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Genetic variability in grain quality characteristics and yield in lowland rice genotypes

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ABSTRACT

Grain quality characteristics of 20 promising rice genotypes were evaluated for twelve physico-chemical, quality traits and yield. Analysis of variance for all the characters indicated significant difference among the genotypes. The values of phenotypic and genotypic coefficient of variation were high for water uptake and yield. Heritability was very low in volume expansion ratio. Hulling (%) ranged from 71.6% to 79.7%. Milling (%) ranged from 63.4 to 76.7% in all the genotypes. Head rice recovery percentage (HRR %) varied from 50.4% to 72.8%. Highest length breadth ratio was observed in long slender genotypes like NDR 9830144, NDR 9830118 and NDR 9830124. Elongation ratio varied from 1.5 to 1.9 and highest was observed in Salivahan. Volume expansion ratio in all the genotypes were less than 4.0 and highest was 3.9 (IR 53945-35-B-3-2CR-1). Amylose content was in intermediate rang (18.7 to 25.6%). Alkali spreading value ranged from 4.0 (OR 1898-2) to 7.0 (OR 1550-26). Yield varied from 1.1 t ha^{-1} (RAU 1314-3-3-3) to 3.3 t ha^{-1} (NDR 9830144). Among the tested genotypes NDR 9830144 and TTB 292-426 were having desirable quality characteristics and therefore these genotypes may be used in quality improvement programme.

Key words: *Genetic variability, quality attributes lowland rice*

In recent times, there is heavy demand for good grain quality in national as well as in international market. Quality rice also fetches higher price for the farmers. Keeping this in view, twenty lowland rice genotypes including one check were evaluated for their physico-chemical characteristics, cooking quality and yield to find out better genotypes to be used as donor in the varietal development programme for quality rice.

MATERIALS AND METHODS

This experiment was conducted with 20 lowland rice genotypes including one check Sabita during wet season 2003 at Central Rice Research Institute, Cuttack. The experimental design was randomized block design with 3 replications. Seedlings of 25 days old were transplanted in 15 x 20 cm. spacing. Recommended dose of fertilizer at 60kg N, 30kg P_2O_5 and 30kg K_2O ha was applied. Seed samples collected after harvest with 14% moisture were analyzed for Hulling%, Milling%, Head Rice Recovery % (HRR%), Amylose content %(AC%), Alkali spreading value (ASV) and Elongation ratio (ER), (Govindswamy and Ghosh 1969). The yield of each variety and other characters were recorded (Table 1). The length and breadth of the grains were measured with dial micrometer. Amylose content and alkali spreading value (ASV) and elongation ratio (ER) were estimated following the methods of Juliano (1971) and Little *et al*.,(1958) respectively. Water uptake and volume expansion ratio were determined (Beachell and Stansel, 1963). Analysis of variance (ANOVA), coefficient of variation (CV%), phenotypic coefficient of variation (PVC), genotypic coefficient of variation (GCV) and heritability in broad sense, and genetic advance as percentage of mean were calculated following Singh and Choudhury (1985), Johnson et al. (1955) (Table 2 and 3).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the 20 genotypes for all the physico-chemical, quality traits and yield indicating sufficient scope for further improvement. The environmental impact was very less because PCV and GCV had very little difference. It was observed that the PCV and GCV were very high in case of water uptake and yield. The high GCV of these traits indicated further selection to

Table 1. Physicochemical characteristics of twenty lowland rice genotypes

Variety/Culture	Hull (%)	Mill (%)	HRR (%)	KL (mm)	KB (mm)	L/B	WU (ml $100g^{-1}$)	VER	ASV	ER	KLAC (mm)	AC (%)	Yield (t ha^{-1})	Grain type
NDR 9830144	79.70	71.60	65.30	7.6	2.0	3.8	128	3.7	5.0	1.5	11.8	21.5	3.3	LS
OR 1550-23	79.30	71.30	66.70	5.4	2.2	2.5	244	3.6	4.5	1.5	8.6	21.4	1.5	SB
TTBSB 19-146	79.03	74.30	72.80	5.5	2.4	2.3	151	3.4	5.0	1.7	9.2	19.7	2.4	SB
RAU 1326-94-2	75.30	70.20	58.70	6.0	2.2	2.7	141	3.7	5.0	1.6	9.5	22.4	2.4	LB
OR 1550-26	78.00	73.10	69.10	5.8	2.5	2.3	290	3.8	7.0	1.8	10.2	22.3	2.0	SB
NDR 9830118	76.30	67.70	59.40	7.2	2.1	3.3	175	3.5	6.8	1.6	11.2	25.6	1.2	LS
NDR 9830124	77.70	67.70	62.60	6.5	2.1	3.1	134	3.7	4.3	1.7	11.1	25.2	2.1	LS
OR 1898-2	79.30	73.40	64.70	5.5	2.2	2.5	122	3.7	4.0	1.8	9.3	24.2	2.4	SB
TTB 292-426	77.30	68.60	61.60	5.6	2.1	2.7	103	3.7	4.0	1.7	9.6	23.6	2.3	MS
IR 53945-35-B-3-2-CRI-1	75.30	71.80	64.80	6.6	2.3	2.9	118	3.9	5.0	1.7	11.0	24.8	2.9	LB
NDR 9830108	78.00	76.70	64.50	5.9	2.2	2.8	140	3.6	4.2	1.8	10.7	23.1	1.5	MS
RAU 1326-94-65	76.00	76.40	50.40	6.4	2.2	3.0	123	3.6	5.0	1.6	10.4	24.5	1.2	LB
NDR 9830133	76.80	70.90	54.30	5.9	2.1	2.7	246	3.8	6.0	1.9	11.2	18.7	1.3	MS
NDR 9830-132	78.70	75.50	67.20	6.7	2.2	3.0	297	3.8	6.8	1.8	12.0	23.8	1.2	LB
RAU 1314-3-3-3	77.40	71.60	61.40	5.4	2.4	2.2	156	3.7	4.2	1.8	9.5	23.9	1.1	SB
Rajashree	76.00	68.10	63.50	5.3	2.1	2.5	138	3.8	4.0	1.7	9.1	21.7	1.4	LS
Mahsuri	78.50	70.80	66.30	5.1	2.1	2.4	135	3.7	4.1	1.7	8.2	20.8	1.7	SB
Salibahan	77.30	70.90	60.20	5.2	2.5	2.1	155	3.8	4.1	1.9	9.8	21.9	2.7	SB
Moti	71.60	63.40	54.50	5.9	2.1	2.8	146	3.7	4.3	1.8	10.6	20.2	2.4	LB
Sabita	75.00	67.50	57.80	7.2	2.1	3.5	117	3.8	5.0	1.6	11.5	24.7	1.2	LS
Mean	77.10	70.40	62.30	6	2.19	2.8	163	3.7	4.9	1.7	10.3	22.7	1.9	
CV (%)	1.4	0.6	2.65	1.3	5.0	5.7	1.56	5.4	5.6	9.2	2.48	1.67	9.9	
SEM $\pm$	0.64	0.24	0.95	0.04	0.06	0.09	1.47	0.11	0.15	0.09	0.14	0.21	0.10	
CD (P=0.05)	1.84	0.70	2.7	0.13	0.18	0.26	4.2	-	0.45	-	0.4	6.2	0.31	

Hull %: Hulling %, Mill %: Milling % HHR%: Head Rice Recovery (%), KL: Kernel length, KB: Kernel Breadth, L/B: Kernel length/kernel breadth, WU: Water uptake, VER: Volume expansion ratio. ASV: Alkali spreading value, ER: Elongation ratio, KLAC: Kernel length after cooking, AC: Amylose content

Table 2. Analysis of variance of 13 characters for 20 genotypes

Characters	Sources of variation		
	Replication	Genotypes	Error
Hulling %	0.481	11.323**	1.248
Milling %	4.466	22.76**	0.181
HRR%	14.216	87.952**	2.727
KL (mm)	0.484	1.560**	0.006
KB (mm)	0.085	0.061**	0.012
L/B	0.002	0.580**	0.024
Water uptake	129.03	10042.868**	6.524
ASV	0.712	2.925**	0.076
KLAC (mm)	1.547	3.255**	0.065
VER	0.197	0.040	0.040
ER	0.078	0.038	0.024
AC %	3.002	11.399**	0.14
Yield (t ha^{-1})	1.188	1.305**	0.036

** and * significant at 1% and 5% level of probability respectively. HHR%: Head Rice Recovery (%), KL: Kernel length, KB: Kernel Breadth, L/B: Kernel length/kernel breadth, ASV: Alkali spreading value, KLAC: Kernel length after cooking. VER: Volume expansion ratio, ER: Elongation ratio, AC: Amylose content

to both. High heritability with high genetic advance were observed in water uptake, yield and alkali spreading values. This indicated prevalence of additive gene action for expression of these traits (Panse, 1957). The characters viz., Hulling %, Milling %, HRR%, kernel length, kernel breadth, kernel length after cooking, amylose content % etc were having high heritability and low genetic advance indicating that these characters were under the control of non-additive gene effects. (Rao *et al*. 2003).

Amongh the genotypes, five were long slender, five were long bold, three were medium slender and seven were short bold (Table 3). The grain length is highest in NDR 9830144 (7.6 mm) and lowest in Mahsuri (5.1 mm). The grain breadth was highest in OR 1550-26 (2.5 mm) and lowest in NDR 9830144 (2.0 mm).

All the genotypes were having very good hulling percentage (>70%). It varied from 71.6 (Moti) to 79.7% (NDR 9830144). Similarly milling recovery was very good and ranged from 76.7 (NDR 9830108) to 63.4% (Moti). HRR is the key factor for giving more

Table 3. Estimate of different genetic parameter for 12 quality characters and yield for twenty genotypes

Characters	Range	Mean ± SE	PCV	GCV	Heritability (%) Broad sense	Geneticadvance (as % of mean)
Hulling %	71.6-79.7	77.12 ± 0.64	2.51	2.37	88.97	4.61
Milling %	63.4-76.7	70.47 ± 0.25	3.90	3.89	99.20	7.98
HRR%	50.4-72.8	62.03 ± 0.95	8.69	8.55	96.90	17.34
KL (mm)	5.1-7.6	6.02 ± 0.05	11.97	11.95	99.59	24.56
KB (mm)	2.0-2.5	2.19 ± 0.06	6.51	5.82	79.93	10.72
L/B	2.1-3.8	2.76 ± 0.09	15.92	15.58	95.70	31.39
Water uptake	103.3-296.6	162.91 ± 1.47	35.51	35.50	99.94	73.11
ASV	4.0-7.0	4.92 ± 0.16	20.04	19.78	97.38	40.22
KLAC (mm)	8.2-12.0	10.25 ± 0.15	10.16	10.06	98.00	20.51
VER	3.4-3.9	3.70 ± 0.11	3.14	0.29	0.84	0.05
ER	1.5-1.9	1.71 ± 0.90	6.61	3.9	34.72	4.72
AC %	18.7-25.6	22.70 ± 0.22	8.59	8.53	98.73	17.46
Yield (t ha^{-1})	1.1-3.3	1.92 ± 0.11	34.34	33.86	97.24	68.79

HHR%: Head Rice Recovery (%), KL: Kernel length, KB: Kernel Breadth, L/B: Kernel length/kernel breadth, ASV: Alkali spreading value, KLAC: Kernel length after cooking VER: Volume expansion ratio, ER: Elongation ratio, AC: Amylose content

improve superior genotypes. The high heritability was observed in all the traits except volume expansion ratio and elongation ratio. The estimate of heritability and genetic advance in combination are more important than of heritability alone as the selection efficiency is related

profit that depends mainly on grain type, drying condition and cultural practices. It varied from 50.4% (RAU 1326-94-65) to 72.8% (TTB SB-19-146). Most of the genotypes were very good in HRR% (> 60%).

Linear elongation usually gives good shape to

rice than breadth wise elongation. In this experiment, elongation ratio ranged from 1.5 (NDR 9830144) to 1.9 (Salivahan). Volume expansion ratio of most of the genotypes was< 4.0, a good quality feature. It varied from 3.4 (TTBB 19-146) to 3.9 (IR 53945-35-B-3-2-CR-1) indicating very less variability.

4 lkali spreading value ranged from 4.0 (OR 1898-2) to 7.0 (OR 1550-26). Usually intermediate amylose content (20-25%) is preferred by the Indians. Below this value it would be sticky and above this, it would be hard. The tested genotypes were having intermediate amylose content except NDR 9830133 (18.7%), NDR 9830118 (25.6%) and NDR 9830124 (25.2%). Among the tested genotypes highest yield was recorded in NDR 9830144 (3.3 t ha^{-1}) and lowest in RAU 1314-3-3-3 (1.1 t ha^{-1}).

Considering all the characters, it is concluded that the genotypes NDR 9830144 and TTB 292-426 were having acceptable grain quality characters and good yield. So these two genotypes may be used as donors in varietal development programme.

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