



## Correlation and path studies of local germplasm of rice of Himachal Pradesh

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### Abstract

The present investigation was carried out to study the correlation and path analysis in forty five genotypes including checks of rice (*Oryza sativa* L.). In general, genotypic correlation coefficient was higher in magnitude than the phenotypic correlation, indicating more genetic association among the various traits. Grain yield per plant exhibited significantly positive association with days to 50% flowering, plant height, panicle length, grains per panicle, spikelets per panicle, 1000-grain weight, grain length, grain breadth and spikelet fertility at both genotypic level and at phenotypic level indicating that simultaneous improvement of all the characters is possible. Path analysis revealed that at genotypic level, grain length had the highest positive direct effect on the grain yield per plant followed by spikelet fertility, effective tillers per plant, spikelets per panicle, panicle length, 1000-grain weight and protein content. Hence, emphasis can be laid out on these traits during selection for further improvement in grain yield in rice.

**Keywords:** Genotypic correlation, phenotypic correlation, path analysis, direct and indirect effects

### Introduction

Rice (*Oryza sativa* L.) is the staple food crop for more than 60 per cent of people across the world. About 60 per cent of the world's rice is grown and consumed in Asia, which is known as "Rice bowl of the World", where it accounts for 50 to 80% of daily calorific intake (Pratap *et al.*, 2012). Rice is being planted on approximately 11 per cent of earth's cultivated land area and ranks second in production after wheat (Anis *et al.*, 2016).

Rice is grown under various agro-climatic conditions ranging from foot-hills to an altitude as high as 2,200 m above mean sea level. Based upon genotypic and phenotypic correlation, the breeder would be able to decide the method of breeding that could be used to exploit the desirable associations and apply diverse methods of recombination to break the undesirable associations. Path coefficient analysis specifies the cause and measures the relative importance of each variable. The yield potential of each variety can be exploited if the relative importance of each component is ascertained and is increased to a certain desired degree by suitable management practices.

### Materials and Methods

Forty five diverse genotypes of rice along with one check (HPR 2880) from different geographical origin in Himachal Pradesh were transplanted in 3 replications in RBD design at Rice and Wheat Research Centre, Malan,

CSK HP Krishi Vishvavidyalaya, Palampur, during *Kharif*, 2018. In each replication, single seedling was transplanted per hill in 4 rows with 20 x 15 cm spacing.

The observations were recorded on five plants taken randomly from each plot for days to 50 per cent flowering, days to 75 per cent maturity, plant height at maturity, total tillers per plant at maturity, effective tillers per plant at maturity, grain yield per plant, spikelets per panicle, grains per panicle, panicle length, 1000-grain weight, spikelet fertility, kernel elongation, grain length (L), grain breadth (B), length breadth ratio (L:B), gel consistency (GC), gelatinization temperature (GT) rating, protein content and amylose content. Phenotypic and genotypic coefficients of correlation were worked out by following the procedure of Al-Jibouri *et al.*, (1958) and Dewey and Lu (1959). The path analysis of important component traits and quality traits was done following Dewey and Lu (1959).

### Results and Discussion

In general, genotypic correlation coefficient was higher in magnitude than the phenotypic correlation coefficient, indicating more genetic association among the various traits. Grain yield per plant exhibited significantly positive association with days to 50% flowering, plant height, panicle length, grains per panicle, spikelets per panicle, 1000-grain weight, grain length, grain breadth and spikelet

**Table 1: Estimates of phenotypic correlation coefficient among various yield, morphological and quality traits in rice**

Traits	Days to 75% maturity	Plant height (cm)	Total tillers/plant	Effective tillers/plant	Panicle length (cm)	Grains/panicle	Spikelets/panicle	Grain yield/plant (g)	1000-grain weight (g)	Grain length (mm)	Grain breadth (mm)	L:B ratio	Kernel elongation (mm)	Spikelet fertility (%)	Gel consistency (mm)	GT rating	Amylose (%)	Protein (%)
Days to 50% flowering	0.667*	0.214*	-0.385*	-0.386*	0.569*	0.355*	0.451*	0.132	-0.007	0.260*	-0.162	0.314*	0.152	-0.229*	0.051	-0.157	-0.259*	0.413*
Days to 75% maturity		0.144	-0.219*	-0.196*	0.416**	0.188*	0.297*	0.021	-0.052	0.294*	-0.207*	0.350*	0.179*	-0.284*	0.251*	-0.087	0.005	0.428*
Plant height (cm)			-0.408*	-0.430*	0.308*	0.359*	0.268*	0.244*	0.242*	-0.133	0.321*	-0.304*	-0.175*	0.267*	-0.089	-0.005	-0.110	0.052
Total tillers/plant				0.964*	-0.110	-0.489*	-0.485*	0.046	0.063	0.102	-0.047	0.102	0.063	0.010	-0.013	-0.149	0.057	-0.147
Effective tillers/plant					-0.159	-0.463*	-0.451*	0.050	-0.014	0.062	-0.099	0.109	0.034	-0.010	-0.025	-0.127	0.062	-0.111
Panicle length (cm)						0.210*	0.265*	0.369*	0.393*	0.460*	-0.011	0.343*	0.371*	-0.111	0.024	-0.175*	-0.114	0.304*
Grains/panicle							0.939*	0.395*	-0.215*	-0.312*	-0.092	-0.146	-0.314*	0.252*	0.074	-0.152	-0.021	0.058
Spikelets/panicle								0.322*	-0.256*	-0.224*	-0.192*	-0.024	-0.245*	-0.074	0.128	-0.124	-0.008	0.159
Grain yield/plant (g)									0.324*	0.121	0.188*	-0.058	0.080	0.298*	-0.128	-0.071	0.025	-0.009
1000 grain weight (g)										0.479*	0.481*	-0.021	0.390*	0.146	-0.170*	0.089	0.021	-0.120
Grain length (mm)											-0.160	0.746*	0.749*	-0.278*	-0.075	-0.024	0.050	0.158
Grain breadth (mm)												-0.755*	-0.084	0.269*	-0.085	0.189*	-0.103	-0.276*
L:B ratio													0.558*	-0.356*	0.022	-0.180*	0.061	0.331*
Kernel elongation (mm)														-0.218*	-0.005	-0.088	-0.023	0.108
Spikelet fertility (%)															-0.139	-0.154	-0.059	-0.300*
GC (mm)																-0.074	0.025	0.084
GT rating																	0.206*	0.021
Amylose (%)																		0.016

\*Significant at 5% level of significance

**Table 2: Estimates of genotypic correlation coefficient among various yield, morphological and quality traits in rice**

Traits	Days to 75% maturity	Plant height (cm)	Total tillers/plant	Effective tillers/plant	Panicle length (cm)	Grains/panicle	Spikelets/panicle	Grain yield/plant (g)	1000-grain weight (g)	Grain length (mm)	Grain breadth (mm)	L:B ratio	Kernel elongation (mm)	Spikelet fertility (%)	Gel consistency (mm)	GT rating	Amylose (%)	Protein (%)
Days to 50% flowering	0.811*	0.234*	-0.455*	-0.469*	0.604*	0.379*	0.496*	0.169*	-0.002	0.308*	-0.208*	0.359*	0.200*	-0.324*	0.054	-0.181*	-0.273*	0.425*
Days to 75% maturity		0.182*	-0.260*	-0.276*	0.513*	0.266*	0.448*	0.110	-0.064	0.348*	-0.280*	0.416*	0.231*	-0.573*	0.292*	-0.099	0.018	0.518*
Plant height (cm)			-0.493*	-0.548*	0.319*	0.365*	0.281*	0.268*	0.265*	-0.162	0.374*	-0.335*	-0.205*	0.357*	-0.091	-0.007	-0.107	0.054
Total tillers/plant				0.986*	-0.109	-0.589*	-0.600*	-0.051	0.034	0.219*	-0.057	0.176*	0.152	0.011	-0.013	-0.204*	0.066	-0.183*
Effective tillers/plant					-0.176*	-0.574*	-0.575*	-0.067	-0.053	0.168	-0.135	0.197*	0.111	-0.008	-0.028	-0.177*	0.086	-0.147
Panicle length (cm)						0.188*	0.252*	0.404*	0.450*	0.550*	-0.006	0.379*	0.449*	-0.161	0.025	-0.197*	-0.125	0.319*
Grains/panicle							0.966*	0.432*	-0.277*	-0.343*	-0.089	-0.158	-0.350*	0.329*	0.079	-0.187*	-0.026	0.069
Spikelets/panicle								0.364*	-0.321*	-0.231*	-0.220*	-0.010	-0.278*	0.074	0.141	-0.151	-0.013	0.182*
Grain yield/plant (g)									0.385*	0.238*	0.270*	-0.035	0.110	0.395*	-0.159	-0.128	0.021	-0.002
1000 grain weight (g)										0.582*	0.609*	-0.042	0.464*	0.098	-0.193*	0.154	0.018	-0.143
Grain length (mm)											-0.297*	0.784*	0.849*	-0.451*	-0.092	-0.032	0.062	0.204*
Grain breadth (mm)												-0.814*	-0.182*	0.458*	-0.101	0.262*	-0.108	-0.305*
L:B ratio													0.650*	-0.552*	0.020	-0.227*	0.065	0.361*
Kernel elongation (mm)														-0.325*	-0.006	-0.122	-0.017	0.139
Spikelet fertility (%)															-0.196*	-0.229*	-0.100	-0.426*
GC (mm)																-0.081	0.025	0.085
GT rating																	0.225*	0.021
Amylose (%)																		0.016

\*Significant at 5% level of significance

**Table 3: Estimates of direct and indirect effects at phenotypic level for different traits in rice**

Traits	Days to 50% flowering	Days to 75% maturity	Plant height (cm)	Total tillers/plant	Effective tillers/plant	Panicle length (cm)	Grains/panicle	Spikelets/panicle	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	L:B ratio	Kernel elongation (mm)	Spikelet fertility (%)	Gel consistency (mm)	GT rating	Amylose (%)	Protein (%)	Grain yield/plant
Days to 50% flowering	<b>0.037</b>	-0.067	0.012	0.084	-0.233	0.112	0.002	0.265	-0.001	0.191	0.074	-0.289	0.018	-0.082	-0.003	-0.009	-0.010	0.035	0.132
Days to 75% maturity	0.025	<b>-0.100</b>	0.008	0.048	-0.118	0.082	0.001	0.175	-0.007	0.217	0.079	-0.319	0.021	-0.102	-0.016	-0.005	0.000	0.036	0.021
Plant height (cm)	0.008	-0.014	<b>0.055</b>	0.089	-0.260	0.061	0.002	0.158	0.032	-0.098	-0.136	0.271	-0.020	0.096	0.006	0.000	-0.004	0.004	0.244*
Total tillers/plant	-0.014	0.022	-0.023	<b>-0.217</b>	0.582	-0.022	-0.003	-0.285	0.008	0.078	0.015	-0.094	0.007	0.003	0.001	-0.009	0.002	-0.012	0.046
Effective tillers/plant	-0.014	0.020	-0.024	-0.209	<b>0.604</b>	-0.031	-0.003	-0.265	-0.002	0.047	0.036	-0.100	0.004	-0.004	0.002	-0.007	0.002	-0.009	0.050
Panicle length (cm)	0.021	-0.042	0.017	0.024	-0.096	<b>0.197</b>	0.001	0.156	0.053	0.338	0.005	-0.316	0.043	-0.040	-0.002	-0.010	-0.004	0.025	0.369*
Grains/panicle	0.013	-0.019	0.020	0.106	-0.280	0.041	<b>0.006</b>	0.552	-0.029	-0.230	0.045	0.137	-0.037	0.090	-0.005	-0.009	-0.001	0.005	0.395*
Spikelets/panicle	0.017	-0.030	0.015	0.105	-0.272	0.052	0.005	<b>0.588</b>	-0.034	-0.166	0.084	0.027	-0.029	-0.026	-0.008	-0.007	0.000	0.013	0.322*
1000 grain weight (g)	0.000	0.005	0.013	-0.014	-0.008	0.077	-0.001	-0.151	<b>0.134</b>	0.350	-0.202	0.013	0.046	0.052	0.011	0.005	0.001	-0.010	0.324*
Grain length (mm)	0.010	-0.030	-0.007	-0.023	0.039	0.091	-0.002	-0.133	0.064	<b>0.734</b>	0.065	-0.696	0.088	-0.099	0.005	-0.002	0.002	0.013	0.123
Grain breadth (mm)	-0.007	0.019	0.018	0.008	-0.052	-0.003	-0.001	-0.119	0.065	-0.116	<b>-0.414</b>	0.699	-0.010	0.094	0.006	0.012	-0.003	-0.023	0.176*
L:B ratio	0.012	-0.035	-0.016	-0.022	0.066	0.067	-0.001	-0.017	-0.002	0.553	0.313	<b>-0.924</b>	0.065	-0.125	-0.001	-0.010	0.002	0.027	-0.048
Kernel elongation (mm)	0.006	-0.018	-0.010	-0.014	0.021	0.073	-0.002	-0.144	0.052	0.551	0.035	-0.516	<b>0.117</b>	-0.078	0.000	-0.005	-0.001	0.009	0.080
Spikelet fertility (%)	-0.009	0.029	0.015	-0.002	-0.006	-0.022	0.001	-0.043	0.020	-0.202	-0.108	0.323	-0.025	<b>0.358</b>	0.009	-0.009	-0.002	-0.025	0.298*
Gel consistency (mm)	0.002	-0.025	-0.005	0.003	-0.015	0.005	0.000	0.075	-0.023	-0.056	0.040	-0.017	-0.001	-0.050	<b>-0.065</b>	-0.004	0.001	0.007	-0.128
GT rating	-0.006	0.009	0.000	0.032	-0.076	-0.034	-0.001	-0.073	0.012	-0.020	-0.085	0.163	-0.010	-0.055	0.005	<b>0.058</b>	0.008	0.002	-0.071
Amylose (%)	-0.010	-0.001	-0.006	-0.012	0.037	-0.022	0.000	-0.005	0.003	0.036	0.033	-0.055	-0.003	-0.021	-0.002	0.012	<b>0.039</b>	0.001	0.025
Protein (%)	0.015	-0.043	0.003	0.032	-0.067	0.060	0.000	0.093	-0.016	0.115	0.113	-0.299	0.013	-0.107	-0.005	0.001	0.001	<b>0.084</b>	-0.009

Residual effect = 0.477 ; \*Significant at 5% level of significance; Bold values are direct effects

**Table 4: Estimates of direct and indirect effects at genotypic level for different traits in rice**

Traits	Days to 50% flowering	Days to 75% maturity	Plant height (cm)	Total tillers/plant	Effective tiller/plant	Panicle length (cm)	Grains / panicle	Spikelets/panicle	1000-grain weight (g)	Grain length (mm)	Grain breadth (mm)	L:B ratio	Kernel elongation (mm)	Spikelet fertility (%)	GC (mm)	GT rating	Amylose (%)	Protein (%)	Grain yield/plant
Days to 50% flowering	<b>-2.221</b>	2.851	-0.313	1.503	-1.032	0.818	-1.104	0.778	-0.001	1.134	1.228	-2.631	-0.062	-0.974	-0.029	-0.010	0.164	0.069	0.169*
Days to 75% maturity	-1.801	<b>3.517</b>	-0.243	0.858	-0.609	0.694	-0.775	0.703	-0.063	1.300	1.461	-3.054	-0.071	-1.721	-0.156	-0.006	-0.010	0.084	0.109
Plant height (cm)	-0.520	0.639	<b>-1.337</b>	1.628	-1.208	0.431	-1.064	0.442	0.263	-0.602	-2.047	2.390	0.062	1.071	0.049	0.000	0.064	0.009	0.269*
Total tillers/plant	1.011	-0.914	0.659	<b>-3.302</b>	2.172	-0.147	1.717	-0.942	0.034	0.828	0.214	-1.292	-0.046	0.032	0.007	-0.011	-0.039	-0.030	-0.050
Effective tillers/plant	1.040	-0.971	0.733	3.255	<b>2.204</b>	-0.238	1.673	-0.901	-0.052	0.640	0.623	-1.432	-0.033	-0.026	0.015	-0.010	-0.051	-0.025	-0.067
Panicle length(cm)	-1.340	1.801	-0.426	0.358	-0.387	<b>1.355</b>	-0.551	0.396	0.449	2.035	0.046	-2.811	-0.138	-0.484	-0.013	-0.011	0.074	0.052	0.405*
Grains /panicle	-0.841	0.935	-0.489	1.946	-1.266	0.256	<b>-2.914</b>	1.515	-0.276	-1.278	0.592	1.182	0.106	0.987	-0.042	-0.011	0.016	0.012	0.432*
Spikelets/panicle	-1.102	1.577	-0.376	1.983	-1.267	0.342	-2.814	<b>1.569</b>	-0.319	-0.862	1.260	0.112	0.084	0.223	-0.075	-0.008	0.007	0.030	0.363*
1000-grain weight (g)	0.003	-0.223	-0.354	-0.112	-0.116	0.611	0.808	-0.504	<b>0.995</b>	2.141	-3.329	0.243	-0.143	0.289	0.103	0.009	-0.012	-0.023	0.385*
Grain length (mm)	-0.681	1.235	0.217	-0.739	0.381	0.745	1.006	-0.366	0.576	<b>3.699</b>	1.574	-5.834	-0.258	-1.364	0.050	-0.002	-0.037	0.033	0.236*
Grain breadth (mm)	0.498	-0.938	-0.500	0.129	-0.251	-0.011	0.315	-0.361	0.605	-1.062	<b>-5.479</b>	5.907	0.053	1.272	0.058	0.015	0.049	-0.049	0.250*
L:B ratio	-0.792	1.456	0.433	-0.579	0.428	0.516	0.467	-0.024	-0.033	2.926	4.387	<b>-7.377</b>	-0.197	-1.631	-0.009	-0.012	-0.038	0.058	-0.021
Kernel elongation (mm)	-0.451	0.822	0.274	-0.500	0.242	0.617	1.017	-0.435	0.468	3.141	0.958	-4.795	<b>-0.303</b>	-0.974	0.000	-0.007	0.011	0.023	0.108
Spikelet fertility (%)	0.721	-2.017	-0.477	-0.035	-0.019	-0.218	-0.959	0.117	0.096	-1.681	-2.322	4.009	0.098	<b>3.001</b>	0.105	-0.013	0.060	-0.069	0.396*
GC (mm)	-0.119	1.027	0.122	0.042	-0.062	0.032	-0.231	0.221	-0.192	-0.344	0.596	-0.122	0.000	-0.591	<b>-0.533</b>	-0.005	-0.014	0.014	-0.159
GT rating	0.401	-0.350	0.009	0.674	-0.389	-0.267	0.546	-0.236	0.154	-1.134	-1.477	1.622	0.037	-0.685	0.043	<b>0.056</b>	-0.136	0.004	-0.128
Amylose (%)	0.608	0.062	0.143	-0.215	0.189	-0.168	0.076	-0.019	0.021	0.231	0.452	-0.470	0.005	-0.302	-0.012	0.013	<b>-0.598</b>	0.003	0.018
Protein (%)	-0.940	1.808	-0.075	0.615	-0.335	0.432	-0.209	0.290	-0.141	0.753	1.639	-2.626	-0.044	-1.277	-0.044	0.001	-0.010	<b>0.163</b>	-0.001

Residual effect =0.210; Bold values are direct effects; \*Significant at 5% level of significance

fertility at both genotypic level and at phenotypic level (Table 1 & 2). Days to 50% flowering and grain length was not significantly correlated with grain yield per plant. Thus, the results indicate that improvement in grain yield per plant can be obtained by laying more emphasis on the above characters. Correlation coefficient at the genotypic level also showed similar trends as at the phenotypic correlation level for almost all traits. The results were similar to the findings of Dhanraj *et al.*, (1987) for panicle length, Sinha *et al.*, (2004) for 1000-grain weight, Abdul *et al.*, (2011) for effective tillers per plant, panicle length and spikelet fertility, Haider *et al.*, (2012) for spikelets per panicle.

Path analysis revealed that at genotypic level, grain length had the highest positive direct effect on the grain yield per plant followed by 75% days to maturity, spikelet fertility, effective tillers per plant, spikelets per panicle, panicle length, 1000-grain weight and protein content. However, at the phenotypic level, grain length had the highest positive direct effect on the grain yield per plant followed by effective tillers per plant, spikelets per panicle, spikelet fertility, panicle length, 1000-grain weight, kernel elongation, protein content, gelatinization temperature, plant height, amylose content, days to 50% flowering, and grains per panicle (Table 3). Concurrently, at genotypic level, grain breadth showed highest indirect effect on grain yield per plant *via* L:B ratio followed by L:B ratio *via* grain breadth, spikelet fertility *via* L:B ratio, kernel elongation *via* grain length, L:B ratio *via* grain length (Table 4). At phenotypic level, grain breadth had highest indirect effect on grain yield per plant *via* L:B ratio followed by L:B ratio *via* grain length, grains per panicle *via* spikelets per panicle, kernel elongation *via* grain length and panicle length *via* grain breadth. These findings were in agreement with reports of Bhadru *et al.*, (2012) for plant height, Garg *et al.*, (2010) for days to 75% maturity, Madhavalatha *et al.*, (2005) for effective tillers per plant. The overall results obtained from path analysis are more or less in concurrence with earlier findings of Akhi *et al.*, (2016) and Sharma and Sharma (2009).

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