Journal of Crop and Weed, 9(2):115-121(2013)

Morphologybased multivariate analysis of phenotypic diversity of landraces of rice (O*ryza sativa* L.) of Bankura district of West Bengal

A. K. SINHA AND PK MISHRA

Department of Botany
Vinoba Bhave University, Hazaribag-825 301, India

ABSTRACT

The morphological characterization of plant is the basic criteria in order to provide fundamental information for plant breeding programme. The main objective of the present work was to characterize 34 landraces of rice of Bankura District of West Bengal, based on 12 quantitative agro-morphological characters. Agro-morphological characters were analyzed using Multivariate statistical analysis. Multivariate analysis involves observation and analysis of more than one statistical variable at a time. Pearson correlation coefficient, The un- weighted variable pair group method of the average linkage cluster analysis (UPGMA), principal component analysis (PCA), were used to analyze the data obtained. This analysis helps to enabled pattern of variation of the germplasm of landraces of rice and identification of the major traits contributing to the diversity of landraces. Five cluster groups were obtained from the 12 agro-morphological characters using multivariate analysis. PCA showed the contribution of each characters to the classification of the rice landraces into different cluster groups. The first three principal components explained about 86.9% of the total variation among the 12 characters. The results of PCA suggested that characters such as leaf length, leaf width, panicle length and grain size (100 grain weight, length and width of grain and kernel) were the principal discriminatory characteristics of landraces of rice.

Key Words : Agronomic characters, landraces and multivariate analysis, West Bengal.

Rice is the staple food grain of West Bengal. The unfortunate aspect is that out of over five thousand landraces, more than 90% of the landraces was disappeared from the rice field of Bengal. More than 95% of rice cultivation of West Bengal is done by using high yielding varieties only (Sinha and Mishra 2012, 2013). The landraces are valuable as they possess treasure of genetic materials which may prove valuable in future crop development and improvement programs. Our information about them is incomplete and is therefore urgent to collect and conserve this landraces of rice. Green revolution was considerably held to improve production of food grains in our country and its role in achieving status of self sufficiency in food grain is beyond any doubt (Srivastava and Jaffe 1993). But high yielding varieties, which are the back bone of green revolution, have indirectly stimulated erosion of landraces and wild varieties of rice (Fowler and Moony 1990). Presently more than 90% of rice cultivation is being done using high yielding variety only. Obviously landraces are disappearing fast (Durning 1990; Holden *et al* 1993; Matson *et al* 1997). 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 only (Shiva 1991, Holden *et al* 1993). Landraces offer a valuable gene pool for future breeding programme (Richharia 1979, Patra 2000). In present era of overpopulation, *Ex-Situ* conservation is the best strategy to conserve this landraces (Lipton and Longhurt, 1989) because marginal and poor farmers who are the main keepers of traditional variety of rice are more interested in high production but not in genetic diversity.

Several workers reported the use of agro-morphological markers in the characterization of rice diversity. Chakravorty *et al* (2012, 2013) studied multivariate analysis of 51 landraces of rice of West Bengal based upon 18 agro-morphological traits. Assessment of genetic diversity is very important in rice breeding from the standpoint of selection, conservation of different landraces of rice and proper utilization (Mohammadi-Najad G 2008). Evaluation and characterization of existing landraces of rice is important due to increasing needs of varietal improvement. Agro-morphological characterization of germplasm variety is fundamental in order to provide information for plant breeding programme (Lin, 1991). Yawen *et al* (2003) studied the genetic diversity of 5285 accessions of landraces of rice in China and found considerable morphological variation among accessions. Patra and Dhua (2003) analyzed the agro-morphological diversity of upland rice.

The main objective of the present study was to characterize thirty two landraces of rice of Bankura district of West Bengal using twelve agro-morphological characters to provide useful information to facilitate the choice of genitors for rice plant breeding programme.

Email- anjansinha06@gmail.com

MATERIALS AND METHODS

The present investigation was carried out using 34 traditional lowland and upland rice cultivars, collected from the lateritic region of West Bengal, during kharif season of 2011. The *In-Situ* cultivation of collected landraces of traditional rice variety from various remote village of these district was conducted at the village of Ranbahal (22˚38´N latitude and 86˚36´E-87°47´E longitude with an altitude of 78 meters above sea level). The soil reaction gives a slightly acidic pH of 5.2, with low soluble salts (EC of 0.0.06 dS m-1), medium organic carbon content (0.49%), Total N (0.051%), medium in available P (45 kg ha-1) and K (210 kg ha-1).

Thirty four (34) races land of rice cultivars collected from the remote villages of Bankura district of West Bengal, were evaluated in the study are given in table 1.

Table1: List of various landraces of rice collected from various parts of Bankura district.

Code	Name of the cultivars	Code	Name of the cultivars	Code	Name of the cultivars
V1	Dharansal	V2	Suakalma	V3	Vutmuri
V4	Tulsibhog	V5	Sitasal	V6	Gobindabhog
V7	Rupsal	V8	Kalamkati	V9	Neta
V10	Nagrasail	V11	Danarguri	V12	Chandrakanta
V13	Daharlagra	V14	Badshabhog	V15	Bhurisal
V16	Khajurchari	V17	Gangajali	V18	Raghusal
V19	Basmati	V20	Kataribhog	V21	Chotodidi
V22	Fulkhar	V23	Uri	V24	Mihidana
V25	Bhadoi	V26	Kalobyar	V27	Byamajhupi
V28	Jhara	V29	Sindurmukhi	V30	Mukta
V31	Dudhersar	V32	Bhuri	V33	Malabati
V34	Patnai-23				

The materials were grown using completely randomized block design with three replications. Each variety was transplanted (45 day's old seedling) in a plot of 6m^2 with a spacing of 25cm. between rows and 20cm. between plants in a row. A random sample of five competitive plants was used for observations on different traits under study. No synthetic nutrients were applied. During the crop period the water depth of the field was 40-50cm. Measurements of 12 quantitative characteristics of these collected landraces at different stages of growth will be recorded following National guidelines for the conduct of Test for Distinctness, Uniformity and Stability of Rice (*Oryza sativa* L.). INDIA. ITG/01 Date: 03/09/2003, methods in the descriptors for rice *O. Sativa* (IRRI, 1980) or Standard Identification System (SIS by IRRI). Variables considered in the descriptive and multivariate analyses were morphological i.e. plant height, leaf length, leaf width; phenological i.e. days to 50% flowering and days to harvest maturity, both measured from the day of sowing; and grain traits i.e. panicle length, number of panicle, grain length, grain width, grain shape, and weight of 100 grains. The Phenotypic and genotypic correlation coefficient values were calculated and computed by Pearson's Correlation Coefficient method and the data were analyzed using higher clustering methods for similarity/distance measure. Cluster analysis was done by according to the Bray and Curtis Distance/similarity measure with nearest neighbour cluster method to yield a dendrogram depicting the morphological relatedness of the 34 landraces of rice cultivars. Principal component analysis was also used to detect underlying sources of morphological variability. PCA had been used to determine the optimum number of clusters (Thompson *et.al.* 1998), to complement cluster analysis (Lombard *et. al.* 2000), and to investigate patterns of genetic diversity (Mohammadi and Prasanna 2003). All analyses were done using the StatistiXL- verson1.8 statistical package.

RESULTS AND DISCUSSION

Pearson's Correlation analysis of 12 quantitative characters of 34 Landraces of rice.

Pearson's correlation is measure of strength of linear relationship in between two variables. Association and correlation in between characters are represented in Table 2. Character Length of blade is correlated with stem length and panicle length. Width of blade character is positively correlated with yield characters i.e. 100 grain weight, grain width, kernel length and kernel width. 50% heading is highly correlated with maturity time and also correlated with stem length. Stem length character shows correlation with time of maturity. Panicle length negatively correlated with 100 grain weight. Panicle number shows maximum correlation (0.150) with grain length. 100 grain weight shows maximum of correlation with grain length, grain width, kernel width and kernel length. Grain length and grain weight possesses maximum correlation with kernel length and kernel weight respectively. Time of maturity was poorly correlated with other morphological characters; it shows negative correlation with 7 other morphological characters and significantly correlated with 50% heading, stem length and leaf length. Stem length was highly correlated with length of blade, showing the morphogenetic compatibility in the architectural configuration of rice plant. Through correlation studies we could easily assume the relationship between groups of characters or which character is directly associated with other character.

The negative correlations show that grain weight and kernel weight tended to decrease as the length of blade increased and kernel length tended to decrease as panicle length increased. The positive correlations between the grain weight and grain width (r = 0.697), grain weight and grain length (r = 0.683) , grain weight and kernel length (r=0.671) and grain weight and kernel width (r= 0.492) indicate that the wider and/or longer the grain, the heavier it is. The highly positive correlation between 50% heading and maturity time (r = 0.849) showed that the maturity time tend to increase along with the 50% flowering duration. The positive correlation between width of blade and the yield character indicate that higher the blade width higher the grain weight simultaneously a negative correlation show that panicle number tended to decrease as width of blade increase, or width of blade increase as grain production decrease.

Table: 2 Correlation coefficient among 12 quantitative traits of 34 landraces of rice cultivars

	LB	WB	50%HEAD	STLN	PL	PN	TM	100GW	GL	GW	KL
LB											
WB	-0.082										
50%HEAD	0.248	0.046									
STLN	0.531*	0.025	0.482(*)								
PL	0.518(*)	-0.055	-0.136	0.272							
PN	0.071	-0.235	-0.225	0.061	-0.046						
TM	0.297(**)	-0.184	0.849(*)	0.423(*)	0.010	-0.142					
100GW	-0.297(**)	0.378(*)	0.079	-0.034	-0.496(*)	0.022	-0.270(**)				
GL	0.025	0.261(**)	0.053	-0.011	-0.240	0.150	-0.147	0.683(*)			
GW	-0.242	0.353(*)	0.122	0.071	-0.313	-0.171	-0.203	0.697(*)	0.264		
KL	0.021	0.345(*)	0.015	-0.020	-0.283(**)	0.129	-0.180	0.671(*)	0.971(*)	0.280(**)	
KW	-0.321(*)	0.367(*)	0.070	0.114	-0.257(**)	-0.122	-0.168	0.492(*)	0.007	0.908(*)	0.030

(*)and (**) indicated 0.01 and 0.05 level of significance respectively. Correlation coefficient r>2.652 and r>1.996 are significant at 0.01(two tailed) and 0.05 level (two tailed).

Principal component analysis

PCA explained the genetic diversity of the different landraces of rice. PCA measure the importance and contribution of each component to total variance or PCA can be used for measurement of independent impact of a particular character to the total variance whereas each coefficient of proper vectors indicates the degree of contribution of every original variable with which each principal component is associated. The first 5 component in PCA analysis contribute 86.9% of the variability with eigenvalues

>1 among total genotypic variability for 12 quantitative characters of 32 landraces are represented in Table 3. PC6 to PC12 possesses eigenvalue <1. PC1 with eigenvalue of 3.715 contribute 30.95% of the total variability, PC2 with eigenvalue of 2.387 contribute 19.89% of the total variability. PC3, PC4 and PC5 with eigenvalue 1.907, 1.358 and 1.069 respectively possess 15.888%, 11.313% and 8.909% contribution to the total genotypic variability respectively.

The first principal component accounted for more than 30% of total variance. Variables highly and positively correlated were length of blade with loading of 0.433, panicle length (0.555) and maturity duration (0.398). First component identified yield component variables i.e. grain weight, grain length, kernel width and kernel length presenting negative contributions. As a result, the first component differentiated those accessions that had length of blade and panicle length variation and low yield-component values. The second principal component PC2 accounted for more than 19% variation and was associated with length of blade (0.514), 50% heading (0.881), time of maturity (0.752), stem length (0.749). PC3 is related to panicle number (0.480), grain length (0.667), grain width (-0.429), kernel length (0.646), kernel width (-0.623). PC 4 is related to length of blade (0.430), panicle length (0.686) and time of maturity (-0.428). PC 5 is more related to width of blade (-0.455) and panicle number (0.754).

In PC1 length of blade, panicle length, maturity duration possesses positive contribution and grain weight, grain length, kernel width and kernel length contribute negatively to PC1; thus both vegetative and reproductive characters give contribution to the component. Panicle length exhibited the highest positive value to PC1 (0.555). In PC2 length of blade (0.514), 50% heading (0.881), time of maturity (0.752), stem length(0.749) contributed positively. This component is weighted by vegetative characters only. In PC3 panicle number (0.480), grain length (0.667), grain width (-0.429), kernel length (0.646) and kernel width (-0.623) contributes both positively and negatively to the component and these are fully reproductive character. In PC4 component related to length of blade (0.430), time of maturity (-0.428) and panicle length (0.686) consist of both vegetative and reproductive characters. In PC5 panicle number (0.754) exhibit the highest positive weight to the component which is a reproductive character followed by a negative contribution of a vegetative character width of a blade (0.-455) to the component. Thus we can conclude from the above discussion in most of the cases the accession contributes both vegetatively and reproductively (PC1, PC2, PC4 and PC5). In PC3 each accession contributes one-sidedly i.e. reproductively. Thus through PCA we could identify the number of plant characters which are responsible for the observed genotypic variation within a group. PCA also helps us to indentify the characters which have great impact of phenotype of different landraces of rice variety, and this is very much important to the selection procedure of breeding programme.

Cluster analysis

Relationship between 34 landraces of rice revealed cluster analysis are represented in figure 1. First 2 principal component of principal component analysis are used to graph the clustering pattern. There are 5 clusters which could be framed from cluster analysis. Out of 34 landraces Bhadoi (V25), Vutmuri (V3) and Fulkhar (V22) alone formed cluster 1, cluster 2 and cluster 3 respectively. Variety Neta (V9), Bymajhupi (V27) and Dharlagra (V13) together form cluster 5 and rest of the 28 landraces variety formed cluster 4 (Figure 1). The first cluster was characterized by lowest length of blade, lowest stem length, lowest panicle length, lowest panicle number and lowest maturity time. Vutmuri (V3) form cluster 2 as this variety shows second lowest blade length, lowest duration of 50% flowering in days, and maximum number of panicle per plant. Variety Fulkhar (V22) form cluster 3 which shows average value of 12 quantitative characters; Neta (V9), Bymajhupi (V27) and Dharlagra (V13) form cluster 5 shows average mean value of all the estimated characters; rest of the varieties form cluster 4 which shows highest value of leaf blade length, highest time to maturity is days, highest value of grain length, 100 grain weight and highest stem length etc.

Euclidean distance among different landraces of rice

Relationship among 34 landraces of rice revealed by UPGMA cluster analysis is presented in Figure 2. Clustering of 34 landraces showed that variety 25, 3 and 22 are distinct from other varieties and form 3 separate clusters. Variety 27, 13, and 9 together form a distinct group and rest of the variety formed a separated group. High yielding variety has a great impact in increasing food crisis due to overpopulation. But in present situation High yielding varieties has no longer been competent for the present changing environmental condition. HYV are much more susceptible for pathogenic attack, environmental stress, and thus we should improve the variety to compete the future food crisis. For future crop improvement we must take helps from the landraces of rice, and thus proper screening and identification of suitable morphological and agronomic characters is the most important factors. In this present study we tried to find out the important morphological and agronomical characters of landraces of rice which have a great impact on plants agromorphic characterization and future morphogenetic improvement of hybrid rice. From this study we can also conclude that leaf length, leaf width, number of panicle per plant, 100 grain weight, length and breadth of grain, length and breadth of the kernel are the characters which have great importance in plant breeding programme. Multivariate analysis also suggests the suitability of different landraces of rice for future breeding programme.

Table 3: Principal component analysis of 12 agro-morphological characters for 34 landraces of rice. (correlations between initial variables and principal components: component loading)

Variable	PC 1	PC 2	PC 3	PC 4	PC 5
Length of Blade (cm)	0.433	0.514	0.402	0.430	0.032
Width of Blade (cm)	-0.516	0.156	-0.095	0.390	-0.455
50% Heading (days)	0.061	**0.881**	-0.170	-0.352	-0.065
Stem Length (cm)	0.164	0.749	0.038	0.332	0.326
Panicle Length(cm)	**0.555**	0.055	0.142	**0.686**	-0.118
Panicle Number (cm)	0.023	-0.183	0.480	-0.047	**0.754**
Time of Maturity (in days)	0.398	0.752	-0.115	-0.428	-0.041
100 Grain Weight (gm)	**-0.913**	0.145	0.094	-0.052	0.076
Grain Length(mm)	-0.671	0.205	**0.667**	-0.062	-0.109
Grain Width(mm)	-0.775	0.205	-0.429	0.222	0.204
Kernel Length(mm)	-0.699	0.185	0.646	-0.034	-0.147
Kernel Width(mm)	-0.624	0.138	-0.623	0.270	0.291
Eigen value	3.715	2.387	1.907	1.358	1.069
% variance contribution	30.957	19.892	15.888	11.313	8.909
%cumulative variance contribution	23.468	37.507	50.303	60.502	75.825

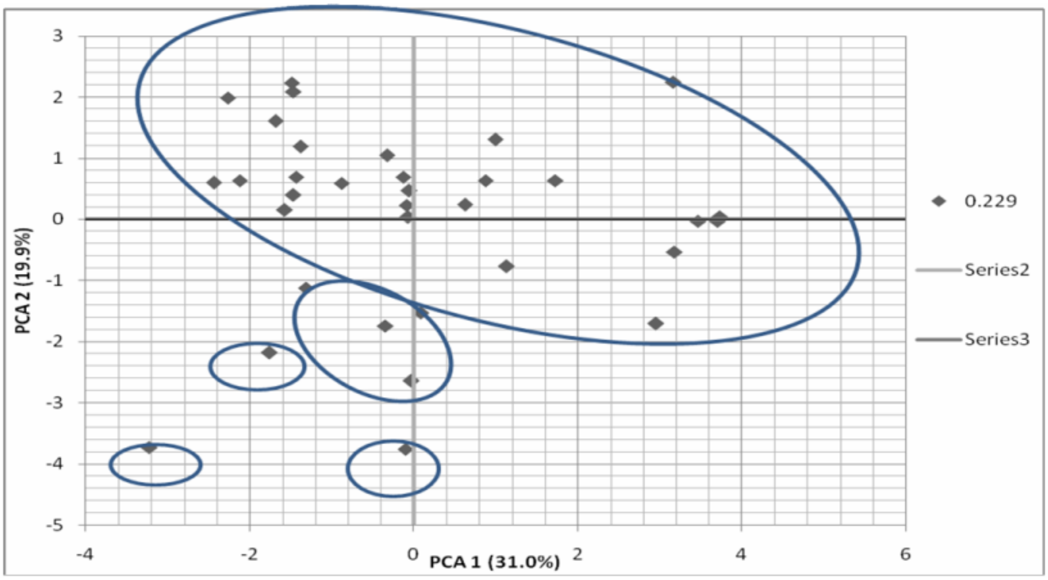

Fig:1 Clustering of 34 landraces of rice from 12 quantitative agro- morphological traits.

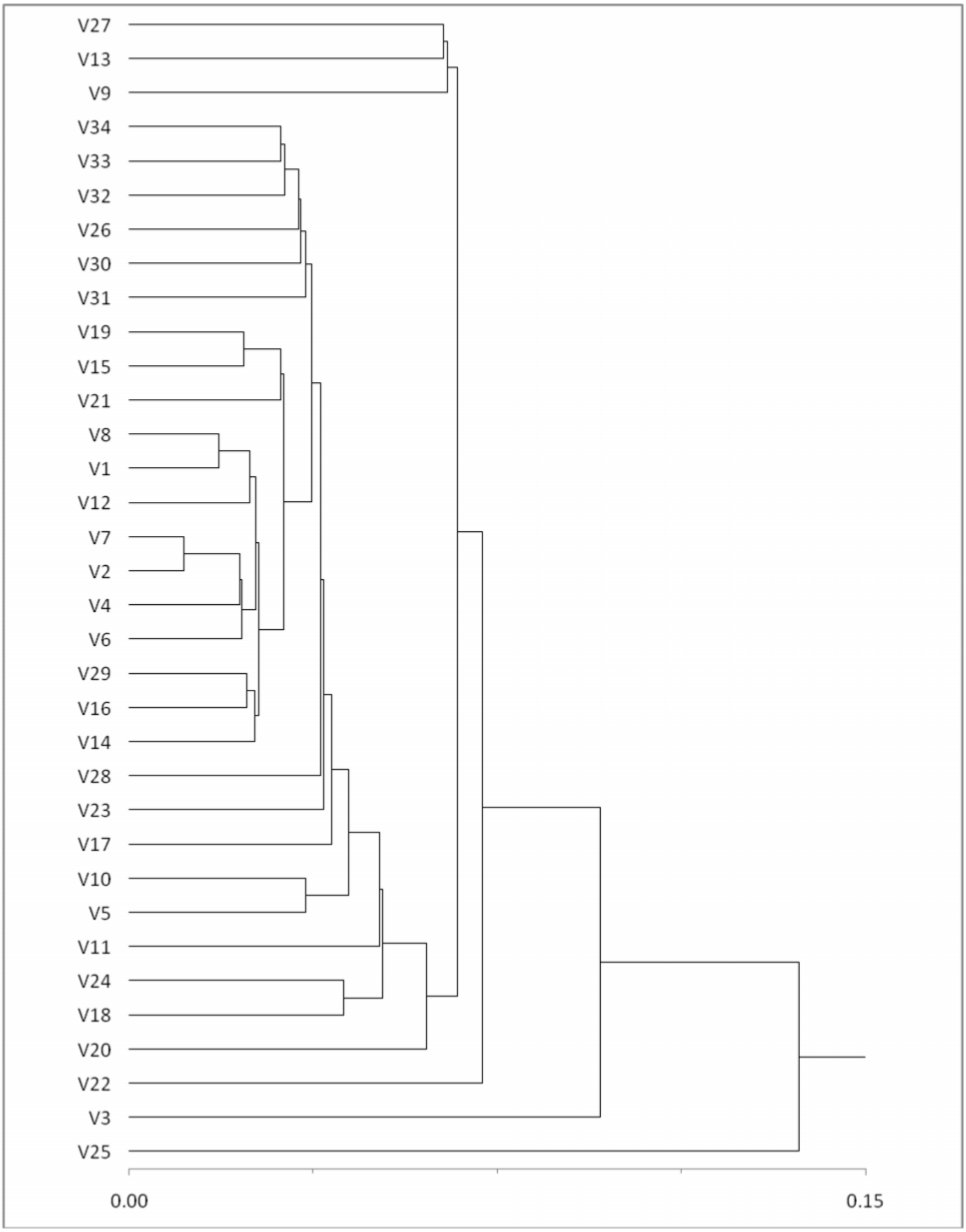

Fig: 2 Dendrogram of 34 Landraces of rice cultivars derived by UPGMA from 12 morphological traits (according to the Bray and Curtis Distance/similarity measure with nearest neighbour cluster method) .

REFERENCE

Chatterjee, S.D., Adhikari, B., Ghosh, A., Ahmed. J., Neogi ,S.B. and Pandey, N. 2008. *The rice biodiversity in West Bengal*. Department of Agriculture, Govt. of West Bengal. 50.

Chakravorty, A., Ghosh, P.D. and Sahu, P.K. 2013. Multivariate analysis of Phenotypic diversity of landraces of rice of West Bengal, *Ameri. J. . Expt. Agric.* **3**: 110-23.

Chakravorty, A. and Ghosh, P.D.2012. Genetic divergence in landraces of rice (*O. sativa* L.) of West Bengal, India, *J. Crop Weed*, **8** : 23-28.

Durning, A.B. 1990. *Crop Evolution, Adaption and Yield.* Cambridge University Press, Cambridge.

Fowler, C. and Mooney, P. 1990. *Shattering: Food, Politics and Loss of Genetic diversity*. University of Arizona Press. Tucson.

Guevarra, E. 2000. *No. of Bengal Folk Rice Variety, Genetic Resources Centre* , IRRI, Manila.

Holden, J., Peacock, J. and Williams, T. 1993. *Gens, Crops and the Environment.* Cambridge University Press, Cambridge.

Lipton, M. and Longhurst, R. 1989. *New Seeds and Poor People.* Johns Hopkins University Press. Baltimore.

Lin, M.S. 1991. Genetic base of japonica rice varieties released in Taiwan. *Euphytica* **56**: 43-46

Lombard, V., Baril, C., Dubreuil, P., Blouet, F. and Zhang, D. 2000. Genetic Relationships and Fingerprinting of Rapeseed Cultivars by AFLP: *Consequences for Varietal Registration*. *Crop Sci* **40**: 417-25

Matson, A.P., Parton, W.J,. Power, A.G. and Swift, M.J. 1997. " Agricultural intensification and ecosystem properties." *Science* **277**:504-09.

Mohammadi-Najad, G., Arzani, A., Rezai, A.M., Singh, R.K. and Gregerio, G.B. 2008. Assessment of rice genotypes for salt tolerance using microsatellite markers associated with the saltol QTL. *African J. of Biotech*. **7**:730-36.

Mohammadi, S.A. and Prasanna, B.M. 2003. Analysis of genetic diversity in crop plants - salient statistical tools and considerations. *Crop Sci.*, **43**:1235-48.

Patra, B.C. and Dhua, S.R. 2003. Agro-morphological diversity scenario in upland rice germplasm of Jeypore tract. *Genetic Resources and Crop Evol.*, **50**: 825-28.

Patra, B.C. 2000 Collection and characterization of rice genetic resources from Keonjhar district of Orissa. *Oryza*.;**34:**324-26.

Patra, B.C. 2000 Collection and characterization of rice genetic resources from Keonjhar district of Orissa. *Oryza*.;34:324-326.

Richharia R.H. 1979. An aspect of Genetic Diversity in Rice. *Oryza.*; **16**:1-31.

Thompson JA, Nelson RL and Vodkin L.O. 1998. Identification of diverse soybean germplasm using RAPD markers. *Crop Sci.*; **38**:1348-55.

Sinha, A.K. and Mishra, P.K. 2012. Rice diversity of Bankura District of West Bengal (INDIA), *Bioscience Discovery.,* **3**(3):284-287, November.

Sinha, A.K. and Mishra, P.K. 2012. Agronomic Evalution of landraces of Rice (*Oryza sativa*) of Bankura District of West Bengal, *Columban J. of Life Sci.*, **13** : 35-38.

Sinha, A.K. and Mishra, P.K. 2013. Agromorphological characterization and morphology based genetic diversity analysis of landraces of rice variety (*Oryza sative*) of Bankura district of West Bengal. *Int. J. Curr. Res.*, **5**: 2764-2769.

Srivastava, J.P. and Jaffe, S.1993. Best practices for Moving Seed Technology: New Approaches to doing Business. World Bank Technical Paper No-213. The World Bank. Washington, DC.

Shiva, V. 1991. The Violence of the Green Revolution. Third World Network, Penang.

Yawen, Z., Shiquani, S., Zicho, L., Zhongyi, Y., Xiangkun, W., Hongliang, Z. and Guosong, W. 2003. Ecogeographic and genetic diversity based on morphological characters of indigenous rice (*Oryza sativa* L.) in Yunnan, china. *Genetic Res. Crop Evol.* **50**: 567-77.