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Assessment of Morphological, Genetical and Diversity Studies in Landraces of Rice (*Oryza sativa* L.)

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ABSTRACT

Background: Landraces displayed a wide range of genetic diversity in rice farming system. Landraces or local types have been used as the sources for the characters such as resistance to pest, disease, abiotic stresses and genetic sources for some physicochemical characters. Various types of landraces of rice are available in the major rice growing regions of Karnataka and hence, their characterization and establishment in uniformity is essential, to consider them as variety and can be protected under PPV and FR act. Investigation was undertaken to assess genetic variability and diversity in fifty one landraces of rice.

Methods: The materials comprised of fifty one landraces of rice collected from Zonal Agricultural and Horticultural Research Station, Brahmavar and the experiment was conducted in randomized complete block design with two replications, following spacing of 20 cm between rows and 15 cm between plants at College of Agriculture, Shivamogga, during the *Kharif* 2018.

Result: The present experiment will be useful for the farmers and researchers to identify the valuable germplasm for utilization in rice yield improvement and seek protection under Protection of Plant Varieties and Farmers' Rights Act and also for protection of rice landrace like Gulvadisanna and Kayame registration made under PPV and FRA.

Key words: Characterization, Diversity, Genetic variability, Registration, Rice landrace.

INTRODUCTION

India has a rich and wide genetic wealth of rice cultivars. Various types of landraces of rice are available in the major rice-growing regions of Karnataka especially in Coastal region, people prefer red rice for their daily consumption because, bran layer of red rice contains polyphenols and anthocyanin and possesses antioxidant properties. In many parts of Karnataka rice (including red rice) has also been used as medicine and in therapy by the traditional practitioners in treating allergies, skin ailments, nerve disorders (as paralysis and muscular weaknesses), intestinal and digestive problems such as diarrhea, vomiting, indigestions, liver and kidney disorders, fever and infection (Table1). The zinc and iron content of red rice is two-three times hig
her than that of white rice (Ramaiah and Rao, 1953).

A systematic landrace evaluation may define patterns of diversity, which will facilitate identifying alleles for enhancing yield, biotic and abiotic stress adaptation, thus raising the productivity and stability of staple crops in vulnerable environments. Hence, their characterization and establishment of uniformity is essential to consider them as variety and can be protected under PPV and FR act. More than their registration as a variety, a better performing local type may be utilized in crop improvement programs as a genetic resource. To efficiently conserve, manage and use such germplasm resources, an understanding of structure, apportionment and dynamics of local landrace variation is required. Several studies have examined genetic variation and differentiation among rice landrace varieties (Bajracharya *et al.,* 2006). In view of the above background, an investigation was carried out with 51 rice landrace to study the genetic variation in collected rice landrace and also genetic divergence using Mahalanobis D^2 analysis (Mahalanobis, 1936).

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MATERIALS AND METHODS

The assessment of morphological characteristics, genetic variability and diversity studies was done in 51 landraces of rice. The experiment was carried out in randomized complete block design (RCBD) with two replications at College of Agriculture, UAHS, Shivamogga in *Kharif* 2018. The spacing maintained was 20 cm between rows and 15 cm between plants within the row. 41 qualitative characters were evaluated as per Distinctiveness, Uniformity and Stability

(DUS) testing guidelines given by PPV and FRA, 2001 and Data was collected from five randomly selected plants on 13 phenological, morphological and yield traits *viz*., days to 50% flowering, days to maturity, leaf length (cm), leaf width (cm), plant height (cm), stem thickness (cm), total number of tillers per plant, number of productive tillers per plant, panicle length (cm), L/B ratio, panicle fertility (%), Test weight(g), yield per plant (g) for estimation of genetic variability, heritability, genetic advance as per cent mean, character association by using the WINDOSTAT 9.2 software and genetic divergence by using Mahalanobis' D^2 statistics (Mahalanobis, 1936).

RESULTS AND DISCUSSION

Morphological characterization of landraces of rice

Forty one qualitative and thirteen quantitative characters were evaluated as per Distinctiveness, Uniformity and Stability (DUS) testing guidelines given by PPV and FRA, 2001. Beganbeach, Bilinellu, Seethmog, Juli, Kanakachudi, Kavalakannu, Kuruva and Meesebhatta had recorded anthocynin coloration only on leaves. Landraces of rice such as Beganbeach, Bilinellu and Kuruva recorded the distribution of anthocynin coloration of leaf on tips only whereas, landraces of rice *viz*., Seethmog, Juli, Somasale, Kavalakannu and Meesebhatta recorded the distribution of anthocynin coloration of leaf on margins only. Seethmog, Juli, Kanakachudi, Kavalakannu, Kuruva and Meesebhatta landraces of rice showed anthocynin coloration on leaf sheath. Anthocynin coloration of auricles was recorded in the landraces of rice Seethmog, Kavalakannu and Kuruva. The anthocynin coloration of collar was recorded in Beganbeach, Seethmog, Kavalakannnu, Kayame, Kuruva and Meesebhatta. The density of pubescence of lemma was recorded strong in landraces of rice Juli, Kalame and Kanakachudi very strong density of pubescence of lemma was exhibited by the landraces of rice Seethmog, Giddabasumati, Halaga, Kuruva, Nattijaddu and Peetasale. The density of pubescence of lemma was recorded strong in landraces of rice Juli, Kalame and Kanakachudi, very strong density of pubescence of lemma was exhibited by the landraces of rice Seethmog, Giddabasumati, Halaga, Kuruva and Peetasale. These characters are useful in varietal identification and could be used as morphological markers in the hybridization program.

Analysis of variance

The estimates of analysis of variance for yield and its contributing traits (13) in landraces of rice are furnished in Table 2.

The days to 50% flowering (70.50-146.26), Days to maturity (86.60-179.49) and plant height(70.00-142.00) were exhibited in a wide range and the difference between the phenotypic coefficient of variation and the genotypic coefficient of variation is less for the characters like leaf width (26.63 and 25.11), test weight (19.48 and 18.70), panicle length (18.72 and 18.54), leaf length (18.44 and 18.26) and plant height (17.06 and 16.98) this indicated the low environmental influence and selection based on phenotype would be of more rewarding. Stem thickness (33.72 and 31.37), total number of tillers per plant (33.69 and 28.22), number of productive tillers per plant(36.84 and 30.79), L/B ratio (21.54 and 14.49), panicle fertility (13.25 and 10.92) and yield per plant (21.59 and 17.32) exhibited higher estimates of phenotypic coefficient of variation than genotypic coefficient of variation for above mentioned traits suggesting variation for these traits was not only genotypic but also due to the involvement of higher environmental effect.

Table 1: Special uses of rice landraces.

Landraces	Specialty uses
Kalame	Grown in residual moisture, Resistant to pest and disease, excellent for ganjee and Kayi Kadubu and had good aroma
Kayame	Oldest land race referred to as the "Moola Thali". Promoting lactation, Cure diarrhea, Skin allergies, used in Kajjaya preparation, Parboiled rice, flaked rice, parched rice
Peetasale	Parboiled rice, Payasa preparation
Gulvaadi sanna	Payasa preparation, Soft Idli and Neer dosa preparation
Halaga	Grown in lowland areas, Excellent cooking and eating quality, straws are being used for Kaccha house and rope making purpose
Pratheeksha	High zinc and iron content hence it is good for pregnant women and children. Used to prepare sweets
Basmati and Chiksale	Taste and aroma, Biriyani preparation, Kajjaya preparation (Minimally polished)
Nettijedu	Parboiled rice, Kajjaya preparation (Minimally polished)
Bilinellu	Parboiled rice, straw of this variety is very much liked by cattle
Maskat	Used as raw and parboiled rice, good storage life
Mesebhatta	Excellent for Parboiling and ganjee preparation, paddy has long awns
Kavalakannu	Parboiled rice, the entire crop looks red at the time of harvest
Kuruva	Parboiled rice, especially used as coolent
Chare	Has long straw- used as cattle feed or put to some other alternative use

The traits like plant height (99.10%), panicle length (98.10%), days to 50 per cent flowering (97.60%) and test weight (92.10%) showed high heritability with high genetic advance as per cent mean, indicating that these traits are less influenced by the environment and emerged as the ideal traits for improvement through the selection.

Association study

The grain yield had a significant and positive association at phenotypic level with the total number of tillers per plant, number of productive tillers per plant, test weight, panicle length and panicle fertility.

Cluster analysis

Based on D^2 values all 51 rice landrace were grouped into eight clusters and values given in Table 5. Clustering pattern revealed that Cluster I had twenty landrace, forming the largest cluster, Cluster II had seventeen genotypes, cluster III had six, cluster V had four landrace, whereas Cluster IV, VI, VII and VIII had single rice landrace in each cluster (Table 3).

Range of an average intra-cluster D^2 values was 0 to 5.16 (Table 4). The maximum intra-cluster distance was shown by cluster V (280.47) followed by cluster III (210.38), cluster II (160.16), while cluster I showed a minimum intra-cluster distance (153.71). Cluster IV, VI, VII and VIII had zero intra-cluster distance, as they were having single genotype each. High intra-cluster distance in Cluster V suggested wide genetic diversity among the genotypes in this cluster. Hence, the genotypes included under cluster V could be used as parents in the recombination breeding program owing to the presence of greater diversity within these genotypes.

When diversity among the clusters (inter-cluster) was studied, it showed a range of 255.57 to 1355.55. Cluster IV and cluster V showed maximum inter-cluster distance (1355.55) followed by cluster V and cluster VI (1077.79), which indicated the existence of high genetic diversity among genotypes in these clusters and therefore crosses between the genotypes of these clusters could yield desirable transgressive segregants, similar explanation was given by Amegan

Table 2: Estimates of range, mean, variability, heritability and genetic advance as per cent mean for yield and its contributing traits in landraces of rice.

Characters	Mean	Range		PCV	GCV	h^2 Broad	GAM
		Min.	Max.	(%)	(%)	sense (%)	(%)
Days to 50% flowering	124.59	70.50	146.26	14.07	13.90	97.60	28.30
Days to maturity	140.89	86.60	179.49	16.81	15.69	87.10	30.16
Leaf length (cm)	31.04	16.75	41.75	18.44	18.26	98.03	37.25
Leaf width (cm)	0.67	0.34	0.98	26.63	25.11	88.90	48.78
Plant height (cm)	98.82	70.00	142.00	17.06	16.98	99.10	34.82
Stem thickness (cm)	0.52	0.27	0.85	33.72	31.37	86.60	60.13
Total number of tillers per plant	18.70	8.17	29.12	33.69	28.22	70.20	48.70
Number of productive tillers per plant	16.29	7.46	27.00	36.84	30.79	69.90	53.03
Panicle length (cm)	25.54	17.25	35.56	18.72	18.54	98.10	37.82
L/B ratio	2.45	1.54	3.42	21.54	14.49	45.20	20.08
Panicle fertility (%)	72.88	44.71	88.43	13.25	10.92	68.00	18.55
Test weight (g)	25.00	16.75	35.01	19.48	18.70	92.10	36.96
Yield per plant (g)	23.55	14.98	33.00	21.59	17.32	64.40	28.62

Table 3: Clustering pattern of 51 landraces of rice.

Clusters	No. of entries	Genotypes
I	20	Bhagyodaya, IR-8, Seethmog, Giddabhatta, Gulvadisanna, Halaga, Kalame, Kavadari, Kavalakannu, Kayame, Tulasimog, Kuruva, Malabar, Maskat, Nattijaddu, Peetasale, Meterbhatta, Andanoorsanna, Dasarapatti, Parlan.
II	17	Atire, BMR-US-1-24-2, Pingara, Intaan, Irga, Juli, Kanakachudi, Somasale, Halinga, Pratiksha, BMR-MS-1-2-1, Basumati, Andrabasumati, Shankarakempakki, BPT-5204, JGL-1798.
III	6	Kempurajesh, Lalneth, Meesebhatta, Mysoresanna, Naddantarasale.
IV	1	Anekombinabhatta
V	4	Beganbeach, Bilinellu, Chare, Chicksale.
VI	1	Ratan
VII	1	Giddabasumati
VIII	1	Arjuna

et al. (2020) and Sudeepthi *et al*. (2020). Whereas the lowest inter-cluster distance was noticed between cluster VI and cluster VIII (255.57) followed by cluster II and cluster IV (269.07), suggesting closeness and similarities among the genotypes in these clusters for most of the traits.

Cluster means of all the characters is presented in Table 5. The cluster mean values varied in all the clusters for all the 13 quantitative traits studied. Cluster IV showed highest mean values for days to 50 per cent flowering (134.50), days to maturity (157.50) and stem thickness (0.66). Cluster III showed highest mean values for leaf length (38.05) and panicle length (34.05). Highest mean for leaf width (0.99) was exhibited by cluster VII. The results indicated the existence of high genetic diversity among genotypes in these clusters; therefore, genotypes in these clusters could be used for specific trait improvement in plant breeding programmes, similar results were explained by Muthuramu *et al*. (2017).

Plant height contributed forty-five percent (45%) of total divergence indicated that genotypes differ significantly with respect to their different plant height followed by panicle length 19.14 (Table 6) and least contribution to divergence was made by yield per plant similar results was obtained by Raghavendra *et al*. (2018) and Devi *et al*. (2019).

Table 4: Intra and inter cluster distances for yield and its component characters in landraces of rice.

Clusters	I	II	III	IV	V	VI	VII	VIII
I	153.71	360.54	293.99	814.84	348.23	695.24	433.89	658.27
II		160.16	479.75	269.07	787.10	291.79	449.14	436.54
III			210.38	1016.90	557.64	775.04	551.22	919.97
IV				0.00	1355.55	256.87	768.19	458.36
V					280.47	1077.79	522.13	723.50
VI						0.00	272.56	255.57
VII							0.00	300.80
VIII								0.00

*Diagonal values indicate intra cluster distances.

*Above diagonal values indicate inter cluster distances.

Table 5: Cluster means for yield and its component characters in rice landraces.

Clusters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
I	127.78	146.30	33.38	0.70	109.05	0.49	19.65	16.86	25.16	2.44	73.77	24.94	23.77
II	131.82	134.47	27.77	0.69	84.12	0.52	18.45	16.03	23.82	2.45	73.01	24.64	24.06
III	133.25	146.67	38.05	0.66	99.94	0.59	22.37	19.87	34.05	2.54	74.38	26.83	25.71
IV	134.50	157.50	17.98	0.55	71.00	0.66	8.18	7.57	19.50	2.83	56.72	17.18	15.96
V	95.75	139.63	30.28	0.43	126.50	0.59	12.02	10.46	24.69	2.36	66.76	25.61	18.46
VI	95.50	148.00	25.68	0.92	70.00	0.65	24.24	23.62	24.80	2.59	75.98	25.36	25.25
VII	70.50	112.00	33.78	0.99	91.50	0.48	15.32	12.88	26.50	1.90	71.60	20.54	19.62
VIII	74.78	117.50	16.75	0.48	91.00	0.39	17.40	16.11	20.78	2.49	31.32	31.32	28.03

X1- days to 50% flowering, X2- Days to maturity, X3- Leaf length, X4- Leaf width, X5- Plant height, X6- Stem thickness, X7- Total no. of tillers per plant, X8- Total no. of productive tillers per plant,X9- Panicle length, X10-L/B ratio, X11- Panicle fertility, X12- Test weight, X13- Yield per plant.

Table 6: Per cent contribution of each character towards divergence in rice landraces.

Characters	Per cent contribution
Plant height (cm)	45.88
Panicle length (cm)	19.14
Leaf length (cm)	16.55
Days to 50% flowering	10.82
Test weight (g)	4.71
Stem thickness (cm)	0.86
Leaf width (cm)	0.71
Days to maturity	0.55
Panicle fertility	0.47
Yield per plant (g)	0.08
Number of productive tillers per plant	0.08
Total number of tillers per plant	0.08

CONCLUSION

The landraces of rice falling under cluster IV and cluster V could be selected for the breeding program to obtain higher heterotic expression in F_1's as they were found to be more divergent. Hence these landraces of rice (Anekombinabhatta, Beganbeach, Bilinellu, Chare and Chicksale) could be utilized in hybridization to identify desirable recombinants to increase both the quality and quantity of grain.

The present experiment would be useful for the farmers and researchers to identify the valuable germplasm utilization in rice yield improvement and to seek protection

under Protection of Plant Varieties and Farmers' Rights Act and for protection of rice landrace like Gulvadi Sanna (Ack. No. REG/2018/666) and Kayame (Ack. No. REG/2018/664) registration made under PPV and FRA.

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Conflict of interest

All authors declared that there is no conflict of interest.

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