

## Genetic variability of native rices of Kerala, India

C.B. Mini and K.V. Mohanan\*

*Genetics and Plant Breeding Division, Department of Botany, University of Calicut, Kerala- 673635, India*

### ABSTRACT

*Kerala state of India had a very rich diversity of native rice cultivars. A considerable part of it had disappeared from farmers' fields due to the intervention of modern agriculture. An effort has been made to revisit the hamlets of the traditional farmers of the state and to analyse the extent of variability of native rices available in such areas. Thirty nine cultivars were collected and their genetic variability was studied. The cultivars were found to be very rich in genetic diversity and many of them showed their competence in terms of many agronomic characters. Varieties like Chitteni, Chettadi, Ponmani, Ponnariyan, Arikkinai, Athian, Muttuppatta, Palakkadan, Navara and Kuthiru yielded more than 15 g plant<sup>-1</sup>.*

**Key words:** : Native rice cultivars, Kerala, variability, heritability

Intraspecific variability of a crop evolves in relation to the peculiarities of the habitat of each and every population. Kerala State of India is a traditional rice cultivating area which had a very rich diversity of native cultivars suited for specific habitats and cultural practices. A considerable number of it has disappeared from farmers' fields due to the intervention of new technologies. The present study was carried out to study the genetic variability of the native rice cultivars being cultivated by the farmers in spite of the establishment of new seeds and technologies.

### MATERIALS AND METHODS

Thirty nine native rice cultivars collected from different parts of Kerala from farmers' field in 2001-02 have been used for the present study (Table 1). The plants were grown in the net house of the Genetics and Plant Breeding Division of the Department of Botany, University of Calicut, Kerala, India in completely randomised design in experimental pots of 20 cm diameter, on one plant pot<sup>-1</sup> basis during the first crop season of 2002 with 9 replications. The plants were maintained under standard cultural conditions with paddy soil, sand and enriched compost mixed at 4:1:1 ratio used as planting medium and application of 1 gm of Factamphos (N:P:K:S = 20.:20:0:15) plant<sup>-1</sup> at monthly intervals starting from 30<sup>th</sup> day of planting till flower initiation. Wetland condition was maintained in the pots.

Observations were made on 7 plant characters and 8 yield characters (Table 1 and 2). Data were analysed for intra varietal and inter varietal variability of the rice cultivars and its significance. Analysis of variance was carried out and phenotypic and genotypic variances, phenotypic and genotypic coefficients of variation (Singh and Choudhary, 1985), heritability (broad sense) and genetic advance under selection (Jain, 1982; Singh and Choudhary, 1985) were worked out to study the extent of variability between the accessions.

### RESULTS AND DISCUSSION

Tiller initiation started at the earliest in the cultivar Ponmani (16<sup>th</sup> day) and the latest in Chomala (34<sup>th</sup> day), indicating that it is a varietal character. The earliest flowering cultivar among the 39 cultivars studied was Navara (71.11 days) and the latest flowering was in Kuttadan (216.67 days) which was photosensitive. Total duration was also minimum in Navara and maximum in Kuttadan. The study showed that native rice cultivars of Kerala are medium to long duration types. Number of tillers at flowering ranged from 10-39 with the minimum tiller number in Navara and maximum in Aruvakkari. However, tiller number at harvest was the minimum in Kunhukunhu and maximum in Aruvakkari itself. Number of ear bearing tillers (EBT) varied from 8-28 in the different cultivars studied. Allikkannan with 8 EBT on the average showed the minimum and Palakkadan with 28 EBT showed the

**Table 1. The native rice varieties of Kerala collected for the study and data on their growth characters**

Cultivar	IC No.	Age at tiller initiation (days)**	Age at flowering (days)**	Number of tillers at flowering**	Number of tillers at harvest**	EBT Number**	Plant height (cm)**
Chitteni	CUR 1	19.22±1.79	195.33±4.36	30.22±3.60	31.33±4.18	23.78±1.71	98.54±5.10
Thekkan chitteni	CUR2	21.00±1.00	190.22±12.37	33.11±3.89	34.74±3.90	24.00±7.30	82.80±11.24
Ponni	CUR3	18.89±0.60	165.00±3.16	30.56±3.36	31.33±3.74	22.11±4.31	87.24±4.48
Chemmeen	CUR4	19.22±0.83	175.44±19.49	19.78±4.89	20.56±5.77	15.67±6.24	87.52±8.20
Cheru vellari	CUR 5	18.33±0.71	195.11±4.14	23.00±10.16	24.00±10.33	19.78±10.13	86.56±6.69
Vellari vembala	CUR6	18.33±0.50	189.78±7.65	26.89±3.62	27.33±3.46	18.44±3.32	103.28±12.45
Chettadi	CUR7	19.89±0.93	130.56±4.50	24.11±4.17	25.11±4.20	18.33±4.00	98.53±9.22
Ponmani	CUR8	16.22±0.66	182.89±8.88	31.89±8.89	32.56±8.85	25.44±8.83	75.19±7.59
Gandhakasala	CUR 9	18.00±0.01	129.56±4.07	11.44±2.88	11.78±2.95	11.00±2.92	97.10±5.22
Veliyan	CUR10	19.22±0.44	179.22±5.21	31.44±6.80	32.33±6.65	25.44±6.06	101.61±7.20
Chuvanna chitteni	CUR11	18.11±0.33	157.00±5.79	27.67±8.85	28.67±8.97	21.00±5.12	82.16±8.20
Punjakaima	CUR12	19.33±0.50	203.11±2.37	25.56±2.60	26.33±1.87	22.67±3.54	98.89±5.06
Kaima	CUR 13	19.56±0.88	134.00±2.69	28.67±2.96	26.33±3.35	16.11±2.26	90.59±5.15
Ponnariyan	CUR14	18.56±0.53	101.11±2.47	16.22±2.82	15.33±3.08	12.78±2.33	105.44±5.95
Vithandan	CUR15	19.33±0.50	211.11±3.06	35.22±3.87	37.78±5.67	26.11±3.62	81.37±4.95
Chomala	CUR16	33.56±1.66	167.00±6.65	20.89±3.86	21.67±4.39	16.22±3.35	92.79±3.96
Kottarakkara	CUR 17	24.44±0.88	201.89±0.93.	24.89±4.65	25.00±4.44	17.00±4.33	86.78±3.73
Arikkinai	CUR18	20.56±0.52	196.00±1.00	30.33±2.29	31.89±1.67	18.22±3.11	98.07±7.40
Athian	CUR19	20.44±0.52	197.33±5.45	32.33±4.15	32.89±4.14	24.89±6.47	95.72±7.73
Muttuppatta	CUR20	19.56±0.52	128.22±1.09	31.89±6.73	30.89±6.41	24.33±4.56	82.27±5.97
Palakkadan	CUR 21	19.22±0.44	208.00±4.03	37.11±5.75	38.00±5.59	27.78±3.46	106.10±8.46
Kunhukunhu	CUR22	21.33±0.50	88.22±2.54	10.56±1.40	9.89±1.36	8.78±0.97	66.61±2.43
Orkazhama	CUR23	22.00±0.50	102.67±0.71	14.00±2.87	14.33±2.87	9.56±2.07	119.68±7.39
Navara	CUR24	22.00±0.71	71.11±4.54	9.67±2.82	23.89±4.83	21.11±3.98	96.73±11.00
Kuttadan	CUR 25	20.56±0.52	216.67±2.24	36.78±6.57	37.89±6.81	25.89±3.76	77.00±6.80
Mundakan	CUR26	20.22±1.09	209.33±5.70	34.56±9.02	37.78±11.00	25.89±7.90	87.76±8.37
Kuthiru	CUR27	19.78±0.44	132.67±4.74	17.33±3.67	16.78±3.60	9.22±0.83	101.54±9.47
Aruvakkari	CUR28	20.00±0.01	199.44±11.98	39.33±6.75	39.33±6.75	27.56±7.36	79.97±5.81
Vellarian	CUR 29	18.44±0.52	183.33±2.55	26.44±3.97	27.56±3.78	20.44±2.74	88.40±5.62
Kuruva	CUR30	22.33±0.50	140.33±3.20	25.44±7.13	26.00±7.07	20.22±4.12	77.26±1.66
Thondi	CUR31	18.33±0.50	126.44±5.36	17.89±4.68	20.33±4.03	14.11±2.15	101.20±10.35
Punnadan thondi	CUR32	22.00±0.01	120.11±4.62	19.33±4.58	19.33±3.64	14.78±3.87	104.42±9.07
Mara thondi	CUR 33	21.00±0.01	111.11±4.65	16.33±5.27	17.11±5.28	12.22±3.87	97.01±10.23
Adukkann	CUR34	18.33±0.50	116.33±3.67	24.67±6.95	22.44±6.52	12.33±2.35	98.83±7.15
Allikkannan	CUR35	18.22±0.44	107.00±4.58	9.78±1.99	10.00±2.00	8.11±1.62	139.84±22.42
Kururai	CUR36	23.44±0.52	106.89±2.67	12.89±2.71	11.67±2.78	8.78±3.27	162.58±27.25
Vrischikappandi	CUR37	21.00±0.01	144.67±1.80	24.89±6.45	25.22±6.38	19.78±4.92	94.09±7.20
Kuttiveliyan	CUR38	21.22±0.44	135.00±1.32	17.22±3.80	18.00±4.12	13.22±2.17	105.91±11.44
Jeerakasala	CUR39	30.00±0.87	140.44±2.92	18.44±4.33	21.33±4.39	13.44±2.70	101.58±4.80

\*\*: significant at 1% level

**Table 2. Variability of yield characters in the 39 cultivars of rice collected from Kerala**

Cultivar	Panicle length (cm)**	Spikelets Panicle <sup>-1</sup> **	Panicle density**	Grain length (mm)**	Grain thickness (mm)**	100 grain weight (gm)**	Fertility percentage**	Yield plant <sup>-1</sup> (gm)**
Chitteni	17.48±1.62	42.67±6.87	2.44±0.31	7.85±0.32	2.33±0.37	1.96±0.11	84.91±1.94	17.11±3.65
Thekkan chitteni	16.72±2.26	39.00±18.75	2.25±0.70	7.83±0.45	2.39±0.32	2.04±0.16	79.62±11.26	14.27±7.32
Ponni	18.24±2.07	58.22±12.13	3.19±0.59	7.15±0.37	1.84±0.27	1.52±0.08	75.97±9.98	14.10±4.48
Chemmeen	20.97±2.88	59.67±18.84	2.84±0.34	7.85±0.72	2.34±0.42	1.72±0.16	74.70±13.35	11.69±5.41
Cheru vellari	16.47±1.82	36.78±9.35	2.21±0.37	7.83±0.33	2.04±0.19	2.12±0.19	80.74±12.19	11.86±6.16
Vellari vembala	17.42±1.67	44.33±7.98	2.43±0.32	8.18±0.49	2.19±0.25	2.12±0.12	84.27±6.75	14.54±3.45
Chettadi	21.33±1.99	79.44±13.30	3.71±0.47	7.88±0.90	1.76±0.16	1.31±0.30	88.82±5.00	16.87±5.26
Ponmani	16.89±1.39	44.44±12.25	2.61±0.57	7.67±0.59	2.14±0.24	1.84±0.25	83.52±10.15	16.04±2.77
Gandhakasala	19.67±2.60	58.67±16.20	2.95±0.28	6.53±0.14	1.73±0.13	1.03±0.11	70.23±10.82	4.70±1.43
Veliyan	16.16±2.68	40.33±9.11	2.48±0.26	7.64±0.31	2.18±0.13	2.00±0.18	76.27±8.22	14.98±3.07
Chuvanna chitteni	16.96±1.57	34.22±7.08	2.00±0.33	8.55±0.48	2.07±0.15	2.30±0.23	80.79±7.66	13.17±2.18
Punjakaima	16.51±2.01	37.67±13.82	2.22±0.57	7.86±0.18	2.14±0.10	2.07±0.12	82.24±6.81	11.05±3.30
Kaima	20.34±1.48	78.00±13.44	3.84±0.62	7.50±0.19	1.85±0.24	1.43±0.40	75.21±13.72	12.94±3.43
Ponnariyan	23.88±1.64	107.33±13.84	4.49±0.45	8.50±0.19	1.85±0.18	1.77±0.31	90.74±1.63	21.19±5.34
Vithandan	16.63±1.39	31.44±5.08	1.86±0.25	8.16±0.64	2.28±0.20	2.30±0.27	75.46±7.57	13.24±3.36
Chomala	16.98±1.99	40.67±8.99	2.37±0.31	7.70±0.48	2.08±0.14	1.94±0.11	77.01±9.90	10.81±4.31
Kottarakkara	16.84±1.15	41.89±9.41	2.37±0.34	7.36±0.24	2.05±0.16	1.87±0.07	81.33±2.83	9.98±0.34
Arikkinai	17.57±0.57	49.67±6.44	2.88±0.32	7.53±0.18	2.21±0.27	1.89±0.08	90.40±5.49	15.34±2.74
Athian	15.51±1.86	38.33±5.48	2.29±0.54	7.88±0.13	2.37±0.24	2.08±0.12	78.38±14.96	16.16±5.87
Muttuppatta	19.91±1.03	87.33±15.24	4.37±0.61	7.64±0.29	1.64±0.17	1.21±0.19	76.36±8.19	21.39±5.70
Palakkadan	15.74±0.88	35.56±6.77	2.24±0.31	8.35±0.10	2.23±0.20	2.06±0.20	82.95±9.12	16.08±3.06
Kunhukunhu	20.28±1.44	107.89±19.90	5.29±0.65	8.15±0.46	1.77±0.20	1.55±0.34	88.77±2.20	13.83±3.80
Orkazhama	23.73±1.08	87.33±13.71	3.67±0.47	8.83±0.26	2.17±0.19	2.42±0.25	66.46±10.21	13.76±4.30
Navara	18.44±2.62	67.89±21.55	3.64±0.75	7.57±0.30	1.93±0.18	1.76±0.26	90.23±9.10	24.53±12.71
Kuttadan	16.77±1.02	31.67±6.82	1.87±0.30	8.08±0.43	2.16±0.25	1.92±0.26	69.52±11.18	10.88±1.91
Mundakan	17.62±0.77	41.56±6.35	2.36±0.36	7.79±0.35	2.02±0.12	2.03±0.28	75.80±9.28	14.88±2.60
Kuthiru	23.24±3.00	83.89±17.75	3.59±0.41	8.85±0.30	2.29±0.13	2.44±0.23	79.27±14.70	15.22±3.47
Aruvakkari	16.01±1.32	33.89±5.51	2.13±0.37	7.57±0.37	1.97±0.10	1.85±0.17	76.92±5.56	13.47±3.24
Vellarian	14.72±1.07	36.44±4.85	2.47±0.20	7.63±0.42	2.14±0.26	1.83±0.01	76.87±12.10	10.81±1.89
Kuruva	16.51±1.33	47.67±9.03	2.87±0.38	6.19±0.22	2.24±0.44	1.20±0.15	82.12±9.82	10.22±3.42
Thondi	23.19±2.59	66.00±15.96	2.84±0.56	7.60±0.16	2.03±0.06	2.13±0.10	61.86±5.56	14.53±3.69
Punnadan thondi	18.83±2.03	50.00±15.19	2.62±0.57	7.81±0.12	2.25±0.13	2.00±0.25	59.94±12.89	8.47±5.37
Marathondi	21.98±1.03	74.78±6.52	3.40±0.24	7.90±0.20	2.09±0.08	2.22±0.18	64.28±8.68	13.08±2.45
Adukkannan	18.11±0.37	55.00±7.09	3.03±0.34	8.02±0.24	2.42±0.08	2.02±0.06	67.99±3.60	12.25±2.10
Allikkannan	23.76±4.29	113.56±53.98	4.56±1.55	8.47±0.19	2.28±0.24	2.39±0.19	63.79±13.29	14.06±6.81
Kururai	23.14±2.18	94.44±25.15	4.05±0.92	8.43±0.22	2.31±0.10	2.31±0.11	65.76±9.94	13.39±6.61
Vrischikappandi	17.19±1.82	42.78±6.85	2.48±0.27	7.73±0.49	2.24±0.36	1.91±0.28	70.58±8.01	11.42±3.74
Kuttaveliyan	20.00±1.82	68.11±17.14	3.38±0.65	7.54±0.30	2.25±0.17	2.18±0.32	64.49±9.52	12.62±5.07
Jeerakasala	22.20±2.41	63.78±15.38	2.85±0.48	7.52±0.29	1.80±0.06	1.49±0.06	78.17±5.48	10.32±2.22

\*\* : significant at 1% level

maximum. This shows that the native rices of Kerala range from low tillering to high tillering types. Plant height was the minimum in Kunhukunhu and maximum in Kururai (66.61 cm- 162.60 cm) indicating that they are mostly medium to tall in nature.

The study of variability of growth and yield characters among the cultivars showed that panicle length ranged from 14.7 cm to 23.9 cm and it was the minimum in Vellarian and maximum in Ponnariyan. Mean number of spikelets panicle<sup>-1</sup> was minimum in Vithandan (31.44) and the maximum in Allikkannan (113.56). The lowest panicle density (1.86) was shown by Vithandan and the highest by Kunhukunhu (5.29). Grain length was the minimum in Kuruva (6.19 mm) and maximum in Kuthiru (8.85 mm) and grain thickness was the minimum in Muttuppatta and maximum in Thekkan chitteni. Hundred grain weight was the lowest in Gandhakasala (1.03 gm) and the highest in Kuthiru (2.44 gm). Fertility percentage was the lowest in Punnadan thondi (59.94%) and the highest in Ponnariyan (90.74%) and yield plant<sup>-1</sup> was the lowest in Gandhakasala (4.70 gm) and the highest in Navara (24.53 gm).

All the thirteen growth/ yield characters studied showed statistically significant variations between the cultivars (Tables 1 and 2) indicating significant morphological and genetic differences between them. Genotypic variation between cultivars or populations is the expression of their genetic differences and phenotypic variation is the result of interaction between genetic differences and environment. Genotypic and phenotypic variations have been studied in the thirty nine rice accessions based on genotypic variance, phenotypic variance, genotypic coefficient of variation and phenotypic coefficient of variation (Table 3). In all the cases phenotypic variance was higher than the genotypic variance indicating the polygenic nature of the characters under study and also the involvement of additive genes in the control of the characters. Genotypic coefficients of variation were lower in all the cases when compared to phenotypic coefficients of variation showing the different levels of influence of environmental factors on the expression of the characters under study. Among the growth characters the highest GCV and PCV were shown by number of tillers at flowering followed by number of tillers at harvest and number of ear bearing tillers showing the

**Table 3. Mean, range, genotypic variance, phenotypic variance, GCV(%), PCV(%), Heritability % and genetic advance (%) of growth characters in 39 cultivars of rice from Kerala.**

Character	Mean	Range	Genotypic variance	Phenotypic variance	GCV(%)	PCV(%)	Heritability (%)	Genetic advance (%)
Growth characters								
Age at tiller initiation (days)	20.54	16-34	9.79	10.27	15.23	15.60	95.33	30.64
Age at flowering (days)	156.15	71.11-216.67	1632.83	1666.43	25.88	26.14	97.98	52.77
Total duration (days)	185.15	101.11-246.67	1589.03	1625.07	21.53	21.77	97.78	43.86
Number of tillers at flowering	24.33	9.67-39.33	65.68	93.03	33.31	39.64	70.60	57.66
Number of tillers at harvest	25.55	9.89-39.33	65.69	94.68	32.10	38.54	69.38	55.08
Number of Ear bearing tillers	18.37	8.11-27.78	33.34	54.11	31.43	40.04	61.62	50.83
Plant height (cm)	95.59	66.61-162.58	280.26	365.98	17.51	20.01	76.58	31.57
Yield characters								
Panicle length (cm)	18.82	14.72-23.88	6.91	10.59	13.97	17.29	62.25	23.24
Spikelets panicle <sup>-1</sup>	57.75	31.44-113.56	513.94	749.07	39.26	47.39	68.61	66.98
Panicle density	2.95	1.86-5.29	0.65	0.94	27.33	32.87	69.15	46.82
Grain length (mm)	7.82	6.19-8.85	0.26	0.38	6.52	7.88	68.42	11.11
Grain thickness (mm)	2.10	1.64-2.39	0.04	0.09	9.52	14.29	44.44	13.08
Hundred grain weight (gm)	1.90	1.03-2.44	0.12	0.17	18.23	21.70	70.59	31.56
Fertility percentage	76.74	59.94-90.74	59.11	146.99	10.02	15.80	40.21	13.09
Yield plant <sup>-1</sup> (gm)	13.72	4.70-24.53	10.22	31.04	23.30	40.61	32.93	27.55

wide variability of these characters among the cultivars studied and suggesting the feasibility of selection of high tillering native rices especially in the present era of evergreen revolution and organic farming thus improving the sustainability of rice farming in Kerala using niche specific high tillering and high yielding cultivars. Among the yield characters spikelets panicle<sup>-1</sup> showed the highest variation as revealed by their highest GCV and PCV (Table 3). This shows that there is enough scope for selection using these characters to improve the yield of native rice cultivars cultivated in Kerala.

Most of the agronomic characters of rice are polygenic in nature and they show different levels of heritability based on the influence of environment on them. Among the characters studied presently, the highest heritability was shown by age at flowering (97.98%) and total duration followed by age at tiller initiation (95.33%) and plant height (76.58%). Heritability of number of tillers at flowering, number of tillers at harvest and number of ear bearing tillers was comparatively low thus showing the influence of environment on the expression of these characters. Among the yield characters hundred grain weight showed the highest heritability indicating the varietal nature of the character. It was closely followed by panicle density, spikelets panicle<sup>-1</sup>, grain length and panicle length. Heritability value was the lowest in yield plant<sup>-1</sup> followed by fertility percentage indicating the impact of environment on these characters. Percentage of genetic advance possible under selection is a parameter that can be used to find out the utility of characters in crop improvement programmes. Among the growth characters, genetic advance was found to be the highest in the case of characters associated with tiller number followed by age at flowering and duration (Table 3). This shows that these characters can be effectively used for selecting superior genotypes. Among the yield characters seeds panicle<sup>-1</sup> showed the highest genetic advance followed by spikelets panicle<sup>-1</sup> indicating that these are the characters to be considered first when selection is practiced for yield characters.

Studies on genetic variability of rice and heritability and genetic advance of agronomic characters in rice have been carried out by different workers like Chauhan *et al.*, 1989; Lokanathan *et al.*,

1991; Angrish and Panwar, 1992; Yadav, 1992; Vivekanandan *et al.*, 1992; Sarma and Roy 1993; Sarawgi and Soni 1994; Sawant and Patil 1995; Marekar and Siddiqui 1996; Reddy and Kumar 1996; Singh and Choudhary 1996; Manonmani *et al.*, 1996; Choudhury and Das 1997; Panwar *et al.*, 1997; Mani *et al.*, 1997; Vange and Ojo 1997; Basavaraja *et al.*, 1997; Singh *et al.*, 1997; Rather *et al.*, 1998; Borbora and Hazarika, 1998; Gonzales and Ramirez, 1998; Thakur *et al.*, 1998; Kandhola and Panwar 1999; Chikkalingaiah *et al.*, 1999; Kumari *et al.*, 1999; etc. based on different morphological characters and under different agroclimatic conditions and cultural practices and they have reported differential variability of different characters.

Varieties like Chitteni, Chettadi, Ponmani, Ponnariyan, Arikkinai, Athian, Muttuppatta, Palakkadan, Navara and Kuthiru yielded more than 15 g plant<sup>-1</sup> and this shows the yield potential of these native varieties. Number of tillers at flowering in these varieties ranged from 10-37 showing the comparatively high tillering potential.

The present study provides information on the extent of variability existing among the traditional rice cultivators of Kerala and their tillering and yield potential. Differential heritability of agronomic characters of rice has also been further confirmed by the present study. Optimum tillering rice varieties with higher number of primary and secondary tillers that emerge and flower uniformly have been recently highlighted as ideal for sustainable high yield in rice (Khush, 2000; Mohanan and Mini, 2008).

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