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Diversity of traditional and improved rice cultivars for seed characteristics

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Abstract
The main objective of this study was to access the existing diversity for seed characteristics in the collected traditional and improved cultivars. The rice collection for diversity analysis consists of 82 traditional and 14 improved cultivars. Clustering pattern of 96 traditional and improved cultivars for 12 seed characteristics revealed fifteen clusters, cluster I having maximum 57 cultivars. There is high diversity among the traditional rice cultivars for seed characteristics, which represents great importance of traditional cultivars for breeding programs on quality traits.

Keywords: Rice, traditional cultivars, seed characteristics, diversity

1. Introduction
Agriculture relies heavily on the genetic diversity of crop plants. It is estimated that not even 15 percent of the potential diversity has been utilized. Thousands of valuable allelic variations of traits of economic significance remain unutilized in nearly all crop plants. Rice (Oryza sativa L.) is the most important staple food crop in the world. Breaking the yield ceiling through genetic improvement becomes the priority in rice research. Although, yield was improved using these breeding strategies, the grain quality characteristics of rice remains stagnated and attention given to grain quality is on the rise. Premium quality characteristics for rice are slender and translucent grains, stable high milled rice and head rice yields, good cooking and eating quality, and aroma (Juliano 1996) [2]. Quality preference has become evident in the domestic market (Andales *et al*. 1995) [1]. Traditional rice cultivars may provide the genetic diversity needed to diversify the desperate gene pool for seed or grain characteristics. Despite the importance of seed characteristics, very little work has been done on the evaluation and characterization of rice germplasm. Therefore the main objective of this study was to access the existing diversity for seed characteristics in the collected traditional and improved rice cultivars.

2. Materials and Methods
2.1 Seed material
The seed collection for diversity analysis consists of traditional and improved cultivars. The collection consists of 96 cultivars of which 82 are traditional cultivars and 14 improved cultivars (Table 1). About 76 traditional cultivars were collected from an NGO at Adhirangam and six cultivars were from Kerala. The improved cultivars were collected from the central farmyard of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. The seed of traditional and improved cultivars were repacked and labelled serially.

Table 1: List of collected traditional and improved rice cultivars

S. No.	Traditional Cultivars	Place collected	S. No.	Traditional Cultivars	Place collected
1	Ananthanoor Sannam	Tamil Nadu	20	Kalo Moda	Tamil Nadu
2	Anash Pal	Tamil Nadu	21	Karikaja Valli	Tamil Nadu
3	Illupaipoo Samba	Tamil Nadu	22	Kamini	Tamil Nadu
4	Urasal	Tamil Nadu	23	Kantha Kar	Tamil Nadu
5	Ottayanam	Tamil Nadu	24	Kaveer Sari	Tamil Nadu
6	Kattu Samba	Tamil Nadu	25	Kari Satti	Tamil Nadu
7	Kattu Ponni	Tamil Nadu	26	Kichili Samba	Tamil Nadu
8	Karupu Seeraga Samba	Tamil Nadu	27	Kuruvi Kar	Tamil Nadu
9	Kanda Saali	Tamil Nadu	28	Kuzhi Vedichan	Tamil Nadu
10	Kappa Samba	Tamil Nadu	29	Kuruvi Kalanjiam	Tamil Nadu
11	Katha Malli Samba	Tamil Nadu	30	Kuda Vazhai	Tamil Nadu
12	Karupu Kavuni	Tamil Nadu	31	Kunsi	Tamil Nadu
13	Kamban Samba	Tamil Nadu	32	Kulla Kar	Tamil Nadu
14	Karudan Samba	Tamil Nadu	33	Koom Palai	Tamil Nadu
15	Kadar Swar	Tamil Nadu	34	Kaivari Samba	Tamil Nadu
16	Kar Nel	Tamil Nadu	35	Kosuva Kalthanai	Tamil Nadu
17	Kanda Vari	Tamil Nadu	36	Kottara Samba	Tamil Nadu
18	Kanda Raji	Tamil Nadu	37	Kovintha Vok	Tamil Nadu
19	Kandavavi Samba	Tamil Nadu	38	Kole	Tamil Nadu

Sl. No.	Traditional Cultivars	Place collected	Sl. No.	Traditional Cultivars	Place collected
39	Sannaki Patti	Tamil Nadu	69	Vadan Samba	Tamil Nadu
40	Samba Mosanam	Tamil Nadu	70	Vasanai Seeraga Samba	Tamil Nadu
41	Saatha Moda	Tamil Nadu	71	Vellai Kar	Tamil Nadu
42	Sivappu Kurivikar	Tamil Nadu	72	Haimayi	Tamil Nadu
43	Singini	Tamil Nadu	73	Halara Samba	Tamil Nadu
44	Chitti Sandai	Tamil Nadu	74	Haluvupavu Patti	Tamil Nadu
45	Chinna Ponni	Tamil Nadu	75	Hopila	Tamil Nadu
46	Chittika Patti	Tamil Nadu	76	HMT	Tamil Nadu
47	Sumothi	Tamil Nadu	77	Ratna	Kerala
48	Sempalai Samba	Tamil Nadu	78	Mundagan	Kerala
49	Salem Samba	Tamil Nadu	79	Palliyaral	Kerala
50	Sornavari	Tamil Nadu	80	Thavalakannan	Kerala
51	Sorir Pona	Tamil Nadu	81	Cherutheeni	Kerala
52	Thanga Samba	Tamil Nadu	82	Vellaipunaran	Kerala
53	Thalmukoor	Tamil Nadu			
54	Thulasi Vasam	Tamil Nadu	**S. No.**	**Improved Cultivars**	**Place collected**
55	Thooyamalli	Tamil Nadu	83	ADT 38	Karaikal
56	Thengaipoo Samba	Tamil Nadu	84	ADT 39	Karaikal
57	Narikal Saari	Tamil Nadu	85	ADT 43	Karaikal
58	Niko	Tamil Nadu	86	ADT 45	Karaikal
59	Neela Samba	Tamil Nadu	87	ADT 46	Karaikal
60	Panagattu Kudavazhai	Tamil Nadu	88	ADT 48	Karaikal
61	Patnayi	Tamil Nadu	89	ADT 49	Karaikal
62	Basumathi	Tamil Nadu	90	ASD 18	Karaikal
63	Mattakuruvai	Tamil Nadu	91	CR 1009	Karaikal
64	Mappilai Samba	Tamil Nadu	92	KKL(R) – 1	Karaikal
65	Muthirai Sannam	Tamil Nadu	93	Samba Masuri	Karaikal
66	Mysore Malli	Tamil Nadu	94	TKM 9	Karaikal
67	Rathna Chutti	Tamil Nadu	95	TRY – 1	Karaikal
68	Varittarpana Sooli	Tamil Nadu	96	White Ponni	Karaikal

2.2 Seed characterisation

The 82 traditional cultivars and 14 improved cultivars were observed and scored for following seed characteristics using the IRRI's Standard Evaluation System.

1. Awning
2. Awn colour
3. Apiculous colour
4. Lemma and Palea colour
5. Lemma and palea pubescence
6. Sterile lemma colour
7. Sterile lemma
8. Grain length
9. Grain size
10. Seed index
11. Translucency
12. Chalkiness

2.3 Diversity analysis

The data of seed characters of 96 cultivars were analyzed by using diversity analysis software DARwin5 (Perrier *et al*., 2003; Perrier and Jacquemoud-Collet, 2006) [3, 4]. The morphological scores of seed characters data was converted to text tab limited format and the text were imported in DARwin. The dissimilarity index was as follows:

$$d_{ij} = \frac{u}{2m + u}$$

Where,

d_{ij} : dissimilarity between units *i* and *j*

u : number of unmatching variables

m : number of matching variables

The tree were constructed by using hierarchical clustering. The cluster analysis and dendrogram was constructed by Unweighted Pair Group Method (UPGMA).

3. Results

Data scored for twelve seed characteristics in 82 traditional cultivars and 14 improved cultivars were subjected for calculating dissimilarity index. Phylogenetic tree and principle coordinate's analysis methods constitute two very different approaches for the representation of diversity structure. Tree methods tend to represent individual relations faithfully and may be less accurate for the overall structure. On the other hand, principal coordinates methods aim mainly to give an overall representation of diversity and are not really interested in individual effects. They are thus two different ways of viewing the data and must be considered complementary rather than concurrent.

3.1 Clustering analysis

Genetic dissimilarities obtained from seed characteristic data of 96 cultivars were used to create a cluster diagram. Cluster analysis based on hierarchical clustering corresponds to the definition of neighbourhood according to the minimal dissimilarity using UPGMA grouped cultivars into fifteen clusters (Table 2). Genetic dissimilarity among 96 cultivars s as revealed by UPGMA cluster analysis based on seed characteristic is represented as radial tree structure in Figure 1. Clusters of each group are highlighted in different colours.

Table 2: Clustering of 96 traditional and improved rice cultivars for seed characteristics

Cluster No.	Cultivar No.
I	3,4,5,7,8,9,11,13,14,15,17,20,21,23,24,25,28,30,36,39,40,42,43,44,47,51,52,53,54,55, 56,57,58,59,60,63,65,66,68,69,70,71,72,74,75,76,77,79,81,82,85,88,91,92,93,94,96
II	27,32
III	64,80
IV	83,87,90
V	84,86
VI	89,95
VII	19,32
VIII	37,38
IX	73,78
X	2,22
XI	61,62
XII	6,10,16,48,67
XIII A	1,26,49
XIII B	45,50
XIV-A	12
XIV-B	18,33
XV A	35
XV B	29,31,41,46

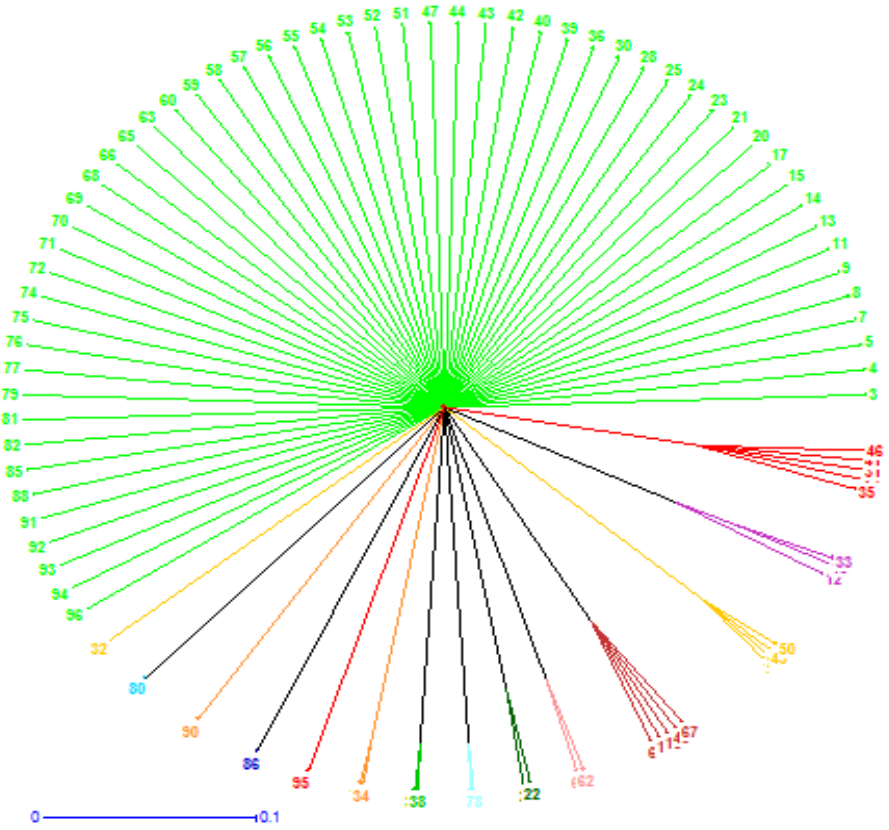

Fig 1: Radial tree structure of 96 traditional and improved rice cultivars for seed characteristics using UPGMA hierarchical clustering analysis.

3.2 Principal coordinates analysis (PCoA)

Principal coordinates analysis (PCoA) is a member of the factorial analysis family working on distance matrices. It considers the space of high dimension defined by the distances between units two by two. The output is the list of coordinates of each unit on each axis. The coordinate of a unit on an axis is given by the projection of this unit on this axis. But this unit is well represented by its projection only if the distance between the unit in the full space and its projection on the axis is small. Principal coordinates analysis showing the relationship between clusters of 96 traditional and improved cultivars for seed characteristics is presented in Figure 2.

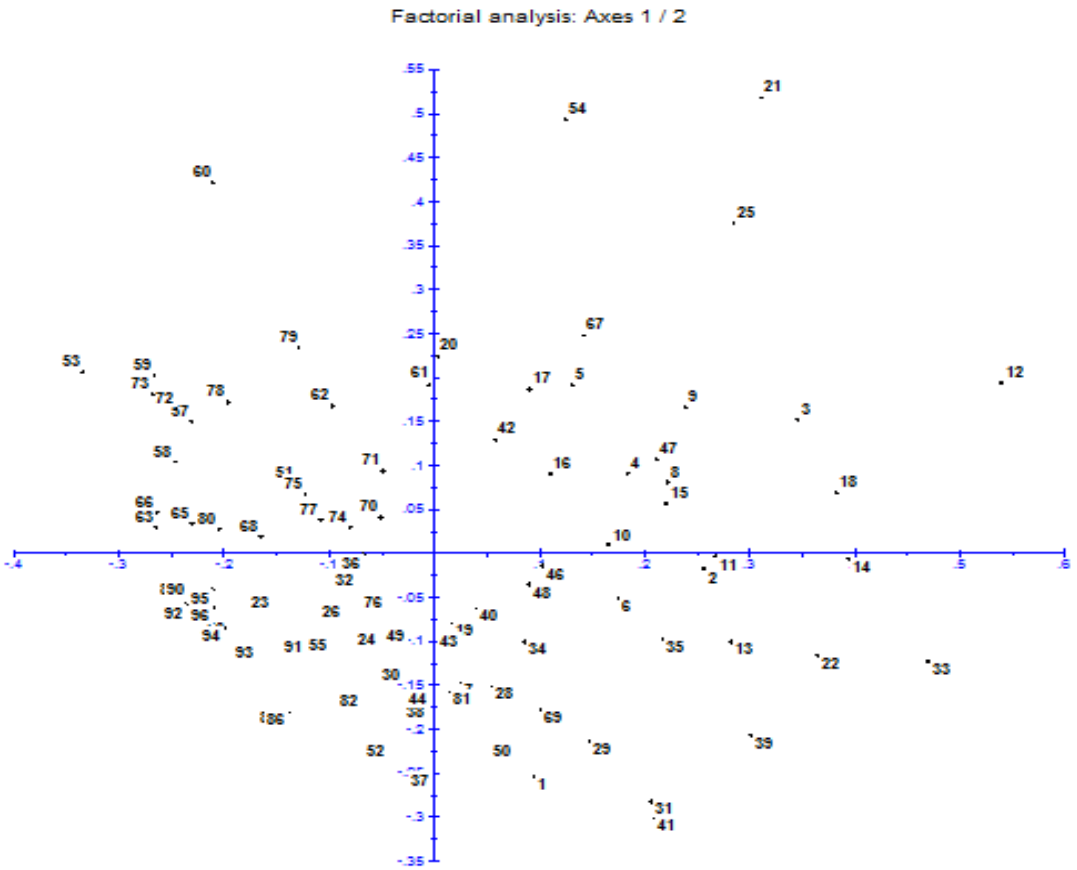

Fig 2: Principal coordinates analysis (PCoA) showing the relationship between 96 traditional and improved cultivars for seed characteristics

4. Discussion

A total of 96 rice cultivars that comprises of 82 traditional cultivars were collected from an NGO at Adhirangam and Kerala, 14 improved cultivars were collected from the central farmyard of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. All the cultivars are scored for seed characteristics such as awning, awn colour, apiculous colour, lemma and palea colour, lemma and palea pubescence, sterile lemma colour, sterile lemma, grain length, grain size, seed index, transluency and chalkiness using the IRRI's Rice descriptor score chart. The glimpse of seed characteristics of collected traditional and improved rice cultivars are presented in Plate 1. From the plates observation it was clear that traditional cultivars have wide variability for seed characteristics.

The physical dimensions of rice kernels are of vital interest to those engaged in the rice industry. These dimensions are important in marketing and grading, in developing new rice cultivars, in cleaning and grading equipment, in drying operations, and in processing. These include the seed and grain size, shape and weight. These can be determined by careful measurement of the seed and grain of the rice kernels.

Appearance is an another critical quality attribute for rice. Rice buyers and consumers judge the quality of the rice on the uniformity of its size and shape as well as the appearance of its overall size-shape relationship. Grouping of cultivars is made on the basis of sizes: long, medium or short. Rice of different sizes adversely affects the milling quality and yield; therefore, proper segregation of grain according to sizes is absolutely necessary to improve the milling quality of rice.

The length and width of the seed rice are variable, sometimes even within a cultivar, because of the variation in the length of the awn and the pedicel. The size and shape (seed width) is a stable varietal property that can be used to identify a cultivar. Rice cultivars are classified as short, medium, or long grain by rough kernel dimension ratio. Since kernel type and dimension are of importance to the millers and processors, these characteristics are considered in the breeding of a new variety.

Dissimilarity index for the seed characteristics were obtained among 96 rice cultivars. Clustering pattern is derived using dissimilarity index based on hierarchical clustering corresponds to the definition of neighborhood according to the minimal dissimilarity using UPGMA. Clustering pattern of 96 traditional and improved cultivars for seed characteristics revealed fifteen clusters. Cluster I had about 57 rice cultivars, which includes 50 traditional and 7 improved cultivars. Cultivars in cluster I might expect to share similar scores for the most of seed characteristics. Other seven improved cultivars are in clusters V, VI and VII indicated their close relatedness and narrow variability for seed characteristics. Cluster XIV-A and XV A had only one genotype that might reveal a unique seed characteristic. These genotypes 12 (Karupu Kavuni) and 35 (Kosuva Kalthanai) are traditional cultivars. The remaining 30 traditional cultivars are distributed into various cluster groups, showed great diversity for seed characteristics. There is high diversity observed among the traditional rice cultivars for seed characteristics, which represents great importance of traditional cultivars for breeding programs on quality traits.

Plate 1: Seed characteristic of rice cultivars

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