Journal of Crop and Weed 7(2):59-63 (2011)

An analysis on genetic parameters of different *Land races* of rice of West Bengal

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Received:10.04.2011, Revised: 27.10.2011, Accepted : 09.10.2011

ABSTRACT

The characterization and diversity pattern were analyzed among 51 traditional rice cultivars of West Bengal, India. This analysis assess the diversity of the genetic base with respect to agro-morphological features with special reference to 18 quantitative traits like leaf length, leaf width, plant height, flag leaf angle, grain length, grain breadth, grain weight, maturity, number of grains per panicle etc. Qualitative traits were also studied following Distinctness, Uniformity and Stability (DUS) test. Statistical analyses were taken up to explain performance in terms of mean, standard error of mean, genotypic coefficient of variation, phenotypic coefficient of variation, heritability in broad sense, genetic advance. Considerable variability has been found among the traits studied. The study will help in identifying the promising genotypes for rice improvement programme.

Key words: Agro-morphological traits, diversity, DUS, traditional rice

West Bengal is one of the major rice producing states in India and the rice growing regions of this state specially the Gangetic alluvial zone include a diverse agroecological niches with a number of diverse traditional lines which have been reported to be tolerant against a number of abiotic stresses (Chatterjee *et al.*, 2007). In breeding programme, introduction of novel germplasms is very much required to diversify the genetic base (Thompson *et al.*, 1988). Land races have a diverse genetic base, most of them remain untapped, uncharacterized and underutilized (Richharia 1979, Sharma *et al.* 1987, Patra 2000). Also, the genetic improvement of any crop mainly depends upon the amount of genetic variability present in the population (Vivekanandan and Subramanian, 1993). Genotypes having diverse genetic background may be helpful to obtain high heterotic response and transgressive segregants in future breeding programme (Verma *et al.*, 2004). Considering the immense importance of traditional rice germplasms in the crop improvement, the objective of the present work is to assess some traditional germplasms of rice growing in Nadia, Murshidabad and 24 Parganas (N) and analyze their genetic parameters with special reference to the examination of diversity pattern in their agromorphological traits. The knowledge of genetic variability, heritability and genetic advance is the prime parameter of different yield contributing traits for selecting superior genotypes from the germplasms and for conservation of genetic resources. Johnson *et al.* (1955) suggested that heritability estimates along with genetic advance would be more useful in predicting gain under phenotypic selection than heritability estimates alone.

MATERIALS AND METHODS

A field experiment was carried out in Gangetic alluvium soil having sandy clay loam texture with moderate soil fertility status during *Kharif* season of 2006 at the Instructional Farm (23°24′N latitude and 88°31′E longitude with an altitude of 9.75 meters above mean sea level) of Zonal Adaptive Research Station (Z.A.R.S.), Krishnagar, Nadia, West Bengal to study the diversity pattern among the land races. The soil reaction gives a slightly acidic pH of 6.0, with low soluble salts (EC of 0.15 dS m^{-1}), medium organic carbon content (0.57%), Total N (0.056%), medium in available P (25.28 kg ha^{-1}) and K (148.77kgha^{-1}).

The experimental site belongs to tropical humid climate having the average rainfall of 1464 mm, most of the amount falls in between June to September. Temperature ranges from 7.6° to 41°C. The minimum temperature reaches 7.6°C in the month of January and the maximum 41.1°C in the month of May. It has been observed that 74.7% of the annual rainfall is obtained during June to September and more than 83.6% during June to October. Maximum temperature often reaches as high as 41°C during May to September. Such a high temperature is though unfavourable for grain formation and ripening (Nishiyama, 1976), yet its soil quality of Alluvium type prefers its suitability to proper cultivation. The field experiment was laid out in Randomized Block Design. Seedlings of each entry were transplanted in 3.0×2.85m^2 plot and there were three replications for each entry. All entries in each replication were planted randomly. Plant to plant distance was 15 cm, row to row distance was 20 cm and plot to plot distance was 60 cm. Five plants were selected at random from each plot for recording observations on various characters. Crop was raised following recommended (Hartman *et al.*, 1962) package of practices. Fertilizers ($N:P_2O_5:K_2O$) @ 50:25:25 kg ha^{-1} were applied.

Characterization has been done on 8 qualitative and 18 quantitative traits. The data on 18 quantitative traits viz. leaf length, leaf breadth, plant height (seedling), flag leaf angle, culm length, culm diameter, culm number, ligule length, panicle length,

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grain length, grain breadth, grain length/breadth ratio, grain weight (1000), kernel weight (1000), sterile lemma length, maturity, number of primary branches per panicle and number of grains per panicle were recorded using standard evaluation system for rice by IRRI (1996).

Various agro-morphological and agronomical traits were studied for 51 cultivars (both qualitatively and quantitatively). The quantitative characters were studied by using statistical parameters. Genetic parameters for variability like mean, standard error of mean, coefficient of variation (both genotypic and phenotypic), heritability, genetic advance were analyzed as proposed by Johnson *et al.* (1955). Besides these, statistical analysis was done using SPAR and MSTATC computer software.

Among the qualitative traits, eight visually assessed characteristics (qualitative) *viz.*, leaf blade pubescence, panicle exsertion, colour of ligule and auricle, distribution of awning, leaf senescence, flag leaf attitude and basal leaf sheath colour were observed according to the National Test Guide Lines for DUS test in rice which was developed by Directorate of Rice Research (Rajendarnagar, Hyderabad) in consultation with the National core group experts for development of National guideline in crop plants and also with the rice experts.

The observations of various characteristics were recorded at different stages of growth with appropriate procedures as per the DUS test guideline of PPV (Protection of Plant Variety) and FR (Farmers Right Act, 2001) authority. The various stages with their respective codes are like Booting stage (40 DAT), Ripening stage (90 DAT) and the stage of Caryopsis hard (92DAT).

The issue of ownership over the varieties became alive only after an international body UPOV (Convention of the Union for the Protection of New Varieties of Plants) was established in Paris in 1961. The UPOV aimed to ensure protection of varieties by the grant of an exclusive right on the protected new plant varieties on the basis of a set of uniform and clearly defined principles (Dutfield, 2001).

Table 1: Mean, S.E., range, GCV, PCV, heritability, genetic advance and CV% of 18 quantitative traits of 51 traditional rice cultivars

Traits	Mean±S.E.	Range	GCV	PCV	h^2 (Heritability)	GA of mean (%)	CV%
1. Leaf length	47.47±1.11	31-61#	13.86	14.05	0.972	28.14	2.35
2. Leaf breadth	1.51±0.05	1.1-2.5#	16.95	17.37	0.952	34.43	3.79
3. Seedling height	29.46±2.14	24-43#	18.30	19.69	0.864	35.03	7.26
4. Flag leaf angle	2.37± 0.24	1°-4°	40.39	40.39	0.999	83.12	14.85
5. Ligule length	1.82±0.23	0.90-3.5#	40.15	42.10	0.910	79.12	12.64
6. Culm length	133.9±10.26	94-151#	10.03	12.62	0.632	16.43	7.65
7. Culm diameter	0.48±0.3.53	0.3-0.9#	28.86	28.86	0.999	59.18	0.01
8. Culm number	8.97±0.58	6-15	24.46	25.31	0.934	48.71	6.49
9. Panicle length	24.80±1.12	21.0-30.5#	8.66	9.77	0.785	15.80	4.52
10. Grain length	8.30±0.58	3.9-11.2@	13.78	15.47	0.794	25.30	7.02
11. Grain breadth	3.06±0.02	2.05-4.2@	18.72	18.74	0.998	38.44	0.79
12. Grain length: breadth	2.85±0.51	1.73-4.96@	21.01	27.79	0.572	32.63	18.17
13. Grain weight (1000)	21.41±0.09	10.34-29.9$	19.39	19.40	0.999	39.43	0.46
14. 1000 kernel weight	18.19±0.42	8.0-25.0$	21.16	21.28	0.988	43.32	2.31
15. Maturity (Day)	139.94±3.86	116-172.5	12.12	12.43	0.951	24.33	2.76
16. Sterile lemma length	1.23±0.31	0.1-0.2 #	23.45	34.64	0.458	32.52	25.49
17. No. of primary branches panicle^{-1}	11.85±0.47	5.5-17	22.70	23.06	0.969	46.06	4.04
18. No. of grains panicle^{-1}	169.50±0.003	30-318.5	35.28	40.86	0.746	62.76	20.60

Note: # - cm, @ - mm, $ - g

Like UPOV, in PPV and FR Act, a variety must fulfill the criteria of Distinctiveness, Uniformity, Stability (DUS) and novelty (if new) so as to get protection under this act (Anon, 2001). There are 62 (essential 29 and additional 33) morpho-physiological DUS descriptors for rice which are species specific and recommended procedures for conducting DUS trials. Plant morphological DUS descriptors have been the universally undisputed descriptors applied for DUS testing of crop varieties.

RESULTS AND DISCUSSION

The analysis of variance for 18 quantitative traits indicates high and significant variation for all

the traits except flag leaf angle and culm diameter. Phenotypic coefficient of variation (PCV) was greater than Genotypic coefficient of variation (GCV) for maximum characters. A few cases have been found during analysis where there is a remarkable difference between GCV and PCV indicating the influence of environment over genotypic effects. The results of the present study exhibited high heritability coupled with high GA% for flag leaf angle, plant height, leaf length, maturity etc. High heritability was observed in case of leaf length, leaf breadth, flag leaf angle, ligule length, culm diameter, culm number, grain breadth, grain weight, maturity, number of primary branches per panicle. The illustrations of this matter are presented in the table-1. Coefficient of variation at phenotypic (PCV) and genotypic (GCV) levels were relatively high for majority of the traits except panicle length, maturity and culm length. The magnitude of PCV was higher than GCV for all the traits except flag leaf angle and culm diameter, indicating the influence of environment. GCV value closer to the respective PCV value for most of the characters clearly indicate the lesser influence of environment on these traits which is an indication towards genetic governance of these characters.

High heritability was observed for all the traits except grain length/breadth ratio and sterile lemma length. Similar kind of result has been reported by Singh *et al.* (2007) and Manoj Kumar *et al.* (2008). Genetic advance expressed as percent of mean was high for flag leaf angle, ligule length, number of grains per panicle, culm number and number of primary branches per panicle; low for panicle length, maturity, grain length and moderate for remaining traits. The relationship between heritability and genetic advance for all the traits suggested that they were governed by both additive and dominant gene action. However high heritability coupled with high genetic gain for flag leaf angle, ligule length, number of grains per panicle, culm number and number of primary branches per panicle revealed that the preponderance of additive genetic variance employing the direct selection would be quite effective for these traits. Roy *et al.*, (2001), Verma and Srivastava (2004) and Manoj Kumar (2008) have also recorded similar result.

Regarding the qualitative traits studied (following the DUS test), a remarkable variation has been found in significant amount specially among the traits like basal leaf sheath colour, leaf blade pubescence, panicle exertion, ligule colour, auricle colour, leaf senescence, flag leaf attitude, stem length, panicle length, tip colouration in lemma, awn distribution etc. Regarding coleoptile colour, 7.54% of the accessions showed purple colouration while in case of leaf blade pubescence, it is very much interesting to note that 13.72% of the accessions are lacking the pubescence which is beneficial to the farmers. Also, regarding the panicle exertion 41.51% of the accessions are partly exerted, 47.16%, mostly but 11.33% are well exerted. Variations in stigma colour with 3.93% are purple and 13.72% showed light purple colouration. In case of ligule colouration, 74.5% showed light purple while in case of ligule shape, 1.96% of the accessions showed truncate whereas 88.24% showed split shape of ligule. Regarding leaf senescence, 31.38% of the accessions are very late, 47.06% showed inter mediate while 21.56% showed early leaf senescence. In case of flag leaf attitude, it has been found that maximum accessions showed semierect type (60.78%) whereas 31.37% showed erect type of flag leaf attitude. Breeding for erect flag leaf has been suggested as a method of increasing grain yield in cereal crop. Chang and Tagumpay (1970) found that erect flag leaf angle was associated with high yield in rice. In case of awning, it is absent in 70.59% of the accessions while 73.33% of the accessions have been found to have awn at the tip only. Also regarding awn colouration, remarkable variation with 15.68% yellow white, 5.89% purple, 3.93% black, 1.96% brown coloured awn has been found. Awn creates a problematic view in plant breeding programme. Farmers prefer awnless grain in threshing and milling. Variations in respect to ligule shape, ligule colour, collar colour, pubescence of lemma, time of maturity, time of heading have been found remarkably. Frequency distribution in some qualitative traits for 51 traditional rice cultivars is presented in the table-2.

Thus, it can be safely concluded that the present study has been able to characterize some promising germplasms. Among the selected germplasms so far studied, diversity has been found with respect to both quantitative and qualitative traits. It will help the breeder to select the desirable traits from the varieties for hybridization and crop improvement programme. This will also help the plant breeder to identify and choose the restoration and conservation of beneficial gene for crop improvement.

Table 2: Frequency distribution of 8 qualitative traits in 51 traditional rice cultivars (using DUS test)

Stage of observation	Code	Trait	No. of accessions	Frequency (%)
1. 40 DAT		Leaf blade pubescence		
	1	Absent	7	13.72
	3	Weak	21	41.18
	5	Medium	21	41.18
	7	Strong	2	3.92
	9	Very Strong	0	0.00
2. 90 DAT		Panicle exertion		
	3	Partly	21	41.51
	5	Mostly	24	47.16
	7	Well	6	11.33
3. 40 DAT		Ligule colour		
	1	Green	6	11.77
	2	Light purple	38	74.50
	3	Purple	7	13.73
4. 40 DAT		Auricle colour		
	1	Colourless	31	60.78
	2	Light purple	7	13.72
	3	Purple	6	11.78
	4	Absent	7	13.72
5. 90 DAT		Distribution of awning		
	1	Absent	36	70.59
	9	Present	15	29.41
6. 92 DAT		Leaf senescence		
	3	Early	11	21.56
	5	Intermediate	24	47.06
	7	Late	16	31.38
7. 90 DAT		Flag leaf attitude		
	1	Erect	16	31.37
	3	Semierect	31	60.78
	5	Horizontal	3	5.89
	7	Deflexed	1	1.96
8. 40 DAT		Basal leaf sheath colour		
	1	Green	46	90.19
	2	Light purple	2	3.92
	3	Purple Lines	3	5.89
	4	Purple	0	0.00

Note: Total (N)=51

ACKNOWLEDGEMENT

The authors acknowledge to the Head of the Department of Botany, K.U. for providing facilities in the department and Dr. A. Ghosh (Z.A.R.S) for necessary help and assistance.

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