

DUS characterization of aromatic rice germplasm

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ABSTRACT: Characterization of 78 aromatic cultivars of rice was done using 29 traits following Distinctiveness, Uniformity and Stability test (DUS) during kharif season of 2013 and 2014 at Norman E. Borlaugh Crop Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India. Out of 78 cultivars studied, 45 were found to be distinctive on the basis of 29 essential 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: Aromatic rice, characterization, distinctness, DUS test, essential characters, novelty, PPV & FR Act, uniformity

Rice is the world's most important food crop and a primary food source for more than one third of world's population (Singh and Singh, 2008). The essence of plant breeding lies in the creation of genetic variation which is a prerequisite for any improvement in crop. The development of one or more varieties depends on the final selection of superior plants by the plant breeder who uses several techniques to create the genetic variation and to select from within that variation (Siddiq, 2002). India has a rich and wide range of 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 introduction of high yielding varieties and the spread of modern agriculture and new technologies 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 (Song *et al.*, 1999, Richharia, 1979 and Sharma *et al.*, 1987). 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. As the existing UPOV models of plant variety protection were not suitable for Indian requirements, the Government of India enacted our own legislation on the "Protection of Plant Varieties

and Farmers Act" (PPV&FRA) in 2001 for providing protection to plant varieties based on distinctiveness, uniformity and stability (DUS) test apart from novelty. This is a unique and model act which gives equal importance to the farmers and breeders and treats them as partners in their efforts for sustainable food security (Patra, 2000). Therefore the characterization of a variety is prerequisite. Thus the process of variety identification includes several steps i.e. identification of a variety, confirmation of the variety, distinctness of the variety from all other in common knowledge, purity of the variety and characterization of the variety which enumerates its full descriptors. The concept of distinctness, uniformity and stability are thus fundamental to the characterization of a variety as a unique creation. The uniqueness of a particular variety is to be established by the test called DUS. The first step to implement our PPV&FR Act provisions is formulation of National Test Guidelines for conducting DUS tests. In this context, an attempt was made to characterize a set of seventy eight aromatic cultivars of rice for 29 essential DUS characters and identify the variability available in the collection (Dutefield, 2001). Microsatellite markers have been characterized with multiallelic nature, codominance inheritance, and relative abundance as well as requiring small quantities of DNA for amplification which have made these markers efficiently applicable in DUS test of rice varieties (Bonow *et al.*, 2009). UPOV has confirmed the application of SSR markers as one of the commonly practical molecular marker systems for the identification of plant varieties (Singh *et al.*, 2004).

MATERIALS AND METHODS

Seventy eight aromatic cultivars of rice (Table 1) were grown in a randomized complete block design with two replications at the Norman E. Borlaugh Crop Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India, situated at 29 degrees N latitude, 79 degree 30" East longitude and altitude of 243.84 m above mean sea level. The soil reaction gives a pH of 8.06. The soil type was clay loam type. Crop was raised following recommended package

of practices. The material was grown in a randomized block design with five checks in two replications during *Kharif* 2013 and 2014. Each cultivar was sown in six rows of 5 m length at spacing of 20 cm between rows and 15 cm between plants. Observations were recorded on ten randomly chosen plants of each genotype per replication for twenty-nine essential DUS traits. Twenty nine essential DUS characteristics were observed according to the National Test Guidelines for DUS test in rice which was developed by Directorate of Rice Research Rajendarnagar, Hyderabad (Rani *et al.*, 2004). The observation of various characteristics was recorded at

Table 1: List of core material (CANP) in the present study

S.No.	Name	CANP No.	S.No.	Name	CANP No.
1	RAU 3043	CANP - 15	40	Karnal Local	CANP -327
2	Maguraphulla	CANP -17	41	Muskan 41	CANP -337
3	Kanika bhog	CANP -51	42	Basmati 37	CANP -339
4	Kapoor kranti	CANP -58	43	Basmati Type 3	CANP -344
5	Adam Chini B	CANP -85	44	Basmati 410	CANP -347
6	Kanak Jeer	CANP - 90	45	Basmati 370	CANP -353
7	Bhanta Phool A	CANP - 91	46	Basmati 6141	CANP -354
8	Kamini Joha	CANP -108	47	Basmati Mahan	CANP -355
9	KDML 105	CANP -121	48	Basmati 5836	CANP -371
10	Co ACC 167 (T167)	CANP -123	49	Basmati 385	CANP -372
11	Haryana Basmati 1	CANP -129	50	Basmati 5874	CANP -375
12	Bindli	CANP -132	51	Basmati 11	CANP -383
13	Improved Sarbati	CANP -139	52	Basmati 138	CANP -385
14	Laldhan	CANP -140	53	Ayepyaung	CANP -403
15	Sathi	CANP -142	54	Binirhen	CANP -404
16	Basmati 386	CANP -151	55	Bong Cay	CANP -406
17	Banspatri	CANP -162	56	Daw Leuang	CANP -410
18	Shyamjeera	CANP -168	57	Guinata	CANP -412
19	Ranbir Basmati	CANP -199	58	Hung-mi-hsiang-ma-tsan	CANP -413
20	Domsaih	CANP -206	59	Hawm Jan	CANP - 416
21	Basmati 564	CANP -210	60	Lua Nhe Den	CANP -421
22	Chimbalate Basmati	CANP -212	61	Longku Labat	CANP -422
23	Basmati 217	CANP -242	62	Niaw Hawm Mali	CANP -427
24	Taroari Basmati	CANP-246	63	Popot	CANP -429
25	Mahisugandha	CANP -250	64	HBC 46	CANP -440
26	Pusa Basmati 1	CANP -251	65	IR 841-85-1-1-2	CANP -444
27	Pusa Basmati 1121	CANP -252	66	Kalimooch (Raipur)	CANP -446
28	Yamini (Basmati CSR 30)	CANP -255	67	IR 62873-2271-16	CANP -463
29	Vasumati	CANP -256	68	IR 62873-238-2-3	CANP -465
30	Basmati Bahar	CANP -260	69	Hasan Serai	CANP -471
31	Basmati 106-12	CANP -261	70	JGL 1798 (Jagithyal Sannalu)	CANP496
32	Lectimachi	CANP -265	71	Kasturi	CANP -500
33	Tarunbhog	CANP -295	72	Kh.sakani	CANP -510
34	Ganjeikalli	CANP -299	73	UPR 3565-10-1-1	CANP -520
35	Neelabati	CANP -302	74	UPR 2828-7-2-1	CANP -521
36	Kalikhasa	CANP -307	75	IR 75428-6-3	CANP -535
37	Improved Pusa Basmati 1	CANP -309	76	IET 18033 (RP 3644-9-5-3-2)	CANP -549
38	PDKV Shriram	CANP -318	77	IET 22787 (RP 4594-121-148-24-11)	CANP 551
39	Dhanaprasad	CANP -325	78	Bas 867	CANP -554

different stages of growth with appropriate procedures as per the DUS test guidelines of PPV & FR Act, 2001. Like UPOV, in PPV and FR Act, a variety must fulfill the criteria of Distinctiveness, Uniformity, Stability and novelty (if new) so as to get protection under this act (Anonymous, 2001). The traits studied were basal leaf sheath colour, pubescence of leaf blade surface, auricles, anthocyanin colouration of auricles, shape of ligule, colour of ligule, culm attitude, time of heading, attitude of flag leaf blade, spikelet: density of pubescence of lemma, anthocyanin colouration of area below apex, colour of stigma, stem length, anthocyanin colouration of nodes, panicle length of main axis, curvature of panicle main axis, number of panicles per plant, colour of tip of lemma, panicle awns, awn colour, distribution of awns, panicle: attitude of branches, panicle exertion, time maturity (days), sterile lemma colour, 100 grain weight, decorticated grain length, decorticated grain width, decorticated grain shape, decorticated grain colour, presence of amylose in endosperm and decorticated grain aroma. Varieties were grouped according to the prescribed grouping characteristics of DUS test guidelines. Eight grouping characteristics have been mentioned in the DUS test guidelines for determining distinctiveness of the varieties. One grouping characteristics viz. presence of amylose in endosperm was monomorphic in the cultivars under study. Thus, grouping of varieties was based only on 7 characteristics, viz. basal leaf sheath colour, time of heading, stem length, decorticated grain length, decorticated grain shape, decorticated grain colour and decorticated grain aroma.

RESULTS AND DISCUSSION

To establish distinctiveness among rice cultivars, 29 essential DUS characters have been used. Qualitative characters are considered as morphological markers in the identification of landraces of rice, because they are less influenced by environmental changes (Raut, 2003). The accurate description of basmati rice varieties is crucial for registration under PPV&FR Act. The identity/profile of a rice variety is to be established by using a set of morphological characteristics prescribed in the DUS test guidelines on rice. Out of the 29 DUS descriptors studied (Table 3), 5 were monomorphic, 3 were dimorphic and 21 were polymorphic.

Regarding leaf characteristics (Table 2), basal leaf sheath colour was green in 69 cultivars, 1 cultivar was found to be distinct for having light purple colour i.e. Maguraphulla while 8 cultivars were purple coloured.

Regarding pubescence of leaf surface, 27 cultivars were glabrous, 32 showed intermediate pubescence and 19 cultivars were pubescent. All 78 cultivars exhibited presence of leaf auricle. 15 out of 78 cultivars shown light purple auricle while 10 shown purple auricle. All the cultivars were having split shape of ligule. Three cultivars namely RAU 3043, Kanak Jeer and Bindli) posses light purple colour of ligule and thus were distinct for this character. Regarding time of heading out of 78 cultivars 15 cultivars are early type, 31 are of medium type, 6 are late and 26 are of very late type. Erect type of flag leaf was observed for 39 cultivars, 26 cultivars showed semi-erect and 12 cultivars have horizontal flag leaf. For density of pubescence of lemma, 29 were of very strong pubescence, 14 were of medium type and 22 have strong pubescence and 12 showed weak pubescence.

Twenty four cultivars showed absence of anthocyanin colouration of area below apex in lemma, 21 cultivars has weak, 14 has medium, 10 has strong and 9 showed very strong anthocyanin colouration. For colour of stigma 62 cultivars shown white, 15 were of purple and only 1 i.e. Domsaih was of light green colour and thus is distinct. With respect to stem length, 5 cultivars showed very short stem length, 15 has short, 25 has medium stem length, 20 has long and 14 has very long stem length.

All the cultivars showed absence for anthocyanin colouration of node. Length of main axis of panicle was very short in 2 cultivars, short in 3, medium in 24, long in 27 and very long in 16 cultivars. Flag leaf was erect type in 16 cultivars, 18 cultivars have semi erect flag leaf and 44 showed horizontal flag leaf. Panicle (curvature of main axis) was straight in 12 cultivars, in 19 cultivars it was semi-straight, 30 cultivars showed deflexed and 17 exhibited drooping panicle curvature.

Colour of tip of lemma was white in 1 cultivar i.e. Basmati Mahan it was distinct for this character, 41 possessed yellowish, 22 showed brown, 1 was purple i.e. Bindli and thus distinct and 13 cultivars showed black coloured lemma tip. Awns were absent in 63 cultivars and 15 were showed presence of awns. Regarding the awn colour, 8 cultivars exhibited yellowish white coloured awns, 3 cultivars were distinguished for yellowish brown awns (Shyamjeera, Taroari Basmati and Kasturi), 2 cultivars were distinct for brown awns (Bindli and Kalimooch) and 3 cultivars (RAU 3043, Kanak Jeer and Banspatri) showed black coloured awn. Awns were present at the tip in 10 cultivars, one cultivar (Haryana Basmati 1) was distinct for showing awns at the upper

Annexure-I

Table 2: Data recorded on DUS characterization of the core group (CANP)

CANP	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	ag	ah	ai	aj	ak	am	an	ao	ap
15	1	2	2	2	3	2	9	3	5	7	5	3	1	5	3	3	6	9	9	1	3	7	4	1	5	3	1	1	9	9	7	8	9	5	9	7	127	38	1.088	1.629
17	3	1	2	1	3	1	9	1	9	9	5	4	1	5	1	3	3	1	-	-	3	7	1	1	7	2	1	9	9	3	5	13	9	9	3	101	22	0.718	1.609	
51	1	2	2	2	3	1	9	3	5	1	1	3	1	3	5	3	2	1	-	-	3	7	1	1	5	1	1	9	9	5	3	18	9	5	63	29	0.152	0.707		
58	1	2	2	1	3	1	9	5	5	9	5	3	1	5	5	3	6	1	-	-	3	7	4	1	7	2	2	9	9	5	5	11	9	5	83	30	0.28	0.472		
85	1	1	2	1	3	1	9	3	5	7	5	4	1	5	5	3	6	1	-	-	5	7	4	1	7	2	1	9	9	5	5	12	9	9	5	100	42	0.452	0.801	
90	1	1	2	1	3	2	5	3	7	9	1	5	1	9	5	5	6	9	1	-	5	7	4	3	5	3	2	9	9	5	5	15	5	9	9	92	46	1.254	1.741	
91	1	1	2	1	3	1	9	5	3	9	5	4	1	5	3	1	1	-	-	3	7	7	1	1	3	2	1	9	9	7	5	14	9	9	7	112	12	0.254	0.741	
108	1	2	2	2	3	1	9	5	3	1	1	3	1	3	5	3	3	1	-	-	3	7	1	1	3	2	1	9	9	5	5	15	9	5	85	17	0.206	0.351		
121	1	3	2	2	3	1	9	3	7	1	1	3	1	3	3	3	3	1	-	-	3	7	1	3	3	3	1	9	9	3	5	14	9	5	3	101	17	0.678	1.317	
123	1	3	2	2	3	1	9	1	9	7	1	4	1	5	1	3	2	1	-	-	3	7	1	1	7	2	1	9	9	3	5	11	9	9	3	98	18	1.496	2.125	
129	1	2	2	2	3	1	5	1	9	3	1	2	1	7	1	3	2	9	1	3	5	7	1	5	3	5	1	9	9	3	5	15	5	1	9	3	68	12	2.18	2.234
132	1	2	2	3	3	2	9	5	7	7	1	4	1	5	3	5	5	9	3	5	5	7	3	1	7	2	1	9	9	5	5	10	9	9	5	106	27	0.918	1.985	
139	1	3	2	1	3	1	5	3	7	1	1	2	1	5	3	7	2	1	-	-	7	7	1	5	5	5	1	9	1	5	5	15	5	5	9	5	104	13	2.426	2.318
140	1	2	2	2	3	1	3	3	9	7	1	4	1	7	5	5	3	1	-	-	7	7	1	1	7	2	2	9	1	5	7	9	3	9	5	181	18	1.878	2.36	
142	4	2	2	1	3	1	3	1	9	9	1	1	1	1	1	1	6	9	1	5	1	7	1	1	7	2	6	9	1	5	7	8	3	1	9	5	53	3	0.942	2.581
151	1	2	2	3	3	1	5	3	9	5	1	3	1	5	3	5	2	1	-	-	5	7	1	3	5	3	1	9	9	7	5	15	5	5	7	66	26	1.612	2.249	
162	1	2	2	3	3	1	9	1	5	7	1	2	1	7	3	5	6	9	1	-	5	7	4	1	5	2	1	9	9	7	7	6	9	1	9	7	120	34	0.922	1.65
168	1	2	2	1	3	1	9	1	3	5	1	2	1	3	5	1	2	9	2	5	1	7	1	1	5	2	2	9	1	3	5	9	9	1	9	3	81	31	0.718	1.409
199	1	1	2	3	3	1	5	3	3	3	1	3	1	9	5	5	3	1	-	-	5	7	1	3	5	3	1	9	1	3	5	10	5	5	9	3	128	43	1.772	2.09
206	1	2	2	1	3	1	3	3	9	1	2	3	1	7	5	5	3	1	-	-	7	7	1	5	5	5	1	9	1	5	7	8	3	5	9	5	78	12	1.304	2.225
210	1	2	2	1	3	1	3	5	5	1	1	5	1	9	5	3	2	1	-	-	5	7	1	3	5	3	1	9	1	5	7	9	3	9	5	100	19	1.38	1.975	
212	4	2	2	1	3	1	5	5	7	1	1	3	1	9	5	7	3	1	-	-	5	7	1	3	5	3	1	9	1	5	5	12	5	5	9	5	131	16	1.716	2.353
242	1	1	2	1	3	1	5	3	9	3	1	3	1	7	3	5	3	9	1	-	7	7	1	3	5	3	1	9	9	5	5	8	5	5	9	5	157	47	0.986	2.03
246	1	2	2	1	3	1	5	3	9	1	1	4	1	5	3	5	2	9	1	-	5	7	1	5	5	5	1	9	9	5	3	19	5	9	5	81	13	1.392	2.353	
250	1	1	2	1	3	1	5	1	3	1	1	3	1	7	1	5	2	1	-	-	5	7	1	5	5	5	1	9	9	5	5	10	5	5	9	5	168	28	2.8	2.218
251	1	2	2	1	3	1	7	1	9	1	1	1	1	7	5	5	2	9	1	-	5	7	1	5	5	5	1	9	9	7	5	13	7	1	9	7	145	19	2.612	2.352
252	1	2	2	1	3	1	7	1	9	1	1	2	1	5	5	5	2	1	-	-	5	7	1	5	5	5	2	9	9	5	5	19	7	1	9	5	65	7	2.508	2.77
255	1	2	2	1	3	1	5	5	7	1	1	4	1	5	5	5	2	1	-	-	5	7	1	5	5	5	1	9	9	5	3	22	5	9	5	58	13	1.582	2.428	
256	1	1	2	1	3	1	5	1	3	1	1	3	1	7	1	7	2	1	-	-	7	7	1	3	5	3	1	9	1	7	5	12	5	5	9	7	138	14	1.544	2.191
260	1	2	2	1	3	1	5	3	5	1	1	3	1	5	5	7	2	9	1	-	7	7	1	3	5	3	1	9	9	3	7	9	5	5	9	3	151	8	1.552	1.998
261	1	1	2	1	3	1	5	5	9	1	3	1	3	1	9	3	5	3	1	-	5	7	1	3	5	3	1	9	1	7	7	8	5	5	9	7	112	23	1.052	1.813
265	4	1	2	1	3	1	9	1	7	1	1	3	1	3	5	1	3	1	-	-	1	7	1	1	1	1	1	9	1	5	5	15	9	5	9	5	87	27	0.266	0.387
295	1	2	2	1	3	1	9	1	7	5	1	4	1	3	1	3	2	1	-	-	3	7	1	1	7	2	1	9	1	5	5	9	9	9	5	133	24	0.762	1.223	
299	1	2	2	1	3	1	5	1	7	3	1	2	1	5	3	5	2	1	-	-	5	7	1	3	5	3	1	9	9	7	5	15	5	1	9	7	101	17	2.104	2.381
302	1	2	2	1	3	1	9	5	3	9	5	3	1	3	5	3	6	1	-	-	3	7	4	1	5	1	1	9	9	3	5	17	9	5	9	3	88	23	0.39	0.507
307	1	1	2	1	3	1	9	5	5	9	5	4	1	9	5	3	6	1	-	-	5	7	4	1	7	2	1	9	9	7	7	8	9	9	7	63	45	0.314	0.79	
309	1	2	2	1	3	1	5	1	9	3	1	2	1	9	1	3	2	9	1	-	5	7	1	5	5	5	1	9	1	7	5	11	5	1	9	7	178	41	2.186	2.263
318	1	1	2	1	3	1	5	5	5	5	1	4	1	5	3	7	2	1	-	-	7	7	1	1	5	1	2	9	1	5	5	9	5	9	5	197	28	1.45	1.304	
325	1	1	2	1	3	1	9	1	5	1	1	3	1	7	5	7	6	1	-	-	7	7	1	1	5	1	1	9	9	5	5	10	9	5	9	5	114	20	0.422	1.396

CANPa	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	ag	ah	ai	aj	ak	am	an	ao	ap
327	1	3	2	1	3	1	7	3	9	3	1	4	1	7	3	5	2	1	-	5	7	1	3	5	3	1	9	1	3	3	20	7	9	9	3	73	8	1.67	2.242
37	1	1	2	1	3	1	3	3	7	1	1	3	1	7	5	3	1	-	5	7	1	3	5	3	1	9	1	9	3	3	21	3	5	9	3	67	38	1.734	2.051
339	1	3	2	1	3	1	7	1	9	5	1	5	1	9	5	2	1	-	5	7	1	3	5	3	6	9	1	3	5	12	7	9	9	3	180	39	1.754	2.314	
344	1	3	2	1	3	1	5	1	7	1	1	5	1	9	5	3	1	-	7	7	1	3	5	3	2	9	9	3	5	15	5	9	9	3	150	28	1.92	2.106	
347	1	2	2	1	3	1	5	3	3	1	4	1	7	5	5	3	1	-	5	7	1	3	5	3	1	9	1	5	7	6	5	9	9	5	150	7	1.732	2.189	
353	1	1	2	1	3	1	5	1	3	1	1	5	1	9	5	2	1	-	5	7	1	3	5	3	1	9	9	5	5	13	5	9	9	5	104	11	1.522	1.84	
354	1	1	2	2	3	1	3	1	9	3	1	5	1	7	5	1	2	1	-	5	7	1	3	5	3	1	9	9	5	11	3	9	9	5	100	13	1.35	2.059	
355	1	1	2	2	3	1	9	3	7	5	1	4	1	7	5	7	1	-	5	7	1	3	5	3	2	9	9	3	5	15	9	9	9	3	98	31	0.402	1.712	
371	4	1	2	2	3	1	5	3	7	5	5	2	9	5	7	3	1	-	5	7	1	3	5	3	1	9	9	5	5	12	5	9	9	5	112	31	0.5	1.078	
372	1	2	2	1	3	1	5	1	9	5	5	3	1	7	5	5	3	1	-	5	7	1	1	7	2	2	9	1	5	7	5	5	9	5	191	48	2.344	2.272	
375	1	3	2	2	3	1	3	1	3	7	1	2	1	7	5	7	3	1	-	5	7	1	3	5	3	1	9	1	5	5	10	3	1	9	5	70	28	1.328	1.56
383	1	2	2	2	3	1	5	3	9	3	1	4	1	5	1	3	2	1	-	5	7	1	3	5	3	1	9	1	5	5	12	5	9	9	5	132	31	1.97	2.081
385	1	3	2	1	3	1	7	3	9	3	1	5	1	7	5	2	1	-	5	7	1	5	3	1	9	9	3	7	8	7	9	9	9	3	70	24	1.264	2.052	
403	1	2	2	1	3	1	9	3	7	3	1	4	1	1	2	1	1	-	1	7	1	1	5	3	1	9	1	3	5	9	9	9	9	3	111	15	0.2	0.407	
404	1	1	2	1	3	1	3	3	9	3	1	3	1	9	5	2	1	-	5	7	1	3	7	4	2	9	1	7	5	15	3	5	9	7	174	35	1.524	2.196	
406	1	2	2	1	3	1	9	1	7	1	1	4	1	3	3	1	2	1	-	1	7	1	3	5	3	1	9	1	5	5	13	9	9	9	5	90	40	0.210	2.432
410	1	3	2	1	3	1	9	1	9	7	5	3	1	3	1	1	2	1	-	1	7	1	1	5	3	1	9	1	5	5	9	9	5	9	5	71	26	0.176	0.834
412	1	1	2	1	3	1	9	1	9	9	5	4	1	3	1	6	1	-	1	7	4	1	7	2	2	9	9	9	3	20	9	9	9	7	42	18	0.406	1.323	
413	4	2	2	3	3	1	9	1	9	3	5	2	3	5	5	3	1	-	5	7	1	1	7	2	6	9	1	3	5	10	3	9	9	3	76	12	2.382	2.818	
416	1	3	2	3	3	1	9	1	5	7	5	1	7	1	1	6	1	-	1	7	1	3	5	3	1	9	9	3	7	6	9	9	9	3	46	12	0.408	1.515	
421	1	1	2	2	3	1	5	1	7	5	1	5	1	5	5	3	2	1	-	7	7	1	1	5	3	1	9	1	5	5	13	5	9	9	5	149	22	1.79	2.034
422	1	1	2	1	3	1	7	3	9	5	1	5	1	7	5	1	2	1	-	3	7	1	1	7	2	1	9	1	3	5	12	7	9	9	3	102	88	1.028	2.213
427	4	3	2	1	3	1	9	1	9	7	5	2	2	3	5	1	6	1	-	1	7	4	3	7	4	1	9	9	5	17	9	1	9	5	91	36	0.584	2.746	
429	1	3	2	1	3	1	9	3	9	3	1	5	1	9	1	3	3	1	-	3	7	1	3	7	2	1	9	1	5	5	10	5	9	9	5	99	29	1.098	2.001
440	1	3	2	1	3	1	5	1	9	1	1	2	1	7	5	5	3	1	-	5	7	1	3	5	3	1	9	9	5	3	20	5	1	9	5	105	22	1.352	2.248
444	1	1	2	1	3	1	5	1	5	3	1	2	1	5	5	7	2	1	-	7	7	1	3	7	3	1	9	1	5	3	19	5	1	9	5	154	22	3.18	2.001
446	1	1	2	2	3	1	9	3	5	5	1	1	1	7	1	1	3	1	-	5	7	1	3	5	3	2	9	9	7	3	13	9	1	9	7	68	10	0.149	2.160
463	4	3	2	3	3	1	5	1	7	3	1	1	5	5	7	3	1	-	7	7	1	3	5	3	3	1	9	1	5	14	5	1	9	5	66	38	1.73	1.589	
465	4	3	2	3	3	1	3	1	9	5	5	2	1	5	5	7	3	1	-	9	7	1	3	5	3	1	9	1	3	13	3	1	9	3	132	40	2.176	2.121	
471	1	2	2	3	3	1	3	3	5	5	1	3	1	7	5	7	2	1	-	7	7	1	3	5	3	1	9	1	5	6	3	5	9	5	131	23	2.086	2.264	
496	1	1	2	3	3	1	5	1	1	3	1	1	1	5	1	7	2	1	-	9	7	1	1	5	1	1	9	1	7	8	5	1	9	5	239	42	3.104	1.569	
500	1	3	2	1	3	1	5	3	7	5	1	3	1	9	3	7	2	9	1	-	7	7	1	3	5	3	1	9	1	7	9	5	5	9	3	120	16	1.952	2.118
510	1	3	2	1	3	1	5	3	1	7	1	1	3	1	9	1	3	2	9	1	-	5	7	1	3	5	3	1	9	7	9	9	9	3	73	28	2.488	1.303	
520	1	3	2	1	3	1	5	3	1	7	1	1	3	1	7	3	7	2	1	-	7	7	1	5	5	1	9	1	3	5	11	3	5	9	3	190	20	2.4	2.033
521	1	1	2	1	3	1	5	5	7	1	1	4	1	5	5	5	2	1	-	7	7	1	5	5	5	1	9	1	5	5	12	5	9	9	5	145	33	1.752	2.001
535	1	3	2	1	3	1	3	1	3	3	1	4	1	5	5	2	1	-	9	7	1	3	5	3	2	9	1	3	5	13	3	9	9	3	77	38	1.636	1.474	
549	1	3	2	1	3	1	5	1	7	3	1	5	1	9	5	5	2	1	-	9	7	1	3	5	3	1	9	1	5	17	5	9	9	3	112	49	2.064	2.091	
551	1	3	2	1	3	1	5	1	3	3	1	2	1	7	5	7	2	1	-	7	7	1	5	5	1	9	1	3	5	13	3	1	9	3	111	18	2.634	2.385	
554	1	1	2	1	3	1	3	1	7	3	1	3	1	7	5	5	2	1	-	5	7	1	3	5	3	1	9	1	3	5	19	3	5	9	3	130	43	2.286	2.033

Table 3: Essential DUS characters along with descriptors

Description	Description of the state	Description	Description of the state
a Basal Leaf Sheath Colour	Green-1, Purple lines-2, Light purple-3, Purple-4	v Panicle: Exsertion	Partly exserted-3, Mostly exserted-5, Well exserted-7
b Leaf: Pubescence of Blade surface	Glabrous-1, Intermediate-2, Pubescent-3	w Sterile Lemma colour	Straw-1, Gold-2, Red-3, Purple-4
c Leaf: Auricles	Absent-1, Present-2	x Decorticated Grain: Length	Short-1, Medium-3, Long-5, Extra long-9
d Leaf: Anthocyanin Colouration of Auricles	Colourless-1, Light purple-2, Purple-3	y Decorticated Grain: Width	Narrow (<2.0mm)-3, Medium (2.00-2.5mm)-5, Broad (>2.5)-7
e Leaf: Shape of Ligule	Truncate -1, Acute-2, Split-3	z Decorticated Grain: Shape (lateral view)	Short slender-1, Short bold-2, Medium slender-3, Long bold-4, Long slender-5, Extra long slender-7
f Leaf: Ligule Colour	White-1, Light purple-2, Purple-3	aa Decorticated Grain: Colour	White-1, Light brown-2, Variegated brown-3, Dark brown-4, Light red-5, Red-6, Variegated purple-7, Purple-8, Dark purple-9
g Time of Heading (50% of plants with panicles)	Early (71-90)-3, Medium (91-110)-5, Late (111-130)-7, Very late (>131 days)-9	ab Endosperm: Presence of Amylose	Absent-1, Present-9
h Flag Leaf: Attitude of Blade	Erect-1, Semi-erect-3, Horizontal-5, Drooping-7	ac Decorticated Grain: Aroma	Extra vigorous-1, Vigorous-3, Normal-5, Weak-7, Very weak-9
i Spikelet: Density of Pubescence of lemma	Absent-1, Weak-3, Medium-5, Strong-7, Very strong-9	ad Vegetative Vigour	Very high (>25)-1, Good (20-25)-3, Medium (10-19)-5, Low (5-9)-7, Very low (<5)-9
j Lemma: Anthocyanin colouration of area below apex	Absent-1, Weak-3, Medium-5, Strong-7, Very strong-9	ae Tillering Ability	
k Spikelet: Colour of Stigma	White-1, Light green-2, Yellow-3, Light purple-4, Purple-5	ag Productive Tillers/plant	
l Stem: Length (excluding panicle; excluding floating rice)	Very short (<91 cm)-1, Short (91-110cm)-2, Medium (111-130 cm)-3, Long (131-150 cm)-4, Very long (>150 cm)-5	ah Days to 50% flowering	
m Stem: Anthocyanin colouration of nodes	Absent-1, Present-2	ai Plant Height	Semi-dwarf (90-110 cm)-1, Intermediate (110-130cm)-5, Tall (>130cm)-9
n Panicle: Length of main axis	Very short (<16 cm)-1, Short (16-20cm)-3, Medium (21-25 cm)-5, Long (26-30 cm)-7	aj Panicle Threshability	Difficult (<1%)-1, Moderately difficult (1-5%)-3, Intermediate (6-25%)-5, Loose (26-50%)-7, Easy (51-100%)-9
o Flag Leaf: Attitude of Blade (Late observation)	Erect-1, Semi-erect-3, Horizontal-5, Deflexed-7	ak Phenotypic Acceptability	Excellent-1, Good-3, Fair-5, Poor-7, Unacceptable-9
p Panicle: Curvature of main axis	Erect-1, Semi-erect-3, Horizontal-5, Deflexed-7, Straight-1, Semi-straight-3, Deflexed-5, Drooping-7	am Fertile grain no./ panicle	
q Spikelet: Colour of tip of Lemma	White-1, Yellowish-2, Brown-3, Red-4, Purple-5, Black-6	an Sterile grain no./panicle	
r Panicle: Awns	Absent-1, Present -9	ao Grain yield (kg/plot)	
s Panicle: Colour of Awns (late observation)	Yellowish White-1, Yellowish Brown-2, Brown-3, Reddish Brown-4, Light Red-5, Red-6, Light purple-7, Purple-8, Black-9	ap 100 grain weight (gm)	
t Panicle: Distribution of Awns	Tip only-1, Upper half only-3, Whole length-5		
u Panicle: Attitude of branches	Erect -1, Erect to semi-erect-3, Semi-erect-5, Semi-erect to spreading-7, spreading-9		

half and in 4 cultivars showed awn presence in the whole length. Panicle was well exerted in all the cultivars. Sterile lemma colour is straw coloured in 66 cultivars, gold in one i.e. Basmati Mahan and thus distinct for this character, red in one i.e., Bindli and thus distinct, and purple in 10. Similar results were also reported by Mondal *et al.*, 2014.

Decorticated grain length was short in 27 cultivars, medium in 38 and long in 13 cultivars. Decorticated grain width was narrow in 6, medium in 55 and broad in 17. Decorticated grain shape was short slender in 6, short bold in 18, medium slender in 39, 2 cultivars namely were distinguished for long bold shape (Binirhen and Niaw Hawm Mali) and the shape was long slender in 13 cultivars. Decorticated grain colour was white in 62, light brown in 13 and two cultivars namely (Sathi and Hung-mi-hsiang-ma-tsan) were distinguished for red colour.

Amylose was present in all the cultivars. Aroma was present in 38 cultivars while it was absent in 40 cultivars. Regarding vegetative vigour, 26 cultivars were vigorous, 39 cultivars showed normal vigour 13 cultivars were weak. Tillering ability was good (20-25 tillers) in 9 cultivars, medium (10-19 tillers) in 53 cultivars and low (5-9 tillers) in 16 cultivars. Lodging Incidence was observed in 14 cultivars. For the grain weight 45 cultivars shown high hundred grain weight (2.001-2.881 gram), 22 showed medium (1.078-1.998 gram) and 10 showed low (0.351-0.834 gram) 100 grain weight. Studies on quantitative traits have earlier been made by (Chakravorty and Ghosh, 2011).

On the basis of grouping characters as Gazette notified by Govt. of India in the PPV&FR Act, 45 cultivars which could be discriminated from the others are: RAU 3043, Kapoor kranti, Kamini Joha, KDML 105, Laldhan, Sathi, Banspatri, Shyamjeera, Basmati 564, Chimbamate Basmati, Mahisugandha, Pusa Basmati 1, Pusa Basmati 1121, Lectimachi, Tarunbhog, Improved Pusa Basmati 1, PDKV Shriram, Karnal Local, Basmati 370, Basmati 6141, Basmati Mahan, Basmati 5836, Basmati 5874, Basmati 138, Ayepyaung, Binirhen, Bong Cay, Hung-mi-hsiang-ma-tsan, Hawm Jan, Lua Nhe Den, Longku Labat, Niaw Hawm Mali, Popot, Kalimooch (Raipur), IR 62873-227-1-16, IR 62873-238-2-3, JGL 1798 (Jagithyal Sannalu), UPR 2828-7-2-1, IR 75428-6-3 and IET 22787 (RP 4594-121-148-24-11). Out of the 78 cultivars studied 33 remained in groups, which could not be discriminated on the basis of morphological grouping characteristics.

CONCLUSION

Thus, it is concluded that out of 78 landraces of rice, 45 cultivars were found to be distinctive on the basis of 29 essential DUS 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.

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