



Determination of Correlation and Path Coefficient for Seed Yield and it's Contributing Characters in Soybean Germplasm

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ABSTRACT

Background: Soybean is one of the world's most important legumes contributing significantly as an oilseed in terms of total production and international trade. It is a multipurpose crop. Selection of genotypes with higher yield is always given priority by breeders for developing high yielding varieties. The present experimentation was conducted to know character association and path coefficient analysis among yield and its components for enhancing the usefulness of selection criterion to be followed during development of cultivars.

Methods: The experimental material consisted of 32 soybean genotypes sown at Sipani Krishi Anusandhan Farm, Changli, Mandsaur Madhya Pradesh in Kharif season, 2022 in RBD with three replication. The character association and path coefficient was analysed between seed yield and nine yield attributing quantitative characters.

Result: Grain yield per plot showed highly significant and positive correlation with number of primary branches per plant (0.501** and 0.444**), number of pods per plant (0.714** and 0.684**), number of pods per cluster (0.709** and 0.673**), number of nodes per plant (0.746** and 0.687**) and plant height (0.253* and 0.214*) respectively at both the genotypic and phenotypic levels.

Out of ten, five characters had positive direct effect on seed yield per plot. Highest positive direct effect on seed yield per plot was exhibited by number of pods /plant followed by number of nodes /plant, number of primary branches per plant, number of pods /cluster, days to 50% pod initiation.

Key words: Correlation Coefficient, Genotypes, Path Coefficient, Seed Yield, Soybean.

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill., 2n=40] is one of the world's most important legume contributing significantly as an oilseed for trade and production (Mishra and Patidar 2023; Bairagi *et al.*, 2023). In, India, among eight annual edible oilseed, soybean is the first largest oilseed crop followed by Rapeseed-Mustard (Mandal *et al.*, 2022). It is also known as a 'miracle crop' due to its agricultural, medicinal and industrial properties (Suresh and Basavaraja 2019; Kumawat *et al.*, 2023). It has an average protein content of 40 per cent and is more protein rich than any of the other common plant's protein food sources and equivalent to animal protein in vegetarian diets (Huges *et al.*, 2011, Messina, 2016, Watanabe *et al.*, 2017 and Wiederstein *et al.*, 2023). In diet of human, around 70 per cent of the total protein is shared by soya (Wiederstein *et al.*, 2023). Soybean seeds also contain about 20 per cent oil on a dry matter basis of which 85 per cent is unsaturated and cholesterol free (Suresh and Basavaraja, 2019). Thus, low saturated fat content along with rich source of vitamin nutrition, its oil is also rich in contents that have additional health benefits (Jooyandeh, 2011; Sharma, 2023). Soybean cultivation has expanded due to its demand for meal and vegetable oil.

Among a series of routine activities in the breeding program, selection is the most important step for obtaining high yielding genotypes (Sulistyo *et al.*, 2018). The effectiveness of selection is determined by the selection

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criteria used. Determining selection criteria can be done in various ways. Knowledge of correlation is needed as a basis for planning a more efficient selection program. Because knowledge of traits associated with grain yield allows the breeder to use additional information to precisely promote accessions of interest (Bisinotto *et al.*, 2017). So, correlation of traits with pod yield in soybean and other legumes is an important component for selecting high yielding cultivars (Thakur *et al.*, 2023). Analysis of simple correlation coefficients does not represent the relationship of cause and effect between characters (Rodrigues *et al.*, 2010). It is because the high correlation between two characters can

be misleading due the indirect effect promoted by other features (Dewey and Lu 1959). Therefore, the direct and indirect effects of agronomic traits with seed yield also need to be known in determining selection criteria. Wright (1921) developed a method in order to better understand the causes of associations between characters originated from the analysis of correlations, which is called path analysis. This method allows unfolding the correlations into direct and indirect effects of variables in just on a base variable (Wright 1921). If association is due to direct effect, it shows true relationship and selection is focused for such a trait for improving seed yield (Singh *et al.*, 2022). Thus the present investigation was undertaken with an aim to characterize soybean genotypes at morphological level with the objectives to determine correlation and path coefficient for yield and yield related traits.

MATERIALS AND METHODS

Collection of germplasm and experimental site

The experimental material was consisted of 32 soybean genotypes, collected and sown at the IARI - SKAF, Changli, Mandasaur (M.P.) -India in the *kharif* season 2022 in RBD with three replications. Each genotype was grown in six rows of four meter length with row to row and plant to plant spacing of 45 cm and 10 cm respectively. Observations were recorded for randomly selected ten individual plants of each genotype on whole plot from per plot and tagged from each replication for ten characters *viz.*, days to 50% flowering, days to 50% pod initiation, plant height (cm), number of nodes per plant, number of pods per cluster, number of pods per plant, days to maturity, grain yield (Gm), number of primary branches per plant, 100 seed weight (gm). Number of days to 50% flowering was counted from the date of sowing to the date on which 50% plants of a plot completed the opening flower for each genotype. Number of days taken to 50% pod initiation was counted from the date of sowing to the date on which 50% plants of a plot completed the pod initiation for each genotype. The plant height was measured in centimeters from the base of the plant to the top of the main stem at termination point of trifoliate leaf. The number of nodes per plant was counted from the base of the primary branches to the top of the plants of randomly selected ten plants and there mean performance was analyzed. Numbers

of pods per cluster of ten plants were taken randomly, number of pods was counted in from each cluster and average was worked out. Number of pods per plant of all randomly selected was measured during maturity stage of crop. Number of days attained to physical maturity was counted on randomly selected plants from the date of sowing to the date of maturity when leaves of the plants turn from green to yellowish color and pod turn into brownish color. Randomly ten selected plants were counted for each genotype from each plot and numbers of primary branches per plant were counted from main stem. For 100 Seed Weight (gm), randomly ten plants were counted for each genotype from each plot and weighed in grams after air drying using electronic single pan balance of Aczet Pvt Ltd. (Model CG203L). For character, grain yield, manually counted the number of plant in selected plot and average was estimated in gram after air drying.

Experimental material

In the present investigation seed of thirty two diverse genotypes/varieties of *Glycine max* L. Merrill were procured from different geographical sources listed in Table 1.

Statistical analysis

The mean data was estimated according to Gomez and Gomez (1984). The correlation coefficients were calculated using the variance and co-variance components (Robinson *et al.*, 1951).

Path-coefficient analysis

The genotypic coefficients were used to work out path-coefficient analysis (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

Grain yield is a complex character and is highly influenced by environment. Moreover, this character is intricate in inheritance and may involve several related quantitative characters. Hence, correlation coefficient analysis is widely used to measure the degree and direction of relationship between various characters and grain yield. In present experiment, grain yield per plot showed highly significant and positive correlation with number of primary branches per plant (0.501** and 0.444**), number of pods per plant (0.714** and 0.684**), number of pods per cluster (0.709**

Table 1: Name of 32 genotypes of *Glycine max* L. Merrill used for study.

S.No	Name of genotypes	S. No	Name of genotypes	S. No	Name of genotypes	S. No	Name of genotypes	S. No	Name of genotypes
1	SKF-7T	8	SKF-403	15	SKF-6128	22	SKAF-Exo-99	29	SKAF-616
2	SKF-340	9	SKF-6017	16	SKF-601	23	JS-95-60 ©	30	Kuber
3	NRC-86	10	SKF-6035	17	SKF-449	24	SKAF-208	31	Chamtkar
4	SKF-Exo-142	11	SKF-206	18	SKF-75-46	25	SKAF-409	32	JS-335 ©
5	SKF-470	12	SKF-221	19	NRC-181	26	SKAF-Exo-131		
6	SKF-2012	13	SKF-547	20	SKAF-623	27	SKAF-6038		
7	SKF-6125	14	SKF-535	21	SKAF-BS-6	28	SKAF-2007		

and 0.673**), number of nodes per plant (0.746** and 0.687**) and plant height (0.253* and 0.214*) respectively at both the genotypic and phenotypic levels (Table 2 and Table 3). It is indicating that selection of plants with a higher number of primary branches per plant, number of pods per plant, number of pods per cluster, number of nodes per plant and plant height would result more productive plants. So, these characters may serve as a marker/indicator for the improvement of soybean grain yield. The results obtained from this study are in agreement with the results of Saharan *et al.* (2006), Okonkwo *et al.* (2013), Barh *et al.* (2014), Mahbub *et al.* (2015), Chavan *et al.* (2016), Neelima *et al.* (2017) and Dvorjak *et al.* (2019) for number of pods per plant, Okonkwo *et al.* (2013), Ghodrati (2013) and Neelima *et al.* (2017) for number of nodes per plant, Ganesamurthy and Seshadri (2004), Balla and Ibrahim (2017) for plant height and number of pods per plant. This suggests that while selecting for improvement in seed yield these characters can be kept in mind provided the character should show high variability in correlation which is basis for selection. Path analysis of nine quantitative characters with grain yield (gm) is presented in Table 4 and Table 5.

Path analysis depicted that out of nine, five characters had positive direct effect on seed yield per plot. Highest positive direct effect on seed yield per plot was exhibited by number of pods /plant (0.4197) followed by number of nodes /plant (0.3546), number of pods /cluster (0.2101) number of primary branches per plant (0.1658) and days to 50% flowering (0.1017). Neelima *et al.* (2017) also observed positive effect of pods per plant on seed yield. Similarly Chavan *et al.* (2016); Baig *et al.* (2017); Khan *et al.* (2022) also reported positive direct of days to 50% flowering and number of pods per plant on seed yield. The phenotypic path coefficient analysis revealed that the number of pods per plant exhibited high and positive direct effects on seed yield. The character number of pods per plant also expressed highly significant positive correlation with seed yield. This trait turned out to be major component of seed yield for direct selection. Character, number of pods per plant is the most influential character in soybean yield improvement because it is the major production component that imposed the highest direct effect on the grain yield (0.3546). Similar results has been reported by for number of pods per plant by Patil *et al.* (2011), Haghi *et al.* (2012), Baraskar *et al.* (2014), Jain *et al.* (2017), Neelima *et al.* (2017), Dubey *et al.*, (2018), Dvorjak *et al.* (2019), Bhuva *et al.* (2020). The character, number of primary branches per plant depicted low and positive direct effect towards seed yield. Similar finds was registered by Gaikwad *et al.* (2007) and Bhuva *et al.* (2020).

Highest negative direct effect on seed yield was recorded by days to 50% pod initiation (-0.3169) followed by days to maturity (-0.0138), plant height (-0.0311) and 100 Seed weight (gm) (-0.0856) as presented in Table 4. However, among these four characters which have directly impact on seed yield, characters namely plant height was significant and positive associated (0.214*) with seed yield and days to

Table 2: Genotypic Correlation for ten characters in soybean under field condition.

Characters	Days to 50% flowering	Days to 50% pod initiation	Plant height (cm)	No. of nodes /plant	No. of pods/ cluster	No. of pod/ plant	Maturity (days)	N/o primary branches /plant	100 seed weight (g)	Grain yield (gm)
Days to 50% flowering	1.000	1.046**	-0.067	0.057	0.298**	0.144	0.442**	0.067	-0.087	-0.059
Days to 50% pod initiation			-0.045	0.186	0.310**	0.197	0.686**	-0.101	-0.032	-0.059
Plant Height (cm)				0.281**	0.286**	0.210*	-0.031	0.075	-0.031	0.253*
No. of nodes /plant					0.724**	0.455**	-0.038	0.489**	-0.008	0.746**
No. of pods /cluster						0.682**	0.223*	0.309**	-0.112	0.709**
No. of pod/plant							0.281**	0.251*	0.017	0.714**
Maturity (days)								-0.141	-0.040	-0.015
N/o primary branches/plant									0.130	0.501**
100 seed weight (g)										-0.044
Grain yield (gm)										1.000

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

Table 3: Phenotypic correlations for ten characters in soybean under field condition.

Characters	Days to 50% flowering	Days to 50% pod initiation	Plant height (cm)	No. of nodes /plant	No. of pods /cluster	No. of pod /plant	Maturity (days)	N/o primary branches /plant	100 seed weight (g)	Grain yield (gm)
Days to 50% flowering	1.000	0.705**	-0.082	0.103	0.255*	0.125	0.370**	0.014	-0.148	0.033
Days to 50% pod initiation			-0.116	0.084	0.299**	0.143	0.407**	0.015	-0.072	-0.086
Plant height (cm)				0.219*	0.234*	0.212*	-0.113	0.023	0.043	0.214*
No. of nodes /plant					0.605**	0.402**	0.100	0.374**	0.014	0.687**
No. of pods /cluster						0.631**	0.139	0.309**	-0.124	0.673**
No. of pod/plant							0.184	0.207*	0.033	0.684**
Maturity (days)								-0.129	-0.122	0.030
N/o primary branches/plant									0.041	0.444**
100 seed weight (g)										-0.078
Grain yield (gm)										1.000

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

Table 4: Phenotypic path of nine quantitative characters with grain yield (gm) in soybean.

Characters	Days to 50% flowering	Days to 50% pod initiation	Plant height (cm)	No. of nodes /plant	No. of pods /cluster	No. of pods /plant	Maturity (days) /Plant	No primary branches	100 seed weight (g)	R with grain yield (gm)
Days to 50% flowering	0.1017	-0.2235	0.0026	0.0365	0.0537	0.0525	-0.0051	0.0023	0.0126	0.033
Days to 50% pod initiation	0.0717	-0.3169	0.0036	0.0298	0.0628	0.0602	-0.0056	0.0025	0.0062	-0.086
Plant height (cm)	-0.0084	0.0367	-0.0311	0.0775	0.0491	0.0891	0.0016	0.0038	-0.0037	0.214*
No. of nodes /plant	0.0105	-0.0267	-0.0068	0.3546	0.1270	0.1686	-0.0014	0.0620	-0.0012	0.687**
No. of pods /cluster	0.0260	-0.0948	-0.0073	0.2145	0.2101	0.2648	-0.0019	0.0513	0.0106	0.673**
No. of pods/plant	0.0127	-0.0455	-0.0066	0.1425	0.1326	0.4197	-0.0025	0.0344	-0.0028	0.684**
Maturity (days)	0.0376	-0.1289	0.0035	0.0356	0.0292	0.0773	-0.0138	-0.0214	0.0104	0.030
No primary branches/plant	0.0014	-0.0048	-0.0007	0.1325	0.0650	0.0870	0.0018	0.1658	-0.0035	0.444**
100 seed weight (gm)	-0.0150	0.0229	-0.0013	0.0048	-0.0261	0.0137	0.0017	0.0068	-0.0856	-0.078

Resi = 0.224

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

Table 5: Genotypic path of nine quantitative characters with grain yield (gm) in soybean.

Characters	Days to 50% flowering	Plant height (cm)	No. of nodes /plant	No. of pods /cluster	No. of pods /plant	Maturity (days)	N/o primary branches/plant	100 seed weight (gm)	R with Grain Yield (gm)
Days to 50% flowering	-0.2339	0.0010	0.0183	0.0525	0.0642	-0.0323	0.0133	0.0068	-0.059
Days to 50% pod initiation	-0.2446	0.0007	0.0602	0.0546	0.0881	-0.0502	-0.0199	0.0025	-0.059
Plant height (cm)	0.0157	-0.0151	0.0907	0.0504	0.0938	0.0023	0.0149	0.0024	0.253*
No. of nodes /plant	-0.0132	-0.0042	0.3231	0.1275	0.2031	0.0028	0.0969	0.0006	0.746**
No. of pods /cluster	-0.0697	-0.0043	0.2339	0.1761	0.3044	-0.0163	0.0613	0.0087	0.709**
No. of pods/plant	-0.0336	-0.0032	0.1470	0.1201	0.4464	-0.0206	0.0497	-0.0013	0.714**
Maturity (days)	-0.1033	0.0005	-0.0124	0.0393	0.1254	-0.0732	-0.0280	0.0031	-0.015
N/o primary branches/plant	-0.0157	-0.0011	0.1581	0.0545	0.1119	0.0103	0.1981	-0.0101	0.501**
100 seed weight (gm)	0.0204	0.0005	-0.0025	-0.0198	0.0077	0.0030	0.0257	-0.0778	-0.044

Resi = 0.204.

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

maturity was only positive associated (0.030) at phenotypic level with seed yield, because of the minor cumulative positive indirect effect via other characters except days to 50% flowering (-0.0084) and 100-seed weight (-0.0037) in phenotypic path for character plant height and days to 50% pod initiation (-0.1289) and number of primary branches per plant (-0.0214) for days to maturity. Similar negative effect on seed yield was also recorded by Khan *et al.* (2022) for characters plant height and days to maturity respectively, for plant height by Shrivastava *et al.* (2001), Balla and Ibrahim (2017) and Chavan *et al.* (2016) for plant height and 100 seed weight by Bhuva *et al.* (2020) in soybean. The above results reveal that the characters number of pods /plant, number of nodes /plant, number of pods /cluster, number of primary branches per plant and days to 50% flowering are directly affecting to seed yield. These characters will be fruitful for identification and further selection of high yielding genotypes. So, improvements in seed yield, this information may be used in determine selection criteria in soybean breeding program. A considerable amount of residual effects was observed at both genotypic and phenotypic levels showing the contribution of other traits for seed yield than the traits observed in the investigation.

CONCLUSION

The trait, number of pods per plant exhibited highest and positive direct effects on seed yield as well as expressed highest significant positive correlation with seed yield. This trait turned out to be major component of seed yield for direct selection. The other biometrical traits like number of nodes per plant, number of pods per cluster and number of primary branches per plant due to significant positive correlation and direct effect on seed yield are other components for direct selection of good genotypes in soybean breeding programme.

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Conflict of interest

The authors declare no conflicts of interest.

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