The Pharma Innovation Journal 2023; 12(3): 4773-4780

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 4773-4780

www.thepharmajournal.com
Received: 26-01-2023
Accepted: 28-02-2023

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Morphological characterisation of rice accessions (*Oryza sativa* L.) using morphological descriptors and quality parameters

Priya Gupta, Mangla Parikh, Sahana Bhat and Krishna Tandekar

Abstract
The present investigation was undertaken with the objective of DUS characterisation of 49 rice germplasm accessions rice including 4 checks has been planted in Randomised Block Design within two replication for 39 visually assessed characters and 25 quantitative characters. Trials were conducted for two seasons during Kharif 2019 at research cum instructional farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) in a Randomized Complete Block Design (RCBD) in two replications with the spacing of 20 cm × 15 cm and the recommended cultural practices were followed. For this data were recorded for sixty-one DUS descriptors following the guidelines of the International Union for the Protection of New Varieties of Plants (UPOV) and the Protection of Plant Varieties and Farmer's Rights Authority (PPV & FRA). In the present study, 9 visually assessed characteristics are found to be monomorphic, 15 are dimorphic and 15 are polymorphic. The descriptors that registered maximum variation were basal leaf: sheath color, spikelet: density if pubescence of lemma, stem length, flag leaf: attitude of blade (late observation) were found to be polymorphic in nature.

Keywords: DUS characterization, germplasm accessions, morphological descriptors

Introduction
Rice (*Oryza sativa* L.) is the most important cereal crop of the world and about 90 percent of the people of south East Asia consume rice as staple food. Rice production in India was 113 million tonne for 2018-19 (The Economic Times) and estimated production for India for the year of 2019-20 is 114.1 mt (United States Department of Agriculture). According to United States Department of Agriculture rice production in world was 499.07 mt for 2018-19 and its estimated production for 2019-20 is reduced by 1.5 mt because of late monsoon. Being the staple food grain of more than 50% of the world's population it meets 21% of dietary energy and 15% of global protein requirement. More than 3.5 billion people i.e. almost half of the total world's population is dependent on rice to meet their daily requirements (Muthayya *et al.*, 2014) [2]. In many rice growing regions of India farmers are cultivating some unique land races, having special characteristics especially for high yield and disease resistance, which are valuable in commerce as well as for breeding programmes. A large number of such germplasm are still underdeveloped to utilise its potential for the development of good rice germplasm source and are found in different parts of the country. Many of these varieties may be eligible for registration as donor, under the NBPGR, if fully characterized and meet the requirements of registration. The registration of a newly bred variety or genotype shall only be entertained if it fulfills to the criteria of novelty, distinctiveness, uniformity and stability (Banshidhar *et al.*, 2019) [1]. India has recently enacted Distinctiveness, Uniformity and Stability (DUS) characterization for rice. For this data is recorded for twenty nine quantitative and thirty nine qualitative characters. DUS descriptors were analysed as laid down in the guidelines of the International Union for the Protection of New Varieties of Plants (UPOV) and the Protection of Plant Varieties and Farmer's Rights Authority (PPV & FRA). Therefore it our need to find out potential accessions which can be used for the development of a new variety or can directly be used as a rice germplasm source for the future varieties or can be used as directly a parents for the creation of good hybrid.

Materials and Methods
A field experiment was conducted with forty eight rice genotypes including four checks (Pusa

basmati 1, Swarna, IGKV R 1244, Indira sugandhit dhan 1) during kharif 2019 at research cum instructional farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi krishi vishwavidyalaya, Raipur (Chhattisgarh) in Randomized Block Design (RBD) with two replications. Twenty seven days old seedlings were transplanted with a spacing of 20 cm and 15 cm between rows and hills, respectively. Five representative plants for each genotypes in each replications were randomly selected to record the observations for 25 quantitative traits

Observation, Scoring and Assessment

The observations were made on 5 plants or plant parts per replication of each accession following the guidelines of PPV & FRA, 2001. Four types of assessments *viz*. Visual assessment by observation of individual plant or parts of plants (VS), Visual assessment by a single observation of a group of plants or parts of plants (VG), measurement of a number of individual plants or parts of plants (MS) and measurement by a single observation of a group of plants or parts of plants (MG) was followed for the scoring.

Results and Discussion

DUS Characterisation of Rice The test guideline for rice (UPOV/TG/16/8, 2004) is used for distinctness, uniformity and stability (DUS) tests of new varieties of rice. Novelty, Distinctiveness, Uniformity and Stability of a variety is defined according to Article 7 of the 1961/1972 and 1978 Acts and Article 12 of the 1991 Act of the UPOV Convention. In the present study, data were recorded on 49 accessions of rice which includes 4 checks (Pusa Basmati 1, Swarna, IGKV R 1244, Indira Sugandhit Dhan 1) for twenty nine quantitative and thirty nine qualitative characters as per the DUS test guidelines. Observations were recorded on 70 morphological characteristics which included 39 visually assessed characteristics and 29 measurable characteristics. The characters studied in this investigation were scored under visually assessed characteristics and measurable characteristics.

Characterization based on visual observations of phenotype

The morphological data scored to identify diverse genotype, sixty one quantitative and qualitative traits were taken into consideration observation Frequency distribution and percentage value of 39 qualitative traits studied are presented in Table 1 and mean data of 29 quantitative characters are presented in Table 2. These characters were assessed either by visual observation on individual plants or a group of plants. Visually assessed characters play key role in establishing distinctiveness of a variety from other known variety in public domain. Distinctiveness of a variety is determined through clear and distinct differences between test variety and reference variety for one or more characteristics following the test guidelines. Qualitative traits are good indicator of morphological distinctness as they do not get easily influenced by environmental fluctuations. Any variety having stable and novel morphological characters can be very useful to separate pronounced individuals. Morphological traits are useful markers when they are novel, distinct, uniform and inherit to further generation also then they could be used as reliable form of markers.

Lot of variability found in frequency distribution among variables. Results obtained for morphological traits were as follows; Coleoptile colour frequency of 82.92% were of green colour whereas, 27.08% of purple colour. Basal leaf sheath colour showed frequency of green colour (75%), purple (16.66%) and light purple (2.08%) as leaf sheath colour distribution. With respect to intensity of green colour the accessions were categorized as light, medium and dark (22.91%, 54.17% and 22.92% respectively). Leaf anthocyanin colouration was found to be present in 18.75% of genotypes. Distribution of anthocyanin colouration was found to be in the form of marginal distribution in 18.75% population of genotypes. Intensity of distribution of anthocyanin colouration was weak in 8.4%, medium in 8.4% and strong in 2.08% rest 83.17% were found to show no colour. Anthocyanin colouration of leaf sheath was present in 18.75% of genotypes among all 48 genotypes studied.

Pubescence on leaf surface was strong in 11%, medium in 88% and weak in 2% population of genotypes under study. The high diversity for the leaf pubescence can be of great help in developing the varieties possessing tolerance to sucking pests. Presence of leaf auricle was in 100% of population. Anthocyanin coloration of auricle was green in 88%, purple in 8.5% and 4% were of light purple colour. Leaf collar was present in 100% of population. Colouration of collar was present in 9% population. Presence of leaf ligule was prominent in all genotypes with shape of split types in all genotypes under study (Rawte *et al.*, 2017) [11]. Colour of ligule was purple in 7%, 5% were of light purple colour, rest 89.58 were of white colour. Length of leaf blade was found between the range of maximum 67.43 cm and minimum of 40 cm. whereas, minimum value for width of leaf blade was 0.87 cm and its maximum value was 1.63 cm.

Days to 50% percent flowering ranged from 107 days to 152 days. Lemma: spikelet density of pubescence carried wide range of variation as 9, 46, 36, and 9% for very strong, strong, medium and weak respectively. 100% of population showed medium thickness for stem. Anthocyanin colouration in nodes was purple only in 4% of genotypes (IC0114851 and IC0133950) and 96% genotypes showed normal green colour of medium intensity. Internode colour was green in 96% whereas, rest 4% showed purple colour (IC0114851 and IC0133950). Late observation for attitude of blade was observed and wide variety was observed for this character as 47, 36, 10 and 6 percent population showed horizontal, semi erect, erect and deflated kind of attitude variation.70% deflated and 30% drooping kind of main axis curvature was found.12.5% of population showed presence of awn, among which accession number IC0114615 had yellow coloured awn with tip distribution, IC0115006 was yellow white in colour and had tip distribution, IC0134422 had yellow and IC0135406 yellow white awn in colour and both had tip distribution however, half distribution was found in IC0135803 which had yellow coloured awn and IC0423347 had brown awn which was distributed to the tip region only. IC0423347 showed awn length of medium to long and rest other genotypes showed awn of smaller type. Stigma colour in spikelet was found mainly of two colours white (85.41%) and green (14.58%).

Late observation for attitude of flag leaf showed wide range of variation as 10.4, 35.4, 47.9 and 6.2% flag leaf showed erect, semi erect, horizontal and deflexed angle of attitude.70.8% flag leaf showed deflexed axis of curvature while 29.2% showed drooping type of curvature, while in

case of panicle exertion 85.5% genotypes showed well exerted panicle, 10.5 showed mostly exerted panicle and 4% were partially exerted. All 48 genotypes had secondary branching among which 35.5% showed weak type of secondary branching 58.5% were of strong type while IC0115104, IC0115375 and EC0205278 had clustered type of secondary branching.98% genotypes had attitude of branches as erect to semi erect type while IC0135703 had attitude of branch of erect kind. Leaf senescence was found as early, medium and late in the proportion of 35.5, 33.4 and 31.1%. Present study showed that there was morphologically considerable amount of variation among accessions hence we can go for hybridization among diverse genotypes. Awns carrying accessions show more stability towards physiological and biological fluctuations but its presence causes difficulty at the time of milling hence a breeder could go for those genotypes which showed smaller length of awns as in accessions IC0114615, IC0115006, IC0134422, IC0135406. Out of 39 characters studied wide range of variation was obtained for sheath colour of basal leaf, intensity of green colour in leaf, pubescence in leaf blade, anthocyanin colouration of auricle, ligule colour in leaf, density of pubescence in lemma, late observation for attitude of blade leaf, panicle exertion leaf senescence, grain width, stem length, and panicle length. Whereas only two kind of alternative forms were obtained for colour of coleoptiles, length leaf blade, width of leaf blade, colour of stigma colour in spikelet, main axis curvature of flag leaf and attitude of branches. Non-polymorphic traits were presence of auricles, presence of collar in leaf, thickness of stem and presence of secondary branching. Thus, phenotypic distinctiveness was found in genotypes at a considerable amount. The accessions undertaken for this study registered wide range of distinctiveness for almost all the agro-morphological traits studied and similar frequencies has been reported earlier by studies of Lavanya *et al.* (2021) [3], Singh *et al.* (2021) [4], Priyanga *et al.* (2020) [5], Gour *et al.* (2019) [6], Manjunatha *et al.* (2018) [7], Umarani *et al.* (2017) [10], Kalyan *et al.* (2017) [9], Sinha and Mishra (2013) [12], and Chakrabarty *et al.* (2012) [8].

Table 1: Analysis of DUS descriptor in rice

S. No.	Descriptors	Observed phenotype classes	Frequency	Percentage	Stage of observation	Types of assessment
1	Colour of coleoptile	1-Colourless	0	0	First leaf stage(less 1 cm)	VS
		2-Green	40	83.3		
		3-Purple	8	16.7		
2	Basal leaf: Sheath colour	1- Green	36	75	Booting	VS
		2- Light purple	3	6.3		
		3- Purple line	1	2.1		
		4- Uniform purple	8	16.6		
3	Leaf: Intensity of green colour	3- light	11	22.9	Booting	VG
		5- medium	26	54.2		
		7- dark	11	22.9		
4	Leaf: Anthocyanin colouration	9-Present	9	18.8	Booting	VG
		1-Absent	39	81.2		
5	Leaf: Distribution of anthocyanin colouration	1-On tips only	0	0	Booting	VG
		2- on margins only	9	100		
		3- in blotches only	0	0		
		4- uniform	0	0		
6	leaf sheath: Anthocyanin colouration	1-absent	39	81.3	Booting	VG
		9-present	9	18.3		
7	Leaf sheath: Intensity of anthocyanin colouration	1-very weak	0	0	Booting	VG
		3-weak	4	44.5		
		5-medium	4	44.5		
		7-strong	1	11		
		8- very strong	0	0		
8	Leaf: Pubescence of blade surface	1-absent	0	0	Booting	VS
		3- weak	1	2.1		
		5- medium	42	87.5		
		7- strong	5	10.4		
9	Leaf: Auricles	9-present	48	100	Booting	VS
		1- absent	0	0		
10	Leaf: Anthocyanin colouration of auricles	1-colourless	42	87.5	Booting	VS
		2-light purple	2	4.2		
		3- purple	4	8.3		
11	Leaf: Collar	1-absent	0	0	Booting	VS
		9-present	48	100		
12	Leaf: Anthocyanin colouration of collar	1-absent	44	91.7	Booting	VS
		9-presence	4	8.3		
13	Leaf: Ligule	1-present	48	100	Booting	VS
		9-absent	0	0		
14	Leaf: Shape of ligule	1-truncate	0	0	Booting	VS
		2-acute	0	0		
		3-split	48	100		
15	Leaf: Colour of ligule	1-white	43	89.6	Booting	VS
		2-light purple	2	4.2		
		3- purple	3	6.2		
16	Leaf: Length of blade	3-short(<30 cm)	0	0	Booting	MS
		5-med(30-45 cm)	4	91.7		
		7long(>45)	44	8.3		

17	Leaf: Width of blade	3-narrow (<1 cm)	1	2.1	Booting	VS
		5-medium (1-2 cm)	47	97.9		
		7- broad (>2 cm)	0	0		
18	Time of heading: (50% plant with panicle)	1- very early (<71)	0	0	Half of inflorescence emerged	VG
		3- early (71-90)	8	16.7		
		5- medium (91-110)	33	68.8		
		7- late (111-130)	7	14.5		
		9- very late (>131)	0	0		
19	Spikelet: Density of pubescence of lemma	1-absent	0	0	Beginning of anthesis to dough development	VS
		3-weak	4	8.4		
		5-medium	18	37.5		
		7-strong	22	45.8		
		9-very strong	4	8.3		
20	Spikelet: Colour of stigma	1-white	41	85.4	Beginning of anthesis	VS
		2-light green	0	0		
		3-yellow	0	0		
		4-light purple	0	0		
		5-purple	7	14.6		
21	Stem: Thickness	3-thin(<0.40 cm)	0	0	Milk development stage	MS
		5-medium(0.40-0.55 cm)	48	100		
		7-thick(>0.55 cm)	0	0		
22	Stem: Anthocyanin coloration of nodes	1-absent	46	95.8	Milk development stage	VS
		9-present	2	4.2		
23	Stem: Intensity of anthocyanin colouration of nodes	3- weak	0	0	Milk development stage	VS
		5- medium	2	100		
		7- strong	0	0		
24	Stem: Anthocyanin colouration of internodes	1-absent	46	95.8	Milk development stage	VS
		9-present	2	4.2		
25	Flag leaf: Attitude of blade(Late observation)	1- erect	5	10.4	Ripening	VG
		3- semi-erect	17	35.4		
		5-horizontal	23	47.9		
		7- deflexed	3	93.7		
26	Flag leaf: Curvature of main axis	1- straight	0	0	Ripening	VG
		3- semi- straight	0	0		
		5- deflexed	34	70.8		
		7- dropping	14	29.2		
27	Panicle: Awn	1- absent	42	87.5	Ripening	VS
		9- present	6	12.5		
28	Panicle: Colour of awn (late observation)	1- yellowish white	3	50	Ripening	Vs
		2- yellowish brown	2	34		
		3- brown	1	16		
		4- reddish brown	0	0		
		5- light red	0	0		
		6- red	0	0		
		7- light purple	0	0		
		8-purple	0	0		
		9-black	0	0		
29	Panicle: Length of longest awn	1-very short	0	0	Ripening	VS
		3- short	5	84		
		5- medium	0	0		
		7- long	1	16		
		9- very long	0	0		
30	Panicle: Distribution of awn	1-tip only	5	84	Ripening	VG
		3- upper half	0	0		
		5-whole length	1	16		
31	Panicle: Exertion	3- partially	2	4.2	Ripening	VG
		5- mostly	5	10.4		
		7-well	41	85.4		
32	Panicle: Presence of secondary branching	1- present	48	100	Ripening	VG
		9- absent	0	0		
33	Panicle: secondary branching	1- weak	17	35.4	Ripening	VG
		2- strong	28	58.3		
		3- clustered	3	6.3		
34	Panicle: Attitude of branches	1- erect	0	0	Ripening	VG
		3-erect to semi erect	47	97.9		
		5- semi erect	1	2.1		
		7- semi erect to spreading	0	0		
		9- spreading	0	0		
35	Leaf: Senescence	3- early	17	35.4	Caryopsis hard	VG
		5- medium	16	33.3		
		7- late	15	31.3		
36	Grain: Length	1-very short (<6.0 mm)	19	39.6	Caryopsis hard	MS
		3-short (6.1-8.5cm)	29	60.4		
		5-medium(8.6-10.5 cm)	0	0		
		7- long (10.6-12.5 cm)	0	0		

		Very long (>12.5 cm)	0	0		
37	Grain: Width	1-very narrow(<2.0cm)	7	14.6	Caryopsis hard	MS
		3-narrow (2.1- 2.5 cm)	30	62.5		
		5-medium (2.6-3.0 cm)	11	22.9		
		7-broad (3.1-3.5 cm)	0	0		
		9-very broad (>3.5 cm)	0	0		
38	Stem: Length(excluding panicle; excluding floating rice)	1-Very short (<91 cm)	11	22.9	Milk development stage	MS
		3-short (91-110 cm)	5	10.4		
		5-medium (111-130 cm)	29	60.4		
		7- long (131- 150 cm)	4	6.3		
		9-very long (>150 cm)	0	0		
39	Panicle: Length of main axis	1- very short (<16 cm)	0	0	Milk development stage to ripening	MS
		3- short (16-20 cm)	0	0		
		5- medium (21-25 cm)	12	25		
		7-long (26-30 cm)	33	68.8		
		9- very long (>30 cm)	3	6.2		

Table 2: Mean data of quantitative traits for 48 accessions including four checks

Accessions name	Leaf length	Leaf width	Days to 50% flowering	Hulling percent	Milling percent	Head rice recovery	Paddy length	Paddy width	Paddy L/B ratio
EC0522635	57.45	1.02	111	79.09	74.42	66.07	8.15	2.1	4
EC0523186	52.73	1.12	115	74.19	67.14	53.67	8.55	2.4	3.6
EC0523164	50.75	1.18	98	79.09	73.19	42.23	7.55	2.5	3.1
EC0205223	46	1.27	92	83.75	81.22	54.5	7.75	2.8	2.8
IC0114615	56.32	1.1	96	71.25	75.9	62.19	9.05	2.5	3.7
IC0114614	49.93	1.12	108	79.05	70.73	50.99	9.6	2.5	3.9
IC0114851	48.32	1.15	97	76.99	68.89	51.01	8.5	2.2	4
IC0114849	57.35	1.17	97	79.94	71.04	44.47	7.1	2.5	2.9
IC0114879	49.18	1.3	97	74.84	71.18	55.92	6.05	2.6	2.4
IC0115000	51.17	1.22	97	79.52	73.52	46.06	6.9	3.2	2.2
IC0115006	44.15	1.12	112	78.28	73.83	64.95	8.25	2.7	3.1
IC0115046	56.3	1.32	95	76.94	71.96	38.96	6.45	2.7	2.4
IC0115194	54.13	1.42	97	75.94	71.17	48.48	7.7	2.8	2.8
IC0115259	53.65	1.17	101	84.3	75.25	67.31	10.15	2.4	4.3
IC0115289	52.35	1.2	98	79.79	74.42	44.71	7.75	2.5	3.1
IC0115375	53.92	1.15	95	84.33	73.65	68.98	6.65	1.7	4
IC0115707	54.18	1.05	99	78.74	73.81	49.35	8.2	2.6	3.2
IC0116083	45.52	1.17	117	80.95	76.85	67.62	7.85	2.5	3.2
EC0544923	56.93	1.08	106	80.52	77.55	56.92	8.95	2.1	4.3
EC0204899	60.78	1.33	107	79.84	77.72	63.89	9.6	3.1	3.1
EC0205091	59.65	1.13	109	80.84	77.72	68.33	7.7	3.1	2.5
EC0205118	53.57	1.2	95	82.06	80.77	64.53	8.55	2.3	3.7
EC0205278	54.25	1.3	89	82.32	68.88	45	7.35	2.1	3.5
IC0133949	55.4	1.37	91	74.21	66.17	46.29	7.5	1.8	4.7
IC0133950	50.32	1.23	93	84.81	75.34	44.65	6.9	2.5	2.8
IC0134422	50.97	1.15	82	78.58	56.13	38.12	7.95	2.8	2.9
IC0134901	45.42	1.13	88	77.44	64.99	41.32	8.5	2.5	3.5
IC0135142	49.52	1.33	85	77.94	69.03	44.97	7.95	3.1	2.6
IC0135325	53.82	1.37	87	81.13	75.37	38.05	7.6	3	2.6
IC0135491	48.62	1.18	88	83.45	76.51	42.38	7.3	2.9	2.5
IC0135406	48.17	1.2	94	80.61	77.32	45.65	7.65	2.8	2.8
IC0135703	45.47	1.07	105	83.58	80.58	60.37	8.65	2.2	3.9
IC0135803	55.45	1.27	97	79.03	72.29	56.75	8.35	2.7	3.1
IC0089304	43.32	1.19	89	81.01	69.74	43.46	7.65	2.7	2.9
IC0144644	56.3	1.23	96	65.06	56.94	45.68	9.05	2.4	3.8
IC0144647	56.92	1.3	98	82.86	76.84	43.81	8.9	2.6	3.4
IC0144664	52.55	1.3	94	64.65	49.45	47.33	8.35	2.5	3.3
IC0144675	42.48	1.18	95	75.1	56.53	39.37	8.25	2.9	2.9
IC0098713	60.53	1.2	95	58.78	56.53	42.98	8.95	2.6	3.5
IC0098983	53.12	1.08	112	83.5	73.7	63.39	7.3	2.7	2.7
IC0089256	49.63	1.13	95	51.67	47.14	40.53	9.15	2.6	3.6
IC0423347	49.8	1.5	94	74.34	65.88	38.77	7.65	2.3	3.4
IC0443939	57.03	1.18	105	81.22	70.87	62.26	10.65	2.6	4.2
IC0369378	49.73	0.98	87	59.01	53.3	37.84	7.7	2.8	2.8
Pusa basmati 1	36.92	1.05	99	84.93	77.22	55.66	6.4	2.2	2.9
Swarna	37.45	1.12	93	78.01	68.25	51.13	9.05	2.3	3.9
IGKV R 1244	44.95	0.95	103	74.05	69.99	52	9.95	1.9	5.2
Indira sugandhit dhan 1	40.08	1.1	111	78.08	70.36	59.29	7.15	2.6	2.8

Accessions name	Brown rice length	Brown rice width	Brown rice L/B ratio	Kernel length	Kernel width	Kernel L/B ratio	Alkali spreading value	GC
EC0522635	6.25	2.1	2.98	6.05	2	3.03	7	30.5
EC0523186	6.48	2.33	2.79	5.98	2.23	2.69	7	29.5
EC0523164	5.8	2.25	2.58	5.35	2.2	2.43	7	43.5
EC0205223	6.35	2.55	2.49	5.55	2.53	2.2	4	35.5
IC0114615	7.85	2.18	3.61	6.78	2	3.39	5	30.5
IC0114614	7.46	2.15	3.47	6.83	2.05	3.33	5	53.5
IC0114851	6.58	1.95	3.37	6.06	1.95	3.11	5	37.5
IC0114849	6.35	1.85	3.44	5.5	1.95	2.82	3	32.5
IC0114879	4.55	2.35	1.94	4.05	2.25	1.8	4	33.5
IC0115000	5.18	2.95	1.75	4.85	2.95	1.64	5	32.5
IC0115006	6.38	2.48	2.58	5.65	2.45	2.31	5	31
IC0115046	4.85	2.68	1.81	4.75	2.55	1.86	4	22.5
IC0115194	6.05	2.61	2.32	5.55	2.53	2.2	4	21
IC0115259	6.9	2.1	3.29	6.6	1.5	4.95	4	34
IC0115289	5.85	2.35	2.49	5.65	2.4	2.35	5	32.5
IC0115375	5.45	1.55	3.52	4.85	1.5	3.23	2	35.5
IC0115707	5.15	2.05	2.51	4.38	2	2.19	3	25
IC0116083	6.05	2.28	2.66	5.45	2.05	2.66	6	33.5
EC0544923	6.73	1.95	3.45	6.08	1.88	3.24	5	31.5
EC0204899	7.38	2.85	2.59	6.3	2.65	2.38	6	68.5
EC0205091	5.95	2.76	2.16	5.45	2.5	2.18	6	28.5
EC0205118	6.85	2.15	3.19	6.55	2	3.28	4	29.5
EC0205278	5.75	2.05	2.81	4.95	1.95	2.54	4	30.5
IC0133949	6.05	2.05	2.95	5.53	1.95	2.83	5	28.5
IC0133950	5.75	2.25	2.56	5.15	2.15	2.4	5	31.5
IC0134422	6.55	2.15	3.05	5.95	2.05	2.9	3	31.5
IC0134901	6.35	2.23	2.85	5.75	2.05	2.81	5	32.5
IC0135142	5.95	2.68	2.22	5.35	2.58	2.08	5	32.5
IC0135325	5.98	2.75	2.17	5.5	2.68	2.06	5	33.5
IC0135491	5.75	2.55	2.26	5.05	2.55	1.98	5	39.5
IC0135406	5.9	2.48	2.38	5.35	2.4	2.23	3	31.5
IC0135703	6.5	2	3.25	6.08	2.05	2.96	7	45.5
IC0135803	5.58	2.55	2.19	5.4	2.4	2.25	4	33.5
IC0089304	6.98	2.51	2.78	5.6	2.48	2.26	4	40.5
IC0144644	6.5	2.4	2.71	5.65	2.3	2.46	3	38.5
IC0144647	6.65	2.25	2.96	6.05	2.21	2.74	6	37.5
IC0144664	6.3	2.15	2.93	5.58	2.05	2.72	6	30.5
IC0144675	6.35	2.4	2.65	5.65	2.45	2.31	7	31
IC0098713	6.58	2.15	3.06	5.95	2.05	2.9	3	37.5
IC0098983	4.75	2.68	1.78	4.5	2.55	1.77	6	38.5
IC0089256	6.55	1.95	3.36	5.85	2.2	2.66	7	30.5
IC0423347	5.88	2.05	2.87	5.48	1.94	2.82	6	33
IC0443939	7.58	2.2	3.44	6.25	2.15	2.91	6	95.5
IC0369378	5.7	2.53	2.26	5.35	2.55	2.1	4	43
Pusa basmati 1	4.95	2.38	2.09	4.75	2.3	2.07	6	78.5
Swarna	7.18	2.1	3.42	6.58	2	3.29	3	33.5
IGKV R 1244	7.99	1.86	4.29	7.15	1.78	4.03	7	80.5
Indira sugandhit dhan 1	5.78	2.43	2.38	5.43	2.2	2.47	6	31.5

Accessions name	Cooked rice length	Cooked rice width	Cooked rice L/B ratio	Plant height	Panicle length	Effective tiller	100 seed weight	Fertile spikelet	Sterile spikelet	Biological yield	Harvest index	Grain yield
EC0522635	8.75	2.45	3.57	153	27.24	13.9	1.86	153.8	41	71.7	56.68	41.7
EC0523186	8.75	2.85	3.07	153.1	29.21	17.6	2.12	195.1	73	89.4	42.26	38
EC0523164	8.45	3.05	2.77	146	26.53	10	1.99	190.1	10.2	106	36.02	38.2
EC0205223	8.65	3.05	2.84	160.2	30.11	7.6	2.34	143.3	19	74.03	37.03	25.17
IC0114615	9.95	2.65	3.76	122.9	26.78	12.3	2.62	106.3	12.1	66.98	41.71	27.93
IC0114614	10	3.05	3.28	138.7	25.07	11.6	2.59	115.6	39	81.5	44.28	36
IC0114851	8.15	2.55	3.2	118.7	25.77	14.5	2.06	116.5	19.4	105	40.36	43.6
IC0114849	8.95	2.95	3.04	133.13	26.4	12.13	1.96	179.4	16.2	67.7	51.56	32.9
IC0114879	7.45	3.05	2.44	136.9	22.69	7.2	1.61	184.5	41.9	48.25	36.73	17.98
IC0115000	8.9	3.45	2.58	140	25.88	7.6	2.9	160.7	9.3	56.5	34.82	19.5
IC0115006	8.75	3.35	2.61	132.7	26.5	11.1	2.25	83.9	73.7	68.9	28.44	19.6
IC0115046	8.25	3	2.75	138	29.84	9.8	2.02	177	5.6	66.6	48.46	32.4
IC0115194	8.25	3.25	2.54	142.2	24.39	7.9	2.64	134.5	30.3	54.1	40.65	22
IC0115259	9.5	2.75	3.46	148.7	24.91	10	2.65	109.2	17.9	67.4	34.69	23.5

IC0115289	8.35	3	2.78	126.3	22.22	11.9	2.38	98.7	11.6	85.1	39.31	33.4
IC0115375	6.9	2.45	2.82	107.5	26.39	10.25	1.01	217.7	53.4	67.13	23.08	15.29
IC0115707	7.55	2.95	2.56	149.9	31.21	9.7	2.15	104.5	51.9	58.58	27.27	16.2
IC0116083	7.85	2.85	2.75	111.4	22.82	9.4	2.22	71.9	30.2	51.3	43.75	22.1
EC0544923	8.8	2.95	2.98	153.1	28.46	9.3	2.04	138.7	39.6	84.2	36.69	31
EC0204899	8.95	3.05	2.94	141.3	26.17	8.7	3.24	133.9	54.8	90.3	31.28	28.3
EC0205091	8.85	3.05	2.9	147.6	26.38	8.4	2.67	148.9	30	79.1	32.58	25.7
EC0205118	11.25	2.55	4.41	142	30.14	13.1	2.13	126.8	25.8	110.85	25.61	27.13
EC0205278	7.35	2.75	2.67	117.02	25.8	25.5	1.56	105.5	8.2	58.33	53.04	31.33
IC0133949	7.75	2.85	2.72	113.71	26.84	16.54	1.62	123.4	34	69.8	32.82	22.9
IC0133950	8.95	3.05	2.93	139.13	24.2	9.77	1.87	121.6	31.2	80.7	43.56	35.87
IC0134422	8.8	2.95	2.98	142.8	26.74	9.6	2.66	76.8	2.2	63.85	32.67	20.6
IC0134901	8.75	2.75	3.18	127.8	24.57	9.8	2.39	81.2	8.1	63.05	30.6	19.3
IC0135142	8.95	3.25	2.75	142.6	25.54	8.3	2.89	108.5	39.2	59.4	37.34	22.1
IC0135325	10.2	3.35	3.04	144.3	27.57	9	2.67	192.8	21.6	38.4	30.61	11.7
IC0135491	9.05	2.95	3.07	133.8	24.22	9.1	2.52	123.5	20.1	72.6	37.26	27
IC0135406	8.15	2.75	2.96	129.1	23.64	8.7	2.43	83.2	7	72.3	47.13	35.2
IC0135703	9.75	2.95	3.31	117	28.05	14.9	2.13	90.5	21.7	58.53	37.04	21.5
IC0135803	8.15	2.85	2.86	138.3	26.44	12.6	2.54	114.6	19.5	84.4	40.18	33.9
IC0089304	8.35	2.95	2.83	129.25	26.4	8.5	2.5	134.4	26.7	57.5	20.47	11.75
IC0144644	8.25	3.05	2.71	156	26.55	8.4	2.58	123.8	20.3	69.8	34.97	24.3
IC0144647	9.95	2.75	3.62	142.1	25.59	9.5	2.53	117.6	10.6	64.58	37.35	24.53
IC0144664	8.05	3.05	2.64	120.19	29.21	10.3	2.28	111.4	33.8	79.4	38.39	30.6
IC0144675	8.95	3.2	2.8	155.4	26.31	8.1	2.55	117.2	22.2	44.85	43.49	20.2
IC0098713	6.95	3	2.32	159.6	25.96	9.7	2.41	93.2	23.9	69.1	32.26	22.3
IC0098983	7.55	3.25	2.32	138.7	23.63	8.5	2.51	88.5	34.8	48.6	32.1	15.6
IC0089256	9.05	2.95	3.07	146.3	27.22	9.1	2.35	119	28.6	65.5	21.28	14.3
IC0423347	6.95	2.8	2.49	95.9	25.12	9.4	1.48	126.4	29.8	43.9	31.94	13.7
IC0443939	8.45	2.95	2.87	146.5	28.44	11.2	2.83	76.8	43.3	58.4	36.21	21
IC0369378	8.05	3.15	2.56	147	26.65	8	2.24	91.7	20.1	44.7	40.07	17.9
Pusa basmati 1	7.75	3.05	2.54	87.2	23.03	17.7	1.51	167.6	14.6	78.1	48.52	38
Swarna	9.05	2.45	3.7	84.6	23.21	14.7	2.42	97.8	9.7	51.6	41.74	21.5
IGKV R 1244	11.75	2.25	5.2	105.7	28.07	12.7	1.91	102.9	66.9	49.2	32.16	16
Indira sugandhit dhan 1	7.95	2.95	2.7	87.6	21.82	15.4	1.94	97.3	50	57.4	35.03	20.1

Measurable Characteristics

Mean performances over the year of the 29 measurable characteristics are presented in Table 2. Analysis of quality traits showed wide range of variation among different classes as hulling percent was ranged between 84.93 g (Pusa Basmati 1) to 51.67 g (IC0089304) with an average of 77.41 g. Milling percent ranged between 81.22 g (EC0205223) to 47.14 g (IC0089256) with an average of 70.36 g. Head rice recovery percent ranged between 68.98 g (IC0115375) to 37.84 g (IC0369378), average 51.21 g. Paddy length was found to be between 10.65 cm (IC0443939) and 6.05 cm (IC0114879), average 8.10 cm. Kernel length ranged between 7.2 cm (IGKV R 1244) to 4.1 cm (IC0114879), average of 5.6 cm. Kernel elongation ratio ranged from 4.95cm (IC0115259) to 1.64 cm (IC0115000) with an average of 2.62 cm. Alkali spreading value was found highest up to 7 till lowest value up to 2 (EC0523186) with an average of 5. Gel consistency was found highest for IC0443939 (95.5) and lowest for EC0522635, EC0523186 and IC0115194 (26) with an average 37.67.

Cooked rice length was found highest as 11.75 cm (IGKV R 1244) and lowest as 6.9 cm (IC0115375) with an average of 8.6 cm. Elongation ratio for cooked rice ranged from 5.2 cm (IGKV R 1244) to 2.32 cm (IC0098983) with an average of 2.98 cm. Plant height of tallest genotype was 160.2 cm (EC0205223) and lowest height was 84.60 cm (Swarna) with an average height of 133.14 cm. Panicle length was longest in IC0115707 (31.21 cm) and least in Indira Sugandhit Dhan 1 (21.82 cm) and average panicle length was 26.16 cm.

Effective tiller was found maximum in EC020578 (26) and least in IC0114879 (8) with an overall average of 11 in number. 100 seed weight was found highest in EC0204899 (3.24 g) and lowest in IC0115375 (1.01 g) with an average weight of 2.26 g. Maximum filled grains per panicle were found in accession number IC0115357 (217.7) and minimum in IC0116083 (71.9). Biological grain yield was highest for accession number EC0205118 (110.85 g) and minimum for IC0135325 (38.40 g), average 67.80 g. Harvest index was 56.68% for EC0522635 and minimum as 20.47% for IC0089304 averaged as 37.11%. Grain yield was obtained highest for IC0114851 (43.6 g) and was least for IC0135325 (11.70 g) with an average grain yield as 25.22 g.

Conclusion

Selection in these genotypes will be quite returning for deriving early maturity genotypes, which would be a major improvement for large scale adoption of this long duration genotype. The reported results from DUS characterisation will be quite helpful for students, breeders, farmers and others who are in academic and research activities as a good source of information in selecting improved genotypes for various breeding programmes *viz*. resistance breeding, breeding for early maturity, breeding for intermediate amylose content, breeding for lodging resistance etc.

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