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RESEARCH ARTICLE

Genetic Divergence among Rice (*Oryza sativa* L.) Landraces of Odisha Based on Economically Important Metric Traits

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The present study was undertaken to investigate the nature and magnitude of genetic divergence among 55 rice Landraces and nine varieties of Odisha based on economically important metric traits. Based on the relative magnitude of D^2 values, 64 rice cultivars were grouped into 11 clusters. Among different traits, grain length to breadth ratio (28.79%), 100-grain weight (13.02%) and straw yield per plant (9.66%) had more contribution towards the total divergence. The cluster means indicated that none of the clusters contained genotypes with all the desirable characters which could be directly selected and utilized. The grouping of most of the landraces of Odisha and improved cultivars of rice in one cluster (II) indicates the use of these landraces in the blood of the improved cultivars. Twelve cultivars (eight high yielders and four low yielders) were chosen from different clusters for molecular characterization. Primers RM413 and RM480 were informative (PIC value=0.97) and could distinguish all the cultivars.

Key Words: Dendrogram, Genetic diversity, Low land rice, Molecular diversity, SSR markers

Introduction

In India rice is grown in different ecosystems such as rainfed upland, irrigated medium land, rainfed lowland and flood prone areas. These ecosystems account for 13%, 53.9%, 27.1% and 6% of the total rice area, respectively (Odisha Agricultural Statistics, 2012-13). Rainfed lowland ecosystem is often characterized by too much or too little water in the same season. Rice is cultivated traditionally in Odisha and diversety of native cultivars/ landraces are being maintained by the local farmers to meet their specific needs and are part and parcel of their traditional crop management system. But unfortunately most of these cultivars are fast disappearing. Farmers are lured by high yielding varieties; have confined themselves to few races of rice and have stopped cultivating local varieties. These local varieties are of immense value in agriculture as they are the storehouse of important genes.

Characterization and quantification of genetic diversity has long been a major goal in evolutionary biology and plant breeding. Information on genetic diversity within and among closely related crop germplasm is essential for rational use of genetic resources (Arunachalam, 1981). Parents selected on the basis of such studies would help in obtaining higher amount of heterotic expression and broad spectrum of variability in segregating generations. Keeping in view the importance of characterizing local cultivars, the present investigation was undertaken to study the nature and magnitude of genetic divergence in 64 cultivars using 12 economically important quantitative traits in order to identify diverse parents for possible hybridization.

Materials and Methods

The experimental material for the present investigation consisted of 55 rice landraces, 4 improved varieties and 5 released high yielding varieties suitable for lowland ecology (Table 1). The local landraces were collected from 14 districts of Odisha state spread over different agro-climatic zones. These varieties are popular among the rice farmers in rainfed lowland areas. The experiment was laid out in RBD with two replications. Each entry consisted of three rows of 3m length with spacing 20 cm × 15 cm. The recommended package of practices was followed including need based plant protection measures to

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Table 1. Details of 64 rice cultivars used in the study

S No.	Name of the Genotype	Remarks	Place of Collection
1	Mahipal	Landrace	Nawapara
2	Nadiarasi	Landrace	Koraput
3	Machakanta	Landrace	Koraput
4	Jubaraj	Landrace	Sonpur
5	Seulapana	Landrace	Keonjhar
6	Dhinkiasali	Landrace	Keonjhar
7	Kanthakamal	Landrace	Keonjhar
8	Ganjamgedi	Landrace	Cuttack
9	Dhulia	Landrace	Balasore
10	Julpaya	Landrace	Malkangiri
11	Nilarpati	Landrace	Malkangiri
12	Haladichudi	Landrace	Kalahandi
13	Ratanmali	Landrace	Kalahandi
14	Badashabhoga	Landrace	Kalahandi
15	Juiphoola	Landrace	Jharsuguda
16	Karpurakranti	Landrace	Jharsuguda
17	Ganjeijata	Landrace	Angul
18	Kalachampa	Landrace	Angul
19	Baudiachampa	Landrace	Angul
20	Ghumusara	Landrace	Angul
21	Bagudi	Landrace	Angul
22	Anu	Landrace	Angul
23	Baiganmanji	Landrace	Nayagarh
24	Mayurakantha	Landrace	Nayagarh
25	Kadaliachampa	Landrace	Nayagarh
26	Champeisiali	Landrace	Nayagarh
27	Landi	Landrace	Nayagarh
28	Bhutia	Landrace	Nayagarh
29	Parvatajeera	Landrace	Boud
30	Ranisaheba	Landrace	Boud
31	Kusuma	Landrace	Boud
32	Basabhoga	Landrace	Sambalpur
33	Jaladubi	Landrace	Sambalpur
34	Kendrajhalli	Landrace	Sambalpur
35	Laxmi	Landrace	Sambalpur
36	Sunakathi	Landrace	Sambalpur
37	Khandasagar	Landrace	Sambalpur
38	Budidhan	Landrace	Sambalpur
39	Bagadachinamala	Landrace	Sambalpur
40	Ratnachudi	Landrace	Sambalpur
41	Jalagudi	Landrace	Sambalpur
42	Desijhilli	Landrace	Sambalpur
43	Kadalipendi	Landrace	Sambalpur
44	Rasapanjari	Landrace	Puri
45	Champa	Landrace	Puri
46	Bankoi	Landrace	Puri
47	Biradiabankoi	Landrace	Puri
48	Habira	Landrace	Puri
49	Kakudimanji	Landrace	Puri
50	Jagabalia	Landrace	Puri
51	Dhoiabankoi	Landrace	Puri
52	Kalakadamba	Landrace	Puri
53	Damodarbhoga	Landrace	Puri
54	Gunjimanika	Landrace	Puri
55	Madhabi	Landrace	Puri
56	T 90	Improved variety	EB-1, OUAT
57	T 141	Improved variety	EB-1, OUAT
58	FR 13A	Improved variety	EB-1, OUAT
59	T 1242	Improved variety	EB-1, OUAT
60	Swarna	High yielding variety	EB-1, OUAT
61	Upahar	High yielding variety	EB-1, OUAT
62	Kanchan	High yielding variety	EB-1, OUAT
63	Mrunalini	High yielding variety	EB-1, OUAT
64	Jagabandhu	High yielding variety	EB-1, OUAT

raise a normal crop. Observations were recorded in respect of metric characters *viz.*, plant height (PH), effective tillers per plant (EBT), flag leaf area (FLA), panicle length (PL), fertile grains per panicle (FGP), grain fertility % (GF), 100-grain weight (GW), grain yield per plant (GYP), straw yield per plant (SYP), harvest index (HI) and grain length/breath ratio (LB) on five competitive plants from each replication selected randomly from the middle row of each plot, whereas character like days to 50% flowering (DF) was recorded on plot basis. Mahalonobis's D^2 statistics was used for estimation of genetic divergence and clustering was done following the Tocher's method.

From these 64 cultivars genotypes eight high yielders and four low yielders on the basis of yield performance were taken from different clusters (developed based on phenotype) for molecular characterization. Seven microsatellite markers were used as a preliminary assay. Genomic DNA was isolated from 10 days old seedling following CTAB method followed by PCR amplification for 40 cycles. PCR amplification products were separated on a 2.5% agarose gel along with 50bp DNA ladder. The possible inclusion of artifacts or non-specific bands in scoring was ruled out by repeated amplification. The scoring of bands was done as present (1) or absent (0) for each marker allele-genotype combination. Unweighted Pair Group Method with Arithmetic Means (Sneath and Sokal 1973) dendrogram was constructed using the software NTSYS- PC 2.02.

Result and Discussion

The analysis of variance revealed significant differences among the cultivars for all the characters studied, there by providing the evidence for the presence of genetic variability among landraces. On the basis of D^2 value, the 64 rice genotypes were grouped into eleven clusters (Table 2). Average inter-cluster D^2 distance ranged from 97.31 (clusters I and IX) to 577.13 (clusters VIII and XI) and the intra cluster distances ranged from zero (IX, X and XI) to 93.05 (cluster VIII). Maximum inter cluster distance was observed between cluster VIII and XI (577.13) followed by cluster III and XI (548.27). Relative contributions of 12 characters towards divergence were estimated and presented in Table 3. Among the twelve characters, grain L/B ratio contributed maximum toward divergence (28.79%) followed by 100-grain weight (13.02%) and straw yield per plant (9.66%). These findings are in agreement with published reports by Bharadwaj *et al.*, (2001) and Rather *et al.*, (2001) for grain L/B ratio and 100-grain weight; Subudhi and Dikshit (2009) for 1000-grain weight. Cluster VIII recorded the highest mean value for grain yield per plant (19.74g) and straw yield per plant (33.13g) and second highest mean values for grain fertility % (86.28), 100-grain weight (2.63g), and harvest index (0.38). Cluster III recorded high mean values for fertile grains per plant (147.60) and grain fertility % (88.77%). Cluster IX recorded high mean

Table 2. Composition of genetic clusters rice landraces using D^2 value

Clusters	No. of genotypes	Name of genotypes
I	28	Khandasagar, Gunjimanika, Madhabi, Bagudi, Jalagudi, Baudiachampa, Kusuma, Nadiarasi, Mahipal, Champeisiali, Bhutia, Habira, Dhulia, Kanthakamal, Nilarpati, Jubaraj, Ghumusara, Bankoi, Dhoiabankoi, Haladichudi, Kadaliachampa, Bagadachinamala, Jagabalia, Ratanmali, Kakudimanji, Ganjamgedi, Jaladubi, Kalakadamba
II	16	Ratnachudi, Laxmi, Machakanta, Juiphoola, T 90, Desijhilli, Landi, Champa, Ranisaheba, Dhinkiasali, Sunakathi, Seulapana, T 1242, Kendrajhalli, Kalachampa, Kadalipendi
III	3	Basubhoga, Baiganamanji, Ganjeijata
IV	3	Rasapanjari, Mayurakantha, Budidhana,
V	4	Anu, Paravatajeera, Badashabhoga, Karapurakranti
VI	3	Swarna, Mrunalini, Jagabandhu
VII	2	Upahar, Kanchan
VIII	2	Damodarbhoga, FR 13A
IX	1	Biradibankoi
X	1	T 141
XI	1	Julpaya

Table 3. Relative contribution of individual character to genetic divergence

Character	Average D^2 value	% Contribution
Days to 50% flowering	8.014	5.959 (VIII)
Plant height (cm)	5.127	3.812 (X)
Flag leaf area (cm^2)	10.935	8.130 (IV)
Effective tillers/plant (No.)	4.357	3.239 (XI)
Panicle length (cm)	8.246	6.131 (VII)
Fertile grains/panicle (No.)	3.718	2.765 (XII)
Grain fertility (%)	6.076	4.518 (IX)
100 – grain weight (g)	17.512	13.020 (II)
Grain L/B ratio	38.717	28.786 (I)
Straw yield/plant (g)	12.992	9.659 (III)
Harvest index	9.218	6.854 (VI)
Grain yield/plant (g)	9.588	7.128 (V)

NB: Figures in parantheses indicate the order of contribution to divergence

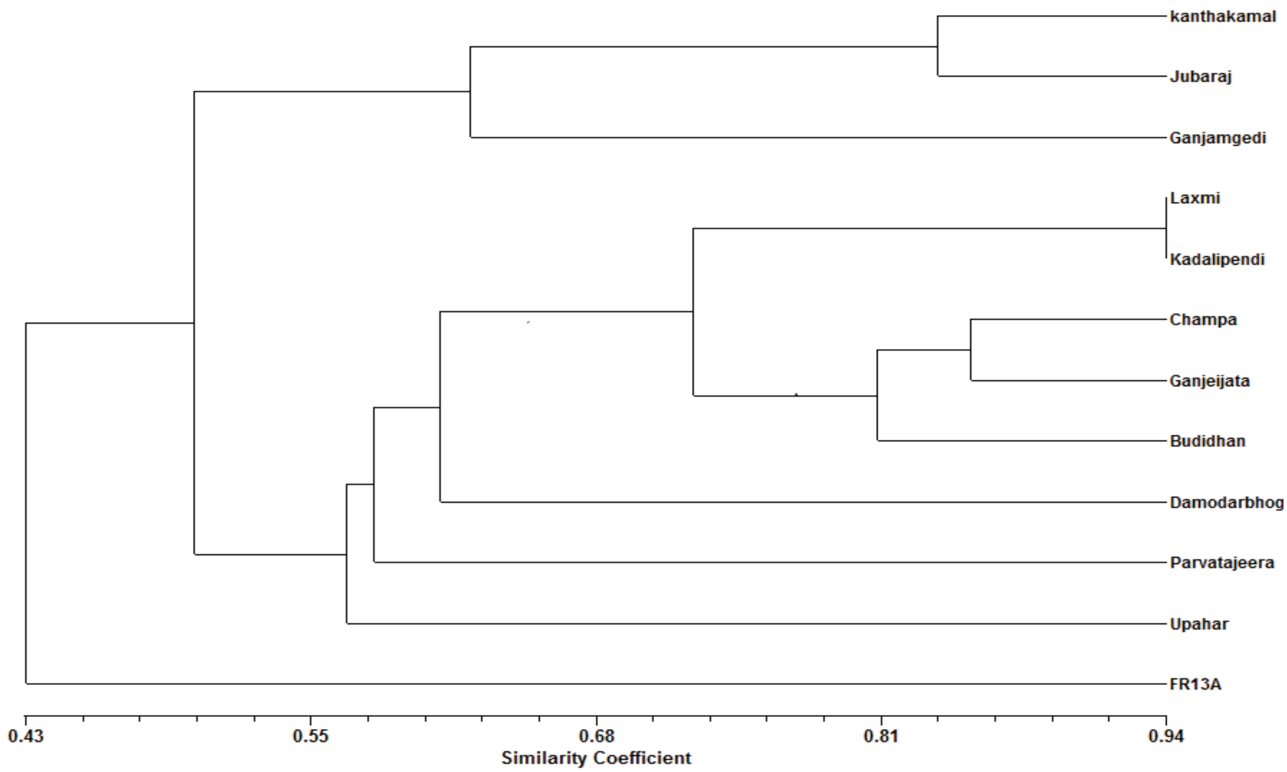

Fig. 1. Dendrogram depicting genetic relationship among 12 lowland rice cultivars based on SSR profile.

values for flag leaf area (45.06 cm^2) and 100-grain weight (2.95g) where as cluster X recorded high mean values for number of effective tillers per plant (8.75) and harvest index (0.43). Cluster XI had high mean value for grain L/B ratio (5.30). The cluster means indicated that no clusters had genotypes with all the desirable characters which could be directly selected and utilized. Hence recombination breeding between genotypes of different clusters may be followed.

To realize much variability and high heterotic effect earlier (Yadav *et al.*, 2011, Vennila *et al.,* 2011 and Latif *et al.,* 2011) recommended that parents should be selected from two clusters having wider inter cluster distance. The inter cluster distance was maximum between cluster VIII and XI followed by cluster III and XI, genotypes from cluster VIII and XI or cluster III and XI may be selected as parents for hybridization. Thus, cross combination such as Damodarbhoga × Julpaya, FR 13A × Julpaya, Basabhoga × Julpaya, Baiganamanji × Julpaya, Ganjeijata × Julpaya may be made to get large variability in the early segregating generation. In order to ascertain if the cultivars from different clusters indeed exhibit broader genetic divergence, neutral markers were used.

A total of seven microsatellite markers were used to assess the extent of genetic diversity across the 12 genotypes. Five SSR markers (RM520, RM 480, RM 413, RM219 and RM 222) generated polymorphic bands. A total of 13 alleles were detected with an average of 2.6 per locus. The PIC value for five polymorphic primers varied from 0.95 (RM 219) to 0.97 (RM 480, RM 413) with a mean of 0.96. The genetic similarity matrix based on Jaccards coefficient ranged from 0.310 (Kanthakamal and Budidhan) to 0.94 (Laxmi and Kadalipendi) with average similarity index of 0.56. Based on UPGMA analysis (Fig. 1), cluster-I contained the most divergent genotype FR13A and the cluster-II included rest 11 genotypes was further subdivided to Cluster-IIa (8 genotypes) and Cluster-IIb (3 genotypes).The cluster largely matched with those generated by metric traits.

Our study provides pointers to identifying diverse parents for hybridization landraces from diverse clusters may be chosen as parents for crossing.

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