



# Distinctiveness, Uniformity and Stability (DUS) Characterization in Twenty Five Landraces of Rice (*Oryza sativa* L.)

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

For the establishment of Distinctiveness, Uniformity and Stability (DUS) characterization, Twenty five landraces of rice (*Oryza sativa* L.), collected from different parts of Tamil Nadu, were characterized according to the DUS guidelines of the Plant Varieties Protection and Farmers' Rights Authority, using thirty agro-morphological traits. Rice accessions were planted with three replications using the randomized block design (RBD) in 2021 at the Plant Breeding Farm, Department of Genetics and plant Breeding, Faculty of Agriculture, Annamalai University. Observations were recorded on various agro-morphological traits such as Leaf sheath, flag leaf, leaf blade, awns, panicle, ligule and clum characteristics. The results obtained revealed a wide

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range of variability for twenty five landraces, essential characters of the thirty DUS characters studied. The results of this study will be useful for restoration and conservation of beneficial genes. Contemporary research work will be advantageous for breeders to choose the right parent for crop improvement and the researchers for genetic diversity among landraces.

**Keywords:** *Oryza sativa L*; cereal crop; rice farmers; genetic diversity; germplasm; agronomic traits; plant breeding.

## 1. INTRODUCTION

“One of the most significant cereal crops worldwide is rice (*Oryza sativa* L.) which act as a primary food source for more than half of the world's population is rice” [1]. “Rice is the second most important cereal crop after maize in terms of world production. India has a rich and wide range of genetic wealth of rice. According to estimates from various surveys, the nation is still home to roughly 50,000 rice farmers”. [2]. “In India rice is cultivated in an area of about 431.94 hectares with a production of about 110.15 million tonnes and productivity of 2550 kg per ha as of 2016-2017. Rice has the largest germplasm collections in the world. Landraces traditionally cultivated, evolved over generations with proven special features over wild relatives hence serve as a treasure of useful genes. They played a very important role in the local food security and sustainable development of agriculture, in addition to their significance as genetic resource for rice genetic improvement” [3]. “Characterization of germplasm eventually means recording and storing useful data that can be readily retrieved and made available to others and comfort in planning breeding programmes” [4]. “Twenty five landraces collected from different locations were used in the present investigation. Rice descriptors of Biodiversity International were used for evaluation and characterization. The genetic diversity existing among landraces will provide information on the superior parental selection for future breeding programmes. Different studies suggest that India has over 70,000 germplasm accessions and also needs the selection and protection of a large number of wild species” [5]. The Government of India has introduced Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act in 2001, for the IP protection over crop varieties including farmers' rights over traditional varieties. The concept of DUS is fundamental to the characterization of a variety as unique and provides an official description of a variety for its identity as it is globally accepted for varietal identification. In this research work, an attempt

was made to characterize a set of twenty five landraces of rice germplasm for different morphological and agronomic traits and identify the variability available in the collection.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Area

Twenty-five landraces of rice were grown in a Randomized block design (RBD) with three replications in 2021 at the Plant Breeding farm, Department of Genetics and plant Breeding, Faculty of Agriculture, Annamalai, University. The experimental site has the co-ordinates of 11°24' N latitude and 79°41' E longitude at an altitude of 5.1 m above the mean sea level.

### 2.2 Experiment Materials

The present research experimental material consisted of twenty five landraces of rice genotypes (*Oryza sativa* L.) and their source of collection were presented in Table 1. Relevant common name was gathered from local farmers.

### 2.3 Field Plot Setup

Accessions were grown in a randomized block design in three replications. Each entry was sown in three rows of 25 plants, at a spacing of 25 cm between plants and 30 cm between rows and 1mt isolation separation was maintained between two entries in each block. Crop was raised by following recommended package of practices [6].

### 2.4 Recorded Observations

“The observations were taken for morphological and agronomic characters. In these observations, Morphological characterization of twenty-five landraces of rice was carried out using twelve DUS characters. All the characters were studied as per procedure of biodiversity at field condition. The qualitative characters were

**Table 1. Twenty five landraces of rice used for DUS Test**

Accession	Rice Landraces	Source of collection
G1	Attur Samba	Attur, Salem
G2	Arupatham Kuruvai	Maangulam, Madurai
G3	Arcode Kichili Samba	Ediyure, Kancheepuram
G4	Bhavani	Rayanathur, Thanjavur
G5	Chandikar	Vayalogam, Pudhukottai
G6	Kuruvai Kalanjium	Thiruppurambiam, Kumbakonam
G7	Kaatu Yaanam	Palamuthur, Thanjavur
G8	Kallundai	Vilangudi, Thanjavur
G9	Kichili Samba	Ediyure, Kancheepuram
G10	Karudan Samba	Ananthapuram, Tiruvannamalai
G11	Karunkuruvai	Ananthapuram, Tiruvannamalai
G12	Kallurandaikar	Parmakudi, Ramanathapuram
G13	Kandasaali	Semballur, Thanjavur
G14	Kothamalli Samba	Karungalammelpathi Thanjavur
G15	Kuzhiyadicham	Thennampalagai Thanjavur
G16	Mysore Malli	Puliyancholai, Trichy
G17	Navara	Mailaduthurai, Cuddlore
G18	Norungan	Coastal area, Nagapattinam
G19	Sivapu Chittirai Kar	Anumantankadi, Sivagangai
G20	Salam Sannam	Mangalam, Kancheepuram
G21	Sigapu Kavuni	Krishnapuram, Thanjavur
G22	Sornamugi	Rayanathur, Thanjavur
G23	Seeraga samba	Puliyancholai, Trichy
G24	Thulasi Vasanai Seeraga samba	Kondakulan, Thanjavur
G25	Thoyamalli	Keelapalayam, Thanjavur

scored visually, and the quantitative characters were measured. Visual observations were recorded based on single plant basis on ten randomly selected plants in each genotype at appropriate growth stages” [7].

### 3. RESULTS AND DISCUSSION

Thirty traits were observed in twenty five germplasm to establish distinctiveness among germplasm and these are presented.

**Table 2. DUS Characterization of Twenty five landraces of rice**

Sl. No.	Characters	Types	Scale	No. of Germplasms	Frequency Distribution (%)
1.	Basal leaf sheath : colour	Green Green with	1	18	71.50
		Purple lines	2	3	12.51
		Light Purple	3	3	12.0
		Purple	4	1	3.94
2.	Leaf sheath : anthocyanin colouration	Absent	0	20	79.9
		Weak	3	3	12.1
		Medium	5	2	7.80
		Strong	7	0	0.00
3.	Leaf blade : anthocyanin colouration	Absent	0	11	44.0
		Present	1	15	56.0
4.	leaf blade : distribution of anthocyanin	Tips only	1	23	91.4
		On margins	2	0	0.00
		In Blotches	3	0	0.00
		Even	4	2	8.32
5.	Leaf blade : intensity of colour	No green	0	0	0.00
		Green	3	13	53.6
		Medium	5	8	31.15
		Dark	7	4	15.23

Sl. No.	Characters	Types	Scale	No. of Germplasms	Frequency Distribution (%)
6.	Leaf blade: attitude	Erect	1	19	75.50
		Horizontal	5	4	16.00
		Drooping	7	2	7.90
7.	Leaf blade: pubescence	Glabrous	1	3	13.1
		Intermediate	2	20	79.8
		Pubescent	3	2	8.10
8.	Auricle collar: colour	No green	0	25	100
		Green	1	0	0.00
		Light green	2	0	0.00
		Purple	3	0	0.00
		Purple lines	4	0	0.00
9.	Ligule shape	Absent	0	0	0.00
		Truncate	1	8	31.61
		Acute	2	16	63.90
		2-cleft	3	1	4.30
10.	Ligule Pubescence	Glabrous	1	15	61.07
		Partially < 50%	2	7	28.14
		Mostly >50%	3	3	10.79
11.	Ligule colour	Absent	0	0	0.00
		Whitish	1	16	63.58
		Yellowish green	2	5	21.10
		Purple	3	0	0.00
		Light Purple	4	4	15.31
		Purple lines	5	0	0.00
12.	Ligule margin hairiness	Absent	0	19	76.00
		Present	1	6	24.00
13.	Leaf blade : Length(cm)	Very short (<21cm)	1	2	7.70
		Short (22-30cm)	3	9	36.01
		Intermediate (31-50cm)	5	4	16.00
		Long (51-70)	7	6	23.98
		Very long (>80cm)	9	4	16.28
14.	Leaf blade : width(cm)	Narrow (<1cm)	3	5	21.09
		Intermediate	5	16	63.91
		Broad (>2cm)	7	4	14.94
15.	Flag leaf : length(cm)	Short (<30cm)	3	6	23.90
		Medium (30-45cm)	5	11	44.00
		Long (>45cm)	7	8	32.07
16.	Flag leaf : width(cm)	Narrow (<1cm)	3	13	52.47
		Intermediate	5	9	35.34
		Broad (>2cm)	7	3	12.18
17.	Flag leaf : attitude(Early)	Early	1	12	48.23
		Semi- erect	3	8	30.25
		Horizontal	5	5	21.50
		Descending	7	0	0.00
18.	Culm : Habit	Erect (<15°)	1	6	23.25
		Semi-erect (-20°)	3	12	48.02
		Open (-40°)	5	3	13.41
		Spreading (>60-80°)	7	4	14.99
			9	0	0.00

Sl. No.	Characters	Types	Scale	No. of Germplasms	Frequency Distribution (%)
		Procumbent			
19.	Culm : length	Very short (>50 cm)	1	2	7.20
		Very short to short(51-70 cm)	2	3	12.90
		Short(71-90cm)	3	7	28.14
		Short to intermediate(91-105cm)	4	2	7.12
		Intermediate(106-120cm)	5	9	36.07
		Intermediate to long(121-140cm)	6	1	4.31
		Long (141-155cm)	7	1	4.20
		Long to very long (156-180cm)	8	0	0.00
		Very long(>180cm)	9	0	0.00
20.	Culm : anthocyanin colour on node	Absent	0	16	64.32
		Purple	1	4	14.79
		Light purple	2	3	12.87
		Purple Lines	3	2	8.00
21.	Culm : internode anthocyanin	Absent	0	20	80.00
		Purple	1	2	7.90
		Purple Lines	2	3	12.10
22.	Culm : lodging resistance	Very weak	1	0	0.00
		Weak	3	3	11.63
		Intermediate -45°	5	15	62.07
		Strong 20°	7	7	26.14
		Very Strong	9	0	0.00
23.	Flag leaf : attitude(Late)	Erect	1	12	48.00
		Semi-erect	3	7	28.12
		Horizontal	5	6	23.85
		Descending	7	0	0.00
24.	Lemma and palea : colour	White	1	1	3.98
		Green stripped white	2	3	12.13
		Gold and gold furrows	3	1	4.01
		Brown	4	2	8.91
		Brown spots and green	5	0	0.00
		Brown furrows on green	6	6	25.91
		Blackish brown	7	2	8.10
		Green	8	9	32.92
		Yellowish green	9	0	0.00
		Purple	10	0	0.00
		Reddish to light purple	11	0	0.00
		Purple shade	12	0	0.00
		Purple spots on green	13	0	0.00
			14	1	4.03
			15	0	0.00

Sl. No.	Characters	Types	Scale	No. of Germplasms	Frequency Distribution (%)
		Purple furrows on green			
		Black			
25.	Awn presence	Absent	0	15	60.00
		Partly awned	1	10	40.00
		Fully awned	2	0	0.00
26.	Awn distribution	Awnless	0	15	60.00
		Tips only	1	10	40.00
		Upper quarter only	2	0	0.00
		Upper half only	3	0	0.00
		Upper three-quarters only	4	0	0.00
		Whole length	5	0	0.00
27.	Awns : colour	Absent	0	15	60.00
		Whitish	1	2	7.89
		Straw	2	0	0.00
		Gold	3	1	4.01
		Brown	4	2	8.06
		Light green	5	3	12.13
		Red	6	0	0.00
		Purple	7	1	4.00
		Black	8	1	3.91
28.	Texture of panicle	Scabrous	1	25	100
		Smooth	2	0	0.00
29.	Panicle : shattering	Very Low (<1%)	1	3	12.15
		Low (.3%)	3	17	68.11
		Moderate (.15%)	5	5	19.70
		High (.35%)	7	0	0.00
		Very high (>50%)	9	0	0.00
30.	Panicle : threshability	Difficult (few or no grains)	1	14	55.52
		Intermediate (25-50%)	2	6	24.45
		Easy (>50%)	3	5	20.02

A total of twenty five rice landraces was taken for DUS characterization using thirty characters which include both qualitative (colour, shape, pigmentation etc.) and quantitative (length, width, yield etc.) characters. The rice landraces undertaken for this study showed wide range of distinctiveness characters for all most all the morphological traits studied and similar results has been reported earlier by Chakrabarty et al. [8], Parikh et al. [9], Rao et al. [10], Tirkey et al. [11], Sinha and Mishra [12], Mondal et al. [13], Manjunatha et al. [14], Kalyan et al. [15], Umarani et al. [7], Manjunatha et al. [6], Islam et al. [16], Poudel et al. [17] and Lavanya et al. [18]. Frequency distributions for all the characters under study were computed and qualitative and quantitative characters of different

agronomic and morphological parameters are given in Table 2.

For the morphological characterization or identification of land races of rice, quantitative characters are considered as morphological markers, because they are less influenced by the environmental changes. Out of 25 land races studied, 71.50% possessed green coloured basal leaf sheath, 12.51% had green with purple lines, 12% with light purple and 3.94% had purple colour. Anthocyanin colouration in leaf blade was present in 62.4% land races and absent in 37.3% of land races. All the land races showed the distribution of anthocyanin at the tip of the leaf blade.

Anthocyanin coloration on leaf sheath was absent in 79.9% landraces and has 12.1% were weak and 7.80% were medium. For the intensity of green colour in leaf blade all the accessions exhibited light to dark green in colour, in which 31.15% exhibited medium, while 53.6% and 15.23% exhibited light and dark green colour respectively. 75.50% of landraces had erect leaf blade, while 16.00% and 7.90% had horizontal and drooping attitude respectively. For pubescence on leaf blade surface 8.10% landraces were found to be distinct for having strong pubescence, while 79.8% with intermediate pubescence and 13.1% were marked for glabrous nature. For the leaf ligule character, 63.90% possessed acute shaped ligules, 4.30% 2 cleft and 31.61% recorded truncate ligules. Among the land races 21.10% of them had yellowish green ligule, 63.58% had whitish and 15.31% had light purple colour. Ligule margin is hairy in 24% of the landraces. The length of the leaf blade was short in 36.01% and also exhibited intermediate width in 63.91% of rice landraces.

With respect to flag leaf 44% of had medium length, while 32.07% and 23.90% had long and short flag leaf length respectively. Intermediate flag leaf width was observed in 35.34% landraces, 52.47% showed narrow flag leaf width. Incase of flag leaf attitude 30.25% of the types were semi erect 48.23% and 21.50% were erect and horizontal respectively. Regarding culm characters, 48.02% landraces were of semi erect type, 13.41% were open type and 23.25% were erect type. For culm length (excluding panicle), 7.02% were of very short, 12.90% were of very short to short, 28.14% were of short type, 7.12% were of short to intermediate 36.07% were of intermediate and 4.31% were of intermediate to long type and 4.20% were of long type. With respect to anthocyanin colour on node, it was absent in 64.32%; while 14.79% possessed purple colour, 12.87% had light purple and 8.0% had purple lines. 26.14% of the culm are strong and 62.07% were intermediate in culm strength. Lemma and Palea colour was Green in 32.92% and brown furrows on green in 25.91% of landraces.

Awns were absent in 60%; partly awned in 40% and no fully awned. Awns were present in the tip only at 40% and the colour was whitish in 7.89%; purple in 4.00% and gold in 4.01% landraces. The awn colour, lemma and palea colour, flower colour, colour of hair, seed colour were the most stable characters across the agro-climatic zones [19,20]. Panicle shattering was low in 68.11%

and moderate in 19.70% of the landraces. The threshable was easy in 20.02%, intermediate in 24.45% and difficult in 55.52%.

"The quantitative traits are economically important measurable phenotypic traits. The above mentioned quantitative characters were useful for yield, its contributing trait studies for yield improvement in rice breeding. A qualitative trait is expressed qualitatively, which means that the phenotype falls into different categories. These categories do not necessarily have a certain order. The qualitative characters can be used for improvement of quality characters in rice breeding programmes. Landraces are a complex and genetically diverse population tolerant to stress. Utilization of these materials in breeding programmes may be somewhat problematic due to undesirable linkages. Landraces are excellent sources of genetic variation for breeding of crops" [21].

#### 4. CONCLUSION

Morphological descriptors were widely used in sequential fashion and were found convenient in discriminating different genotypes. The 25 genotypes under study exhibited wide range of variability for twenty five landraces, essential characters of the thirty DUS characters studied. This study will be useful for restoration and conservation of beneficial genes. Farmers, researchers, and breeders can all benefit from this characterization data since it will help to find and preserve valuable genes for crop improvement. The data gathered on these landraces can also help to justify their registration under the Farmers Rights Act and Plant Protection Varieties.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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