GRAIN MORPHOLOGICAL DIVERSITY OF TRADITIONAL RICE VARIETIES (ORYZA SATIVA L.), IN LATERITIC REGION OF WEST BENGAL

Anjan Kumar SINHA[1*], Goutam Kumar MALLICK[2], Prashant Kumar MISHRA[3]

[1]Department of Botany, Bankura Sammilani College, Bankura-722102, West Bengal,
[2]Rice Research Station, Nutanchati, Bankura- 722101, West Bengal,
[3]Department of Botany, Vinoba Bhave University, Hazaribag, 820 301, Jharkhand, India.

Abstract

Fifty five traditional rice varieties of West Bengal, mostly from the lateritic region, were investigated for grain morphological characters. A wide variation of grain characters, like gain size and shape, anthocyanin colouration of lemma-palea and kernel, presence or absence of aroma, awning characteristics, ware found among the studied varieties. Wide variation among the grain morphological characters indicated wide genetic variation present among these varieties, which may be utilized for the selection of the parents for the plant breeding and production of new improved variety.

Keywords: Grain morphology; Traditional rice; Lateritic region; West Bengal

Introduction

Rice is a staple food grain of West Bengal. The West Bengal state is one of the biggest producers of this grain. The lateritic region of West Bengal is one of the richest reservoirs of traditional rice varieties, since immemorial times. In contrast with the diverse geographical distribution of this region, traditional varieties are also found so diverse. Agro-morphological characterization of traditional rice germplasm varieties is a fundamental task required in order to provide information for plant breeding programs [1]. Grain characters of rice are considered as one of the most important agro-morphic characters for any variety and acceptance and rejection of a rice variety by the farmers is solely dependent on these characters. Various genotypes of rice have classified on the basis of grain characters like, length, shape, 1000-grain weight or 100-grain weight etc., and these are the main important characters for the classification of rice genotypes according to Bhattacharya *et al* [2], Das *et al* [3], Kato and Matsunaga [4].

Rice varieties were classified on the basis of grain shape, grain weight and grain dimensions. Rice and grain characters like length, shape, 1000-grain weight or 100-grain weight and profile value are the important distinguishing agronomic characters of rice genotypes [3]. Kato and Matsunaga [4] have studied various grain characters like grain size, grain length, breadth and shape of rice and reported that these characters have a direct effect on the marketability or commercial success of improved rice cultivars. They introduced Image analysis of shape as a new technique for selection. Vanaja and Babu [5] classified the 56 high yielding

* Corresponding author: anjansinha06@gmail.com

varieties from different eco-geographical areas *viz*., Bangladesh, China, Indonesia, Malaysia, Pakistan, Philippines and Sri Lanka based on grain characters like grain length, grain width and L/B ratio. Satoh et al [6,7,8,9], have studied distribution and grain morphology of cultivated and wild rice variety of Tanzania and Madagascar and reported that wide genetic diversity was present among the rice cultivars of different countries. Genetic diversity is a fundamental criterion for increasing yield and sustainable production of rice in spite of pathogenic attack and present fluctuating environmental condition [10]. Anonymus [11] has provided guideline of morphological and physico-chemical characteristics of rice for conduct of test for distinctiveness, uniformity and stability on rice. Studies on various agro-morphic characterization and conservation of landraces of rice of lateritic region of West Bengal have earlier been made by Sinha and Mishra [12-15]. They have worked on various important morphological characters present among the landraces of lateritic region of West Bengal, which have a great significance in plant breeding program. In this study special emphasis has given on grain morphology of landraces of lateritic region of West Bengal.

Materials and methods

Fifty five indigenous rice landraces were collected from the various remote villages of lateritic region of West Bengal in 2010, 2011 and 2012, during the kharif season and propagated in a small farm for obtaining various morphological data on grain characters. Data were collected during three consecutive rice growing season i.e. 2011, 2012 and 2013 respectively (Table 1).

Table 1. List of landraces of rice cultivars used in the study

Code	Name of the cultivars	Code	Name of the cultivars	Code	Name of the cultivars
V1	Agniban	V20	Jamainadu	V39	Nagrasal
V2	Badshabhog	V21	Kakua	V40	Narkeljhopa
V3	Bachi	V22	Kaksal	V41	Neta
V4	Bahurupi	V23	Kalamkati	V42	Nikunja
V5	Badamsaru	V24	Kalobhat	V43	Nonabogra
V6	Baskamini	V25	Kalojira	V44	Nugenbaro
V7	Byamajhupi	V26	Kalobayar	V45	Patnai-23
V8	Bhuri	V27	Kanakchur	V46	Raghusal
V9	Bhadoi	V28	Kartiksal	V47	Radhatilak
V10	Barani	V29	Kataribhog	V48	Rupsal
V11	Chotodidi	V30	Kelesh	V49	Sitasal
V12	Chandrakanta	V31	Khajurchari	V50	Sindurmukhi
V13	Dharansal	V32	Kheuch	V51	Suakalma
V14	Daharlagra	V33	Lalbadshabhog	V52	Tulsibhog
V15	Danarguri	V34	Langalmura	V53	Talmugurdahn
V16	Dudherswar	V35	Laltipa	V54	Valki
V17	Fulkhar	V36	Malabati	V55	Vutmuri
V18	Fulpagri	V37	Malsira		
V19	Gangajali	V38	Marichsal		

The materials were grown using completely randomized block design with three replications. Each variety was transplanted (45 day's old seedling) in a plot of 6m^2 with a spacing of 25cm. between rows and 20cm. between plants in a row. A random sample of five competitive plants was used for observations on different grain characters under study. Various morphological characters of grains was taken as per the guideline of DUS test reported by Shobarani [16] (Table 2).

Table 2. Various grain characters of traditional rice varieties of
lateritic region of West Bengal according to DUS guidelines

Character	Descriptors				
	1	**2**	**3**	**4**	**5**
Grain: weight of 1000 fully developed grains (WT)	Very low	Low	Medium	High	Very high
Grain: length (GL)	Very short	Short	Medium	Long	Very long
Grain: width (GW)	Very narrow	Narrow	Medium	Broad	Very broad
Decorticated grain: length (DL)	Very short	Short	Medium	Long	Very long
Decorticated grain width (DW)	Narrow	Medium	Broad		
Decorticated grain: shape (in lateral view) (S)	1- Short slender 2-Short bold 3-Medium slender, 4-Long slender 5-Long bold 6-Basmati type 7-Extra long slender				
Panicle: awns (AW)	Absent	Present			
Panicle: colour of awns (AWC)	1. Yellowish white, 2. Black, 3. Yellowish brown, 4. Brown, 5. Reddish brown, 6. Light red.				
Panicle: length of longest awn (AWL)	Very short	Short	Medium	Long	Very long
Lemma and palea: colour (LP)	1-Straw, 2- Gold and gold furrows on straw, 3- Background brown spots on straw, 4- Brown furrows on straw, 5-Brown (tawny), 6-Reddish to light purple, 7-Purple spots on straw, 8-Pruple furrows on straw, 9-Purple 10-Black				
Decorticated grain: colour (DC)	1-White, 2-Light brown, 3-Variegated brown, 4-Dark brown, 5-Light red, 6-Red, 7-Variegated purple, 8-Purple, 9-Black.				
Decorticated grain: aroma (AR)	Non Scented	Mild Scented	Strongly scented		
Grain length breadth ratio (GLB)	Very Low	Low	Medium	High	Very high
Kernel length breadth ratio (KLB)	Very Low	Low	Medium	High	Very high

Results and discussions

Various qualitative and quantitative grain morphological characters of rice landraces of lateritic region of West Bengal are given in Table 3. The variation of grain length of studied 55 landraces of rice ranged from 5.6 to 11.2 mm, grain width form 1.8 to 4 mm, kernel length from 3.95 to 8.3 mm, kernel breadth from 1.6 to 3.1 mm. Length to width ratio of grain varied from 2.15 to 4.45 and kernel length to width varied from 1.56 to 4.11 and 1000 grins weight from 10.1 to 33.6 gm. Maximum and minimum value and other statistical value of quantitative morphological characters of grain were given in Table 4. On the basis of kernel (decorticated grain) length and length breadth ratio only one variety each shows short slender (Kataribhog) and extra long slender (Patnai-23) gain size, 2 varieties shows Basmati type (Daharlagra and Suakalma variety), 5 varieties shows medium slender (Bahurupi, Bhadoi, Fulpari, Khajurchari, Malsira and Vutmuri variety), 7 varieties shows long slender, 10 varieties shows long bold and the remaining 29 varieties fall into short bold type of grain shape in lateral view. Lemma and pale color (Hull color) consist of 10 classes according to DUS test guideline.

These are: Straw, Gold and gold furrows on straw, Background brown spots on straw, Brown furrows on straw, Brown (tawny), Reddish to light purple, Purple spots on straw, Purple furrows on straw, Purple and Black. Most of the cultivars poses straw color hull while purple and black hull colour is rare. The kernel colour (pericarp or decorticated grain) also consist of 9 categories. Among them white kernel colour was found abundant, only one variety i.e. Kalobhat shows black kernel colouration, four varieties namely Bhuri, Langalmura, Neta and Nona bogra poses red kernel colouration. Anthocyanin colouration of Rice Hull and Seed Coat of different landraces of rice is depicted in Figure 1. Another important grain characteristic is the presence or absence of aroma. Maximum varieties were without aroma and only few varieties are aromatic. According to the intensity of aroma, grains are classified into non aromatic or non scented, mild scented and strong scented.
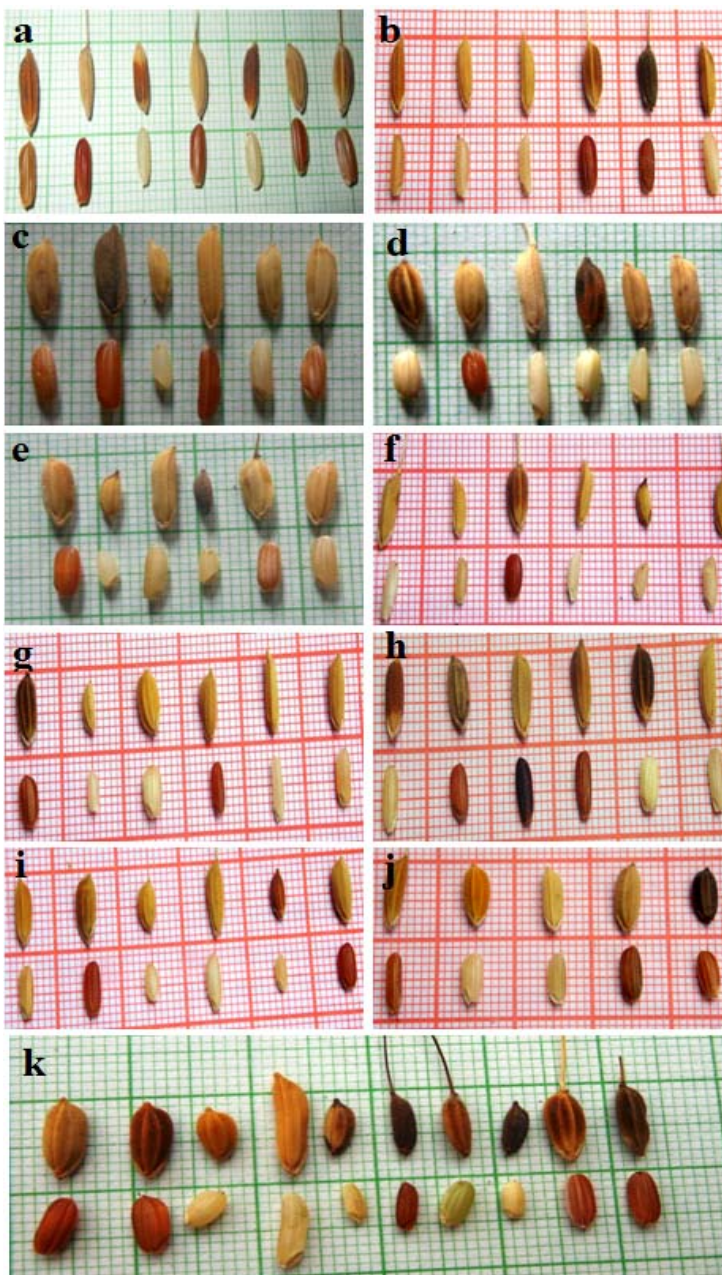
Fig. 1. Anthocyanin Colorations of 55 rice landraces (Left to Right): a - Jamaynadu, Neta, Fulpagri, Nagrasal, Malsira, Valki, Panati, b - Nikunja, Kalamkati, Badamsaru, Like-kakua, Kelesh and Fulkahr, c - Talmugurdhan, Kaksal, Gayasur, Lunishree, Kartiksal, Jamaybichi, d - Bachi, Seshphal, Kabiraj, Barani, Narkeljhopa, Bhudep, e - Chotodidi, Radhatilak, Mahananda, Kalojira, Murkimala, Jaladhi, f - Suakalma, Kataribhog, Kakua, Dhuderswar, Badshabhog, Gangajali, g - Malabati, Danarguri, Nugembaro, Chandrakanta, Daharlagra, Dharansal, h - Bahurupi, Bhuri, Kalobhat, Sindurmukhi, Bachi, Byamajhupi, i - Raghusal, Bhadoi, Baskamini, Rupsal, Lalbadshabhog, Agniban, j - Sitasal, Kheuch, Khajurchari, Langalmura, Kalobayar, k - Nona bogra, Laltipa, Marichsal, Patnai-23, Gobindabhog, Kalonunia, Kankchur, Tulsibhog, Like-kakua, Vutmuri.

Table 3. Grain morphological characteristics of rice landraces of Lateritic region

Name of landraces	WT	GL	GW	DL	DW	S	AW	AWC	LPC	DC	AR	GLB	KLB
Agniban	3	2	3	1	2	2	1	NA	1	3	1	3.07	2.39
Badshabhog	1	2	2	1	2	2	1	NA	3	1	3	2.81	2.00
Bachi	3	2	4	1	3	2	1	NA	4	1	1	2.22	1.83
Bahurupi	4	3	3	2	2	3	1	NA	4	1	1	3.39	2.8
Badamsaru	2	3	2	2	2	4	1	NA	1	1	1	3.95	3.15
Baskamini	1	1	2	1	2	2	1	NA	4	1	2	2.43	2.15
Byamajhupi	3	3	2	2	2	4	2	1	1	1	1	3.77	3.03
Bhuri	4	3	4	1	3	2	1	NA	4	6	1	2.52	2.14
Bhadoi	3	2	3	1	2	3	1	NA	2	3	1	2.98	2.51
Barani	3	2	3	1	2	2	2	1	4	1	1	3.08	2.43
Chotodidi	5	2	4	1	3	2	1	NA	1	3	1	2.57	1.99
Chandrakanta	3	3	3	1	3	2	1	NA	2	5	1	3.30	2.28
Dharansal	3	3	3	2	2	2	1	NA	1	1	1	3.37	2.77
Daharlagra	2	3	2	2	1	6	1	NA	1	1	1	4.45	4.11
Danarguri	1	2	2	1	3	2	1	NA	1	1	3	3.00	1.84
Dudherswar	3	2	2	2	1	4	1	NA	1	1	2	3.81	3.44
Fulkhar	3	3	2	2	2	5	2	1	1	1	1	3.82	2.95
Fulpagri	2	2	2	1	2	3	1	NA	7	1	1	3.50	2.77
Gangajali	2	2	2	2	1	4	2	1	2	1	1	3.81	3.44
Jamainadu	3	3	3	2	2	5	1	NA	5	1	2	2.86	2.86
Kakua	4	2	4	1	3	2	2	1	4	2	1	2.51	2.24
Kaksal	5	3	4	2	3	5	1	NA	5	5	1	2.91	2.43
Kalamkati	3	3	2	2	1	4	1	NA	1	1	1	3.91	3.18
Kalobhat	4	3	4	2	3	5	1	NA	1	9	2	3.12	2.59
Kalojira	1	2	2	1	1	2	1	NA	10	1	3	2.86	2.15
Kalobayar	3	2	4	1	3	2	1	NA	10	2	1	2.40	1.96
Kanakchur	2	2	3	1	3	2	2	4	4	1	3	2.53	2.42
Kartiksal	2	2	2	1	2	2	1	NA	1	1	1	3.09	2.39
Kataribhog	1	2	1	1	1	1	1	NA	1	1	2	4.33	3.62
Kelesh	2	2	3	1	2	2	1	NA	10	2	1	2.80	2.20
Khajurchari	4	2	3	1	2	3	2	2	1	1	1	3.15	3.00
Kheuch	4	2	4	1	3	2	1	NA	5	1	1	2.51	2.01
Lalbadshabhog	1	2	2	1	1	2	1	NA	6	1	3	2.92	2.21
Langalmura	5	3	5	2	3	5	1	NA	1	6	1	2.15	2.33
Laltipa	4	2	4	1	3	2	1	NA	4	1	1	2.56	2.03
Malabati	4	3	4	2	3	5	1	NA	4	2	1	2.83	2.46
Malsira	2	3	3	1	2	3	1	NA	6	1	1	3.30	2.67
Marichsal	3	2	3	1	3	2	1	NA	2	1	1	2.20	1.56
Nagrasal	5	2	3	1	2	2	1	NA	2	2	1	3.13	2.02
Narkeljhopa	2	2	2	1	2	2	1	NA	1	1	1	3.42	2.35
Neta	2	3	3	2	2	5	2	1	2	6	1	3.15	2.55
Nikunja	2	2	2	2	3	5	2	1	4	2	1	3.38	2.56
Nonabogra	4	2	4	1	3	2	1	NA	1	6	1	2.82	2.13
Nugenbaro	4	2	5	1	3	2	1	NA	1	2	1	2.33	1.93
Patnai-23	4	4	3	3	2	7	1	NA	1	1	1	4.00	3.77
Raghusal	3	2	2	2	2	4	1	NA	1	1	1	3.50	3.10
Radhatilak	1	2	2	1	1	2	1	NA	1	1	3	3.02	2.37
Rupsal	3	3	2	2	2	4	2	2	6	1	1	3.87	3.20
Sitasal	2	3	2	2	2	2	2	1	6	1	1	3.60	2.04
Sindurmukhi	4	3	3	2	2	5	1	NA	4	2	1	3.42	2.83
Suakalma	4	4	3	2	2	6	2	1	1	1	1	3.88	3.22
Tulsibhog	1	1	2	1	1	2	1	NA	9	1	3	2.79	2.05
Talmugurdahn	5	3	4	2	2	5	1	NA	1	3	1	2.72	2.86
Valki	4	2	4	1	3	2	1	NA	1	3	1	2.48	2.05
Vutmuri	2	2	3	1	2	3	2	2	10	2	1	2.81	2.56

WT: 1000 Grain weight. 1. Very low (<15gm), 2. Low (15-20gm), 3. Medium (21-25gm), 4. High (26-30gm), 5. Very high (>30gm).
GL: Grain length. 1. Very short (<6.0mm), 2. Short (6.1- 8.5mm), 3. Medium (8.6-10.5mm), 4. Long (10.6-12.5mm), 5. Very long (>12.5mm).
GW: Grain width. 1. Very narrow (<2.0mm), 2. Narrow (2.1-2.5mm), 3. Medium (2.6-3.0mm), 4. Broad (3.1-3.5mm), 5.Very broad (>3.5mm).
DL: Decorticated grain length. 1. Short (<6.0mm), 2. Medium (6.1- 8.5mm), 3. Long (8.6-10.5mm), 4. Basmati type (10.6-12.5mm), 5. Etra long (>12.5mm).
DW: Decorticated grain width. 1. Narrow (<2.0mm), 2. Medium (2.0-2.5mm), 3. Broad (>2.5mm).
GLB: Grain length breath ratio. 1. Very low (<2), 2. Low (2.1-2.5), 3. Medium (2.6-3.0), 4. High (3.1-3.5), Very high (>3.5).
KLB: Kernel length breath ratio. 1. Very low (<2), 2. Low (2.1-2.5), 3. Medium (2.6-3.0), 4. High (3.1-3.5), Very high (>3.5).
S: Shape of grain. 1- Short slender 2-Short bold 3-Medium slender, 4-Long slender 5-Long bold 6-Basmati type 7-Extra long slender

Varieties Badshabhog, Tulsibhog, Kanackchur, Danarguri, Gobindabhog poses strong aroma, varieties Baskamini, Kalobhat possesses mild aroma while the rest of the varieties were without aroma. Presence or absence of awn in tip of the palea is another important characteristic of traditional rice cultivars, which is absolutely absent in the present high yielding varieties. Presence of awn is a protective pattern of plant from grazing. Varieties Neta, Panati, Kalonunia, Kanakchur, Like-kakua, Kakua, Suakalma, Gangajali, Byamajhupi consist of considerably long awn and Jamanadu, Nagrasal, Vuatmuri, Kabiraj, Murkimala, Rupsal, Sitasal and Kelesh varieties consist of considerably short awn on the tip of the grain. Colour of awn was also varied form one variety to another, but most of the varieties posses yellowish white coloured awn.

Table 4. Descriptive statistics of 55 rice landraces grain characters used in this study

Variable	Mean	Std. Dev.	Std. Err.	N	Min.	Max.
1000 GW	21.978	5.618	0.758	55	10.1	33.6
GL	8.208	1.063	0.143	55	5.6	11.2
GW	2.708	0.475	0.064	55	1.8	4
GL/GW	3.111	0.561	0.076	55	2.15	4.45
KL	5.815	0.873	0.118	55	3.95	8.3
KW	2.684	2.707	0.365	55	1.6	3.1
KL/KW	2.548	0.539	0.073	55	1.56	4.11

Phenotypic correlation coefficient among quantitative grain characters of the 55 landraces of rice cultivars has given in Table 5. Form the correlation relationship among the grain character, it was observed that character grain length (GL), grain width (GW), kernel length (KL) has significant positive correlations with 1000 grain weight. Character grain length to width ratio have significant correlations with grain length and kernel length width ratio and these characters area again negatively correlated with the grain width. Phenotypic correlation coefficient among quantitative grain characters of 55 landraces of rice cultivars were given in Table 5.

Table 5. Phenotypic correlation coefficient among quantitative grain characters of 55 landraces of rice cultivars (Similarity Matrix (Pearson Correlation)).

	1000 GW	GL	GW	GL/GW	KL	KW	KL/KW
1000 GW	1						
GL	**0.664***	1					
GW	**0.685***	**0.271***	1				
GL/GW	-0.165	**0.481***	**-0.662***	1			
KL	**0.615***	**0.861***	**0.272***	**0.405***	1		
KW	0.077	0.147	0.043	0.076	0.131	1	
KL/KW	0.054	**0.548***	**-0.432***	**0.846***	**0.657***	0.015	1

(*) indicated 0.01 level of significance. Correlation coefficient r>2.652 and r>1.996
are significant at 0.01(two tailed) and 0.05 level (two tailed).

Presence of aroma and shape of grains, these two characters, are most important grain characters of a particular variety and possess maximum economical accretion. Long slender gain with slight aroma have highest market value and as these characters are single gene regulated, plant breeders fail to incorporate those genes in hybrid variety or any other variety in

most of the cases. Thus these characters are a gift of nature and only available on these traditional varieties.

Conclusions

Agromorphic characters of grains are an important pre-criterion for the selection of particular rice variety. Market value and the acceptability of rice variety solely depend upon the grin characteristics of rice variety. There are so many traditional rice varieties still growing in the agricultural fields of lateritic region of West Bengal which possess important grain characters (presence of high aroma, high mineral content, high alkali spreading value etc.) and have high market value also. Badshabhog, Baskamini, Daharlagra, Patnai-23, Lal badshabhog, Kankakchur, Kataribhog, Kalojira, Kalobhat etc. are some of the potential varieties which have large market value and marginal farmers of this region welcome this varieties into their agricultural fields again in spite of having lower productivity.

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