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Estimation of variability, diversity and correlation studies with respect to different agro-morphological traits in traditional rice of West Bengal

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ABSTRACT

Landraces of rice containing 51 traditional rice cultivars of three districts viz. Nadia, 24 Parganas (N) and Murshidabad of West Bengal, India, collected from Zonal Adaptive Research Station, Krishnagar, Nadia, were evaluated for 11 quantitative and 6 qualitative characters. A significant amount of genetic variation was displayed for most of the traits examined. Coefficient of variation was more than 10% for the characters like grain length/breadth ratio and no. of grains panicle^{-1} and it was more than 5% in case of the characters like plant height(seedling), culm length, culm number and grain length. Leaf length was positively correlated with leaf breadth (r=0.784), culm length (r=0.439) and panicle length (r=0.431). Plant height showed positive correlation with flag leaf angle(r=0.363), culm diameter (r=0.740), culm no. (r=0.784) and panicle length (r=0.783), indicating the importance of plant height in improving the panicle length. Grain length is significantly correlated with kernel weight (r=0.508) and grain weight (r=0.490).

Key words: *traditional rice cultivars, genetic variability, correlation coefficient agro-morphological traits*

Rice production needs to be increased to keep pace with the growing population, however, its productivity may be effected by several biotic and abiotic stresses. The genetic diversity for these stresses is limited in the current rice cultivars. There is urgent need to broaden the genetic base of this important crop by introgressing genes from diverse sources. Land races genotypes, wild and weedy relatives are an important source of useful genes.

A large number of traditional rice cultivars of accessions have been collected from various parts of three districts of West Bengal viz. Nadia, 24 Parganas(N) and Murshidabad and maintained in the gene bank of Zonal Adaptive Research Station, Krishnagar, Nadia. The adequate characterization and evaluation is prerequisite both for the effective management and use of plant germplasms in breeding programmes. Until the collected germplasm in the gene bank is properly evaluated and its attributes are made available to the breeders, it has little practical value.

Acurate assessment of the levels and patterns of genetic diversity can be invaluable in crop breeding for diverse applications including analysis of genetic variability in land races genotypes of traditional rice cultivars (Cox *et al*.,1986); identifying divers parental combinations to create segregating progenies with maximum genetic variability for further selection (Barret and Kidwell,1998) and introgressing desirable genes from divers germplasm into the available genetic base (Thompson *et al.,* 1998). This paper reports on phenotypic diversity available for 11+6=17 quantitative and qualitative characters respectively in 51 traditional rice cultivars of rice collected from three districts of West Bengal, India.

MATERIALS AND METHOD

A total of 51 accessions of rice were collected from three districts viz. Nadia, 24 Parganas(N) and Murshidabad of West Bengal and they were taken from the gene bank of Krishnagar, Nadia. The material was planted on 31st July, 2006 under field condition at Z.A.R.S, using RCBD technique and evaluated for various traits of interest. Nursery was raised in beds and transplanted in the field after 31st July, 2006. 51

Table 1. List of 51traditional rice with their respective codes.

Sl No	Code	Name of the cultivars
1	G1	Ranisal
2	G2	Badhabna
3	G3	Machkata
4	G5	Laldhula
5	G6	Dhuladhan
6	G7	Dhuri
7	G9	Kalamkathi (White)
8	G11	Suakalama
9	G14	Nakrasal
10	G15	Asanlaya(white)
11	G16	Asanlaya(red)
12	G17	Pubalgara
13	G18	Daharnagra
14	G20	Kalonunia
15	G21	Tulsibhog
16	G22	Mashisladan
17	G24	Dudhkalama
18	G25	Sankarsal
19	G26	Badsabhog
20	G27	Agnisal
21	G28	Chadrakanta
22	G29	Muktasal/Suryakanta
23	G31	Punjabsal
24	G33	Sitasal
25	G34	Behalsal
26	G35	Kabirajsal
27	G36	Laldhusri
28	G37	Malliksal
29	G38	Baidjhulur
30	G39	Jhulur
31	G40	Manikanchan
32	G41	Nagra
33	G42	Danaguri
34	G43	Majhisal
35	G44	Basmoti Local
36	G45	Netaisal
37	G47	Sankar kalma
38	G48	Rupsal
39	G49	Jhingasal
40	G50	Sungakalma
41	G52	Jhuli
42	G54	Raja Badsa
43	G55	Kalma
44	G56	Sunga Nagra
45	G57	Kerala Sundari
46	G58	Balaram sal
47	G59	Danga
48	G61	Asanlaya
49	G62	Lalhusri
50	G65	Annanda
51	G73	Sarkele(aman)

traditional rice cultivars were used to find out the diversity pattern. The observations were recorded in accordance with IBPGR and IRRI descriptor.

Quantitative data included leaf length, plant height (seedling), flag leaf angle, culm length, culm number, panicle length, grain length, grain weight (1000), kernel weight (1000), maturity and no. of grains panicle^{-1}. The qualitative data included panicle exsertion, distribution of awning, distribution of flag leaf angle, distribution of ligule colouration, distribution of colouration of auricle and distribution of spikelet colouration.

Simple statistics (mean, ranges, standard deviation, and coefficient of variation) was calculated to have an idea of the level of genetic diversity. Frequency distribution were computed to categorize the genotypes into different classes. Correlation coefficients were also calculated among various characters of the cultivars.

RESULTS AND DISCUSSION

Basic statistics for the quantitative traits is like leaf length, plant height (seedling), flag leaf angle, culm length, culm number, panicle length, grain length, grain weight(1000), kernel weight(1000), maturity and no. of grains panicle^{-1} (Table 2). A reasonable amount of genetic variation was displayed for the traits evaluated.

Leaf length is an important agromorphological character regarding the evaluation of genetic divergence in plant breeding.It had mean value of 47.47±1.11 and a wider range of variation from 34.0-61.0cm. The

Table 2. Mean±S.E, range, coefficient of variation (C.V.%) of 51 traditional rice cultivars evaluated at Z.A.R.S

Traits	Mean±S.E	Range	C.V.%
Leaf length	47.47±1.11	34.0-61.0cm	2.35
Plant height(S.H.)	29.46± 2.14	24.0-43.0cm	7.26
Flag leaf angle	2.37±0.24	1Ú-4Ú	14.85
Culm length	133.99±10.26	94-151cm	7.65
Culm number	8.97±0.58	6-15	6.49
Panicle length	24.80±1.22	21-30.5cm	4.52
Grain length	8.30±0.58	3.9-11.2mm	7.02
Grain weight (100)	21.41±0.099	10.34-29.91g	0.46
Kernel weight (100)	18.19±0.42	8.0-25.0g	2.31
Maturity	139.94± 3.86	116-172.5days	2.76
No. of grains panicle^{-1}	169.50±0.003	30-334	20.60

coefficient of variation for this trait was 2.35%. Most of the lines (58.8%) were in the range of 44.0-53.0cm. Cultivars with various ranges of leaf length have been observed in this set of germplasm.

Plant Height (Seedling) had mean value of 29.46± 2.14 and a wider range of 24.0-43.0cm. This is typical of landrace genotypes which excel in their capacity to support panicle growth by large stem reserve mobilization. Plant height in rice is a complex character and is the end product of several genetically controlled factors. (Cheema *et al*., 1987). Reduction in plant height may improve their resistance to lodging and reduce substantial yield losses associated with this trait (Abbasi *et al*., 1995).

A breakthrough in plant breeding was attained with the development of semi dwarf cultivars characterized by lodging resistance, nitrogen response and erect leaves. The success of the "green revolution" is directly related to the intensive use of the semi-dwarf varieties (Hirano *et al.,* 1992). The semi dwarf plant type has been extensively utilized in the improvement of rice cultivars throughout the world. In Kerala, farmers want tall rice so that they can feed its straw to cattle. However, tall varieties lodge when heavily fertilized, significantly reducing yields.Thus, there has been a desire to combine desirable characteristics of tall varieties with yielding ability and a new type of architecture with intermediate plant height. The grand mean and coefficient of variation were 2.37±0.24 and 14.85, respectively. Most of the lines were in the category of 2Ú leaf angle.

Culm Length had mean value of 133.99±10.26 and a wider range of variation from 94-151cm. The coefficient of variation was 7.65%. Most of the lines were in the range of 130-154cm. Cultivars with various ranges of culm length have been observed in this set of germplasm. Culm number is also a yield attributing trait.

Table 3. Genotypic(r_g) and Phenotypic(r_p) Correlation coefficients among eleven quantitative traits of 51 traditional rice cultivars

Traits		Leaf length	Plant height	Flag leaf angle	Culm length	Culm number	Panicle length	Grain length	Grain Weight	Kernel Weight	Maturity	No. of grains panicle^{-1}
Leaf length	r_g	1.000	0.335*	0.211	0.439**	0.339*	0.431**	0.013	0.256	0.258	0.008	-0.213
	r_p	1.000	0.309*	0.208	0.352**	0.325*	0.348*	0.008	0.253	0.252	0.016	-0.183
Plant height	r_g		1.000	0.363**	0.168	0.784**	0.783**	-0.061	0.106	0.067	-0.059	-0.027
	r_p		1.000	0.337*	0.127	0.706**	0.654**	-0.053	0.099	0.058	-0.045	0.003
Flag leaf angle	r_g			1.000	0.040	0.181	0.182	-0.065	0.149	0.137	0.337*	0.027
	r_p			1.000	0.032	0.175	0.161	-0.058	0.149	0.136	0.328*	0.024
Culm length	r_g				1.000	0.320*	0.363**	-0.332*	-0.092	-0.122	0.008	-0.096
	r_p				1.000	0.136	0.160	-0.231	-0.074	-0.100	0.003	-0.118
Culm number	r_g					1.000	0.712**	-0.172	0.120	0.093	-0.137	0.020
	r_p					1.000	0.611**	-0.161	0.116	0.089	-0.132	0.033
Panicle length	r_g						1.000	-0.180	0.122	0.078	-0.093	-0.262
	r_p						1.000	-0.143	0.109	0.065	-0.059	-0.165
Grain length	r_g							1.000	0.490**	0.508**	0.024	-0.105
	r_p							1.000	0.437**	0.449**	0.029	-0.132
Grain wt 1000	r_g								1.000	0.988**	0.145	-0.197
	r_p								1.000	0.982**	0.141	-0.167
Kernel wt 1000	r_g									1.000	0.133	-0.190
	r_p									1.000	0.133	-0.164
Maturity	r_g										1.000	-0.052
	r_p										1.000	-0.049
No. of grains panicle^{-1}	r_g											1.000
	r_p											1.000

* and ** indicate significance at 5% and 1% levels, respectively

The coefficient of variation was 6.49 with grand mean of 8.97±0.58. Most of the lines were in the range of 4-9.

Panicle Length exhibited reasonable amount of variation with range values of 21.0-30.50cm. The average panicle length was 20.1-25.0cm. The maximum panicle length was observed in Serkele aman. Although, it contributed positively yet maximum panicle length is not the only factor responsible for higher kernel weight.

Grain size is an important factor to be found out in plant breeding aspect. It is mainly dependent on leaf length parameter. This also exhibited reasonable amount of variation with range value of 3.90-11.2cm. The coefficient of variation for this trait was 7.02%. Test weight of grains is also a yield attributing trait (Abbasi *et al*.,1995). The coefficient of variation was 0.46%. Most of the lines were in the range of 10.34-29.91g. Lines with high grain weight were also observed in this set of germplasm. Kernel weight is a major yield attributing trait. The coefficient of variation was 2.31%. Most of the lines were in the range of 18.0-22.0g. Cultivars with various ranges of kernel weight have been observed in this set of germplasm.

Maturity also has equal weightage regarding the production in plant breeding. The coefficient of variation was 2.76%. This also exhibited reasonable amount of variation with range from 116.5-172.5 days.Though 50% of the accessions showed early maturity but a large amount showed late time to maturity within the range of 151-162 days. Minimum value for days to maturity represents that the cultivars have a benefit of early ripening.

Number of grains panicle^{-1} exhibited high range of variation with the range from 30.0-334.0. The coefficient of variation was found to be 20.60%. It has been found to have maximum accessions within the range of 112-194 grains panicle^{-1}, since, greater number of grains per panicle is one of the major criteria which contribute to higher grain yield (Akram *et al*.,1994).

Qualitative characters are also important for plant description and mainly influenced by the consumers preference, socio-economic scenario and natural selection. Frequency distribution for six qualitative traits (Table 4). A wider variation was observed for panicle exsertion. Majority of the lines were mostly exserted 24(47.16%) but the proportion of well exserted accessions was only 6(11.33%). IIhamuddin et al.(1988) found that panicle exsertion was the most conspicuous character for identification of the rice cultivars. In the present germplasm it varied from well exserted to partly exserted. No accessions were found with enclosed panicle exsertion.

Regarding the distribution of awning, a total of 15(29.41%) of the accessions were found with awns, where significant proportion of 36 (70.59%) was without awn. Acharya *et al.* (1991) stated that awns appear to be equipped with physiological and biological buffers that enable them to adjust to changes in the environment. A remarkable variation has also been found regarding awn colour ranging from different shades of black, purple to black colour.

Breeding for erect leaf has been suggested as a method of increasing grain yield in cereal crops. Increasing light penetration into crop canopy has been

Table 4. Frequency distribution for six qualitative traits in landrace genotypes following the DUS Test

Trait	No. of accession	Proportion(%)
Panicle exsertion		
Partly	21	41.51
Mostly	24	47.16
Well	6	11.33
Distribution of awning		
Absent	36	70.59
Present	15	29.41
Flag leaf attitude		
Erect	16	31.37
Semierect	31	60.78
Horizontal	3	5.89
Deflexed	1	1.96
Ligule colour		
Green	6	11.77
Light purple	38	74.5
Purple	7	13.73
Auricle colour		
Colourless	31	60.78
Light purple	7	13.72
Purple	6	11.78
Absent	7	13.72
Spikelet colour(lemma)		
White	17	33.34
Yellowish	18	35.29
Brown	9	17.64
Red	1	1.97
Purple	3	5.88
Black	3	5.88

suggested as one of the way of obtaining higher grain yield. Duncan (1971) showed that increased penetration of light into canopy would increase photosynthetic rate and perhaps enhance grain yield. Chang and Tagumpay (1970) found that erect leaf angle was associated with high yield in rice (*O. sativa* L.). Regarding the distribution of flag leaf, it has been found that 16 (31.37%) of the accessions showed erect type of flag leaf attitude. Only 5.89% and 1.96% of the accessions showed horizontal and deflexed form of flag leaf attitude.

Much variation was observed for ligule and auricle colour in the present germplasm. Regarding the spikelet colour, it exhibited great variability ranging from white to black through yellowish, brown, red and purple respectively. Only one accession (1.97%) was found with red spikelet colour specially the tip of lemma.

Correlation is a measure of the degree to which variables vary together or a measure of intensity of association. Leaf length was positively and significantly correlated with plant height, culm length and panicle length (Table 3). Plant height also showed positive and highly significant correlation to panicle length, flag leaf angle and culm number. Flag leaf angle has significant correlation with maturity in days, panicle length and kernel weight. The results of this study are in agreement with Bhatt (1972) and Amirthandevarathinam (1983).

On the basis of experimental data, it can be concluded that a lot of variation exists among these traditional rice cultivars of the three districts of West Bengal, India. These traditional rice cultivars of this area of Gangetic alluvial soil have a wide agroecological range and exhibited significant variation for quantitative and qualitative traits studied that can be suggested for exploitation in breeding programme for future work.

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