Correlation and Path Analysis in Traditional Rice Accessions of Chhattisgarh

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Abstract

Association analysis studies indicated that grain yield per plant had positive significant correlation with leaf width, days to 50% flowering, plant height, panicle length, number of filled grains per panicle, 100 seed weight and paddy (grain) length. A positive and significant correlation of head rice recovery percentage was also observed with leaf length, leaf width, days to 50% flowering, number of filled grains per panicle, spikelet sterility (%) and milling (%). Path coefficient analysis revealed that direct selection for days to 50% flowering, 100 seed weight, panicle length, leaf length and milling percentage would likely be effective for increasing grain yield. Direct selection for days to 50% flowering and number of filled grains per panicle would increase head rice recovery percentage. This study indicated that there is no common causal factor that directly influence grain yield per plant and head rice recovery percentage. Although, days to 50% flowering and leaf length could be used as selection criteria for the simultaneous improvement of both the traits.

Most of the characters of interest to breeders are complex and are the result of the interaction of a number of components. Understanding the relationship between yield and its components is of paramount importance for making the best use of these relationships in selection. Character association derived by correlation coefficient, forms the basis for selecting the desirable plant, aiding in evaluation of relative influence of various component characters on grain yield. Path coefficient analysis discerns correlation into direct and indirect effects. In the present study, an attempt was made to understand the association and path analysis of component characters for grain yield and head rice recovery percentage in rice Accessions.

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Supplementary Tables only in online edition

Materials and Methods

The material for the study consisted of 96 accessions of rice from Bastar region of Chhattisgarh state in India along with six standard cultivars. The material was grown in a Complete Randomized Block Design with two replications. Each line was grown in plots of three meter long rows at spacing of 20 cm between rows and 15 cm between plants in a row. The experiment was conducted during the wet season under upland bunded conditions. The nutrients (N: P: K) were applied at the rate of 60, 40 and 20 kg ha^{-1}, as urea, super phosphate and murate of potash, respectively. No plant protection measures were applied. Observations were recorded on five randomly selected plants of each line per replication for 19 traits *viz.,* leaf length, leaf width, days to 50% flowering, number of effective tillers per plant, plant height, panicle length, number of filled grains per panicle, spikelet sterility percentage, 100 seed weight, paddy length, paddy breadth, brown rice length, brown rice breadth, kernel length, kernel breadth, milling percentage, head rice recovery percentage and grain yield per plant.

Genotypic and phenotypic correlation coefficients for all the possible comparisons were computed as per the formulae suggested by Miller *et al.* (1958). The partitioning of genotypic correlation coefficient of traits into direct and indirect effects was carried out using the procedure suggested by Dewey and Lu (1959).

Results and Discussion

Analysis of variance revealed significant differences within the germplasm for all the traits studied. The genotypic correlations in general were higher than the corresponding phenotypic correlations (S. Table 1). This is due to the modified effect of environment on character association at the genetic level. Grain yield per plant exhibited significant positive correlations with leaf width, days to 50% flowering, plant height, panicle length, number of filled grains per panicle, 100 seed weight and paddy length at both genotypic and phenotypic levels, whereas leaf length and milling percentage were positively and significantly associated with grain yield per plant at the genotypic level only. This indicates the relative utility of all these traits for selection with respect to grain yield. Head rice recovery percentage showed positive and significant association with leaf length, leaf width, days to 50% flowering, number of filled grains per panicle, spikelet sterility percentage and milling percentage at both genotypic and phenotypic levels. Head rice recovery percentage was also significantly negatively associated at both phenotypic and genotypic level with number of effective tillers per plant, 100 seed weight, paddy breadth, brown rice breadth and kernel breadth. The observed positive correlation of grain yield with various traits was supported by earlier workers *viz.,* Ismail and Alvarez (1986), Rao and Srivastava (1999) and Rajeshwari and Nandrajan (2004) for number of filled grains per panicle; Sharma and Dubey (1997) for panicle length; Basavaraja *et al.* (1997) for plant height; Rao and Srivastava (1999) and Rajeshwari and Nandrajan (2004) for days to 50% flowering; Chakraborty *et al.* (2001) for 100 seed weight; Kaul and Kumar (1982) for paddy length. In the present study, significant positive association of head rice recovery percentage with milling percentage was in agreement with the findings of Chouhan *et al.* (1995) and Choudhary and Motiramani (2003), indicating that this character can also be considered to achieve better results for improving yield as well as quality.

In the present study path coefficient analysis has been conducted taking grain yield per plant and head rice recovery percentage as dependent variables. Path coefficient analysis revealed that brown rice breadth had highest positive direct effect on grain yield per plant, followed by 100 grain weight, leaf width, number of effective tillers per plant, paddy length, days to 50% flowering, leaf length, milling percentage and panicle length (Table 1). The correlation analysis did not reveal any association of grain yield per plant with brown rice breadth. This may be due to high negative indirect effects via kernel breadth and paddy breadth. The characters leaf length, leaf width, days to 50% flowering, panicle length, 100 seed weight, paddy length and milling percentage had positive direct effect and exhibited significant positive correlation with grain yield, indicating the true relationship among these traits. This may indicate that the direct selection for panicle length, 100 seed weight, paddy length and milling percentage would likely be effective in increasing grain yield.

The direct and indirect effects of different characters on head rice recovery percentage are presented in Supplementary Table2. The highest positive direct effect of paddy breadth was followed by kernel breadth, paddy length, brown rice length, number of filled grains per panicle, days to 50% flowering, leaf length and spikelet sterility percentage. Paddy breadth and kernel breadth exhibited negative correlation with head rice recovery percentage. This is due to the negative indirect effect of paddy breadth via 100 seed weight, brown rice breadth, head rice recovery percentage and brown rice length and the negative indirect effect of kernel breadth via 100 seed weight, brown rice breadth, head rice recovery percentage, paddy length, and brown rice length. The characters days to 50% flowering and number of filled grains per panicle had positive direct effect and also revealed significant positive correlation with head rice recovery percentage indicating true relationship. This suggested that the selection for days to 50% flowering and number of filled grains per panicle would likely bring the improvement in head rice recovery.

The path analysis indicated that there is no common causal factor that directly influences both grain yield per plant and head rice recovery percentage although days to 50% flowering and leaf length could be used as selection criteria for the simultaneous improvement of both traits. The direct selection of days to 50% flowering, 100 seed weight, paddy length, leaf length and milling percentage for grain yield; days to 50% flowering and filled grains per panicle for head rice recovery percentage could be used as selection criterion for their improvement.

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Supplementary Table 1: Phenotypic (P), Genotypic (G) and Environmental (E) correlation coefficients for morphological and quality traits

Char.	LW (cm)	DF	ET/P	PH (cm)	PaL (cm)	FG/Pa	SPS %	TW (g)	PL (mm)	PB (mm)	BRL (mm)	BRB (mm)	KL (mm)	KB (mm)	Mill %	HRR %	GY/P (g)
LL																	
P	0.358**	0.480**	-0.480**	0.699**	0.303**	0.528**	0.209*	-0.061	0.025	0.012	0.079	-0.016	0.057	-0.031	0.047	0.209*	0.190
G	0.391**	0.552**	-0.546**	0.746**	0.344**	0.571**	0.236*	-0.056	0.022	0.043	0.087	-0.078	0.070	-0.083	0.112	0.250*	0.256*
E	0.340**	-0.162	-0.047	0.203*	0.040	0.197	0.052	-0.105	0.061	0.237*	0.015	0.212*	-0.040	0.164	-0.039	-0.120	-0.198
LW																	
P		0.286**	-0.329**	0.340**	0.257*	0.480**	0.228*	0.147	0.037	0.202*	0.047	0.140	0.043	0.180	0.148	0.252*	0.365**
G		0.396**	-0.477**	0.427**	0.357**	0.632**	0.298**	0.192	0.044	0.248*	0.068	0.139	0.060	0.175	0.456**	0.384**	0.537**
E		-0.035	0.048	0.157	0.015	0.091	0.072	0.034	0.025	0.121	-0.011	0.142	-0.003	0.191	-0.089	-0.146	-0.044
DF																	
P			-0.326**	0.355**	0.205*	0.537**	0.463**	-0.143	0.034	0.089	0.086	-0.121	0.094	-0.142	0.228*	0.623**	0.214*
G			-0.353**	0.375**	0.236*	0.584**	0.514**	-0.168	0.046	0.109	0.083	-0.167	0.099	-0.168	0.443**	0.677**	0.234*
E			-0.105	-0.004	-0.047	0.034	0.100	0.144	-0.130	0.004	0.128	0.068	0.042	-0.052	-0.042	0.045	0.071
ET/P																	
P				-0.383**	-0.292**	-0.429**	-0.027	-0.050	0.024	0.112	-0.009	-0.084	-0.006	-0.048	-0.035	-0.203*	0.070
G				-0.417**	-0.355**	-0.472**	-0.012	-0.059	0.037	0.113	0.012	-0.090	0.017	-0.059	-0.123	-0.214*	0.086
E				-0.024	0.089	-0.109	-0.111	0.019	-0.097	0.117	-0.159	-0.076	-0.176	-0.012	0.092	-0.117	-0.021
PH																	
P					0.284**	0.361**	-0.049	0.005	-0.011	0.165	-0.024	0.128	-0.030	0.101	-0.061	0.118	0.269**
G					0.296**	0.381**	-0.060	0.010	-0.013	0.200	-0.033	0.143	-0.033	0.105	-0.121	0.126	0.298**
E					0.219*	0.088	0.063	-0.103	0.025	0.005	0.107	0.126	0.019	0.156	0.040	-0.013	0.016
PaL																	
P						0.207*	0.160	0.010	0.345**	0.159	0.376**	-0.174	0.396**	-0.168	-0.060	0.108	0.206*
G						0.228*	0.200	0.009	0.379**	0.192	0.408**	-0.181	0.430**	-0.199	-0.065	0.128	0.227*
E						0.051	-0.057	0.023	0.068	0.051	0.159	-0.171	0.158	-0.073	-0.083	-0.038	0.094
FG/Pa																	
P							0.200	-0.114	0.035	0.094	0.087	-0.125	0.089	-0.112	0.352**	0.491**	0.382**
G							0.211*	-0.126	0.047	0.132	0.093	-0.161	0.099	-0.136	0.687**	0.549**	0.437**
E							0.129	0.005	-0.105	0.063	0.039	0.000	0.001	-0.027	-0.042	-0.055	0.020
SPS%																	
P								-0.021	0.084	0.073	0.144	-0.088	0.130	-0.123	0.175	0.355**	0.000
G								-0.015	0.104	0.078	0.162	-0.087	0.121	-0.126	0.322**	0.398**	0.018
E								-0.060	-0.076	0.061	0.026	-0.100	0.193	-0.121	0.033	0.070	-0.089
TW																	
P									0.352**	0.650**	0.212*	0.588**	0.274**	0.622**	-0.014	-0.294**	0.253*
G									0.384**	0.804**	0.236*	0.744**	0.313**	0.773**	-0.102	-0.336**	0.283**
E									-0.049	0.041	-0.008	0.040	-0.101	0.074	0.164	0.126	0.053

PL																	
P										0.101	0.835**	-0.185	0.894**	-0.157	-0.073	0.056	0.201*
G										0.146	0.913**	-0.264**	0.969**	-0.239*	-0.082	0.056	0.230*
E										0.124	0.011	0.168	0.068	0.240*	-0.136	0.062	-0.023
PB																	
P											-0.208*	0.863**	-0.201*	0.852**	0.047	-0.175	0.129
G											-0.288**	0.974**	-0.240*	0.980**	-0.032	-0.244*	0.159
E											0.110	0.624**	-0.061	0.569**	0.138	0.115	0.032
BRL																	
P												-0.243*	0.925**	-0.253*	-0.104	0.074	0.134
G												-0.339**	0.987**	-0.341**	-0.099	0.070	0.148
E												0.098	0.409**	0.067	-0.188	0.108	0.049
BRB																	
P													-0.263**	0.939**	0.054	-0.203*	0.093
G													-0.324**	0.988**	0.097	-0.305**	0.124
E													-0.065	0.837**	0.020	0.188	0.003
KL																	
P														-0.238*	-0.077	0.086	0.164
G														-0.286**	-0.065	0.092	0.190
E														-0.081	-0.160	0.027	-0.005
KB																	
P															0.071	-0.210*	0.138
G															0.146	-0.308**	0.182
E															0.008	0.181	0.003
Mill %																	
P																0.368**	0.195
G																0.549**	0.384**
E																0.303**	-0.002
HRR%																	
P																	0.109
G																	0.107
E																	-0.002

Note :- LL - Leaf length, **LW -** Leaf width, **DF** - Days to 50% flowering, **FG/Pa -** Number of filled grains per panicle, **PH -** Plant height; **PaL -** Panicle length, **ET/P –** Number of effective tillers per plant, **SPS %-** Spikelet sterility percentage, **TW -**100 seed weight, **PL -** Paddy length, **PB -** Paddy breadth, **BRL -** Brown rice length, **BRB -** Brown rice breadth, **KL -** Kernel length, **KB -** Kernel breadth, **Mill % -** Milling percentage, **HRR % -** Head rice recovery percentage, **GY/P -** Grain yield per plant

Table 1: Genotypic path coefficients showing direct and indirect effects of different characters on grain yield per plant

	LL	LW	DF	ET/P	PH	PaL	FG/Pa	SPS %	TW	PL	PB	BRL	BRB	KL	KB	Mill %	HRR %	GY/P
LL	**0.499**	0.397	0.319	-0.534	-0.010	0.062	-0.202	-0.215	-0.116	0.017	0.084	0.000	-0.204	-0.113	0.213	0.056	0.003	0.256
LW	0.195	**1.014**	0.229	-0.466	-0.006	0.064	-0.223	-0.272	0.399	0.034	-0.481	0.000	0.363	-0.098	-0.448	0.226	0.005	0.537
DF	0.275	0.402	**0.577**	-0.345	-0.005	0.043	-0.206	-0.469	-0.348	0.035	0.212	0.000	-0.438	-0.161	0.432	0.220	0.009	0.234
ET/P	-0.273	-0.484	-0.204	**0.977**	0.006	-0.064	0.167	0.011	-0.122	0.028	0.220	0.000	-0.235	-0.027	0.151	-0.061	-0.003	0.086
PH	0.372	0.433	0.216	-0.408	**-0.013**	0.053	-0.135	0.054	0.021	-0.010	-0.387	0.000	0.375	0.054	-0.270	-0.060	0.002	0.298
PaL	0.172	0.363	0.136	-0.347	-0.004	**0.180**	-0.081	-0.183	0.018	0.290	0.372	0.002	-0.472	-0.701	0.512	-0.032	0.002	0.227
FG/Pa	0.285	0.641	0.377	-0.461	-0.005	0.041	**-0.353**	-0.193	-0.262	0.036	0.255	0.000	-0.422	-0.162	0.350	0.341	0.007	0.437
SPS %	0.118	0.302	0.296	-0.011	0.001	0.036	-0.075	**-0.913**	-0.032	0.079	0.152	0.001	-0.227	-0.198	0.323	0.160	0.005	0.018
TW	-0.028	0.195	-0.097	-0.057	0.000	0.002	0.045	0.014	**2.077**	0.294	-1.559	0.001	1.946	-0.510	-1.983	-0.051	-0.005	0.283
PL	0.011	0.045	0.027	0.036	0.000	0.068	-0.017	-0.094	0.798	**0.767**	0.283	0.004	-0.690	-1.579	0.612	-0.041	0.001	0.230
PB	-0.022	0.251	-0.063	-0.111	-0.003	-0.035	0.046	0.071	1.669	-0.112	**-1.940**	-0.001	2.547	0.391	-2.513	-0.016	-0.003	0.159
BRL	0.043	0.069	0.048	0.012	0.000	0.074	-0.033	-0.148	0.489	0.700	0.559	**0.004**	-0.887	-1.608	0.874	-0.049	0.001	0.148
BRB	-0.039	0.141	-0.097	-0.088	-0.002	-0.033	0.057	0.079	1.545	-0.202	-1.890	-0.001	**2.616**	0.528	-2.535	0.048	-0.004	0.124
KL	0.035	0.061	0.057	0.016	0.000	0.078	-0.035	-0.111	0.651	0.743	0.466	0.004	-0.847	**-1.629**	0.733	-0.032	0.001	0.190
KB	-0.041	0.177	-0.097	-0.058	-0.001	-0.036	0.048	0.115	1.606	-0.183	-1.901	-0.001	2.585	0.466	**-2.565**	0.073	-0.004	0.182
Mill %	0.056	0.462	0.256	-0.120	0.002	-0.012	-0.243	-0.294	-0.212	-0.063	0.063	0.000	0.254	0.106	-0.375	**0.497**	0.007	0.384
HRR %	0.125	0.390	0.391	-0.209	-0.002	0.023	-0.194	-0.364	-0.699	0.043	0.473	0.000	-0.797	-0.150	0.791	0.273	**0.014**	0.107

Residual effect = 0.0473

Note – Diagonal values are direct effects

Note :- LL - Leaf length, **LW -** Leaf width, **DF** - Days to 50% flowering, **FG/Pa -** Number of filled grains per panicle, **PH -** Plant height, **PaL -** Panicle length, **ET/P –** Number of effective tillers per plant, **SPS %-** Spikelet sterility percentage; **TW -**100 seed weight; **PL -** Paddy length; **PB -** Paddy breadth, **BRL -** Brown rice length, **BRB -** Brown rice breadth, **KL -** Kernel length, **KB -** Kernel breadth, **Mill % -** Milling percentage, **HRR % -** Head rice recovery percentage, **GY/P -** Grain yield per plant

Supplementary Table 2: Genotypic path coefficients showing direct and indirect effects of different characters on head rice recovery percentage

	LL	LW	DF	ET/P	PH	PaL	FG/Pa	SPS%	TW	PL	PB	BRL	BRB	KL	KB	Mill %	GY/P	HRR%
LL	**0.133**	-0.019	0.194	0.054	-0.442	0.019	0.202	0.027	0.114	0.023	-0.085	0.062	0.100	-0.056	-0.091	-0.007	0.021	0.250
LW	0.052	**-0.048**	0.139	0.047	-0.253	0.020	0.224	0.034	-0.392	0.048	0.485	0.048	-0.177	-0.049	0.191	-0.030	0.043	0.384
DF	0.074	-0.019	**0.352**	0.035	-0.222	0.013	0.207	0.059	0.342	0.050	-0.214	0.059	0.214	-0.080	-0.184	-0.029	0.019	0.677
ET/P	0.073	0.023	-0.124	**-0.098**	0.247	-0.020	-0.167	-0.001	0.120	0.040	-0.221	0.009	0.115	-0.014	-0.064	0.008	0.007	-0.214
PH	0.099	-0.020	0.132	0.041	**-0.593**	0.017	0.135	-0.007	-0.021	-0.014	0.390	-0.023	-0.183	0.027	0.115	0.008	0.024	0.126
PaL	0.046	-0.017	0.083	0.035	-0.175	**0.056**	0.081	0.023	-0.017	0.411	-0.375	0.291	0.231	-0.348	-0.218	0.004	0.018	0.128
FG/Pa	0.076	-0.030	0.206	0.046	-0.226	0.013	**0.354**	0.024	0.257	0.052	-0.257	0.066	0.206	-0.080	-0.149	-0.045	0.035	0.549
SPS %	0.031	-0.014	0.181	0.001	0.035	0.011	0.075	**0.115**	0.032	0.113	-0.153	0.116	0.111	-0.098	-0.137	-0.021	0.001	0.398
TW	-0.007	-0.009	-0.059	0.006	-0.006	0.000	-0.045	-0.002	**-2.040**	0.417	1.572	0.168	-0.951	-0.254	0.844	0.007	0.023	-0.336
PL	0.003	-0.002	0.016	-0.004	0.008	0.021	0.017	0.012	-0.784	**1.087**	-0.285	0.650	0.337	-0.784	-0.260	0.005	0.019	0.056
PB	-0.006	-0.012	-0.039	0.011	-0.118	-0.011	-0.047	-0.009	-1.640	-0.159	**1.956**	-0.205	-1.245	0.194	1.069	0.002	0.013	-0.244
BRL	0.012	-0.003	0.029	-0.001	0.019	0.023	0.033	0.019	-0.481	0.992	-0.564	**0.712**	0.434	-0.799	-0.372	0.006	0.012	0.070
BRB	-0.010	-0.007	-0.059	0.009	-0.085	-0.010	-0.057	-0.010	-1.518	-0.287	1.904	-0.241	**-1.278**	0.262	1.079	-0.006	0.010	-0.305
KL	0.009	-0.003	0.035	-0.002	0.020	0.024	0.035	0.014	-0.639	1.053	-0.470	0.703	0.414	**-0.809**	-0.312	0.004	0.015	0.092
KB	-0.011	-0.008	-0.059	0.006	-0.062	-0.011	-0.048	-0.015	-1.577	-0.259	1.916	-0.243	-1.263	0.231	**1.092**	-0.009	0.015	-0.308
Mill %	0.015	-0.022	0.156	0.012	0.072	-0.004	0.244	0.037	0.208	-0.089	-0.064	-0.071	-0.124	0.053	0.160	**-0.065**	0.031	0.549
GY/P	0.034	-0.026	0.083	-0.008	-0.177	0.013	0.155	0.002	-0.576	0.250	0.311	0.106	-0.158	-0.154	0.199	-0.025	**0.081**	0.107

Residual effect = 0.2816

Note – Diagonal values are direct effects

Note :- LL - Leaf length, **LW -** Leaf width, **DF** - Days to 50% flowering, **FG/Pa -** Number of filled grains per panicle, **PH -** Plant height, **PaL -** Panicle length, **ET/P –** Number of effective tillers per plant, **SPS %-** Spikelet sterility percentage, **TW -**100 seed weight, **PL -** Paddy length, **PB -** Paddy breadth, **BRL -** Brown rice length, **BRB -** Brown rice breadth, **KL -** Kernel length; **KB -** Kernel breadth, **Mill % -** Milling percentage, **HRR % -** Head rice recovery percentage, **GY/P -** Grain yield per plant

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