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Research Article

DUS Characterization of rice (*Oryza sativa* L.) landraces of wayanad, kerala

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Abstract
Sixty landraces of rice (*Oryza sativa* L.), including the aromatic genotypes collected from different parts of Wayanad, Kerala, and were characterized for both qualitative and quantitative characters following the guidelines from the International Union for the Protection of New Varieties of Plants (UPOV) and Protection of Plant Varieties and Farmer's Rights Authority (PPV&FRA). The experiment was conducted in Augmented Block Design with three check varieties (Kanchana, Uma and Aathira). Out of 25 descriptors studied, three characteristics were found monomorphic, seven were dimorphic, six were of trimorphic, seven were tetramorphic and decorticated grain shape showed five states of expression, and lemma and palea colour recorded six states of expression. This detailed characterization of Wayanad rice landraces is very important for rice breeding from the standpoint of selection and conservation of different landraces for further utilization in crop improvement programmes and also to seek protection under PPV&FR Act, 2001 of India.

Key words
DUS, Characterization, Rice landraces/farmer varieties, PPV & FR Act

Introduction

Wayanad is a part of Western Ghats and is considered as a "hot-spot" of biodiversity. This district is having maximum tribal population in Kerala and as a part of their rituals, the tribal people conserve many rice landraces. A total of 75 traditional rice varieties, including scented (Jeerakasala and Gandhakasala) and medicinal varieties has been reported in Wayanad district Rekha *et al*.(2011). 75 traditional rice varieties, including scented (Jeerakasala and Gandhakasala) and medicinal varieties Rekha *et al*.(2011). In recent years due to change in varietal spectrum and use of paddy fields for non-agricultural purposes, valuable rice germplasm of this region is disappearing fast Latha *et al.(* 2013). Hence, there is an urgent need for characterization and conservation of these traditional landraces.

In the evolution of rice and its genetic differentiation into distinct varietal groups, consumer quality preferences have played a significant role besides agro ecological factors. One such varietal group comprising the aromatic/scented rice in India which fetches higher price in domestic as well as international markets. Wayanad Jeerakasala rice and Wayanad Gandhakasala rice are the two unique aromatic rice's of Wayanad registered as Geographical Indications (GI) from Kerala Elsy *et al*.(2010); Elsy (2012).

The landraces are valuable as they possess a huge treasure of genetic material which is the base for future variety development programmes. Importance of landraces can never be denied in agriculture system, because improvement in existing variety depends upon desirable genes which are possibly present in landraces and wild varieties Holden *et al.(*1993). In this context, an attempt was made to characterize a set of sixty 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, for the IP protection over crop varieties including farmers' rights over traditional varieties. Protection of IP rights over varieties can be accomplished by their registration under this Act. Morphological characterization based on DUS (Distinctness, Uniformity and Stability) is the requisite for registering varieties under PPV&FR Act. Hence the programme is aiming for DUS characterization of sixty rice landraces of Wayanad District of Kerala, which is the 'Hot-spot' of biodiversity, using twenty- four agro-morphological characters, which may prove important in future variety development programmes.

Materials and Methods

Sixty landraces of rice (Table 1) collected from Wayanad district of Kerala were grown in an Augmented Block Design at the RARS farm, Ambalavayal, KAU, Situated at 11° 61' N latitude, 76° 21' E longitude and altitude of 938m above mean sea level. The collected landraces were grown in 6 blocks, along with three check varieties (Kanchana, Uma and Aathira), during *Nancha* (first crop) season, 2016. Each entry was sown in three rows of 20 plants each, at a spacing of 15 cm between plants and 20 cm between rows, and 1mt isolation distance has been maintained between two entries in each block. All the cultural practices followed according to package of practices of Kerala Agricultural University (KAU). Observations were recorded on 10 randomly selected plants of each genotype for all the traits under study, at different stages of growth with appropriate procedures as per the "Guidelines for the Conduct of Test for DUS on Rice" (PPV & FRA, 2007). The traits studied are reported in (Table 2).

Results and Discussion

A total of 60 rice land races was taken for DUS characterization using 25 characters which include 18 qualitative and seven quantitative 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 Rao *et al*.(2013); Tirkey *et al*.(2013); Mondal *et al.(* 2014); Manjunatha *et al*.(2016); Kalyan *et al*., (2017); and Umarani *et al*.(2017). Frequency distribution for all the characters under study were computed (in Table 2) and qualitative and quantitative characters of different agronomic and morphological parameters are given in Table 3.

Out of 60 landraces studied, no landraces exhibited the anthocyanin colouration of keel and anthocyanin colouration of area below apex of lemma. But, 45% landraces showed very strong anthocyanin coloration of apex, 18% landraces were strong type and remaining 37% landraces didn't shown anthocyanin coloration of apex. In case of density of pubescence of lemma, one landrace (Mangalapurampuncha) exhibited very strong pubescence, 62% landraces with strong pubescence, 27% landraces with medium type and 10% landraces have weak pubescence. In stigma colour, 62% cultivars exhibited purple stigma, 3% landraces were of light green stigma and 35% were of white stigma. With regard to colour of the lemma and palea, 17% of landraces were straw colour, 3% landraces recorded gold and gold furrows on straw background, 15% landraces were of brown spots on straw, 30% landraces were of brown furrows on straw, 22% landraces were of brown (tawny), 13% landraces were of purple black. All most all the landraces were of straw coloured sterile lemma, except for one landrace (Kayama) which have purple colour sterile lemma. For the 1000 grain weight, 10% landraces observed low grain weight (15-20 g), 18% landraces were of medium (21-25 g), 28% landraces were of high (26-30 g), and 43% landraces were of very high (>30 g). For grain length, 7% of landraces showed very short grain length, 75% with short, 17% with medium and one landrace (Sugandhamathi) had long grain length. For grain width, 22% landraces showed very broad grain width (>3.5 mm), 70% landraces with broad (3.1-3.5 mm), 7% landraces with medium (2.6-3.0 mm) and one landrace (Sugandhamathi) recorded for very narrow (<2.0 mm) grain type respectively.

With respect to panicle characters, 12% landraces were of deflexed and 88% landraces were of drooping type of panicle curvature of main axis. In case of panicle awns, 10% landraces (i.e. Kothandon, Mullanpuncha, Chomala 2, Jeerakasala, Sugandhamathi and Kayama) recorded the presence of awns. Out of which, five landraces observed yellowish brown and one landrace (Kothandon) had purple coloured awns. The awns distribution was limited to upper half only in Kothandon, Chomala 2, Sugandhamathi, whereas the awn was distribured through the entire length of panicle in case of Mullanpuncha, Jeerakasala and Kayama. All the 60 landraces have secondary branching, of which, 87% have clustered secondary branching, 12% landraces were strong type and one landrace (Mullanpuncha) exhibited weak secondary branching. For the character attitude of branches in panicle, erect to semi-erect was observed in 10% landraces, 7% landraces were of semi erect, 27% landraces were of semi-erect to spreading type and 57% landraces were of spreading type. For panicle exertion from flag leaf, 93% cultivars with exerted and 7% landraces with mostly exerted type. Panicle length of main axis for 3% cultivars was of short, 32% landraces were of medium, 57% landraces were of long and 8% landraces were of very long type. With respect to panicle number per plant, 88% landraces exhibited few in number and 12% landraces were of medium type.

With respect to kernel traits, for decorticated grain shape, 5% landraces were of short slender type, 8.33% landraces were of short bold, 3% landraces exhibited medium slender type, 82% landraces were of medium bold type and one landrace (Sugandhamathi) recorded long slender type. For the character colour of the decorticated grain, 28% landraces were of white in colour, 22% landraces light red type and 50% landraces exhibited red type kernels. Aroma of decorticated grain was recorded in four landraces (namely Gandhakasala, Jeerakasala, Sugandhamathi and Gandhakasala dwarf). For the character kernel length, 63%

landraces have short length, 35% landraces with medium length and one landrace (Sugandhamathi) recorded long type kernel. With respect to kernel width, broad type of kernel is exhibited for 87% landraces and 13% landraces were of medium width type.

Out of four aromatic landraces recorded, Jeerakasala and Gandhakasala are the two most popular traditional aromatic rice (non-basmati) cultivars of Wayanad district, famous for their characteristic fragrance and aroma, mainly cultivated by Wayanad chettis, kurichya and kuruma tribal group, and are registered as Geographical Indication (GI) from Kerala during 2010 Elsy *et al*.(2010).

It is concluded that out of 60 landraces evaluated for 25 descriptors, three characteristics *viz*., panicle presence of secondary branching, anthocyanin colouration of area below apex of lemma, anthocyanin colouration of keel of lemma were found monomorphic. Seven characteristics *viz.*, curvature of main axis of panicle, panicle awns, panicle exertion, sterile lemma colour, decorticated grain aroma, Panicle number per plant, decorticated grain width were dimorphic. Six characteristics *viz*., decorticated grain length, decorticated grain colour, panicle secondary branching, panicle colour of awns, spikelet colour of stigma, anthocyanin colouration of apex of lemma were of trimorphic. Seven characteristics *viz*., density of pubescence of lemma of spikelet, distribution of awns of panicle, attitude of branches of panicle, panicle length of main axis, weight of 1000 fully developed grains, grain length and grain width were of tetramorphic. Decorticated grain shape showed five states of expression and lemma and palea colour recorded six states of expression. This information on characterization will be useful for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes for crop improvement. The information generated on these varieties may also support their registration with the PPV&FRA.

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Table 1. List of sixty rice landraces and place of collection

Sl. No.	Genotype Name	Sl. No.	Genotype Name
1	Kalladiyaran	31	Chenthadi
2	Thondi 1	32	Peruvaya
3	Ambalavayal 1	33	Palthondi
4	Ayirankana	34	Vaalicha
5	Palveliyan	35	Veliyathondi
6	Kannali	36	Edavaga
7	Chomala	37	Velumpala
8	Keervana	38	Kumbali
9	Kothandon	39	Adukkan
10	Kannikayama	40	Ambalavayal 2
11	Addy	41	Urunikayama
12	Koduveliyan	42	Gandhakasala
13	Thondi 2	43	Kothandan
14	Chenthondi	44	Thavalakannan
15	Mangalapuram puncha	45	Kunam kulumban
16	Chennellu	46	Chomala 2
17	Punnadanthondi	47	Jeerakasala
18	Puttabetta	48	Kuttiveliyan
19	Rajameni	49	Thonnooran thondi
20	Chettuveliyan	50	Chomala 1
21	Kuruva	51	Rasagatham
22	Mullakuruva	52	Njavara
23	Mannuveliyan	53	Sugandhamathi
24	Njavara black	54	Palthondimatta
25	Veliyan	55	Vellimuthu
26	Mahikuruva	56	Marathondi
27	Valichoori	57	Kayama
28	Urulankayama	58	Onamottan
29	Thondi 3	59	Karimpalan
30	Mullanpuncha	60	Gandhakasala dwarf
Place of collection : Wayanad district, Kerala			

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

Sl. No.	Characteristics	States	Note	Number of genotypes	Frequency distribution (%)
1	Spikelet: Density of pubescence of lemma	Absent	1	00	0.00
		Weak	3	06	10.00
		Medium	5	16	26.67
		Strong	7	37	61.67
		Very strong	9	01	1.67
2	Lemma: Anthocyanin colouration of keel	Absent or very weak	1	60	100.00
		Weak	3	00	0.00
		Medium	5	00	0.00
		Strong	7	00	0.00
		Very strong	9	00	0.00
3	Lemma: Anthocyanin colouration of apex	Absent	1	22	36.67
		Weak	3	00	0.00
		Medium	5	00	0.00
		Strong	7	11	18.33
		Very strong	9	27	45.00
4	Lemma: Anthocyanin colouration of area below apex	Absent	1	60	100.00
		Weak	3	00	0.00
		Medium	5	00	0.00
		Strong	7	00	0.00
		Very strong	9	00	0.00
5	Spikelet: Colour of stigma	White	1	21	35.00
		Light green	2	02	3.33
		Yellow	3	00	0.00
		Light purple	4	00	0.00
		Purple	5	37	61.67
6	Panicle: Curvature of main axis	Straight	1	00	0.00
		Semi-straight	3	00	0.00
		Deflexed	5	07	11.67
		Dropping	7	53	88.33
7	Lemma and Palea: Colour	Straw	1	10	16.67
		Gold and gold furrows on straw background	2	02	3.33
		Brown spots on straw	3	09	15.00
		Brown furrows on straw	4	18	30.00
		Brown (tawny)	5	13	21.67
		Reddish to light purple	6	00	0.00
		Purple spots /	7	00	0.00
		furrows on straw	8	00	0.00
		Purple Black	9	08	13.33
8	Panicle: Awns	Absent	1	54	90.00
		Present	9	06	10.00
9	Panicle: Colour of awns	Absent	1	54	90.00
		Yellowish White	1	00	0.00
		Yellowsh Brown	2	05	8.33
		Brown	3	00	0.00
		Reddish brown	4	00	0.00
		Light red	5	00	0.00
		Red	6	00	0.00
		Light purple	7	00	0.00
		Purple	8	01	1.67
		Black	9	00	0.00
10	Panicle: Distribution of awns	Absent	1	54	90.00
		Tip only	3	03	5.00
		Upper half only	5	01	1.67
		Whole length	7	02	3.33
11	Panicle : Presence of secondary branching	Absent	1	00	0.00
		Present	9	60	100.00
12	Panicle: Secondary branching	Weak	1	01	1.67
		Strong	2	07	11.67
		Clustered	3	52	86.67

13	Panicle: Attitude of branches	Erect	1	00	0.00
		Erect to semi-Erect	3	06	10.00
		Semi-erect	5	04	6.67
		Semi-erect to spreading	7	16	26.67
		Spreading	9	34	56.67
14	Panicle: Exertion	Partly exerted	3	00	0.00
		Mostly exerted	5	04	6.67
		Well exerted	7	56	93.33
15	Sterile lemma: Colour	Straw	1	59	98.33
		Gold	2	00	0.00
		Red	3	00	0.00
		Purple	4	01	1.67
16	Decorticated grain: Shape	Short slender	1	03	5.00
		Short bold	2	05	8.33
		Medium slender	3	02	3.33
		Medium bold	4	49	81.67
		Long slender	5	01	1.67
		Long bold	6	00	0.00
		Extra long slender	7	00	0.00
17	Decorticated grain: Colour	White	1	17	28.33
		Light brown	2	00	0.00
		Variegated brown	3	00	0.00
		Dark brown	4	00	0.00
		Light red	5	13	21.67
		Red	6	30	50.00
		Variegated purple	7	00	0.00
		Purple	8	00	0.00
		Dark purple	9	00	0.00
18	Decorticated grain: Aroma	Absent	1	56	93.33
		Present	9	04	6.67
19	Panicle: Length of main axis	Very short (<16 cm)	1	00	0.00
		Short (16-20 cm)	3	02	3.33
		Medium (21-25 cm)	5	19	31.67
		Long (26-30 cm)	7	34	56.67
		Very long (>30 cm)	9	05	8.33
20	Panicle: Number per plant	Few (<11)	3	53	88.33
		Medium (11-20)	5	07	11.67
		Many (>20)	7	00	0.00
21	Grain: Weight of 1000 fully developed grains	Very low (<15 g)	1	00	0.00
		Low (15-20 g)	3	06	10.00
		Medium (21-25 g)	5	11	18.33
		High (26-30)	7	17	28.33
		Very high (>30 g)	9	26	43.33
22	Grain: Length	Very short (<6.0 mm)	1	04	6.67
		Short (6.1-8.5 mm)	3	45	75.00
		Medium (8.6-10.5 mm)	5	10	16.67
		Long (10.6-12.5 mm)	7	01	1.67
		Very long (>12.5 mm)	9	00	0.00
23	Grain: Width	Very narrow (<2.0 mm)	1	01	1.67
		Narrow (2.1-2.5 mm)	3	00	0.00
		Medium (2.6-3.0 mm)	5	04	6.67
		Broad (3.1-3.5 mm)	7	42	70.00
		Very broad (>3.5 mm)	9	13	21.67
24	Decorticated grain: Length	Short (<6 mm)	1	38	63.33
		Medium (6.1-8.0 mm)	3	21	35.00
		Long (8.1-10.0 mm)	5	01	1.67
		Extra-long (>10 mm)	7	00	0.00
25	Decorticated grain: Width	Narrow (<2.0 mm)	3	00	0.00
		Medium (2.0-2.5 mm)	5	08	13.33
		Broad (>2.5 mm)	7	52	86.67

Table.3. Characterization of rice landraces (total 60) as per DUS guidelines

Sl. No.	Genotype	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
1	Kanchana (Check)	5	1	1	1	1	7	4	1	1	1	9	2	7	7	1	4	6	1	3	5	9	3	7	3	7
2	Uma (Check)	5	1	1	1	1	7	3	1	1	1	9	2	7	7	1	4	6	1	5	5	7	3	7	1	7
3	Athira (Check)	7	1	1	1	1	7	2	1	1	1	9	3	9	7	1	4	6	1	7	3	7	3	7	3	7
4	Kalladiyaran	7	1	1	1	1	7	5	1	1	1	9	3	7	7	1	4	6	1	7	5	9	3	9	3	7
5	Thondi 1	7	1	9	1	5	7	4	1	1	1	9	3	9	7	1	4	6	1	7	3	9	3	7	3	7
6	Ambalavayal 1	5	1	1	1	1	7	5	1	1	1	9	3	9	7	1	4	6	1	7	3	7	3	7	1	7
7	Ayirankana	7	1	9	1	5	7	3	1	1	1	9	3	5	5	1	4	6	1	5	3	9	5	9	3	7
8	Palveliyan	7	1	9	1	5	7	3	1	1	1	9	3	9	7	1	4	1	1	7	3	9	3	7	1	7
9	Kannali	3	1	9	1	5	7	9	1	1	1	9	3	7	7	1	4	5	1	7	3	9	5	9	3	7
10	Chomala	7	1	1	1	1	7	2	1	1	1	9	3	9	7	1	4	5	1	7	3	7	3	7	1	7
11	Keervana	7	1	9	1	5	7	9	1	1	1	9	3	9	7	1	4	5	1	7	3	7	3	7	1	7
12	Kothandon	7	1	9	1	5	7	9	9		3	9	3	9	7	1	4	5	1	7	3	7	3	7	3	7
13	Kannikayama	7	1	9	1	5	7	1	1	1	1	9	3	7	7	1	4	6	1	5	5	9	3	7	1	7
14	Addy	7	1	1	1	1	7	3	1	1	1	9	2	3	7	1	2	1	1	5	3	3	1	7	1	7
15	Koduveliyan	7	1	7	1	5	7	4	1	1	1	9	2	7	7	1	4	6	1	5	5	7	3	7	1	7
16	Thondi 2	7	1	9	1	5	7	4	1	1	1	9	3	7	7	1	4	6	1	7	3	9	3	7	3	7
17	Chenthondi	7	1	9	1	5	7	9	1	1	1	9	3	9	7	1	4	5	1	7	3	7	3	9	3	7
18	Mangalapuram puncha	9	1	1	1	1	7	4	1	1	1	9	3	7	7	1	4	6	1	7	3	9	3	9	3	7
19	Chennellu	7	1	9	1	1	7	5	1	1	1	9	3	7	7	1	4	5	1	5	3	7	3	7	1	7
20	Punnadanthondi	7	1	7	1	1	7	4	1	1	1	9	3	7	7	1	4	6	1	5	3	9	3	7	1	7
21	Puttabetta	5	1	7	1	5	7	4	1	1	1	9	3	9	7	1	4	1	1	7	3	9	3	7	3	7
22	Rajameni	7	1	9	1	5	7	4	1	1	1	9	3	7	7	1	4	5	1	7	3	5	3	7	1	5
23	Chettuveliyan	7	1	9	1	5	7	3	1	1	1	9	3	9	7	1	4	1	1	7	3	9	3	7	1	7
24	Kuruva	3	1	9	1	5	7	3	1	1	1	9	3	5	7	1	2	6	1	7	3	5	3	7	1	7
25	Mullakuruva	7	1	1	1	1	5	4	1	1	1	9	3	3	7	1	2	6	1	5	3	5	3	7	1	7
26	Mannuveliyan	5	1	9	1	5	5	5	1	1	1	9	3	9	7	1	4	6	1	7	3	7	3	7	1	7
27	Njavara black	3	1	1	1	1	5	9	1	1	1	9	2	3	7	1	4	6	1	5	3	5	3	7	1	5
28	Veliyan	7	1	9	1	5	7	5	1	1	1	9	3	7	7	1	4	6	1	7	3	7	3	7	1	7
29	Mahikuruva	7	1	1	1	1	5	5	1	1	1	9	3	3	7	1	2	1	1	5	3	3	1	7	1	5
30	Valichoori	5	1	1	1	1	5	4	1	1	1	9	3	7	5	1	4	6	1	5	3	9	5	9	3	7
31	Urulankayama	5	1	9	1	5	7	1	1	1	1	9	3	9	7	1	4	1	1	5	5	5	3	7	1	7
32	Thondi 3	3	1	1	1	1	7	5	1	1	1	9	3	7	7	1	4	6	1	5	3	9	5	9	3	7
33	Mullanpuncha	5	1	1	1	1	7	9	9	2	7	9	1	7	7	1	4	5	1	7	3	7	5	7	1	7

34	Chenthadi	7	1	9	1	5	7	9	1	1	1	9	3	9	7	1	4	5	1	7	3	7	3	7	1	7
35	Peruvaya	7	1	9	1	5	7	4	1	1	1	9	3	9	7	1	4	6	1	7	3	9	5	9	3	7
36	Palthondi	7	1	9	1	5	7	1	1	1	1	9	3	9	7	1	4	1	1	7	3	5	3	7	1	7
37	Vaalicha	5	1	9	1	5	7	1	1	1	1	9	3	9	7	1	4	6	1	7	3	9	3	7	1	7
38	Veliyathondi	5	1	9	1	5	5	4	1	1	1	9	3	9	7	1	4	6	1	7	3	9	3	7	1	7
39	Edavaga	7	1	9	1	5	7	3	1	1	1	9	3	9	7	1	4	5	1	5	3	7	3	7	1	7
40	Velumpala	5	1	9	1	5	7	1	1	1	1	9	3	9	7	1	4	1	1	7	3	7	3	7	3	7
41	Kumbali	7	1	9	1	5	7	4	1	1	1	9	3	9	7	1	4	5	1	7	3	9	3	9	3	7
42	Adukkan	7	1	7	1	5	7	4	1	1	1	9	3	9	7	1	4	6	1	5	3	9	3	9	1	7
43	Ambalavayal 2	5	1	9	1	5	7	2	1	1	1	9	3	9	7	1	4	1	1	7	3	7	3	7	1	7
44	Urunikayama	7	1	9	1	5	7	3	1	1	1	9	3	9	7	1	2	1	1	7	3	3	1	7	1	7
45	Gandhakasala	7	1	1	1	2	7	3	1	1	1	9	3	9	7	1	1	1	9	9	3	3	3	5	1	5
46	Kothandan	7	1	7	1	5	7	5	1	1	1	9	3	9	5	1	4	6	1	7	5	9	3	9	1	7
47	Thavalakannan	3	1	9	1	5	7	5	1	1	1	9	3	3	7	1	4	6	1	5	3	5	3	7	1	7
48	Kunam kulumban	7	1	1	1	1	7	5	1	1	1	9	3	9	7	1	3	5	1	7	3	5	5	7	1	5
49	Chomala 2	7	1	1	1	1	7	4	9	2	3	9	3	9	7	1	4	2	1	9	3	5	3	7	1	7
50	Jeerakasala	5	1	1	1	1	7	1	9	2	5	9	3	9	7	1	3	1	9	9	3	5	3	5	3	5
51	Kuttiveliyan	7	1	7	1	5	7	1	1	1	1	9	3	9	7	1	4	1	1	7	3	9	3	7	1	7
52	Thonnooran thondi	7	1	7	1	5	7	5	1	1	1	9	2	5	5	1	4	6	1	7	5	9	3	7	3	7
53	Chomala 1	7	1	1	1	1	7	4	1	1	1	9	3	9	7	1	4	6	1	7	3	7	3	7	1	7
54	Rasagatham	5	1	1	1	1	5	5	1	1	1	9	2	3	7	1	1	1	1	5	3	1	1	5	1	5
55	Njavara	5	1	1	1	1	7	5	1	1	1	9	3	5	7	1	4	6	1	7	3	9	3	7	3	7
56	Sugandhamathi	3	1	1	1	1	7	1	9	2	3	9	2	7	7	1	5	1	9	5	3	7	7	3	5	7
57	Palthondimatta	5	1	7	1	5	7	4	1	1	1	9	3	9	5	1	4	6	1	7	3	9	3	9	1	5
58	Vellimuthu	7	1	7	1	5	7	4	1	1	1	9	3	7	7	1	4	6	1	5	3	9	5	7	3	7
59	Marathondi	5	1	7	1	5	7	4	1	1	1	9	3	9	7	1	4	6	1	7	3	7	5	7	3	7
60	Kayama	7	1	1	1	1	7	1	9	2	7	9	3	9	7	3	4	1	1	9	3	5	3	7	1	7
61	Onamottan	5	1	7	1	5	7	1	1	1	1	9	2	9	7	1	4	6	1	7	5	9	5	9	3	7
62	Karimpalan	7	1	7	1	5	7	9	1	1	1	9	3	7	7	1	4	5	1	5	3	9	3	7	3	7
63	Gandhakasala dwarf	7	1	1	1	2	7	3	1	1	1	9	3	9	7	1	1	1	9	9	3	3	3	7	1	5

(A) Spikelet: Density of pubescence of Lemma, **(B)** Lemma: Anthocyanin colouration of keel, **(C)** Lemma: Anthocyanin colouration of apex, **(D)** Lemma: Anthocyanin colouration of area below apex, **(E)** Spikelet: Colour of stigma, **(F)** Panicle: Curvature of main axis, **(G)** Lemma and Palea: Colour, **(H)** Panicle: Awns, **(I)** Panicle: Colour of awns, **(J)** Panicle: Distribution of awns, **(K)** Panicle: Presence of secondary branching, **(L)** Panicle: Secondary branching, **(M)** Panicle: Attitude of branches, **(N)** Panicle: Exertion, **(O)** Sterile lemma: Colour, **(P)** Decorticated grain: Shape, **(Q)** Decorticated grain: Colour, **(R)** Decorticated grain: Aroma, **(S)** Panicle: Length of main axis, **(T)** Panicle: Number per plant, **(U)** Grain: Weight of 1000 fully developed grains, **(V)** Grain: Length, **(W)** Grain: Width, **(X)** Decorticated grain: Length, **(Y)** Decorticated grain: Width

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Fig 1. Stereomicroscopic evaluation of grains of sixty rice landraces

(1) Kalladiyaran, **(2)** Thondi 1, **(3)** Ambalavayal 1, **(4)** Ayirankana, **(5)** Palveliyan, **(6)** Kannali, **(7)** Chomala, **(8)** Keervana, **(9)** Kothandon, **(10)** Kannikayama, **(11)** Addy, **(12)** Koduveliyan, **(13)** Thondi 2, **(14)** Chenthondi, **(15)** Mangalapuram puncha, **(16)** Chennellu, **(17)** Punnadanthondi, **(18)** Puttabetta, **(19)** Rajameni, **(20)** Chettuveliyan, **(21)** Kuruva, **(22)** Mullakuruva, **(23)** Mannuveliyan, **(24)** Njavara black, **(25)** Veliyan, **(26)** Mahikuruva, **(27)** Valichoori, **(28)** Urulankayama, **(29)** Thondi 3, **(30)** Mullanpuncha, **(31)** Chenthadi, **(32)** Peruvaya, **(33)** Palthondi, **(34)** Vaalicha, **(35)** Veliyathondi, **(36)** Edavaga, **(37)** Velumpala, **(38)** Kumbali, **(39)** Adukkan, **(40)** Ambalavayal 2, **(41)** Urunikayama, **(42)** Gandhakasala, **(43)** Kothandan, **(44)** Thavalakannan, **(45)** Kunam kulumban, **(46)** Chomala 2, **(47)** Jeerakasala, **(48)** Kuttiveliyan, **(49)** Thonnooran thondi, **(50)** Chomala 1, **(51)** Rasagatham, **(52)** Njavara, **(53)** Sugandhamathi, **(54)** Palthondimatta, **(55)** Vellimuthu, **(56)** Marathondi, **(57)** Kayama, **(58)** Onamottan, **(59)** Karimpalan, **(60)** Gandhakasala dwarf

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25 	26 	27 	28 	29 	30 
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