Environment & Ecology 35 (3A) : 1957—1963, July—September 2017
Website: environmentandecology.com ISSN 0970-0420

Diversity of Grain Morphology on Boro Rice (*Oryza sativa* L.) Genotypes

K. Rajendra Prasad, B. Kalyan, K. V. Radha Krishna, L. V. Subba Rao

Received 13 September 2016; Accepted 17 October 2016; Published online 7 November 2016

Abstract Fifty (50) genotypes of boro rice collected from the Indian Institute of Rice Research, Hyderabad were investigated for the grain morphological characters. A wide variation of grain characters like gain size and shape, anthocyanin coloration of lemma-palea and kernel, presence or absence of aroma, awning characteristics were found among the studied varieties. Wide variation among the grain morphological characters indicated wide genetic variation was presented among these genotypes which may be utilized for the selection of the parents for the plant breeding and production of new improved variety.

Keywords Grain morphology, Boro rice, DUS test, Correlation.

K. R. Prasad*
PhD Scholar,
Department of Genetics and Plant Breeding,
College of Agriculture, Professor Jayashankar Telengana State Agricultural University,
Rajendranagar, Hyderabad 500030, Telangana, India
e-mail : krprasad456@gmail.com

B. Kalyan
PhD Scholar,
Department of Genetics and Plant Breeding,
Agriculture College, Bapatla,
Acharya N.G Ranga Agricultural University

K. V. R. Krishna
Professor,
Department of Genetics and Plant Breeding,
College of Agriculture, PJTSAU,
Rajendranagar, Hyderabad 500030, Telangana, India

L. V. S. Rao
Principal Scientist,
Crop Improvement Section,
Indian Institute of Rice Research,
Rajendranagar, Hyderabad 500030, Telangana, India
*Correspondence

Introduction

Boro rice has traditionally been cultivated in the river basins, deltas, chaurs or saucer shaped depressions, where water accumulates during the monsoons but cannot be drained, thus providing ideal settings for boro rice cultivation during winter season. Although, boro rice cultivation has been an old practices in deep water areas, it is only recently that it has emerged as a major break through in enhancing rice productivity, not only in traditional, but also in non-traditional boro rice areas with assured irrigation and modern inputs. The credit primarily goes to the farmers' own initiatives in adopting its cultivation in a big way. But proper research imputs have not been fully exploited by the farmers. It is therefore worthwhile to examine the current scenario and analyse the future concerns. North eastern region is one of the richest reservoirs of traditional rice varieties from the time immemorial. In contrast with the diverse geographical distribution of this region, traditional varieties are also found so diverse.

Table 1. Details of 50 genotypes of boro rice.

Sl. No.	Name of the genotype	Place of the collection	Sl. No.	Neme of the genotype	Place of collection
1	IC-65889	DRR, Hyderabad	26	IC-99143	DRR, Hyderabad
2	IC-67586	DRR, Hyderabad	27	IC-99288	DRR, Hyderabad
3	IC-67589	DRR, Hyderabad	28	IC-99437	DRR, Hyderabad
4	IC-67626	DRR, Hyderabad	29	IC-99445	DRR, Hyderabad
5	IC-67638	DRR, Hyderabad	30	IC-99487	DRR, Hyderabad
6	IC-67729	DRR, Hyderabad	31	IC-99510	DRR, Hyderabad
7	IC-67935	DRR, Hyderabad	32	IC-99512	DRR, Hyderabad
8	IC-70855	DRR, Hyderabad	33	IC-99513	DRR, Hyderabad
9	IC-85969	DRR, Hyderabad	34	IC-99518	DRR, Hyderabad
10	IC-86011	DRR, Hyderabad	35	IC-99520	DRR, Hyderabad
11	IC-86123	DRR, Hyderabad	36	IC-99527	DRR, Hyderabad
12	IC-86142	DRR, Hyderabad	37	IC-137335	DRR, Hyderabad
13	IC-86143	DRR, Hyderabad	38	IC-145194	DRR, Hyderabad
14	IC-86154	DRR, Hyderabad	39	IC-145239	DRR, Hyderabad
15	IC-89079	DRR, Hyderabad	40	IC-145408	DRR, Hyderabad
16	IC-89115	DRR, Hyderabad	41	IC-145632	DRR, Hyderabad
17	IC-89125	DRR, Hyderabad	42	IC-145633	DRR, Hyderabad
18	IC-89138	DRR, Hyderabad	43	IC-145634	DRR, Hyderabad
19	IC-89143	DRR, Hyderabad	44	IC-145635	DRR, Hyderabad
20	IC-98731	DRR, Hyderabad	45	IC-145639	DRR, Hyderabad
21	IC-98734	DRR, Hyderabad	46	IC-145640	DRR, Hyderabad
22	IC-98938	DRR, Hyderabad	47	IC-145643	DRR, Hyderabad
23	IC-98974	DRR, Hyderabad	48	IC-145645	DRR, Hyderabad
24	IC-98997	DRR, Hyderabad	49	IC-145651	DRR, Hyderabad
25	IC-99132	DRR, Hyderabad	50	IC-203562	DRR, Hyderabad

Agro-morphological characterization of traditional rice germplasm varieties is fundamental task 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 rice variety by the farmers is solely depends 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 and these are the main important characters for the classification of rice genotypes according to Bhattacharya et al. [2], Das et al.

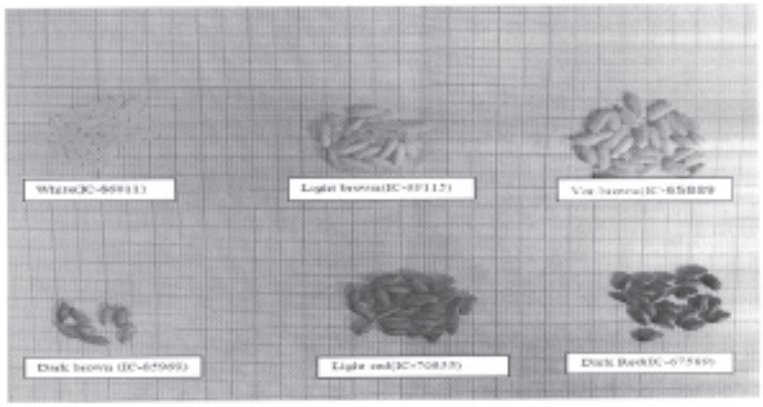

Fig. 1. Variation in decorticated grain color.

Table 2. Various grain characters of rice according to DUS guidelines.

Characters	Descriptors
Grain: weight of 1000 fully developed grains (WT)	1-Very low, 3-Low, 5-Medium, 7-High, 9-Very high
Grain: length (GL)	1-Very narrow, #-Narrow, 5-Medium, 7-Long, 9-Very long
Grain: width (GW)	1-Very narrow, 3-Narrow, 5-Medium, 7-Broad, 9-Very broad
Decorticated grain: length (DL)	1-Very short, 3-Short, 5-Medium, 7-Long, 9-Very long
Decorticated grain width (DW)	1-Narrow, 3-Medium, 5-Broad
Decorticated grain shape (in lateral view) (S)	1-Short slender, 3-Short bold, 5-Medium slender, 7-Long slender 9-Long bold 11-Vasmati type, 13-Extra long selender
Panicle: awns (AW)	1-Absent, 3-Present,
Panicle: color of awns	1-Yellowish white, 3-Black, 5-Yellowish brown, 7-Brown, 9-Reddish brown, 11-Light red.
Panicle: length of longest awn (AWL)	1-Very short, 3-Short, 5-Medium, 7-Long, 9-Very long
Lemma and palea: color (LP)	1-Straw, 3-Gold and gold furrows on straw, 5-Background brown spots on straw, 7-Brown furrows on straw, 9-Brown (tawny), 11-Reddish to light purple, 13-Purple spots on straw, 15-Pruple furrows on straw, 17-Purple, 19-Black
Decorticated grain: color (DC)	1-White, 3-Light brown, 5-Variegated brown, 7-Dark brown, 9-Light red, 11-Red, 13-Variegated purple, 15-Purple, 17-Black
Decorticated grain: aroma (AR)	1-Non Scented, 3-Mild Scented, 5-Strongly scented
Grain length breadth ratio (GLB)	1-Very low, 3-Low, 5-Medium, 7-High, 9-Very high
Kernel length breadth ratio (KLB)	1-Very low, 3-Low, 5-Medium, 7-High, 9-Very high

[3], Kato and Matsunaga [4]. Rice varieties were classified on the basis of grain shape, grain weight and grain dimensions in hulled 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 this 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 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—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 fundamental criteria 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 physicochemical 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 significant in plant breeding program [16]. In this study special emphasis has given on grain morphology of boro rice genotypes.

Materials and Methods

The materials were grown using fifty indigenous rice landraces were collected from IIRR, Hyderabad, 2014 during the *rabi* season and planted in a ICRISAT farm for obtaining various morphological data on grain characters (Table 1). The material were grown using randomized block design with three replications. Each entry was transplanted (25 day's old seedling) in three rows of 2m length at spacing of 20 cm between rows and 15 cm. between plants in a row. A random sample of five competitive plants ware used for observations on different grain characters under study. Various

Table 3. Details of various grain characters of boron rice genotypes of according to DUS guidelines.
WT: 1000 Grain weight. 1. Very low (<15g), 2. Low (15–20 g), 3. Medium (21–25 g), 4. High (26–30 g), 5. Very high (>30g).
GL: Grain length. 1. Very short (<6.0 mm), 2. Short (6.1–8.5 mm), 3. Medium (8.6–10.5 mm), 4. Long (10.6–12.5 mm), 5. Very long (>12.5 mm).
GW: Grain width. 1. Very narrow (<2.0 mm), 2. Narrow (2.1–2.5 mm), 3. Medium (2.6–3.0 mm), 4. Broad (3.1–3.5 mm), 5. Very broad (>3.5 mm).
DL: Decorticated grain length. 1. Short (<6.0 mm), 2. Medium (6.1–8.5 mm), 3. Long (8.6–10.5 mm), 4. Basmati type (10.6–12.5 mm), 5. Etra long (>12.5 mm).
DW: Decorticated grain width. 1. Narrow (<2.0 mm), 2. Medium (2.0–2.5 mm), 3. Broad (>2.5 mm).
GLB: Grain length breath ratio. 1. Very low (<2), 2. Low (2.1–2.5), 3. Mediun (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.

IC No.	WT	GL	GW	DL	DW	S	AW	AWC	LPC	DC	AR	AC	GT
IC-65889	5	3	5	3	5	7	3	1	1	5	1	3	1
IC-67586	1	5	7	3	5	3	1	NA	7	5	1	3	3
IC-67589	3	3	5	1	1	7	3	1	1	11	1	3	3
IC-67626	7	3	5	3	5	7	1	NA	1	11	1	3	5
IC-67638	5	3	5	1	5	3	1	NA	1	11	1	3	5
IC-67729	5	3	5	1	1	7	1	NA	1	11	1	3	3
IC-67935	5	3	5	3	5	3	1	NA	5	11	1	5	5
IC-70855	3	3	5	3	5	3	1	NA	7	9	1	5	5
IC-85969	5	3	5	3	5	3	3	17	5	7	1	5	1
IC-86011	3	5	5	3	5	3	1	NA	7	1	1	5	3
IC-86123	3	3	5	5	5	9	3	NA	7	1	1	5	3
IC-86142	3	1	3	1	5	3	3	1	7	1	1	5	3
IC-86143	7	3	5	3	5	3	3	7	1	1	1	5	7
IC-86154	3	3	5	3	5	3	1	NA	1	11	1	5	3
IC-89079	1	5	5	5	5	5	3	1	7	1	1	5	1
IC-89115	1	5	5	3	1	9	3	NA	1	3	1	5	1
IC-89125	5	3	5	1	5	3	1	15	7	11	1	3	1
IC-89138	3	5	5	5	1	9	1	NA	7	3	1	3	1
IC-89143	5	3	5	3	5	3	1	NA	7	9	1	5	3
IC-98731	3	3	5	3	5	7	1	NA	7	3	1	5	3
IC-98734	3	3	5	3	5	7	1	NA	7	3	1	5	3
IC-98938	1	5	5	5	1	5	3	1	7	9	1	5	3
IC-98974	3	3	5	3	5	7	1	NA	7	9	1	7	3
IC-98997	5	3	5	3	3	7	1	NA	7	11	1	7	5
IC-99132	5	5	5	3	5	7	1	NA	7	3	1	5	3
IC-99143	3	3	5	3	5	3	1	NA	5	7	1	5	3
IC-99288	3	3	5	3	5	3	1	NA	7	9	1	5	1
IC-99437	3	3	5	3	5	3	1	NA	7	9	1	5	1
IC-99445	5	3	5	1	3	3	3	1	1	9	1	5	1
IC-99487	5	3	5	3	5	3	3	1	7	9	1	5	1
IC-99510	3	3	5	3	5	3	3	1	7	9	1	5	3
IC-99512	1	3	5	1	3	3	3	1	1	9	1	5	3
IC-99513	3	3	5	3	3	7	3	1	7	9	1	5	3
IC-99518	5	3	5	3	5	3	1	NA	7	9	1	5	7
IC-99520	5	3	5	3	3	3	1	NA	7	9	1	5	5
IC-99527	5	3	5	1	5	3	1	NA	7	9	1	5	3
IC-137335	3	3	5	3	3	7	1	NA	7	7	1	5	5
IC-145194	5	3	5	1	3	3	1	NA	1	9	1	5	1
IC-145239	5	3	5	3	3	3	1	NA	7	1	1	5	1
IC-145408	5	3	5	3	5	3	3	1	7	9	1	7	3
IC-145632	5	3	5	1	5	3	1	NA	7	3	1	7	3
IC-145633	5	3	5	3	5	7	1	NA	7	9	1	7	1
IC-145634	7	3	5	3	3	7	1	NA	7	9	1	3	1

Table 3. Continued.

IC No.	WT	LG	GW	LD	DW	S	AW	AWC	LPC	DC	AR	AC	GT
IC-145635	3	3	5	3	5	3	1	NA	5	9	1	3	1
IC-145639	7	3	3	3	3	3	1	NA	7	3	1	3	3
IC-145640	3	3	3	3	1	7	1	NA	1	3	1	5	3
IC-145643	5	3	5	3	1	3	3	1	5	3	1	5	3
IC-145645	7	3	5	1	3	3	3	NA	7	3	1	5	3
IC-145651	1	5	5	3	5	3	1	NA	7	3	1	5	1
IC-203562	3	5	5	3	3	7	1	1	5	3	1	5	1

morphological characters of grains was taken as per the guideline of DUS test was reported by Shobharani [17] and given in Table 2.

Results and Discussion

Various qualitative and quantitative grain morphological characters of boro rice have given in Table 3. The variation of grain length of studied 50 genotypes of rice ranged from 5.23 to 8.98 mm, grain width form 2.01 to 3.12 mm, kernel length form 3.52 to 7.90 mm, kernel breadth form 1.35 to 2.53 mm. length to width ratio of grain varied from 3.01 to 5.32 and kernel length to width varied from 2.66 to 4.49 and 1000-grains weight from 11.18 to 27.78 g. The maximum and minimum value and other statistical value of quantitative morphological characters of grain are shown in Table 4. On the basis of kernel (decorticated grain) length and length breadth ratio only one genotype shows medium slender (IC-89079) and 3 genotypes shows long bold (IC-86123, IC-89115 and IC-89138), 15 genotypes shows long slender and the remaining 31 genotypes fall into short bold type of grain shape in lateral view. Lemma and palea 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 possessed straw color hull while purple and black hull color is rare. The kernel color (pericarp or decorticated grain) was also consist of 9 categories among them white kernel color was found abundant among the studied landraces, only six genotypes i.e. IC-86011, IC-86123, IC-86142, IC-86143, IC-89079 and IC-145239 shows white kernel coloration, two genotypes namely IC-65889 and IC-67586 possess variegated brown coloration (Fig. 1). Another important grain character is presence or absence of aroma all genotypes were without aroma 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. Presence or absence of awn in tip of the palea is another important characteristics 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 genotypes IC-85969, IC-86142, IC-89115 and IC-99513 consist of considerably long awn and genotypes IC-67729, IC-86011, IC-99132 and IC-145639 consist of considerably short awn on the tip the grain. Color of awn was also varied form one variety to another but most of the varieties posses yellowish white colored awn.

Table 4. Mean, standard deviation standard error and minimum and maximum value of grain characters of 50 boro rice genotypes.

Variable	Mean	Sd	SE	N	Min	Max
1000GW	20.19	3.99	0.56	50	11.18	27.78
GL	6.77	0.73	0.10	50	5.23	7.98
GW	1.58	0.11	0.01	50	1.35	1.79
GL/GW	4.29	0.53	0.07	50	3.01	5.32
KL	4.91	0.65	0.09	50	3.52	6.90
KW	1.42	0.10	0.01	50	1.25	1.65
KL/KW	3.40	0.36	0.05	50	2.66	4.49

Table 5. Phenotypic correlation coefficient among quantitative grain characters of 50 boro rice cultivars [Similarity Matrix (Pearson Correlation)].

	1000GW	GL	GW	GL/GW	KL	KW	KL/KW
1000-GW	1.0						
GL	0.36**	1.0					
GW	-0.05	0.10	1.0				
GL/GW	-0.07	0.81**	-0.47**	1.0			
KL	0.48**	0.71**	-0.10**	-0.68	1.0		
KW	-0.09	0.15	0.88**	-0.36**	-0.01	1.0	
KL/KW	-0.02	0.59**	-0.15	0.60**	0.86**	-0.07	1.0

Phenotypic correlation coefficient among quantitative grain characters of 50 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), kernel length (KL) have significant positive correlation with 1000 grain weight, Character grain length to width ratio have significant positive correlation with grain length and kernel length and these characters area again negatively correlated with the grain width. Phenotypic correlation coefficient among quantitative grain characters of 50 landraces of rice cultivars were given in Table 5.

Conclusion

Presence of aroma and shape of grain, 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 gift of nature and only available on these traditional varieties.

References

1. Lin MS (1991) Genetic base of japonica rice varieties released in Taiwan. Euphytica 56 : 43—46.
2. Bhattacharya KR, Sowbhagya CM (1980) Size and shape classification of rice. RISO 29 : 181—185.
3. Das GR, Ahmed T, Bhattacharjee BC (1983) Classifications of grain shape and relationship between grain weight and grain dimensions in hulled rice. Ind J Agric Sci 53 : 744—751.
4. Kato T, Matsunaga R (1990) Image analysis of shape as a new technique for selection, report of the Tohoku Branch. The Crop Sci Soc Japan 33 : 85—86.
5. Vanaja T, Babu LC (2006) Variation for grain and quality characteristics in rice (*Oryza sativa* L.). Ind J Genet and Pl Breed 66 : 13—15.
6. Satoh H, Ching HM, Ilaila D, Katayama IC (1990) On distribution and grain morphology of cultivated rice collected in Tanzania, 1988. Res Center for the South Pacific, Kagoshima Univ, Occasional Papers 18 : 114—126.
7. Satoh H, Ching HM, Ilaila D, Katayana TC (1990) Distribution and grain morphology of wild rice collected in Tanzania, 1988. Res Center for the South Pacific, Kagoshima Univ. Occasional Papers 18 : 38—62.
8. Satoh H, Roland RX, Katayama TC (1990) On distribution and grain morphology of cultivated rice collected in Madagascar, 1988. Res Center for the South Pacific, Kagosima Univ. Occasional Papers 18 : 63—72.
9. Satoh H, Roland RX, Katayama TC (1990) Distribution and grain morphology of wild rice collected in Madagascar, 1988. Res Center for the South Pacific, Kagosima Univ. Occasional Papers 18 : 18—37.
10. Sario Y (2000) Integration of biodiversity and genome technology for crop improvement. National Inst Agrobio Resources. Tsukuba, Japan, pp 181.
11. Anonymous (2007) Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on Rice (*Oryza sativa* L.). Prot Pl Varieties and Farmers' Rights Authority, New Delhi, pp 1—24.
12. Sinha AK, Mishra PK (2012) Agronomic evaluation of

landraces of rice (*Oryza sativa* L.) of Bankura district of West Bengal. Columban J Life Science 13 : 35—38.
13. Sinha AK, Mishra PK (2013) Agro-morphological characterization of rice landraces variety (*Oryza sativa* L.) of Bankura district of West Bengal. Res Pl Biol 3 : 28—36.
14. Sinha AK, Mishra PK (2013) Agromorphological characterization and morphology based genetic diversity analysis of landraces of rice variety (*Oryza sativa* L.) of Bankura district of West Bengal. Int J Curr Res 5 : 2764—2769.
15. Sinha AK, Mishra PK (2013) Morphology based multivariate analysis of phenotypic diversity of landraces of rice (*Oryza sativa* L.) of Bankura district of West Bengal. J Crop and Weed 9 : 115—121.
16. Sinha AK, Mishra PK (2015) Identification of genetically distant rice genotypes for selection based crop improvement from rice landraces of red and lateritic region of West Bengal through cluster analysis. Am Euras J Agric & Environ Sci 15 : 411—414.
17. Shobha Rani N, Shobha Rao LV, Viraktamath BC, Mishra B (2004) National Guidelines for the Conduct of Tests for Distinctiveness, Uniformity and Stability. Directorate of Rice Research, pp 6—13.