International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 2465-2469

Received: 10-03-2018
Accepted: 12-04-2018

Venkataramana S Kalagare
Dept. of Genetics and Plant Breeding, IGKV, Raipur, Chattisgarh, India

Ritu R Saxena
Dept. of Genetics and Plant Breeding, IGKV, Raipur, Chattisgarh, India

Suman Rawte
Dept. of Genetics and Plant Breeding, IGKV, Raipur, Chattisgarh, India

Correspondence
Venkataramana S Kalagare
Dept. of Genetics and Plant Breeding, IGKV, Raipur, Chattisgarh, India

Morphological characterization of super core rice (*Oryza sativa* L.) germplasm using dus description

Venkataramana S Kalagare, Ritu R Saxena and Suman Rawte

Abstract
Current study was conducted on 399 super core rice (*Oryza sativa* L.) germplasm in *kharif* season of 2017 at R. H. Richeria Biodiversity Park, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. Morphological characterization was done by using 40 different morphological characters based on following Distinctiveness, Uniformity and Stability test (DUS) description. Among the 40 DUS characters utilized in the characterization of 399 rice genotypes, six character viz., presence of leaf auricles, presence of leaf collar, presence of leaf ligule, shape of leaf ligules, male sterility and presence of secondary branching in panicles showed no variability. Maximum variability was recorded nine characters. Maximum variability helps for the selection and rare classification in morphological characters helps in identification among germplasm.

Keywords: Morphological characterization, super core rice (*Oryza sativa* L.) germplasm

Introduction
In the world rice is the second most important cerial crop after the corn. Nearly 482 million metric tons of husked rice were produced in 2017 (Anon., 2018 a) [1]. In India rice is the major staple food crop and having highest production. Production reaches to 109.70 million tonnes in 2016-2017 and having an estimates of 111.01 million tonnes in 2017-2018 (Directorate of Economics & Statistics, 2018). Chhattisgarh, also known as rice bowl, is estimated (first advance estimate) to produce 73 lakh tonnes of Rice in 2017-18, down 9.3% from a year ago 2016-17 final estimate 80 lakh tonnes (Anon., 2018 b) [2]. About 425,500 rice accessions conserved in various gene banks of the world are potential gene sources for directed crop improvement. These not only include sources for simply inherited traits such as resistance or tolerance against biotic and abiotic stresses, but also provide genes for complex traits for further improvement of grain quality and yield. India has one of the richest rice germplasm collections, with more than 60,000 accessions (Chakrabarty *et al*., 2012) [3]. The information regarding Novelty, distinctness, uniformity and stability are the basic mandates for protection under the Protection of Plant Varieties and Farmers' Rights Act (PPVFRA), 2001. The varieties have different physiological and morphological characteristics that contribute towards yield (Yang *et a*l., 2007; Yang and Hwa, 2008) [6, 7]. Ashrafuzzaman *et al*. (2009) [8] found variation in morphological and yield components in different varieties of aromatic rice. Hence, Morphological characterization of the released varieties and landraces helps in developing the database based on which new varieties developed can be distinguished and the characterization would also help in assessment of genetic diversity existing in the landraces and released varieties. The new varieties developed in agricultural and horticultural crops should be distinct from other varieties, with the introduction of Indian legislation on 'The Protection of Plant Varieties and Farmer's Rights (PPV & FR) Act, 2001'. Present study was focus on morphological characterization of super core rice (*Oryza sativa* L.) germplasm using DUS description.

Materials and Methods
The present research work was conducted at R. H. Richeria Biodiversity Park, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, during the Kharif season of 2017. Three ninety nine land races of rice belonging to Chhattisgarh were selected for this study. Nurseries were raised and twenty-one

days old seedlings were subsequently transplanted in the field with Augmented Design. Net plot size was 3 m x 0.8 m with both row to row & plant to plant distance of 20 cm X 15 cm. The crop was maintained under irrigated condition. Fertilizer dose @ of 50 N: 40 P: 30 K kg/ha was applied. The entire dose of phosphorus and potassium along with half the dose of nitrogen was applied as basal dose before transplanting. The remaining dose of nitrogen was applied in two splits, first at the time of beginning of tillering and second one week after it. Agronomical practices adopted were similar for all the treatments. To assess distinctness, uniformity and stability (DUS), the characteristics and their status was done as given by PPV & FR Authority, GOI, 2007.

Results and Discussion

Qualitative characters are considered as marker characters in the identification of landraces of rice, which are less influenced by environmental fluctuations. Morphological characterization was done by using 40 different morphological characters based on following Distinctiveness, Uniformity and Stability test (DUS) description. Among the 40 DUS characters utilized in the characterization of 399 rice genotypes, six character viz., presence of leaf auricles, presence of leaf collar, presence of leaf ligule, shape of leaf ligules, male sterility and presence of secondary branching in panicles showed no variability. Maximum variability was recorded nine characters with respect to leaf sheath intensity of anthocyanin colouration, leaf pubescence of blade surface, Anthocyanin colouration of keel of lemma, anthocyanin colouration of area below apex of lemma, anthocyanin colouration of apex of lemma, colour of tip of lemma of spikelet (late observation), colour of lemma of spikelet and palea (late observation), colour of awns (late observation) and attitude of branches of panicles which having 5 to 9 classification.

Coleoptile colour was observed under two categories; green (265) and purple (134). Basal leaf sheath colour was observed under four categories, green (272), light purple (47), purple lines (37) and uniform purple (43). Leaf intensity of green colour was observed under three categories; light green (21), medium green (253) and dark green (125). Leaf pubescence of blade surface was observed under five categories; absent (1), weak (14), medium (134), strong (218) and very strong (32). Leaf auricles was present in all 399 landraces. Leaf auricles were present in all genotypes studied (Subba Rao, 2013). Anthocyanin colouration of auricles was observed under three categories; colourless (303), light purple (48) and purple (48). Leaf collar was present in all 399 landraces. Leaf ligule was found in all the 399 landraces. Leaf shape of ligule was observed under only one categories; split (399).Same results were reported by Chakravorty and Ghosh (2012). Colour of ligules observed under three categories; white (305), light purple (65) and purple (29). Culm attitude was observed under four categories; erect (9), semi-erect (357), open (31) and spreading (2). Attitude of flag leaf (Early) was observed under two categories; Erect (40) and Semi-erect (8). Spilelet density of pubescence of lemma. This trait was observed under four categories; weak (113), medium (193), strong (89) and very strong (4). Male Sterility was found absent in all the 399 germplasm accession. Anthocyanine colouration of keel of lemma was found under4 five categories; absent (235), Weak (3), Medium (72), Strong (80) and Very Strong (9). Anthocyanine colouration of area below apex of lemma was found under five categories; Absent (341), Weak (16), Medium (29), Strong (8) and Very Strong (5). Anthocyanine colouration of apex of lemma was found under five categories; absent (311), weak (8), medium (45), Strong (30) and Very Strong (9). Colour of stigma of different forty eight accessions were found under two categories; White (270) and Purple (129). Anthocyanine colouration of nodes was found under two categories; absent (300) and present (99). Intensity of anthocyanine colouration of nodes was found under three categories; weak (8), medium (56) and strong (35). Anthocyanine colouration of internode was found under two categories; absent (172) and present (227). Flag leaf attitude of blade (late observation) was found under four categories; erect (173), semi-erect (108) horizontal (116) and deflexed (2). Curvature of panicle was found under three categories; Semi-straight (27), Deflexed (112) and drooping (260). Colour of tip of lemma was found under five categories; Yellowish (195), Brown (147), Red (17), Purple (11) and Black (29). Lemma and palea colour was observed under nine categories; Straw (82), Gold and gold (167), Furrows on straw (24), Background (28), Brown spots on straw (45), Brown furrows on straw (42), Reddish to light purple Purple spots / furrows on straw (3) Black (5), Purple (3). Awns trait was observed under two categories; absent (265) and present (134). Colour of awns (late observation) was found under nine categories; yellowish white (68), yellowish brown (2), brown (8), reddish brown (3), light red (9), red (2), light purple (19), purple (22) and black (1). Distribution of awns was found in three categories; Tiponly (47), upper half only (51) and whole length (36). Secondary branching in panicle was present in all 399 germplasm accessions. Secondary branching of panicle was found under three categories; Weak (118), Strong (273) and Cluster (8). Panicle attitude of branches was found under five categories; Erect (15), Erect to Semi-erect (39), Semi-erect (318), Semi-erect to spreading (19) and Spreading (8). The exertion of panicle was found under three categories; partly exerted (165), Mostly exerted (62) and Well exerted (172). Leaf senescence was observed under three categories; Early (185) and Medium (181) and late (33). The colour of sterile lemma of forty eight accession were found under four categories; straw (27), gold (15), red (1) and purple (4).

We can use the above result for the identification of rice germplasm by selecting some of the exception or rare classification in morphological characters (Singh *et al*., 2015) [5]. Leaf distribution of anthocyanin colouration is uniform in case of only four germplasm MTU 1010, Kalam Gurmatia (3053), Shyamala, Parwat Kala. Pubescence of blade surface of leaf is absent in CT 9993 out of 399 germplasm. Attitude of culm is spreading in only two germplasm Sehra dabri, Koudi Dhull. Attitude of blade flag leaf is horizontal in two germplasm out of 399 *ie.* Banas kupi, Kanhai. Lemma and palea colour observed after the maturity shows a lot of variability. Purple spots/furrows on straw of lemma palea colour is seen in only Jodhari, Anjan, Barangi and Purple colour is seen in case of Karhani, Kalokuchi, Mehar Dhan. Presence of panicle is one of the good identification for rice germplasm. Since of having more germplasm their color will gain the significance *ie.* Yellowish brown awns can be seen in Bajarang Bali and Bagri. Secondary branch is present in all germplasm but the clustered of secendory branches gains significance as GP-145-42, Ama Jhopa, Koudi Dhull, Chhind Guchchhi, Nariyal Phool, Khajur Jhopa and Muni Bog having clustered secondary branching.

Table: Frequency distribution of agro-morphological and quality traits based on DUS 399 germplasm accessions

S. No.	Traits	Category	Number	Frequency (%)	DUS Code
1	Coleoptile: Colour	Green	265	66.42	2
		Purple	134	33.58	3
2	Basal leaf: Sheath colour	Green	272	68.17	1
		Light purple	47	11.78	2
		Purple lines	37	9.27	3
		Uniform purple	43	10.78	4
3	Leaf: Intensity of colour	Light	21	5.26	3
		Medium	253	63.41	5
		Dark	125	31.33	7
4	Leaf: Anthocyanin colouration	Absent	260	65.16	1
		Present	138	34.59	9
5	Leaf: Distribution of anthocyanin colouration	On tips only	11	3.96	1
		On margins only	125	44.60	2
		Uniform	4	50.00	4
6	Leaf Sheath: anthocyanin colouration	Absent	370	92.73	1
		Present	29	7.27	9
7	Leaf sheath: Intensity of anthocyanin colouration	Very weak	1	3.70	1
		Weak	12	44.44	3
		Medium	9	33.33	5
		Strong	3	11.11	7
		Very strong	2	7.41	9
8	Leaf: Pubescence of blade surface	Absent	1	0.25	1
		Weak	14	3.51	3
		Medium	134	33.58	5
		Strong	218	54.64	7
		Very strong	32	8.02	9
9	Leaf: Auricles	Present	399	100.00	9
10	Leaf: Anthocyanin colouration of auricles	Colourless	303	75.94	1
		Light purple	48	12.03	2
		Purple	48	12.03	3
11	Leaf: Collar	Present	399	100.00	9
12	Leaf: Anthocyanin colouration of collar	Absent	300	75.19	1
		Present	99	24.81	9
13	Leaf: Ligule	Present	399	100.00	9
14	Leaf: Shape of ligule	Split	399	100.00	3
15	Leaf: Colour of ligule	White	305	76.44	1
		Light purple	65	16.29	2
		Purple	29	7.27	3
16	Culm: attitude	Erect	9	2.26	1
		Semi erect	357	89.47	3
		Open	31	7.77	5
		Spreading	2	0.50	7
17	Flag leaf: Attitude of blade (early observation)	Erect	236	59.15	1
		Semi erect	161	40.35	3
		Horizontal	2	0.50	5
18	Spikelet: Density of pubescence of lemma	Weak	113	28.32	3
		Medium	193	48.37	5
		Strong	89	22.31	7
		Very strong	4	1.00	9
19	Male sterility	absent	399	100.00	1
20	Lemma: Anthocyanin colouration of keel	Absent/very weak	235	58.90	1
		Weak	3	0.75	3
		Medium	72	18.05	5
		Strong	80	20.05	7
		Very strong	9	2.26	9
21	Lemma: Anthocyanin colouration of area below apex	Absent	341	85.46	1
		Weak	16	4.01	3
		Medium	29	7.27	5
		Strong	8	2.01	7
		Very strong	5	1.25	9
22	Lemma: Anthocyanin colouration of apex	Absent	311	77.94	1
		Weak	8	2.01	3
		Medium	45	11.28	5
		Strong	30	7.52	7
		Very strong	9	2.26	9
23	Spikelet: Colour of stigma	White	270	67.67	1

		Purple	129	32.33	5
24	Stem: Anthocyanin colouration of nodes	Absent	300	75.19	1
		Present	99	24.81	9
25	Stem: Intensity of anthocyanin coloration of nodes	Weak	8	8.08	3
		Medium	56	56.57	5
		Strong	35	35.35	7
26	Stem: Anthocyanin colouration of internodes	Absent	172	43.11	1
		Present	227	56.89	9
27	Flag leaf: Attitude of blade (late observation)	erect	173	43.36	1
		semi erect	108	27.07	3
		horizontal	116	29.07	5
		deflexed	2	0.50	7
28	Panicle: Curvature of main axis	Semi-straight	27	6.77	3
		Deflexed	112	28.07	5
		Dropping	260	65.16	7
29	Spikelet: Colour of tip of lemma	Yellowish	195	48.87	2
		Brown	147	36.84	3
		Red	17	4.26	4
		Purple	11	2.76	5
		Black	29	7.27	6
30	Lemma and Palea: Colour	Straw	82	20.55	1
		Gold and gold Furrows on straw Background	167	41.85	2
		Brown spots on straw	24	6.02	3
		Brown furrows on straw	28	7.02	4
		Brown (tawny)	45	11.28	5
		Reddish to light purple	42	10.53	6
		Purple spots / furrows on straw	3	0.75	7
		Black	5	1.25	8
		Purple	3	0.75	9
31	Panicle: Awns	Absent	265	66.42	1
		Present	134	33.58	9
32	Panicle: Colour of awns (late observation)	Yellowish White	68	50.75	1
		Yellowish Brown	2	1.49	2
		Brown	8	5.97	3
		Reddish brown	3	2.24	4
		Light red	9	6.72	5
		Red	2	1.49	6
		Light purple	19	14.18	7
		purple	22	16.42	8
		Black	1	0.75	9
33	Panicle: Length of longest awn	very short	32	23.88	1
		short	33	24.63	3
		medium	34	25.37	5
		long	26	19.40	7
		very long	9	6.72	9
34	Panicle: Distribution of awns	tip only	47	35.07	1
		upper half only	51	38.06	3
		whole length	36	26.87	5
35	Panicle: Presence of secondary branching	Present	399	100.00	9
36	Panicle: Secondary branching	Weak	118	29.57	1
		Strong	273	68.42	2
		Clustered	8	2.01	3
37	Panicle: Attitude of branches	Erect	15	3.76	1
		Erect to semi erect	39	9.77	3
		Semi erect	318	79.70	5
		Semi erect to spreading	19	4.76	7
		Spreading	8	2.01	9
38	Panicle: Exertion	Partly exerted	165	41.35	3
		Mostly exerted	62	15.54	5
		Well exerted	172	43.11	7
39	Leaf: Senescence	Early	185	46.37	3
		Medium	181	45.36	5
		Late	33	8.27	7
40	Sterile lemma: Colour	Straw	317	79.45	1
		Gold	14	3.51	2
		Red	9	2.26	3
		Purple	59	14.79	4

Conclusion

Among the 40 DUS characters utilized in the characterization of 399 genotypes, six characters not having variability, maximum variability observed in nine characters and there are more than nine rare classification in morphological characters. Maximum variability helps for the selection and rare classification in morphological characters helps in identification among germplasm. This study will be useful for breeders, researchers and farmers to identify the varieties and conservation of beneficial genes for crop improvement.

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