**	20.10**	2.00**	0.04**	0.53**	1.08**	0.17**
Error	126	1.06	0.62	1.13	0.02	0.002	0.001	0.003	0.044

* Significant at P = 0.05 level; ** Significant at P=0.01 level

HL%: Hulling percentage; ML%: Milling percentage; HRR: Head Rice Recovery; KL: Kernel Length; KB: Kernel Breadth ; L/B: Kernel L/B ratio; KLAC: Kernel Length After Cooking; KBAC: Kernel Breadth After Cooking

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Source of variation	df	K L/B AC	KLER	KBER	WU	VER	AC	GT	GC
Replications	2	0.006	0.0001	0.006	0.05	0.003	10.54	0.51	4.74
Genotypes	63	0.25**	0.01**	0.04**	0.20**	0.002**	98.56**	6.88**	119.54**
Error	126	0.002	0.0003	0.002	0.02	0.001	1.10	0.27	2.31

* Significant at P = 0.05 level; ** Significant at P=0.01 level

K L/B AC: Kernel L/B ratio After Cooking; KLER: Kernel Linear Elongation Ratio;KBER: Kernel Breadth wise Expansion Ratio; WU: Water Uptake; VER: Volume Expansion Ratio; AC: Amylose Content; GT: Gelatinization Temperature;GC: Gel Consistency

TABLE (3): ESTIMATION OF GENETIC VARIABILITY AND GENETIC PARAMETERS IN PARENTS FOR GRAIN YIELD AND ITS CONTRIBUTING CHARACTERS IN RICE

S. 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.	DF	105.27	84.67	–	120.33	94.96	95.29	9.26	9.27	0.99	20.04	19.04
2.	DM	135.04	119.33	–	144.67	72.78	73.06	6.32	6.33	0.99	17.54	12.99
3.	PH	93.37	85.30	–	113.83	74.47	75.70	9.24	9.32	0.98	17.63	18.88
4.	TPTP	7.30	4.40	–	10.57	3.52	3.59	25.71	25.96	0.98	3.83	52.46
5.	PL	23.75	21.75	–	25.84	1.42	1.58	5.02	5.30	0.89	2.33	9.79
6.	NGPP	185.80	126.62	–	268.13	1190.11	1233.83	18.57	18.91	0.96	69.80	37.57
7.	GY	12.34	9.04	–	16.59	4.28	5.37	16.76	18.77	0.79	3.81	30.84
8.	200-KTW	3.78	3.11	–	5.02	0.22	0.22	12.27	12.50	0.96	0.94	24.82
9.	HI	24.13	12.58	–	35.39	56.35	56.76	31.11	31.23	0.99	15.41	63.86
10.	HL%	79.26	76.24		81.40	1.86	2.97	1.72	2.18	0.62	2.23	2.81
11.	ML%	74.34	71.65		76.80	1.27	2.20	1.52	2.00	0.57	1.76	2.37
12.	HRR%	68.86	64.18		71.61	4.49	5.07	3.08	3.27	0.88	4.10	5.96

DF: Days to 50% Flowering; DM: Days to Maturity; PH: Plant Height; TPTP: Total number of Productive Tillers per Plant; PL: Panicle Length; NGPP: Number of Grains Per Panicle; GY: Grain Yield per plant; 200 KTW: 200-Kernel Test Weight; HI: Harvest Index; HL%: Hulling percentage; ML%: Milling percentage; HRR%: Head Rice Recovery.

TABLE (4): ESTIMATION OF GENETIC VARIABILITY AND GENETIC PARAMETERS IN PARENTS FOR 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.	KL	7.49	5.50	–	7.63	1.55	1.55	16.60	16.62	0.99	2.56	34.15
2.	KB	2.18	1.97	–	2.22	0.01	0.01	3.85	4.38	0.77	0.15	6.96
3.	L/B	3.44	2.48	–	3.52	0.31	0.31	16.06	16.20	0.98	1.13	32.79
4.	KLAC	8.69	6.87	–	9.23	0.89	0.89	10.84	10.88	0.99	1.93	22.24
5.	KBAC	2.82	2.36	–	2.87	0.09	0.09	10.69	10.81	0.97	0.61	21.78
6.	K L/B AC	3.11	2.48	–	3.19	0.16	0.16	12.67	12.78	0.98	0.80	25.87
7.	KLER	1.16	1.01	–	1.20	0.01	0.01	8.33	8.46	0.9	0.20	16.90
8.	KBER	1.28	1.03	–	1.28	0.01	0.02	8.33	9.76	0.72	0.19	14.65
9.	WU	2.43	2.00	–	2.48	0.04	0.07	8.46	10.83	0.61	0.33	13.62
10.	VER	1.24	1.17	–	1.25	0.001	0.001	2.32	2.95	0.61	0.05	3.75
11.	AC	24.60	18.41	–	27.06	4.08	4.98	8.22	9.07	0.82	3.77	15.33
12.	GT	3.69	2.00	–	6.33	3.14	3.31	48.01	49.32	0.94	3.55	96.30
13.	GC	56.32	48.92	–	69.37	30.49	32.00	9.80	10.04	0.95	11.10	19.72

KL: Kernel Length; KB: Kernel Breadth; L/B: Kernel L/B ratio; KLAC: Kernel Length After Cooking; KBAC: Kernel Breadth After Cooking; K L/B AC: Kernel L/B ratio After Cooking; KLER: Kernel Linear Elongation Ratio;KBER: Kernel Breadth wise Expansion Ratio; WU: Water Uptake; VER: Volume Expansion Ratio; AC: Amylose Content; GT: Gelatinization Temperature;GC: Gel Consistency

TABLE (5): ESTIMATION OF GENETIC VARIABILITY AND GENETIC PARAMETERS IN F_1 GENERATION FOR GRAIN YIELD AND ITS CONTRIBUTING CHARACTERS IN RICE

S. 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.	DF	100.49	84.33	–	116.67	62.63	63.08	7.88	7.90	0.99	16.24	16.17
2.	DM	134.06	116.33	–	144.67	48.13	48.51	5.18	5.20	0.99	14.24	10.62
3.	PH	90.59	77.33	–	111.07	44.47	44.60	7.36	7.37	0.99	13.72	15.14
4.	TPTP	7.33	4.40	–	10.73	3.02	3.09	23.73	24.00	0.97	3.54	48.33
5.	PL	23.59	20.66	–	27.35	2.15	2.31	6.21	6.44	0.93	2.91	12.34
6.	NGPP	196.50	103.00	–	293.97	2097.39	2236.42	23.31	24.07	0.93	91.36	46.50
7.	GY	15.57	11.17	–	21.26	5.62	6.71	15.23	16.65	0.83	4.47	28.71
8.	200-KTW	3.83	2.83	–	4.98	0.25	0.26	12.96	13.39	0.93	0.99	25.85
9.	HI	25.62	14.97	–	38.82	27.96	28.58	20.64	20.87	0.97	10.77	42.04
10.	HL%	78.53	74.63	–	80.90	2.04	3.05	1.82	2.22	0.66	2.41	3.07
11.	ML%	73.17	58.46	–	76.49	9.74	10.27	4.27	4.38	0.94	6.26	8.56
12.	HRR%	68.10	54.87	–	72.21	6.92	8.17	3.86	4.20	0.84	4.99	7.33
13.	L/B	1.08	0.97	–	1.17	0.01	0.02	2.82	3.46	0.66	0.05	4.74

DF: Days to 50% Flowering; DM: Days to Maturity; PH: Plant Height; TPTP: Total number of Productive Tillers per Plant; PL: Panicle Length; NGPP: Number of Grains Per Panicle; GY: Grain Yield per plant; 200 KTW: 200-Kernel Test Weight; HI: Harvest Index; HL%: Hulling percentage; ML%: Milling percentage; HRR%: Head Rice Recovery percentage.

TABLE (6): ESTIMATION OF GENETIC VARIABILITY AND GENETIC PARAMETERS IN F_1 GENERATION FOR 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.	KL	8.36	7.60	–	9.47	0.20	0.22	5.34	5.63	0.90	0.87	10.43
2.	KB	2.21	2.02	–	2.62	0.01	0.02	5.06	5.38	0.88	0.22	9.81
3.	L/B	3.80	3.10	–	4.50	0.10	0.11	8.46	8.82	0.92	0.64	16.71
4.	KLAC	9.08	7.61	–	10.02	0.16	0.16	4.39	4.42	0.98	0.82	8.98
5.	KBAC	2.88	2.25	–	3.29	0.04	0.05	7.30	7.36	0.98	0.43	14.91
6.	K L/B AC	3.17	2.47	–	4.14	0.06	0.06	7.65	7.74	0.97	0.49	15.58
7.	KLER	1.09	1.00	–	1.18	0.02	0.03	4.12	4.41	0.87	0.09	7.93
8.	KBER	1.30	1.04	–	1.49	0.01	0.01	8.41	8.71	0.93	0.22	16.73
9.	WU	2.39	1.92	–	3.24	0.07	0.09	10.85	12.20	0.79	0.48	19.88
10.	VER	1.24	1.16	–	1.29	0.01	0.03	1.70	2.50	0.46	0.03	2.38
11.	AC	25.79	11.96	–	41.25	41.90	43.03	25.10	25.44	0.97	13.16	51.02
12.	GT	2.97	1.00	–	6.00	1.82	2.13	45.43	49.05	0.85	2.58	86.67
13.	GC	56.87	46.90	–	76.32	42.63	45.09	11.48	11.81	0.94	13.08	23.00

KL: Kernel Length; KB: Kernel Breadth ;L/B: Kernel L/B ratio; KLAC: Kernel Length After Cooking; KBAC: Kernel Breadth After Cooking; K L/B AC: Kernel L/B ratio After Cooking; KLER: Kernel Linear Elongation Ratio; KBER: Kernel Breadth wise Expansion Ratio; WU: Water Uptake; VER: Volume Expansion Ratio; AC: Amylose Content; GT: Gelatinization Temperature; GC:Gel Consistency

The PCV estimates were higher than GCV for all the traits, indicating the influence of environment for the expression of these traits in case of parents. The difference between PCV and GCV estimates were relatively low for all the traits except for total number of productive tillers per plant, number of grains per panicle, grain yield per plant, 200-kernel test weigh, harvest index kernel length, kernel breadth and kernel Length/Breadth ratio after cooking indicating less environmental influence on these traits. Contrary to this total number of productive tillers per plant, harvest index and gelatinization temperature showed higher estimates of GCV and PCV therefore, simple selection can be practiced for further improvement of these characters. This was in conformity with the findings of Kundu *et al*. (2008) and Rema Bai *et al.* (1992) for grain yield and total number of productive tillers and Sanjukta Das *et al.* (2007) and Vanaja *et al.* (2006) for gelatinization temperature. Moderate estimates of PCV and GCV values were recorded for number of grains per panicles, grain yield per plant, 200-kernel test weight, kernel length, kernel breadth, kernel Length/Breadth ratio after cooking and kernel Length/Breadth ratio. These results were in consonance with the findings of Kundu *et al.* (2008) for test weight, Sharma and Sharma (2007) for number of grains per panicle and Sarkar and Bhutia (2007) for kernel L/B ratio. However, other characters showed low PCV and GCV estimates. In case of hybrids, the difference between PCV and GCV estimates were relatively low for all the traits except for total number of productive tillers per plant, number of grains per panicle, grain yield per plant, 200-kernel test weight, harvest index kernel length, gelatinization temperature, amylose content, water uptake indicating less environmental influence on these traits. The characters viz., total number of productive tillers per plant, harvest index, number of grains per panicles and gelatinization temperature showed higher estimates of GCV and PCV therefore, simple selection can be practiced for further improvement of these characters. This was in conformity with the findings of Sharma *et al.*(2006) for total number of productive tillers per plant, Singh *et al.* (2000) for harvest index in rice and Vanaja *et al.* (2006) for gelatinization temperature. Moderate estimates of PCV and GCV values were recorded for number of grains per panicle, grain yield per plant, 200-kernel test weight, gel consistency and water uptake. These results were in consonance with the findings of Kundu *et al.* (2008) for test weight and Sharma and Sharma (2007) for number of grains per panicle. However, other characters showed low PCV and GCV estimates.

High heritability values were recorded for all the characters except volume expansion ratio in the generation indicating the least influence of environment on the expression of kernel quality characters in both parental and F_1 generation. These findings were in consonance with the reports made earlier in rice by Kundu *et al*. (2008) and Deepa Sankar *et al.* (2006). High heritability coupled with high genetic advance as per cent of mean were recorded for gelatinization temperature, harvest index, total number of productive tillers per plant, number of grains per panicle, kernel length, kernel L/B ratio and grain yield per plant in case of parents and for gelatinization temperature, amylose content, total number of productive tillers per plant, number of grains per panicle and harvest index in case of hybrids indicating the additive gene effects in the genetic control of these traits and can be improved by simple selection in the present breeding material. Similar kind of observations were reported by Kundu *et al*. (2008) for number of grains per panicle, Deepa Sankar *et al.* (2006) for plant height, total number of productive tillers per plant, number of grains per panicle, test weight and grain yield per plant and Veerabadhiran *et al.* (2009) for gelatinization temperature and amylose content. The present study revealed that, total number of productive tillers per plant, number of grains per panicle, 200-kernel test weight, harvest index, kernel length, kernel L/B ratio gelatinization temperature and amylose content were less influenced by environment and high heritability coupled with high genetic advance indicating that most likely the heritability is due to additive gene effects and selection may be effective for these characters based on phenotypic values in order to obtain maximum genetic gain for yield improvement in rice by simple selection process.

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