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Correlation and Path Analyses over Environments in Greengram [*Vigna radiata* (L.) Wilczek]

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ABSTRACT

Correlation and path coefficient analyses carried out using twelve genotypes of mungbean grown under six different environments involving ten quantitative traits revealed that number of pods per plant had significant association with seed yield per plant in all the six environments at phenotypic and genotypic levels. Number of seeds per pod exhibited significant positive association with seed yield per plant in all the environments at both levels except in environment 3. Number of clusters per plant exhibited significant positive association with seed yield per plant in all environments both at phenotypic and genotypic levels except in environment 2 and 4. Seed yield per plant had a significant positive association with days to 50% flowering, plant height and number of primary branches per plant in all environments except in environment 1 at genotypic level. Path coefficient analysis showed direct positive contribution of number of pods per plant, number of seeds per pod, plant height and number of primary branches per plant in majority of environments. These traits deserve special emphasis in selection while selecting for improvement in seed yield per plant of greengram.

Key words : Correlation,Greengram, Mungbean, Path Analysis.

Seed yield per plant is a complex trait; therefore direct selection is not useful. Knowledge of the association of various quantitative characters and the direct and indirect effects of yield components on seed yield would be of immense help to the breeders for selection. Therefore, in the present study the association between yield and its component characters through correlations and the magnitude of direct and indirect effects of component characters on yield through path analysis were estimated in six environments in green gram [*Vigna radiata* (L.) Wilczek].

MATERIAL AND METHODS

The present experiment was conducted during *rabi,* 2006-07 at Agricultural Research Station (ARS) Madhira, Khammam in Andhra Pradesh in a randomised block design with twelve genotypes and three replications over six environments [three dates of sowing i.e 15-09-2006, 30-09-2006 and 15-10-2006; two fertility levels i.e 20Kg N: 50 Kg P per ha (only basal) and 20 Kg N: 50 Kg P per ha (basal) + 20 Kg N per ha (top dressing at 30 DAS) in each date of sowing]. Data were recorded from each genotype in each replication for ten quantitative traits *viz*., days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, 1000 seed weight, seed yield per plant and protein content. The means of the data were utilized for statistical analysis of correlations as per Falconer (1964) and path analysis as per Dewey and Lu (1959).

RESULTS AND DISCUSSION

The correlations among ten quantitative characters are presented environment-wise in Table 1 and Table 2. Correlation among yield and yield components indicated that seed yield per plant had a positive significant association with number of pods per plant in all the six environments both at genotypic and phenotypic levels. Hence, simultaneous selection for this trait will be more reliable for deriving high yielding genotypes of greengram irrespective of the environment. Similar results in greengram were reported by Ghosh and Panda (2006) and Vijaylaxmi and Bhattacharya (2006).

Number of seeds per pod exhibited significant positive association with seed yield per plant in all environments at genotypic and phenotypic levels except in environment 3. Similar results in greengram were reported by Venkateswarlu (2001).

Number of clusters per plant exhibited significant positive association with seed yield per plant in all environments at genotypic and phenotypic levels except in environment 2 and 4. Similar results were reported by Iranna nagaral and Kajjidoni (2005),

Table 1. Genotypic and phenotypic correlation coefficients among ten quantitative traits of greengram (*Vigna radiata* (L.) Wilczek) from environment 1 to 3 (E1 to E3)

Character	Environments		Days to maturity	Plant height	No.of primary branches plant^{-1}	No.of clusters plant^{-1}	No.of pods plant^{-1}	No. of seeds pod^{-1}	1000-seed weight	Protein content	Seed yield plant^{-1}
Days to 50% flowering	E1	G	0.709**	0.729**	0.580**	0.016	0.357*	-0.266	-0.360*	0.148	0.029
		P	0.636**	0.564**	0.413*	0.021	0.245	-0.120	-0.157	0.077	-0.020
	E2	G	0.733**	0.274	0.562**	-0.479**	0.638**	-0.182	-0.693**	0.081	0.415*
		P	0.456**	0.198	0.381*	-0.400*	0.254	-0.077	-0.412*	-0.058	0.103
	E3	G	0.481**	0.754**	0.232	0.311	0.652**	-0.069	-0.393*	-0.162	0.484**
		P	0.404*	0.581**	0.184	0.231	0.480**	0.009	-0.293	-0.121	0.301
Days to maturity	E1	G		0.239	0.267	-0.110	0.323	-0.482	-0.320	0.483**	-0.116
		P		0.130	0.170	-0.044	0.094	-0.240	-0.336*	0.305	-0.143
	E2	G		-0.122	0.357*	-0.225	0.335*	-0.420*	-0.065	0.188	-0.179
		P		0.093	0.213	-0.226	0.373*	-0.257	-0.190	0.256	0.106
	E3	G		0.142	0.543**	0.341*	0.577**	-0.276	-0.318	0.148	0.171
		P		0.069	0.373*	0.269	0.317	-0.256	-0.289	0.154	0.173
Plant height	E1	G			0.258	-0.186	0.104	0.300	0.192	-0.089	0.242
		P			0.119	-0.085	0.055	0.269	0.247	-0.059	0.354*
	E2	G			0.405*	0.053	0.785**	0.740**	0.004	-0.247	0.883**
		P			0.169	-0.028	0.373*	0.430**	0.065	-0.263	0.468**
	E3	G			0.167	0.370*	0.457**	-0.253	-0.335*	-0.228	0.636**
		P			0.209	0.271	0.465**	-0.164	-0.034	-0.185	0.207
No.of primary branches plant^{-1}	E1	G				0.678**	0.437**	0.189	-0.301	0.175	0.177
		P				0.589**	0.333*	-0.039	-0.290	0.115	0.054
	E2	G				0.412*	1.000**	0.456**	-0.577**	-0.330*	0.583**
		P				0.218	0.489**	0.330*	-0.289	-0.320	0.308
	E3	G				0.959**	0.625**	-0.068	0.599**	-0.034	0.534**
		P				0.759**	0.542**	-0.009	0.330*	-0.043	0.334*
No.of clusters plant^{-1}	E1	G					0.790**	0.590**	0.155	-0.497**	0.663**
		P					0.644**	0.212	0.058	-0.301	0.468**
	E2	G					0.466**	0.135	0.105	-0.553**	0.263
		P					0.230	0.099	0.086	-0.243	0.151
	E3	G					0.839**	0.102	-0.887**	-0.526**	0.626**
		P					0.619**	0.018	-0.629**	-0.250	0.570**
No.of pods plant^{-1}	E1	G						0.338*	0.122	-0.574**	0.768**
		P						0.008	0.096	-0.384*	0.645**
	E2	G						0.657**	-0.405*	-0.641**	0.891**
		P						0.245	-0.364*	-0.134	0.489**
	E3	G						-0.206	-0.910**	-0.452**	0.977**
		P						-0.043	-0.526**	-0.430**	0.432**
No. of seeds pod^{-1}	E1	G							0.847**	-0.406*	0.966**
		P							0.406*	-0.450**	0.362*
	E2	G							-0.073	-0.284	0.802**
		P							0.020	-0.088	0.372*
	E3	G							-0.028	-0.285	0.213
		P							-0.040	-0.101	0.094
1000-seed weight	E1	G								-0.940**	0.830**
		P								-0.458**	0.534**
	E2	G								-0.194	-0.020
		P								-0.116	-0.123
	E3	G								0.657**	-0.676**
		P								0.360*	-0.390*
Protein content	E1	G									-0.992**
		P									-0.480**
	E2	G									-0.694**
		P									0.064
	E3	G									-0.931**
		P									-0.402*

P = Phenotypic correlation coefficient G = Genotypic correlation coefficient

* Significant at 0.05 level ** Significant at 0.01 level

Table 2. Genotypic and phenotypic correlation coefficients among ten quantitative traits of greengram (*Vigna radiata* (L.) Wilczek) from environment 4 to 6 (E4 to E6)

Character	Environments		Days to maturity	Plant height	No.of primary branches plant^{-1}	No.of clusters plant^{-1}	No.of pods plant^{-1}	No. of seeds pod^{-1}	1000-seed weight	Protein content	Seed yield plant^{-1}
Days to 50% flowering	E4	G	0.726**	0.664**	0.256	0.297	0.447**	0.364*	-0.705**	-0.223	0.488**
		P	0.604**	0.486**	0.238	0.188	0.265	0.225	-0.462**	-0.134	0.441**
	E5	G	0.712**	0.433**	0.497**	0.424**	0.412*	0.366*	0.640**	-0.752**	0.517**
		P	0.641**	0.253	0.407*	0.275	0.264	0.246	0.503**	-0.303	0.340*
	E6	G	0.780**	0.492**	0.276	0.459**	0.652**	0.649**	-0.284	-0.643**	0.398*
		P	0.568**	0.251	0.267	0.251	0.524**	0.362*	-0.134	-0.411*	0.239
Days to maturity	E4	G		-0.003	0.542**	0.443**	0.051	0.161	-0.537**	0.066	0.096
		P		0.022	0.399*	0.309	0.005	0.123	-0.403*	-0.026	-0.026
	E5	G		0.250	0.541**	0.605**	0.522**	0.079	0.355*	-0.226	0.530**
		P		0.286	0.387*	0.453**	0.359*	0.211	0.262	-0.106	0.293
	E6	G		0.140	0.415*	0.740**	0.639**	0.143	-0.1301	-0.334*	0.310
		P		0.110	0.349*	0.367*	0.458**	0.103	0.046	-0.141	0.249
Plant height	E4	G			0.126	0.164	0.694**	0.120	-0.680**	-0.022	0.460**
		P			0.142	0.240	0.552**	0.047	-0.159	-0.103	0.328
	E5	G			0.564**	0.317	0.625**	0.633**	0.819**	-0.415*	0.818**
		P			0.251	0.249	0.460**	0.357*	0.348*	-0.091	0.360*
	E6	G			0.383*	0.530**	0.581**	0.594**	-0.170	-0.556**	0.908**
		P			0.205	0.249	0.290	0.447**	-0.201	-0.266	0.503**
No.of primary branches plant^{-1}	E4	G				0.971**	0.718**	0.033	-0.174	-0.348*	0.346*
		P				0.770**	0.459**	-0.066	-0.047	-0.224	0.257
	E5	G				1.020**	0.935**	0.425**	0.821**	-0.858**	0.991**
		P				0.711**	0.573**	0.299	0.539**	-0.514**	0.698**
	E6	G				0.957**	0.640**	0.432**	-0.546**	-0.329*	0.360**
		P				0.787**	0.634**	0.233	-0.335*	-0.190	0.275
No.of clusters plant^{-1}	E4	G					0.793**	0.144	-0.137	-0.333*	0.490**
		P					0.480**	0.063	-0.097	-0.248	0.310
	E5	G					0.951**	0.312	0.612**	-0.697**	0.895**
		P					0.758**	0.107	0.293	-0.403*	0.671**
	E6	G					0.764**	0.451**	-0.289	-0.494**	0.645**
		P					0.711**	0.076	-0.250	-0.321	0.459**
No.of pods plant^{-1}	E4	G						0.478**	-0.404*	-0.315	0.740**
		P						0.255	-0.231	-0.348*	0.440**
	E5	G						0.734**	0.643**	-0.783**	0.957**
		P						0.347*	0.292	-0.545**	0.829**
	E6	G						0.995**	-0.206	-1.055**	0.774**
		P						0.497**	-0.098	-0.539**	0.661**
No. of seeds pod^{-1}	E4	G							-0.837**	-0.195	0.690**
		P							-0.462**	-0.158	0.416*
	E5	G							0.488**	-0.723**	0.875**
		P							0.183	-0.379*	0.503**
	E6	G							-0.113	-1.009**	0.784**
		P							-0.118	-0.549**	0.329*
1000-seed weight	E4	G								0.370*	-0.617**
		P								0.239	-0.248
	E5	G								-0.804**	0.840**
		P								-0.314	0.356*
	E6	G								-0.069	0.221
		P								0.116	-0.068
Protein content	E4	G									-0.780**
		P									-0.468**
	E5	G									-0.840**
		P									-0.539**
	E6	G									-0.901**
		P									-0.387*

P = Phenotypic correlation coefficient G = Genotypic correlation coefficient

* Significant at 0.05 level ** Significant at 0.01 level

Table 3. Direct & Indirect effects of component traits on seed yield per plant of greengram [*Vigna radiata* (L.) Wilczek] phenotypic level (from environment 1 to 6 (E1 to E6)).

Character	Environ-ments	Days to 50% flowering	Days to maturity	Plant height	No.of primary branches plant^{-1}	No.of clusters plant^{-1}	No.of pods plant^{-1}	No. of seeds pod^{-1}	1000-seed weight	Protein content	Seeds yeild plant^{-1} (rp)
	E1	**-0.5701**	0.1350	0.2988	0.0139	0.0014	0.1551	-0.0050	-0.0450	-0.0046	-0.021
	E2	**-0.0213**	-0.0202	0.0667	0.0418	-0.0286	0.0759	-0.0083	0.0053	-0.0078	0.103
Days to	E3	**0.2357**	0.0372	-0.0737	-0.0427	0.1765	-0.0075	0.005	-0.0615	0.0365	0.301
50%	E4	**0.6722**	-0.3529	-0.0316	0.0457	0.0310	-0.0115	0.0749	-0.0255	0.0392	0.441**
flowering	E5	**0.1599**	-0.1274	-0.0239	0.1307	0.0098	0.1771	0.0624	**-0.0147**	**-0.0341**	0.340*
	E6	**-0.2488**	0.0298	0.1072	-0.0832	-0.0096	0.4932	-0.0712	0.0079	0.0138	0.239
	E1	-0.3625	**0.2123**	0.0688	0.0057	-0.0028	0.0594	-0.0099	-0.0966	-0.0180	-0.144
	E2	-0.0097	**-0.0444**	0.0313	0.0234	-0.0163	0.1126	-0.0279	0.0024	0.0347	0.106
Days to	E3	0.0953	**0.0920**	-0.0088	-0.0863	0.2052	-0.0050	-0.0142	-0.0597	-0.0463	0.173
maturity	E4	0.4059	**-0.5844**	-0.0015	0.0766	0.0508	0.0000	0.0410	-0.0222	0.0077	-0.026
	E5	0.1025	**-0.1988**	-0.0270	0.1242	0.0162	0.2414	0.0536	-0.0076	-0.0119	0.293
	E6	-0.1412	**0.0524**	0.0470	-0.1087	-0.0140	0.4313	-0.0202	-0.0027	0.0047	0.249
	E1	-0.3218	0.0276	**0.5294**	0.0040	-0.0055	0.0347	0.0111	0.0711	0.0035	0.354*
Plant	E2	-0.0042	-0.0041	**0.3376**	0.0185	-0.0020	0.1126	0.0467	-0.0008	0.0358	0.468**
height	E3	0.1370	0.0064	**-0.1269**	-0.0483	0.2065	-0.0073	-0.0090	-0.0070	0.0556	0.207
	E4	03625	-0.132	**-0.0651**	0.0273	0.0395	-0.0238	0.0155	-0.0088	0.0300	0.328
	E5	0.0404	-0.0568	**-0.0945**	0.0805	0.0114	0.3089	0.0907	-0.0102	-0.0102	0.360*
	E6	-0.0625	0.0058	**0.4265**	-0.0638	-0.0095	0.2734	-0.0878	0.0119	0.0089	0.503**
No.of	E1	-0.2532	0.0360	0.0632	**0.0338**	0.0380	0.2105	-0.0016	-0.0835	-0.0068	0.055
primary	E2	-0.0081	-0.0095	0.0569	**0.1095**	0.0157	0.1478	0.0358	0.0037	-0.0435	0.308
branches	E3	0.0434	0.0343	-0.0265	**-0.2315**	0.5788	-0.0085	-0.0005	-0.0683	0.0128	0.334
plant^{-1}	E4	0.1599	-0.2334	-0.0093	**0.1919**	0.1267	-0.0198	-0.0221	-0.0026	0.0652	0.257
	E5	0.0652	-0.0770	-0.0237	**0.3206**	0.0225	0.3851	0.0761	-0.0157	-0.0580	0.698**
	E6	-0.0665	0.0183	0.0873	**-0.3115**	-0.0301	0.5972	-0.0458	0.0198	0.0064	0.275
	E1	-0.0126	-0.0093	-0.0450	0.0199	**0.0646**	0.4701	0.0087	0.0166	0.0178	0.468**
No.of	E2	0.0085	0.0100	-0.0093	0.0239	**0.0721**	0.0696	0.0108	-0.0011	-0.0330	0.151
clusters	E3	0.0546	0.0248	-0.0344	-0.1758	**0.7621**	-0.0097	0.0010	-0.1301	0.0774	0.570**
plant^{-1}	E4	0.1266	-0.1805	-0.0156	0.1478	**0.1646**	-0.0207	0.0210	-0.0054	0.0723	0.311
	E5	0.0439	-0.0900	-0.0300	0.2280	**0.0358**	0.5097	0.0272	-0.0085	-0.0454	0.671**
	E6	-0.0624	0.0192	0.1061	-0.2457	**-0.0381**	0.6992	-0.0148	0.0148	0.0107	0.459**
	E1	-0.1399	0.0199	0.0291	0.0112	0.0416	**0.6321**	0.0003	0.0275	0.0226	0.645**
No.of	E2	-0.0054	-0.0166	0.1259	0.0536	0.0166	**0.3020**	0.0266	0.0047	-0.0182	0.489**
pods	E3	0.1133	0.0292	-0.0590	-0.1254	0.4718	**-0.0157**	-0.0024	-0.1087	0.1294	0.432**
plant^{-1}	E4	0.1784	-0.0003	-0.0359	0.0882	0.0790	**-0.0432**	0.0846	-0.0128	0.1014	0.440**
	E5	0.0421	-0.0714	-0.0434	0.1837	0.0272	**0.6722**	0.0882	-0.0085	-0.0614	0.829**
	E6	-0.1303	0.0240	0.1238	-0.1976	-0.0271	**0.9417**	-0.0975	0.0058	0.0181	0.661**
	E1	0.0687	-0.0511	0.1425	-0.0013	0.0137	0.0049	**0.0411**	0.1168	0.0265	0.362*
	E2	0.0016	0.0114	0.1452	0.0361	0.0071	0.0741	**0.1086**	-0.0003	-0.0120	0.372*
No. of	E3	0.0023	-0.0236	0.0208	0.0022	0.0142	0.0007	**0.0552**	-0.0083	0.0306	0.094
seeds	E4	0.1516	-0.0721	-0.0030	-0.0127	0.0140	-0.0110	**0.3323**	-0.0255	0.0461	0.416*
pod^{-1}	E5	0.0393	-0.0419	-0.0337	0.0960	0.0038	0.2334	**0.2541**	-0.0053	-0.0427	0.503**
	E6	-0.0902	0.0054	0.1905	-0.0726	-0.0029	0.4676	**-0.1965**	0.0070	0.0184	0.329*
	E1	0.0893	-0.0714	0.1310	-0.0098	0.0037	0.0604	0.0167	**0.2874**	0.0270	0.534**
	E2	0.0088	0.0084	0.0219	-0.0317	0.0062	-0.1100	0.0022	**-0.0129**	-0.0158	-0.123
	E3	-0.0701	-0.0236	0.0043	0.0764	-0.4795	0.0082	-0.0022	**0.2068**	-0.1083	-0.391*
1000-	E4	-0.3108	0.2354	0.0104	-0.0091	-0.0160	0.0100	-0.1535	**0.0552**	-0.0697	-0.248
seed	E5	0.0805	-0.0521	-0.0329	0.1727	0.0105	0.1960	0.0464	**-0.0292**	-0.0354	0.356*
weight	E6	0.0033	0.0024	-0.0858	0.1043	0.0095	-0.0919	0.233	**-0.0590**	-0.0039	-0.068
	E1	-0.0442	0.0647	-0.0313	0.0039	-0.0194	-0.2426	-0.0185	-0.1315	**-0.0590**	-0.478**
	E2	0.0012	-0.0113	-0.0889	-0.0350	-0.0175	-0.0404	-0.0096	0.0015	**0.1359**	0.064
	E3	-0.0286	0.0142	0.0235	0.099	-0.1960	0.0067	-0.0056	0.0745	**-0.3008**	-0.402*
Protein	E4	-0.0903	0.0154	0.0067	-0.0429	-0.0408	0.0150	-0.0525	0.0132	**-0.2919**	-0.468**
content	E5	-0.0484	0.0210	0.0086	-0.1649	-0.0144	-0.3664	-0.0964	0.0092	**0.1127**	-0.539**
	E6	0.1023	-0.0074	-0.1132	0.0591	0.0122	-0.5076	0.1078	-0.0068	**-0.0335**	-0.387*

Residual effect of E1 = 0.4419; E2 = 0.7093; E3 = 0.7374; E4 =0.6057; E5 = 0.4199; E6 = 0.6001

(rp) = Phenotypic correlation coefficients
Bold figures indicate direct effects.

* Significant at 0.05 level
** Significant at 0.01 level

Anbumalarmathi *et al.* (2005) and Mallikarjuna Rao *et al.* (2006). Seed yield per plant had a significant positive association with days to 50% flowering, plant height and number of primary branches per plant in all six environments except in environments 1 at genotypic level in accordance with Venkateswarlu (2001) and Anbumalarmathi *et al.* (2005).

Number of pods per plant recorded highly significant positive correlation with number of primary branches per plant in all the six environments and with number of clusters per plant in all the six environments at genotypic and phenotypic levels except in environment 2 (where it showed significance at genotypic level only). This type of association is highly desirable because of significant association between number of pods per plant and seed yield per plant. The results suggested that selection of any of the above characters in combination with more number of pods per plant would bring about improvement in seed yield per plant irrespective of environment. However, protein content showed negative association with yield in all environments at genotypic and phenotypic levels except in environment 2 (where it showed significant negative association at genotypic level only). Hence, there should be a balance between protein and yield during the selection programme.

Based on path coefficient analysis, number of pods per plant showed high direct effect in all the environments except environment 3 and 4. Eswari and Rao (2006) reported that number of pods per plant had high positive effect on seed yield per plant. Days to 50% flowering, plant height, number of primary branches per plant and number of seeds per pod had positive direct effect in majority of environments. From the above presentation it can be conclude that the yield improvement could be achieved through component character like number of pods per plant, number of seeds per pod, number of primary branches per plant, plant height and days to 50% flowering in many environments, which exhibited positive direct effect on seed yield per plant in majority of environments. (Table 3)

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