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DUS Characterization of Tamil Nadu Traditional Rice (*Oryza Sativa* L.) Varieties

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ABSTRACT

Background: Twenty-seven landraces of rice (*Oryza sativa* L.), collected from different parts of Tamil Nadu, were characterised according to the DUS guidelines of the Plant Varieties Protection and Farmers' Rights Authority, GOI.

Methods: Rice accessions were planted with three replications using the randomized block design (RBD) in 2019 at the Plant Breeding Farm, Department of Genetics and plant Breeding, Faculty of Agriculture, Annamalai University.

Result: Observations were recorded on 49 different agro-morphological traits, out of 49 descriptors analysed, six were monomorphic, seventeen were dimorphic, thirteen were trimorphic, seven were tetramorphic and spikelet: density pubescence of lemma, 1000 grain weight of fully developed grains and decorticated grain colour showed five expressive states and lemma and palea colour reported six expressive states. Contemporary research work will be advantageous for breeders to choose the right parent for crop improvement and the researchers for genetic diversity among landraces.

Key words: Agronomic traits, DUS, Landraces, Morphological characterization.

INTRODUCTION

In the world, rice is the second most important cereal crop after the corn. Rice is grown in over one hundred countries and produces more than 700 million tonnages annually, with total harvested area of approximately 158 million hectares (470 million tons of milled rice). Asia produces almost 640 million tons of rice, which accounts for 90% of the world demand. Rice is the main staple food crop and the most competitive in India (Barua and Saikia 2018). Production reaches to 116.42 million tonnes in 2018-2019 and having an estimate of 120.48 million tonnes in 2019-2020 (Anonymous 2019). India has a rich and wide range of genetic wealth of rice (Anju and singhl 2003). Approximately, 425, 500 rice accessions stored in various gene banks on worldwide are possible genetic sources for improving guided crops Chakrabarty *et al*. (2012) 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 (Siddiq 1992). Indigenous rice varieties also have an impact for various conditions such as skin disorders, blood pressure, fever, paralyzes, rheumatism, leukorrhea and for increasing tone of lactation in the Indian states of Karnataka, Madhya Pradesh, Kerala, Tamil Nadu, Uttar Pradesh, Western Ghats and the Himachal Pradesh Ahuja *et al*. (2008). In addition to providing sources for clearly inherited traits such as resistance or the tolerance to biotic and abiotic stresses, traditional rice varieties also provide genes for complex properties for further improvements in grain quality and yield. Singh *et al*. (2010) Valuable rice germplasm in this region has rapidly disappeared over the last few years due to the change in the variety spectrum and the usage of paddy fields for non-agricultural purposes Latha *et al*. (2013). Hence, there is an urgent need for characterization and conservation of these traditional landraces. In this context, an attempt was made to characterize a set of twenty-seven rice landraces for different morphological and agronomic traits and identify the variability available in the collection.

Government of India has introduced Protection of Plant Varieties and Farmers' Rights (PPV & FR) Act in 2001. DUS-based morphological characterization (Distinctness, Uniformity and Stability) is the criterion for variety registration under the PPVandFR Act. Hence the programme is aiming for DUS characterization of twenty-seven landraces of Tamil Nadu.

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MATERIALS AND METHODS

Study site

Twenty-seven traditional varieties of rice were grown in a Randomized block design with three replications in 2019 at the Department of Genetics and plant Breeding farm situated near 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 main sea level.

Experiment materials

The present research experimental material consists of 27 local rice cultivars (*Oryza sativa* L.) of Tamil Nadu. Relevant common name was gathered from local farmers. (Table 1).

Field plot

Accessions were grown in a randomized block design with the three replications. Each entry was sown in three rows of 20 plants, at a spacing of 15 cm between plants and 20 cm between rows and 1mt isolation separation was maintained between two entries in each block. Crop was raised by following recommended package of practices. (Manjunatha *et al*. (2018).

Observations

The observations were taken for forty-nine morphological and agronomic characters. In these observations, Morphological characterization of twenty-seven landraces of rice was carried out using twelve DUS characters. Visual observations were recorded on remaining thirty-seven characters for single plant basis on ten randomly selected plants in each genotype at appropriate growth stages as reported by Umarani *et al.* (2017).

RESULTS AND DISCUSSION

Fourty-nine traits were observed in twenty-seven germplasm to establish distinctiveness among germplasm and these are presented below.

Morphological characterization

Qualitative characters are important for the definition of plants and are mainly influenced by consumer preference, socio economic scenario and natural selection (Ismaeel *et al.* 2016). Frequency distribution for 39 qualitative traits is depicted in (Table 2). Most of the morphological characters display variability in different accessions, with the exception of Basal sheath colour, Leaf collar, Leaf collar anthocyanin colouration and Leaf Ligule. A majority of accessions possess green (96.30%) coleoptile colour, purple colour coleoptiles found in (karupu kavuni) 3.70% of plant as a unique genotype because more than 95% of the purple coleoptile colour plant is resistant to insect pest *i.e.* brown plant hopper (Bph) (Bennet 1994) while in wheat purple colour of coleoptile is reportedly related with resistance to bunt. (Shoeva and Elena, 2015).

The observations for leaf traits were recorded as leaf anthocyanin colouration (88% present), leaf distribution of anthocyanin colouration (81% Uniform), leaf sheath anthocyanin coloration (88% present), leaf auricles (85% Present), leaf anthocyanin coloration of auricles (85% colourless), leaf colour of ligule (96% white), leaf intensity of green colour (40% Medium, 33% light, 26% dark), leaf sheath intensity of anthocyanin coloration (44% medium, 30% weak, 26% strong), leaf pubescence of blade surface (52% medium, 33% strong, 14% weak,) leaf shape of ligule (52% acute, 30% split, 18% truncate), Similar type of work was also reported (Bisne and Sarawgi, 2008; Ahmed *et al.* 2016) and some of the accessions possessed various distributions were found in (Shrivastava *et al.,* 2015). Culm attitude is an indicator of the growth habit of a particular species. During the current study valuable variation was observed among the accessions for culm angle. (Rawte and Saxena, 2018). Culm attitude (for floating rice) (81% procurement), culm attitude (40% erect, 19% semi erect, 4% spreading) (Fonseca *et al*., 2002). Time of heading 50% of plants with panicles were observed and noticed that 52% landraces are medium type, 44% landraces are very late type and 3% (Arupatham kuruvai) landraces were of early and a short duration variety. Flag leaf: attitude of blade (early observation) (48% semi erect, 30% horizontal, 18% erect, 3% drooping), Spikelet: density of pubescence of lemma (55% absent, 18% medium, 14% strong, 7% weak, 3% very strong), Spikelet: colour of stigma (30% light green, 7% yellow and purple) (Nascimento *et al*. 2011) Stem: Thickness (59% thick, 29% thin, 11% medium), Panicle: length of main axis (19% medium, 15% very short, 7% long and very long), Flag leaf: attitude of blade (late observation) (19% semi

Table 1: List of genotypes and the place of collection.

Name of the Genotypes	Place of collection
Karupu Kavuni	Thirukadaiyur, Nagapattinam
Illapai Poo Samba	Thirukadaiyur, Nagapattinam
Kattu Yanam	Vellapallam Nagapattinam
Arcode Kichili Samba	Ediyure, Kancheepuram
Sorna Masuri	Chembudai, Nagapatinam
Seeraga Samba	Coastal area, Nagapatiinam
Thooyamalli	Sukan Kollai, Kanchipuram
Navara	Vellapallam Nagapattinam
Mapillai Samba	Sukkankollai, Kanchipuram
Mysore Samba	Sukkankollai, Kanchipuram
Karudan Samba	Ananthapuram Tiruvannamalai
Milagu Samba	Kanchipuram
Kattue Vallai	Vellapallam Nagapattinam
Kuzhi Adichan	Denkanikottai krishnagiri
Salam Sanna	Mangalam, Kancheepuram
Arupatham Kuruvai	Sivagangai
Kichili Samba	Ediyure, Kancheepuram
Kalan Namak	Sukkankollai, Kanchipuram
Poonkar	Ramanathapuram
Karunkuruvai	Ananthapuram Tiruvannamalai
Kattanure	Vellapallam Nagapattinam
Sivapu Chittirai Kar	Anumantankadi, Sivagangai
Vallai Chittrai Kar	Sukan Kollai, Kanchipuram
Matti Kar	Thirukadaiyur, Nagapattinam
Norungan	Coastal area, Nagapatiinam
Nootripathu	Coastal area, Nagapatiinam
Kuruvai Kalanjium	Thiruppurambiam, Kumbakonam

Table 2: Frequency distribution of landraces of rice for various DUS characters.

Characteristics	States	Scale	Number of genotypes	Frequency distribution(%)
Coleoptile: Colour	Colorless	1	00	00
	Green	2	26	96.30
	Purple	3	01	3.70
Basal leaf: Sheath colour	Green	1	27	100
	Light purple	2	00	00
	Purple lines	3	00	00
	Uniform purple	4	00	00
Leaf: Intensity of	Light	3	09	33.33
green colour	Medium	5	11	40.74
	Dark	7	07	25.92
Leaf: Anthocyanin	Absent	1	03	11.11
colouration	Present	9	24	88.88
Leaf: Distribution of	On tips only	1	02	7.40
anthocyanin colouration	On margins only	2	00	00
	In blotches only	3	00	00
	Uniform	4	22	81.48
Leaf sheath:	Absent	1	03	11.11
Anthocyanin colouration	Present	9	24	88.88
Leaf sheath: Intensity of	Very weak	1	00	00
anthocyanin colouration	Weak	3	08	29.62
	Medium	5	12	44.44
	Strong	7	07	25.92
	Very strong	9	00	00
Leaf: Pubescence of	Absent	1	00	00
blade surface	Weak	3	04	14.81
	Medium	5	14	51.85
	Strong	7	09	33.33
	Very strong	9	00	00
Leaf: Auricles	Absent	1	04	14.81
	Present	9	23	85.18
Leaf: Anthocyanin	Colorless	1	23	85.18
coloration of auricles	Light purple	2	00	00
	Purple	3	01	3.70
Leaf: Collar	Absent	1	00	00
	Present	9	27	100
Leaf: Anthocyanin	Absent	1	00	00
coloration of collar	Present	9	27	100
Leaf: Ligule	Absent	1	00	00
	Present	9	27	100
Leaf: Shape of ligule	Truncate	1	05	18.51
	Acute	2	14	51.85
	Split	3	08	29.62
Leaf: Colour of ligule	White	1	26	96.29
	Light purple	2	00	00
	Purple	3	01	3.70
Leaf: Length of blade	Short (<30 cm)	3	05	18.51
	Med. (30-45 cm)	5	13	48.14
	Long (>45 cm)	7	09	33.33
Leaf: Width of blade	Narrow (<1 cm)	3	16	59.25
	Medium (1-2 cm)	5	04	14.81
	Broad (>2 cm)	7	07	25.92

Table 2: Continue...

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Culm: Attitude (for floating rice only)	Non procumbent	1	05	18.51
	Procumbent	9	22	81.48
Culm: Attitude	Erect	1	11	40.74
	Semi-erect	3	05	18.51
	Open	5	00	00
	Spreading	7	01	3.70
Time of heading (50% of plants	Very early (<71)	1	00	00
withpanicles) (days)	Early (71-90)	3	01	3.70
	Medium (91-110)	5	14	51.85
	Late (111-130)	7	00	00
	Very late (> 131)	9	12	44.44
Flag leaf: Attitude of blade	Erect	1	05	18.51
(early observation)	Semi-erect	3	13	48.14
	Horizontal	5	08	29.62
	Drooping	7	01	3.70
Spikelet: Density of	Absent	1	15	55.55
pubescence of lemma	Weak	3	02	7.40
	Medium	5	05	18.51
	Strong	7	04	14.81
	Very strong	9	01	3.70
Lemma: Anthocyanin	Absent/very weak	1	14	51.85
colouration of keel	Weak	3	01	3.70
	Medium	5	01	3.70
	Strong	7	03	11.11
	Very strong	9	00	00
Lemma: Anthocyanin colouration	Absent	1	14	51.85
of area belowapex	Weak	3	01	3.70
	Medium	5	01	3.70
	Strong	7	03	11.11
	Very strong	9	00	00
Lemma: Anthocyanin	Absent	1	14	51.85
colouration of apex	Weak	3	01	3.70
	Medium	5	01	3.70
	Strong	7	03	11.11
	Very strong	9	00	00
Spikelet: Colour	White	1	00	00
of stigma	Light green	2	08	29.62
	Yellow	3	02	7.40
	Light purple	4	00	00
	Purple	5	02	7.40
Stem: Thickness	Thin (<0.40 cm)	3	08	29.62
	Medium (0.40-0.55 cm)	5	03	11.11
	Thick (>0.55 cm)	7	16	59.25
Stem: Length (excluding panicle;	Very short (<91 cm)	1	12	44.44
excluding floating rice)	Short (91-110 cm)	3	15	55.55
	Medium (111-130 cm)	5	00	00
	Long (131-150 cm)	7	00	00
	Very long (>150 cm)	9	00	00
Stem: Anthocyanin	Absent	1	19	70.37
colouration of nodes	Present	9	08	29.62
Stem: Intensity of anthocyanin	Weak	3	02	7.40
colouration of nodes	Medium	5	01	3.40
	Strong	7	05	18.51

Table 2: Continue...

Stem: Anthocyanin colouration	Absent	1	05	18.51
of internodes	Present	9	08	29.62
Panicle: Lengthof main axis	Very short (<16cm)	1	04	14.81
	Short (16-20 cm)	3	00	00
	Medium (21-25 cm)	5	05	18.51
	Long (26-30 cm)	7	02	7.40
	Very long (>30 cm)	9	02	7.40
Flag leaf: Attitude of blade	Erect	1	04	14.81
(late observation)	Semi-erect	3	05	18.51
	Horizontal	5	01	3.40
	Deflexed	7	01	3.40
Panicle: Curvature of main axis	Straight	1	04	14.81
	Semi-straight	3	05	18.51
	Deflexed	5	00	00
	Dropping	7	02	7.40
Panicle: Numberper plant	Few (<11)	3	06	22.22
	Medium (11-20)	5	05	18.51
	Many (>20)	7	00	00
Spikelet: Colourof tip of lemma	White	1	00	00
	Yellowish	2	02	7.40
	Brown	3	04	14.81
	Red	4	00	00
	Purple	5	01	3.70
	Black	6	04	14.81
Lemma and Palea: Colour	Straw	1	01	3.40
	Gold and gold furrows on strawbackground	2	01	3.40
	Brown spots on straw	3	00	00
	Brown furrows on straw	4	00	00
	Brown (tawny)	5	01	3.40
	Reddish to light purple	6	01	3.40
	Purple spots/furrows on straw	7	03	11.11
	Purple	8	00	00
	Black	9	03	11.11
Panicle: Awns	Absent	1	01	3.40
	Present	9	01	3.40
Panicle: Presence of	Absent	1	02	7.40
secondary branching	Present	9	08	29.62
Panicle: Secondary branching	Weak	1	06	22.22
	Strong	2	02	7.40
	Clustered	3	00	00
Panicle: Attitude of branches	Erect	1	00	00
	Erect to semi-Erect	3	00	00
	Semi-erect	5	02	7.40
	Semi-erect to		00	00
	spreading	7	00	00
	Spreading	9	00	00
Panicle: Exsertion	Partly exserted	3	03	11.11
	Mostly exserted	5	00	00
	Well exserted	7	05	18.51
Grain: Weight of 1000 fully	Very low (<15 g)	1	02	7.40
developed grains	Low (15-20 g)	3	04	14.81
	Medium (21-25 g)	5	05	18.51

Table 2: Continue...

	High (26-30)	7	02	7.40
	Very high (>30 g)	9	01	3.40
Grain:length	Very short (<6.0 mm)	1	27	100
	Short (6.1-8.5 mm)	3	00	00
	Medium (8.6-10.5 mm)	5	00	00
	Long (10.6-12.5 mm)	7	00	00
	Very long (>12.5 mm)	9	00	00
Grain:width	Very narrow (<2.0 mm)	1	25	92.59
	Narrow (2.1-2.5 mm)	3	02	7.40
	Medium (2.6-3.0 mm)	5	00	00
	Broad (3.1-3.5 mm)	7	00	00
	Very broad (>3.5 mm)	9	00	00
Decorticated grain: Length	Short	1	14	51.85
	Medium	3	12	44.44
	Long	5	01	3.40
	Long*	7	00	00
	(Long for Basmati type) Extra long	9	00	00
	Medium (2.0-2.5 mm)	5	19	70.37
	Broad (>2.5 mm)	7	00	00
Decorticated grain: Shape	Short slender	1	17	62.96
(in lateral view)	Short bold	2	00	00
	Medium slender	3	01	3.70
	Long bold	4	00	00
	Long slender	5	06	22.22
	Long slender*	6	03	11.11
	(For Basmati type)			
	Extra-long slender			
Decorticated grain: colour	White	1	07	25.92
	Light brown	2	12	44.44
	Variegated brown	3	02	7.40
	Dark brown	4	03	11.11
	Light red	5	03	11.11
	Red	6	00	00
	Variegated purple	7	00	00
	Purple	8	00	00
	Dark purple	9	00	00

erect, 15% erect, 3% horizontal and deflexed), panicle curvature of main axis (19 semi straight, 15% straight, 7% drooping), spikelet colour of tip of lemma (15% brown and black, 7% yellowish, 4% purple, 3% straw), Lemma and Palea: colour (11% purple and black, 3.40% reddish, gold and brown), Panicle: presence of secondary branching (30% present, 7% absent) (Ndour *et al*. 2016), Panicle: secondary branching (22% weak, 7% strong), In the traditional growing areas of Asia, rices of various colors-red, black, brown, yellow and green have been known and grown, but for the present day generation, rice connotes pearly white grain. Colored rices have been preferred in the past for their special features such as medicinal value and exclusive taste. Flavoured, black rices were the favourites of the royals of China, while red rices were preferred by people in many parts of India, Sri Lanka and Bhutan. (Rood, 2000) Decorticated grain: colour (44% light brown, 30% white, 11% dark brown and light red, 7% variegated brown) (Rao *et al*., 2013; Tirkey *et al*., 2013; Mondal *et al*., 2014; Manjunatha *et al*., 2016; Kalyan *et al*., 2017; Umarani *et al*., 2017) and similar results has been reported earlier and some morphological characters showed similar type of variations in different accessions such as Lemma: anthocyanin colouration of keel, Lemma: anthocyanin colouration of area below apex, Lemma: anthocyanin colouration of apex.

Agronomic characterization

The quantitative characters also showed wide variation among all varieties (Table 2). Most of the Agronomic characters exhibited variations in various accessions except grain length. A majority of accessions were found to possess Grain: width (92.59% very narrow) and the balance 7.40%

Fig 1: Evaluation of indigenous rice cultivars from Tamil Nadu.

narrow genotypes possess kattu yanam and karudan samba. Leaf: length of blade (48% medium, 33% long, 19% short), Leaf: width of Blade (59% narrow, 26% broad, 15% medium), Stem: length (excluding panicle; excluding floating rice) (55% short), Panicle: number per plant (22% few, 19% medium), Grain: weight of 1000 fully developed grains consist of 19% medium, 15% low, 7% high, 7% (Illaapai poo samba (14.59 gram) and Milagu samba (14.84 gram) very low) and 3% (Mapillai Samba (30.41 gram) very high). By compare with the hybrid varieties, hybrid had higher grain weight than inbred varieties but traditional rice varieties have more over high in inbred and hybrid varieties. (Lu *et al*., 2020).

According to the DUS protocol decorticated rice grain length and width have been grouped into three categories short grains, medium grain and long grain, in decorticated grain width 70% of the accessions possessed medium and others were found various distributions. Decorticated grain: length possessed 52% short, 44% medium, 3% long. Seed shape have been used to differentiate the rice genotypes by various researchers (Bhattacharya and sowbhagya 1980) Decorticated grain: shape (63% of the varieties are short slender, 22% long slender and 11% possess Long slender (For Basmati type) Extra-long slender variety (sorna masuri, kattue vallai and kuzhiadichan) (Komala *et al*. 2017).

CONCLUSION

The identified variability and unique characteristics can be utilized for the development of varieties. Unique genotypes can be registered in PPV and FRA. Qualitative features such as dark green leaf colour, heavy pubescence on the leaf blade or purple surface, margin leaf blade etc. have been identified (Karuppu kavuni) and utilized for developing rice varieties with tolerant to leaf surface, related insects and diseases.

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Conflict of interests

The authors declare that there is no competing interest.

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