Genetic variability, Correlation and Path Analysis for Quantitative Characters in Rainfed Upland Rice of Uttarakhand Hills

J. P. Aditya* and Anuradha Bhartiya

Crop Improvement Division, Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR), Almora 263 601 Uttarakhand.

Abstract

Genetic parameter, correlation coefficients among yield and yield components, direct and indirect effect of yield components on yield were studied in eighteen rice genotypes under rainfed ecosystem for fifteen quantitative traits. The analysis of variance revealed that there were highly significant differences for all the characters among the genotypes. The estimate of GCV and PCV was found to be highest for grain yield per plot followed by fertile grains per panicle and grains per panicle. The broad sense heritability was highest for plant height and fertile grains per panicle (98.14%) followed by grains per panicle (97.74%), days to 50 per cent flowering (95.18) and days to maturity (94.71). The estimate of genetic advance was found to be highest for grains per panicle and fertile grains per panicle. The number of grains per panicle and fertile grains per panicle had high heritability as well as high genetic advance. The phenotypic correlation coefficient among fifteen traits showed that grain yield was significantly and positively correlated with plant height, days to 50 per cent flowering, days to maturity, flag leaf length, flag leaf width, panicle length, grains per panicle, fertile grains per panicle, kernel length and L/B ratio. The estimates of direct and indirect effect revealed that L/B ratio had the highest positive direct effect on grain yield followed by kernel width, grains per panicle, and tillers per plant.

Key Words: Rainfed upland rice, genetic parameters, correlation, path analysis, yield components

Rice (*Oryza sativa* L.) is the staple food of more than three billion people in the world. Nearly, hundred million people depend on the upland rice as their daily staple food. Almost two third of the upland rice area is in Asia. In India, the total area under upland

*Corresponding author : jayprakashaditya@gmail.com

rice is 6 m. ha. which accounts 13 per cent of the total area under rice crop in the country. Upland rice is generally grown under rainfed conditions and crop growth is entirely depends on the monsoon. Upland rice ecology is much harsh environment for rice production in which intermittent drought is the major constraint (Hanamaratti *et al*., 2005) and cause a yield penalty from 12 to 46 per cent (Oak *et al*., 2006). Rainfed upland rice is an important component of cropping system in Uttarakhand hills. Rainfed upland rice cultivation in hills is suffering from the problem of poor productivity mainly due to erratic rainfall, poor soil fertility as well as lack of improved varieties. Poor yield potential of traditional rice cultivars necessitates the development of the high yielding cultivars for rainfed upland condition of hills. Development of high yielding varieties requires a thorough understanding of existing genetic variability as well as magnitude and direction of genetic association among the yield contributing characters. Knowledge of association direct and indirect effect between grain yield and other characters can be helpful in efficient selection of suitable cultivars of rice for rainfed upland condition. Therefore, the present study aimed to determine the extent of genetic variability, genetic parameters with correlation and path coefficient to select superior rice genotypes adapted to rainfed upland ecosystem of Uttarakhand hills.

Materials and Methods

The experimental material consisted of eighteen rainfed upland rice genotypes (Table 1). These genotypes were evaluated in a completely randomized block design with three replications during *kharif* season at experimental farm of Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR), Almora. The crop was direct seeded under the rainfed condition. Each plot consisted of five rows plot of 3.5m length with spacing of 20cm between rows. Ten plants from middle row of each entry in each replication were randomly selected for recording observations on quantitative traits *viz.*, plant height, tillers per plant, flag leaf length, flag leaf width, panicles per plant, panicle length, grains per panicle, fertile grain per panicle, thousand grain weight, kernel length, kernel width and L/B ratio. Whereas, days to 50 per cent flowering, days to maturity and grain yield were recorded on whole plot basis. The mean value was used as the replicated data and was subjected to statistical analysis using INDOSTAT software package. Analysis of

variance was estimated following Panse and Sukhatme (1985). The phenotypic and genotypic coefficient of variability, heritability in broad sense, genetic advance at 5 per cent selection intensity were computed as suggested by Johnson *et al.* (1955). The phenotypic correlation coefficients among all the traits under study were calculated following Al-Jobouri *et al.* (1958) and the path analysis was carried out as per method of Dewey and Lu (1959).

Results and Discussion

Analysis of variance indicated the existence of highly significant differences among the genotypes for all the characters studied except tillers per plant. This suggested that there is an inherent genetic difference among the genotypes (Table 2). The range, mean, standard error of mean, genotypic coefficient of variation, phenotypic coefficient of variation, heritability, genetic advance at 5 per cent selection intensity for different characters are given in Table-3. Among rainfed upland rice genotypes, the average grain yield per plot ranged from 0.23 kg to 0.95 kg and crop duration varied from 114 to 131 days. Five genotypes *viz*., VL 8204 (0.95 kg/plot), VL 8302 (0.82 kg/plot), VL 8185 (0.80 kg/plot), VL 31402 (0.75 kg/plot) and VL 8292 (0.70 kg/plot) were found significantly superior for grain yield. A wide range of variability was observed for grains per panicle (76-150) followed by fertile grain per panicle (65-137). The range of variation obtained for kernel width (2.22-2.63) and flag leaf width (1.39-1.95) was least when compared to all other characters. The estimate of GCV and PCV was found to be highest for yield per plot followed by fertile grains per panicle and grains per panicle. Padmaja *et al.* (2008) also recorded similar observation for grains per panicle and single plant yield. Low GCV and PCV estimates were noticed for plant height, days to 50 per cent flowering, days to maturity, tillers per plant, panicle length, thousand grain weight, kernel length, kernel width and LB ratio. These results are in conformity with Padmaja *et al.* (2008) for days to 50 per cent flowering and panicle length. The estimates of PCV were slightly higher than the corresponding GCV estimates for plant height, days to 50 per cent flowering, days to maturity, grains per panicle and fertile grains per panicle indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits. In general, the magnitude of PCV was found to be higher than the

corresponding GCV for all the characters suggesting the influence of environment on the expression of the traits. However, the differences between PCV and GCV were very small for most of the characters indicating the lesser contribution of environmental variation towards the expression of these traits. Similar observations were also recorded by (Karad and Pol 2008; Ubarhande *et al.*, 2009) in rice genotypes.

The broad sense heritability was highest for plant height and fertile grains per panicle (98.14%) followed by grains per panicle (97.74%), days to 50 per cent flowering (95.18) and days to maturity (94.71). Sharma and Sharma (2007) also reported similar finding for these traits. The estimate of heritability alone is not very much useful because it includes the effect of both additive and non additive gene. The genetic advance is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. The estimate of genetic advance was found to be highest for grains per panicle and fertile grains per panicle (Sharma and Sharma, 2007). The number of grains per panicle and fertile grains per panicle had high heritability as well as high genetic advance. It is suggested that these characters were predominantly controlled by additive gene action. Hence genetic improvement through selection for these traits may be effective. Heritability estimates along with genetic advance are more helpful in predicting gain under selection than heritability estimate alone (Sinha *et al.*, 2004; Johnson *et al.*, 1955).

The phenotypic correlation coefficient among 15 traits including grain yield in the present investigation is presented in Table-4. Grain yield was observed to be positively and significantly correlated with plant height, days to 50 per cent flowering, days to maturity, flag leaf length, flag leaf width, panicle length, grains per panicle, fertile grains per panicle, kernel length and L/B ratio. Among the component traits plant height was significantly positively correlation with days to 50 per cent flowering, days to maturity, flag leaf length, flag leaf width, panicle length, grains per panicle and fertile grains per panicle. Sharma and Sharma (2009); Subudhi and Dikshit (2009) reported significant positive correlation between plant height and grains per panicle and panicle length. Days to 50 per cent flowering showed significant positive correlation with days to maturity, flag leaf length, flag leaf width, panicle length, grains per panicle and fertile grains

per panicle. Chandra *et al*. (2006) reported significant positive correlation of days to 50 per cent flowering with panicle length. Days to maturity was found to be significantly positively correlated with flag leaf length, flag leaf width, panicle length, grains per panicle and fertile grains per panicle. Tillers per plant exhibited significant positive correlation with panicles per plant while it was negatively correlated with panicle length. Flag leaf length, flag leaf width, panicle length, grains per panicle and fertile grains per panicle were mutually correlated with each other. L/B ratio showed significant positive correlation with grains per panicle, thousand grain weight, kernel length and kernel width.

The above inter se association amongst the traits indicated that although tillers per plant, panicles per plant, thousand grain weight, and kernel width did not exhibit positive significant association with grain yield, their role in contributing towards grain yield could not be overlooked as these component traits exhibited positively significant association with important yield attributes. Thus, these traits may be assumed to indirectly contribute via other traits in governing grain yield. In this regard it is important to partition out the observed phenotypic association into direct and indirect effects of the component traits towards grain yield.

A character contributing to grain yield may contribute directly or indirectly. It is essential to conduct the path analysis. The estimates of direct and indirect effect are presented in Table-5. In the present investigation, L/B ratio had the highest positive direct effect on grain yield followed by kernel width, grains per panicle, and tillers per plant. Highest positive but indirect effect was observed for kernel length via L/B ratio followed by thousand grain weight via L/B ratio. Plant height, days to 50 per cent flowering, days to maturity, tillers per plant, flag leaf length, panicles per plant, thousand grains weigh and kernel length grains per panicle were observed to contribute positively to an appreciable extent via L/B ratio. Direct and indirect effect of yield component traits on grain yield have also been reported earlier (Shivani and Reddy, 2000; Kavitha and Reddi, 2001; Biao *et. al.*, 2002; Shanthala *et al.*, 2004 and Shashidhar *et al.*, 2005).

References

Al Jibouri, H.A., Miller, R.A. and Robinson, H.F. 1958. Genetic environmental variances and covariances in an upland cotton cross interspecific origin. *Agronomy Journal* 50: 633-636.

Biao, G.L., Lijun, L., Zhong, X.Y., Yipin, W., Wei, M.H., Qian, Q. and Cunshan, Y. 2002. Path analysis for yield and its component characters in rice. *Chinese Rice Research Newsletter* 10: 5-6.

Chandra, R., Pradhan. S.K., Singh, S., Bose, L.K. and Singh, O.N. 2006. Agro-morphological traits as selection parameters for improvement of upland rice. *Indian Journal of Plant Genetic Resources* 19 (2): 184-187.

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

Hanamaratti, N.G., Prashanthi, S.K., Angadi, V.V. and Salimath, P.M. 2005. Rice research in rain-fed drill sown rice in Karnataka. In : Five Decades of Rice Research in Karnataka, Directorate of Research, University of Agricultural Sciences, GKVK, Bengaluru, pp. 55-68.

Johnson, H.N., Robinson, H.F. and Comstock, R.E. 1955. Estimate of genetic and environmental variability in soybean. *Agronomy Journal* 27: 314-318.

Karad, S.R. and Pol, K.M. 2008. Character association, genetic variability and path coefficient analysis in rice (*Oryza sativa* L.). *International Journal of Agricultural Sciences* 4 (2): 663-666.

Kavitha, S. and Reddi, N.S.R. 2001. Correlation and path coefficient analysis of yield component in rice (*Oryza sativa* L.) *The Andra Agricultural Journal* 48:311-314.

Oak, M.B., Tsubo, J., Fukai, M., Fisher, S., Cooper, K.S. and Nesbitt, M. 2006. Use of drought response index for identification of drought tolerant genotypes in rainfed lowland rice. *Crop Science Research* 99(1):48-58.

Padmaja, D., Radhika, K., Subba Rao, L.V. and Padma, V. 2008. Studies on variability, heritability and genetic advance for quantitative characters in rice (*Oryza sativa* L.) *Indian Journal of Plant Genetic Resources* 21(3): 196-198.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. Indian Council of Agricultural research, New Delhi.

Shanthala, J., Latha, J. and Hittalmani. 2004. Path coefficient analysis for grain yields and in component characters in hybrid rice. *Environment and Ecology* 22: 734-736.

Sharma, A.K. and Sharma, R.N. 2007. Genetic variability and character association in early maturing rice. *Oryza* 44 (4): 300-303.

Sharma, M.K. and Sharma, A.K. 2009. Character association and path analysis of yield and its component in direct seeded upland rice (*Oryza sativa* L.). *Progressive Agriculture* 9 (1): 117-120.

Shashidhar, H.E., Pasha, F., Janamatti, M., Vinod, M.S., and Kanbar, A. 2005. Correlation and path coefficient analysis in traditional cultivars and double haploid lines of rainfed low land rice. *Oryza* 42: 156-159.

Shivani, D. and Reddy, N.S.R. 2000. Correlation and path analysis in rice (*Oryza sativa* L.) hybrids. *Oryza* 37: 183-186.

Sinha, S.K., Tripathi, A.K. and Bisen, U.K. 2004. Study of genetic variability and correlation coefficient analysis in midland land races of rice. *Annals of Agricultural Research* 25 (1):1-3.

Subudhi, H.N. and Dikshit, N. 2009. Variability and character association of yield components in rainfed lowland rice. *Indian Journal of Plant Genetic Resources* 22 (1): 31-35.

Ubarhande, V.A., Prasad, R., Singh, R.P., Singh, S.P. and Agrawal, R.K. 2009. Variability and diversity studies in rainfed rice (*Oryza sativa* L.) *Indian Journal of Plant Genetic Resources* 22 (2): 134-137.

Table 1. List of rainfed upland rice genotypes under study and their pedigree

Genotypes	Pedigree
VL 8257	Pant Dhan 6 x Barakat
VL 8201	VR 539-2 x VLD 81
VL 8204	VR 539-2 x VLD 81
VL 8302	VL 9588 x A-57
VL 8292	VL 9588 x A-57
VL 8214	VLD 81 x VR 539-2
VL 8188	VR 539-2 x IR 63872-93-2-37
VL 8185	VR 539-2 x IR 63872-93-2-37
VL 8369	VL 9588 x VR 539-2
VL 31384	China 4 x BG 367-4
VL 31402	SRSN 38 x VL 6394
VL 31430	Pant Dhan 6 x VL 3288
VL 31590	VL 3861 x IR 59656-5- K-1
VL 31567	Vivek Dhan 82 x WAB 337-B-B-13-1-1-3
VL 31440	VHC 1253 x Thapachini
VL 31419	Vivek Dhan 82 x VLD 206
Vivek Dhan 154	VL Dhan 221 x VL- 24
VLD 221	IR 2053-521-1-1-1 x Ch- 1039

Table 2: Analysis of variance for various yield contributing characters

Source of variance	d.f	Plant height	Days to 50% flowering	Days to maturity	Tillers per plant	Flag leaf length	Flag leaf width	Panicles per plant	Panicle length	Grains per panicle	Fertile grains per panicle	1000grain weight	Grain yield per plot	Kernel length	Kernel width	L/B ratio
Replication	2	18.91	0.91	4.24	0.91	1.27	0.01	1.46	1.04	16.07	4.46	1.13	0.009	0.07	0.006	0.0004
Treatments	17	281.62**	74.73**	70.01**	0.90	40.50**	0.08**	1.09*	5.39**	1898.27**	1589.33**	17.68**	0.12**	0.47**	0.04**	0.61**
Error	34	1.77	1.24	1.28	0.71	1.91	0.008	0.54	0.60	14.54	9.95	1.32	0.004	0.03	0.004	0.01

*, ** Significant at 5% and 1% level of probability respectively.

Table 3: Range, mean and genetic parameters of 15 yield attributing characters in rainfed upland rice

Characters	Range	GM	CV %	CD at 5%	SEm	GCV (%)	PCV (%)	h^2 (%)	GA at 5%	GA as % mean
Plant height (cm)	104-142	121.52	1.09	2.21	1.08	7.95	8.02	98.14	19.71	16.22
Days to 50% flowering (days)	82-99	91.74	1.21	1.85	0.91	5.39	5.53	95.18	9.95	10.84
Days to maturity (days)	114-131	122.81	0.92	1.88	0.92	3.90	4.00	94.71	9.60	7.81
Tillers per plant (number)	5-8	6.30	13.39	1.40	0.69	3.96	13.96	8.03	0.14	2.31
Flag leaf length (cm)	21.29-34.31	28.85	4.78	2.29	1.13	12.43	13.32	87.09	6.90	23.90
Flag leaf width (cm)	1.39-1.95	1.66	5.44	0.15	0.07	9.00	10.51	73.21	0.26	15.86
Panicles per plant (number)	5-7	5.96	12.34	1.22	0.60	7.20	14.28	25.38	0.45	7.47
Panicle length (cm)	20.98-26.13	22.98	3.37	1.29	0.63	5.49	6.45	72.61	2.22	9.65
Grains per panicle (number)	76-150	118.43	3.22	6.33	3.11	21.16	21.40	97.74	51.03	43.09
Fertile grains per panicle (number)	65-137	103.76	3.04	5.23	2.58	22.10	22.31	98.14	46.80	45.10
1000grain weight (g)	22.53-31.22	27.64	4.16	1.91	0.94	8.45	9.42	80.52	4.32	15.62
Grain yield per plot (Kg)	0.23-0.95	0.55	12.07	0.11	0.05	35.72	37.70	89.74	0.38	69.70
Kernel length (cm)	5.88-7.35	6.68	2.37	0.26	0.13	5.74	6.21	85.48	0.73	10.94
Kernel width (cm)	2.22-2.63	2.47	2.63	0.11	0.05	4.44	5.16	74.03	0.19	7.86
L/B ratio	2.40-3.24	2.72	3.74	0.17	0.08	9.41	10.13	86.35	0.49	18.01

Table 4: Phenotypic correlation coefficients among grain yield and component traits in rainfed upland rice

Characters	Plant height	Days to 50% flowering	Days to maturity	Tillers per plant	Flag leaf length	Flag leaf width	Panicles per plant	Panicle length	Grains per panicle	Fertile grains per panicle	1000grain weight	Grain yield per plot	Kernel length	Kernel width	L/B ratio
Plant height	1.000	0.645**	0.691**	-0.241	0.708 **	0.418**	-0.126	0.499**	0.308 *	0.335*	0.164	0.471**	0.109	-0.118	0.134
Days to 50% flowering		1.000	0.980**	-0.154	0.4453**	0.477**	-0.083	0.408**	0.315 *	0.306*	0.162	0.284*	0.033	-0.139	0.107
Days to maturity			1.000	-0.171	0.459**	0.499**	-0.084	0.436**	0.313*	0.303*	0.139	0.307*	0.023	-0.126	0.095
Tillers per plant				1.00	-0.105	-0.0918	0.849**	-0.317 *	-0.226	-0.240	0.006	0.053	0.147	-0.164	0.181
Flag leaf length					1.000	0.663**	-0.027	0.4170**	0.583**	0.602**	0.313*	0.602**	0.202	-0.036	0.133
Flag leaf width						1.000	-0.039	0.369 **	0.535**	0.515**	0.057	0.383**	-0.134	0.157	-0.186
Panicles per plant							1.000	0.394**	-0.256	0.279*	0.112	-0.042	0.238	-0.206	0.259
Panicle length								1.000	0.543**	0.545**	-0.057	0.369**	-0.254	0.163	-0.251
Grains per panicle									1.000	0.982**	0.122	0.485**	-0.156	0.329*	0.289*
Fertile grains per panicle										1.000	0.133	0.502**	-0.099	0.294*	-0.236
1000grain weight											1.000	0.184	0.688**	0.089	0.390 **
Grain yield per plot												1.000	0.306*	-0.256	0.319 *
Kernel length													1.000	0.479**	0.884**
Kernel width														1.000	0.832**
L/B ratio															1.000

Table 5: Phenotypic path coefficient analysis among the quantitative characters in rainfed upland rice

Characters	Plant height	Days to 50% flowering	Days to maturity	Tillers per plant	Flag leaf length	Flag leaf width	Panicles per plant	Panicle length	Grains per panicle	Fertile grains per panicle	1000grain weight	Kernel length	Kernel width	L/B ratio	Grain yield per plot
Plant height	**0.330**	0.213	0.228	-0.080	0.234	0.138	-0.042	0.164	0.101	0.110	0.054	0.036	-0.039	0.044	0.471
Days to 50% flowering	-0.295	**-0.457**	-0.448	0.071	-0.203	-0.218	0.038	-0.186	-0.144	-0.140	-0.074	-0.015	0.064	-0.049	0.284
Days to maturity	0.130	0.184	**0.188**	-0.032	0.086	0.094	-0.016	0.082	0.059	0.057	0.026	0.004	-0.024	0.018	0.307
Tillers per plant	-0.129	-0.082	-0.091	**0.532**	-0.056	-0.049	0.452	-0.169	-0.120	-0.128	0.003	0.078	-0.087	0.096	0.053
Flag leaf length	0.039	0.025	0.026	-0.006	**0.056**	0.037	-0.002	0.023	0.032	0.033	0.017	0.011	-0.002	0.007	0.602
Flag leaf width	0.092	0.105	0.110	-0.020	0.146	**0.220**	-0.009	0.081	0.118	0.113	0.013	-0.029	0.034	-0.041	0.383
Panicles per plant	0.058	0.038	0.038	-0.389	0.012	0.018	**-0.458**	0.180	0.117	0.128	-0.051	-0.109	0.094	-0.119	-0.042
Panicle length	0.041	0.033	0.036	-0.026	0.034	0.030	-0.032	**0.082**	0.044	0.045	-0.005	-0.021	0.013	-0.021	0.369
Grains per panicle	0.253	0.258	0.257	-0.185	0.478	0.439	-0.210	0.446	**0.821**	0.806	0.100	-0.128	0.270	-0.237	0.485
Fertile grains per panicle	-0.114	-0.104	-0.103	0.082	-0.205	-0.175	0.095	-0.186	-0.334	**-0.341**	-0.045	0.034	-0.100	0.080	0.502
1000grain weight	-0.015	-0.015	-0.013	-0.001	-0.029	-0.005	-0.010	0.005	-0.011	-0.012	**-0.093**	-0.064	-0.008	-0.036	0.184
Kernel length	-0.141	-0.043	-0.030	-0.189	-0.261	0.173	-0.306	0.327	0.202	0.128	-0.888	**-1.290**	0.618	-1.140	0.306
Kernel width	-0.130	-0.153	-0.139	-0.180	-0.040	0.173	-0.227	0.180	0.362	0.323	0.099	-0.528	**1.102**	-0.917	-0.256
L/B ratio	0.353	0.283	0.249	0.475	0.350	-0.490	0.684	-0.661	-0.762	-0.620	1.028	2.327	-2.191	**2.633**	0.319

Residual effect= 0.591