



Correlation and Path Analyses over Environments in Soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

Twelve soybean genotypes were evaluated in three different environment (3 sowing dates). Correlation and path coefficient analyses revealed that number of pods per plant, biological yield per plant and harvest index were positively correlated with seed yield per plant in all three environments at both levels. Days to maturity showed significant positive association with seed yield per plant in all the three environments at genotypic level only. Path coefficient analysis showed direct positive contribution of number of pods per plant, biological yield per plant and harvest index in all the three environments. These traits deserve special emphasis in selection for improvement of seed yield in soybean.

Key words : Correlation, Path Analysis, Soybean.

Seed yield per plant is a complex trait, therefore, direct selection is not useful. A knowledge on the association of various quantitative characters and the direct and indirect effects of yield components on grain yield would be of immense help to the breeders for selection (Singh and Chaudhary, 1977). Therefore, in the present study the association between yield and its component characters through correlation and the magnitude of direct and indirect effects of component characters on yield through path analysis were estimated in three environments.

MATERIAL AND METHODS

Twelve genotypes of soybean were grown on three sowing dates *i.e.*, 30-07-2006, 17-11-2006 and 2-12-2006 during *kharif*, *rabi* and late *rabi*, at Regional Agricultural Research Station, Lam, Guntur in Andhra Pradesh. The experimental material was grown in a randomized block design with three replications, four rows of 4 m length per replication with inter - and intra - row spacing of 30 × 7.5 cm, respectively. Data were recorded on ten randomly selected plants from each genotype in each replication for plant height (cm), number of branches per plant, pod length (cm), number of seeds per pod, biological yield per plant (g) and seed yield per plant. Days to 50% flowering, days to maturity, 100 seed weight (g), protein content (%), oil content (%) and harvest index (%) were recorded on plot basis. The means of the data were utilized for statistical analysis to estimate correlation (Falconer, 1964) and path analysis (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

The correlation among thirteen quantitative characters are presented environment - wise in Table 1 to 3. Character association among yield and yield components indicated that seed yield per plant had a positive significant association with number of pods per plant in all three environments both at genotypic as well as at phenotypic levels. Hence, simultaneous selection for this trait will be more reliable for deriving high yielding genotypes of soybean. This was also observed by Praveen Kumar *et al.* (2005), Turke (2005), Hina Kausar (2006) and Sriranjani *et al.* (2007).

Biological yield per plant exhibited significant positive association with seed yield per plant in all environments both at genotypic and phenotypic levels. Similar results were earlier reported by Ramana (2003), Kushal Chandel *et al.* (2005) and Sriranjani *et al.* (2007). Seed yield per plant had a significant positive association with days to maturity in all three environments only at genotypic level, as also reported by Ramana (2003), Mukhekar *et al.* (2004) and Praveen Kumar *et al.* (2005).

Harvest index exhibited significant positive association with seed yield per plant in all environments at both levels. Similar results were earlier reported by Mishra and Rao (2005) and Sriranjani *et al.* (2007). Seed yield per plant had a significant positive association with oil content in environments I and III at both levels and days to 50% flowering showed positive association with seed yield per plant in environment I and III, as also reported by Bangar *et al.* (2003), Ramana (2003) and Mukhekar *et al.* (2004).

Table 1. Phenotypic and genotypic correlation coefficients among 13 quantitative traits of soybean [*Glycine max* (L.) Merrill] in environment I

Character	Days to maturity	Plant height	No. of branches per plant	Pods per plant	Pod length	Seeds per pod	100 seed weight	Protein content	Oil content	Biological yield/plant	Harvest index (%)	Seed yield/plant
Days to 50% flowering	0.88** (0.84)**	-0.12 (-0.11)	0.00 (0.03)	0.62** (0.42)	-0.61** (-0.44)**	-0.27 (-0.23)	0.13 (0.14)	-0.38* (-0.07)	0.60** (0.33)*	0.46** (0.37)	0.44** (0.26)	0.51** (0.39)*
Days to maturity		0.18 (0.16)	0.38* (0.31)	0.62** (0.41)*	-0.55** (-0.37)*	0.02 (0.01)	-0.10 (-0.09)	-0.09 (-0.00)	0.42** (0.28)	0.48** (0.42)**	0.15 (0.09)	0.39* (0.32)
Plant height			0.84** (0.51)**	-0.04 (0.01)	-0.06 (0.01)	0.31 (0.19)	-0.84** (-0.60)**	0.79** (0.12)	0.00 (-0.11)	0.01 (0.06)	-0.57** (-0.37)*	-0.27 (-0.19)
No. of branches / plant				0.10 (0.03)	0.20 (-0.00)	0.68** (0.48)**	-0.70** (-0.44)**	0.37* (0.28)	-0.21 (-0.06)	0.14 (0.18)	-0.29 (-0.22)	-0.05 (-0.00)
Pods per plant					-0.33** (-0.10)	-0.05 (-0.03)	0.01 (0.06)	0.27 (0.02)	0.92** (0.64)**	0.97** (0.74)**	0.70** (0.72)**	0.98** (0.89)**
Pod length (cm)						0.87** (0.65)**	0.27 (0.07)	0.61** (-0.12)	-0.38 (-0.06)	-0.32 (-0.11)	-0.05 (-0.06)	-0.22 (-0.10)
Seeds per pod							-0.19 (-0.26)	0.92** (-0.09)	-0.35 (-0.02)	-0.11 (0.04)	-0.19 (-0.14)	-0.15 (-0.04)
100 seed weight								-0.91** (-0.08)	0.23 (-0.04)	0.20 (0.10)	0.51** (0.05)	0.10 (-0.07)
Protein content									0.75** (-0.09)	0.14 (-0.18)	0.51** (0.05)	0.10 (-0.07)
Oil content										0.94** (0.67)**	0.96 (0.50)**	0.97** (0.71)**
Biological yield/plant											0.49* (0.37)*	0.90** (0.85)**
Harvest index												0.80** (0.79)**

Figures in parentheses indicate phenotypic correlation coefficients

* Significant at 0.05 level

** Significant at 0.01 level

Table 2 . Phenotypic and genotypic correlation coefficients among 13 quantitative traits of soybean [*Glycine max* (L.) Merrill] in environment II

Character	Days to maturity	Plant height	No. of branches per plant	Pods per plant	Pod length	Seeds per pod	100 seed weight	Protein content	Oil content	Biological yield/plant	Harvest index	Seed yield / plant
Days to 50% flowering	0.80** (0.57)**	-0.23 (-0.12)	0.32 (0.27)	0.30 (0.21)	-0.39* (-0.06)	-0.49** (-0.20)	-0.36* (-0.36)*	-0.76** (-0.25)	0.63** (0.40)*	0.02 (0.08)	0.46* (0.04)	0.17 (0.10)
Days to maturity	0.23 (0.14)	0.52** (0.37)*	0.69** (0.55)**	0.16 (0.15)	-0.18 (-0.12)	-0.13 (-0.02)	-0.17 (-0.09)	-0.08 (-0.09)	0.68** (0.57)**	0.50** (0.46)**	0.28 (0.20)	0.51** (0.45)*
Plant height		0.43** (0.23)	0.43** (0.23)	0.06 (0.01)	0.06 (-0.02)	0.06 (0.01)	-0.36 (-0.29)	0.32 (0.03)	-0.16 (-0.17)	0.23 (0.10)	0.35* (0.08)	0.31 (0.12)
No. of branches / plant		0.61** (0.26)	0.61** (0.26)	0.47** (0.31)	0.59** (0.37)*	0.47** (0.31)	-0.25 (-0.09)	0.81** (0.07)	0.55** (0.21)	0.56** (0.29)	0.00 (-0.12)	0.45** (0.17)
Pods per plant		0.40** (0.20)	0.40** (0.20)	0.38** (0.36)*	0.40** (0.20)	0.38** (0.36)*	-0.45* (-0.24)	0.68** (0.32)	0.09 (0.19)	0.96** (0.87)**	0.69** (0.56)**	0.96** (0.91)**
Pod length				0.98** (0.80)**		0.98** (0.80)**	-0.22 (-0.03)	0.72** (0.48)**	-0.04 (-0.16)	0.47** (0.32)	-0.24 (-0.03)	0.31 (0.22)
Seeds per pod				0.00 (0.03)		0.00 (0.03)	0.00 (0.03)	0.89** (0.46)**	-0.04 (-0.06)	0.60** (0.51)**	-0.42** (-0.03)	0.34* (0.36)*
100 seed weight								0.02 (-0.06)	0.29 (0.21)	-0.11 (-0.09)	-0.84*** (-0.25)	-0.38** (-0.20)
Protein content									-0.18 (-0.05)	0.83** (0.47)**	0.45** (0.08)	0.82** (0.39)**
Oil content										0.14 (0.20)	-0.36* (-0.05)	0.00 (0.13)
Biological yield/ plant											0.48** (0.37)*	0.95*** (0.90)**
Harvest index												0.71** (0.72)**

Figures in parentheses indicate phenotypic correlation coefficients
level

* Significant at 0.05 level

** Significant at 0.01 level

Table 3 . Phenotypic and genotypic correlation coefficients among 13 quantitative traits of soybean [*Glycine max* (L.) Merrill] in environment III

Character	Days to maturity	Plant height	No. of branches per plant	Pods per plant	Pod length	Seeds per pod	100 seed weight	Protein content	Oil content	Biological yield/plant	Harvest index	Seed yield / plant
Days to 50% flowering	0.90** (0.75)**	0.13 (0.07)	0.46** (0.08)	0.30 (0.17)	-0.30 (-0.15)	-0.13 (0.03)	0.13 (0.13)	0.08 (-0.02)	0.49* (0.33)*	0.48** (0.35)*	0.09 (0.06)	0.42** (0.25)
Days to maturity		0.08 (0.10)	0.26 (0.09)	0.00 (-0.04)	-0.61 (-0.45)**	-0.22 (-0.16)	0.18 (0.16)	-0.24 (-0.07)	0.67** (0.57)**	0.33* (0.30)	0.17 (0.11)	0.34* (0.21)
Plant height			0.72** (0.07)	-0.12 (-0.08)	-0.15 (-0.09)	0.00 (0.10)	-0.53 (-0.33)*	-0.43** (-0.18)	-0.60** (-0.48)**	-0.17 (-0.16)	-0.39* (-0.18)	-0.36* (-0.22)
No. of branches / plant				0.04 (-0.03)	0.34 (0.19)	0.45** (0.11)	0.48** (0.20)	-0.82** (-0.06)	-0.21 (-0.09)	0.98 (0.38)*	-0.74** (-0.32)	0.22 (0.05)
Pods per plant					0.10 (0.05)	0.03 (-0.06)	0.00 (-0.05)	0.29 (0.08)	0.37* (0.14)	0.48** (0.44)**	0.68** (0.68)**	0.85** (0.82)**
Pod length						0.56** (0.59)**	-0.20 (0.02)	0.80** (0.23)	-0.46* (-0.19)	0.23 (0.28)	-0.43* (-0.30)	-0.09 (0.05)
Seeds per pod							-0.42 (-0.04)	0.96** (0.14)	-0.47* (-0.18)	0.46* (0.32)	-0.44** (-0.36)*	0.01 (-0.01)
100 seed weight								-0.08 (-0.14)	0.38* (0.36)*	0.43* (0.40)*	0.03 (-0.03)	0.30 (0.22)
Protein content									0.12 (0.04)	0.25 (0.03)	0.07 (0.09)	0.29 (0.51)
Oil content										0.38* (0.35)*	0.75** (0.42)**	0.79** (0.46)**
Biological yield/ plant											-0.01 (0.10)	0.71** (0.70)**
Harvest index												0.69** (0.75)**

Figures in parentheses indicate phenotypic correlation coefficients

* Significant at 0.05 level

** Significant at 0.01 level

Table 4 . Direct and indirect effects of yield component traits on seed yield of soybean [*Glycine max* (L.) Merrill] in environment I

Character	Days to 50% flowering	Days to maturity	Plant height	No.of branches per plant	No.of pods per plant	Pod length	No.of Seeds per pod	100 seed weight	Protein content	Oil content	Biological yield/plant	Harvest index	Correlation with Seed yield /plant
Days to 50% flowering	0.0262	-0.0416	0.0083	0.0000	0.0456	0.0097	-0.0084	-0.0037	-0.0020	-0.0057	0.2375	0.1244	0.3902*
Days to maturity	0.0221	-0.0493	-0.0116	-0.0005	0.0442	0.0080	0.0007	0.0025	0.0002	-0.0048	0.2670	0.0444	0.3230
Plant height	-0.0031	-0.0082	-0.0702	-0.0008	0.0020	-0.0002	0.0072	0.0154	0.0032	0.0019	0.0390	-0.1772	-0.1910
No. of branches / plant	0.0008	-0.0155	-0.0358	-0.0016	0.0036	0.0002	0.0176	0.0115	0.0072	-0.0010	0.1128	-0.1044	-0.0046
No.of Pods per plant	0.0112	-0.0204	-0.0013	-0.0001	0.1068	0.0022	-0.0014	-0.0017	0.0005	-0.0109	0.4640	0.3422	0.8912**
Pod length	-0.0117	0.0183	-0.0007	0.0000	-0.0108	-0.0216	0.0242	-0.0020	-0.0030	0.0011	-0.0696	-0.0306	-0.1065
No.of Seeds per pod	-0.0060	-0.0010	-0.0138	-0.0008	-0.0042	-0.0143	0.0367	0.0068	-0.0023	0.0004	0.0280	-0.0697	-0.0403
100 seed weight	0.0038	0.0048	0.0424	0.0007	0.0069	-0.0017	-0.0097	-0.0256	-0.0021	0.0008	0.0684	0.0813	0.1701
Protein content	-0.0020	-0.0003	-0.0087	-0.0005	0.0023	0.0026	-0.0034	0.0021	0.0254	0.0016	-0.1173	0.0261	-0.0723
Oil content	0.0088	-0.0139	0.0079	-0.0001	0.0692	0.0015	-0.0008	0.0013	-0.0024	-0.0169	0.4234	0.2394	0.7172**
Biological yield/ plant	0.0099	-0.0210	-0.0044	-0.0003	0.0793	0.0024	0.0016	-0.0028	-0.0048	-0.0114	0.6255	0.1781	0.8521**
Harvest index	0.0069	-0.0046	0.0263	0.0004	0.0771	0.0014	-0.0054	-0.0044	0.0014	-0.0085	0.2350	0.4741	0.7996**

r_p = Phenotypic correlation coefficients

Residual effect = 0.0495

bold figures indicate direct effects

* Significant at 0.05 level

** Significant at 0.01 level

Table 5 . Direct and indirect effects of yield component traits on seed yield of soybean [*Glycine max* (L.) Merrill] in environment II

Character	Days to 50% flowering	Days to maturity	Plant height	No.of branches per plant	No.of pods per plant	Pod length	No. of Seeds per pod	100 seed weight	Protein content	Oil content	Biological yield/plant	Harvest index	Correlation with Seed yield /plant
Days to 50% flowering	0.0181	-0.0048	0.0002	0.0044	0.0169	0.0014	-0.0037	0.0020	-0.0060	0.0014	0.0534	0.0176	0.1010
Days to maturity	0.0104	-0.0084	-0.0002	0.0061	0.0446	0.0027	-0.0005	0.0005	-0.0023	0.0020	0.3068	0.0900	0.4517**
Plant height	-0.0022	-0.0012	-0.0016	0.0025	0.0191	0.0005	0.0002	0.0016	0.0009	-0.0006	0.0697	0.0354	0.1243
No. of branches / plant	0.0049	-0.0031	-0.0002	0.0162	0.0213	-0.0083	0.0056	0.0005	0.0018	0.0008	0.1934	-0.0558	0.1771
No. of Pods per plant	0.0038	-0.0047	-0.0004	0.0043	0.0799	-0.0046	0.0063	0.0013	0.0077	0.0007	0.5723	0.2441	0.9108**
Pod length	-0.0012	0.0010	0.0000	0.0061	0.0167	-0.0220	0.0142	0.0002	0.0115	-0.0006	0.2152	-0.0149	0.2262
No. of Seeds per pod	-0.0038	0.0002	0.0000	0.0052	0.0289	-0.0178	0.0175	-0.0002	0.0110	-0.0002	0.3376	-0.0149	0.3647**
100 seed weight	-0.0067	0.0008	0.0005	-0.0016	-0.0193	0.0008	0.0007	-0.0054	-0.0016	0.0008	-0.0647	-0.1111	-0.2068
Protein content	-0.0046	0.0008	-0.0001	0.0012	0.0259	-0.0107	0.0081	0.0004	0.0237	-0.0002	0.3128	0.0386	0.3960**
Oil content	0.0073	-0.0048	0.0003	0.0035	0.0154	0.0036	-0.0011	-0.0011	-0.0013	0.0036	0.1368	-0.0249	0.1371
Biological yield/ plant	0.0015	-0.0039	-0.0002	0.0048	0.0697	-0.0072	0.0090	0.0005	0.0113	0.0007	0.6559	0.1647	0.9067**
Harvest index	0.0007	-0.0017	-0.0001	-0.0021	0.0449	0.0008	-0.0005	0.0014	0.0021	-0.0002	0.2489	0.4340	0.7281**

r_p = Phenotypic correlation coefficients

Residual effect = 0.0592

bold figures indicate direct effects

* Significant at 0.05 level

** Significant at 0.01 level

Table 6. Direct and indirect effects of yield component traits on seed yield of soybean [*Glycine max* (L.) Merrill] in environment III

Character	Days to 50% flowering	Days to maturity	Plant height	No. of branches per plant	No. of pods per plant	Pod length	No. of seeds per pod	100 seed weight	Protein content	Oil content	Biological yield/plant	Harvest index	Correlation with seed yield/plant
Days to 50% flowering	-0.0880	0.1460	-0.0034	0.0025	0.0386	-0.0248	0.0009	0.0062	0.0018	-0.0257	0.1604	0.0385	0.2530
Days to maturity	-0.0661	0.1943	-0.0050	0.0029	-0.0091	-0.0716	-0.0038	0.0075	0.0050	-0.0437	0.1372	0.0702	0.2178
Plant height	-0.0065	0.0211	-0.0458	0.0023	-0.0192	-0.0155	0.0026	-0.0153	0.0125	0.0365	-0.0761	-0.1212	-0.2246
No. of branches / plant	-0.0071	0.0180	-0.0035	0.0310	-0.0081	0.0311	0.0027	0.0094	0.0047	0.0071	0.1752	-0.2095	0.0511
No. of Pods per plant	-0.0156	-0.0081	0.0040	-0.0011	0.2183	0.0088	-0.0016	-0.0024	-0.0060	-0.0113	0.2021	0.4404	0.8276**
Pod length	0.0140	-0.0894	0.0046	0.0062	0.0124	0.1558	0.0139	0.0010	-0.0161	0.0148	0.1289	-0.1943	0.0517
No. of Seeds per pod	-0.0033	-0.0314	-0.0050	0.0035	-0.0146	0.0921	0.0236	-0.0021	-0.0098	0.0141	0.1473	-0.2298	-0.0155
100 seed weight	-0.0119	0.0319	0.0153	0.0063	-0.0114	0.0033	-0.0011	0.0459	0.0098	-0.0276	0.1853	-0.0251	0.2206
Protein content	0.0022	-0.0138	0.0083	-0.0021	0.0188	0.0360	0.0033	-0.0064	-0.0696	-0.0035	0.0162	0.0617	0.0510
Oil content	-0.0298	0.1123	0.0221	-0.0029	0.0327	-0.0305	-0.0044	0.0167	-0.0032	-0.0756	0.1590	0.2710	0.4673**
Biological yield/plant	-0.0312	0.0589	0.0077	0.0120	0.0975	0.0444	0.0077	0.0188	-0.0025	-0.0266	0.4527	0.0651	0.7044**
Harvest index	-0.0053	0.0214	0.0087	-0.0102	0.1506	-0.0474	-0.0085	-0.0018	-0.0067	-0.0321	0.0461	0.6384	0.7531**

r_p = Phenotypic correlation coefficients

Residual effect = 0.0941

bold figures indicate direct effects

* Significant at 0.05 level

** Significant at 0.01 level

Number of pods per plant recorded high significant positive correlation with biological yield per plant and harvest index in all the three environments at both levels. This type of association is highly desirable because of significant association between number of pods per plant and seed yield per plant, biological yield per plant and seed yield per plant, harvest index and seed yield per plant and among themselves will ease the selection process of genotypes for higher yield. 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.

Based on path coefficient analysis number of pods per plant showed high direct effect on seed yield per plant in all the environments (Table 4 to 6). Mishra and Rao (2005) and Sriranjani *et al.* (2007) also reported that number of pods per plant had positive effect on seed yield per plant. Biological yield per plant and harvest index had positive direct effect on seed yield per plant in three environments.

It is concluded that the yield improvement could be achieved through component characters like number of pods per plant, biological yield per plant and harvest index in three environments, which exhibited positive direct effect on seed yield per plant in all environments.

LITERATURE CITED

- Bangar N D, Mukhekar G D, Lad D B and Mukhekar D G 2003.** Genetic variability, correlation and regression studies in Soybean, Journal of Maharashtra Agricultural Universities 28:320-321.
- Dewey D R and Lu K H 1959.** A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal 47:477-483.
- Falconer D S 1964.** Introduction to Quantitative Genetics. Oliver and Boyd, Edinberg. pp 365.
- Hina Kausar 2006.** Genetic investigations in segregating populations of soybean [*Glycine max* (L.) Merrill]. Karnataka Journal of Agricultural Sciences 19 (1): 200.
- Kushal Chandel Sood O P, Sood V K and Gartan S 2005.** Character associations and path analysis studies in cultivated soybean [*Glycine max* (L.)Merrill]. Genotypes restricted through introgression of *G. soja* Chromatin. Journal of Maharashtra Agricultural Universities 29 (3):256-258.
- Mishra V and Rao S S 2005.** Genetic variability and correlation studies for yield and its attributes in soybean [*Glycine max* (L.) Merrill]. Journal of Agricultural Issue 9 (1 &2): 75-81.
- Mukhekar G D, Bangar N D and Lad D B 2004.** Character association and path coefficient analysis in soybean [*Glycine max* (L.) Merrill]. Journal of Maharashtra Agricultural Universities 29 (3):256-258.
- Praveenkumar A, Ramana M V, Razia Sultana and Srinivasa Rao V 2005.** Character association and path Analysis in soybean [*Glycine max* (L.) Merrill] during non-conventional *rabi* season. Andhra Agricultural Journal 52: 48-51.
- Ramana M V 2003.** Genetic studies on soybean [*Glycine max* (L.) Merrill] in non-traditional areas and seasons. Ph.D Thesis ANGR Agricultura University, Hyderabad.
- Singh R K and Chaudhary B D 1977.** Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi; pp :318.
- Sriranjani K, Ramana M V, Srinivasa Rao V and Rama Kumar P V 2007.** Correlation and path analysis in soybean [*Glycine max* (L.) Merrill]. The Andhra Agricultural Journal 54: 6-8.
- Turke A 2005.** Correlation and path analysis of yield components in soybean varieties. Turkish Journal of Field Crops 10(1): 43-48.

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