Electronic Journal of Plant Breeding, 6(2): 570-573 (June 2015)
ISSN 0975-928X

Research Note

Correlation and path analysis for seed yield in soybean [*Glycine max* (L.) Merrill]

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(Received: 04 April 2014; Accepted:03 July 2015)

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 nine characters in 61 genotypes of soybean. The seed yield was positively and significantly correlated with days to maturity, 100-seed weight, biological yield per plant and harvest index, but negatively correlated with number of primary branches per plant. Path coefficient analysis revealed that number of pods per plant, number of clusters per plant, number of pods per cluster, pod length, biological yield per plant, harvest index, oil content and protein content had positive direct effect on seed yield per plant.

Keywords
Soybean, correlation, path analysis

The soybean [*Glycine max* (L.) Merrill] has emerged as one of the major edible oilseed crops in the world. The estimation of genetic correlation coefficient between yield and its component characters has been immense help for the indirect selection of the desired plant ideotype. Yield being a dependent on morpho-physiological characters of the developing indirect effect of different characters on seed yield. Hence, for a better insight into the cause and effect relationship between different pairs of characters study of correlation in conjunction with path analysis is essential.

The present investigation was conducted at the Instructional Farm, Junagadh Agricultural University, Junagadh during *kharif*-2012. In the experiment 61 genotypes were evaluated in a randomized block design with three replications. The entries were sown in one row each of 4 m length adopting inter row spacing of 45 cm and intra row spacing of 10 cm. The package of practices was followed to raise a good crop. Five competitive plants were randomly selected in each genotype in each replication and observations were recorded for 15 characters *viz*., days to 50 % flowering, days to maturity, plant height (cm), number of primary branches per plant**,** number of clusters per plant, number of pods per plant, number of pods per cluster, pod length (cm), number of seeds per pod, 100-seed weight (g), biological yield per plant (g), harvest index (%), protein content (%), oil content (%) and seed yield per plant (g). Observations on days to 50% flowering and days to maturity were recorded on per plot basis. The phenotypic and genotypic correlation coefficients of all the characters were worked-out as per Al-Jibouri *et al*. (1958). Path coefficient of various characters was calculated as per the method suggested by Dewey and Lu (1959).

The genotypic and phenotypic correlations among the yield and yield contributing characters in soybean are presented in Table 1. The genotypic and phenotypic correlations were at par with each other suggesting the negligible role of environment on the genotypic expression. Seed yield per plant was found to be significantly and positively associated with days to maturity, number of primary braches per plant, 100-seed weight, biological yield per plant and harvest index. Similar results were also reported by Mukhekar *et al.* (2004); Arshad and Ghafoor (2006); Malik *et al.* (2006); Faisal *et al.* (2007); Karnwal and Singh (2009); Bhat and Basavaraja (2011) and Shaikh *et al.* (2012).

Plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, 100-seed weight, harvest index and biological yield per plant were positively and significantly correlated among themselves. This means that increasing in one character would ultimately increase another one and thereby increase in seed yield. The strong and positive associations among harvest index, biological yield per plant and seed yield per plant indicated great possibility while selecting for any of them for crop improvement.

The association of days to 50% flowering was significantly and positively associated with days to maturity, but significantly and negatively associated with 100-seed weight. Also, oil content was positively associated with number of pods per

plant. All these four characters were independent to seed yield per plant as they showed non-significant correlation with it. This means that development of early maturity genotypes with high oil content without loosing protein content and yield is possible. Faisal *et al.* (2007) also reported non-significant relationship between oil and protein content.

It is interesting to note that correlation between number of pods per plant and oil content were significant and positive at phenotypic level but it was significant and negative at genotypic level. The possible explanation to such observation could be that the genetical and environmental forces might be affecting the traits through different physiological mechanisms.

Thus, overall observations on correlations depicted that biological yield per plant, number of primary branches per plant, 100-seed weight, days to maturity and harvest index were the most important components contributing towards seed yield. Therefore, more emphasis should be given to these characters for selecting high yielding genotypes in soybean.

Direct and indirect effects of the yield components on seed yield per plant indicated that biological yield per plant exerted maximum direct effect followed by harvest index and oil content (Table 2). Hence, selection based on above traits would be effective in increasing yield. Harvest index, number of pods per plant, pod length and oil content had positive and direct effects on seed yield per plant. Similar results also reported by Ali Rasaei *et al.* (2011), Shaikh *et al* (2012) and Udensi and Ikpeme (2012). However, these effects were of low magnitude. In contrast, days to 50% flowering, days to maturity, plant height and number of primary branches per plant had negative direct effects on seed yield per plant (Haghi *et al.*, 2012 and Shaikh *et al.*, 2012). The yield contributing characters *viz*., plant height, number of primary branches per plant, number of clusters per plant and protein content *via*. number of pods per plant had positive indirect effects and in high magnitudes on yield at both genotypic and phenotypic levels. These results are in conformity with the results of Shaikh *et al.* (2012).

Through, the study of path analysis it was apparent that maximum direct effects were exerted by biological yield per plant, harvest index and oil content. Out of these five traits; days to maturity, biological yield per plant, 100-seed weight and harvest index exhibited positive and significant correlation with seed yield per plant, therefore, these characters may be considered as most important yield contributing characters and due emphasis should be placed on these characters while breeding for high seed yield in soy bean.

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Table 1. Phenotypic (r_p) and genotypic (r_g) correlations among fifteen characters in soybean

Character		Days to maturity	Plant height (cm)	No. of primary branches/ plant	No. of pods/ plant	No. of clusters/ plant	No. of pods/ cluster	Pod length (cm)	No. of seeds/ pod	100-seed wt. (g)	Biolo-gical yield/ plant (g)	Harvest index (%)	Oil content (%)
Days to 50% flowering	r_p	0.166*	0.085	0.031	0.010	-0.119	-0.054	-0.022	-0.019	-0.187*	0.057	0.135	
	r_g	0.550	0.128	0.075	-0.165	-0.196	0.004	0.044	-0.287	-0.564	-0.251	0.230	
Days to maturity	r_p		0.019	-0.064	-0.002	-0.093	-0.020	-0.008	0.007	-0.019	0.169*	0.248**	
	r_g		0.013	-0.158	-0.055	-0.287	-0.021	0.482	-0.029	-0.063	0.015	0.701	
Plant height (cm)	r_p			0.532**	0.523**	-0.081	0.202**	0.102	0.123	-0.185*	-0.127	0.036	
	r_g			0.679	0.775	-0.130	0.550	0.252	0.282	-0.493	-0.200	0.016	
No. of primary branches/plant	r_p				0.548**	0.007	0.335**	0.130	0.132	-0.232**	-0.249**	-0.125	
	r_g				0.700	-0.091	0.699	0.196	0.430	-0.642	-0.530	-0.208	
No. of pods/plant	r_p					0.110	0.500**	0.008	0.181*	-0.094	0.050	-0.035	
	r_g					0.033	1.054	-0.011	0.576	-0.445	-0.166	-0.155	
No. of clusters/plant	r_p						0.049	-0.221**	-0.025	0.279**	0.051	-0.352**	
	r_g						-0.033	-0.941	-0.076	0.645	0.057	-0.537	
No. of pods/cluster	r_p							-0.028	0.046	-0.082	0.033	-0.128	
	r_g							0.068	-0.064	-0.723	0.001	-0.273	
Pod length (cm)	r_p								0.259**	-0.065	-0.050	0.130	
	r_g								0.731	-0.764	-0.610	0.561	
No. of seeds/pod	r_p									0.051	0.017	0.096	
	r_g									-0.083	-0.229	0.281	
100- seed wt. (g)	r_p										0.293**	0.068	
	r_g										0.954	-0.141	
Biological yield/plant (g)	r_p											0.309**	
	r_g											0.327	

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

Table 2. Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effect of different characters on seed yield in soybean

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches/ plant	No. of pods/ plant	No. of clusters/ plant	No. of pods/ cluster	Pod length (cm)	No. of seeds/ pod	100-seed wt. (g)	Biologi-cal yield/ plant (g)	Harvest index (%)	Oil content (%)	Protein content (%)	Seed yield/ plant (g)
Days to 50% flowering	**-0.039**	-0.022	-0.005	-0.003	0.007	0.008	0.000	-0.002	0.011	0.022	0.010	-0.009	0.000	0.016	-0.148
Days to maturity	-0.051	**-0.092**	-0.001	0.015	0.005	0.027	0.002	-0.044	0.003	0.006	-0.001	-0.065	-0.018	0.064	0.239
Plant height (cm)	-0.003	0.000	**-0.024**	-0.016	-0.018	0.003	-0.013	-0.006	-0.007	0.012	0.005	0.000	0.002	0.004	-0.169
No. of primary branches/plant	-0.004	0.008	-0.035	**-0.052**	-0.036	0.005	-0.036	-0.010	-0.022	0.033	0.027	0.011	0.006	0.015	-0.530
No. of pods /plant	-0.001	0.000	0.003	0.002	**0.003**	0.000	0.004	0.000	0.002	-0.002	-0.001	-0.001	-0.001	0.000	-0.204
No. of clusters/plant	-0.010	-0.015	-0.007	-0.005	0.002	**0.053**	-0.002	-0.050	-0.004	0.034	0.003	-0.029	-0.002	0.064	-0.170
No. of pods/cluster	0.000	-0.001	0.022	0.028	0.042	-0.001	**0.039**	0.003	-0.003	-0.029	0.000	-0.011	-0.005	0.000	-0.068
Pod length (cm)	0.002	0.018	0.009	0.007	0.000	-0.035	0.003	**0.037**	0.027	-0.028	-0.023	0.021	-0.006	-0.016	-0.281
No. of seeds/pod	0.012	0.001	-0.012	-0.018	-0.025	0.003	0.003	-0.031	**-0.043**	0.004	0.010	-0.012	0.011	0.022	-0.112
100-seed wt. (g)	0.055	0.006	0.048	0.063	0.044	-0.063	0.071	0.075	0.008	**-0.098**	-0.094	0.014	-0.020	-0.092	0.712
Biological yield/plant (g)	-0.205	0.013	-0.164	-0.433	-0.136	0.047	0.001	-0.499	-0.187	0.779	**0.817**	0.267	0.126	0.401	0.939
Harvest index	0.111	0.338	0.008	-0.100	-0.075	-0.259	-0.132	0.271	0.136	-0.068	0.158	**0.483**	-0.067	-0.451	0.626
Oil content (%)	0.000	0.011	-0.006	-0.007	-0.016	-0.002	-0.007	-0.009	-0.014	0.012	0.009	-0.008	**0.057**	-0.002	0.082
Protein content (%)	-0.015	-0.026	-0.006	-0.011	-0.001	0.045	0.000	-0.016	-0.020	0.035	0.018	-0.035	-0.001	**0.038**	0.062

*, ** significant at 5% and 1% levels, respectively