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CORRELATION, INTERGENERATION CORRELATION AND PATH ANALYSIS STUDIES FOR YIELD AND YIELD ATTRIBUTING TRAITS IN F₄ AND F₅ GENERATIONS OF SOYBEAN

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ABSTRACT

Breeding effort was attempted during *kharif* 2022 and summer 2023 to spot the role of independent traits on seed yield and also to know the direct and indirect impacts among the productivity traits. Productive pods per plant registered highly significant and optimistic association with seed yield per plot and branches per plant. Whereas, plant branches unveiled highly notable and positive affiliation with seed yield per plot. The path coefficient analysis registered that productive pod per plant, test weight and plant stature showed strong and favourable direct influences on seed yield per plot. All the traits in both the crosses under study displayed a strong and positive intergenerational correlation coefficient between the F₄ and F₅ generations. Henceforth, highest coefficient of regression values was registered for height of the plant and productive pods per plant. Hence, these traits were confounded by additive gene action and we can rely upon these traits in future for further crop improvement.

Keywords : Additive gene action, soybean, intergeneration correlation, regression coefficient.

Introduction

Soybean [*Glycine max* (L.) Merrill] is considered as “Great Treasure” for its multiple uses. The two important parameters (oil and protein) in a single crop, soybean plays a substantial role in the global agricultural economy. It is mainly popular as oilseed crop rather than a pulse crop because of its extraordinary oil quality. It belongs to genus *Glycine*, species *max*, family Leguminosae, sub-family Papilionoidea and tribe Phaseoleae. The sub genus *Glycine* consists of several (about 22) wild perennial species. Both the species *Glycine max* and *Glycine soja* hybridize readily. *Glycine max* (diploid) and *Glycine soja* (diploid), chromosome number 2n=40.

The productivity of soybean in our country is quite low as compare to other top leading countries of the world. Hence, scope has to be needed to enhance the yield. Selection based solely on yield is ineffective. Hence, selection based on the independent traits might be effective (Spoorthi *et al.*, 2025). To know the contribution of each independent characters on seed

yield, association studies should be studied. Further path analysis can reveal whether this association is direct from particular trait or indirect through any other component traits. So, correlation and path analysis study of constituent traits of interest can provide wider understanding towards soybean genetic improvement. Since, soybean is a prominent self-pollinated crop, by F₄ and F₅ generations, majority of the loci attain homozygosity. Therefore, family mean of selected genotypes in F₄ generation and the corresponding mean in F₅ generation was considered for the calculation of intergeneration correlation. The narrow sense heritability of measurable traits in crop species is often estimated using parent-offspring regression.

Materials and Methods

The contemporary problem was assessed out during *kharif* 2022 and summer 2023 at Botany Garden, Department of Genetics and Plant Breeding, UAS, Dharwad. The investigational material for the present scenario encompassed of F₄ and F₅ generation of two crosses, cross 1 (DSb 23 x MACS 1575) and

cross 2 (DSb 23 x MACS 1460) involving three diverse parents viz., DSb 23, MACS 1575 and MACS 1460. Among the parents, DSb 23 is highly resistant to rust with high yield potential. Whereas, MACS 1575 and MACS 1460 were early maturing but they were extremely susceptible to rust and low yielders. In F₄ generation, from cross 1, 22 genotypes and from cross 2, 14 genotypes were evaluated in *kharif* 2022 with two replications in a randomized completely block design for yield attributing traits. From the analysis of F₄ generation, 18 genotypes from cross 1 and 12 genotypes in cross 2 were selected based on their superiority and were further evaluated in summer 2023 for identification of high yielding genotypes.

Inter-character correlation analysis

The observable phenotypic correlation with yield of the crop were figured as per the recommended formula given by Weber and Moorthy.

$$\text{Phenotypic correlation } (r_{p_{12}}) = \frac{\text{Cov}_{p_{12}}}{\sqrt{\text{Var}_{p_1} \times \text{Var}_{p_2}}} \times 100$$

Where,

Cov p₁₂= Phenotypic covariance of character x₁ and x₂

Var p₁= Phenotypic variance of character x₁

Var p₂= Phenotypic variance of character x₂

Path coefficient analysis

In both the segregating populations path coefficient analysis was carried out using the simple correlation coefficient to know the direct and indirect effects of yield components on seed yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959). Standard path coefficients which are the standardized partial regression coefficients were obtained by solving the following set of 'p' simultaneous equation through the use of "DOO LITTLE TECHNIQUE" as described by Goulden (1959).

$$P_{01} + P_{02}r_{12} + \dots + P_{0p}r_{1p} = r_{01}$$

$$P_{01}r_{12} + P_{02} + \dots + P_{0p}r_{2p} = r_{02}$$

$$P_{01}r_{1p} + P_{02}r_{2p} + \dots + P_{0p} = r_{0p}$$

Where,

P₀₁, P₀₂ P_{0p} = Direct path coefficient of variable
1, 2 p on the dependent variable 0.

r₁₂, r₁₃.. r_{1p}...r_p (P-1) = Possible correlation coefficient
between various

independent variables.

r₀₁, r₀₂.....r_{0p} = The correlations between dependent
variable and independent variable.

The direct effect of ith variable via jth variable was worked out as (p_{0j} × r_{ij}). From the simultaneous equation, it is clear that the correlation coefficient is the sum of direct and indirect effects on dependent character. Residual effect (P_{20x}) was calculated as given below.

$$P_{20x} = 1 - (P_{21} + 2P_{01}P_{01} r_{12} + 2P_{01}P_{03} r_{13} \dots \dots \dots 2P_{02}P_{03}r_{23} + \dots \dots \dots P_{20p}).$$

Intergeneration correlation and narrow sense heritability

To know the correlation and narrow sense heritability of superior genotypes between F₄ and F₅ generation, which depicts the breeding value of the genotypes, intergeneration correlation and narrow sense heritability were calculated as follows,

$$\text{Integration correlation } (r) = b_{yx} \times \frac{\sigma_x}{\sigma_y} \times 100$$

Where,

$$b_{yx} = \frac{\text{Covariance of } xy}{\text{Variance of } x}$$

σ_x = standard deviation of x of F₄ generation.

σ_y = standard deviation of y of F₅ generation.

Narrow sense heritability was determined as per the formula given by Smith and Kinman (1965)

$$h^2 (F_4, F_5) = \frac{b_{xy}}{2r_{xy}}$$

Where,

b_{yx} = regression coefficient of F₅ progeny means on F₄
parental values for respective characters.

2r_{xy}= measure of degree of genetic relationship
between the parent (x) and its offspring (y).

Regressing the offspring means (y) of the F₅ generation on the plants (x) of the F₄ generation allowed the estimation of the gene action for each character between the F₄ and F₅ generations.

Results and Discussion

The outcomes outlined from the contemporary study have been accessible under the following subheads:

Correlation studies

The phenotypic correlations of F₄ and F₅ generations of both the crosses are accessible in Table 1 and Table 2. The seed yield has registered optimistic

association with test weight, branches per plant, productive pods per plant (Aditya *et al.*, 2011, Parmar *et al.*, 2014, Silva *et al.*, 2015, Chavan *et al.*, 2016, Painkra *et al.*, 2018) and plant height (Gohil *et al.*, 2003, Mukhekar *et al.*, 2004, Chandel *et al.*, 2005, Malik *et al.*, 2007) in both the crosses of two generations.

The 50% flowering had substantial and positive connotation with stature of the plant, branches and productive pods/plant but undesirable association with yield per plot and maturity of the crop (Table 1, Table 2). At the phenotypic level, there was a strong and positive correlation between the duration of the crop and plant height. However, height of the plant exhibited highly substantial and positive connotation with productive pods/plant, branches/plant and seed yield per plot. Productive Pods per plant were constructively associated with seed yield per plot and branches per plant. Whereas, branches per plant were unveiled substantial and optimistic relationship with seed yield per plot at phenotypic levels. Similar rapport has been conveyed earlier by Chavan *et al.* 2016, Ghanbari *et al.* 2018, Painkra *et al.* 2018.

Path analysis

The phenotypic correlation coefficients intended for various characters were analysed for partitioning the values into the direct and indirect effects. The results obtained for direct and indirect effects of different traits on seed yield per plot in F₄ and F₅ generation of both the crosses were accessible in Table 3 and Table 4.

The path coefficient analysis disclosed that productive pods/plant, test weight and plant height have a positive direct impact on seed yield per plot. Comparable result has been registered for productive pods/plant by Malik *et al.*, 2007, Baraskar *et al.*, 2015, Jain *et al.*, 2015, Silva *et al.*, 2015, Dubey *et al.*, 2018 in both the generations of two crosses. These traits turned out to be major components of seed yield for direct selection.

The 50% flowering expressed undesirable unswerving effects of very low magnitude on yield of the crop. However, branches/plant and duration of the crop exhibited low and positive direct impact towards seed yield per plot. Comparable results for branches/plant were obtained Kumar *et al.*, 2005, Gaikwad *et al.*, 2007, Akram *et al.*, 2016. The lingering effect was of low magnitude in both F₄ and F₅

generations of both the crosses signifies that the majority of the traits for improving crop yield have been encompassed in the path analysis.

Intergeneration correlation and narrow sense heritability

The intergeneration correlation and narrow sense heritability values for the two crosses are equipped in Table 5. Among two crosses studied, all the traits registered substantial and optimistic intergeneration correlation between F₄ and F₅ generations. Height of the plant and productive pods/plant registered highest regression coefficient value in both crosses (Table 5).

All the yield assigning traits displayed low to moderate values for narrow sense heritability. In both the crosses, maximum value for narrow sense heritability was registered for plant height (cross 1 - 46% and cross 2 - 49%) followed by pods/plant (cross 1 - 43% and cross 2 - 47%). The inclination observed for narrow sense heritability in the two crosses infers that height of the plant and productive pods/plant are controlled by additive gene action. Hence, these traits should give prior importance for selection of the high yielding plants.

From the above results, it would be reasonable to suggest that a breeder engaged in the improvement of soybean yield should lay greater emphasis on the productive pods/plant, height of the plant and test weight.

Conclusion

Highly substantial and optimistic phenotypical associations of plant yield were exhibited with association of plant height, productive pods/plant, branches/plant and test weight. Henceforward, breeder can rely upon these traits for increasing the crop production. The outcomes of path coefficient studies bared that for enhancement of seed yield in soybean through selection programme, more prominence would be given to productive pods/plant, test weight and height of the plant. The leftover effect of path analysis was of low extent suggesting that the most of the yield attributing traits have been comprised in the study of path analysis. Intergeneration correlation emphasis that we can rely upon pods/plant and height of the plant for yield improvement in further generations.

Table 1: Phenotypic correlation coefficients in F₄ and F₅ generations for seed yield and yield components in cross 1 (DSb 23 x MACS 1575) of soybean

Traits	Generation	Days to 50% flowering	Days to Maturity	Plant height	Number of branches /plant	Number of pods/plant	100 seed weight	Seed yield
Days to 50% flowering	F ₄	1						
	F ₅	1						
Days to Maturity	F ₄	0.411**	1					
	F ₅	0.523**	1					
Plant height	F ₄	0.410**	0.268	1				
	F ₅	0.411**	0.025	1				
Number of branches/plant	F ₄	0.338*	0.307*	0.535**	1			
	F ₅	0.403**	0.304*	0.095	1			
Number of pods/plant	F ₄	0.060	0.285*	0.368**	0.273*	1		
	F ₅	0.104	0.334*	0.437**	0.310	1		
100 seed weight	F ₄	0.036	0.310*	0.370**	0.145	0.397**	1	
	F ₅	0.271	0.249	0.388*	0.221	0.606**	1	
Seed yield	F ₄	-0.084	0.162	0.364*	0.405**	0.631**	0.492**	1
	F ₅	-0.078	0.153	0.538*	0.385*	0.700**	0.588**	1

*- Significant at 5 %, **- Significant at 1%

Table 2: Phenotypic correlation coefficients in F₄ and F₅ generations for seed yield and yield components in cross 2 (DSb 23 x MACS 1460) of soybean

Traits	Generation	Days to 50% flowering	Days to Maturity	Plant height	Branches /plant	Productive pods/plant	Test weight	Seed yield/plot
Days to 50% flowering	F ₄	1						
	F ₅	1						
Days to Maturity	F ₄	0.115	1					
	F ₅	0.202**	1					
Plant height	F ₄	0.299	0.308	1				
	F ₅	0.484**	0.250	1				
Branches/plant	F ₄	0.372*	0.380*	0.458*	1			
	F ₅	0.293	0.429*	0.559**	1			
Productive pods/plant	F ₄	-0.057	0.815**	0.517**	0.391*	1		
	F ₅	-0.047	0.850**	0.318	0.513**	1		
Test weight	F ₄	-0.153	0.512**	0.352*	0.143	0.754**	1	
	F ₅	-0.008	0.579**	0.368*	0.398*	0.713**	1	
Seed yield/plot	F ₄	-0.151	0.163	0.596**	0.416**	0.899**	0.752**	1
	F ₅	-0.146	0.113	0.520**	0.555**	0.904**	0.802**	1

*- Significant at 5 %, **- Significant at 1%

Table 3: Phenotypic path coefficient of different components of yield in F₄ and F₅ generations in Cross 1 (DSb 23 x MACS 1575) of soybean

Traits	Generation	Days to 50% flowering	Days to Maturity	Plant height	Branches /plant	Productive pods/plant	Test weight	Phenotypic correlation (r)
Days to 50% flowering	F ₄	-0.182	0.121	-0.128	0.036	0.045	0.024	-0.084
	F ₅	-0.194	0.188	-0.178	0.012	0.052	0.042	-0.078
Days to Maturity	F ₄	-0.034	0.070	-0.016	0.042	0.116	0.124	0.162
	F ₅	-0.102	0.050	-0.011	0.009	0.168	0.039	0.153
Plant height	F ₄	-0.016	0.110	0.189	-0.012	0.150	-0.057	0.364*
	F ₅	-0.080	0.009	0.432	0.003	0.119	0.055	0.538**
Branches/plant	F ₄	-0.028	0.083	0.016	0.136	0.111	0.088	0.405**
	F ₅	-0.078	0.109	0.041	0.156	0.135	0.022	0.385*
Productive pods/plant	F ₄	-0.005	0.077	-0.043	0.037	0.406	0.158	0.631**
	F ₅	-0.020	0.120	-0.103	0.006	0.503	0.194	0.700**
Test weight	F ₄	-0.003	0.084	0.065	0.030	0.161	0.155	0.492 **
	F ₅	-0.053	0.089	-0.155	0.004	0.304	0.399	0.588**

*- Significant at 5% **- Significant at 1%

Residual effect = F₄ – 0.22942 and F₅ – 0.26823Diagonal values represent direct effects in F₄ and F₅ generation

Table 4: Phenotypic path coefficient of different components of yield in F₄ and F₅ generations in Cross 2 (DSb 23 x MACS 1460) of soybean

Traits	Generation	Days to 50% flowering	Days to Maturity	Plant height	Branches /plant	Productive pods/plant	Test weight	Phenotypic correlation (r)
Days to 50% flowering	F ₄	-0.231	0.029	0.098	0.004	-0.020	-0.031	-0.151
	F ₅	-0.243	0.026	0.138	-0.039	-0.027	-0.002	-0.146
Days to Maturity	F ₄	-0.027	0.049	0.101	0.004	-0.059	0.095	0.163
	F ₅	-0.049	0.030	0.071	-0.057	0.064	0.054	0.113
Plant height	F ₄	-0.069	0.077	0.327	0.005	0.184	0.072	0.596**
	F ₅	-0.117	0.033	0.365	-0.074	0.215	0.098	0.520**
Branches/plant	F ₄	-0.086	0.094	0.120	0.120	0.139	0.029	0.416**
	F ₅	-0.071	0.056	0.140	0.132	0.192	0.106	0.555**
Productive pods/plant	F ₄	0.013	0.203	0.169	0.005	0.355	0.155	0.899**
	F ₅	0.012	0.111	0.091	-0.068	0.569	0.190	0.904**
Test weight	F ₄	0.035	0.127	0.115	0.002	0.267	0.206	0.752 **
	F ₅	0.002	0.075	0.105	-0.053	0.406	0.266	0.802**

*-Significant at 5% **-Significant at 1%

Residual effect = F₄ – 0.11292 and F₅ – 0.07120.

Diagonal values represent direct effect

Table 5: Intergeneration correlation (r) and narrow sense heritability (h²) between F₄ and F₅ generations of a cross 1 (DSb 23 X MACS 1575) and cross 2 (DSb 23 X MACS 1460) of soybean

Traits	DSb 23 X MACS 1575		DSb 23 X MACS 1460	
	r	NS(h ²) %	r	NS(h ²) %
Days to 50% flowering	0.76	25	0.88	35
Days to maturity	0.94	38	0.84	37
Plant height	0.98	43	0.97	47
Branches/plant	0.43	18	0.64	30
Productive pods/ plant	0.99	46	0.97	49
Test weight	0.42	29	0.87	42
Seed yield/plot	0.91	40	0.92	41

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