



Genetic Variability, Character Association and Path Coefficient Analyses in Soybean [*Glycine max* (L.) Merrill.]

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ABSTRACT

Forty-five genotypes of soybean [*Glycine max* (L.) Merrill.] of diverse origin were studied for their genetic variability, character association and path analyses. The difference between the genotypes were highly significant for 13 characters. Seed yield per plant, number of pods per plant, branches per plant and harvest index showed high genotypic coefficient of variation. Correlation studies indicated that seed yield per plant showed significant positive correlation with biological yield per plant, number of pods per plant, harvest index, seeds per pod, pod length, plant height, branches per plant and 100 seed weight. Path analysis revealed that biological yield per plant, pods per plant and harvest index will have positive direct influence on seed yield per plant.

Key words : Soybean, Variability, Path Analysis

Soybean [*Glycine max* (L.) Merrill.], is cultivated for its high protein and oil content. The present investigation was carried out with 45 soybean germplasm collection of diverse origin to explore the extent of genetic variability, association of certain characters, their direct contribution to yield and indirect effects through other characters on yield.

MATERIAL AND METHODS

The present investigation was conducted at the Regional Agricultural Research Station, Lam, Guntur with 45 genotypes of soybean during *kharif* season, 2007. The experiment was laid out in randomized block design with three replications. Each genotype was grown in a plot of four rows of 3 m length each with inter-row spacing of 30 cm and intra-row spacing of 7.5 cm. Observations were recorded on days to 50 per cent flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), seeds per pod, 100 seed weight (g), biological yield per plant (g), harvest index (%), protein content (%), oil content (%), and seed yield per plant (g). Standard statistical procedures, were used for the analysis of variance (Panse and Sukhatme, 1967), genotypic and phenotypic coefficients of variation (Burton, 1952), heritability (Hanson *et al.*, 1956) and genetic advance (Johnson *et al.*, 1955). Correlation coefficients were calculated as per Panse and Sukhatme (1967) and path analysis as per Wright (1921) and Dewey and Lu (1959).

RESULTS AND DISCUSSION

Data on mean, variability, heritability and genetic advance as percentage of mean are presented in Table 1. The analysis of variance revealed significant differences among genotypes for all the 13 characters. The characters viz. number of branches per plant, number of pods per plant, biological yield per plant, harvest index, and seed yield per plant showed high PCV and GCV estimates. This suggests that the selection based on these characters would facilitate successful isolation of desirable types. Similar findings were reported for characters like number of pods per plant and seed yield (Harer and Deshmukh, 1992 and Jagtap and Mehetre, 1994).

Heritability estimates (in broad sense) ranged from 69.71 (seeds per pod) to 98.33 (days to maturity). Highly heritable characters like days to 50 per cent flowering, plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), seeds per pod, 100 seed weight (g), biological yield per plant (g), harvest index (%) and seed yield per plant (g) had high genetic advance as per cent of mean indicating that these characters were under the influence of additive gene action. While, high heritability with moderate genetic advance was recorded for days to maturity, protein and oil content rendering them unsuitable for improvement through direct selection.

Correlation analysis (Table 2) revealed that seed yield per plant was significantly and positively

Table 1. Variability, heritability and genetic advance for yield and yield components of 45 soybean [*Glycine max* (L.) Merrill] genotypes

Characters	Mean \pm SEM	Range		Variance			PCV (%)	GCV (%)	h ² (b) (%)	GA	GA as % of mean
		Min	Max	σ^2_g	σ^2_p	σ^2_e					
Days to 50% flowering	38.35 \pm 0.55	30.00	46.00	17.47	18.41	0.94	11.18	10.89	94.88	8.38	21.86
Days to maturity	105.78 \pm 0.65	81.00	118.66	77.24	78.54	1.30	8.37	8.30	98.33	17.95	16.97
Plant height (cm)	50.38 \pm 1.68	30.53	67.07	83.48	92.16	8.68	19.05	18.13	90.57	17.91	35.54
Branches/plant	2.51 \pm 0.13	1.00	4.96	0.59	0.64	0.05	31.92	30.56	91.63	1.51	60.27
Pods/plant	29.94 \pm 1.43	12.35	49.57	124.59	130.87	6.28	38.19	37.26	95.20	22.43	74.90
Pod length (cm)	3.21 \pm 0.07	1.26	4.32	0.25	0.27	0.01	16.35	15.79	93.19	1.00	31.40
Seeds/pod	2.35 \pm 0.13	1.00	3.00	0.13	0.19	0.05	18.57	15.50	69.71	0.62	26.66
100 seed weight (g)	12.79 \pm 0.40	7.26	15.28	2.66	3.16	0.49	13.90	12.76	84.26	3.08	24.13
Biological yield/plant (g)	21.18 \pm 1.12	12.30	33.42	21.94	25.82	3.88	23.98	22.10	84.97	8.89	41.97
Harvest index (%)	36.57 \pm 2.02	19.63	51.85	69.11	81.67	12.56	24.70	22.72	84.62	15.75	43.07
Protein content (%)	37.83 \pm 0.71	33.52	41.55	4.66	6.22	1.56	6.59	5.70	74.90	3.84	10.17
Oil content (%)	20.35 \pm 0.24	18.00	22.48	1.40	1.58	0.18	6.01	5.81	88.18	2.29	11.24
Seed yield/plant (g)	8.00 \pm 0.56	3.34	14.99	9.51	10.48	0.97	40.44	38.51	90.69	6.05	75.55

PCV = Phenotypic coefficient of variation; GCV = Genotypic coefficient of variation; h²(b) = Heritability (broad sense); GAM = Genetic advance as per cent of mean
 GA = Genetic advance

Table 2. Estimates of phenotypic and genotypic (in parentheses) correlation coefficients between yield and yield components in 45 soybean [*Glycine max* (L.) Merrill] genotypes

Character	Days to maturity	Plant height	Branches plant ⁻¹	Pods plant ⁻¹	Pod length	Seeds pod ⁻¹	100 seed weight	Biological yield plant ⁻¹	Harvest index (%)	Protein content (%)	Oil content (%)	Yield plant ⁻¹
Days to 50% Flowering	0.31** (0.32)	0.03 (0.03)	-0.23** (-0.26)	0.03 (0.03)	0.04 (0.04)	0.06 (0.07)	0.25** (0.29)	0.11 (0.11)	0.03 (0.02)	-0.19* (-0.22)	-0.07 (-0.08)	0.06 (0.06)
Days to Maturity	0.11 (0.12)	0.05 (0.05)	0.05 (0.05)	-0.15 (-0.16)	0.26** (0.27)	0.22** (0.25)	0.29** (0.33)	0.04 (0.06)	-0.03 (-0.03)	-0.08 (-0.10)	-0.13 (-0.13)	0.08 (0.08)
Plant height		0.16 (0.17)	0.13 (0.14)	0.13 (0.14)	0.17* (0.19)	0.29** (0.38)	0.18* (0.21)	0.25** (0.28)	0.17* (0.21)	0.24** (0.31)	-0.02 (-0.01)	0.29** (0.30)
Branches plant ⁻¹			0.22** (0.24)	0.01 (0.02)	0.01 (0.02)	0.11 (0.13)	-0.11 (-0.13)	0.23** (0.26)	0.22** (0.25)	0.17* (0.22)	-0.02 (-0.03)	0.27** (0.29)
Pods plant ⁻¹				0.20* (0.21)	0.20* (0.21)	0.19* (0.24)	-0.13 (-0.14)	0.64** (0.72)	0.53** (0.58)	-0.00 (-0.01)	-0.14 (-0.17)	0.72** (0.78)
Pod length					0.74** (0.88)	0.50** (0.56)	0.50** (0.62)	0.31** (0.33)	0.04 (0.07)	-0.26** (-0.33)	0.11 (0.11)	0.36** (0.40)
Seeds Pod ⁻¹						0.46** (0.62)		0.36** (0.46)	0.13 (0.16)	-0.17* (-0.23)	-0.01 (-0.03)	0.39** (0.48)
100 Seed weight								0.13 (0.19)	0.04 (0.06)	-0.01 (-0.01)	-0.03 (-0.00)	0.23 (0.24)
Biological yield plant ⁻¹								0.31** (0.37)	0.01 (0.04)	-0.05 (-0.05)	0.78** (0.89)	Har-
vest index (%)										-0.07 (-0.05)	-0.07 (-0.10)	0.58** (0.69)
Protein content (%)										-0.06 (-0.07)	-0.06 (-0.07)	0.05 (0.05)
Oil content (%)												-0.08 (-0.07)

*, ** = Significant at 5% and 1% level, respectively

Table 3. Estimates of direct (bold) and indirect effects of yield components in soybean [*Glycine max* (L.) Merrill] genotypes during Kharif, 2007.

Character	Days to 50% flowering	Days to maturity	Plant height	Branches plant ⁻¹	Pods plant ⁻¹	Pod length	Seeds pod ⁻¹	100 seed weight	Biological yield plant ⁻¹	Harvest index (%)	Protein content (%)	Oil content (%)
Days to 50% flowering (P)	-0.0591	-0.0187	-0.0022	0.0142	-0.0021	-0.0026	-0.0039	-0.0153	-0.0068	-0.0021	0.0113	0.0046
(G)	-0.0277	-0.0089	-0.0011	0.0072	-0.0010	-0.0012	-0.0020	-0.0081	-0.0033	-0.0008	0.0061	0.0025
Days to maturity (P)	0.0274	0.0868	0.0102	0.0049	-0.0139	0.0227	0.0195	0.0259	0.0041	-0.0027	-0.0075	-0.0116
(G)	0.0074	0.0231	0.0028	0.0013	-0.0037	0.0063	0.0059	0.0077	0.0014	-0.0008	-0.0024	-0.0031
Plant height (P)	0.0002	0.0006	0.0048	0.0008	0.0007	0.0008	0.0014	0.0009	0.0012	0.0008	0.0012	-0.0001
(G)	-0.0005	-0.0015	-0.0122	-0.0021	-0.0018	-0.0024	-0.0047	-0.0026	-0.0035	-0.0026	-0.0039	0.0002
Branches plant ⁻¹ (P)	-0.0049	0.0012	0.0034	0.0206	0.0047	0.0003	0.0024	-0.0024	0.0049	0.0047	0.0035	-0.0005
(G)	0.0056	-0.0012	-0.0037	-0.0217	-0.0053	-0.0006	-0.0029	0.0030	-0.0058	-0.0055	-0.0048	0.0007
Pods plant ⁻¹ (P)	0.0115	-0.0515	0.0447	0.0726	0.3223	0.0669	0.0633	-0.0429	0.2077	0.1714	-0.0009	-0.0470
(G)	-0.0014	0.0064	-0.0057	-0.0097	-0.0398	-0.0087	-0.0098	0.0057	-0.0288	-0.0233	0.0006	0.0069
Pod length (P)	0.0025	0.0148	0.0098	0.0009	0.0117	0.0565	0.0419	0.0288	0.0177	0.0026	-0.0150	0.0062
(G)	0.0180	0.1118	0.0795	0.0108	0.0899	0.4092	0.3629	0.2305	0.1360	0.0304	-0.0367	0.0463
Seeds pod ⁻¹ (P)	0.0004	0.0014	0.0019	0.0007	0.0012	0.0047	0.0063	0.0030	0.0023	0.0009	-0.0011	-0.0001
(G)	-0.0212	-0.0741	-0.1128	-0.0389	-0.0719	-0.2579	-0.2908	-0.1819	-0.1366	-0.0483	0.0690	0.1008
100 seed wt (P)	0.0468	0.0541	0.0328	-0.0212	-0.0241	0.0923	0.0851	0.1812	0.0251	0.0079	-0.0303	-0.0057
(G)	0.0114	0.0130	0.0083	-0.0054	-0.0056	0.0220	0.0244	0.0390	0.0077	0.0026	-0.0083	-0.0001
Biological yield plant ⁻¹ (P)	0.0508	0.0209	0.1122	0.1053	0.2846	0.1386	0.1634	0.0612	0.4418	0.1390	0.0056	-0.0223
(G)	0.0874	0.0461	0.2104	0.1971	0.5365	0.2468	0.3486	0.1473	0.7425	0.2751	0.0313	-0.0436
Harvest index (%) (P)	0.0100	-0.0085	0.0485	0.0628	0.1471	0.0127	0.0383	0.0121	0.0870	0.2767	-0.0221	-0.0197
(G)	0.0134	-0.0160	0.1010	0.1215	0.2791	0.0354	0.0792	0.0314	0.1767	0.4769	-0.0269	-0.0517
Protein content (%) (P)	-0.0205	-0.0093	0.0258	0.0183	-0.0003	-0.0285	-0.0188	-0.0179	0.0013	-0.0086	0.1070	-0.0067
(G)	-0.0284	-0.0135	0.0411	0.0289	-0.0019	-0.0432	-0.0307	-0.0275	0.0054	-0.0073	0.1293	-0.0092
Oil content (%) (P)	-0.0016	-0.0028	-0.0006	-0.0005	-0.0031	0.0023	-0.0004	-0.0007	-0.0011	-0.0015	-0.0013	0.0210
(G)	0.0029	0.0044	-0.0005	0.0011	0.0056	-0.0037	0.0012	0.0001	0.0019	0.0035	-0.0023	-0.0322
Correlation with seed yield plant ⁻¹ (P)	0.0634	0.0890	0.2913**	0.2795**	0.7289**	0.3667**	0.3986**	0.2339**	0.7854**	0.5891**	0.0504	-0.0820
(G)	0.0669	0.0889	0.3079	0.2901	0.7801	0.4021	0.4812	0.2444	0.8939	0.6998	0.0555	-0.0725

P = Phenotypic, G = Genotypic ** = Significant at 1% level

correlated with biological yield per plant (g), number of pods per plant as reported by Nehru *et al.*, 1999 and Praveen Kumar *et al.*, (2005) and harvest index in agreement with Sailaja (1997); Ramana, (2003) and Praveen Kumar *et al.*, (2005). Both the quality characters, oil and protein content, were non-significantly negatively correlated with each other as reported by Harer and Deshmukh (1992) and showed no significant association with seed yield.

Path analysis (Table 3) revealed that the highest positive direct effect on the seed yield per plant was of biological yield per plant followed by number of pods per plant and harvest index in agreement with Sailaja (1997) and Praveen Kumar *et al.*, (2005).

Hence, simultaneous selection based on biological yield per plant, number of pods per plant and harvest index seems to be more promising in improving the seed yield per plant in soybean.

LITERATURE CITED

- Burton G W 1952.** Quantitative inheritance in grasses. Proceedings of Sixth. International. Grassland Congress 1: 277-288.
- Dewey D R and Lu K H 1959.** A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal 51: 515-518.
- Hanson C H, Robinson H F and Comstock R E 1956.** The biometrical studies on yield in segregating population of Korean lespedeza. Agronomy Journal 48: 268-272.
- Harer P N and Deshmukh R B 1992.** Genetic variability, correlation and path coefficient analysis in soybean [*Glycine max* (L.) Merrill.]. Journal of Oilseeds Research 9: 65-71.
- Jagtap D R and Mehetre S S 1994.** Genetic variability in some quantitative characters of soybean [*Glycine max* (L.) Merrill.]. Annals of Agricultural Research 15: 435-439.
- Johnson H W, Robinson H F and Comstock R E 1955.** Estimation of genetic and environmental variability in soybean [*Glycine max* (L.) Merrill.]. Agronomy Journal 47: 314-318.
- Nehru S D, Mahishi D M, Madhukeswara S S, Manjunath A and Kulkarni R S 1999.** Correlations among seed yield, protein yield, oil content and other accessory characters in soybean [*Glycine max* (L.) Merrill.]. Mysore Journal of Agricultural Sciences 33: 11-15.
- Panse V G and Sukhatme P V 1967.** Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi pp.103-108.
- Praveen Kumar 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 Agricultural University, Hyderabad.
- Sailaja G 1997.** Genetic variability and character association studies in soybean [*Glycine max* (L.) Merrill.]. M.Sc (Ag.) Thesis ANGR Agricultural University, Hyderabad.
- Wright S 1921.** Correlation and causation. Journal of Agricultural Research 20: 557-587.

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