Annals of the Sri Lanka Department of Agriculture 2009. 11: 23-32.

GENETIC VARIABILITY OF IMPORTANT TRAITS AND THEIR ASSOCIATION WITH GRAIN YIELD IN RICE

N.P.S. DE SILVA[1], B.P.S. MALIK[2], and K.R. BATTAN[3]
[1]*Regional Rice Research and Development Centre, Bombuwela, Sri Lanka*
[2]*CCS Haryana Agricultural University, Hisar, Haryana, India*
[3]*Rice Research Station, Kaul, CCS Haryana Agricultural University, Haryana, India*

ABSTRACT

The knowledge of genetic diversity among the parents, variability of important traits and their association plays a vital role in success of any hybridization programme. Sixty eight genotypes of rice with a diverse genetic base collected from Rice Research Station, CCS Haryana Agricultural University, Kaul, India were evaluated for their grain yield and yield components. Genotypes were evaluated for days to 50% flowering, days to maturity, plant height, number of effective tillers per plant, panicle length, number of filled grains per panicle, 1000 grain weight, grain yield per plant, hulling %, milling %, head rice recovery %, kernel length, kernel breadth and kernel length/breadth-ratio. Significant differences among the genotypes were observed for all the characters studied. Genotypic coefficient of variation and phenotypic coefficient of variation were high for number of filled grains per panicle and grain yield per plant. Heritability in broad sense and genetic advance as a percent of mean were also high in number of filled grains per panicle and grain yield per plant. Grain yield showed a significant positive correlation with the number of effective tillers per plant, number of grains per panicle, 1000 grain weight and kernel breadth. No associations were observed between grain yield and milling recovery traits.

KEYWORDS: Association, Grain yield, Genetic variability, Rice, Yield components, Traits

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's most important food crop and the staple food of 40 % of the world population. More than 90 % of rice is produced and consumed in Asia (Khush and Brar, 2002). Rapid population growth is exerting an increasing pressure on the food producing resources, which are already approaching their limits. To keep up with population growth and income–induced demand for food, the world's annual rough rice production will have to be increased by almost 10 % over the next 35 years (IRRI, 1993). The extra rice requirement to feed the expanding population ought to be met only by improving the present productivity of rice lands. Increasing grain yield of rice varieties is found to be the most effective way of enhancing productivity of rice lands. Hence, appropriate plant breeding programmes, which are based on variability existing in such crops or variability generated through crossing suitable parents to combine desirable characters, are important. The choice of the parents for the breeding programme can be difficult when attempting to improve the quantitative characters due to influence of the environment.

Grain yield is a complex quantitative character and it depends on the multiplicative product of the yield contributing characters. These characters are inter-related. In order to make effective selections for high yields, the inter-relationships among the yield components and their relationship with the grain yield have to be understood. It will facilitate the decision on the best way of improving them. The rice accessions, which the rice breeders in Sri Lanka expected to utilize for improving varieties according to their respective objectives, can also be evaluated for genetic variability. At the same time the breeders can decide the traits that they could concentrate while selection in early and latter generations and avoid the influence by the environment. Hence, proper evaluations of rice accessions will provide the suitable parents to initiate an effective economical breeding program in the country.

The present study was undertaken to study the genetic variability of important traits including yield components and their association with grain yield in rice of diverse genetic base.

MATERIALS AND METHODS

Sixty eight diverse rice genotypes (Table 1) were planted during *kharif* (June – December) 2007 at Rice Research Station, CCS Haryana Agricultural University (HAU), Kaul, Haryana, India. The experiment was conducted in a randomized complete block design with three replicates and the plots were transplanted using the spacing of 22.5 cm x 15 cm.

The recommended package of practices was always followed for raising a good crop. Observations on 14 quantitative and quality traits *viz.* days to 50% flowering, days to maturity, plant height, number of effective tillers per plant, panicle length, number of filled grains per panicle, 1000 grain weight, grain yield per plant, hulling %, milling %, head rice recovery %, kernel length, kernel breadth and kernel length/breadth (L/B) ratio were recorded on five randomly selected plants in each genotype per replication.

The analysis of variance for different characters was done on the basis of the model described by Panse and Sukhatme (1967). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated by the method suggested by Burton (1952). Heritability in broad sense was calculated according to Hanson *et al.* (1956). Genetic advance as a percentage of mean was estimated by the method of Lush (1948) and Johnson *et al.* (1955). Genotypic and phenotypic correlation coefficients were computed according to Al-Jibouri *et al.* (1958). A software developed by the CCS HAU, India was used for the statistical analysis of the study.

Table 1. Genotypes of rice under investigation

Serial no.	Genotypes	Origin*	Serial no.	Genotypes	Origin
1	IR 26	IRRI	35	HKR 86-11	Haryana (HAU)
2	IR 36	IRRI	36	PR 118	Punjab
3	IR 56	IRRI	37	NDR 118	UP/Faizabad
4	IR 60	IRRI	38	NDR 84	UP/Faizabad
5	IR 64	IRRI	39	PR 110	Punjab
6	Palman 579	Punjab	40	HKR 95-55	Haryana (HAU)
7	HKR 119	Haryana (HAU)	41	HKR 95-173	Haryana (HAU)
8	PR 109	Punjab	42	HKR 95-239	Haryana (HAU)
9	Pusa 169	IARI	43	PR 114	Punjab
10	Pusa 150	IARI	44	PR 113	Punjab
11	HKR 1	Haryana (HAU)	45	Iron 89-54	IRRI
12	Parsad	Uttar Pradesh	46	HKR 96-90	Haryana (HAU)
13	IR 50	IRRI	47	HKR 96-54	Haryana (HAU)
14	BR 827	Bangalore	48	CSR 13	Haryana (CSSRI,Karnal)
15	IR 52	IRRI	49	HKR 96-53	Haryana (HAU)
16	IR62	IRRI	50	HKR 93-49	Haryana (HAU)
17	Jaya	DRR/Hyderabad	51	HKR 02-430	Haryana (HAU)
18	PR 106	Punjab	52	HKR 03-491	Haryana (HAU)
19	HKR 120	Haryana (HAU)	53	HKR 03-428	Haryana (HAU)
20	HKR 126	Haryana (HAU)	54	Taraori Basmati	Haryana (HAU)
21	Manhar	Pant Nagar	55	HKR 04-487	Haryana (HAU)
22	HKR 112	Haryana (HAU)	56	HKR 04-489	Haryana (HAU)
23	IR 20	IRRI	57	HKR 04-417	Haryana (HAU)
24	Pusa 21-86-6	IARI	58	HKR 04-524	Haryana (HAU)
25	CR 129-65	CRRI/Cuttack	59	HKR 04-409	Haryana (HAU)
26	BR 51-202-8	Bangalore	60	HKR 04-479	Haryana (HAU)
27	RP 2151-40-1	DRR/Hyderabad	61	HKR 04-493	Haryana (HAU)
28	Pusa 44-33	IARI	62	HKR 04-523	Haryana (HAU)
29	IET 6288	DRR/Hyderabad	63	Basmati 370	Punjab (Pakistan)
30	HKR 125	Haryana (HAU)	64	CSR 30	Haryana (CSSRI,Karnal)
31	HKR 131	Haryana (HAU)	65	HKR 05-475	Haryana (HAU)
32	Indrasan	Pant Nagar	66	HKR 05-476	Haryana (HAU)
33	Kogyaku	Japan	67	HKR 05-499	Haryana (HAU)
34	HKR 128	Haryana (HAU)	68	HKR 05-416	Haryana(HAU)

*IRRI - International Rice Research Institute; HAU - Haryana Agricultural; University
DDR - Directorate of Rice Research; IARI - Indian Agricultural Research Institute
CRRI - Central Rice Research Institute; CSSRI- Central Soil Salinity Research Institute

RESULTS AND DISCUSSION

The mean squares for genotypes (Table 2) revealed significant differences among the genotypes for all the traits studied. A wide range of variation for all the traits were found, which may give scope for genotypic selection on the basis of phenotypic value of the component traits.

Table 2. Analysis of variance for various traits in rice

Trait	Mean squares for genotypes
Days to 50% flowering	266.623**
Days to maturity	386.361**
Plant height (cm)	1000.38**
No of effective tillers /plant	12.249**
Panicle length (cm)	7.122**
No. of grains per panicle	1206.101**
Grain yield per plant (g)	60.839**
1000 grain weight (g)	13.705**
Hulling (%)	2.39**
Milling (%)	6.08*
Head rice recovery (%)	12.348**
Kernel length (mm)	0.328**
Kernel breadth (mm)	0.151**
Kernel length / breadth ratio	0.791**

* significant at p=0.05, ** significant at p=0.01

The PCV was higher than the GCV for all the traits studied (Table 3), due to the influence of the environment on PCV. High GCV and PCV were observed for number of filled grains per panicle, grain yield per plant, plant height, number of effective tillers per plant and kernel L/B ratio indicating that the presence of ample variation for these traits in the present material. Similar results were reported by Patil and Sarawgi (2005) for number of effective tillers per plant, number of grains per panicle and yield per plant. Saxena *et al.* (2005) also reported similar results for number of grains per panicle, grain yield per plant and kernel L/B ratio.

The broad sense heritability was high for days to 50 % flowering, days to maturity, plant height, number of filled grains per panicle, grain yield per plant and kernel L/B ratio. However, the genetic advance was high only for the number of grains per panicle and grain yield per plant. Panicle length, hulling %, milling %, head rice recovery%, and kernel length showed low genetic advance while the rest of the traits showed moderate genetic advance. The high heritability values together with high genetic advance estimates suggested that there is ample scope of improvement in the above mentioned traits.

In general, genotypic correlations were slightly higher than their respective phenotypic correlations (Table 4 and 5). Days to 50 % flowering had a positive and highly significant phenotypic correlation ($p<0.01$) with days to maturity (Table 4). The days to 50 % flowering and days to maturity had negative and significant phenotypic correlations with filled grains per panicle, grain yield per plant and 1000 grain weight, indicating that the early maturing varieties give higher yields than the late maturing varieties.

Table 3. Mean, Range, Genotypic coefficient of variation (GCV), Phenotypic coefficient of variation (PCV), Broad Sense Heritability (BSH), Genetic advance as a % of mean and Coefficient of variation (CV %) for various traits in rice grown in Haryana , India in *Kharif* 2007.

Trait/Character	*Mean ± SE*†	*Range*	*Coefficient of variation*		*BSH*	*Genetic advance as a % of mean*	*CV (%)*
			GCV	PCV			
Days to 50% flowering	102.09 ± 0.34	74.33-114.00	9.23	9.25	99.59	18.97	0.59
Days to maturity	135.94 ± 0.54	104.33-149.0	8.34	8.37	99.30	17.12	0.70
Plant height (cm)	108.57 ± 3.16	75.53-144.80	16.56	17.32	91.42	32.62	5.07
No. of effective tillers /plant	10.69 ± 0.92	7.40-19.60	16.80	22.52	55.70	25.84	14.99
Panicle length (cm)	23.01 ± 0.83	18.70-28.03	5.63	8.44	44.43	7.73	6.29
No. of filled grains per panicle	75.70 ± 4.22	27.33-118.20	25.88	27.65	87.64	49.92	9.72
1000 grain weight (g)	22.92 ± 0.87	17.69-27.11	8.51	10.78	62.29	13.83	6.62
Grain yield per plant (g)	13.72 ± 1.04	5.72-25.79	31.91	34.57	85.23	60.69	13.29
Hulling (%)	78.48 ± 0.57	75.69-80.20	0.87	1.54	31.82	1.01	1.27
Milling (%)	70.83 ± 1.13	65.92-73.69	1.21	3.03	15.84	0.99	2.78
Head rice recovery (%)	68.35 ± 1.41	62.76-72.04	2.12	4.17	25.87	2.22	3.59
Kernel length (mm)	6.21 ± 0.14	5.67-7.26	4.79	6.26	58.57	7.55	4.03
Kernel breadth (mm)	1.93 ± 0.09	1.52-2.33	10.73	13.22	65.84	17.93	7.73
Kernel L/B ratio	3.27 ± 0.16	2.47-4.38	14.88	17.18	75.02	26.55	8.59

† SE- standard error

Confirming the results reported by Sanker *et al.* (2006), the number of effective tillers per plant and number of grains per panicle showed significant phenotypic correlation with the grain yield per plant. The plant height showed negative and significant phenotypic correlation with grain yield per plant confirming the results of Paramesha *et al.* (2005). However, the plant height had a positive and highly significant correlation with panicle length, kernel length and kernel L/B ratio suggesting that tall genotypes bear long panicles with long grains. Similar results have also been reported by Chaudhary and Motiramani (2003) for panicle length, kernel length and kernel L/B ratio.

Table 4. Phenotypic correlation coefficients among all the studied traits in rice grown in Haryana, India in *Kharif* 2007.

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective tillers per plant	Panicle length (cm)	Grains per panicle	Grain yield per plant (g)	1000 grain weight (g)	Hulling (%)	Milling (%)	Head rice recovery (%)	Kernel length (mm)	Kernel breadth (mm)	Kernel length/ breadth ratio
Days to 50% flowering	1.000	0.924**	0.118	-0.215	- 0.095	-0.423**	-0.468**	-0.290*	-0.157	-0.034	-0.046	0.080	-0.253*	0.224
Days to maturity		1.000	0.114	-0.149	- 0.137	-0.417**	-0.425**	-0.294*	-0.162	-0.048	-0.071	0.067	-0.235	0.210
Plant height (cm)			1.000	0.088	0.424**	-0.448**	-0.313**	-0.068	0.072	0.066	-0.189	0.475**	-0.614**	0.699**
Effective tillers per plant				1.000	- 0.001	- 0.056	0.336**	-0.133	0.123	-0.026	-0.133	0.043	-0.113	0.135
Panicle length (cm)					1.000	0.166	0.228	0.342**	0.054	-0.012	0.045	0.361**	-0.103	0.213
Grains per panicle						1.000	0.745**	0.433**	0.020	0.112	0.268*	-0.297*	0.562**	-0.564**
Grain yield per plant (g)							1.000	0.452**	0.055	0.083	0.209	-0.134**	0.439**	-0.397**
1000 grain weight (g)								1.000	0.143	0.135	0.163	0.340	0.436**	-0.220
Hulling (%)									1.000	0.622**	0.492**	0.147	-0.141	0.177
Milling (%)										1.000	0.765**	0.103	0.020	0.039
Head rice recovery (%)											1.000	0.036	0.135	-0.095
Kernel length (mm)												1.000	-0.360**	0.651**
Kernel breadth (mm)													1.000	-0.896**
Length/breadth ratio														1.000

* and **- significant at p=0.05 and p=0.01, respectively

Table 5. Genotypic correlation coefficients among all the studied traits in rice grown in Haryana, India in *Kharif* 2007.

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective tillers per plant	Panicle length (cm)	No. of grains per panicle	Yield per plant (g)	1000 grain weight (g)	Hulling (%)	Milling (%)	Head rice recovery (%)	Kernel length (mm)	Kernel breadth (mm)	Kernel length / breadth ratio
Days to 50% flowering	1.000	0.924	0.122	- 0.289	-0.142	-0.454	-0.508	-0.362	-0.265	-0.089	-0.096	0.101	-0.305	0.253
Days to maturity		1.000	0.120	- 0.203	-0.201	-0.448	-0.466	-0.365	-0.269	-0.125	-0.147	0.088	-0.282	0.238
Plant height (cm)			1.000	0.091	0.534	-0.523	-3.77	-0.165	0.162	-0.065	-0.358	0.577	-0.753	0.809
Effective tillers per plant				1.000	0.492	-0.041	0.386	-0.114	0.143	-0.185	-0.384	0.084	-0.179	0.205
Panicle length (cm)					1.000	0.105	0.251	0.391	0.318	0.208	0.176	0.454	-0.159	0.341
No. of grains per panicle						1.000	0.848	0.475	0.019	0.265	0.571	-0.44	0.719	-0.690
Grain yield per plant (g)							1.000	0.573	0.166	0.339	0.495	-0.210	0.595	-0.501
1000 grain weight (g)								1.00	0.195	0.309	0.230	0.276	0.582	-0.359
Hulling (%)									1.000	0.908	0.481	0.411	-0.402	0.364
Milling (%)										1.000	0.794	0.210	-0.137	0.079
Head rice recovery (%)											1.000	-0.19	0.299	-0.360
Kernel length (mm)												1.00	-0.486	0.745
Kernel breadth (mm)													1.000	-0.952
Kernel length/ breadth ratio														1.000

The plant height was negatively and highly correlated with grains per panicle, grain yield per plant and kernel breadth indicating that dwarf genotypes produce bold grain type, dense panicles leading to produce comparatively higher yield. The hulling % was highly and positively associated with milling % and head rice recovery %. Non-significant associations were observed between grain yield and milling recovery traits (*i.e.* percentage of hulling, milling and head rice recovery). Though, these traits were not directly related to grain yield per plant, they can also be considered for improving grain quality. Kernel length was positively related with L/B ratio, while the grain breadth was inversely related with the same, in agreement with the results reported by Chand *et al.* (2004).

The grain yield per plant showed a significant and positive correlation with effective tillers per plant, grains per panicle, 1000 grain weight and kernel breadth whereas negative and significant correlations with days to 50 % flowering, days to maturity, plant height, kernel length and kernel L/B ratio.

CONCLUSIONS

The highest genotypic and phenotypic coefficient of variation (GCV and PCV) observed for grain yield per plant, followed by the number of filled grains per panicle, number of effective tillers per plant and plant height suggest the importance of selection for these traits. The lowest difference between GCV and PCV observed at days to 50 % flowering and days to maturity imply that the environment effect for these traits is marginal. The association of high heritability with high genetic advance observed for the grain yield per plant and number of filled grains per panicle suggest the importance of imposing early generation selection on those traits. The high heritability with medium genetic advance as a percentage of mean, which was observed for days to 50 % flowering, days to maturity, plant height and kernel L/B ratio, indicate that those traits has to be practiced at latter generations.

On the basis of results of the variability parameters and correlation coefficient analysis it was advocated that the traits such as grain yield per plant, number of filled grains per panicle, number of effective tillers per plant, plant height and 1000 grain weight may be given due consideration while exercising selection in segregating generations in rice.

ACKNOWLEDGEMENTS

The authors are grateful to Sri Lanka Council for Agriculture Research Policy (CARP) for the financial assistance provided to the first author for the M.Sc. degree programme. The staff of the Rice Research Station, CCS Haryana Agricultural University, Kaul, and the Department of Plant Breeding

CCS Haryana Agricultural University, Hisar, India, are highly appreciated for providing valuable guidance and assistance throughout the study.

REFERENCES

Al-Jibouri, H.A., P.A. Miller and H.F. Robinson. 1958. Genotypic and environmental variances and co-variances in an upland cotton cross of inter specific origin. Agronomy Journal. 50: 630-637.

Burton, G.M. 1952. Quantitative inheritance in grasses. *Proceedings*. 6th International Grassland Congress. 1:277-283.

Chand, S.P., S.K. Roy, G.S. Mondal, P.D. Mahato, S. Panda, G. Sarkar and B.K. Senapati. 2004. Genetic variability and character association in rainfed lowland Aman paddy (*Oryza sativa* L.). Environment and Ecology. 22(2):430-434.

Chaudhary, M. and N.K. Motiramani. 2003. Variability and association among yield attributes and grain quality in traditional aromatic rice accessions. Crop Improvement. 30(1):84-90.

Dewey, D.R. and K.H. Lu. 1959. A correlation and path coefficient analysis of crested wheat-grass. Agronomy Journal. 51:515-518.

Hanson, C.H., H.F. Robinson and R.E. Comstock. 1956. Biometrical studies of yield in segregating population of Korean Lespedza. Agronomy Journal. 48:258-272.

IRRI. 1993. Rice ALMANAC 1993-1995. International Rice Research Institute. Los Banos, Philippines. 7-10

Johnson, H.W., H.F. Robinson and R.E. Comstock. 1955. Estimates of genetic and environmental variability in soyabean. Agronomy Journal. 47:314-318.

Khush, G.S. and D.S. Brar. 2002. Sustainable rice production for food security. Proceedings of the 20th International Rice Commission. Bangkok, Thailand, 23-36 July, 2002.

Lush, J.L. 1948. Heritability of quantitative characters in farm animals. *Proc. 8th Int. Genet. Cong. 1948.* Hereditas (Suppl.): 356-357.

Panse, V.G. and P.V. Sukhatme. 1967. Statistical methods for Agricutlural workers. Indian Council of Agricultural Research, New Delhi.

Paramesha, K., M.R.G. Rao and M.P. Rajanna. 2005. Evaluation of stabilized selections of different crosses of rice (*Oryza sativa* L.) for yield and yield components. Mysore Journal of Agriculture Science. 39(1):31-36.

Patil, P.V. and A.K. Sarawgi. 2005. Studies on genetic variability, correlation and path analysis in traditional aromatic rice accessions. Annals of Plant Physiology. 19(1): 92-95.

Sankar, P.D., A. Sheeba and J. Anbumalarmathi. 2006. Variability and character association studies in rice (*Oryza sativa* L.). Agricultural Science Digest. 26(3):182-184.

Saxena, R.R., N.K. Motiramani, S.S. Nichal and R.K. Sahu. 2005. Studies on Variability, heritability and genetic advance in scented rice germplasm accessions. Journal of interacademica. 9(4):487-489