Eco. Env. & Cons. 30 (October Suppl. Issue) : 2024; pp. (S353-S357)
Copyright@ EM International
ISSN 0971–765X

DOI No. http://doi.org/10.53550/EEC.2024.v30i06s.052

Association of Characters and Path Analysis in French Bean (*Phaseolus vulgaris* L.) Genotypes

Himani Rana[1], D.K. Rana[2] and Chandni Negi[3*]

Department of Horticulture, HNB Garhwal Central University, Srinagar Garhwal 246 174, Uttarakhand, India

(Received 24 March, 2024; Accepted 3 June, 2024)

ABSTRACT

Yield is a composite characteristic that relies on multiple independent traits. An experimental study was conducted during the spring-summer season of 2023 at the Horticultural Research Centre, Department of Horticulture, HNB Garhwal University, Srinagar Garhwal, Uttarakhand, India, to assess the genotypic and phenotypic association among pod yield and its component characteristics in the selected French bean genotypes. Additionally, using path coefficient analysis, the study aimed to determine the impact of various component characteristics on yield, both directly and indirectly. Fifty French bean genotypes were evaluated for nine horticultural traits in a Randomized Complete Block Design. ANOVA showed significant differences in the genotypes for all the traits studied. In the current study, pod yield exhibited a positive and highly significant correlation with pod weight (0.788, 0.711), followed bylength of pod (0.520, 0.466) and the number of primary branches plant^{-1} (0.415, 0.340) at both the levels of genotypic and phenotypic, respectively. However, it exhibited a negative but highly significant correlation with plant height (-0.553, -0.529). Pod weight (0.546) had the highest positive direct effect on pod yield, followed by the number of days taken to first germination (0.241), plant height (0.189), and the number of primary branchesplant^{-1} (0.122). While the characteristics days to 50 percent germination (-0.719), days to first flowering (-0.555), pod width (-0.2013), and pod length (-0.0263) exhibited a negative direct effect on per plant pod yield. Hence, direct selection based on pod weight and the number of primary branches plant^{-1} and indirect selection for length of pod and plant height would be beneficial for the yield improvement of French beans.

Key words*: French bean, Correlation, Path coefficient analysis, Direct effect and indirect effect.*

Introduction

The French bean (*Phaseolus vulgaris* L.) is one of the most widely cultivated and nutritious vegetable and pulse crops globally. It is consumed as a vegetable when the pods are immature, delicate, and tender, or as a dry pulse when fully mature (Borang and Sharma, 2020). French bean seeds contain almost 21.1% of the protein in them. They also contain a significant amount of carbohydrate (69.9%), phosphorus (42.5 mg/100 g), and iron (12.4 mg/100 g). In addition, they have a high fibre content, minerals, antioxidants, and folates, are lower in calories, and provide nutritional advantages (Ali and Kushwaha, 1987; Thapa *et al.*, 2022). It is widely cultivated across Himachal Pradesh, Punjab, Uttarakhand, Haryana, Bihar, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, Tamil Nadu, and Andhra Pradesh (Basavaraj *et al.*, 2022). It is grown on 2.61 lakh hectares in India, producing 25.95 lakh metric tonnes with a productivity of 9.0 tonnes per hectare (Horticulture Statistics Division, 2020-21). The wide-

([1,3] Research Scholar, [2]Assistant Professor)

spread use of low-yielding cultivars across a large geographic region hinders French bean productivity, necessitating the breeding of new improved hybrids with increased productivity.

Yield is a composite characteristic that relies on multiple independent traits. It depends on genes and how traits interact with the environment. Understanding the relationships between traits is important for the indirect selection of traits that are difficult to access and exhibit low heritability in plant breeding (Bijalwan *et al.,* 2013; Kanwar *et al.,* 2017). In complex situations, correlation alone becomes insufficient for elucidating relationships among the traits. Consequently, path analysis of economic yield components in relation to overall yield becomes essential. The path analysis precisely estimates the direct and indirect contributions made by different components to the overall correlation towards yield. Therefore, the present research was conducted to estimate the correlation between pod yield and its components and to investigate the direct and indirect effects of various yield components on pod yield in selected genotypes of French bean.

Materials and Methods

The experiment was carried out in a randomised complete block design with three replications during the spring-summer season of 2023 at the Horticultural Research Centre, Department of Horticulture, HNB Garhwal University, Srinagar Garhwal, Uttarakhand, India. The present study utilized 40 French bean (*Phaseolus vulgaris* L.) genotypes sourced from the NBPGR, Regional Station, Shimla, along with 10 locally sourced genotypes from various locations in Uttarakhand, in addition to one standard variety (Contender) as a check.

Seeds were planted at a spacing of 50cm between rows and 30cm between individual plants in each plot of 1.5 x 1.5 m^2 in each replication, and the recommended amount of fertiliser was applied at various growth stages of the crop. Standard cultural, manual, and plant protection measures were used to maintain healthy crop growth. The observations were taken for five plants chosen randomly from each experimental plot within each replication, and their average was utilized for statistical analysis. Following nine horticultural traits were studied, Days taken to first germination, Days taken to 50% germination, Days taken to first flowering, Number of primary branches $plant^{-1}$, Plant height at harvest, Pod length (cm), Pod width (cm), Pod weight (g), per plant pod yield (g). The method suggested by Al-Jibouri *et al*. (1958) was adopted to determine the genotypic and phenotypic correlation coefficients. The approach of path coefficient analysis, proposed by Dewey and Lu (1959), was used to assess the relative effect of the eight components on yield, both directly (direct effects) and indirectly (via other traits).

Results and Discussion

Correlation analysis

In both the genotypic and phenotypic levels, correlation coefficients were used to estimate the relationships between the nine characters; the results are shown in Table 1. There is a strong inherent association between all of the variables in the current study, as evidenced by the genotypic correlation coefficients being higher than the phenotypic correlation coefficients (Noopur *et al.* 2019).

According to the current study, per plant pod yield exhibited a highly significant and positive correlation with pod weight (0.788, 0.711), followed by pod length (0.520, 0.466), and the number of primary branches $plant^{-1}$ (0.415, 0.340) at both the genotypic and phenotypic levels, respectively, as shown in Table 1. However, it exhibited a negative but highly significant relationship with plant height. (-0.553, -0.529). Mishra *et al*. (2008) and Aklade *et al*. (2018) reported similar outcomes for pod length; Aklade *et al*. (2018) also reported similar results for plant height. The findings for average pod weight and pod length were similar to Singh *et al.* (1994), Rai *et al*. (2006), Murry *et al*. (2022) in French bean, and Mishra *et al*. (2020) in cluster bean. Pod weight and perplant pod yield showed a positive and notable correlation with the number of primary branches $plant^{-1}$. Days to first flowering exhibited a significant negative correlation with the number of primary branches$plant^{-1}$, pod length, pod width, pod weight, and per plantpod yield. Plant height showed a highly negative but significant correlation with pod length, pod width, pod weight, and per plant pod yield. Similar findings were reported by Jhanavi *et al.* (2018) and Basavaraj *et al.* (2022), which align with the current findings. The correlation of pod length and pod weight was found to be similar to Singh *et al.* (1994), Yosef Alemu *et al.* (2017), and Basavaraj *et al*. (2022), who reported a positive cor-

relation between green pod weight and green pod length. Hence, consideration must be given to these characters, namely pod width, length of pod, numbers of primary branches plant^{-1}, and plant height, throughout the selection process in order to enhance the yield of the French beans.

Path coefficient analysis

The genotypic correlation coefficient between the yield of pods plant^{-1} and its component characteristics is further divided into direct and indirect effects. Table 2 presents the findings of the path analysis, detailing the effects (direct and indirect) of every characteristic under study on per plant pod yield. Among the eight characters analysed, four characters exhibited positive direct effect, while the remaining four characters showed negative direct effects on per plant pod yield. The highest positive direct effect was registered by singlepod weight, followed by days to first germination, plant height and number of primary branches plant^{-1}. Yosef Alemu *et al*. (2017) also observed the similar results for single green pod weight. Negative direct effect was recorded through days to 50% germination, days to first flowering, pod width and podlength. Similar findings were also reported by Angadi *et al*.

Table 1. Genotypic and Phenotypic Coefficients of Correlation between different traits.

S.No.	Characters	DTFG	DT50%G	DTFF	NPBPL	PH	PL	PW	PWT	PY
1	DTFG	G								
		P								
2	**DT50%G**	**G**	0.893**							
		P	0.748**							
3	**DTFF**	**G**	-0.124	-0.154						
		P	-0.041	-0.067						
4	**NPBPL**	**G**	0.180*	0.134	-0.374**					
		P	0.140	0.110	-0.289**					
5	**PH**	**G**	0.158	0.228**	0.562**	-0.614**				
		P	0.118	0.167*	0.491**	-0.516**				
6	**PL**	**G**	-0.090	-0.124	-0.430**	0.195*	-0.438**			
		P	-0.025	-0.014	-0.390**	0.158	-0.406**			
7	**PW**	**G**	-0.284**	-0.382**	-0.234**	0.004	-0.332**	0.212**		
		P	-0.095	-0.140	-0.163*	0.014	-0.259**	0.188*		
8	**PWT**	**G**	0.112	-0.038	-0.508**	0.478**	-0.564**	0.625**	0.146	
		P	0.093	-0.011	-0.411**	0.392**	-0.529**	0.540**	0.142	
9	**PY**	**G**	-0.160*	-0.299**	-0.633**	0.415**	-0.553**	0.520**	0.147	0.788**
		P	-0.104	-0.195*	-0.541**	0.340**	-0.529**	0.466**	0.135	0.711**

*Significance at 5% level, ** Significance at 1% level

1. DTFG Days taken to first germination, 2. DT50%G Days taken to 50% germination, 3. DTFF Days taken to first flowering, 4. NPBPL Number of primary branchesplant^{-1}, 5. PH Plant height, 6. PL Pod length (cm), 7. PW Pod width (cm), 8. PWTPod weight (g), 9. PY Pod yield/ plant (g).

Table 2. Genotypic Path Matrix of yield perplot

Characters	DTFG	DT50%G	DTFF	NPBPL	PH	PL	PW	PWT
DTFG	0.24087	-0.64225	0.06885	0.02184	0.02987	0.00236	0.05727	0.06119
DT50%G	0.21522	-0.71880	0.08555	0.01631	0.04294	0.00326	0.07697	-0.02052
DTFF	-0.02988	0.11079	-0.55501	-0.04546	0.10594	0.01130	0.04708	-0.27765
NPBPL	0.04327	-0.09640	0.20751	0.12158	-0.11576	-0.00513	-0.00080	0.26111
PH	0.03815	-0.16368	-0.31181	-0.07464	0.18857	0.01153	0.06693	-0.30772
PL	-0.02164	0.08923	0.23840	0.02371	-0.08264	-0.02630	-0.04267	0.34152
PW	-0.06851	0.27480	0.12980	0.00048	-0.06269	-0.00557	-0.20133	0.07998
PWT	0.02699	0.02701	0.28221	0.05814	-0.10627	-0.01645	-0.02949	0.54604
GCCT PY	-0.160*	-0.299**	-0.633**	0.415**	-0.553**	0.520**	0.147	0.788**

Residual are 0.13889

(2012) Lyngdoh *et al*. (2017) and Murry *et al*.(2022) for negative direct effect of pod length and days taken to first flowering on pod yield.

Days to first flowering, pod weight, days to 50% germination and the number of primary branchesplant^{-1} showed negative indirect effect on pod yield via plant height. A high and moderate indirect positive effect was recorded by pod weight on pod yield through pod length and number of primary branches plant^{-1} respectively. The number of days to first flowering had a moderately positive indirect effect on pod yield through factors such as pod weight, pod length, and the number of primary branchesplant^{-1}, but it had a high negative indirect effect through plant height. Similar results have been observed by Panchbhaiya *et al*. (2017) in French beans, Nagalakshmi *et al*. (2020) in cowpeas.

A low magnitude of residual effect (0.13889) implies that the casual traits explained about 86.11% of the variability in the pod yield, leaving 13.89% of the variability unexplained.

Conclusion

The experimental studies indicated that traits such as pod weight and the number of primary branches plant^{-1} that demonstrated a positive and significant correlation and had a positive direct effect on pod yield should be given prime importance and used as a selection criterion for improving per plant pod yield. Correlation coefficient for Pod length was positive, but the direct effect was negative and negligible, the indirect effect of days to first germination, days to 50% germination, days to first flowering and plant height seems to be the cause of correlation. Therefore, these factors would be considered simultaneously for selection. It is further concluded that the direct selection for number of primary branchesplant^{-1}and pod weight and indirect selection for pod length and plant height would likely be effective in increasing per plant pod yield during crop improvement program in French bean

Acknowledgement

We would like to express our deep gratitude to everyone who helped with this study. The invaluable guidance, insightful suggestions, and steadfast support from our adviser and the members of HNB Garhwal University's horticulture department have strengthened our work. Their unwavering commitment has been crucial in expanding our knowledge.

Conflict of Interest

Authors declare there is no conflict of interest.

References

Aklade, A.S., Patil, H.E., Sarkar, M. and Patel, B.K. 2018. Genetic variability, correlation and path analysis for yield and yield related traits in vegetable type French bean (*Phaseolus vulgaris* L.). *International Journal of Pure and Applied Bioscience*. 6(6): 25-32.

Ali, M. and Kushwaha, B.L. 1987. Cultivation of rabi rajmash in plains. *Indian Farming*. 31(2):20-23.

AlJibouri, H.A., Miller, P.A. and Robinson, H.F. 1958. Genotypic and environmental variances and covariances in an upland Cotton cross of interspecific origin. *Agronomy Journal*. 50(10): 633-636.

Angadi, P.K., Patil, M.G. and Angadi, A. 2012. Path Coefficient Analysis Studies in French Bean (*Phaseolus vulgaris* L.). *Asian Journal of Horticulture.* 7(1): 133-136.

Basavaraj, T., Vishnuvardhana and Shanwaz, A. 2022. Correlation studies of advanced mutants of French bean (*Phaseolus vulgaris* L.) for horticulture traits. *The Pharma Innovation Journal.* 11(9): 2387-2389.

Bijalwan, P. and Mishra, A.C. 2016. Correlation and Path Coefficient Analysis in Chilli (*Capsicum annuum* L.) for Yield and Yield Attributing Traits. *International Journal of Science and Research.* 5(3): 2319-7064.

Borang, B. and Sharma, Y.K. 2020. Evaluation of the Performance of French bean (*Phaseolus vulgaris L.*) varieties under Aluminium Stress Environment. *The Bioscan.* 15(2): 169-172.

Dewey, D.R. and Lu, K.H. 1959. A correlation and path analysis of components of crested wheat grass seed production. *Agronomy Journal*. 15: 515-518.

https://agricoop.nic.in/Government of India, Ministry of Agriculture & Farmers' Welfare, Department of Agriculture, Cooperation & Farmers' Welfare, Horticulture Statistics Division.

Jhanavi, D.R., Patil, H.B., Justin, P., Ranjitha, B.M., Kavyashree, N. and Priyanka. 2018. Correlation Studies for Growth, Yield and Quality Traits in French bean (*Phaseolus vulgaris L.*). *Environment and Ecology.* 36(3): 736-741.

Kanwar, R., Mehta, D.K and Sharma, R. 2017. Studies on variability, correlation and path coefficient analysis in French bean. *Journal of Hill Agriculture*. 8 (2): 138-143.

Lyngdoh, Y.A., Thapa, U., Shadap, A., Singh, J. and Tomar, B.S. 2017. Studies on genetic variability and character association for yield and yield related traits in french bean (*Phaseolus vulgaris* L.). *Legume Research.* 6(158): 810-815.

Mishra, S., Aghora, T.S. and Kumar, S.M. 2020. Genetic

variability, character association and path analysis for quantitative traits to breed vegetable type cluster bean (*Cyamopsis tetragonoloba). Indian Journal of Agricultural Sciences*.90(3): 537-540.

Mishra, S., Kumar, M. and Sahu, G.S. 2008. Relationships among yield contributing characters in pole type French bean (*Phaseolus vulgaris* L.). *Orissa Journal of Horticulture*. 36(2): 108-113.

Murry, N., Kanaujial, S.P., Jha1, A., Shah, P. and Ananda, A. 2022. Studies of Genetic Variability, Correlation and Path Coefficient for Various Characters in French Bean. *SAARC Journal of Agriculture*. 20(2):83-92.

Nagalakshmi, R.M., Kumari, R.U. and Kumar, R.A. 2020. Correlation and Path Analysis in Cowpea (*Vigna unguiculata* (L.) Walp). *The Bioscan*. 15(3): 397-401.

Noopur, K., Jawaharlal, M., Praneetha, S., Kashyap, P. and Somasundram, E. 2019. Genetic variability and character association studies in French bean (*Phaseolus vulgaris*) in Nilgiri hills of Tamil Nadu. *Indian Journal of Agricultural Sciences*. 89 (12):2009-13.

Panchbhaiya, A., Singh, D.K. and Jain, S.K. 2017. Inter-characters association studies for morphological, yield and yield attributes in the germplasm of french bean (*Phaseolus vulgaris* L.) in Tarai region of Uttarakhand, India. *Legume Research*. 40 (1): 196-199.

Rai, N. Asati, B.S., Singh, A.K. and Yadav, D.S. 2006. Genetic variability, character association and path coefficient study in pole type french bean. *Indian Journal of Horticulture*. 63(2): 188-191.

Singh, D.N., Nandi, A. and Tripathy, P. 1994. Genetic variability and character association in french bean (*Phaseolus vulgaris*). *Indian Journal of Agricultural Sciences*. 64(2): 114-116.

Thapa, R., Lamsal, A., Ghimire, J. and Chand, P.B. 2022. Evaluation of French Bean (*Phaseolus vulgaris* L.) Genotypes for Growth, Yield and Seed Production at Khumaltar. *Malaysian Journal of Halal Research Journal*. 5(1): 17-23.

Yosef, A., Sintayehu, A. and Lemma, D. 2017. Correlation and Path Analysis for Green Pod Yield and its Components in Snap Bean (*Phaseolus vulgaris* L.) Genotypes. *International Journal of Research in Agriculture and Forestry*. 4(1): 30-36.