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RESEARCH ARTICLE

Study on various qualitative and quality parameters for distinctness, uniformity and stability test in rice

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SUMMARY

Seventy six rice genotypes collected from five NARS along with eight local checks from IGKV, Raipur were evaluated for 16 qulitative traits and 12 quality parameters during wet season, 2007. A large number of variations were observed for the visual characters studied. Among the sixteen quantitative traits *viz.*, purple line colour of basal leaf sheath, semi-erect angle flag leaf, intermediate leaf pubescence, 2-cleft ligule shape, green internodes, white apiculus, white colour of stigma and straw hull colour were noticed to have higher percentage of entries. Aroma was present in 40.47 per cent of the entries; for quality parameters *viz.*, paddy length, paddy L:B ratio, length of brown rice, L:B ratio of brown rice, kernel length, kernel L:B ratio, hulling per cent, milling per cent, head rice recovery per cent, kernel length after cooking kernel breadth after cooking and elongation ratio. Finally, data were subjected to statistical and biometrical analysis namely genetic variability, heritability and genetic advance.

Key Words : Quantitative traits, Quality parameters, Genotypes, Characterization, Evaluation, Pigmentation

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Distinctness, uniformity and stability (DUS) test being an internationally recognized procedure is standardized mainly for plant variety protection (PVP). It is considered a prerequisite for seed certification. It identifies and compares a variety on its description. The varieties expected to undergo certification in India should be distinct from the existing varieties under certification for its characteristics. DUS test means distinctness: new varieties should be clearly distinguishable from any other existing varieties; uniformity: individual plants of new variety should be sufficiently uniform at the same propagation stages; stability: characteristics of new variety should be stable through repeated propagation. The Seed and Seedlings Act provides the plant variety registration system for protection of plant breeders rights to promote breeding new varieties. The International Union for the Protection of New Varieties of Plants (UPOV), an international organization aiming to protect new plant varieties, and operates its plant variety protection system in harmonization with other member states. UPOV guidelines list "distinctness, uniformity and stability" as conditions for granting of plant breeder's rights. In 2004, participants to the UPOV-INGER (International Network for Genetic Evaluation of Rice) workshop on the "Protection of Plant Breeder's Rights" decided to establish regional rice example varieties for distinctness, uniformity and stability (DUS) test, initially, in the irrigated ecosystem for South-east, South Asia and Southern China. Example varieties are needed to harmonize states of expression for characteristics which are influenced by the environment particularly for asterisked characteristics. In DUS test, candidate varieties are cultivated on farms or in greenhouses and compared with similar existing varieties (reference varieties) for morphological evaluation of characteristics (colour, shape, and size) and physiological characteristics (tolerance to pests, diseases, particular components).

In recent years the study of natural variation has acquired another dimension in term of global trade under WTO regime. It relates to identifying useful biological variation,

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utilizing and exploiting it through modern technique for acquiring patents. It appears that all knowledgeable persons, institutions and commercial firms are running fast to grab and patent every such useful traits, which comes on their way. Member countries of the WTO are required to provide PVP for plant varieties either by patents, an effective *sui generic* system or a combination thereof. Some countries including India have PVP laws in place and others are in the process of legislating one. In lieu of all these, Govt. of India has passed the bill entitled "The Protection of Plant Varieties and Farmers Right Bill 2001" which was assented on October 30, 2001 under Act Number 53 of 2001.

MATERIALS AND METHODS

The experimental material consisted of 76 rice entries from five NARS (Bangladesh, Colombia, India, Philippines and Sri Lanka) and IRRI Philippines along with eight local checks *viz.*, Mahamaya, Karmamahsuri, Danteshwari, Chandrahasini, Samleshwari, Poornima, Indira Sugandhit Dhan-1 and Swarna. The experiment was laid out in Randomized Block Design with two replications. The recommended package of practices was adopted to raise the normal crop.

Each genotype was grown in a plot comprising three rows of 3 meter length. The distance between row-to-row and plant-to-plant was 20 cm and 15 cm, respectively. The distance between plot–to-plot was 30 cm. transplanting of the materials was done manually keeping single seedling per hill with 25 days old seedlings. A fertilizer dose of 60N:40P:20K kg/ha was applied. The entire dose of phosphorus and potassium along with half dose of nitrogen was applied as basal dose at the time of field preparation and the remaining nitrogen dose was applied in two to three splits at 20 days interval in the standing crop.

The data recorded on 84 rice entries including 8 checks for 20 morphological and quality characters were subjected to the following analysis. Observation on the characters *viz.*, leaf blade colour, early plant vigour (EPV), coleoptile colour, basal leaf sheath colour (BLSC), leaf pubescence, internode colour, panicle excertion, stigma colour, apiculous colour, collar colour, threshability, hull colour, panicle type, aroma, ligule colour (LC), ligule shape, auricle colour (AC), awning and seed coat colour (kernel colour) and quality parameters *viz.*, paddy length (mm), paddy L:B ratio, length of brown rice (mm), L: B ratio of brown rice, kernel length (mm), kernel L:B ratio, hulling per cent, milling per cent, head rice recovery per cent, kernel length after cooking (mm), kernel breadth after cooking (mm) and elongation ratio evaluated for characterization of these traits. The characters were recorded as per descriptors (Gautam, 2007). Five plants from each plot in each replication were randomly selected for observations of various characters.

Averages of the data from the sampled plants of each plot with respect to different characters were used for various statistical analysis. The mean values were worked out for all 20 traits of each genotype and check variety. These mean data were utilized to calculate variability parameters *viz.*, range, standard deviation and co-efficient of variation.

RESULTS AND DISCUSSION

Characterization and grouping of the genotypes were carried out on the basis of anthocyanin pigmentation, panicle type, awning character, aroma distribution and hull colour (Table 1, Plate 1, 2 and 3). The percentage of entries were recorded for purple line colour of basal leaf sheath (50.01), green leaf blade colour (44.05), semi-erect angle of flag leaf (54.76), white colour of ligule (97.61), 2-cleft shape of ligule (57.14), green collar colour (64.29), pale green colour of auricle (60.71), white stigma colour (67.85), green internode colour (84.52), white colour of apiculus (50.00) and white sterile lemma colour (95.23). Intermediate type of panicle (41.66), awnless of awning (73.80), absence of aroma (59.53), straw hull colour (79.76) and intermediate leaf pubescence (51.19) (Table 1).

Entries with the characters of purple colour of basal leaf sheath (11.90), purple margine colour of leaf blade (2.38), horizontal flag leaf angle (2.38), purple line colour of ligule (2.39), truncate shape of ligule (4.76), purple colour of collar (4.76), purple stigma colour (14.28), purple internode (1.19), purple apiculus (3.57), red colour of steile lemma (4.77), open type of panicle (17.85), long and partly awned distribution of awning (1.19), presence of aroma (40.47), purple colour of hull (1.19) and pubescent of leaf pubescence (10.71) were found to show very less distribution.

A wide range of variation was observed for quality parameters like paddy length from 7.32 to 9.70 mm with mean performance of 8.03 mm. maximum paddy length (9.70 mm) was observed in PSB RC 96 (Table 2). Mean value of paddy L:B ratio (2.89), length of brown rice (6.77 mm), L: B ratio of brown rice(3.07), kernel length (6.33 mm), kernel L:B ratio (3.17), hulling per cent (74.54 %), milling per cent (68.36 %), head rice recovery per cent (36.24 %), kernel length after cooking (8.16 mm), kernel breadth after cooking (2.91 mm) and elongation ratio (2.81). Among the different quality parameters the highest genotypic co-efficient of variation was observed for head rice recovery per cent (32.88 %) followed by L: B ratio of brown rice (12.21 %), kernel L: B ratio (11.25 %), milling per cent (10.55 %), elongation ratio (10.12 %), kernel breadth after cooking (10.01 %), hulling per cent (8.28 %), kernel length after cooking (7.70 %), length of brown rice (7.40 %), kernel length (6.61 %), paddy length (6.25 %) whereas, it was lowest for paddy L: B ratio (5.78 %).

The phenotypic co-efficient of variation was found the highest for head rice recovery per cent (35.10 %) followed by milling per cent (12.97 %), L: B ratio of brown rice (12.33 %), kernel L: B ratio (11.49 %), elongation ratio (10.38 %), kernel breadth after cooking (10.13 %), hulling per cent (8.79 %), paddy L: B ratio (8.34 %), kernel length after cooking (7.93 %),

Table 1: Classification of visual characters in rice genotypes on the basis of frequency percentage

Sr. No.	Characters	Symbols	No. of entries	Percentage of entries
1.	Basal leaf sheath colour			
	Green	1	22	26.19
	Purple line	2	42	50.01
	Light purple	3	10	11.90
	Purple	4	10	11.90
2.	Leaf blade colour			
	Light green	1	05	05.96
	Green	2	37	44.05
	Dark green	3	31	36.90
	Purple tip	4	09	10.71
	Purple margin	5	02	02.38
3.	Flag leaf angle			
	Erect	1	36	42.86
	Semi-erect	2	46	54.76
	Horizontal	3	02	02.38
4.	Leaf pubescence			
	Glabrous	1	32	38.09
	Intermediate	2	43	51.19
	Pubescent	3	09	10.71
5.	Ligule colour			
	White	1	82	97.61
	Purple line	2	02	02.39
6.	Ligule shape			
	Acute to acuminate	1	32	38.09
	2-cleft	2	48	57.14
	Truncate	3	08	04.76
7.	Collar colour			
	Pale green	1	26	30.95
	Green	2	54	64.29
	Purple	3	04	04.76
8.	Auricle colour			
	Green	1	29	34.53
	Pale green	2	51	60.71
	Purple	3	04	04.76
9.	Stigma colour			
	White	1	57	67.85
	Light green	2	06	07.15
	Yellow	3	07	08.34
	Light purple	4	02	02.38
	Purple	5	12	14.28
10.	Internode colour			
	Green	1	71	84.52
	Light gold	2	08	09.53

Table 1 : Contd……

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	Purple line	3	04	04.76
	Purple	4	01	01.19
11.	Apiculus colour			
	White	1	42	50.00
	Straw	2	09	10.72
	Brown	3	17	20.23
	Red	4	13	15.47
	Red apex	5	-	0.00
	Purple	6	03	3.57
	Purple apex	7	-	0.00
12.	Sterile lemma colour			
	White	1	80	95.23
	Red	2	04	4.77
	Purple	3	-	0.00
13.	Penicle type			
	Compact	1	34	40.47
	Intermediate	2	35	41.66
	Open	3	15	17.85
14.	Awning			
	Absent	1	62	73.80
	Short and partly awned	2	17	20.23
	Short and fully awned	3	01	1.19
	Long and partly awned	4	01	1.19
	Long and fully awned	5	03	3.57
15.	Aroma			
	present	1	34	40.47
	Absent	2	50	59.53
16.	Hull colour			
	Straw	1	67	79.76
	Golden	2	05	5.95
	Golden brown	3	03	3.57
	Brown furrow on straw	4	05	5.95
	Purple	5	01	1.19
	Purple furrow on straw	6	02	2.38
	Brown	7	01	1.19

length of brown rice (7.46 %) and kernel length (6.68 %) whereas, it was found lowest for paddy length (6.27 %).

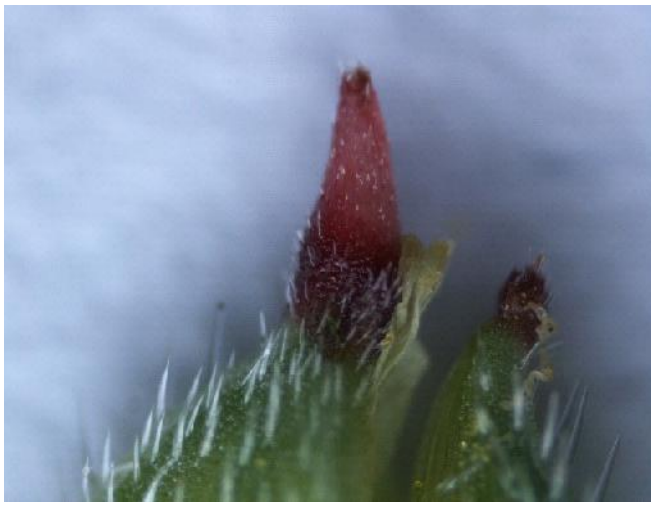
In the present study, seed quality parameters like L: B ratio of brown rice, kernel L: B ratio, milling per cent, elongation ratio and kernel breadth after cooking recorded low to medium genotypic co-efficients of variation. Veni *et al.* (2006) also reported moderate genotypic co-efficient of variation for kernel L: B ratio, elongation ratio and kernel breadth after cooking. Whereas, head rice recovery per cent had high estimate of co-efficient of variation. The present findings were also supported by Chauhan *et al.* (2001).

Estimates of heritability in broad sense and genetic advance as per cent of mean were evaluated for all the 12 quality parameters. Among the quality parameters studied heritability estimates were found to be high for paddy length (99.50 %), length of brown rice (98.40 %), L:B ratio of brown rice (98.00 %), kernel length (98.00 %), kernel breadth after cooking (97.60 %), kernel L:B ratio (95.80 %), elongation ratio (95.00 %), kernel length after cooking (94.50 %), hulling per cent (88.70 %) and head rice recovery per cent (87.70 %).

Purple colour of stigma (IR 65185-3B-8-3-2)

Purple colour of stigma (N-22)

White colour of stigma (K 39-96-1-1-1-2)



Red colour of apiculus (BPI 76)

Purple colour of ligule (FR 13A)

Pale green colour of sterile lemma (IR 45)

Plate 1: Characterization of rice genotypes on the basis of stigma, apiculus and sterile lemm colours

Long and fully awned (WC 1240)

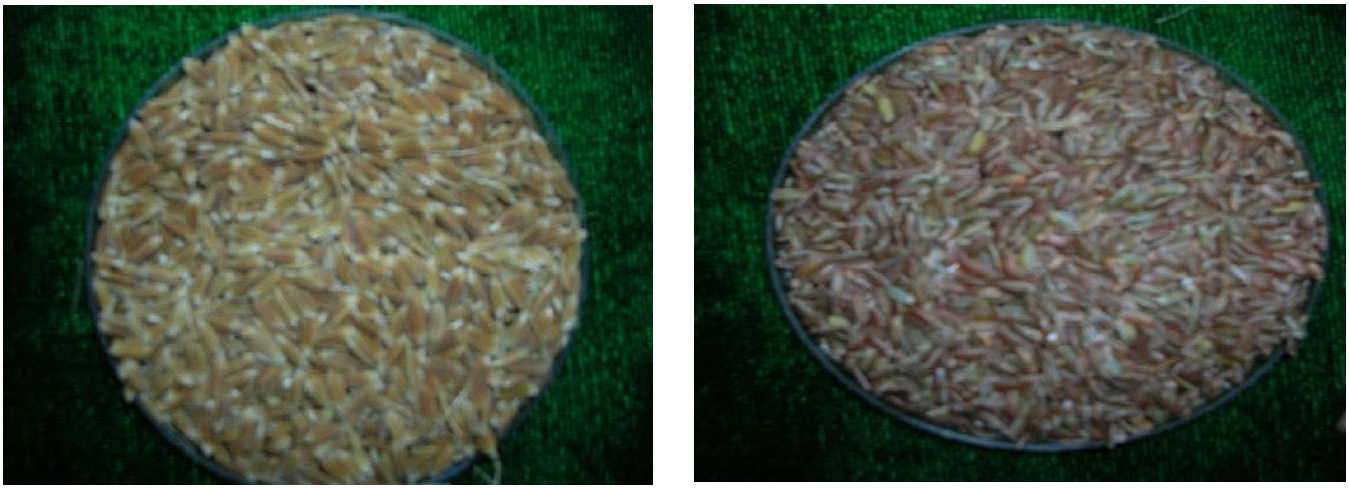
Long and fully awned (Indira Sugandhit Dhan 1)

Long and fully awned (FR 13A)

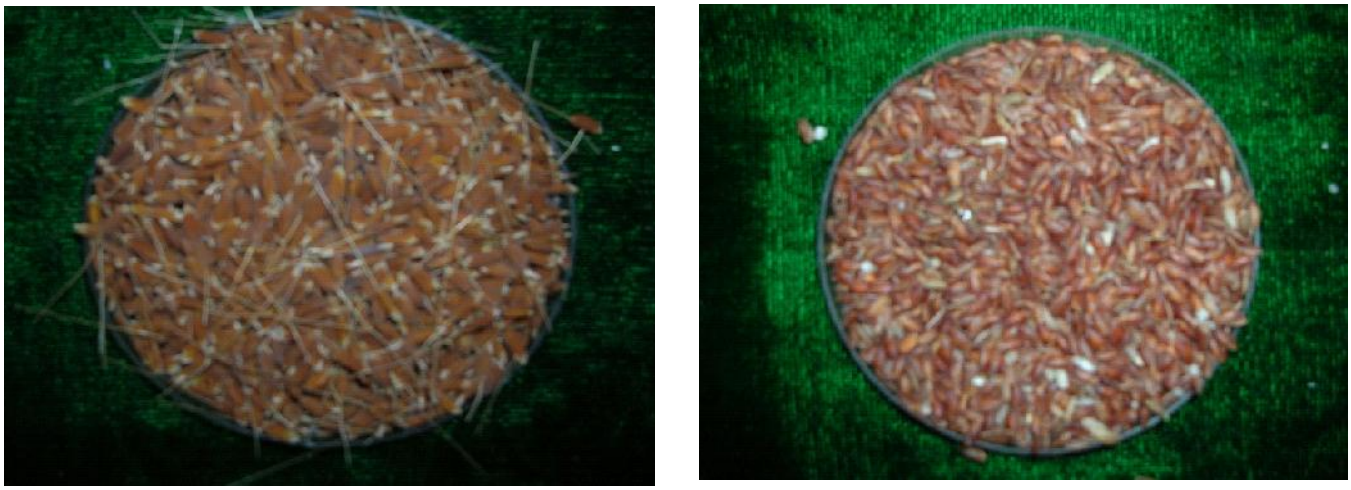
Long and fully awned (BPI 76)

Short and partly awned (P 2025-F4-159-3-1B)

Plate 2 : Characterization of rice genotype on the basis of awning distribution



Purple colour of hull and grain



Red colour of hull and grain

Purple colour of hull and red grain

Plate 3 : Characterization of rice genotypes based on hull colour

While, moderate heritability was recorded for milling per cent (66.20 %). On the other hand, estimates remained low for paddy L: B ratio (48.10 %).

The estimates of genetic advance as percentage of mean was found high for head rice recovery per cent (63.44 %); moderate for kernel breadth after cooking (28.37 %), L:B ratio of brown rice (24.75 %), kernel L:B ratio (22.72 %), elongation ratio (20.29 %), kernel length after cooking (18.43 %), milling per cent (17.70 %), hulling per cent (16.05 %), length of brown rice (15.06 %), kernel length (13.43 %) and paddy length (12.83 %) and it was low for paddy L: B ratio (8.30 %).

To estimate the association between two characters,

Table 2 : Mean performance and genetic parameters of variation for quality parameters in rice

Sr. No.	Characters	Mean	Range		GCV (%)	PCV (%)	h^2_{bs}(%)	GA	GA as % of mean
			Min.	Max.					
1.	Paddy length (mm)	8.03	7.32	9.70	6.25	6.27	99.50	1.03	12.83
2.	Paddy L: B ratio	2.89	2.45	3.31	5.78	8.34	48.10	0.24	8.30
3.	Length of brown rice (mm)	6.77	5.98	8.28	7.40	7.46	98.40	1.02	15.06
4.	L: B ratio of brown rice	3.07	2.03	3.85	12.21	12.33	98.00	0.76	24.75
5.	Kernel length (mm)	6.33	5.49	7.54	6.61	6.68	98.00	0.85	13.43
6.	Kernel L: B ratio	3.17	2.39	4.32	11.25	11.49	95.80	0.72	22.72
7.	Hulling per cent	74.54	55.46	95.33	8.28	8.79	88.70	11.97	16.05
8.	Milling per cent	68.36	37.30	85.80	10.55	12.97	66.20	12.10	17.70
9.	Head rice recovery per cent	36.24	11.47	64.40	32.88	35.10	87.70	22.99	63.44
10.	Kernel length after cooking (mm)	8.16	6.84	9.67	7.70	7.93	94.50	1.26	18.43
11.	Kernel breadth after cooking (mm)	2.91	2.08	3.95	10.01	10.13	97.60	0.59	28.37
12.	Elongation ratio	2.81	2.05	3.78	10.12	10.38	95.00	0.57	20.29

Table 3: Inter-relationship of seed yield and its attributing in rice genotypes

Characters	Level	Plant height (cm)	Panicle length (cm)	Number of effective tillers per plant	100 seed weight (g)	Leaf length (cm)	Leaf width (cm)	Seed yield per plant (g)
Days to 50% flowering	G	-0.104	-0.140	-0.140	0.081	-0.263	-0.061	0.053
	P	-0.066	-0.105	-0.001	0.034	-0.162	-0.034	0.041
	E	-0.012	-0.117	0.181	-0.116	-0.019	0.007	0.046
Plant height (cm)	G		0.328**	-0.264	-0.071	0.517**	0.141	-0.136
	P		0.316**	-0.222	-0.073	0.485**	0.133	-0.118
	E		0.013	-0.011	-0.148	-0.108	0.042	0.097
Panicle length (cm)	G			-0.136	-0.015	0.037	0.205	-0.123
	P			-0.095	-0.013	0.044	0.196	-0.114
	E			0.176	0.035	0.158	0.098	0.015
Number of effective tillers per plant	G				0.081	-0.224	-0.442	0.454**
	P				0.072	-0.189	-0.367	0.431**
	E				0.037	-0.033	-0.063	0.410**
100-seed weight (g)	G					-0.077	0.092	0.526**
	P					-0.069	0.087	0.495**
	E					0.072	0.02	-0.056
Leaf length (cm)	G						0.300*	-0.07
	P						0.257*	-0.072
	E						-0.192	-0.092
Leaf width (cm)	G							-0.047
	P							-0.054
	E							-0.121

* and ** Indicates significance of values at P=0.05 and 0.01, respectively

correlation co-efficient at phenotypic, genotypic and environmental levels have been worked out in all possible combinations amongst yield components (Table 3). The results showed that genotypic correlations were higher than phenotypic correlations which were in turn higher than environmental correlations. Seed yield per plant exhibited a significant positive correlation with the traits namely, 100-seed weight (0.526) and number of effective tillers per plant (0.454) at genotypic level. Thus, it is clear from the present findings that for genetic improvement in seed yield selection must be based on component characters *viz.*, 100-seed weight and number of effective tillers per plant which had shown positive correlation with seed yield. On the other hand significant positive correlation with the traits namely, 100-seed weight (0.495) number of effective tillers per plant (0.431) at phenotypic level.

The observed positive correlation of seed yield with 100-seed weight and number of effective tillers per plant were supported by earlier workers *viz.*, Sarawgi *et al*. (1997) for 100-seed weight and number of effective tillers per plant at genotypic level, Sardana *et al*. (1997)

Verma and Srivastava (2004) for 100-seed weight and number of effective tillers per plant at genotypic and phenotypic level. Naik *et al.* (2005) for number of effective tillers per plant at genotypic and phenotypic level, and 100-seed weight and number of effective tillers per plant.

Among quality parameters head rice recovery per cent had high heritability coupled with high genetic advance. This suggests the presence of additive gene effect for these traits and hence can be improved by simple selection in either direction. Similar finding was also obtained by Chauhan *et al.* (2001). Whereas, high heritability coupled with moderate genetic advance was recorded for paddy length, length of brown rice, L: B ratio of brown rice, kernel length, elongation ratio, kernel breadth after cooking, kernel L: B ratio, kernel length after cooking and hulling per cent, indicating usefulness of these quality parameters in selection criterion. Veni *et al.* (2006) also reported similar findings for elongation ratio, kernel length and kernel breadth after cooking. Moderate heritability with moderate genetic advance for milling per cent and low heritability with low genetic advance observed for paddy L: B ratio.

Based on the screening of different quantitative traits and quality parameters of 84 genotypes, some of the genotypes were identified as donor for desirable characters and it can be utilized in breeding programme for improvement of a particular character.

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