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Correlation and Path Analysis Studies in Elite Lines of Soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

Background: Knowledge about the relationship between yield and the yield contributing characters can help breeders to effectively select for the characters that can efficiently increase yield. The present investigation studies correlation and path coefficient analysis in soybean.

Methods: 30 genotypes of soybean were obtained from Agriculture Research Station (ARS), Kasbe Digraj, Sangli and sown in a randomised block design with three replications. Eleven characters were observed *viz*., days to 50% flowering, nodulation count per plant at 50% flowering, days to maturity, plant height, branches per plant, pods per plant, 100 seed weight, pod blight incidence, seed yield per plant, protein and oil content.

Result: The correlation analysis revealed that seed yield per plant showed highly significant positive correlation with pods per plant (0.8471), followed by 100 seed weight (0.4087) and branches per plant (0.2836). The characters protein content (-0.1600) and days to maturity (-0.1566) showed negative and non-significant association with seed yield per plant. Path coefficient analysis showed that the characters pods per plant (0.8612), 100 seed weight (0.2476) and days to 50% flowering (0.2333) had high to moderate positive direct effect on seed yield per plant. Days to maturity (-0.0758) had negative direct effect on seed yield per plant.

Key words: Correlation, Path analysis, Soybean.

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] (2n=40) is one of the most important legume crops widely grown for its various uses and versatile nutritional composition. Soybean is often referred to as a “wonder crop”, “miracle crop” or “Cow of the field”. It has the highest protein (40%) and oil (18-20%) content among grain legumes and is the world’s major source of vegetable oil. Several products can be prepared from soybeans such as milk, cheese, yogurt, ice-cream, soy nuts, bread, sweets and pastries. In addition to these uses for human consumption, soybean serves as an excellent source of fodder, hay and silage. Soybean cake is very nutritive for livestock and poultry. Production of soybean in India is presently dominated by Maharashtra and Madhya Pradesh which contribute 89% of the total soybean production in the country (FICCI, 2014).

Soybean crop increases the fertility of the soil by fixing large amounts of atmospheric nitrogen through root nodules at the rate of 65-100 kg/ha (Patil *et al*., 2014). with the help of *Rhizobium japonicum* and also by decomposition of leaves that fall from the plant at maturity.

More than 100 plant pathogens have been reported to affect soybean but one of the most important diseases reported to cause economic losses in soybean is anthracnose (Pod Bight) caused by *Colletotrichum truncatum* (Schw.) Andrus and Moore, which can cause a yield loss of 16-100%. This disease is widely distributed especially in the tropics under warm and humid conditions.

The efficiency of selection in any breeding program mainly depends upon the knowledge of the association between the various plant traits. Correlation analysis provides information about the degree of relationship between important characters of the plant and is a good index to predict the yield response to change in a particular character. Genotypic correlation can provide an estimate of the inherent association between any two characters.

In soybean, grain yield is a complex character that is dependent on various variables. Path co-efficient analysis measures the direct and indirect effect of one variable upon another and permits the separation of the correlation co-efficient into components of direct and indirect effect (Dewey and Lu, 1959). This study of the direct and indirect effects of yield and its components provides the basis for a successful breeding program by increasing yield more effectively through the formulation of selection indices for genetic improvement.

MATERIALS AND METHODS

The present investigation was carried out at Agricultural Botany Research Farm, College of Agriculture, Pune during

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Kharif 2020. The experiment was laid down in a Randomised Block Design with three replications. The experimental material with 30 genotypes of soybean was collected from Agriculture Research Station (ARS), Kasbe Digraj, Sangli. The spacing between rows was 30 cm and between plants was 10 cm. The plot consisted of a single row of 3 m in length. Data was collected with randomly selected five plants and their mean was used for statistical analysis for 11 characters *viz.,* days to 50% flowering, nodulation count per plant at 50% flowering, days to maturity, plant height, branches per plant, pods per plant, 100 seed weight, pod blight incidence, seed yield per plant, protein and oil content.

Pod blight incidence was calculated under natural inoculum pressure by counting the average number of pods on 5 plants per genotype per replication showing typical symptoms of pod blight 15 days before harvesting. Pod blight incidence was then measured as percent pod infection given by the formula:

Percent pod infection (%) =

$$\frac{\text{No. of infected pods}}{\text{Total no. of pods observed}} \times 100$$

The protein and oil content of each genotype was estimated by NIR (Near Infrared) spectroscopy method.

The genotypic correlation was calculated among all the characters. Path analysis was done according to the methods suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

In the present investigation, correlation studies at the genotypic level were carried out to determine the association between various characters and seed yield per plant in soybean. The genotypic correlation of 11 characters in 30 genotypes of soybean is presented in Table 1.

The study found that almost all the traits studied showed a positive correlation with seed yield per plant except days to maturity and protein content. The seed yield per plant showed a highly significant positive association with pods per plant (0.8471) followed by 100 seed weight (0.4087) and branches per plant (0.2836) at the genotypic level. Therefore, the study suggests that selection for pods per plant, 100 seed weight and branches per plant will be effective in increasing seed yield per plant. Similar results of positive correlation of seed yield per plant with pods per plant were recorded by Nag *et al.* (2007), Machikowa and Laosuwan (2011), Kumar *et al.* (2013), Shree *et al.* (2017) and Shekar *et al.* (2018).

The characters days to 50% flowering, days to maturity, plant height and branches per plant showed highly significant and positive correlation among themselves indicating that simultaneous selection for these characters would result in improvement of high yielding soybean genotypes.

Path analysis was carried out to find out the direct and indirect effects of various characters and the data is presented in Table 2. The characters pods per plant (0.8612), 100 seed weight (0.2476) and days to 50% flowering

Table 1: Genotypic correlation of 11 characters in 30 genotypes of soybean.

Observations	Days to 50% flowering	Nodulation count per plant at 50 % flowering	Days to maturity	Plant height (cm.)	Branches per plant (No.)	Pods per plant (No.)	100 seed weight (g)	Pod Blight Incidence (%)	Protein content (%)	Oil content (%)	Seed yield per plant (g)
Days to 50% flowering	1.000	0.0056	0.4664**	0.1822	-0.1662	-0.2518*	0.1448	-0.1565	0.1687	-0.0169	0.0276
Nodulation count per plant at 50% flowering		1.000	0.1568	-0.2505*	-0.2446*	0.0488	0.1781	0.2233*	-0.0621	0.2169*	0.0882
Days to maturity			1.000	0.3011**	-0.2364*	-0.1906	-0.1311	0.1480	0.0885	-0.1585	-0.1566
Plant height (cm)				1.000	0.3078**	0.2221*	-0.2624*	-0.1092	-0.2948**	-0.0718	0.1784
Branches per plant (No.)					1.000	0.1748	0.0478	0.0008	-0.0468	-0.1771	0.2836**
Pods per plant (No.)						1.000	0.1645	0.1080	-0.3281**	0.0803	0.8471**
100 seed weight (g)							1.000	-0.0936	-0.1820	0.2956**	0.4087**
Pod blight incidence (%)								1.000	0.0502	0.0274	0.0520
Protein content (%)									1.000	-0.7262**	-0.1600
Oil content (%)										1.000	0.0194

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

Table 2: Direct (diagonal) and Indirect (above and below diagonal) path effects of different characters towards seed yield at genotypic level in soybean.

Character	Days to 50% flowering	Nodulation count per plant at 50% flowering	Days to maturity	Plant height (cm.)	Branches per plant (No.)	Pods per plant (No.)	100 seed weight (g)	Pod Blight Incidence (%)	Protein content (%)	Oil content (%)	Seed yield per plant (g)
Days to 50% flowering	0.2333	0.0013	0.1088	0.0425	-0.0388	-0.0587	0.0338	-0.0365	0.0394	-0.0039	0.0276
Nodulation count per plant at 50% flowering	0.0004	0.0698	0.0109	-0.0175	-0.0171	0.0034	0.0124	0.0156	-0.0043	0.0151	0.0882
Days to maturity	-0.0354	-0.0119	-0.0758	-0.0228	0.0179	0.0144	0.0099	-0.0112	-0.0067	0.0120	-0.1566
Plant height (cm.)	0.0097	-0.0133	0.0160	0.0532	0.0164	0.0118	-0.0140	-0.0058	-0.0157	-0.0038	0.1784
Branches per plant (No.)	-0.0251	-0.0369	-0.0357	0.0464	0.1509	0.0264	0.0072	0.0001	-0.0071	-0.0267	0.2836**
Pods per plant (No.)	-0.2169	0.0420	-0.1642	0.1913	0.1505	0.8612	0.1417	0.0930	-0.2826	0.0692	0.8471**
100 seed weight (g)	0.0359	0.0441	-0.0325	-0.0650	0.0118	0.0407	0.2476	-0.0232	-0.0451	0.0732	0.4087**
Pod Blight Incidence (%)	-0.0018	0.0026	0.0017	-0.0013	0.0000	0.0013	-0.0011	0.0117	0.0006	0.0003	0.0520
Protein content (%)	0.0276	-0.0101	0.0145	-0.0482	-0.0076	-0.0537	-0.0298	0.0082	0.1635	-0.1188	-0.1600
Oil Content (%)	0.0000	0.0006	-0.0005	-0.0002	-0.0005	0.0002	0.0008	0.0001	-0.0021	0.0028	0.0194

(R= 0.3435). *,** Significant at 5 and 1 per cent respectively.

(0.2333) had high to a moderate positive direct effect on seed yield per plant. Similar findings were reported by Ghodrati *et al.* (2013), Jain *et al.* (2015), Akram *et al.* (2016), Shekar *et al.* (2018) and Parihar *et al.* (2020) for pods per plant.

Days to maturity had a negative direct effect (-0.0758) on seed yield per plant. Similar result was obtained by Mukhekar *et al.* (2004) and Malik *et al.* (2006).

This suggests true and perfect relationship between yield and these characters. Thus, direct selection based on these characters would help in selecting for high yielding genotypes of soybean.

The days to 50% flowering had positive and low indirect effect on seed yield per plant *via* days to maturity (0.1088). Nodulation count per plant at 50% flowering showed negligible positive indirect effect on seed yield per plant *via* days to 50% flowering, days to maturity, pods per plant, pod blight incidence, 100 seed weight and oil content. Days to maturity exhibited negligible positive indirect effect *via* branches per plant, pods per plant, 100 seed weight and oil content.

Plant height had a negligible positive indirect effect on seed yield through days to 50% flowering, days to maturity, branches per plant and pods per plant. Branches per plant showed a negligible positive indirect effect on seed yield *via* plant height, pods per plant, pod blight incidence and 100 seed weight. Pods per plant had a low and positive effects on seed yield per plant through plant height (0.1913), branches per plant (0.1505) and 100 seed weight (0.1417) and a moderate negative indirect effect through protein content (-0.2826) and days to 50% flowering (-0.2169). It showed a low negative indirect effect *via* days to maturity (-0.1642). Pod blight incidence had negligible positive and indirect effects *via* nodulation count per plant at 50% flowering, days to maturity, pods per plant, protein content and oil content. 100 seed weight had a negligible positive indirect effect *via* days to 50% flowering, nodulation count per plant at 50% flowering, branches per plant, pods per plant and oil content. Protein content had low negative indirect effect through oil content (-0.1188) and contributed positively but negligibly through days to 50% flowering, days to maturity and pod blight incidence. Oil content had a negligible positive indirect effect *via* nodulation count per plant at 50% flowering, pods per plant, pod blight incidence and 100 seed weight on seed yield per plant.

The characters number of pods per plant, *via* plant height, branches per plant, 100 seed weight, protein content, days to 50% flowering and days to maturity; days to 50% flowering *via* days to maturity and protein content *via* oil content had significant indirect effect on seed yield per plant. Similar findings were reported by Gohil *et al.* (2003), Machikowa and Laosuwan (2011) and Jain *et al.* (2015) for pods per plant.

CONCLUSION

The above results reveal that almost all traits were positively correlated with seed yield per plant except days to maturity

and protein content. Also, the characters pods per plant, 100 seed weight and days to 50% flowering had a positive direct effect on seed yield per plant. Therefore, improvement in seed yield can be achieved by selecting the characters pods per plant, 100 seed weight and days to 50% flowering directly.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of the article.

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