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Assessment of Genetic Parameters for Yield and Quality Traits in Colored Rice (*Oryza sativa* L.) Genotypes

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ABSTRACT

Genetic parameters for 15 yield and quality traits were studied in 26 colored rice genotypes. The results of genetic parameters revealed that high GCV and PCV coupled with high heritability and high genetic advance as percent of mean were observed for test weight, number of filled grains per panicle, total number of grains per panicle, solid loss, water uptake and alkali spreading value suggesting an additive type of gene action. The remaining traits manifested low to high GCV and PCV, moderate to high heritability and low to high genetic advance as percent of mean indicating the preponderance of both additive and non additive gene effects in controlling these traits.

Key words: *GCV, PCV, Heritability, Genetic advance, Quality traits*

Rice (*Oryza sativa* L.) is one of the most important cereal crops in the tropics as well as parts of temperate regions in the world. It is the staple food for more than three billion people (Bhattacharjee *et al*., 2002) in 39 countries that comprises of nearly half of the world's population. Rice is the only cereal, cooked and consumed as a whole grain and hence, quality considerations are much more important in rice than for any other food crop (Hossain *et al*., 2009). Increased income levels and self-sufficiency induced rice availability for consumption has brought a shift in the consumer as well as market preferences towards demand for varieties with better grain quality. Nowadays, whole grain pigmented rice has been categorized as one of the potent functional foods since it contains high amounts of phenolic compounds (Yawadio *et al*., 2007). In addition, colored rice contains higher levels of proteins, vitamins and minerals compared to common white rice. Red rice is reported to be a good source of fibre, antioxidants, magnesium and iron. In this context, the present study on assessment of genetic parameters was undertaken for the yield and quality parameters of different colored rice genotypes.

MATERIAL AND METHODS

The experiment was carried out during *Kharif*, 2017 at Agricultural College Farm, Bapatla, Andhra Pradesh. The experimental material consisted of 26 released/advanced genotypes developed at Agricultural Research Station, Bapatla and varieties received from ARS Pattambi, Kerala. Among the 26 genotypes studied seven had normal light brown pericarp color (BPT 5204, BPT 2270, BPT 2295, BPT 2782, BPT 2595, BPT 2660 and BPT 2776), seven genotypes possess red pericarp color (Aathira, Samyuktha, Matta Triveni, Jyothi, BPT 3111, Annapurna and Harsha) and the remaining had black/purple pericarp. These genotypes were evaluated in randomized block design with three replications under direct sowing by following manual dibbling method. Each genotype was represented by 5 rows of 3m length in each replication with a spacing of 20cm between rows and 15cm between plants. All recommended cultural practices were followed for raising the crop. Observations were recorded on ten plants selected at random per genotype per replication for yield and quality traits *viz*., days to 50% flowering, panicle length (cm), plant height (cm), ear bearing tillers per plant, grain yield per plant (g), test weight (g), number of filled grains per panicle, total number of grains per panicle, fertility %, solid loss, water uptake, volume expansion ratio, alkali spreading value, length/ breadth ratio and amylose content (%). However days to 50% flowering and test weight (g) were recorded on plot basis along with quality parameters by following standard procedures delineated by Sidhu *et al*. (1975) for solid loss for other traits DRR (2006) and Juliano (1971) respectively. Phenotypic and genotypic coefficients of variation (GCV and PCV) were computed according to Burton and Devane (1953). Heritability in broad sense was estimated as per Allard (1960) and genetic advance was estimated as per the formula proposed by Johnson *et al*. (1955). As suggested by Subramanian and Menon (1973), GCV and PCV were categorized into low = less than 10%, moderate = 10-20% high = More than 20%, h^2 (b) estimates were categorized according to Johnson *et al*. (1955), low = 0 – 30 %, moderate = 31-60 % and high = Above 60%, The range of genetic advance as per cent of mean was classified as suggested by Johnson *et al*. (1955) Low = Less than 10% Moderate = 10-20% and high = More than 20%.

Results and Discussion

Table 1. Analysis of variance for yield, yield components and quality characters among 26 genotypes of rice (*Oryza sativa* L.)

S.No.	Source	Replications	Treatments	Error
	Degree of freedom	2	25	50
	MEAN SUM OF SQUARES			
1	Days to 50% flowering	17.58	235.60**	11.16
2	Panicle length (cm)	2.28	22.40**	2.82
3	Plant height (cm)	8.2	176.83**	12.07
4	Ear bearing tillers per plant	2.85	8.2794**	3.045
5	Grain Yield per plant (g)	8.52	142.90**	12.87
6	Test Weight (g)	0.71	49.65**	0.47
7	Number of filled grains per panicle	638.16	12057.005**	1220.16
8	Total number of grains per panicle	727.16	12879.46**	1406.12
9	Fertility %	4.23	18.43**	7.18
10	Solid Loss	0.000015	0.82	0.0021
11	Water Uptake	0.012	2909.06**	11.71
12	Volume Expansion Ratio	0.063	0.5	0.024
13	Alkali Spreading Value	0.89	2.32**	0.29
14	Length/Breadth ratio	0.18	0.34	0.074
15	Amylose Content (%)	1.44	18.66**	0.45

* Significant at 5% level, ** Significant at 1% level

The analysis of variance (Table 1) revealed significant differences among the genotypes for all the characters studied except for solid loss, volume expansion ratio and length/breadth ratio indicating that the absence of variability in the experimental material for these traits.

Mean performance of the 26 genotypes studied for yield and quality traits are presented in Table 2. Wide range of variation was observed for plant height (88.40 - 123.53 cm), number of filled grains per panicle (176 - 385), total number of grains per panicle (191 - 411) and water uptake (50 - 180) among the 15 characters studied. Among the genotypes used in the present study, the red and black pericarp colored rice genotypes flowered earlier when compared with the light brown pericarp colored genotypes. Likewise, more number of filled grains/ panicle and total number of grains/ panicle were observed in red and black genotypes. All red pericarp coloured genotypes recorded more test weight indicating their bolder grain type which is also reflected in L/B ratio (<2.5). Among the genotypes studied, BPT 3142 (58.33g) exhibited maximum grain yield followed by Matha Triveni (50.33g), BPT 3136 (48.83) and BPT 3143 (48.03g). Among the quality traits, majority of the genotypes under study recorded intermediate amylose content which is desirable, since amylose content determines the texture of cooked rice and rice varieties with intermediate amylose content have a fluffy texture after cooking. The genotypes *viz.,* Annapurna (18.86), BPT 3137 (16.41) and BPT 3143 (19.11) recorded low amylose content while Matta Triveni (27.44) and Samyuktha (26.36) recorded high amylose content. Among the brown pericarp colored genotypes, BPT 5204, BPT 2270, BPT 2782 and BPT 2595 manifested both amylose and alkali spreading value in the desirable intermediate range which determines the texture of cooked rice.

The genetic parameters namely PCV, GCV, heritability and genetic advance as percent of mean for the 15 yield and quality traits studied are presented in Table 3. A perusal of these results revealed highest phenotypic and genotypic coefficient of variation for water uptake (47.65 and 47.37 respectively), while fertility percent manifested the least values (3.61 and 2.11 respectively). The estimates of heritability ranged from 34.30 (fertility %) to 99.20 (solid loss). The maximum value for genetic advance as percent of mean was observed for water uptake (96.99) followed by solid loss (70.70), test weight (44.41) and alkali spreading value (41.29). High GCV and PCV coupled with high heritability and high genetic advance as percent of mean were observed for test weight, number of filled

Table 2. Mean performance of rice (*Oryza sativa* L.) genotypes for 15 yield and quality traits

S. No.	Character	Days to 50% flowering	Panicle length (cm)	Plant height (cm)	Ear bearing tillers per plant	Grain yield per plant (g)	Test weight (g)	No.of filled grains	Total no. of grains	Fertility %	Solid loss	Water uptake	VER	ASV	L/B ratio	Amylose content (%)
Light brown pericarp color genotypes																
1	BPT 5204	117	19.89	88.40	13.33	25.00	14.84	175.67	204.33	86.52	1.10	80.00	2.56	5.00	2.85	22.55
2	BPT 2270	127	23.39	116.67	15.67	29.33	13.81	260.33	284.00	91.59	2.25	108.00	2.25	4.33	2.84	20.98
3	BPT 2295	120	27.02	114.73	16.67	33.33	13.50	262.67	294.00	89.24	1.35	90.00	2.29	3.33	2.86	25.45
4	BPT 2595	115	25.58	104.47	17.00	37.00	14.90	247.00	267.67	92.08	1.85	55.00	2.00	4.67	2.87	23.97
5	BPT 2782	112	25.39	94.93	18.33	47.70	15.46	274.00	291.00	94.01	1.10	63.00	2.57	4.33	2.82	21.45
6	BPT 2660	121	25.77	110.53	16.67	36.67	15.31	261.00	295.67	88.19	1.70	180.00	2.50	3.67	2.78	21.11
7	BPT 2776	123	25.73	110.47	17.67	40.33	14.84	273.00	295.67	92.31	1.15	73.00	2.67	4.00	2.87	23.55
Mean		119	24.68	105.74	16.47	35.62	14.66	250.52	276.04	90.56	1.50	92.71	2.40	4.19	2.84	22.72
Red pericarp color genotypes																
8	Matha Triveni	103	25.10	112.67	14.67	50.33	21.09	247.33	271.67	90.97	1.70	67.00	2.25	2.00	2.35	27.44
9	Annapurna	103	27.44	110.00	14.33	45.43	25.58	183.67	203.67	90.46	1.70	57.00	2.00	3.00	2.26	18.86
10	Aathira	108	25.19	101.93	15.67	36.13	22.79	312.33	362.67	86.41	0.80	52.00	2.00	2.00	2.26	24.24
11	Harsha	103	27.23	113.13	13.67	43.53	24.36	177.00	191.00	92.68	2.10	50.00	2.00	2.00	2.68	25.37
12	Jyothi	109	24.47	123.53	15.00	42.00	21.02	192.00	209.67	91.43	1.15	73.00	2.14	2.00	2.75	22.00
13	Samyuktha	104	28.03	123.13	12.33	43.67	27.90	187.33	209.33	89.43	0.85	50.00	2.00	2.00	2.49	26.36
14	BPT 3111	103	27.01	109.87	13.33	42.13	19.35	225.33	249.33	90.38	1.20	53.00	1.75	3.83	2.83	23.02
Mean		104	26.35	113.46	14.14	43.31	23.15	217.85	242.47	90.25	1.35	57.42	2.02	2.40	2.51	23.89
Black/purple color genotypes																
15	BPT 3139	103	28.78	114.67	12.33	34.90	18.12	286.00	312.67	91.45	1.15	85.00	2.29	3.33	2.82	22.40
16	BPT 3137	104	32.44	116.33	12.33	36.93	14.30	361.00	390.00	92.65	1.35	57.00	2.00	4.00	2.83	16.41
17	BPT 3145	103	30.51	114.27	13.33	41.77	21.49	359.00	381.67	94.15	2.30	60.00	1.50	3.67	2.85	21.70
18	BPT 3138	103	29.93	120.87	13.00	39.03	19.54	376.00	393.33	95.59	1.55	55.00	2.00	3.00	3.08	24.08
19	BPT 3136	104	28.64	105.67	14.33	48.83	19.83	195.00	226.00	85.93	1.10	83.33	2.00	4.17	2.79	21.12
20	BPT 3140	103	24.92	116.07	14.67	39.10	18.83	279.33	306.67	90.99	0.60	111.67	3.00	4.00	3.51	22.17
21	BPT 3141	104	27.21	113.87	13.00	37.63	18.10	246.00	268.67	91.46	1.80	57.00	2.25	3.00	3.64	20.27
22	BPT 3142	104	26.07	112.33	14.67	58.33	24.31	349.67	370.67	94.29	1.25	50.00	2.65	3.00	2.70	22.05

Table 2 cont....

S. No.	Character	Days to 50% flowering	Panicle length (cm)	Plant height (cm)	Ear bearing tillers per plant	Grain yield per plant (g)	Test weight (g)	No.of filled grains	Total no. of grains	Fertility %	Solid loss	Water uptake	VER	ASV	L/B ratio	Amylose content (%)
23	BPT 3143	103	28.38	110.80	15.67	48.03	16.90	226.67	242.00	93.59	1.90	50.00	3.25	3.17	2.81	19.11
24	BPT 2848	104	30.74	113.40	13.67	45.50	14.78	303.67	345.67	88.34	1.55	140.00	1.50	4.17	2.82	20.88
25	BPT 3144	106	30.40	110.33	15.33	43.93	14.60	370.67	390.67	94.89	2.75	93.00	1.86	4.00	2.83	22.36
26	BPT 2858	103	30.53	112.67	15.00	41.73	15.77	385.00	410.67	93.82	2.20	70.00	2.25	3.33	2.82	24.18
Mean		103.67	29.04	113.44	13.94	42.97	18.04	311.50	336.55	92.26	1.62	76.00	2.21	3.57	2.95	21.39
	Overall Mean	108.52	27.15	111.37	14.68	41.09	18.51	273.72	298.78	91.42	1.52	75.11	2.21	3.42	2.80	22.42
	C.V (%)	3.14	6.19	3.12	11.89	8.73	3.73	12.76	12.55	2.93	3.08	5.22	7.14	15.85	9.60	3.03
	C.D. (5%)	5.48	2.76	5.70	2.86	5.88	1.13	57.29	61.50	4.40	NS	5.61	NS	0.89	NS	1.11
	C.D. (1%)	7.31	3.68	7.60	3.82	7.84	1.51	76.37	81.99	5.86	NS	7.48	NS	1.19	NS	1.48

VER- volume expansion ratio, ASV= alkali spreading value, L/B ratio= Length/Breadth ratio NS = non significant

Table 3. Mean, variability, heritability and genetic advance as per cent of mean for yield, yield components and grain quality parameters in rice (*Oryza sativa* L.)

S. No.	Character	Mean	Range		Coefficient of variation		Heritability (%) (broad sense)	Genetic advance as per cent of (5% level)
			Minimum	Maximum	PCV %	GCV %		
1	Days to 50% flowering	108.52	103.00	127.00	8.70	8.12	87.00	15.60
2	Panicle length (cm)	27.14	19.89	32.44	11.26	9.41	69.80	16.19
3	Plant height (cm)	111.37	88.40	123.53	7.34	6.65	82.00	12.41
4	Ear bearing tillers per plant	14.67	12.33	18.33	14.91	8.99	36.40	11.18
5	Grain Yield per plant (g)	41.09	25.00	58.33	18.24	16.02	77.10	28.98
6	Test Weight (g)	18.51	13.49	27.90	22.18	21.87	97.20	44.41
7	Number of filled grains per panicle	273.71	175.67	385.00	25.39	21.95	74.80	39.10
8	Total number of grains per panicle	298.78	191.00	410.66	24.20	20.69	73.10	36.45
9	Fertility %	91.41	85.93	95.58	3.61	2.11	34.30	2.55
10	Solid Loss	1.51	0.60	2.75	34.59	34.46	99.20	70.70
11	Water Uptake	75.11	50.00	180.00	47.65	47.37	98.80	96.99
12	Volume Expansion Ratio	2.21	1.50	3.25	19.35	17.98	86.40	34.43
13	Alkali Spreading Value	3.42	2.00	5.00	28.77	24.01	69.70	41.29
14	L/B ratio	2.80	2.26	3.64	14.27	10.56	54.80	16.10
15	Amylose Content (%)	22.42	16.41	27.44	11.43	11.02	93.00	21.89

grains per panicle, total number of grains per panicle, solid loss, water uptake and alkali spreading value suggesting an additive type of gene action. Hence, good response to selection can be attained for improvement of these traits. These findings are in agreement with the results reported by Mamata *et al*. (2018). The remaining yield components and quality parameters *viz*., days to 50% flowering, panicle length (cm), plant height (cm), ear bearing tillers per plant, grain yield per plant (g), fertility %, volume expansion ratio, length/breadth ratio and amylose content (%) manifested low to high GCV and PCV, moderate to high heritability and low to high genetic advance as percent of mean indicating the pre-ponderance of both additive and non-additive gene effects in controlling these traits. These results are in accordance with Krishna Veni et at (2013) Sameera *et al*. (2016) and Nandini *et al*. (2017). Hence, instead of simple selection, other methods like heterosis breeding or recurrent selection could be better alternative methods for improvement of these traits.

CONCLUSION

In the present study, BPT 3142 (58.33g) followed by Matha Triveni (50.33 g) and BPT 3136 (48.83g) recorded high grain yield/plant which is significantly superior to the check variety BPT 5204 (25.0g). BPT 3136, BPT 2848 & BPT 3144 among black rice and BPT 3111 & Jyothi among red rice recorded high grain yield and desirable quality parameters. The

characters viz., test weight, number of filled grains per panicle, total number of grains per panicle, solid loss, water uptake and alkali spreading value are controlled by an additive type of gene action suggesting that these characters can be improved by simple selection.

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