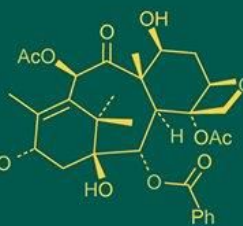


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Assessment of genetic variability, correlation and path analysis for yield and yield-attributing traits in French bean (*Phaseolus vulgaris* L.)

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Abstract

The study evaluated 26 French bean genotypes during Rabi 2024-25 at IGKV, Raipur in a Randomized Block Design with three replications. Significant variability was observed for all morphological, yield, and quality traits. High GCV, PCV, heritability, and genetic advance were recorded for pod yield per plant, number of pods per plant, pod weight, and pod length, indicating additive gene action. Pod yield per plant showed strong positive association and direct effects with number of pods per plant, pod weight, and pod length. Genotypes 2024/FBP VAR-3, 2024/FBP VAR-5 (pole types) and 2023/FBB VAR-1, 2023/FBB VAR-7, and 2022/FBB VAR-6 (bush types) were superior for yield and related traits and can be utilized in future improvement programs under Chhattisgarh conditions.

Keywords: Genetic variability, heritability, genetic advance, correlation, path coefficient analysis, yield-attributing traits

Introduction

French bean (*Phaseolus vulgaris* L.) is a diploid ($2n = 22$), herbaceous annual legume of the family Leguminosae, commonly known as kidney bean, snap bean or Rajmash in India (Schoonhoven and Voyset, 1991) [17]. It originated from *Phaseolus aborigineus*, with South Mexico and Central America as primary centres of origin and Peru and Ecuador as secondary centres (Vavilov). The crop grows best at 15-25 °C, while temperatures below 10 °C or above 35 °C cause flower drop and yield reduction (Duke and Kumar, 2022) [6].

In India, French bean is an important vegetable and cash crop grown mainly for tender pods, covering about 2.56 lakh ha with a production of 2.52 million tonnes (NHB, 2021). In Chhattisgarh, it occupies nearly 9.235 thousand ha (Anonymous, 2024) [1]. Major producing regions include Africa, the Americas, Eastern Asia and parts of Europe (Dursun, 2007) [7]. The crop also improves soil fertility through biological nitrogen fixation and contributes to food and nutritional security.

French bean is nutritionally rich, containing 1.7 g protein, 4.5 g carbohydrates, 1.8 g dietary fibre and 0.1 g fat per 100 g of edible portion, along with essential vitamins and minerals (Sardana *et al.*, 2000) [16]. Improvement in yield and quality depends on the magnitude of genetic variability present in the germplasm (Verma *et al.*, 2014; Devi *et al.*, 2012) [20, 4]. Estimates of genotypic and phenotypic variability, heritability and genetic advance assist in assessing selection efficiency, while correlation and path coefficient analyses help identify important yield-contributing traits for effective breeding programmes (Shukla *et al.*, 2006; Raffi and Nath, 2004; Buys *et al.*, 2002) [18, 14, 2].

Therefore, the present study was undertaken to evaluate diverse French bean genotypes for morphological, growth, yield and quality traits, to assess genetic variability and trait associations, and to identify superior genotypes and key yield-determining characters for varietal improvement under Chhattisgarh conditions.

Materials and Methods

Location and traits: The present study was conducted at the Horticulture Research cum Instructional Farm, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the Rabi season of 2024-25.

The experimental field had clay-loam soil with a pH of 7.09. The experiment was laid out in a Randomized Block Design (RBD) with three replications, using a plot size of 3m × 3 m and a spacing of 50 cm × 40 cm. A total of 26 genotypes of French beans, maintained by the Department of Horticulture, IGKV, Raipur, were used as planting material. Healthy seedlings of all genotypes were transplanted and uniformly managed following standard cultural practices. Data were recorded for 20 characters, including growth traits (germination percentage, plant height (45 DAS and 65 DAS), number of primary branches (45 DAS and 65 DAS), number of secondary branches (45 DAS and 65 DAS), number of leaves per plant (45 DAS and 65 DAS), days of first flower initiation, days of 50% flower initiation, days of first pod harvest, days of last pod harvest, number of pod per plant, pod length (cm), pod width (cm), pod weight (g), pod yield per plant (g), pod yield per plot (kg) and total yield (q/ha). The observations provided comprehensive information on morphological, yield, and quality traits of the 26 genotypes under Chhattisgarh conditions.

Statistical analysis: Statistical analysis was carried out on the mean values of five competitive plants randomly selected from each genotype in every replication, following the procedure outlined by Panse and Sukhatme (1967) [13]. The genotypic and phenotypic coefficients of variation were

estimated using the method described by Lush (1940) [10], while broad-sense heritability was calculated as per Hanson *et al.* (1956) [8]. Expected genetic advance (GA) was determined following the approach suggested by Johnson *et al.* (1955) [9]. The genotypic and phenotypic correlation coefficients among different traits were computed according to Miller *et al.* (1958) [11]. Further, the genotypic correlation coefficients were partitioned into direct and indirect effects through path coefficient analysis, as originally proposed by Wright (1921) [22] and subsequently elaborated by Dewey and Lu (1959) [5].

Results and Discussion

The results of analysis of variance (ANOVA) for all the characters studied are presented in Table No.1. Highly significant differences (at 1% level of significance) were observed among the twenty-six French bean genotypes for all growth, phenological, and yield-related traits, including germination percentage, plant height, number of primary and secondary branches, number of leaves, flowering and harvesting traits, pod characteristics, and yield parameters. The presence of significant variation for these traits indicates a wide range of genetic variability among the genotypes, providing sample scope for selection and improvement in French bean.

Table 1: Analysis of variation for yield and its components

Sl. No.	Source	Mean Sum of Squares (MSS)		
		MS Replication	MS Treatment	MS Error
	Degrees of freedom	2	25	50
1	Germination percentage	4.751	129.919**	36.943
2	Pant height (45 DAS)	4.654	2140.926**	8.862
3	Plant height (65 DAS)	140.915	13042.382**	56.491
4	No. of Primary branches (45 DAS)	0.114	4.508**	0.095
5	No. of Primary Branches (65 DAS)	0.048	6.665**	0.236
6	No. of secondary branches (45 DAS)	0.017	4.191**	0.032
7	No. of secondary branches (65 DAS)	0.021	5.853**	0.097
8	Number of leaves (45 DAS)	22.623	517.579**	9.395
9	Number of leaves (65 DAS)	46.987	2502.252**	20.474
10	Days of First Flower Initiation	0.433	24.212**	9.896
11	Days of 50% flower Initiation	4.508	101.205**	11.264
12	Days of First Pod Harvest	12.154	124.527**	15.698
13	Days of Last Pod Harvest	51.393	47.839**	19.74
14	Number of Pod Per Plant	25.314	168.765**	10.54
15	Pod Length (cm)	0.286	15.193**	1.421
16	Pod Width (cm)	0.001	0.08**	0.007
17	Pod Weight (g)	0.164	1.967**	0.221
18	Pod Yield Per Plant (g)	371.993	19395.777**	710.447
19	Pod Yield Per Plot (kg)	0.447	41.412**	0.767
20	Total Yield (q/ha)	243.411	4113.534**	278.673

*Significant at 5% level of significance, ** Significant at 1% level of significance

Table 2: Estimates of genetic parameters of variation for yield and its attributing traits in French bean

S. No.	Parameters	Mean	Range		CV15. %		Heritability (h ² b) %	Genetic Advance (GA @ 5%)	Genetic Advance as % of mean
			Minimum	Maximum	Genotypic	Phenotypic			
1	Germination percentage	77.782	58.003	88	7.157	10.597	45.62	7.746	9.958
2	Pant height (45 DAS)	45.799	27.57	110.98	58.208	58.569	98.768	54.578	119.167
3	Plant height (65 DAS)	69.435	33.18	215.36	94.754	95.37	98.712	134.656	193.931
4	No. of Primary branches (45 DAS)	4.689	2.8	7.8	25.865	26.687	93.936	2.422	51.641
5	No. of Primary Branches (65 DAS)	5.943	4	10.54	24.631	25.954	90.065	2.862	48.154
6	No. of secondary branches (45 DAS)	2.561	1.1	5.4	45.982	46.51	97.742	2.398	93.647
7	No. of secondary branches (65 DAS)	3.931	2.4	7.103	35.241	36.123	95.177	2.784	70.824
8	Number of leaves (45 DAS)	37.123	27.003	70.403	35.06	36.019	94.745	26.097	70.3
9	Number of leaves (65 DAS)	55.282	36.733	121.8	52.028	52.668	97.585	58.53	105.876
10	Days to First Flower Initiation	38.233	33.4	48.3	5.714	10.017	32.535	2.567	6.714
11	Days to 50% Initiation	49.318	40.13	59.737	11.102	13.022	72.689	9.617	19.499
12	Days to First Pod Harvest	56.313	43.197	68.6	10.695	12.802	69.796	10.366	18.407
13	Days to Last Pod Harvest	70.651	60.533	78.733	4.332	7.636	32.179	3.576	5.062
14	Number of Pod Per Plant	49.126	37.87	60.93	14.783	16.193	83.345	13.658	27.802
15	Pod Length (cm)	18.065	15.133	23.497	11.86	13.573	76.359	3.857	21.35
16	Pod Width (cm)	1.057	0.78	1.45	14.756	16.668	78.37	0.284	26.91
17	Pod Weight (g)	5.701	4.02	7.13	13.384	15.717	72.51	1.338	23.477
18	Pod Yield Per Plant (g)	285.276	152.237	427.73	27.665	29.2	89.761	154.029	53.993
19	Pod Yield Per Plot (kg)	11.6	5.48	18.823	31.731	32.617	94.64	7.376	63.59
20	Total Yield (q/ha)	135.126	82.113	205.843	26.459	29.201	82.101	66.735	49.388

Table 3: Genotypic coefficient (GVC) of correlation for yield and its attributing traits in French bean

Trait	GP	PH	PB	SB	NOL	DFI	DOFFI	DFPH	DLPH	NPP	PL	PW	PWT	PYP	PYPL	TY
GP	1	-0.011	0.468**	0.296*	0.076	0.366**	0.189	0.346**	0.329**	0.410**	0.306**	0.501**	0.587**	0.465**	0.532**	0.449**
PH		1	0.436**	0.808**	0.977**	0.371**	0.607**	0.537**	0.187	0.649**	0.672**	0.613**	0.450**	0.598**	0.509**	0.641**
PB			1	0.723**	0.522**	0.540**	0.461**	0.384**	0.169	0.645**	0.609**	0.736**	0.704**	0.749**	0.782**	0.743**
SB				1	0.860**	0.461**	0.533**	0.565**	0.291*	0.801**	0.733**	0.768**	0.709**	0.807**	0.798**	0.828**
NOL					1	0.404**	0.615**	0.551**	0.206	0.704**	0.702**	0.678**	0.527**	0.662**	0.582**	0.702**
DFI						1	0.527**	0.411**	0.242*	0.466**	0.432**	0.522**	0.496**	0.521**	0.539**	0.513**
DOFFI							1	0.612**	0.176	0.568**	0.553**	0.540**	0.547**	0.596**	0.539**	0.592**
DFPH								1	0.248*	0.600**	0.527**	0.559**	0.524**	0.596**	0.538**	0.594**
DLPH									1	0.342**	0.254*	0.333**	0.314**	0.339**	0.317**	0.313**
NPP										1	0.777**	0.809**	0.825**	0.898**	0.864**	0.911**
PL											1	0.795**	0.658**	0.785**	0.764**	0.836**
PW												1	0.848**	0.850**	0.838**	0.863**
PWT													1	0.871**	0.900**	0.873**
PYP														1	0.932**	0.949**
PYPL															1	0.932**
TY																1

*Significant at 5 % level of significance, ** Significant at 1 % level of significance

PH45D-Plant height per plant at 45 DAS	SB45D-Secondary branches per plant at 45 DAS	DFI-Days of first flower initiation	NPP-Number of pods per plant
PH65D-Plant height per plant at 65 DAS	SB65D-Secondary branches per plant at 65 DAS	DOFFI-Days of 50% flower initiation	PL-Pod length
PB45D-Primary branches per plant at 45 DAS	NOL45D-Number of leaves per plant at 45 DAS	DFPH-Days of first pod harvest	PW-Pod width
PB65D-Primary branches per plant at 65 DAS	NOL65D-Number of leaves per plant at 65 DAS	DLPH-Days of last pod harvest	PWT.-Pod weight
PYP-Pod yield per plant	YPL.-Pod yield per plot	TY-Total marketable yield	

Table 4: Phenotypic coefficient (PVC) of correlation for yield and its attributing traits in French bean

Trait	GP	PH	PB	SB	NOL	DFI	DOFFI	DFPH	DLPH	NPP	PL	PW	PWT	PYP	PYPL	TY
GP	1	-0.013	0.457**	0.284*	0.074	0.356**	0.177	0.337**	0.411**	0.318**	0.311**	0.496**	0.581**	0.447**	0.533**	0.452**
PH		1	0.455**	0.806**	0.977**	0.360**	0.595**	0.528**	0.176	0.611**	0.656**	0.584**	0.433**	0.570**	0.509**	0.643**
PB			1	0.721**	0.523**	0.526**	0.460**	0.384**	0.165	0.606**	0.584**	0.732**	0.702**	0.739**	0.782**	0.744**
SB				1	0.861**	0.460**	0.540**	0.568**	0.302**	0.808**	0.740**	0.777**	0.718**	0.816**	0.799**	0.830**
NOL					1	0.405**	0.615**	0.552**	0.209	0.707**	0.703**	0.682**	0.532**	0.664**	0.588**	0.703**
DFI						1	0.533**	0.409**	0.289*	0.463**	0.432**	0.524**	0.504**	0.522**	0.539**	0.515**
DOFFI							1	0.609**	0.263*	0.560**	0.557**	0.528**	0.554**	0.587**	0.539**	0.593**
DFPH								1	0.320**	0.593**	0.520**	0.560**	0.526**	0.590**	0.538**	0.595**
DLPH									1	0.346**	0.254*	0.337**	0.325**	0.338**	0.326**	0.314**
NPP										1	0.770**	0.813**	0.826**	0.899**	0.864**	0.911**
PL											1	0.795**	0.666**	0.785**	0.765**	0.836**
PW												1	0.845**	0.854**	0.838**	0.864**
PWT													1	0.873**	0.900**	0.875**
PYP														1	0.934**	0.950**
PYPL															1	0.933**
TY																1

*Significant at 5 % level of significance, ** Significant at 1 % level of significance

PH45D-Plant height per plant at 45 DAS	SB45D-Secondary branches per plant at 45 DAS	DFI-Days of first flower initiation	NPP-Number of pods per plant
PH65D-Plant height per plant at 65 DAS	SB65D-Secondary branches per plant at 65 DAS	DOFFI-Days of 50% flower initiation	PL-Pod length
PB45D-Primary branches per plant at 45 DAS	NOL45D-Number of leaves per plant at 45 DAS	DFPH-Days of first pod harvest	PW-Pod width
PB65D-Primary branches per plant at 65 DAS	NOL65D-Number of leaves per plant at 65 DAS	DLPH-Days of last pod harvest	PWT.-Pod weight
PYP-Pod yield per plant	YPL.-Pod yield per plot	TY-Total marketable yield	

The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all twenty characters studied (Table No.2), indicating the influence of environmental factors in addition to genetic variability. High GCV and PCV (>30%) were recorded for plant height at 65 DAS (94.754 and 95.37%), plant height at 45 DAS (58.208 and 58.569%), number of leaves per plant at 65 DAS (52.028 and 52.668%), number of secondary branches per plant at 45 DAS (45.982 and 46.51%) and 65 DAS (35.241 and 36.123%), number of leaves per plant at 45 DAS (35.06 and 36.019%), and pod yield per plot (31.731 and 32.617%), indicating high genetic variability. Moderate GCV and PCV (10-30%) were observed for pod yield per plant (27.665 and 29.2%), total marketable yield (26.456 and 29.201%), primary branches at 45 DAS (25.865 and 26.687%) and 65 DAS (24.631 and 25.954%), number of pods per plant (14.783 and 16.193%), pod width (14.756 and 16.668%), pod weight (13.384 and 15.717%), pod length (11.86 and 13.573%), days to 50% flowering (11.102 and 13.022%), and days to first pod harvest (10.695 and 12.802%). Low GCV and PCV (<10%) were noted for germination percentage (7.157 and 10.597%), days to first flower initiation (5.714 and 10.017%), and days to last pod harvest (4.332 and 7.636%), suggesting limited genetic variability.

Heritability, the ratio of genotypic to phenotypic variance, indicates the transmissibility of traits from parents to offspring and aids in effective selection. In the present study, broad-sense heritability estimates were categorized as high (>80%), moderate (50-80%), and low (<50%). High heritability was recorded for plant height at 45 DAS (98.768%) and 65 DAS (98.712%), number of secondary branches at 45 DAS (97.742%) and 65 DAS (95.177%), number of leaves at 65 DAS (97.585%) and 45 DAS (94.745%), pod yield per plot (94.64%), primary branches at 45 DAS (93.936%) and 65 DAS (90.065%), pod yield per plant (89.761%), number of pods per plant (83.345%), and total marketable yield (82.101%), indicating predominance of additive gene action. Moderate heritability was observed for pod width (78.37%), pod length (76.359%), days to 50% flowering (72.689%), pod weight (72.51%), and days to first pod harvest (69.796%), while low heritability was noted for germination percentage (45.62%), days to first flower initiation (32.535%), and days to last pod harvest (32.179%).

Genetic advance as percent of mean was high for plant height at 65 DAS (193.931%) and 45 DAS (119.167%), number of leaves at 65 DAS (105.876%), secondary branches at 45 DAS (93.647%), pod yield per plot (63.59%), pod yield per plant (53.993%), and primary branches at 45 DAS (51.641%), indicating effective selection response. Moderate genetic advance was recorded for total marketable yield (49.388%), primary branches at 65 DAS (48.154%), number of pods per plant (27.802%), pod width (26.91%), pod weight (23.477%), and pod length (21.35%), while low genetic advance was observed for flowering, harvesting, and germination traits, suggesting greater environmental influence.

Correlation analysis was carried out to determine the magnitude and direction of association among yield and yield-attributing characters at both genotypic (G) and phenotypic (P) levels (Table No. 3 and 4). Genotypic correlations were generally higher than phenotypic correlations, indicating greater genetic control over trait expression, which is in agreement with earlier findings of Dahiya *et al.* (2000) [3], Singh and Singh (2013) [19], Verma *et al.* (2014) [20] and Ramandeep *et al.* (2017) [15]. Germination percentage showed significant positive association with pod weight (0.587, 0.581), pod width (0.501, 0.496), number of pods per plant (0.410, 0.318), pod yield per plant (0.465, 0.447), pod yield per plot (0.532, 0.533) and total marketable yield per hectare (0.449, 0.452), while its association with plant height was non-significant. Plant height at 65 DAS exhibited strong positive correlation with number of leaves per plant (0.977, 0.977), number of secondary branches (0.808, 0.806), number of pods per plant (0.649, 0.611), pod length (0.672, 0.656), pod yield per plant (0.598, 0.570) and total marketable yield per hectare (0.641, 0.643). Similarly, number of primary and secondary branches showed highly significant positive association with pod yield per plot (0.782, 0.782; 0.798, 0.799), pod yield per plant (0.749, 0.739; 0.807, 0.816), number of pods per plant (0.645, 0.606; 0.801, 0.808) and total marketable yield per hectare (0.743, 0.744; 0.828, 0.830). Among yield components, number of pods per plant recorded the highest positive association with total marketable yield per hectare (0.911), followed by pod yield per plant (0.949, 0.950), pod yield per plot (0.932, 0.933), pod weight (0.873, 0.875), pod width (0.863, 0.864) and pod length (0.836), indicating their importance as reliable selection criteria for yield improvement in French bean.

Table 5: Path coefficient showing direct and indirect effects of different characters on yield in French bean

Trait	GP	PH	PB	SB	NOL	NFI	NOFFI	NFPH	NLPH	NPP	PL	PW	PWT	PYP	PYPL	TY
GP	-0.0148	0.0002	-0.0069	-0.0044	-0.0011	-0.0054	-0.0028	-0.0051	-0.0049	-0.0061	-0.0045	-0.0074	-0.0087	-0.0069	-0.0079	0.4487**
PH	-0.0002	0.0193	0.0084	0.0156	0.0188	0.0072	0.0117	0.0104	0.0036	0.0125	0.0130	0.0118	0.0087	0.0115	0.0098	0.6415**
PB	0.0150	0.0139	0.0320	0.0231	0.0167	0.0173	0.0148	0.0123	0.0054	0.0206	0.0195	0.0235	0.0225	0.0240	0.0250	0.7429**
SB	-0.0126	-0.0343	-0.0306	-0.0424	-0.0365	-0.0195	-0.0226	-0.0239	-0.0123	-0.0340	-0.0311	-0.0326	-0.0301	-0.0342	-0.0338	0.8276**
NOL	0.0066	0.0852	0.0455	0.0750	0.0872	0.0352	0.0536	0.0480	0.0179	0.0614	0.0612	0.0591	0.0460	0.0577	0.0507	0.7024**
NFI	-0.0018	-0.0019	-0.0027	-0.0023	-0.0020	-0.0050	-0.0026	-0.0020	-0.0012	-0.0023	-0.0022	-0.0026	-0.0025	-0.0026	-0.0027	0.5132**
NOFFI	-0.0058	-0.0186	-0.0141	-0.0163	-0.0188	-0.0161	-0.0306	-0.0187	-0.0054	-0.0174	-0.0169	-0.0165	-0.0167	-0.0182	-0.0165	0.5915**
NFPH	0.0063	0.0098	0.0070	0.0104	0.0101	0.0075	0.0112	0.0183	0.0045	0.0110	0.0097	0.0102	0.0096	0.0109	0.0099	0.5935**
NLPH	-0.0024	-0.0013	-0.0012	-0.0021	-0.0015	-0.0017	-0.0013	-0.0018	-0.0071	-0.0024	-0.0018	-0.0024	-0.0022	-0.0024	-0.0023	0.3134**
NPP	0.0583	0.0922	0.0917	0.1138	0.1000	0.0662	0.0807	0.0852	0.0486	0.1421	0.1105	0.1149	0.1172	0.1276	0.1227	0.9109**
PL	0.0519	0.1141	0.1034	0.1243	0.1191	0.0734	0.0938	0.0894	0.0430	0.1319	0.1697	0.1348	0.1116	0.1331	0.1296	0.8362**
PW	-0.0152	-0.0186	-0.0223	-0.0233	-0.0205	-0.0158	-0.0163	-0.0169	-0.0101	-0.0245	-0.0241	-0.0303	-0.0257	-0.0258	-0.0254	0.8625**
PWT	0.0848	0.0651	0.1017	0.1025	0.0762	0.0717	0.0791	0.0758	0.0453	0.1192	0.0951	0.1226	0.1446	0.1259	0.1301	0.8731**
PYP	0.1510	0.1943	0.2436	0.2624	0.2151	0.1693	0.1937	0.1937	0.1101	0.2918	0.2551	0.2764	0.2832	0.3250	0.3031	0.9492**
PYPL	0.1275	0.1221	0.1875	0.1913	0.1395	0.1291	0.1292	0.1290	0.0760	0.2070	0.1832	0.2009	0.2158	0.2235	0.2397	0.9321**
*Significant at 5 % level of significance, ** Significant at 1 % level of significance Residual value = 0.213																

Path coefficient analysis, as proposed by Wright (1921) [22], was used to partition correlation coefficients into direct and indirect effects in order to assess the true contribution of individual traits to total marketable yield, with greater emphasis on genotypic path coefficients as phenotypic associations are influenced by environmental factors (Table No. 5). At the genotypic level, pod yield per plant showed the highest direct positive effect on total marketable yield per hectare (0.325), followed by pod yield per plot (0.2397) and pod length (0.1697), while pod weight (0.1446), number of pods per plant (0.1421), number of leaves per plant at 65 DAS (0.0872), number of primary branches at 65 DAS (0.032), plant height (0.0193), days to first pod harvest (0.0183) and days to first flower initiation (0.0183) also exhibited positive direct effects. In contrast, germination percentage (-0.0148), number of secondary branches at 65 DAS (-0.0424), days to first flower initiation (-0.005), days to 50% flowering (-0.0306), days to last pod harvest (-0.0071) and pod weight (-0.0303) exerted negative direct effects. Pod yield per plant further showed strong positive indirect effects via pod yield per plot (0.3031), number of pods per plant (0.2918) and pod weight (0.2832), while pod length contributed indirectly through pod width (0.1348), pod yield per plant (0.1331) and number of pods per plant (0.1319); however, delayed flowering traits such as days to 50% flowering had negative indirect effects through pod yield per plant (-0.0182) and plant height (-0.0186). Overall, the results highlight pod yield per plant, pod length and pod weight as major determinants and reliable selection criteria for yield improvement in French bean.

Summary

The present investigation revealed substantial genetic variability among the French bean (*Phaseolus vulgaris* L.) genotypes for yield and yield-attributing traits. High estimates of GCV, PCV, heritability and genetic advance were recorded for characters such as number of pods per plant, pod yield per plant, pod yield per plot, average pod weight and total green pod yield, indicating predominance of additive gene action and effectiveness of direct selection. Correlation and path coefficient analyses revealed that pod yield per plant, number of pods per plant, pod weight, pod length and plant height exerted positive and direct effects on total yield, whereas delayed flowering traits showed negative effects. Overall, pod yield per plant, pod weight and number of pods per plant emerged as reliable selection

criteria for yield improvement. On the basis of overall performance, genotypes, 2024/FBB VAR-4, 2023/FBB VAR-1, 2022/FBB VAR-6 (bush type) and 2024/FBB VAR-3 (pole type) were identified as superior and can be effectively utilized as promising varieties in future French bean breeding programmes for yield enhancement.

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