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Characterization of Landraces of rice following DUS guidelines

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For the establishment of the distinctness among fifty one landraces of rice, forty six characters were used. Characterization of fifty one landraces of rice was done using 46 agro-morphological traits following Distinctiveness, Uniformity and Stability test (DUS) during kharif season of 2008 2009 and 2010 at the Zonal Adaptive Research Station, Krishnagar, Nadia, West Bengal. Out of fifty one varieties studied, twenty seven were found to be distinctive on the basis of twenty two essential and twenty four additional characters. This study will be useful for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes for crop improvement and also to seek protection under Protection of Plant Varieties and Farmer's Rights Act.

Key words: Rice landraces, Characterization, DUS test, varieties PPV & FR Act

To meet the continuously expanding needs of varietal improvement, the assemblage, evaluation, preservation and characterization of the entire existing germplasms are essential to more rewarding breeding efforts (Chatterjee *et al*. 2007). Until a collection has been properly evaluated, it has little practical use (Chang, 1976). India has a rich and diverse genetic wealth of rice. It has been estimated from various surveys that nearly 50,000 of rice is still being grown in the country (Roy *et al*. 1985). The switch-over to high-yielding varieties with the spread of modern agriculture now posed a great threat to the security of the age-old practice of growing traditional varieties and landraces which may have immense potential for different important traits (Richharia, 1979, Sharma *et al*., 1987, Patra, 2000). In order to prevent further gene erosion, collection and conservation of such invaluable genetic resources of rice is essential. Characterization should eventually lead to a system of recording and storing useful data that can be readily retrieved and made available to others and help in planning breeding programmes (Debas *et al*. 1994). Characterization of variety is useful to identify and avoid duplication. Qualitative traits being more stable over generations (Raut, 2003) hence are reliable for characterization of varieties.

Being signatory to the general agreement on Trade and Tarrifs, Government of India has enacted its sui generis system Protection of Plant Varieties and farmers Right Act(PPV&FRA), 2001 for providing protection to plant varieties based on distinctiveness, uniformity and stability (DUS) test apart from novelty. Therefore the characterization of a variety is prerequisite. Identification of plant varieties of common knowledge is essential for the protection of new plant varieties. Article 15.3(b) of the PPV&FR Act states that the

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new variety must be clearly distinguishable by one or more essential characters from any variety whose existence is a matter of common knowledge at the time of seeking protection. The uniqueness of a variety is to be established by the test called DUS.

A variety is deemed distinct if it is clearly distinguishable in at least by one essential character from the varieties of common knowledge in any country at the time of filling the application. "Varieties of common knowledge" means those varieties which have been the subject of plant variety protection in any country which have been entered in NPVR or such other approved National Register of any country, which are covered under an application before the RGPV and likely to be granted registration, which are in cultivation, which are included in a recognized reference collection or which are described in any publication. "Essential characters" are defined as heritable traits of a plant variety which are determined by the expression of one or more genes or other heritable determinants that contribute to the principal features, performance or value of the plant varieties, e.g., yield, abiotic resistance, quality etc.

Keeping in view of these facts, the present investigation was planned to characterize a set of *aman* rice genotypes of West Bengal, to understand *in situ* variability of different agromorphological traits and interrelationship among them.

Materials and Methods

Fifty one landraces of rice (Table 1) were grown in a randomized complete block design with two replication s at the research farm of Zonal Adaptive Research Station, (23˚24'N latitude and 88˚31'E longitude with an altitude of 9.75 meters above mean sea level) Krishnagar, Nadia, West Bengal, India during kharif season of three consecutive years of 2008, 2009 and 2010. The soil reaction gives a slightly acidic pH of 6.0, with low soluble salts (EC of 0.15 dS m^{-1}**),** medium organic carbon content (0.57%), Total N (0.056%), medium in available P (25.28 kg ha^{-1}) and K (148.77 kg ha^{-1}). The experimental site belongs to tropical humid climate having the average rainfall of 1464 mm, most of the amount falls in between June to September. The minimum temperature reaches 7.6˚C in the month of January and the maximum 41.1˚C in the month of May. It has been observed that 74.7% of the annual rainfall is obtained during June to September and more than 83.6% during June to October. The materials were transplanted in 3.0×2.85m^2 plot with plant to plant spacing 15 cm within a row and row to row spacing of 20 cm. plot to plot distance was 60 cm. A random sample of five competitive plants was used for observations on different traits under study. Crop was raised following recommended package of practices. Fertilizers ($N:P_2O_5:K_2O$) @ 50:25:25 kg ha^{-1} were applied.

Among the qualitative trait, forty six (22 essential and 24 additional) visually assessed characteristics were observed according to the National Test Guidelines for DUS test in rice which was developed by Directorate of Rice Research (Rajendarnagar, Hyderabad) in consultation with the National core group experts for development of National guidelines in crop plants and also with the rice experts (Table 2 and 3). The observation of various characteristics was recorded at different stages of growth with appropriate procedures as per the DUS test guidelines of PPV & FR Act, 2001. The various stages with their respective codes are like First leaf through coleoptile (10DAT), Booting stage (40DAT), First spikelet of inflorescence just visible (50DAT), ½ of inflorescence emerged (55DAT), Beginning of anthesis (60DAT), Anthesis half-way (65DAT), Milk development (70DAT), Dough development (80DAT), Ripening (90DAT) and Caryopsis hard (92DAT).

The issue of ownership over the varieties became alive only after an international body UPOV (Convention of the Union for the Protection of New varieties of Plants) was established in Paris in 1961. The UPOV aims to ensure protection of varieties by the grant of an exclusive right on the protected new plant

varieties on the basis of a set of uniform and clearly defined principle (Dutefield, 2001).

Like UPOV, in PPV and FR Act, a variety must fulfil the criteria of Distinctiveness, Uniformity, Stability and novelty (if new) so as to get protection under this act (Anon, 2001). There are 62 (29 essential and 33 additional) morpho-physiological DUS descriptors for rice which are specific and recommended procedures for conducting DUS traits. Plant morphological DUS descriptors have been the universally undisputed descriptors applied for DUS testing of crop varieties.

Table 1. List of various cultivars with their respective codes and their source of collection

Code	Name of the cultivars	Place of Collection	Code	Name of the cultivars	Place of Collection
G1	Ranisal	Z.A.R.S.	G27	Laldhusri	Z.A.R.S.
G2	Badhabna	,,	G28	Malliksal	,,
G3	Machkata	,,	G29	Baidjhulur	,,
G4	Laldhula	,,	G30	Jhulur	,,
G5	Dhuladhan	,,	G31	Manikanchan	,,
G6	Dhuri	,,	G32	Nagra	,,
G7	Kalamkathi(W)	,,	G33	Danaguri	,,
G8	Suakalma	,,	G34	Majhisal	,,
G9	Nakrasal	,,	G35	Basmoti Local	,,
G10	Asanlaya(white)	,,	G36	Netaisal	,,
G11	Asanlaya(red)	,,	G37	Sankarkalma	,,
G12	Pubalgara	,,	G38	Rupsal	,,
G13	Daharnagra	,,	G39	Jhingasal	,,
G14	Kalonunia	,,	G40	Sungakalma	,,
G15	Tulsibhog	,,	G41	Jhuli	,,
G16	Mashisladan	,,	G42	Raja Badsa	,,
G17	Dudhkalama	,,	G43	Kalma	,,
G18	Sankarsal	,,	G44	Sunga Nagra	,,
G19	Badsabhog	,,	G45	Kerala Sundari	,,
G20	Agnisal	,,	G46	Balaramsal	,,
G21	Chadrakanta	,,	G47	Danga	,,
G22	Muktasal	,,	G48	Asanlaya	,,
G23	Punjabsal	,,	G49	Lalhusri	,,
G24	Sitasal	,,	G50	Annanda	,,
G25	Behalsal	,,	G51	Sarkele(aman)	,,
G26	Kabirajsal	,,	*Z.A.R.S : Zonal Adaptive Research Station, Nadia, West Bengal		

Table 2. Essential (asterisked) characters along with descriptor

	Character	Descriptor code and name					
1	Basal leaf : sheath colour	Green	Light purple	Purple lines	Purple		
2	Leaf : pubescence of blade surface	Absent	Weak	Medium	Strong	Very strong	
3	Leaf : auricles	Absent	present				
4	Leaf : anthocyanin colouration of auricles	Colourless	Light purple	Purple			
5	Leaf : shape of ligule	Truncate	Acute	Split			

6	Leaf : colour of ligule	Green	Light purple	Purple			
7	Flag leaf : attitude of blade (early observation)	Erect	Semierect	Horizontal	Deflexed		
8	Flag leaf : attitude of blade (late observation)	Erect	Semierect	Horizontal	Deflexed		
9	Time of heading (50% of plants with heads)	Very early	Early	Medium	Late	Very late	
10	Lemma : anthocyanin colouration of apex	Absent	Weak	Medium	Strong	Very strong	
11	Spikelet : colour of stigma	White	Light green	Yeallow	Light purple	Purple	
12	Stem length: (excluding panicle; excluding floating rice)	Very short	Short	Medium	Long	Very long	
13	Stem : anthocyanin colouration of nodes	Absent	Present				
14	Panicle : length of main axis	Very short	Short	Medium	Long	Very long	
15	Panicle : curvature of main axis	Straight	Semistraight	Drooping	Deflexed		
16	Panicle : colour of awns (late observation)	Yeallowish white	Yeallowish brown	Brown	Redish brown	Light red	Red
17	Spikelet : density of pubescence of lemma	Absent	Weak	Medium	Strong	Very strong	
18	Spikelet : colour of tip of lemma	White	Yeallowish	Brown	Red	Purple	Black
19	Panicle : awns	Absent	Present				
20	Panicle : distribution of awns	Tip only	Upper half only	Whole length			
21	Panicle : attitude of branches	Erect	Erect to semierect	Semi erect	Semierect to spreading	Spreading	
22	Panicle : exsertion	Partly	Mostly	Well			

Table 3. Additional Characters along with their descriptor

	Character	Descriptor code and name							
1	Coleoptile : colour	Colourless	Green	Purple					
2	Leaf : intensity of green colour	Light	Medium	Dark					
3	Leaf : anthocyanin colouration	Absent	Present						
4	Leaf : distribution of anthocyanin colouration	On tips only	On margins only	In blotches	Uniform				
5	Leaf sheath:anthocyanin colouration	Absent	Present						
6	Leaf sheath : intensity of anthocyanin colouration	Very weak	Weak	Medium	Strong	Very strong			
7	Leaf : collar	Absent	Present						
8	Leaf : anthocyanin colouration of collar	Absent	Present						
9	Leaf : ligule	Absent	Present						
10	Leaf : length of blade	Short	Medium	Long					
11	Leaf : width of blade	Narrow	Medium	Broad					
12	Culm : attitude	Erect	Semi erect	Open	Spreading				

13	Lemma : anthocyanin colouration of keel	Absent	Weak	Medium	Strong	Very strong			
14	Lemma : anthocyanin colouration of area below apex	Absent	Weak	Medium	Strong	Very strong			
15	Stem : Thickness	Thin	Medium	Thick					
16	Stem : intensity of anthocyanin colouration of nodes	Weak	Medium	Strong					
17	Stem : intensity of anthocyanin colouration of internodes	Absent	Present						
18	Panicle : number per plant	Few	Medium	Many					
19	Lemma and palea : colour	Straw	Gold& gold furrows	Brown spots	Brown furrows	Brown(tawny)	Reddish to light purple	Purple spots	Purple furrows
20	Panicle : length of longest awn	Very short	Short	Medium	Long	Very long			
21	Panicle : presence of secondary branching	Absent	Present						
22	Panicle : secondary branching	Weak	Strong	Clustered					
23	Time of maturity	Very early	Early	Medium	Late	Very late			
24	Leaf senescence	Early	Intermediate	Late					

Results and Discussion

Qualitative characters are considered as marker characters in the identification of landraces of rice, which are less influenced by environmental fluctuations. The work on inheritance and linkage studies of qualitative characters was reviewed by Raut (2003). The published work (Satyavathi *et al*., 2004, Gupta *et al*. 2010) also substantiated that the flower colour, presence and absence of pod hair, colour of hair, seed colour were the most stable characters across the agro-climatic zones. To establish distinctiveness among rice cultivars, 46 characters have been used

Regarding leaf characteristics (Table 4), intensity of green colour was dark in 17 cultivars. Out of 51 cultivars, 25 cultivars had leaf anthocyanin colouration. Among 25, variety G28 is distinct for having uniform distribution of anthocyanin colouration. Anthocyanin colouration in leaf sheath was present in 18 cultivars, out of which, 3 cultivars (G6, G36 and G41 had medium, 5 cultivars (G7, G2, G20, G49 and G29) had weak intensity of anthocyanin colouration. Three cultivars (G22, G28 and G48) were found to be distinct for having strong pubescence while 7 cultivars were marked for absence of pubescence in leaf blade.

Seven cultivars were distinguished for absence of leaf auricle (G7, G8, G16, G18, G23, G25 and G45). Out of rest 44 varieties, 6 varieties (G17, G21, G24, G39, G41 and G51 were marked for having purpled coloured auricle. Leaf collar was absent in two cultivars viz., G20 and G45. Out of 49 cultivars, 6 cultivars (G5, G21, G30, G41, G46 and G51) were distinguished for having anthocyanin colouration both in leaf auricle and leaf collar (Table 4).

Regarding leaf ligule shape, variety G49 was distinct for having truncate ligule shape. Six varieties (G12, G14, G15, G24, G42 and G45) were distinguished for having acute ligule shape. . Rest varieties had split shaped ligule. Two cultivars viz. G20 and G45 were marked for absence of leaf ligule among 51 cultivars. Six cultivars (G6, G7, G21, G23, G37 and G51) were distinguished for having purple coloured ligule (Table 4).

Table 4. Characterization of the cultivars (total 51) as per DUS guidelines

Sl. No.	Cultivars	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
G1	Ranisal	C	G	M	P	IBO	A	-	W	P	C	P	A	P	S	LP	M	M	SE	Ho
G2	Badhabna	G	G	M	P	IBO	P	VW	M	P	C	P	A	P	S	LP	M	M	SE	Ho
G3	Machkata	C	G	D	P	IBO	A	-	W	P	C	P	A	P	S	LP	M	M	Ho	Ho
G4	Laldhula	C	G	M	P	IBO	A	-	M	P	C	P	A	P	S	LP	M	M	SE	Ho
G5	Dhuladhan	P	G	D	A	-	A	-	A	P	C	P	P	P	S	LP	L	B	E	SE
G6	Dhuri	C	G	M	P	IBO	P	M	M	P	C	P	A	P	S	P	M	M	SE	Ho
G7	Kalamkathi	P	G	M	P	IBO	P	W	W	A	-	P	A	P	S	P	S	N	E	SE
G8	Suakalma	C	G	M	A	-	A	-	M	A	-	P	A	P	S	LP	M	M	SE	Ho
G9	Nakrasal	C	G	D	A	-	A	-	W	P	C	P	A	P	S	LP	M	M	SE	Ho
G10	Asanlaya (White)	C	G	M	A	-	P	VW	W	P	C	P	A	P	S	LP	M	M	E	SE
G11	Asanlaya (Red)	C	G	M	P	IBO	A	-	M	P	C	P	A	P	S	LP	L	B	E	SE
G12	Pubalgara	C	G	M	A	-	P	W	A	P	LP	P	A	P	Ac	LP	L	B	E	SE
G13	Daharnagra	G	LP	M	A	-	A	-	A	P	LP	P	A	P	S	LP	M	M	SE	Ho
G14	Kalonunia	C	G	D	P	OMO	A	-	W	P	C	P	A	P	Ac	LP	M	M	SE	Ho
G15	Tulsibhog	C	G	L	A	-	A	-	W	p	LP	P	A	P	Ac	LP	S	N	SE	DF
G16	Mahisladan	C	G	M	A	-	A	-	M	A	-	P	A	P	S	LP	L	B	E	SE
G17	Dudhkalma	C	G	M	A	-	A	-	M	P	P	P	A	P	S	LP	M	M	SE	Ho
G18	Sankarsal	G	LP	L	A	-	A	-	W	A	-	P	A	P	S	LP	S	N	Ho	DF
G19	Badsabhog	C	G	D	A	-	A	-	W	P	C	P	A	P	S	LP	M	M	Ho	Ho
G20	Agnisal	C	G	M	P	OMO	P	W	M	P	C	P	A	A	S	G	M	M	SE	SE
G21	Chandrakanta	C	G	M	A	-	A	-	W	P	P	P	P	P	S	P	M	M	SE	Ho
G22	Muktasal	G	G	D	P	OMO	P	VW	S	P	LP	P	A	P	S	LP	L	B	SE	DF
G23	Punjubsal	P	PL	M	A	-	A	-	W	A	-	P	A	P	S	P	M	M	SE	Ho
G24	Sitasal	C	G	D	P	IBO	A	-	W	P	P	P	A	P	Ac	LP	L	B	SE	Ho
G25	Behalsal	C	G	D	A	-	A	-	M	A	-	P	A	P	S	LP	M	M	E	SE
G26	Kabirajsal	C	G	M	A	-	A	-	A	P	C	P	A	P	S	LP	S	N	SE	Ho
G27	Laldhusri	C	G	D	P	OMO	A	-	M	P	C	P	A	P	S	LP	L	B	E	SE
G28	Malliksal	G	G	D	P	U	A	-	S	P	C	P	A	P	S	LP	L	B	E	SE
G29	Baidjhulur	G	G	D	P	OMO	P	VW	M	P	LP	P	A	P	S	LP	L	B	SE	Ho
G30	Jhulur	G	G	M	P	OMO	A	-	M	P	C	P	P	P	S	G	M	M	E	Ho
G31	Manikanchan	C	G	L	A	-	A	-	W	P	C	P	A	P	S	G	S	N	Ho	DF
G32	Nagra	G	G	M	A	-	P	VW	M	P	C	P	A	P	S	LP	M	M	SE	SE
G33	Danaguri	G	G	M	A	-	P	VW	M	P	C	P	A	P	S	LP	S	N	SE	SE
G34	Majhisal	C	G	M	A	-	P	VW	W	P	C	P	A	P	S	LP	M	M	SE	SE
G35	Basmoti local	C	G	M	A	-	P	VW	W	P	C	P	A	P	S	LP	S	N	SE	SE
G36	Netaisal	C	G	M	P	OMO	P	M	W	P	C	P	A	P	S	LP	M	M	SE	SE
G37	Sankar Kalma	C	G	M	P	OMO	A	-	M	P	LP	P	A	P	S	P	M	M	E	E
G38	Rupsal	C	G	L	A	-	A	-	A	P	C	P	A	P	S	G	M	M	SE	SE
G39	Jhingasal	C	G	M	P	IBO	A	-	M	P	P	P	A	P	S	LP	M	M	E	E
G40	Sungakalma	C	PL	M	P	OMO	A	-	W	P	C	P	A	P	S	LP	L	B	SE	SE

G41	Jhuli	P	PL	M	P	IBO	P	M	A	P	P	P	P	P	S	LP	L	B	SE	SE
G42	Raja Badsa	C	PL	D	A	-	A	-	W	P	C	P	A	P	Ac	LP	L	B	E	SE
G43	Kalma	C	PL	M	P	OMO	P	VW	M	P	C	P	A	P	S	LP	M	M	E	SE
G44	Sunga Nagra	C	PL	D	P	OMO	P	VW	M	p	C	P	A	P	S	LP	M	M	SE	SE
G45	Kerala Sundari	C	PL	M	A	-	A	-	A	A	-	P	A	A	Ac	LP	L	B	E	SE
G46	Baloramsal	C	PL	D	P	OMO	P	VW	M	P	C	P	P	P	S	LP	M	M	SE	SE
G47	Danga	C	PL	M	A	-	A	-	M	P	C	P	A	P	S	G	L	B	SE	SE
G48	Asanlaya	C	PL	D	A	-	A	-	S	P	C	P	A	P	S	G	M	M	E	SE
G49	Lalhusri	C	PL	M	A	OMO	P	W	W	P	LP	P	A	P	Tr	LP	S	M	SE	DF
G50	Annada	C	PL	D	A	IBO	A	-	M	P	C	P	A	P	S	LP	M	M	E	SE
G51	Sarkele aman	G	PL	D	A	IBO	A	-	M	p	P	P	P	P	S	P	M	M	SE	Ho

1.Coleoptile Colour, 2.Basal leaf sheath colour, 3.Intensity of green colour, 4.Anthocyanin Colouration, 5.Ditribution of anthocyanin colouration6.Leaf sheath Anthocyanin Colouration, 7.Intensity of Anthocyanin-Colouration, 8.Pubescence of blade surface, 9.Auricle, 10.Anthocyanin Colouration of Auricle11.Leaf Collar, 12.Anthocyanin Colouration of Collar, 13 Leaf Ligule, 14.Ligule Shape, 15.Ligule Colour16.Length of Leaf Blade, 17.Width of Leaf Blade, 18.Flag Leaf (Early observation), 19.Flag Leaf (Late observation),

Table 5: Characterization of the cultivars (total 51) as per DUS guidelines

Sl. No.	Name of the Cultivar	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1	Ranisal	SE	L	VW	A	A	w	M	M	A	-	A	M	Ss	M	A	w
2	Badhabna	SE	L	W	W	A	LG	M	M	A	-	A	M	Ss	M	A	w
3	Machkata	SE	L	W	W	A	LG	M	Sh	A	-	A	M	Ss	M	M	b
4	Laldhula	E	M	VW	A	A	w	Tn	M	A	-	A	Lg	Ss	M	M	B
5	Dhuladhan	E	L	VW	W	S	LG	M	M	A	-	P	Lg	s	F	S	B
6	Dhuri	O	M	VW	A	A	LG	M	M	A	-	P	M	s	m	W	w
7	Kalamkathi	E	E	VW	A	A	LG	M	Sh	A	-	A	VSh	s	M	W	Y
8	Suakalma	E	L	W	M	A	LG	Tn	Sh	A	-	P	M	D	m	W	Y
9	Nakrasal	E	L	VW	A	A	LG	Tn	M	A	-	A	Lg	D	M	W	Y
10	Asanlaya (White)	E	L	VW	A	A	LG	Tn	Lg	A	-	A	Lg	s	F	W	w
11	Asanlaya (Red)	E	L	VW	A	A	LG	Tn	Lg	A	-	A	Lg	s	F	A	w
12	Pubalgara	E	L	VW	A	A	w	Tk	Lg	A	-	A	Sh	Ss	M	S	Y
13	Daharnagra	E	L	VW	A	A	w	Tn		A	-	A	M	Ss	F	S	Y
14	Kalonunia	SE	L	VW	A	A	w	Tn	VSh	A	-	A	M	Ss	M	W	Y
15	Tulsibhog	E	L	VW	A	A	w	M	M	A	-	A	VLg	s	M	W	Y
16	Mahisladan	E	E	W	A	A	LG	M	Lg	A	-	A	M	s	m	M	B
17	Dudhkalma	SE	L	M	S	A	LG	Tk	Vl	A	-	A	M	s	M	W	b
18	Sankarsal	Sp	E	VW	A	A	w	Tn	Sh	A	-	A	Sh	D	F	W	w
19	Badsabhog	O	L	VW	A	A	w	M	Lg	A	-	A	M	Ss	M	M	w
20	Agnisal	SE	L	VW	A	W	LG	M	M	A	-	A	Lg	Ss	F	S	B
21	Chandrakanta	Sp	M	VW	A	A	LG	M	Lg	A	-	A	M	Ss	F	M	B
22	Muktasal	E	M	S	W	A	LG	Tk	VLg	A	W	A	M	s	F	M	Y
23	Punjubsal	Sp	M	VW	W	S	LG	M	VSh	A	-	A	Sh	s	M	M	P
24	Sitasal	E	L	VW	A	A	LG	Tk	M	A	-	A	Lg	s	M	W	Y
25	Behalsal	SE	E	VW	A	A	LG	Tn	M	A	-	A	Sh	Ss	F	W	w
26	Kabirajsal	E	L	VW	A	A	w	M	M	A	-	A	Lg	Ss	M	W	w

27	Laldhusri	E	E	W	A	A	LG	M	M	A	-	A	VLg	s	F	W	w
28	Malliksal	E	VL	VW	A	A	w	Tk	Lg	A	-	A	Lg	s	M	W	w
29	Baidjhulur	E	VL	VW	A	A	w	Tn	Sh	A	-	A	Lg	Ss	M	W	Y
30	Jhulur	Sp	VL	VW	A	A	LG	Tk	VLg	A	-	A	Lg	Ss	M	M	Y
31	Manikanchan	O	M	VW	A	A	w	Tk	VLg	A	-	A	Sh	D	M	W	w
32	Nagra	Sp	VL	W	A	A	w	M	M	A	-	A	Lg	s	F	W	w
33	Danaguri	O	M	VW	W	A	LG	Tn	Sh	A	-	P	M	Ss	M	W	w
34	Majhisal	O	M	VW	A	A	LG	Tk	Lg	A	-	A	M	s	F	S	B
35	Basmoti local	O	M	VW	A	M	w	Tk	Sh	A	-	A	M	Ss	M	M	Y
36	Netaisal	SE	VL	VW	W	A	Y	Tn	M	A	-	A	VLg	Ss	m	W	Y
37	Sankar Kalma	E	L	VW	A	A	w	M	Lg	A	-	A	Lg	Ss	m	M	B
38	Rupsal	Sp	L	VW	A	A	P	Tk	Lg	A	-	A	Lg	Ss	M	W	P
39	Jhingasal	O	L	VW	A	VS	LG	Tk	Lg	A	-	A	Lg	Ss	M	W	Y
40	Sungakalma	E	L	VW	A	A	w	M	M	A	-	A	Lg	s	M	M	w
41	Jhuli	E	E	W	A	A	w	M	M	A	-	A	VLg	Ss	m	M	w
42	Raja Badsa	O	L	M	A	A	w	Tk	Lg	P	S	P	Lg	Ss	m	W	Y
43	Kalma	Sp	M	VW	W	VS	LG	M	Lg	A	-	A	Lg	Ss	F	M	P
44	Sunga Nagra	Sp	VL	VW	A	A	LG	M	M	A	-	A	VLg	Ss	F	W	w
45	Kerala Sundari	E	E	VW	A	A	w	M	M	A	S	P	VLg	s	M	M	Y
46	Baloramsal	Sp	L	VW	A	A	LG	Tk	M	A	-	A	Lg	D	M	W	Y
47	Danga	SE	L	S	W	A	LG	Tk	M	A	-	A	Lg	Ss	M	M	B
48	Asanlaya	E	VL	VW	A	W	LG	Tk	M	A	-	A	Sh	s	F	W	B
49	Lalhusri	Sp	L	VW	A	W	Y	M	Lg	P	W	P	M	D	M	M	Y
50	Annada	SE	M	S	S	S	LP	Tk	Lg	A	-	A	Lg	s	M	M	B
51	Sarkele aman	O	L	VW	W	VW	P	Tk	Lg	P	W	P	Lg	s	M	M	R

20.Culm-Stem attitude. 21.Time of heading, 22.Anthocyanin Colouration of keel, 23.Anthocyanin Colouration of area below apex, 24.Anthocyanin Colouration of apex, 25.Colour of Stigma. 26.Stem, Thickness, 27.Length, 28.Anthocyanin Colouration of the Node, 29.Intensity of Anthocyanin Colouration the Node, 30.Intensity of Anthocyanin Colouration the Internode31.Length of main axis, 32.Curvature of main axis,33. Number per plant, 34.Density of pubescence of Lemma, 35.Colour of tip of Lemma.

Table 6: Characterization of the cultivars (total 51) as per DUS guidelines

Sl. No.	Name of the Cultivar	36	37	38	39	40	41	42	43	44	45	46
1	Ranisal	Sw	A	-	-	-	P	W	E-S	PE	L	I
2	Badhabna	Sw	A	-	-	-	P	S	SE	ME	M	E
3	Machkata	GG	A	-	-	-	P	S	E-S	ME	L	L
4	Laldhula	GG	A	-	-	-	P	S	E-S	PE	M	I
5	Dhuladhan	b	A	-	-	-	P	S	E-S	PE	L	L
6	Dhuri	Sw	A	-	-	-	P	W	E-S	PE	M	E
7	Kalamkathi	Sw	A	-	-	-	P	W	E	ME	E	E
8	Suakalma	By	A	-	-	-	P	W	E-S	ME	L	E
9	Nakrasal	Bf	A	-	-	-	P	W	E-S	ME	L	E
10	Asanlaya (White)	Sw	A	-	-	-	P	W	E-S	ME	L	E
11	Asanlaya (Red)	Sw	A	-	-	-	P	S	E-S	PE	L	E
12	Pubalgara	Bs	P	Yw	L	UHO	P	W	E-S	ME	L	L
13	Daharnagra	Bf	A	-	-	-	P	S	E-S	ME	L	I

14	Kalonunia	GG	A	-	-	-	P	S	E-S	ME	L	I
15	Tulsibhog	GG	P	b	M	TO	P	W	E-S	WE	L	I
16	Mahisladan	Bf	P	b	VSh	WL	P	W	E-S	ME	E	L
17	Dudhkalma	Pf	A	-	-	-	P	S	E-S	PE	L	L
18	Sankarsal	Sw	A	-	-	-	P	W	E	ME	E	E
19	Badsabhog	Bt	A	-	-	-	P	W	E-S	PE	L	I
20	Agnisal	Bf	A	-	-	-	P	S	E-S	WE	L	I
21	Chandrakanta	Bf	P	Yw	L	TO	P	S	E-S	ME	M	I
22	Muktasal	Sw	P	Yb	L	TO	P	W	E-S	ME	M	L
23	Punjubsal	Bt	P	Yw	M	WL	P	W	E-S	ME	M	L
24	Sitasal	Sw	A	-	-	-	P	S	E	PE	L	L
25	Behalsal	GG	P	Yw	VLg	TO	P	W	E	PE	E	E
26	Kabirajsal	GG	A	-	-	-	P	W	E-S	ME	L	I
27	Laldhusri	GG	A	-	-	-	P	W	E	PE	E	I
28	Malliksal	GG	P	Yw	VLg	TO	P	S	E-S	ME	VL	I
29	Baidjhulur	Sw	A	-	-	-	P	W	E-S	ME	VL	I
30	Jhulur	Bf	A	-	-	-	P	W	E	PE	VL	L
31	Manikanchan	Sw	A	-	-	-	P	W	S-S	ME	M	L
32	Nagra	GG	A	-	-	-	P	W	E-S	ME	VL	I
33	Danaguri	Sw	A	-	-	-	P	W	E	ME	M	I
34	Majhisal	GG	A	-	-	-	P	W	E-S	PE	M	I
35	Basmoti local	Bt	A	-	-	-	P	S	E-S	ME	M	I
36	Netaisal	Bt	A	-	-	-	P	W	E	ME	VL	I
37	Sankar Kalma	Bt	P	B	M	TO	P	W	E	PE	L	I
38	Rupsal	Bs	A	-	-	-	P	W	E	PE	L	L
39	Jhingasal	Bt	A	-	-	-	P	S	E	PE	L	L
40	Sungakalma	Bs	A	-	-	-	P	W	E-S	PE	L	L
41	Jhuli	Bs	A		-	-	P	W	E-S	PE	E	I
42	Raja Badsa	Sw	A	-	-	-	P	W	E-S	ME	L	E
43	Kalma	Pf	P	P	M	TO	P	W	E-S	PE	M	E
44	Sunga Nagra	Sw	P	P	M	TO	P	W	E	WE	VL	I
45	Kerala Sundari	Sw	P	Yw	M	TO	P	W	E-S	PE	E	I
46	Baloramsal	Bs	A	-	-	-	P	W	E-S	WE	L	I
47	Danga	Bf	P	Yw	L	TO	P	W	E-S	WE	L	I
48	Asanlaya	GG	A	-	-	-	P	W	E-S	ME	VE	I
49	Lalhusri	Bs	A	-	-	-	P	S	Sr	WE	L	L
50	Annada	Bt	P	P	VLg	WL	P	W	S-S	WE	M	L
51	Sarkele aman	Bf	P	Yw	M	TO	P	S	E-S	PE	L	L

36.Colour of Lemma and Pelea in Spikelet, 37.Awns, 38.Colour of awns, 39.Length of longest awn,40.Distribution of awn.41.Presence of Secondary Branching, 42.Secondary Branching, 43.Attitude of Branches, 44.Exsertion, 45.Time of Maturity, 46.Leaf Senescence.

A=Absent, Ac=Acute, b=broad, B=black, By=Browm tawny, Bs=Brown spot, Bf=Brown furrows, Pf=Purple furrows, C=Colourless, D=Drooping, D=Dark, Df=deflexed, E=erect, F=Few, G=Green, G=Gold & Gold furrows, Ho=Horizontal, LP=Light purple, L=Light, L=Long, Lg=long, M=medium, ME=Mostlu exserted, N=Narrow, O=Open, OTO=On Tip Only, OMO=On Margins Only, OBO=On Blotches Only, P=purple, PL=Purple Lines, P=Present, PE=Partly exserted, R=Red, S=Strong, S=Split, S=Short, SE=Semierect, S-E=Semierect to Spreading, s=Straight, Ss=Semi Short, Tr=Truncate, U=Uniform, VW=Very Weak, VE=very Early, VLg=Very Long, VL=Very Late, Vsh=Very Short, w=White, W=weak, WE=Well exserted, Y=Yeallowish.

Cultivars viz., G5, G11, G12, G16, G27 G28, G42 and G45 were distinguished for having ling leaf length and broad leaf breadth along with erect early flag leaf attitude. There was not any deflexed flag leaf at early observations but 5 cultivars (G15, G18, G22, G31 and G49) showed deflexed flag leaf attitude at the late observations (Table 4).

In case of time of heading, 7 cultivars (G7, G16, G18, G25, G27, G41 and G45) were distinguished for early category while 7 cultivars viz., G28, G29, G30, G32, G36, G44 and G48 showed very late time of heading. It was very interesting to find out that varieties G30 and G44 with spreading culm attitude showed very late time of heading while cultivars viz., G7, G16, G27 and G41 having early time of heading showed erect culm attitude (Table 5).

Regarding anthocyanin colouration in lemma of spikelet, 3 cultivars viz., G22, G47 and G50 had strong colouration in keel, two cultivars viz., G17 and G50 had strong colouration at the area below apex and three cultivars viz., G5, G23 and G50 had strong anthocyanin colouration at the apex. Cultivars G38 and G51 were distinguished for having purple coloured stigma (Table 5).

In case of stem, cultivars with thick and very long stem were G17, G30 and G31. Besides, cultivars G12, G34, G38, G39, G42, G50 and G51 were distinguished for having thick stem with long stem length. Anthocyanin colouration was found in node of three cultivars viz., G22, G42 and G49, among which G22 had strong colouration. Cultivars G42 and G49 have anthocyanin colouration in internode along G5, G6, G8, G33, G45 and G51.

In explaining the panicle features, cultivars G36 and G41 were distinguished for having very long panicle length along with many panicle numbers per plant with semi straight curvature on the mail axis. Few cultivars like G16, G37 and G42 although having many panicle numbers per plant, have medium to long panicle length of main axis. Drooping curvature on main axis were found in 6 cultivars viz., G8, G9, G18, G31, G46 and G49.

In case of density of pubescence on lemma on spikelets, it was absent in 5 cultivars viz., G1, G2, G11, G24 and G25 but it was very strong in cultivars like G5, G12, G13, G20 and G34 which are very much distinct from the rest varieties. Also, colour of tip of the lemma was purple in varieties like G23, G38 and G43 but red in G51.

A large amount of variations in colour have been found in the colouration of lemma and palea (Table 6).Awn was present in 15 cultivars, out of which, very long awn was found in G25 and G50, long in G12, G21, G22 and G47 and very short in G16. The rest 36 cultivars were lacking this awn. Much variation was found in colouration of the awn (Table 6). Awns were distributed on whole length in G16, G23 and G50, only on upper half in G12 and on tips only in the rest of the cultivars (Table 6).

Secondary branching was present in all the cultivars but strong branching was found in 16 cultivars. Well exertion of panicle was found in 7 cultivars like G15, G20, G44, G46, G47, G49 and G50. Cultivars like G36 and G48 was distinguished for very early time of maturity while 5 cultivars viz., G23, G24, G28, G29, G30, G32 and G44 were distinguished for very late time of maturity. Seven cultivars had early but maximum accessions showed late time of maturity. Leaf senescence was early in 11 cultivars while it was late in 16 cultivars. Cultivars G28, G29, G32, G44 and G48 had intermediate while G30 had late leaf senescence (Table 6).

Studies on quantitative traits have earlier been made by Chakravorty and Ghosh (2011). Maximum plant height (43.0cm) was obtained in variety G51 while minimum (24.0cm) in variety G15. Data on 1000 grain weight among varieties varied from 10.4g (in G26) to 29.91g (in G51). G23 and G24 was recorded the late maturity in days (172.5days) while it was recorded to be shortest with G36 (116 days).

Thus, it is concluded that out of 51 landraces of rice, 27 cultivars were found to be distinctive on the basis of 22 essential and 24 additional characters.

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