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Character Association for Seed Yield and its Component Traits in Soybean [*Glycine max* (L.) Merrill]

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Abstract

Seed yield is a complex character governed by several contributing characters. Hence, character association was studied in the present investigation to assess the relationship among yield and its components for enhancing the usefulness of selection criterion to be followed while developing varieties. Correlation and path analysis were made for fourteen characters *viz*., days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per pod, 100-seed weight, biological yield per plant, harvest index, protein content, oil content, seed yield per plant and fodder yield per plant in 50 genotypes of soybean. Number of pods per plant (0.667, 0.675), pod length (0.495, 0.436), number of seeds per pod (0.459, 0.411), 100-seed weight (0.473, 0.464), biological yield per plant (0.533, 0.527), harvest index (0.609, 0.612) and oil content (0.341, 0.319) positively and significantly correlated with seed yield per plant at both genotypic and phenotypic level hence, these characters should be given due consideration while selecting for increasing seed yield. Seed yield per plant showed negative and significant association with plant height which indicated that tall plant yielded less as compared to dwarf plant.Path analysis based on genotypic correlation showed high direct effect of number of seeds per pod and biological yield per plant as well as moderate to high indirect effect for number of branches per plant, number of pods per plant, pod length, 100-seed weight and fodder yield per plant, revealing scope for considering these characters for imposing selection pressure for bringing out an improvement in soybean yield.

Key words : *Soybean, variability, correlation, path analysis.*

Introduction

Soybean [*Glycine max* (L). Merill] is referred as “golden bean” or “miracle crop” of the 20th century, because of its uses (1). Soybean is economically the most important crop in the world, providing vegetable protein for millions of people. It belongs to the family Fabaceae, sub family Papilionaceae with chromosome number 2n=40. Soybean occupies a unique position among edible legumes. Traditional food legumes (pulses) are rich in protein but contain limited amount of oil. Soybean contains more protein (about 40-42 per cent) than other pulses and much higher content of edible oil (about 20 per cent). Soybean protein is rich in valuable amino acids, lycine and tryptophan, in which most of the cereals are deficient. The biological value of soybean protein is as good as meat and fish protein.

India is the larger producer of the crop, its productivity is low as compared to countries like Brazil, China and USA etc. There is good scope to improve the productivity of this crop by varietal improvement and adopting the improved production technology on larger area of country.

Correlation is the measure of the mutual relationship between two variables. The study of correlation may help the plant breeder to know the improvement of one character well bring simultaneous improvement in other characters is helpful in the selection of suitable plant types (2). Path coefficient analysis is a standardized regression coefficient and measures the direct influence of one variable upon the other. It allows separating the direct effect and their indirect effects through other attributes by apportioning the correlations for better interpretation of cause and effect relationship. The present study was planned to investigate correlation and path analysis to identify the best genotypes and the characters which are most suitable for yield improvement.

Materials and Methods

The present investigation was conducted at Agricultural Research Station, Junagadh Agricultural University, Amreli, during *kharif* 2018. The experiment consisted of 50 genotypes, which were evaluated in randomized block design with three replications. The entries were sown in one row each of 5 m length adopting inter row spacing of 45 cm and intra row spacing of 10 cm. The recommended package of practices was followed for raising a healthy crop. The data were recorded on five randomly selected competitive plants in each replication and each genotype

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for 14 characters *viz.,* 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), number of seeds per pod, 100-seed weight (g), biological yield per plant (g), harvest index (%), protein content (%), oil content (%), seed yield per plant (g) and fodder yield per plant (g). Observations of days to 50 per cent flowering and days to maturity were recorded on plot basis. Correlation coefficients was calculated for combination of 14 characters under study at genotypic, phenotypic and environmental levels with the help of formula suggested by (3). Path coefficient analysis was carried out as per the procedure suggested by (4). Following scales were used for the rating of path coefficients.

Scales	Classification
>1.0	Very high
0.30 - 0.99	High
0.20 - 0.29	Moderate
0.10 - 0.19	Low
0.00 – 0.09	Very low

Results and Discussion

The analysis of variance revealed that, prevalence of significant differences among the genotypes for all the fourteen characters studied. The genotypic correlations were generally higher than their respective phenotypic correlation coefficients in most of the cases, suggesting that there was a strong and inherent association between two characters. Seed yield per plant was significantly and positively correlated with number of pods per plant, pod length, number of seeds per pod, 100-seed weight, biological yield per plant, harvest index and oil content at both genotypic and phenotypic level. Hence, these characters should be given due consideration while selecting for increasing seed yield per plant. However, seed yield per plant showed significant and negative association with plant height which indicated that tall plant yielded less as compared to dwarf plant (Table-1). Positive and significant association of seed yield per plant with number of pods per plant was earlier reported by (5,6). Positive and significant association of seed yield per plant with number of seeds per pod was reported by (7,8). Positive and significant association of seed yield per plant with 100-seed weight was reported by (1,9) reported positive and significant association of seed yield per plant with biological yield per plant and harvest index. Negative correlation with plant height was earlier reported by (1,9).

Days to 50 per cent flowering, days to maturity, number of branches per plant, protein content and fodder yield per plant showed positive but non-significant correlation with seed yield per plant, hence simultaneous improvement of these independent traits is possible. On the other hand, days to 50 per cent flowering as well as days to maturity had negative and significant association with 100-seed weight and harvest index, which indicated that selection for early flowering and maturity is likely to increase seed size and harvest index. 100-seed weight is significantly and positively correlated with harvest index, oil content and seed yield per plant, which suggested that selection for seed size is also increase oil content, harvest index and seed yield per plant. Protein content is negatively and non-significantly correlated with oil content which indicated that simultaneous improvement of both the characters for quality purpose is not possible. Similar results were also reported by (8).

Path analysis : The contribution of characters towards the seed yield can be detected by direct and indirect effects. Path analysis helps in estimating both the effects of specified characters on seed yield. The results obtained for direct and indirect effects of different characters in seed yield per plant are presented in Table-2. The overall path analysis based on genotypic correlations revealed that number of seeds per pod and biological yield per plant were major characters having high positive direct effect and significant association with seed yield per plant. Therefore, selection for these characters would be easy and would bring about improvement of seed yield in soybean. The results obtained from this study are in confirmation with the results of (10,11,12,13). The negative direct effect of plant height contributed towards negative and significant correlation with seed yield per plant. The results are in accordance with the findings of (1,7,9,14). The correlation between number of pods per plant and seed yield per plant was positive and significant but its direct effect was positive and low because of positive and high indirect effect *via* biological yield per plant. The direct effect of pod length and 100-seed weight was negative but its association with seed yield per plant was positive and significant due to positive and very high indirect effect *via* biological yield per plant. Harvest index and oil content have a strong correlation with seed yield per plant but its direct effect was very low because of very high indirect effect *via* fodder yield per plant and biological yield per plant, respectively. Negative and significant correlation was found between plant height and seed yield per plant but its direct effect was low due to negative and high indirect effect *via* fodder yield per plant. Hence, selection based on characters *viz.,* number of seeds per pod and biological yield per plant with high direct effect and number of branches per plant, number of pods per plant, pod length, 100-seed weight and fodder yield per plant with moderate to high indirect effect may be useful for improving the seed yield of soybean.

Table-1: Genotypic (rg) and phenotypic (rp) correlation coefficients among fourteen characters in 50 soybean genotypes.

Characters		Days to 50per cent flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	100 seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Protein content (%)	Oil content (%)	Fodder yield per plant (g)	Correlation with seed yield
Days to 50 per cent flowering	r_g	1.000	0.874**	0.552**	0.547**	0.392**	-0.030	0.037	-0.551**	0.213	-0.292*	0.142	-0.066	0.273	-0.030
	r_p	1.000	0.872**	0.536**	0.488**	0.369**	-0.032	0.014	-0.543**	0.206	-0.289*	0.136	-0.056	0.267	-0.032
Days to maturity	r_g		1.000	0.523**	0.573**	0.391**	-0.024	0.018	-0.454**	0.329*	-0.341*	0.206	0.003	0.383**	0.029
	r_p		1.000	0.508**	0.506**	0.367**	-0.032	-0.002	-0.446**	0.319*	-0.335*	0.200	0.002	0.374*	0.024
Plant height (cm)	r_g			1.000	0.477**	0.082	-0.318*	-0.243	-0.490**	0.196	-0.600**	0.170	-0.012	0.379**	-0.356**
	r_p			1.000	0.473**	0.105	-0.271	-0.197	-0.479**	0.196	-0.566**	0.167	-0.014	0.368**	-0.322*
Number of branches per plant	r_g				1.0000	0.656**	-0.261	-0.139	-0.462**	0.490**	-0.282*	0.138	0.178	0.493**	0.185
	r_p				1.0000	0.626**	-0.210	-0.114	-0.413**	0.451**	-0.227	0.129	0.147	0.442**	0.203
Number of pods per plant	r_g					1.000	0.082	0.003	-0.208	0.532**	0.196	0.051	0.173	0.336*	0.667**
	r_p					1.000	0.078	0.015	-0.196	0.514**	0.218	0.051	0.160	0.313*	0.675**
Pod length (cm)	r_g						1.000	0.935**	0.158	0.259	0.302*	-0.042	0.138	0.098	0.495**
	r_p						1.000	0.863**	0.130	0.234	0.286*	-0.046	0.119	0.081	0.436**
Number of seeds per pod	r_g							1.000	0.079	0.244	0.260	0.051	0.069	0.105	0.459**
	r_p							1.000	0.064	0.231	0.266	0.037	0.070	0.089	0.411**
100 seed weight (g)	r_g								1.000	0.153	0.468**	-0.175	0.314*	-0.044	0.473**
	r_p								1.000	0.154	0.460**	-0.168	0.290*	-0.043	0.464**
Biological yield per plant (g)	r_g									1.000	-0.332*	0.093	0.166	0.931**	0.533**
	r_p									1.000	-0.319*	0.088	0.161	0.929**	0.527**
Harvest index (%)	r_g										1.000	-0.132	0.273	-0.645**	0.609**
	r_p										1.000	-0.126	0.255	-0.639**	0.612**
Protein content (%)	r_g											1.000	-0.212	0.120	-0.143
	r_p											1.000	-0.204	0.115	-0.014
Oil content (%)	r_g												1.000	0.041	0.341*
	r_p												1.000	0.042	0.319*
Fodder yield per plant (g)	r_g													1.000	0.188
	r_p													1.000	0.179
Seed yield per plant (g)	r_g														1.000
	r_p														**1.000**

*, ** significant at 5% and 1% level, respectively.

Table-2 : Phenotypic and genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on seed yield per plant in 50 genotypes of soybean.

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	No of branches per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	100 seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Protein content (%)	Oil content (%)	Fodder yield per plant (g)	Correlation with seed yield
Days to 50% flowering	G	-0.0643	0.0870	-0.0178	-0.1413	0.0391	0.0142	0.0156	0.0914	0.5860	-0.0188	0.0030	-0.0045	-0.6130	-0.0295
	P	-0.0057	0.0326	-0.0200	-0.0040	0.0271	0.0001	0.0003	0.0018	0.4689	-0.0279	0.0015	0.0001	-0.5071	-0.0322
Days to maturity	G	-0.0563	0.0994	-0.169	-0.1481	0.0390	0.0115	0.0075	0.0754	0.9053	-0.0220	-0.0044	0.0002	-0.8624	-0.0285
	P	-0.0050	0.0375	-0.0190	-0.0041	0.0270	0.0001	0.0000	0.0015	0.7260	-0.0323	0.0022	0.0000	-0.7100	0.0238
Plant height (cm)	G	-0.0355	0.0519	-0.0323	-0.1230	0.0082	0.1519	-0.1024	0.0814	0.5319	-0.0386	-0.0036	-0.0008	-0.8524	-0.3562*
	P	-0.0031	0.0190	-0.0373	-0.0038	0.0077	0.0008	-0.0042	0.0016	0.4475	-0.0545	0.0018	0.0000	-0.6977	-0.3222*
Number of branches per plant	G	-0.0352	0.0570	-0.0154	-0.2582	0.0654	0.1248	-0.0585	0.0766	1.3474	-0.0182	-0.0029	0.0122	-1.1095	0.1854
	P	-0.0028	0.0190	-0.0177	-0.0081	0.0161	0.0006	-0.0024	0.0014	1.0265	-0.0218	0.0014	-0.0003	-0.8389	0.2030
No. of pods per plant	G	-0.0252	0.0389	-0.0027	-0.1693	0.0997	-0.0394	0.0014	0.0346	1.4609	0.0126	-0.0011	0.0118	-0.1554	0.6668**
	P	-0.0028	0.0137	-0.0039	-0.0051	0.0736	-0.0002	0.0003	0.0006	1.1702	0.0210	0.0006	-0.0003	-0.5931	0.6752**
Pod length (cm)	G	0.0019	-0.0024	0.0103	0.0374	0.0082	-0.4784	0.3940	-0.0262	0.7122	0.0195	0.00099	0.0094	-0.2214	0.4954**
	P	0.0002	-0.0012	0.0101	0.0017	0.0056	-0.0030	0.0185	-0.0004	0.5322	0.0275	-0.0005	-0.0002	-0.1544	0.4362**
Number of seeds per pod	G	-0.0024	0.0018	0.0079	0.0359	0.0003	-0.4473	0.4213	-0.0131	0.6711	0.0168	-0.0011	0.0047	-0.2368	0.4590**
	P	-0.0001	-0.0001	0.0074	0.0009	0.0011	-0.0026	0.0214	-0.0002	0.5264	0.00256	0.0004	-0.0001	-0.1689	0.4113**
100 seed weight (g)	G	0.0354	-0.0452	0.0159	0.1193	-0.0208	-0.0754	0.0333	-0.1659	0.4209	0.0301	0.0037	0.0215	0.0998	0.4726**
	P	0.0031	-0.0167	0.0179	0.0034	-0.0144	-0.0004	0.0014	-0.0033	0.3502	0.0443	-0.0019	0.0006	0.0811	0.4641**
Biological yield per plant (g)	G	-0.0137	0.0327	-0.0063	-0.1266	0.0530	-0.1240	0.1029	-0.0254	2.7480	-0.0213	-0.0020	0.0113	-2.0955	0.5331**
	P	-0.0012	0.0119	-0.0073	-0.0037	0.0378	-0.0007	0.0049	-0.0005	2.2785	-0.0307	0.0010	-0.0003	-1.7627	0.5270**
Harvest index (%)	G	0.0188	-0.0339	0.0194	0.0728	0.0196	-0.1447	0.1097	-0.0777	-0.9111	0.0644	0.0028	0.0186	1.4508	0.6094**
	P	0.0017	-0.0125	0.0211	0.0018	0.0160	-0.0008	0.0057	-0.0015	-0.7266	0.0964	-0.0014	-0.0005	1.2126	0.6120**
Protein content (%)	G	0.0091	0.0205	-0.0055	-0.0356	0.0051	0.0202	0.0216	0.0290	0.2544	-0.0085	-0.0212	-0.0145	-0.2709	-0.0143
	P	-0.0008	0.0075	-0.0062	-0.0010	0.0037	0.0001	0.0008	0.0006	0.19933	-0.0121	0.0110	0.0004	-0.2174	-0.0142
Oil content (%)	G	0.0043	0.0003	0.0004	-0.0460	0.0173	-0.0660	0.0290	-0.0522	0.4552	0.0176	0.0045	0.0683	-0.0916	0.3410*
	P	0.0003	0.0001	0.0005	-0.0012	0.0118	-0.0004	0.0015	-0.0010	0.3659	0.0246	-0.0023	-0.0019	-0.0789	0.3190*
Fodder yield per plant (g)	G	-0.0175	0.0381	-0.0122	-0.1273	0.0335	-0.0471	0.0443	0.0074	2.5595	-0.0415	-0.0025	0.0028	-2.2498	0.1875
	P	-0.0015	0.0140	-0.0137	-0.0036	0.0230	-0.0002	0.0019	0.0001	2.1168	-0.0616	0.0013	-0.0001	-1.8973	0.1790

*, ** significant at 5% and 1% levels, respectively, Residual effect = 0.102

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