

Correlation and path analysis of yield and yield components in transplanted rice

L. L. Panwar* and Mashiat Ali

Agricultural Research Station, Ummedganj, P. O. Box - 7, GPO – Nayapura, Kota – 324 001, Rajasthan, India

ABSTRACT

The association among yield components, their direct and indirect influence on grain yield was investigated in 47 genotypes of rice including 16 local basmati varieties and 31 high yielding varieties / advanced lines under two sowing dates. Grain yield plant⁻¹ had significant positive association with grain yield panicle⁻¹, harvest index, filled grains panicle⁻¹, biological yield plant⁻¹, primary branch number panicle⁻¹, productive tillers plant⁻¹ and secondary branch number panicle⁻¹ in both the environments. Path coefficient analysis revealed that grain yield panicle⁻¹ had the highest direct effect on grain yield plant⁻¹ in both the environments, followed by harvest index, biological yield plant⁻¹ and productive tillers plant⁻¹, suggesting that the improvement in grain yield could be efficient, if the selection is based on these component characters.

Key words: Transplanted rice, yield components, correlation, path analysis

The expression of grain yield depends upon the interplay of a number of complex component attributes. Knowledge of correlation between grain yield and other characters is helpful in selection of suitable plant type. When more characters are included in correlation study, the association become complex. In such situations, selection on the basis of direct and indirect effects is much more useful than selection for yield *per se*. Hence, the present investigation was undertaken to study the association among grain yield and its component characters along with the nature and extent of direct and indirect effects of yield components on the grain yield in transplanted rice.

MATERIALS AND METHODS

The experimental material comprised of 47 genotypes of rice including 16 local basmati varieties and 31 high yielding varieties / advanced lines. The test materials were sown in two sowing dates (20th June and 5th July, 2001) during wet season. 25 days old seedlings were transplanted (15th July and 1st August, 2001) in a randomized block design with three replications at Agricultural Research Station, Ummedganj, Kota, Rajasthan. Each plot consisted of three rows of 5.0 m length with row to row and plant to plant spacing of 20 x 15 cms. The standard package of practices were

followed in each experiment. The observations were recorded on ten randomly selected plants from central row of each variety replication⁻¹ for 14 characters viz., days to 50% flowering, plant height, panicle number plant⁻¹, panicle length, primary branch number panicle⁻¹, secondary branch number panicle⁻¹, filled grains panicle⁻¹, chaffy grains panicle⁻¹, spikelet fertility (%), biological yield plant⁻¹, harvest index, 1000-grain weight, grain yield panicle⁻¹ and grain yield plant⁻¹. The genotypic and phenotypic correlation coefficients and path analysis were computed following the standard statistical procedures of Singh and Chaudhary (1979) and Dewey and Lu (1959), respectively. The data of environment-1 (E₁) and environment-2 (E₂) were separately analysed.

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed highly significant differences among the genotypes for all the characters studied, indicating the existence of considerable genetic variation in the experimental material. The genotypic correlation coefficients were of higher magnitude than the corresponding phenotypic correlation coefficients (Table 2) for most of the character pairs, indicating a strong inherent association between these characters. Grain yield plant⁻¹ had

Table 1. Mean and the analysis of variance under E₁ and E₂ conditions

Characters	Environment-1 (E ₁)				Environment-2 (E ₂)			
	Mean ± SEm	M S S			Mean ± SEm	M S S		
		Replication	Genotypes	Error		Replication	Genotypes	Error
		(2)	(46)	(92)		(2)	(46)	(92)
Days to 50 % flowering	102.36 ± 0.33	0.66	86.16**	0.32624	102.48 ± 0.33	0.20	85.72**	0.32177
Plant height (cm)	106.76 ± 0.18	0.10	1359.95**	0.09306	106.79 ± 0.17	0.31	1360.08**	0.08509
Productive tillers plant ⁻¹	15.36 ± 0.13	0.04	31.78**	0.05364	14.86 ± 0.15	0.19	29.14**	0.06613
Panicle length (cm)	27.98 ± 0.16	0.09	10.84**	0.07681	27.64 ± 0.16	0.15	9.82**	0.07501
Primary branch number panicle ⁻¹	12.13 ± 0.17	0.30	13.21**	0.08803	11.80 ± 0.12	0.06	12.30**	0.04561
Secondary branch number panicle ⁻¹	26.80 ± 0.53	1.67	203.64**	0.84345	25.79 ± 0.15	0.06	182.08**	0.06426
Filled grains panicle ⁻¹	137.29 ± 0.17	0.55	5861.44**	0.08625	134.86 ± 0.17	0.36	5563.46**	0.08966
Chaffy grains panicle ⁻¹	22.88 ± 0.16	0.02	239.26**	0.07634	24.54 ± 0.17	0.08	229.50**	0.08189
Spikelet fertility (%)	85.47 ± 0.12	0.01	58.98**	0.04181	85.15 ± 0.11	0.02	59.64**	0.03676
Biological yield plant ⁻¹	87.22 ± 0.13	0.33	1904.54**	0.04822	87.00 ± 0.32	0.71	1896.91**	0.29871
Harvest index (%)	27.18 ± 0.13	0.04	203.60**	0.05182	26.65 ± 0.11	0.07	187.36**	0.03605
1000 - grain weight (g)	22.39 ± 0.10	0.01	10.44**	0.03105	22.13 ± 0.12	0.08	8.47**	0.04259
Grain yield panicle ⁻¹ (g)	1.55 ± 0.03	0.01	1.09**	0.00339	1.49 ± 0.04	0.01	1.03**	0.00498
Grain yield plant ⁻¹ (g)	23.11 ± 0.11	0.04	171.54**	0.03818	22.75 ± 0.11	0.09	162.89**	0.03525

* and ** significant at P = 0.05 and 0.01 level, respectively.

significant positive correlation with grain yield panicle⁻¹, harvest index, filled grains panicle⁻¹, biological yield plant⁻¹, primary branch number panicle⁻¹, productive tillers plant⁻¹ and secondary branch number panicle⁻¹ in both the environments. Similar findings were earlier reported by Murthy *et al.* (1991) and Sundaram and Palanisamy (1994) for biological yield plant⁻¹, Padhi and Singh (1991) and Meenakshi *et al.* (1999) for grains panicle⁻¹ and Surek *et al.* (1998) and Khedekar *et al.* (2004) for number of panicles plant⁻¹, biological yield plant⁻¹ and harvest index. Plant height exhibited negative and significant correlation while all other characters expressed non-significant association with grain yield plant⁻¹ in both the environments.

As regards inter-relationship between yield

characters, it was quite interesting to observe that grain yield panicle⁻¹, harvest index, biological yield plant⁻¹ and productive tillers plant⁻¹ were mutually correlated with each other. Productive tillers plant⁻¹ was positively and significantly correlated with biological yield plant⁻¹, harvest index and grain yield panicle⁻¹. Biological yield plant⁻¹ showed a positive and significant association with harvest index and grain yield panicle⁻¹ in both the environments. Murthy *et al.* (1991) also obtained similar results. Harvest index showed positive and significant association with grain yield panicle⁻¹. Therefore, selection for any one of the characters would offer the scope for simultaneous improvement in all these four characters in addition to improving the yield.

Path coefficient analysis (Table 3) showed that

Table 2. Genotypic (G) and phenotypic (P) correlation coefficients among yield attributing characters under environment (E₁) and environment (E₂) conditions

Characters	Environments	Plant height (cm)	Productive tillers plant ⁻¹	Panicle length (cm)	Primary branch number panicle ⁻¹	Secondary branch number panicle ⁻¹	Filled grains panicle ⁻¹	Chaffy grains panicle ⁻¹	Spikelet fertility (%)	Biological yield plant ⁻¹ (g)	Harvest index (%)	1000-grain weight (g)	Grain yield plant ⁻¹ (g)	Grain yield panicle ⁻¹ (g)
Days to 50% flowering	E ₁	0.41**	0.28	0.01	-0.15	-0.18	-0.23	-0.29*	0.09	0.46**	-0.46**	0.28	-0.18	-0.02
	E ₂	0.38**	0.25	0.01	-0.12	-0.17	-0.20	-0.25	0.07	0.38**	-0.44**	0.25	-0.15	-0.01
Plant height (cm)	E ₁	0.41**	0.29*	0.02	-0.19	-0.20	-0.25	-0.28	0.07	0.45**	-0.46**	0.25	-0.18	-0.01
	E ₂	0.36**	0.25	0.01	-0.15	-0.18	-0.22	-0.20	0.05	0.36**	-0.44**	0.21	-0.15	-0.01
Productive tillers plant ⁻¹	E ₁	-	0.20	0.15	-0.42**	-0.65**	-0.59**	-0.49**	0.03	0.12	-0.67**	0.32*	-0.45**	-0.47**
	E ₂	-	0.18	0.13	-0.37**	-0.64**	-0.55**	-0.40**	0.01	0.09	-0.59**	0.29*	-0.43**	-0.45**
Panicle length (cm)	E ₁	-	0.19	0.21	-0.32*	-0.65**	-0.58**	-0.50**	0.03	0.12	-0.66**	0.29*	-0.43**	-0.45**
	E ₂	-	0.17	0.18	-0.29*	-0.64**	-0.52**	-0.42**	0.01	0.09	-0.56**	0.25	-0.39**	-0.41**
Primary branch number panicle ⁻¹	E ₁	-	-	0.25	-0.17	-0.22	-0.17	0.21	0.02	0.45**	0.30*	0.19	0.41**	0.38**
	E ₂	-	-	0.22	-0.12	-0.18	-0.13	0.16	0.01	0.40**	0.29*	0.16	0.38**	0.36**
Secondary branch number panicle ⁻¹	E ₁	-	-	0.24	-0.06	-0.23	-0.18	0.20	0.00	0.48**	0.29*	0.16	0.38**	0.39**
	E ₂	-	-	0.19	-0.03	-0.20	-0.15	0.18	0.00	0.42**	0.29*	0.09	0.36**	0.37**
Filled grains panicle ⁻¹	E ₁	-	-	-	0.24	0.19	0.11	0.11	0.01	-0.22	-0.07	-0.21	-0.05	-0.21
	E ₂	-	-	-	0.22	0.16	0.09	0.09	0.01	-0.18	-0.03	-0.17	-0.01	-0.19
Spikelet fertility (%)	E ₁	-	-	-	0.23	0.15	0.09	0.08	0.06	-0.19	-0.12	-0.15	-0.09	-0.22
	E ₂	-	-	-	0.20	0.09	0.03	0.05	0.03	-0.13	-0.10	-0.08	-0.05	-0.20
Chaffy grains panicle ⁻¹	E ₁	-	-	-	-	0.64**	0.73**	0.45**	0.13	0.05	0.42**	-0.44**	0.46**	0.41**
	E ₂	-	-	-	-	0.58**	0.62**	0.40**	0.09	0.05	0.38**	-0.41**	0.41**	0.39**
1000-grain weight (g)	E ₁	-	-	-	-	0.49**	0.65**	0.34*	0.22	0.10	0.39**	-0.27	0.39**	0.42**
	E ₂	-	-	-	-	0.39**	0.56**	0.32*	0.18	0.08	0.36**	-0.22	0.36**	0.40**
Grain yield plant ⁻¹ (g)	E ₁	-	-	-	-	-	0.69**	0.51**	0.04	0.08	0.36**	-0.46**	0.40**	0.36**
	E ₂	-	-	-	-	-	0.65**	0.40**	0.01	0.05	0.34*	-0.39**	0.38**	0.35*
Grain yield panicle ⁻¹ (g)	E ₁	-	-	-	-	-	0.70**	0.53**	0.04	0.08	0.36**	-0.42**	0.40**	0.36**
	E ₂	-	-	-	-	-	0.68**	0.43**	0.03	0.06	0.32*	-0.36**	0.38**	0.34*
Spikelet fertility (%)	E ₁	-	-	-	-	-	-	0.48**	0.32*	0.20	0.51**	-0.50**	0.59**	0.59**
	E ₂	-	-	-	-	-	-	0.45**	0.30*	0.15	0.48**	-0.42**	0.54**	0.55**
Chaffy grains panicle ⁻¹	E ₁	-	-	-	-	-	-	0.49**	0.31*	0.20	0.51**	-0.47**	0.59**	0.59**
	E ₂	-	-	-	-	-	-	0.46**	0.29*	0.13	0.49**	-0.38**	0.52**	0.53**
Harvest index (%)	E ₁	-	-	-	-	-	-	-	-0.65**	-0.01	-0.43**	-0.35*	0.44**	0.27
	E ₂	-	-	-	-	-	-	-	-0.60**	-0.01	-0.39**	-0.32*	0.41**	0.25
1000-grain weight (g)	E ₁	-	-	-	-	-	-	-	-0.64**	0.00	-0.43**	-0.31*	0.41**	0.28
	E ₂	-	-	-	-	-	-	-	-0.58**	0.00	-0.38**	-0.29*	0.38**	0.27
Grain yield plant ⁻¹ (g)	E ₁	-	-	-	-	-	-	-	-	0.13	0.02	-0.06	0.06	0.12
	E ₂	-	-	-	-	-	-	-	-	0.12	0.02	-0.04	0.01	0.10
Grain yield panicle ⁻¹ (g)	E ₁	-	-	-	-	-	-	-	-	0.13	0.02	-0.09	0.08	0.12
	E ₂	-	-	-	-	-	-	-	-	0.09	0.01	-0.03	0.05	0.09

Table 2 contd.../-

Table 2 contd.../-

Biological yield	E ₁	G	0.40**	-0.26	0.36**	0.52**
	E ₂	P	0.38**	-0.22	0.36**	0.48**
plant ⁻¹ (g)	E ₁	G	0.38**	-0.27	0.37**	0.53**
	E ₂	P	0.36**	-0.25	0.36**	0.50**
Harvest index (%)	E ₁	G	-	-0.29*	0.73**	0.64**
	E ₂	P	-	-0.26	0.64**	0.59**
1000-grain weight (g)	E ₁	G	-	-0.25	0.72**	0.65**
	E ₂	P	-	-0.18	0.62**	0.63**
Grain yield	E ₁	G	-	-	-0.10	-0.02
	E ₂	P	-	-	-0.07	-0.01
panicle ⁻¹ (g)	E ₁	G	-	-	-0.07	0.01
	E ₂	P	-	-	-0.03	0.01
	E ₁	G	-	-	-	0.84**
	E ₂	P	-	-	-	0.76**
	E ₁	G	-	-	-	0.83**
	E ₂	P	-	-	-	0.72**

* and ** significant at P = 0.05 and 0.01 level, respectively.

Table 3. Path analysis showing direct and indirect effects of yield attributing characters on grain yield plant⁻¹ under (E₁) and environment (E₂) conditions

Characters	Environ- ments	Days to 50 % flowering	Plant height (cm)	Productive tillers plant ⁻¹	Panicle length (cm)	Primary branch number panicle ⁻¹	Secondary branch number panicle ⁻¹	Filled grains panicle ⁻¹	Chaffy grains panicle ⁻¹	Spikelet fertility (%)	Biological yield plant ⁻¹ (g)	Harvest index (%)	1000- grain weight (g)	Grain yield panicle ⁻¹ (g)	Grain yield plant ⁻¹ (g)
Days to 50 % flowering	E ₁	0.0312	-0.0313	0.0827	0.0003	0.0026	0.0007	0.0092	-0.0152	0.0067	0.1799	-0.1979	0.0044	-0.0967	-0.0235
	E ₂	0.0657	-0.0350	0.0903	0.0006	-0.0020	0.0029	0.0020	-0.0153	0.0042	0.1488	-0.1837	0.0093	-0.0961	-0.0083
Plant height (cm)	E ₁	0.0127	-0.0766	0.0599	0.0040	0.0073	0.0024	0.0238	-0.0255	0.0023	0.0489	-0.2871	0.0050	-0.2422	-0.4651**
	E ₂	0.0270	-0.0852	0.0600	0.0053	-0.0035	0.0093	0.0047	-0.0271	0.0020	0.0400	-0.2659	0.0107	-0.2323	-0.4549**
Productive tillers plant ⁻¹	E ₁	0.0088	-0.0157	0.2931	-0.0066	0.0029	0.0008	0.0070	-0.0110	0.0016	0.1778	0.1271	0.0030	0.2214	0.3763**
	E ₂	0.0189	-0.0163	0.3142	-0.0060	-0.0006	0.0033	0.0014	-0.0108	0.0002	0.1577	0.1117	0.0057	0.2061	0.3899**
Panicle length (cm)	E ₁	0.0003	-0.0117	-0.0735	0.0264	-0.0042	-0.0007	-0.0043	0.0057	0.0007	0.0858	-0.0317	-0.0033	-0.0249	-0.2070
	E ₂	0.0015	-0.0180	-0.0751	0.0251	0.0025	-0.0021	-0.0007	0.0046	0.0037	0.0618	-0.0464	-0.0056	-0.0504	-0.2229
Primary branch number	E ₁	-0.0046	0.0320	-0.0493	0.0063	0.0175	-0.0024	-0.0296	0.0237	0.0096	0.0190	0.1817	-0.0069	0.2473	0.4093**
	E ₂	-0.0122	0.0276	-0.0184	0.0058	0.0108	-0.0070	-0.0052	0.0186	0.0132	0.0335	0.1561	-0.0098	0.2116	0.4244**
Secondary branch number panicle ⁻¹	E ₁	-0.0055	0.0497	-0.0657	0.0051	-0.0112	-0.0037	-0.0280	0.0267	0.0030	0.0313	0.1521	-0.0072	0.2138	0.3605**
	E ₂	-0.0134	0.0557	-0.0730	0.0038	0.0053	-0.0143	-0.0057	0.0291	0.0024	0.0252	0.1458	-0.0152	0.2168	0.3625**
Filled grains panicle ⁻¹	E ₁	-0.0071	0.0452	-0.0506	0.0028	-0.0128	0.0026	0.0404	0.0248	0.0242	0.0778	0.2193	-0.0080	0.3167	0.5894**
	E ₂	-0.0163	0.0498	-0.0552	0.0023	0.0070	0.0100	0.0081	0.0269	0.0182	0.0644	0.2052	-0.0173	0.3182	0.5852**
Chaffy grains panicle ⁻¹	E ₁	-0.0091	0.0375	-0.0617	0.0029	-0.0079	-0.0019	-0.0192	0.0521	-0.0499	0.0039	0.0842	-0.0055	0.0336	0.2711
	E ₂	-0.0183	0.0422	-0.0618	0.0021	0.0037	-0.0076	-0.0040	0.0547	-0.0381	0.0009	0.0726	-0.0113	0.0244	0.2795
Spikelet fertility (%)	E ₁	0.0027	-0.0023	0.0062	0.0003	-0.0022	-0.0001	-0.0128	-0.0340	0.0765	0.0505	0.0065	-0.0009	0.0297	0.1200
	E ₂	0.0047	-0.0028	0.0010	0.0016	0.0024	-0.0006	-0.0025	-0.0351	0.0594	0.0419	0.0082	-0.0031	0.0451	0.1202
Biological yield plant ⁻¹ (g)	E ₁	0.0143	-0.0096	0.1333	-0.0058	-0.0009	-0.0003	-0.0080	-0.0005	0.0099	0.3910	0.1276	0.0041	0.1214	0.5214**
	E ₂	0.0297	-0.0104	0.1504	-0.0047	0.0011	-0.0011	-0.0016	0.0002	0.0076	0.3294	0.1134	0.0101	0.1338	0.5310**
Harvest index (%)	E ₁	-0.0144	0.0514	0.0870	-0.0020	-0.0074	-0.0013	-0.0207	0.0224	0.0012	0.1165	0.4284	-0.0047	0.3930	0.6425**
	E ₂	-0.0301	0.0566	0.0876	-0.0029	0.0042	-0.0052	-0.0041	0.0236	0.0012	0.0932	0.4006	-0.0092	0.3916	0.6455**
1000 - grain weight (g)	E ₁	0.0087	-0.0244	0.0560	-0.0055	0.0077	0.0017	0.0203	-0.0182	-0.0046	0.1015	-0.1263	0.0158	-0.0543	-0.0217
	E ₂	0.0166	-0.0249	0.0489	-0.0039	-0.0029	0.0059	0.0038	-0.0169	-0.0051	0.0903	-0.1000	0.0367	-0.0378	0.0108
Grain yield panicle ⁻¹ (g)	E ₁	-0.0056	0.0346	0.1209	-0.0012	-0.0081	-0.0015	-0.0238	0.0227	0.0042	0.0885	0.3137	-0.0016	0.5367	0.8376**
	E ₂	-0.0116	0.0366	0.1196	-0.0023	0.0042	-0.0057	-0.0047	0.0227	0.0050	0.0814	0.2897	-0.0026	0.5415	0.8344**
Residual Effects	E ₁	0.0063													
	E ₂	0.0058													

* and ** significant at P = 0.05 and 0.01 level, respectively.

grain yield panicle⁻¹ had the highest direct effect on grain yield plant⁻¹ in both the environments, followed by harvest index, biological yield plant⁻¹ and productive tillers plant⁻¹. Similar results were also reported by Ibrahim *et al.* (1990) for effective tillers plant⁻¹, Niranjana Murthy *et al.* (1991) for dry matter production, Murty and Babu (1992) and Chakraborty *et al.* (2001) for harvest index and Surek *et al.* (1998) and Meenakshi *et al.* (1999) for biological yield plant⁻¹ and harvest index. Plant height and secondary branch number panicle⁻¹ had negative yet direct effect on grain yield plant⁻¹ in both the environments. Chakraborty *et al.* (2001) and Khedikar *et al.* (2004) also reported negative direct effect of plant height on the grain yield plant⁻¹. The indirect effects of plant height *via* productive tillers plant⁻¹ and biological yield plant⁻¹ was positive and *via* harvest index and grain yield panicle⁻¹ was negative; whereas indirect effects of secondary branch number panicle⁻¹ *via* productive tillers plant⁻¹ was negative and *via* biological yield plant⁻¹, harvest index and grain yield panicle⁻¹ was positive in both the environments. In the present study, all the characters showed positive indirect effect through biological yield plant⁻¹ in both the environments. Surek *et al.* (1998) also reported positive indirect effect of all the characters through biological yield plant⁻¹.

The results from correlation and path coefficient analysis indicated that grain yield panicle⁻¹, harvest index, biological yield plant⁻¹ and productive tillers plant⁻¹ were the major yield contributing characters, as these characters not only showed positive and significant association with grain yield plant⁻¹, but also had high positive direct effect in both the environments. They also had positive indirect effects *via* each other. Thus, grain yield panicle⁻¹, harvest index, biological yield plant⁻¹ and productive tillers plant⁻¹ could be considered as the most important characters for selection in order to improve the grain yield.

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