

Correlation and path analyses of yield and its component characters in scented rice

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ABSTRACT

Correlation and path analyses were studied for grain yield, its components and quality characters in a set of 65 genotypes of scented rice. A very strong positive correlation of grain yield plant⁻¹ at genotypic, phenotypic and environmental levels was observed with harvest-index, while number of effective tillers plant⁻¹ and biological yield plant⁻¹ showed very strong positive association at both phenotypic and genotypic level. Harvest-index followed by number of effective tillers plant⁻¹, biological yield plant⁻¹, kernel length, L/B ratio, fertility percentage and 1000-grain weight emerged as the most important associate of grain yield in scented rice. Path analysis identified biological yield plant⁻¹ and harvest-index as major direct contributors and number of effective tillers plant⁻¹, days to 50% flowering and days to maturity as main indirect contributors

Key words: scented rice, correlation, path analysis, grain yield, components

Rice is the staple food crops in the world particularly in India and improvement of its productivity has always been a prime focus (Subbaiah *et al.*, 2011). Knowledge on the nature and magnitude of associations among yield and its component traits is essential for effecting genetic improvement. The genetic architecture of grain yield can be better resolved through its component characters as it is the end product of multiple interactions between various yield components. Correlation coefficient does not provide exact picture of relative importance of direct and indirect influence of each component character. Path-coefficient analysis refers to a standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects. In addition, it also provides estimates of residual effects. Path analysis in determining yield contributing characters thus, is useful in indirect selection. Therefore, the present study was conducted to study the correlation and path analysis for yield, and its component characters in scented rice which usually have low productivity.

MATERIALS AND METHODS

The experimental material consisted of 65 diverse scented rice genotypes. All the 65 scented rice genotype

were grown in a randomized complete block design with three replications at Kumarganj, Faizabad, Uttar Pradesh during wet season 2008. The sixty five genotypes included in the study are Maleshiya, T-1, NDR-6242, NDR-6241, Kanakjeer, Sonachoor, Shyamjira, Basmati B, Bansphool A, Tulsimanjri, Harikesh, Tulsiprasad, Vishmaparag, Basmati (Raibareli), Keshar, Kanakjeer A, Lalmati, Kataribhog, Ramdhani Paugal, Pusa Basmati-1, Basmati-370, Basmati Cuttack, Chinnor A, Pakistani Basmati, Shakkarchini, Lalkahwa, N 12, Vishnubhog, Dhaniya B, Basmati A, Ramziawan, Moongphali D, Kalanamak A, ST 10, Multani Basmati, Lalsar, Badshah Pasand A, Dulhania, Juhi Bengal B, Laungchoor B, Laungchoor A, Tilakchandani, Sabarmati (Raibareli), T-3, Rambhog B, Kalanamak (Nichnaul), Moongphali B, Bansphool B, Rambhog, Kapoorchini, Basmati C, Admachini B, Karnal Local, Kasturi Chandauli, Karnal Local A, Basmati Sufaid-106, Bas 213, Bas Shurkh 161, UPRI-93-60-3, Bas Shurkh-6113, Palwan, Pusa Sughanda 4, Pusa Sughanda 3, Pusa sughanda 2, Taraori Basmati. Twenty one days old seedlings of each genotype was transplanted in single rows of 3 m long with 20 cm x 15 cm inter and intra row spacing, respectively. Recommended agronomic practices and

plant protection measures were adopted for raising a healthy crop. The Observations were recorded on five randomly selected competitive plants in each treatment in each replication for 18 characters viz., days to 50% flowering, days to maturity, flag leaf area, plant height, number of effective tillers plant⁻¹, panicle length, number of sterile spikelets panicle⁻¹, number of fertile spikelets panicle⁻¹, fertility percentage, 1000-grain weight, biological yield plant⁻¹, harvest-index, kernel length, kernel width, L/B ratio, kernel elongation ratio, alkali digestion value and grain yield plant⁻¹. The phenotypic, genotypic and environmental coefficients of correlation were computed as suggested by Searle (1961), while genotypic and phenotypic path coefficients were worked-out as suggested by Wright (1921) and as described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied. At phenotypic level (Table 1), the grain yield plant⁻¹ exhibited highly significant and positive phenotypic correlation with number of effective tillers plant⁻¹ (0.646), biological yield plant⁻¹ (0.560) and harvest-index (0.511), while significant and positive phenotypic correlations of grain yield plant⁻¹ were recorded with kernel length (0.290), L/B ratio (0.284) and 1000-grain weight (0.260), suggesting the possibility of improvement in grain yield plant⁻¹ through improvement of these traits. These finding are in agreement with the earlier reports of Adil *et al.* (2007) and Khedikar *et al.* (2004). The estimates of genotypic correlation coefficients between different characters, showed close resemblance in direction with their corresponding phenotypic correlation coefficients (Table 2). The genotypic correlations were slightly higher in magnitude than corresponding correlations at phenotypic level. Khedikar *et al.*, (2004) also reported higher estimates of genotypic correlations than the corresponding phenotypic correlations between yield and yield components in scented rice. At environment level (Table 3) grain yield plant⁻¹ showed highly significant positive correlation with harvest index (0.857). A very strong positive correlation of grain yield plant⁻¹ at genotypic, phenotypic and environmental level was observed with harvest-index, while number of effective tillers plant⁻¹ and biological

Table 1. Estimates of phenotypic correlation coefficients between different characters in scented rice germplasm

Characters	Days to 50% flowering	Days to maturity	Flag leaf area (cm ²)	Plant height (cm)	No. of effective tillers plant ⁻¹	Panicle length (cm)	No. of sterile spikelets panicle ⁻¹	No. of fertile spikelets panicle ⁻¹	Spikelet fertility percentage	1000-grain weight (g)	Biological yield plant ⁻¹ (g)	Harvest index (%)	Kernel length (mm)	Kernel width (mm)	L/B ratio	Kernel elongation ratio	Alkali digestion value	Grain yield plant ⁻¹ (g)
Days to 50 % flowering	1.000	0.997**	-0.404**	0.382**	-0.001	0.085	0.290*	0.406**	-0.062	-0.347**	0.480**	-0.368**	-0.435**	-0.435**	-0.079	0.109	-0.055	0.129
Days to maturity		1.000	-0.406**	0.374**	0.003	0.079	0.281*	0.384**	-0.070	-0.342**	0.473**	-0.369**	-0.432**	-0.432**	-0.082	0.124	-0.052	0.122
Flag leaf area (cm ²)			1.000	-0.310*	-0.011	0.187	0.235	-0.005	-0.229	0.092	-0.266*	0.182	0.096	0.120	-0.058	-0.135	-0.207	-0.099
Plant height (cm)				1.000	-0.367**	0.211	0.193	0.260*	-0.004	-0.276*	0.256*	-0.605**	-0.205	-0.205	-0.158	-0.079	-0.137	-0.324**
No. of effective tillers plant ⁻¹					1.000	0.055	-0.030	-0.127	-0.032	0.115	0.483**	0.195	0.305*	-0.011	0.301*	0.155	0.160	0.646**
Panicle length (cm)						1.000	0.252*	0.072	-0.220	0.274*	0.052	-0.014	0.410**	-0.200	0.455**	0.029	0.188	0.049
No. of sterile spikelets panicle ⁻¹							1.000	0.430**	-0.737**	-0.289*	0.199	-0.305*	-0.101	-0.379**	0.031	-0.028	-0.107	-0.115
No. of fertile spikelets panicle ⁻¹								1.000	0.233	-0.363**	0.323**	-0.114	-0.391**	-0.299*	-0.284*	0.054	-0.019	0.174
Spikelet fertility percentage									1.000	0.046	0.017	0.286*	-0.174	0.216	-0.244	0.002	0.105	0.280*
1000-grain weight (g)										1.000	-0.153	0.433**	0.848**	0.232	0.754**	0.224	0.336**	0.260*
Biological yield plant ⁻¹ (g)											1.000	-0.025	-0.209	0.038	0.083	-0.032	0.560**	
Harvest-index (%)												1.000	0.321**	0.165	0.265*	0.166	0.254*	0.511**
Kernel length (mm)													1.000	0.106	0.947**	0.167	0.419**	0.290*
Kernel width (mm)														1.000	-0.216	-0.106	0.145	-0.007
L/B ratio															1.000	0.185	0.358**	0.284*
Kernel elongation ratio																1.000	0.208	0.235
Alkali digestion value																	1.000	0.218
Grain yield plant ⁻¹ (g)																		1.000

*, ** Significant at 5 and 1 per cent probability level, respectively.

Table 2. Estimates of genotypic correlation coefficients between different characters in scented rice germplasm

Characters	Days to 50% flowering	Days to maturity	Flag leaf area (cm ²)	Plant height (cm)	No. of effective tillers plant ⁻¹	Panicle length (cm)	No. of sterile spikelets panicle ⁻¹	No. of fertile spikelets panicle ⁻¹	Spikelet fertility percentage	1000-grain weight (g)	Biological yield plant ⁻¹ (g)	Harvest index (%)	Kernel length (mm)	Kernel width (mm)	L/B ratio	Kernel elongation ratio	Alkali digestion value	Grain yield plant ⁻¹ (g)
Days to 50 % flowering	1.000	0.998	-0.414	0.387	-0.001	0.093	0.298	0.408	-0.062	-0.352	0.488	-0.401	-0.212	-0.444	-0.079	0.114	-0.065	0.138
Days to maturity		1.000	-0.416	0.379	0.004	0.087	0.288	0.386	-0.071	-0.348	0.483	-0.404	-0.214	-0.441	-0.083	0.130	-0.061	0.130
Flag leaf area (cm ²)			1.000	-0.323	-0.003	0.219	0.238	-0.006	-0.232	0.103	-0.276	0.207	0.100	-0.059	0.124	-0.138	-0.232	-0.104
Plant height (cm)				1.000	-0.378	0.240	0.201	0.262	-0.004	-0.291	0.258	-0.660	-0.227	-0.201	-0.162	-0.086	-0.149	-0.343
No. of effective tillers plant ⁻¹					1.000	0.061	-0.025	-0.129	-0.037	0.113	0.496	0.217	0.310	-0.019	0.309	0.157	0.182	0.686
Panicle length (cm)						1.000	0.265	0.083	-0.229	0.307	0.054	-0.012	0.453	-0.220	0.503	0.042	0.227	0.056
No. of sterile spikelets panicle ⁻¹							1.000	0.441	-0.729	-0.300	0.198	-0.330	-0.104	-0.387	0.027	-0.022	-0.135	-0.124
No. of fertile spikelets panicle ⁻¹								1.000	0.235	-0.369	0.328	-0.124	-0.392	-0.306	-0.286	0.058	-0.024	0.184
Spikelet fertility percentage									1.000	0.048	0.025	0.308	-0.178	0.217	-0.246	-0.001	0.129	0.300
1000-grain weight (g)										1.000	-0.155	0.476	0.863	0.243	0.767	0.232	0.373	0.276
Biological yield plant ⁻¹ (g)											1.000	-0.430	-0.024	-0.213	0.040	0.089	-0.038	0.587
Harvest index (%)												1.000	0.354	0.196	0.289	0.158	0.292	0.467
Kernel length (mm)													1.000	0.100	0.950	0.184	0.454	0.309
Kernel width (mm)														1.000	-0.213	-0.094	0.169	0.003
L/B ratio															1.000	0.195	0.385	0.299
Kernel elongation ratio																1.000	0.232	0.235
Alkali digestion value																	1.000	0.246
Grain yield plant ⁻¹ (g)																		1.000

*,** Significant at 5 and 1 per cent probability levels, respectively.

Table 3. Estimates of environmental correlation coefficients between different characters in scented rice germplasm

Characters	Days to 50% flowering	Days to maturity	Flag leaf area (cm ²)	Plant height (cm)	No. of effective tillers plant ⁻¹	Panicle length (cm)	No. of sterile spikelets panicle ⁻¹	No. of fertile spikelets panicle ⁻¹	Spikelet fertility percentage	1000-grain weight (g)	Biological yield plant ⁻¹ (g)	Harvest index (%)	Kernel length (mm)	Kernel width (mm)	L/B ratio	Kernel elongation ratio	Alkali digestion value	Grain yield plant ⁻¹ (g)
Days to 50 % flowering	1.000	0.869**	0.023	0.157	-0.043	0.018	0.051	0.068	-0.048	-0.029	-0.101	-0.009	-0.174	-0.162	-0.018	0.021	0.178	-0.114
Days to maturity		1.000	-0.008	0.111	-0.065	0.027	0.034	0.067	-0.028	-0.024	-0.114	0.024	-0.183	-0.165	-0.026	-0.012	0.159	-0.072
Flag leaf area (cm ²)			1.000	0.078	-0.243	-0.089	0.163	0.093	-0.155	-0.224	0.047	-0.065	-0.109	-0.029	-0.070	-0.097	0.067	-0.030
Plant height (cm)				1.000	0.039	-0.045	-0.008	0.204	0.009	0.232	0.175	-0.106	-0.226	-0.304 *	0.051	0.050	0.001	-0.028
No. of effective tillers plant ⁻¹					1.000	0.010	-0.149	-0.062	0.118	0.206	-0.035	-0.029	0.017	0.192	-0.184	0.139	-0.119	0.010
Panicle length (cm)						1.000	0.189	-0.105	-0.199	-0.006	0.063	-0.025	0.053	-0.063	0.054	-0.062	-0.022	0.008
No. of sterile spikelets panicle ⁻¹							1.000	0.031	-0.921**	-0.001	0.220	-0.102	0.021	-0.224	0.220	-0.109	0.192	-0.007
No. of fertile spikelets panicle ⁻¹								1.000	0.232	0.052	-0.093	-0.003	-0.113	-0.091	-0.040	-0.085	0.125	-0.052
Spikelet fertility percentage									1.000	-0.003	-0.253*	0.102	-0.009	0.195	-0.180	0.044	-0.177	-0.017
1000-grain weight (g)										1.000	-0.048	0.019	-0.005	-0.069	0.027	0.105	-0.114	0.003
Biological yield plant ⁻¹ (g)											1.000	-0.337 **	-0.180	-0.086	-0.118	-0.015	0.049	0.134
Harvest-index (%)												1.000	-0.091	-0.122	0.019	0.241	0.028	0.857**
Kernel length (mm)													1.000	0.474**	0.534 **	-0.332**	-0.075	-0.151
Kernel width (mm)														1.000	-0.464**	-0.280*	-0.112	-0.155
L/B ratio															1.000	-0.045	0.029	-0.029
Kernel elongation ratio																1.000	0.008	0.237
Alkali digestion value																	1.000	-0.008
Grain yield plant ⁻¹ (g)																		1.000

*,** Significant at 5 and 1 per cent probability levels, respectively.

Table 4. Direct and indirect effects of different characters on grain yield per plant at phenotypic level in scented rice germplasm

Characters	Days to 50% flowering	Days to maturity	Flag leaf area (cm ²)	Plant height (cm)	No. of effective tillers plant ⁻¹	Panicle length (cm)	No. of sterile spikelets panicle ⁻¹	No. of fertile spikelets panicle ⁻¹	Spikelet fertility percentage	1000-grain weight (g)	Biological yield plant ⁻¹ (g)	Harvest index (%)	Kernel length (mm)	Kernel width (mm)	L/B ratio	Kernel elongation ratio	Alkali digestion value	Grain yield plant ⁻¹ (g)
Days to 50 % flowering	0.1354	-0.0837	0.0005	-0.0157	-0.0000	0.0020	-0.0038	-0.0013	-0.0014	0.0124	0.4232	-0.3089	-0.0421	-0.0012	0.0118	0.0013	0.0001	0.129
Days to maturity	0.1350	-0.0839	0.0005	-0.0154	0.0000	0.0018	-0.0037	-0.0013	-0.0016	0.0123	0.4179	-0.3100	-0.0426	-0.0012	0.0123	0.0015	0.0001	0.122
Flag leaf area (cm ²)	-0.0547	0.0340	-0.0012	0.0128	-0.0002	0.0044	-0.0031	0.0000	-0.0052	-0.0032	-0.2344	0.1526	0.0190	-0.0001	-0.0181	-0.0017	0.0006	-0.099
Plant height (cm)	0.0517	-0.0313	0.0003	-0.0413	-0.0100	0.0049	-0.0025	-0.0008	-0.0008	0.0099	0.2255	-0.5083	-0.0449	-0.0005	0.0238	-0.0009	0.0004	-0.324
No. of effective tillers plant ⁻¹	-0.0001	-0.0002	0.0000	0.0151	0.0273	0.0012	0.0003	0.0004	-0.0007	-0.0041	0.4262	0.1638	0.0607	0.0000	-0.0454	0.0019	-0.0005	0.646
Panicle length (cm)	0.0114	-0.0066	-0.0002	-0.0087	0.0015	0.0236	-0.0033	-0.0002	-0.0050	-0.0098	0.0459	-0.0119	0.0817	-0.0005	-0.0686	0.0003	-0.0005	0.049
No. of sterile spikelets panicle ⁻¹	0.0393	-0.0235	-0.0002	-0.0079	-0.0008	0.0059	-0.0133	-0.0014	-0.0169	0.0103	0.1752	-0.2559	-0.0200	-0.0010	-0.0046	-0.0003	0.0003	-0.115
No. of fertile spikelets panicle ⁻¹	0.0550	-0.0322	0.0000	-0.0107	-0.0034	0.0017	-0.0057	-0.0034	0.0053	0.0130	0.2850	-0.0953	-0.0778	-0.0008	0.0428	0.0006	0.0000	0.174
Spikelet fertility percentage	-0.0083	0.0058	0.0002	0.0001	-0.0008	-0.0051	0.0098	-0.0007	0.0230	-0.0016	0.0151	0.2401	-0.0347	0.0006	0.0367	0.0000	-0.0003	0.280
1000-grain weight (g)	-0.0469	0.0287	-0.0001	0.0114	0.0031	0.0064	0.0038	0.0012	0.0010	-0.0360	-0.1346	0.3637	0.1689	0.0006	-0.1136	0.0028	-0.0010	0.260
Biological yield plant ⁻¹ (g)	0.0649	-0.0397	0.0003	-0.0105	0.0131	0.0012	-0.0026	-0.0011	0.0003	0.0054	0.8827	-0.3446	-0.0050	-0.0006	-0.0056	0.0010	0.0001	0.560
Harvest-index (%)	-0.0497	0.0309	-0.0002	0.0250	0.0053	-0.0003	0.0040	0.0003	0.0065	-0.0155	-0.3620	0.8403	-0.0640	0.0004	-0.0399	0.0021	-0.0007	0.511
Kernel length (mm)	-0.0286	0.0179	-0.0001	0.0093	0.0083	0.0097	0.0013	0.0013	-0.0040	-0.0305	-0.0224	0.2698	0.1993	0.0003	-0.1427	0.0021	-0.0013	0.290
Kernel width (mm)	-0.0588	0.0362	0.0000	0.0084	-0.0003	-0.0047	0.0050	0.0010	0.0049	-0.0083	-0.1842	0.1386	0.0211	0.0028	0.0323	-0.0015	-0.0004	-0.007
L/B ratio	-0.0106	0.0068	-0.0001	0.0065	0.0082	0.0107	-0.0004	0.0009	-0.0056	-0.0271	0.0331	0.2225	0.1886	-0.0006	-0.1508	0.0023	-0.0011	0.284
Kernel elongation ratio	0.0142	-0.0103	0.0001	0.0032	0.0042	0.0006	0.0003	-0.0001	0.0000	-0.0080	0.0734	0.1397	0.0333	-0.0003	-0.0279	0.0126	-0.0006	0.235
Alkali digestion value	-0.0074	0.0043	0.0002	0.0056	0.0043	0.0044	0.0014	0.0000	0.0024	-0.0120	-0.0285	0.2132	0.0834	0.0004	-0.0540	0.0026	-0.0031	0.218

Residual effect = 0.022

Table 5. Direct and indirect effects of different characters on grain yield per plant at genotypic level in scented rice

Characters	Days to 50% flowering	Days to maturity	Flag leaf area (cm ²)	Plant height (cm)	No. of effective tillers plant ⁻¹	Panicle length (cm)	No. of sterile spikelets panicle ⁻¹	No. of fertile spikelets panicle ⁻¹	Spikelet fertility percentage	1000-grain weight (g)	Biological yield plant ⁻¹ (g)	Harvest index (%)	Kernel length (mm)	Kernel width (mm)	L/B ratio	Kernel elongation ratio	Alkali digestion value	Grain yield plant ⁻¹ (g)
Days to 50 % flowering	0.1873	-0.1302	0.0000	-0.0126	0.0000	0.0029	-0.0113	-0.0024	0.0003	0.0234	0.4598	-0.3441	-0.0365	-0.0095	0.0093	0.0016	-0.0002	0.138
Days to maturity	0.1869	-0.1305	0.0000	-0.0123	0.0000	0.0027	-0.0109	-0.0022	0.0003	0.0232	0.4549	-0.3467	-0.0369	-0.0095	0.0098	0.0018	-0.0001	0.130
Flag leaf area (cm ²)	-0.0776	0.0542	0.0001	0.0105	0.0000	0.0068	-0.0090	0.0000	0.0012	-0.0068	-0.2599	0.1779	0.0172	-0.0012	-0.0147	-0.0019	-0.0007	-0.104
Plant height (cm)	0.0724	-0.0494	0.0000	-0.0325	-0.0017	0.0075	-0.0076	-0.0015	0.0000	0.0194	0.2428	-0.5666	-0.0391	-0.0043	0.0192	-0.0012	-0.0004	-0.343
No. of effective tillers plant ⁻¹	-0.0001	-0.0004	0.0000	0.0123	0.0045	0.0019	0.0009	0.0007	0.0002	-0.0075	0.4680	0.1864	0.0535	-0.0004	-0.0367	0.0022	0.0005	0.686
Panicle length (cm)	0.0174	-0.0113	0.0000	-0.0078	0.0002	0.0312	-0.0100	-0.0004	0.0012	-0.0204	0.0507	-0.0103	0.0782	-0.0047	-0.0597	0.0006	0.0007	0.056
No. of sterile spikelets panicle ⁻¹	0.0557	-0.0376	0.0000	-0.0065	-0.0001	0.0082	-0.0380	-0.0026	0.0040	0.0200	0.1869	-0.2832	-0.0179	-0.0086	-0.0032	-0.0003	-0.0004	-0.124
No. of fertile spikelets panicle ⁻¹	0.0763	-0.0503	0.0000	-0.0085	-0.0005	0.0025	-0.0168	-0.0058	-0.0013	0.0246	0.3094	-0.1061	-0.0677	-0.0066	0.0339	0.0008	0.0000	0.184
Spikelet fertility percentage	-0.0116	0.0092	0.0000	0.0001	-0.0001	-0.0071	0.0277	-0.0013	-0.0055	-0.0031	0.0236	0.2646	-0.0307	0.0046	0.0292	0.0000	0.0004	0.300
1000-grain weight (g)	-0.0659	0.0454	0.0000	0.0094	0.0005	0.0096	0.0114	0.0021	-0.0002	-0.0666	-0.1463	0.4087	0.0190	0.0052	-0.0910	0.0033	0.0011	0.276
Biological yield plant ⁻¹ (g)	0.0913	-0.0629	0.0000	-0.0083	0.0022	0.0016	-0.0075	-0.0019	-0.0001	0.0103	0.9428	-0.3685	-0.0040	-0.0046	-0.0047	0.0012	-0.0001	0.587
Harvest-index (%)	-0.0751	0.0527	0.0000	0.0215	0.0009	-0.0003	0.0125	0.0007	-0.0017	-0.0317	-0.4049	0.8581	0.0611	0.0042	-0.0342	0.0022	0.0009	0.467
Kernel length (mm)	-0.0396	0.0279	0.0000	0.0073	0.0013	0.0141	0.0039	0.0023	0.0009	-0.0575	-0.0221	0.3040	0.1727	0.0021	-0.1128	0.0026	0.0014	0.309
Kernel width (mm)	-0.0831	0.0575	0.0000	0.0065	0.0000	-0.0068	0.0147	0.0018	-0.0012	-0.0162	-0.2012	0.1680	0.0172	0.0216	0.0252	-0.0013	0.0005	0.003
L/B ratio	-0.0148	0.0107	0.0000	0.0052	0.0013	0.0157	-0.0010	0.0016	0.0013	-0.0511	0.0374	0.2476	0.1640	-0.0045	-0.1188	0.0028	0.0012	0.299
Kernel elongation ratio	0.0213	-0.0169	0.0000	0.0027	0.0007	0.0013	0.0008	-0.0003	0.0000	-0.0154	0.0835	0.1355	0.0317	-0.0020	-0.0232	0.0144	0.0007	0.235
Alkali digestion value	-0.0121	0.0079	0.0000	0.0048	0.0008	0.0071	0.0051	0.0001	-0.0007	-0.0248	-0.0359	0.2504	0.0783	0.0036	-0.0457	0.0033	0.0031	0.246

Residual effect = 0.015

yield plant⁻¹ showed very strong positive association at phenotypic as well as genotypic level. Kernel length, L/B ratio, fertility percentage and 1000-grain weight exhibited strong positive association at genotypic and phenotypic level. Thus, harvest-index followed by number of effective tillers plant⁻¹, biological yield plant⁻¹, kernel length, L/B ratio, fertility percentage and 1000-grain weight emerged as most important associate of grain yield in scented rice. The positive association of grain yield plant⁻¹ with the character mentioned above has also been observed by various workers (Sadhukhan and Chattopadhyay, 2000; Chaudhary and Motiramani, 2003; Khedikar *et al.*, 2004). Plant height is the only character which showed strong negative associations with grain yield plant⁻¹ at genotypic as well as phenotypic level.

The results obtained from path analysis indicated that biological yield plant⁻¹ (0.882) had the maximum direct contribution toward grain yield followed by harvest index (0.840), kernel length (0.199) and days to 50% flowering (0.135) at phenotypic level (Table 4), while highest negative direct effect on grain yield was exerted by L/B ratio (-0.150). Similarly, number of effective tillers plant⁻¹ (0.426), followed by days to 50% flowering (0.423) and days to maturity (0.417) exhibited the highest positive indirect effects on grain yield plant⁻¹ via biological yield plant⁻¹. Number of fertile spikelets panicle⁻¹ (0.285), plant height (0.225) and number of sterile spikelets panicle⁻¹ (0.175) also exerted substantial positive indirect effects on grain yield plant⁻¹ via biological yield plant⁻¹. Harvest index (-0.362), flag leaf area (-0.234), kernel width (-0.184) and 1000-grain weight (-134) made substantial negative indirect contribution on grain yield plant⁻¹ via biological yield plant⁻¹. At genotypic level, the highest positive direct effect on grain yield plant⁻¹ was recorded for biological yield plant⁻¹ (0.942), followed by harvest-index (0.858), kernel length (0.172) and days to 50% flowering (0.187) (Table 5). In contrast to the above observation, high order negative direct effects on grain yield plant⁻¹ were exerted by days to maturity (-0.130) and L/B ratio (-0.118). Number of effective tillers plant⁻¹ (0.468) exhibited highest positive indirect effect on grain yield plant⁻¹ via biological yield plant⁻¹. Days to 50% flowering (0.459), days to maturity (0.454), number of fertile spikelets panicle⁻¹ (0.309), plant height (0.242) and number of sterile spikelets panicle⁻¹

(0.186) also exerted substantial positive indirect effects on grain yield plant⁻¹ via biological yield plant⁻¹, while high order negative indirect effects on grain yield plant⁻¹ were exerted by harvest-index (-0.404), flag leaf area (-0.259), kernel width (-0.201) and 1000-grain weight (-0.146) via biological yield plant⁻¹. Biological yield plant⁻¹ followed by harvest index exerted very high positive direct effect on grain yield plant⁻¹ at genotypic as well as phenotypic level. Kernel length followed by days to 50 % flowering also exhibited considerable positive direct effect on grain yield plant⁻¹ at phenotypic as well as genotypic level. Thus, biological yield and harvest index emerged as most important direct yield contributing characters followed by kernel length and days to 50% flowering. These characters have also been identified as major direct contributors towards grain yield in scented rice by earlier workers (Chaudhary and Motiramani, 2003; Khedikar *et al.*, 2004; Nayak *et al.*, 2004; Zia-ul-Qamar *et al.*, 2005; Jaiswal *et al.*, 2007). L/B ratio was the only traits which showed considerable negative direct effect on grain yield, while direct effects of remaining traits were negligible.

The present investigation suggested harvest-index, number of effective tillers plant⁻¹, biological yield plant⁻¹, kernel length, L/B ratio, fertility percentage and 1000-grain weight as the important yield components in scented rice and may be important in formulating selection criteria for genetic improvement of grain yield in scented rice. The path analysis revealed biological yield plant⁻¹ and harvest-index as major direct contributors and number of effective tillers plant⁻¹, days to 50% flowering and days to maturity as main indirect contributors of grain yield in scented rice.

REFERENCES

- Adil J, Muhammad A, Ejaz A and Zahid MA 2007. Genotypic and phenotypic correlations among various plant traits in rice hybrids (*Oryza sativa* L.). *Sci Internat Lahore* 19: 287-290
- Chaudhary M and Motiramani NK 2003. Variability and association among yield attributes and grain quality in traditional aromatic rice accessions. *Crop Improvement* 30(1): 84-90
- Dewey DR and Lu KH 1959. A correlation and path analysis of components of crested wheat grass seed production. *Agron J* 57: 515-518

- Subbaiah PV, Sekhar MR, Reddy KHP and Reddy NPE 2011. Variability and genetic parameters for grain yield and its components and kernel quality attributes in CMS based rice hybrids (*Oryza sativa* L). International Journal of Applied Biology and Pharmaceutical Technology 2(3): 603-609
- Searle S 1961. Phenotypic, Genotypic and environmental correlations. Biometrics 17: 474-480
- Sadhukhan RN and Chhtopadhyay P 2000. Variability and character association between yield attributes and grain quality in aromatic rice. Journal of Interacademia 4(4): 494-497
- Jaiswal HK, Srivastava AK and Dey A 2007. Variability and association studies in indigenous aromatic rice (*Oryza sativa* L). Oryza 44(4): 351-353
- Khedikar VP, Bharose AA, Sharma D, Khedikar YP and Khillare AS 2004. Path coefficient analysis of yield components of scented rice. Journal of Soils and Crops 14(1): 198-201
- Nayak AR, Chaudhary D and Reddy JN 2004. Studies on variability and characters association in scented rice over environments. Indian Journal of Agricultural Research 38(4): 250-255
- Wright S 1921. Correlation and causation. J Agric Res 20: 257-287
- Zia Ul Qamar, Cheema AA, Muhammad Ashraf, Muhammad Rashid and Tahir GR (2005). Association analysis of some yield influencing traits in aromatic and non aromatic rice. Pakistan Journal of Botany 37(3): 613-627