Int.J.Curr.Microbiol.App.Sci (2020) *9*(7): 2454-2466

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 7 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.907.288

Evaluation of Coloured and White Rice Genotypes for Yield and Quality

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Keywords

Coloured Rice, Grain Yield, Mean performance and Nutritional Quality

Article Info

Accepted:
20 June 2020
Available Online:
10 July 2020

A B S T R A C T

The present investigation was undertaken with 33 coloured and white rice genotypes to identify promising slender grain genotypes with high yield and good nutrition quality. The study involved seven red pericarp, eight black pericarp and 17 white rice genotypes, in addition to the check, BPT 5204. The results revealed black pericarp genotypes to be in general, high yielding with intermediate amylose content, high phenol, protein, zinc and iron content, compared to the red pericarp and white rice genotypes studied in the present investigation. The red pericarp genotypes were in general noticed to be early with high antioxidant activity, compared to the black pericarp and white rice genotypes. The white rice genotypes, however, recorded higher head rice recovery per cent, compared to the red and black pericarp genotypes. Further, the red pericarp genotype, BPT 3178; black pericarp genotype, BPT 2848; and the white rice genotypes, BPT 2615, BPT 2782 and MTU 1281 were identified to be promising high yielding and nutritionally rich rice genotypes, compared to BPT 5204.

Introduction

Rice is a major source of food for about three million people worldwide and accounts for about 20 per cent of calorie consumption. In Asia, nearly two billion people depend on rice for their 60-70 percent calories. Increased health consciousness among the rice consumers in the recent years has resulted in greater attention to rice genotypes containing higher levels of bioactive compounds, such as antioxidants. In this context, rice genotypes with red and black pericarp color containing high levels of antioxidants (Tian *et al.*, 2004) are in increasing demand. The present investigation is therefore, an attempt to identify slender grain colored rice genotypes, superior to BPT 5204, the popular rice variety, in terms of grain yield and nutritional quality, namely, level of antioxidants, zinc, iron and protein content.

Materials and Methods

The experimental material consisted of 33 white and coloured rice genotypes obtained from Agricultural Research Station, Bapatla, Andhra Pradesh state in addition to

collections from Telangana and Tamil Nadu states. Among the 33 genotypes, 15 genotypes were coloured, of which, seven were with red pericarp and eight genotypes were with black pericarp, while remaining 18 genotypes had brown pericarp and were white rice genotypes including, BPT 5204, a popular high yielding white rice genotype with excellent cooking quality traits, which was used as check variety in the present study. Details of the genotypes studied in the present investigation are presented in Table 1 and Plates 1-2.

All the 33 genotypes were sown at Agricultural College Farm, Bapatla during *Kharif* 2019 on separate raised nursery beds. All recommended package of practices were adopted to raise a healthy nursery and thirty days old seedlings were transplanted in the main field laid out in Randomized Block Design (RBD) with three replications. Each genotype was transplanted separately in 5 rows of 4.5 m length by adopting a spacing of 20 cm between rows and 15 cm between plants. All the recommended package of practices were adopted throughout the crop growth period and need based plant protection measures were taken up to raise a healthy crop. Observations were recorded on five randomly selected plants for grain yield per plant; days to 50 per cent flowering; and the quality characters, namely, head rice recovery per cent, amylose content, alkali spreading value, protein content, total phenol content, total antioxidant activity, zinc and iron content in addition to grain type were recorded.

However, days to 50 per cent flowering was recorded on plot basis. In contrast, observations for the quality traits studied were obtained from a random grain sample drawn from each plot in each genotype and replication using standard procedures. The data collected was subjected to standard statistical procedures given by Panse and Sukhatme (1967).

Results and Discussion

The analysis of variance (ANOVA) for yield and quality characters studied in the present investigation is presented in Table 2. A perusal of the results revealed significant differences among the genotypes for all the characters studied, indicating the existence of sufficient variation among the genotypes studied.

Mean performance of the genotypes studied for yield, days to 50 per cent flowering and quality characters are presented in Table 3 and Fig.1. Grain yield per plant in the present study was observed to range from 11.00g (BPT 2507) to 33.41g (Hallabhatta) with an overall mean value of 21.91g, indicating high variability among the genotypes with respect to grain yield. The findings are in agreement with the reports of Nagadurga Rao (2019). Among the black pericarp genotypes, BPT 3141 (18.66g) recorded minimum grain yield per plant, while BPT 3165 recorded maximum grain yield per plant (29.33g).

Grain yield per plant among the red pericarp genotypes was noticed to range from 16.00g (Chittiga) to 33.41g (Hallabhatta); and from 11.00g (BPT 2507) to 32.04g (BPT 2615) among the white rice genotypes. A perusal of the results also revealed significantly higher grain yield per plant, compared to the check, BPT 5204 (17.00g) for five red pericarp genotypes, namely, Apputhokal, Asandi, BPT 3111, BPT 3178 and Hallabhatta; six black pericarp genotypes, namely, BPT 2841, BPT 2848, BPT 3136, BPT 3145, BPT 3165 and Kakirekalu; and six white rice genotypes, namely, BPT 2615, BPT 2776, BPT 2782, BPT 3173, MTU 1281 and US 301. The red (23.64g) and black (24.16g) pericarp genotypes studied in the present investigation had in general recorded higher grain yield per plant, compared to the white rice genotypes (20.21g) studied in the present investigation.

The findings are in conformity with the reports of Sridevi (2018).

Days to 50 per cent flowering in the present study was observed to range from 95 (Asandi) to 120 days (BPT 2660) with an overall mean of 110 days. Further, early flowering of the red (104 days) and black pericarp genotypes (109 days) was observed in the present study, compared to the white rice genotypes (112 days). The findings are in agreement with the reports of Sridevi (2018). Among the red rice genotypes, Asandi (95 days) recorded minimum days to 50 per cent flowering, while BPT 3139 recorded maximum number of days to 50 per cent flowering (118 days). Days to 50 per cent flowering among the black pericarp genotypes was noticed to range from 96 days (Kakirekalu) to 117 days (BPT 3141); and from 103 days (ADT 49) to 120 days (BPT 2660) among the white rice genotypes.

Head rice recovery was noticed to range from 42.33 per cent (Chittiga) to 69.40 per cent (BPT 2660). Overall average head rice recovery of the genotypes studied in the present investigation was 59.83 per cent. In general, the white rice genotypes recorded higher head rice recovery percentage (63.12%), compared to black pericarp (56.50%) and red pericarp (55.15%) genotypes. Among the white rice genotypes, BPT 2776 (56.15%) recorded minimum head rice recovery percentage, while BPT 2660 recorded maximum head rice recovery percentage (69.40%). Among the black pericarp genotypes, head rice recovery percentage was noticed to range from 50.83 (BPT 2841) to 68.50 per cent (BPT 2848); and from 42.33 (Chittiga) to 64.33 per cent (BPT 3111) among the red pericarp genotypes. Further, none of the genotypes studied had recorded significantly greater head rice recovery per cent, compared to the check, BPT 5204 (65.50%) in the present investigation. However, BPT 3111 and BPT 3178 red pericarp genotypes; BPT 2848 black pericarp genotype; and 12 white rice genotypes, namely, BPT 2507, BPT 2595, BPT 2615, BPT 2660, BPT 2782, BPT 3173, JKRH 3333, MTU 1281, US 301, WGL 14 and 27 P 63 had recorded head rice recovery per cent on par with BPT 5204.

Amylose content of milled rice has been found to be positively correlated with hardness values of cooked rice and negatively with stickiness values. Amylose content determines the texture of cooked rice and rice varieties with amylose content between 20-25 are considered as intermediate which cook as fluffy and flaky (Sridevi, 2018). In the present study, amylose content was noticed to range from 17.53 (BPT 3173) to 30.32 per cent (BPT 2766) with an overall mean value of 22.63 per cent. In general, the red pericarp genotypes recorded higher amylose content percentage (23.76%), compared to black pericarp (21.50%) and white rice (22.68%) genotypes. Among the red pericarp genotypes, Chittiga (21.75%) recorded minimum amylose content, while BPT 3111 recorded maximum amylose content (25.22%). Among the black pericarp genotypes, amylose content was noticed to range from 19.52 (Kakirekalu) to 24.39 per cent (BPT 2841); and from 17.53 (BPT 3173) to 30.32 per cent (BPT 2766) among the white rice genotypes. Further, all red pericarp genotypes studied; all black pericarp genotypes studied, except Kakirekalu; and all white rice genotypes studied, except, ADT 49, BPT 2660, BPT 2766, BPT 3173, US 301 and 27 P 63 were noticed to have intermediate amylose content of 20-25 per cent desired by the rice consumers of the state of Andhra Pradesh.

Rice genotypes with intermediate alkali spreading value (4-5) are desirable. However, alkali spreading value of the genotypes

studied in the present investigation was observed to range from 2.50 (MTU 1281) to 7.00 (BPT 3173 and BPT 2776) with an overall mean value of 4.17. In general, the white rice genotypes recorded higher ASV (4.27), compared to black pericarp (4.06) and red pericarp (4.00) genotypes. Among the white rice genotypes, MTU 1281 (2.50) recorded minimum ASV, while BPT 3173 and BPT 2776 recorded maximum ASV (7.00). Among the black pericarp genotypes, ASV was noticed to range from 3.00 (BPT 3141) to 5.16 (BPT 2841); and from 3.22 (BPT 3139) to 5.00 (BPT 3178 and Hallabhatta) among the red pericarp genotypes. Further, intermediate ASV (4.00 – 5.00) was noticed for the red pericarp genotypes, namely, Apputhokal, BPT 3178 and Hallabhatta; black pericarp genotypes, namely, BPT 2848, BPT 3145 and BPT 3165; and six white rice genotypes, namely, BPT 2411, BPT 2595, BPT 2782, BPT 2846, BPT 5204 and US 301.

Protein being the second dominant component of rice grain after starch, its content and amino acid composition will determine the nutritional quality of rice. Based on protein content, rice varieties are classified into high (>12%), medium (9-12%) and low (<9%) as suggested by Meijuam and Samuel (2005). The protein per cent of genotypes studied in the present investigations was observed to range from 6.80 (MTU 1281) to 13.50 per cent (Kakirekalu) with an overall mean value of 9.45 per cent. In general, the black (12.09%) and red pericarp (10.60%) genotypes had recorded higher protein content, compared to white rice (7.82%) genotypes. Similarly, Raghuvanshi *et al.*, (2017) earlier reported that the red rice genotypes had higher amount of protein content, when compared with white rice genotypes. They also suggested that the nutritional quality of red rice was comparable to many millets, fruits and vegetables. Pathak *et al.*, (2017) also reported that pigmented rice had higher amount of protein content than non-pigmented rice, similar to the findings of the present study. Among the black pericarp genotypes, BPT 3140 (10.35%) recorded minimum protein content, while Kakirekalu recorded maximum protein content (13.50%). Further, the three black pericarp genotypes, namely, BPT 2848 (12.85%), BPT 3136 (12.50%) and Kakirekalu (13.50%) only had recorded high protein content (>12.0%) among the 33 genotypes studied in the present investigation. Among the red pericarp genotypes, protein content was noticed to range from 8.20 (BPT 3139) to 11.50 per cent (Chittiga); and from 6.80 (MTU 1281) to 10.00 per cent (BPT 2660) among the white rice genotypes. A perusal of the results revealed significantly greater protein content, compared to the check, BPT 5204 (8.40%) for all red pericarp genotypes studied, except, BPT 3139; all black pericarp genotypes studied; and BPT 2595 white rice genotype.

A perusal of the results on total phenol content of the genotypes studied in the present investigation revealed the trait to range from 39.52mg (BPT 2615) to 267.13mg (Kakirekalu) with an overall average value of 90.56mg, indicating wide range of variation. The phenolic compounds are mainly associated with the pericarp in rice and the grains with darker pericarp colour such as red and black contain higher amount of polyphenols (Itani, 2004). The concentration of total phenolics in the grain has been positively associated with antioxidant activity Itani *et al.*, 2002) with potential beneficial effects on health such as reduction of oxidative stress (Hu *et al.*, 2003). Hence, highest amount of phenolic compounds is a desirable trait and the coloured rice genotypes (black and red) studied in the present investigation were observed to contain high amount of phenolic compounds than white rice genotypes evaluated. In general, the black

pericarp genotypes had recorded higher total phenol content (156.16mg), compared to red pericarp (96.41mg) and white rice (59.13mg) genotypes. Among the black pericarp genotypes, BPT 3136 (82.69mg) recorded minimum total phenol content, while Kakirekalu recorded maximum total phenol content (267.13mg). Among the red pericarp genotypes, total phenol content was noticed to range from 82.00mg (Hallabhatta) to 114.84mg (Apputhokal); and from 39.52mg (BPT 2615) to 80.90mg (BPT 3173) among the white rice genotypes. A perusal of the results revealed significantly greater total phenol content, compared to the check, BPT 5204 (53.83mg) for all red and black pericarp genotypes studied; and six white rice genotypes, namely, ADT 49, BPT 2660, BPT 2766, BPT 2782, BPT 3173, PHI 17108 and 27 P 63. Irkali *et al.,* (2012) also reported that total phenol content was more in black and red rice than non pigmented rice. Chakuton *et al*., (2012), Saikia *et al.,* (2012) and Pathak *et al.,* (2017) also reported that pigmented rice had higher amount of total phenol content than non pigmented rice.

In the present study, the white coloured genotype, BPT 2595, recorded minimum value for total antioxidant activity (25.68mg), while maximum value was manifested by the red coloured genotype, Apputhokal (109.73 mg). Overall average value of the genotypes studied in the present investigation was 62.32mg. In general, the red (96.62mg) and black pericarp (90.63mg) genotypes had recorded higher total antioxidant activity, compared to white rice (36.38mg) genotypes. The findings are in conformity with the reports of Tian *et al.,* (2004). Coloured rice was reported to have a health promoting potential due to its instantial antioxidant activity which inhibits the formation or reduces the concentration of reactive cell damaging free radicals thus protecting the body tissues from oxidative damage. Among the red pericarp genotypes, Chittiga (76.25mg) recorded minimum total antioxidant activity, while Apputhokal recorded maximum total antioxidant activity (109.73mg). Among the black pericarp genotypes, total antioxidant activity was noticed to range from 74.39mg (BPT 3165) to 103.87mg (BPT 3141); and from 25.68mg (BPT 2595) to 47.07 per cent (BPT 3173) among the white rice genotypes. A perusal of the results revealed significantly greater total antioxidant activity, compared to the check, BPT 5204 (29.92mg) for all red and black pericarp genotypes studied; and eight white rice genotypes, namely, BPT 2660, BPT 2782, BPT 2846, BPT 3173, JKRH 3333, PHI 17108, MTU 1281 and 27 P 63. Raghuvanshi *et al.,* (2017) also reported that red pericarp coloured rice genotypes showed excellent antioxidant properties which are in agreement with the present results. Chakuton *et al.,* (2012), Veni *et al.* (2016) and Pathak *et al.* (2017) also reported that the pigmented rice was found to have highest total antioxidant activity than non pigmented rice.

Zinc content of the genotypes studied in the present investigation ranged from 12.15ppm (ADT 49) to 30.16ppm (BPT 3136) with an overall mean of 20.88ppm. In general, the black pericarp genotypes recorded higher Zinc content (27.78ppm), compared to red pericarp (24.87ppm) and white rice (16.27ppm) genotypes. Similar results were reported earlier by Sridevi (2018) for zinc content in red and black coloured genotypes, compared to white rice genotypes. Pathak *et al.,* (2017) and Laenoia *et al.,* (2015) also reported that pigmented rice was found to have high amount of zinc content than non pigmented rice. Among the black pericarp genotypes, BPT 2848 (24.81ppm) recorded minimum zinc content, while BPT 3136 recorded maximum zinc content (30.16ppm). Among the red pericarp genotypes, zinc content was noticed to range from 22.16ppm

(Hallabhatta) to 27.16ppm (BPT 3139); and from 12.15ppm (ADT 49) to 19.50ppm (JKRH 3333) among the white rice genotypes. A perusal of the results revealed significantly greater zinc content, compared to the check, BPT 5204 (16.50ppm) for all red and black pericarp genotypes studied; and four white rice genotypes, namely, BPT 2660, BPT 2776, BPT 2782 and JKRH 3333.

Table.1 Details of the rice genotypes studied in the present investigation

S.No.	Genotype	Cross combination/ Pedigree	Origin
Red pericarp genotypes			
1.	Apputhokal	Landraces	Telangana
2.	Asandi	Landraces	Telangana
3.	Chittiga	Landraces	Telangana
4.	BPT 3111	Swarna/ IRGC 18195// MTU 1081	Andhra Pradesh
5.	BPT 3139	Cult. 01120305/ cult. 0910025-7	Andhra Pradesh
6.	BPT 3178	Cult. 01120305/ cult. 0910025-7	Andhra Pradesh
7.	Hallabhatta	Landraces	Telangana
Black pericarp genotypes			
8.	BPT 2841	MTU 7029/IRGC 18195/MTU 1081	Andhra Pradesh
9.	BPT 2848	RP Bio 226*1/1RGC 48493	Andhra Pradesh
10.	BPT 3136	RP Bio 226*1/1RGC 18195	Andhra Pradesh
11.	BPT 3140	Swarna/1RGC 18195 /MTU 1081	Andhra Pradesh
12.	BPT 3141	RP Bio 226*1/ 1RGC 30938	Andhra Pradesh
13.	BPT 3145	RP Bio 226/ IRGC26940// MTU 1081	Andhra Pradesh
14.	BPT 3165	BPT 3291/BPT 2411	Andhra Pradesh
15.	Kakirekalu	Landraces	Telangana
Brown pericarp white rice genotypes			
16.	ADT 49	CR 1009/Jeeragasambha	Tamil Nadu
17.	BPT 2411	BPT 5204/BPT 4358	Andhra Pradesh
18.	BPT 2507	BPT 1235/BPT 5204//BPT 5204	Andhra Pradesh
19.	BPT 2595	Mutant of BPT 2270	Andhra Pradesh
20.	BPT 2615	IR 8/Tulasi	Andhra Pradesh
21.	BPT 2660	BPT 1768/ NLR 145	Andhra Pradesh
22.	BPT 2766	BPT 2270/NLR 145	Andhra Pradesh
23.	BPT 2776	BPT 2231/ NLR 145	Andhra Pradesh
24.	BPT 2782	NLR 145/ MTU 2077	Andhra Pradesh
25.	BPT 2846	MTU 1061/IR 78585-64-2-4-3-1	Andhra Pradesh
26.	BPT 3173	BPT 3291/JGL 3844	Andhra Pradesh
27.	BPT 5204	GEB24/TN1/ Mahsuri	Andhra Pradesh
28.	JKRH 3333	Pvt. Research Hybrid	Telangana
29.	PHI 17108	Pvt. Research Hybrid	Telangana
30.	WGL 14	BPT 5204/ARC 5984//BPT 3291	Andhra Pradesh
31.	MTU 1281	MTU 1075/MTU 1081/MTU 1121	Andhra Pradesh
32.	27 P 63	Pvt. Research Hybrid	Telangana
33.	US 301	Pvt. Research Hybrid	Telangana

Table.2 Analysis of variance for yield and quality characters in rice

Source of variation	d.f.	Grain yield per plant	Days to 50 per cent flowering	Head Rice Recovery	Amylose Content	Alkali Spreading Value	Protein Content	Total Phenol Content	Total Antioxidant Activity	Zinc content	Iron content
		Mean sum of squares									
Replications	2	9.11	52.16	15.98	1.93	0.050	0.13	21.78	47.27	2.89	2.71
Genotypes	32	99.61**	133.54**	118.60**	18.55**	3.77**	13.12**	7154.33**	2709.38**	95.66**	25.74**
Error	64	5.22	13.32	6.16	0.56	0.13	0.10	18.58	15.74	1.23	0.96

** Significant at 1 per cent level of probability

Table.3 Mean performance of the genotypes studied for yield and quality characters in rice

S. No.	Genotypes	Grain yield per plant (g)	Days to 50 per cent flowering	Head Rice Recovery (%)	Amylose Content (%)	Alkali Spreading Value	Protein Content (%)	Total Phenol Content (mg/100g)	Total Antioxidant Activity (mgAAE/100g)	Zinc content (ppm)	Iron content (ppm)
Red pericarp genotypes											
1.	Apputhokal	24.03	98	56.68	23.43	4.50	10.90	114.84	109.73	23.66	10.93
2.	Asandi	23.38	95	47.66	23.88	3.50	10.75	87.59	95.49	25.46	11.68
3.	BPT 3111	23.25	107	64.33	25.22	3.88	11.16	92.70	91.57	27.00	13.08
4.	BPT 3139	18.00	118	59.33	23.11	3.22	8.20	87.54	101.41	27.16	13.33
5.	BPT 3178	27.43	115	61.59	24.9	5.00	10.92	97.58	106.49	23.01	10.76
6.	Chittiga	16.00	98	42.33	21.75	3.33	11.50	112.68	76.25	25.66	12.33
7.	Hallabhatta	33.41	100	54.16	24.03	5.00	10.80	82.00	95.46	22.16	10.83
	Range- Min.	16.00	95	42.33	21.75	3.22	8.20	82.00	76.25	22.16	10.76
	-Max.	33.41	118	64.33	25.22	5.00	11.50	114.84	109.73	27.16	13.33
Mean		**26.64**	**104**	**55.15**	**23.76**	**4.00**	**10.60**	**96.41**	**96.62**	**24.87**	**11.84**
Black pericarp genotypes											
1.	BPT 2841	24.97	105	50.83	24.39	5.16	11.83	152.62	96.58	26.16	13.00
2.	BPT 2848	25.00	112	68.50	20.72	4.11	12.85	134.29	91.22	24.81	12.33
3.	BPT 3136	28.93	111	55.34	21.90	3.88	12.50	82.69	77.90	30.16	15.16

4.	BPT 3140	20.33	111	58.69	22.72	3.61	10.35	200.22	102.88	26.41	13.21
5.	BPT 3141	18.66	117	60.91	20.58	3.00	13.00	146.10	103.87	27.98	14.32
6.	BPT 3145	22.33	110	52.78	21.69	4.38	12.00	127.99	93.00	28.89	14.41
7.	BPT 3165	29.33	109	54.16	20.55	4.94	10.74	138.28	74.39	29.83	19.25
8.	Kakirekalu	23.80	96	51.00	19.52	3.44	13.50	267.13	85.22	28.00	14.66
	Range-Min.	18.66	96	50.83	19.52	3.00	10.35	82.69	74.39	24.81	12.33
	-Max.	29.33	117	68.50	24.39	5.16	13.50	267.13	103.87	30.16	19.25
	Mean	**24.16**	**109**	**56.50**	**21.50**	**4.06**	**12.09**	**156.16**	**90.63**	**27.78**	**14.54**
Brown pericarp white rice genotypes											
1.	ADT 49	19.66	103	61.41	25.60	5.33	7.65	66.99	32.00	12.15	6.93
2.	BPT 2411	18.74	118	61.22	20.52	4.00	7.23	54.32	30.32	16.50	8.16
3.	BPT 2507	11.00	109	62.00	22.63	2.55	8.10	56.43	35.75	14.74	8.66
4.	BPT 2595	18.00	117	63.33	23.55	4.44	9.76	56.33	25.68	17.28	8.56
5.	BPT 2615	32.04	107	64.23	22.32	2.94	8.15	39.52	33.21	14.90	7.43
6.	BPT 2660	20.93	120	69.40	25.88	2.88	10.00	64.07	40.81	19.16	9.46
7.	BPT 2766	20.83	116	60.79	30.32	5.16	6.90	66.23	32.32	17.33	8.60
8.	BPT 2776	23.00	119	56.15	22.90	7.00	7.00	49.66	36.04	18.65	9.20
9.	BPT 2782	28.50	113	63.60	21.64	4.16	7.50	70.06	39.30	19.12	9.43
10.	BPT 2846	14.16	116	60.54	22.40	4.16	7.25	58.49	37.87	12.75	6.46
11.	BPT 3173	28.69	110	61.73	17.53	7.00	7.90	80.90	47.07	15.83	7.92
12.	BPT 5204	17.00	110	65.5	24.80	4.00	8.40	53.83	29.92	16.50	9.30
13.	JKRH 3333	12.00	107	67.60	21.89	6.00	7.90	55.09	43.32	19.50	10.46
14.	PHI 17108	20.33	109	57.72	22.61	3.00	7.31	64.41	45.00	17.5	10.16
15.	MTU 1281	27.80	111	69.12	21.29	2.50	6.80	57.53	42.00	17.78	9.63
16.	US 301	23.66	106	65.66	17.90	4.55	7.50	46.43	32.63	12.61	7.13
17.	WGL 14	14.50	108	62.83	24.91	3.33	8.25	58.62	31.00	17.66	9.53
18.	27 P 63	13.00	110	63.33	19.67	3.88	7.30	65.44	40.61	12.95	7.20
	Range-Min.	11.00	103	56.15	17.53	2.50	6.80	39.52	25.68	12.15	6.46
	-Max.	32.04	120	69.40	30.32	7.00	10.00	80.90	47.07	19.50	10.46
	Mean	**20.21**	**112**	**63.12**	**22.68**	**4.27**	**7.82**	**59.13**	**36.38**	**16.27**	**8.56**
Overall Range-Min.		11.00	95	42.33	17.53	2.50	6.80	39.52	25.68	12.15	6.46
	-Max.	33.41	120	69.40	30.32	7.00	13.50	267.13	109.13	30.16	19.25
	Mean	**21.91**	**110**	**59.83**	**22.63**	**4.17**	**9.45**	**90.56**	**62.32**	**20.88**	**10.71**
SEM		1.32	2.10	1.43	0.43	0.21	0.19	2.48	2.29	0.64	0.56
C.D. (0.05)		3.72	5.95	4.05	1.23	0.59	0.53	7.03	6.47	1.81	1.60

Table.4 Details of the promising slender grain genotypes identified in the present study

S. No.	Genotypes	Grain yield per plant (g)	Per cent increase in yield over BPT 5204	Grain type	Duration	Head rice recovery (%)	Protein content (%)	Total Antioxidant Activity (mg AAE/100g)	Zinc content (ppm)	Iron content (ppm)
Red pericarp										
1.	BPT 3178	27.43	61.35	LS	Mid-late	61.59	10.92	106.49	25.66	10.76
Black pericarp										
2.	BPT 2848	25.00	47.05	MS	Mid-late	68.50	12.85	91.22	24.81	12.33
Brown pericarp white rice genotypes										
3.	BPT 2615	32.04	88.47	MS	Medium	64.23	8.15	33.21	14.90	7.43
4.	BPT 2782	28.50	67.64	MS	Mid-late	63.60	7.50	39.30	19.12	9.43
5.	MTU 1281	27.80	63.52	MS	Medium	69.12	6.80	42.00	17.78	9.63
Check variety										
1.	BPT 5204	17.00	_	MS	Mid-late	65.50	8.40	29.92	16.50	9.30
C.D (0.05)		3.72	_	_	7.32	4.05		0.53	1.81	1.60

Fig.1 Mean performance of the genotypes for yield and quality characters

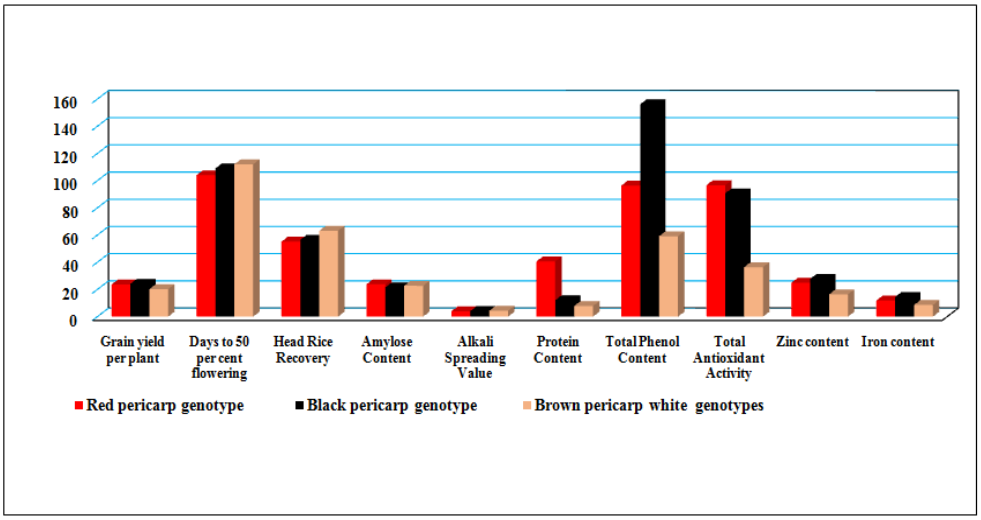


Fig.2 Performance of promising genotypes for important traits, in comparison to the check, BPT 5204

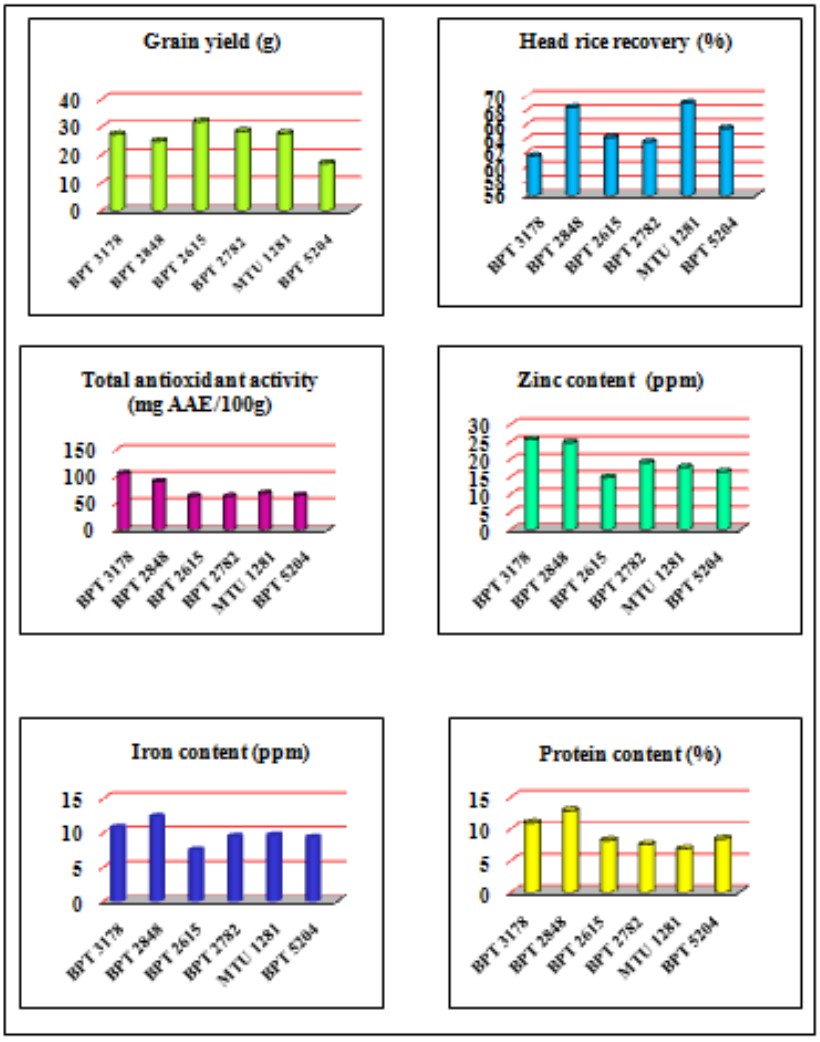
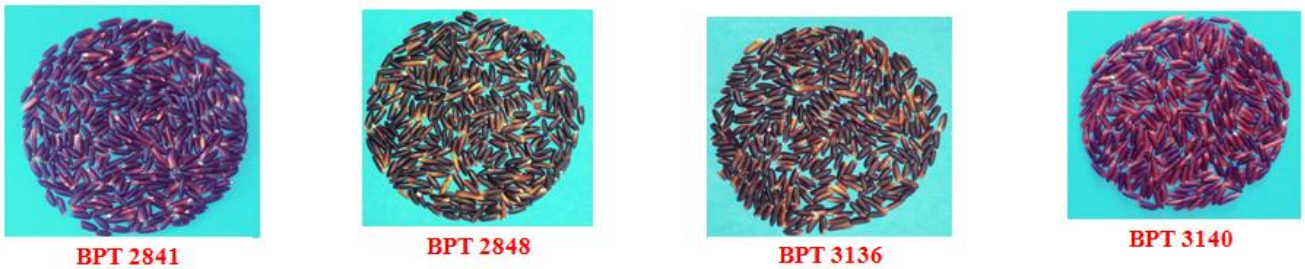
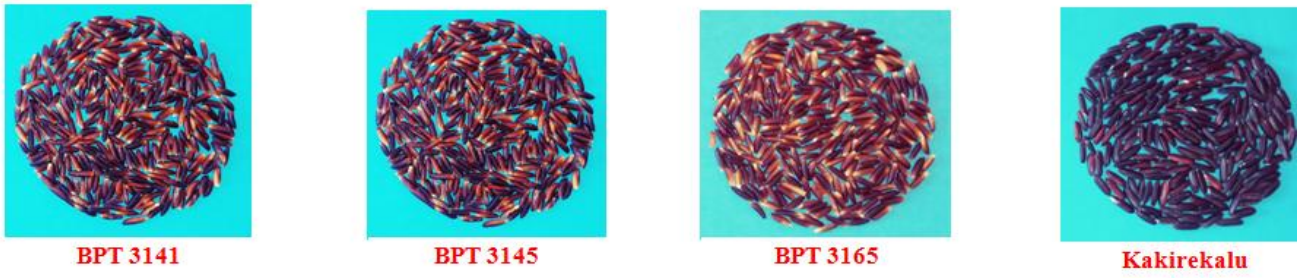


Plate.1 Red pericarp rice genotypes studied in the present investigation

Plate.2 Black pericarp rice genotypes studied in the present investigation





Major nutritional problems in rice consuming countries comprise of malnutrition and deficiency of iron resulting in anaemia. Identification of a genotype with high iron content is therefore required. In the present study, iron content was noticed to range from 6.46ppm (BPT 2846) to 19.25ppm (BPT 3165). The overall mean iron content of the genotypes studied in the present investigation was 10.71ppm. In general, the black pericarp genotypes recorded higher iron content (14.54ppm), compared to red pericarp (11.84ppm) and white rice (8.56ppm) genotypes. Raghuvanshi *et al.,* (2017) and Pathak *et al.,* (2017) also reported that pigmented rice was found to have high amount of iron content than non-pigmented rice. Among the black pericarp genotypes, BPT 2848 (12.33ppm) recorded minimum iron content, while BPT 3165 recorded maximum iron content (19.25ppm). Among the red pericarp genotypes, iron content was noticed to range from 10.76ppm (BPT 3178) to 13.33ppm (BPT 3139); and from 6.46ppm (BPT 2846) to 10.46 per cent (JKRH 3333) among the white rice genotypes. A perusal of the results revealed significantly greater iron content, compared to the check, BPT 5204 (9.30ppm) for all red and black pericarp genotypes studied; and none among the white rice genotypes studied.

The results revealed 23 genotypes of medium slender group, of which two were red pericarp genotypes (BPT 3111 and BPT 3139) and three black pericarp genotypes (BPT 2841, BPT 2848 and BPT 3145), while all the 18 white rice genotypes studied belonged to the medium slender group. Further, four red pericarp (Apputhokal, Asandi, Chiitiga and Hallabhatta) and two black pericarp genotypes (BPT 3136 and BPT 3141) recorded medium bold grain type, while one red pericarp (BPT 3178) and two black pericarp genotypes (BPT 3140 and BPT 3165) had recorded long slender grain type. Only one black pericarp genotype (Kakirekalu) had recorded long bold grain type in the present study.

In general, the black pericarp genotypes studied were observed to be high yielding, with intermediate amylose content, high phenol, protein, zinc and iron content, compared to the red pericarp and white rice genotypes studied in the present investigation. The red pericarp genotypes were however, early with high antioxidant activity, compared to the black pericarp and white rice genotypes studied in the present investigation. Further, the red pericarp genotypes were also observed to possess intermediate amylose content in addition to relatively high total phenols, protein, zinc and iron content, compared to the white rice genotypes studied. The white rice genotypes, however, recorded higher head rice recovery per cent, in general, compared to the red and black pericarp genotypes. The findings are in broad agreement with the reports of Sridevi (2018).

Details of the promising slender grain genotypes with intermediate amylose content in addition to superiority over the check variety, BPT 5204, with more than 30 per cent higher grain yield, coupled with significantly higher levels of total antioxidant activity and zinc along with at least on par head rice recovery per cent, iron content and protein content are presented in Table 4 and Fig.2. The performance of these genotypes, as alternate to the popular rice variety, BPT 5204, needs to be evaluated across seasons and locations prior to their potential commercial exploitation as high yielding and nutritionally rich rice genotypes.

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How to cite this article:

Kumar Saurabh Singh, Y. Suneetha, G. Vinay Kumar, V. Srinivasa Rao, D. Sandeep Raja and Srinivas, T. 2020. Evaluation of Coloured and White Rice Genotypes for Yield and Quality. *Int.J.Curr.Microbiol.App.Sci.* 9(07): 2454-2466. doi: https://doi.org/10.20546/ijcmas.2020.907.288