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Character association and path analysis for green pod yield in French bean (*Phaseolus vulgaris*)

Gangadhara.K[1], Ashvathama. V.H[2], Raj Kumar[2], and Vikas Yadav[3]

[1,3]*Central Horticultural Experiment Station (ICAR-CIAH), Godhra, Gujarat, India*

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ABSTRACT

Sixty-six genotypes of French bean (*Phaseolus vulgaris* L.) were evaluated for correlation and path coefficient analysis at KRCCH, Arabhavi, University of Horticultural Sciences, Bagalkot. In most cases, genotypic correlations were higher than phenotypic correlations, indicating highly heritable nature of green pod yield/plant. It showed positive and significant correlation with plant height, number of branches/plant 60 days after sowing and 100-seed weight both at genotypic and phenotypic level, whereas number of branches/plant at 30 days after sowing, number of pods/plant and number of seeds/plant showed positive and significant correlation at genotypic level. Path coefficient revealed that number of branches/plant at 60 days after sowing and pod weight characters have direct positive effect on green pod yield/plant. Thus, these characters deserve greater weightage during selection for yield. The direct selection in these traits would be rewarding for improvement in pod yield/plant.

Key Words: Weight, Branches/plant, Genotypes, Seed Correlation

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French bean (*Phaseolus vulgaris* L., 2n=22) family Leguminosae has evolved from wild growing vine distributed in high lands of Middle-America and Andes. A study of correlation between different quantitative characters provides an idea of association. It could be effectively exploited to formulate selection strategies for improving yield and quality. The path coefficient technique developed by Wright (1921) helps in estimating direct and indirect contribution of various components in building up the correlation towards yield. This study will help the breeder to know the degree of association among traits, which can be used for crop improvement through selection of component traits.

MATERIAL AND METHODS

The study was carried out to assess the variability and character association in 66 diverse genotypes of French bean at KRCCH, Arabhavi, University of Horticultural Sciences, Bagalkot. The experimental plot was ploughed repeatedly and land was brought to a fine tilth . About 25 tonnes of FYM per hectare and recommended basal dose of fertilizers (62.5: 100: 75 kg NPK/ha) were incorporated into the soil, just before sowing as per the packages of practices of UAS, Dharwad. Ridges and furrows were opened at a distance of 30 cm. Seeds of each genotype were dibbled at a distance of 10 cm in a row.

Observations were recorded on five plants chosen at random in each cross and in each replication and the mean of five plants were taken for analysis. The correlation co-efficient among all possible character combinations at phenotypic (rp) and genotypic (rg) level were estimated employing formula (Al-Jibouri *et al.*, 1958). Path co-efficient analysis (Wright, 1921) and Dewey and Lu (1959) were carried out to know the direct and indirect effect of morphological traits on plant yield.

RESULTS AND DISCUSSION

There was highly significant (P=0.01) difference among genotypes for all the characters. Similarly, highly significant variations for all characters were reported by Makhdoomi and Dar (2011) and Kamaluddin and Shahid (2011). In any crop improvement programme, it becomes necessary to have simultaneous progress of more than one character, especially in yield, which is influenced by many other traits (Tripathi*et al.*, 2018; Singh *et al.*, 2021).

***Corresponding author :** vikasyadav.hot @gmail.com
[2]KVK, Panchamahal, Gujarat, India
[2]College of Agriculture, Vijayapura (UAS), Karnataka

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This is due to physiological and linkage relationship of genes governing various characters. The genotypic correlation was higher than phenotypic correlations for all the characters, indicating little influence of environment and presence of inherent association among characters (Tables 1 and 2).

In genotypic level, plant height at 30 DAS showed highly significant and positive correlation with plant height at 60 DAS(0.865), number of pods/plant (0.816), number of branches/plant at 30 DAS (0.776), number of branches/plant at 60 DAS (0.636), green pod yield/plant (0.449) and 100-seed weight (0.404). There was positive and significant association with number of seeds/plant (0.253). Plant height at 60 DAS exhibited highly significant and positive correlation with number of pods /plant (1.121), number of branches/plant at 60 DAS (0.929), green pod yield/plant (0.725), number of seeds/plant (0.554), number of branches/plant at 30 DAS (0.443) and 100-seed weight (0.344).

In phenotypic level, plant height at 30 DAS showed highly significant and positive correlation with plant height at 60 DAS (0.750), number of branches at 60 DAS (0.459) and green pod yield/plant (0.380). It also reflected positive and significant association with 100-seed weight (0.266), whereas plant height at 60 DAS showed highly significant and positive correlation with number of branches/plant at 60 DAS (0.656), green pod yield/plant (0.530) and number of seeds/plant (0.334). It also showed positive and significant association with 100-seed weight (0.282) and number of pods/plant (0.279). Similar results were reported by Roy *et al.* (2006), Bhushan *et al.* (2007) and Mishra *et al.* (2006).

In genotypic level, number of branches/plant at 30 DAS showed highly significant and positive correlation with number of pods/plant (0.974), 100-seed weight (0.812), number of seeds/plant (0.664), number of branches/plant at 60 DAS (0.656), green pod yield/plant (0.570) and days to 50% flowering (0.365). Number of branches/plant at 60 DAS exhibited highly significant and positive correlation with number of pods/plant (1.032), green pod yield/plant (0.782), number of seeds/plant (0.597) and 100-seed weight (0.449).

At phenotypic level, number of branches/plant at 30 DAS manifested positive correlation with 100-seed weight (0.241) and green pod yield (0.095). Number of branches/plant at 60 DAS reflected highly significant and positive correlation with green pod yield/plant (0.812) and 100-seed weight (0.357). It also showed positive and significant association with number of seeds/plant (0.270) and number of pods/plant (0.252). Similar results were given by Karasu and Oz (2010). Pod weight showed significant and positive correlation with green pod yield/plant and pod length both at genotypic (0.314 and 0.271) and phenotypic levels (0.212 and 0.186). Pod length showed highly significant and positive correlation with green pod yield/plant both at genotypic (0.672) and phenotypic (0.596) levels. It also showed significant and negative correlation with days to 50% flowering at both genotypic (-0.285) and phenotypic (-0.161) levels.

It indicates that as the days to 50% flowering increases there is decrease in pod length. Anjani *et al.* (2009), Chaudhary *et al.* (2017) and Basavaraj *et al.* (2022) also supported these finding. At the genotypic level, number of per plant showed highly significant and positive correlation with number of seeds/ plant (0.950) and green pod yield/plant (0.746). Phenotypic level, number of pods/plant showed highly significant and positive correlation only with number of seeds/ plant (0.732). Similar results were reported by Raffi and Nath (2004), Mishra *et al.* (2009), Karasu and Oz (2010). In genotypic level, number of seeds/plant exhibited highly significant and positive correlation with days to 50% flowering (0.381). It is also showed significant and positive correlation with green pod yield/plant (0.303).

Number of seeds/plant showed only positive association with days to 50% flowering (0.053) and green pod yield (0.172) at phenotypic level. These results are in agreement with Verma *et al.* (2015). The 100-seed weight showed highly significant and positive correlation with green pod yield/plant in both genotypic (0.471) and phenotypic levels (0.379). Days to 50% flowering showed negative correlation with green pod yield at both genotypic (-0.122) and phenotypic (-0.046) levels. It indicates that as days to 50% flowering increases with decrease in green pod yield. Similar results were given by Mishra *et al.* (2009) and Kamaluddin and Shahid (2011). The green pod yield/plant had highly significant association with number of branches/plant at 60 DAS (0.782), number of pods/plant (0.746), plant height at 60 DAS (0.725), pod length (0.672), number of branches/plant at 30 DAS (0.570), 100-seed weight (0.471) and plant height at 30 DAS (0.449). Hence, selection of component characters is worth rewarding for improving the yield.

The number of branches/plant at 60 DAS and pod length, indicate their true positive significant association with green pod yield/plant. Similar results were obtained by Roy *et al.* (2006), Dursen (2007), Anjani *et al.* (2009) and Karasu and Oz (2010). The plant height at 60 DAS despite its negative direct effect (-0.022) had strong positive association with green pod yield/plant (rG=0.725). This is mainly because of its high indirect positive effect through number of branches/plant at 60 DAS (0.757) and pod length (0.047). The negative indirect effect of trait through plant height failed to alter its positive association was observed at both genotypic and phenotypic levels. Similar results have been reported by Karasu and Oz (2010).Number of branches/plant at 30 DAS showed negative and direct effect (-0.016) on green pod yield/plant (rG=0.570).

However, its strong positive association with green pod yield was mainly of its positive indirect effect through number of branches/plant at 60 DAS (0.535) and pod length (0.118). The negative indirect effect of trait *via* plant height was observed. Number of branches/plant at 60 DAS showed positive and direct effect (0.816) on green pod yield/plant (rG=0.782 and

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Table 1. Genotypic correlation for growth and yield characters

character	1	2	3	4	5	6	7	8	9	10	11
1	1.000	0.865**	0.776**	0.636**	0.100	0.009	0.816**	0.253*	0.404**	0.081	0.449**
2		1.000	0.443**	0.929**	0.234	0.076	1.121**	0.554**	0.344**	0.084	0.725**
3			1.000	0.656**	0.061	0.192	0.974**	0.664**	0.812**	0.365**	0.570**
4				1.000	0.201	0.070	1.032**	0.597**	0.449**	0.115	0.782**
5					1.000	0.271*	-0.001	-0.091	-0.018	-0.240	0.314*
6						1.000	-0.007	-0.186	0.239	-0.285	0.672**
7							1.000	0.950**	0.100	-0.060	0.746**
8								1.000	0.095	0.381**	0.303*
9									1.000	0.025	0.471**
10										1.000	-0.122
11											1.000

Critical r- 1% = 0.325 5%= 0.250 *Significant at 5% ** Significant at 1%

Table 2: Genotypic path coefficient analysis for growth and yield characters

character	1	2	3	4	5	6	7	8	9	10	rG
1	**-0.0270**	-0.0190	-0.0130	0.5180	-0.0020	0.0050	-0.0030	-0.0070	-0.0030	-0.0020	0.449**
2	-0.0230	**-0.0220**	-0.0070	0.7570	-0.0040	0.0470	-0.0040	-0.0150	-0.0020	-0.0020	0.725**
3	-0.0210	-0.0100	**-0.0160**	0.5350	-0.0010	0.1180	-0.0030	-0.0180	-0.0050	-0.0090	0.570**
4	-0.0170	-0.0210	-0.0110	**0.8160**	-0.0030	0.0430	-0.0040	-0.0160	-0.0030	-0.0030	0.782**
5	-0.0030	-0.0050	-0.0010	0.1640	**-0.0160**	0.1660	0.0000	0.0020	0.0000	0.0060	0.314*
6	0.0000	-0.0020	-0.0030	0.0570	-0.0040	**0.6140**	0.0000	0.0050	-0.0020	0.0070	0.672**
7	-0.0220	-0.0250	-0.0160	0.8420	0.0000	-0.0040	**-0.0030**	-0.0260	-0.0010	0.0010	0.746**
8	-0.0070	-0.0120	-0.0110	0.4870	0.0010	-0.1140	-0.0030	**-0.0270**	-0.0010	-0.0090	0.303*
9	-0.0110	-0.0080	-0.0130	0.3660	0.0000	0.1470	0.0000	-0.0030	**-0.0060**	-0.0010	0.471**
10	-0.0020	-0.0020	-0.0060	0.0940	0.0040	-0.1750	0.0000	-0.0100	0.0000	**-0.0250**	-0.122

Residual= 0.0032 Diagonal indicates direct effect

* Significant at 5% ** Significant at 1% rG. Genotypic correlation with green pod yield per plant

1, Plant height at 30 DAS (cm)
2, Plant height at 60 DAS (cm)
3, No. of branches per plant at 30 DAS
4, No. of branches per plant at 60 DAS
5, Pod weight (g)
6, Pod length (cm)
7, No. of pods per plant
8, No. of seeds per plant
9, 100-seed weight (g)
10, Days to 50% flowering
11, Green pod yield plant (g)

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rP=0.812), because of its indirect positive association through pod length (0.043 and 0.017) at both genotypic and phenotypic levels. Similar results were obtained by Raffi and Nath (2004) and Karasu and Oz (2010).

The pod weight despite its negative direct effect (-0.016) had strong positive association with green pod yield/plant (rG=0.314). This is mainly because of its high indirect positive effect through pod length (0.166) and number of branches/plant at 60 DAS (0.164) in genotypic level. These results are in accordance with findings of (Dursun, 2010). The pod length showed positive direct effect (0.614) and had strong positive association with green pod yield/plant. This might be its indirect positive effect through number of branches/ plant at 60 DAS observed at genotypic and phenotypic levels. Negative indirect effect on green yield/plant *via* plant height at 60 DAS was observed only in phenotypic level. Similar results have been reported by Anjani *et al.* (2009), Verma *et al.* (2015) and Basavaraj *et al.* (2022).The number of pods/ plant showed negative direct effect (-0.0030) and strong positive association with green pod yield/plant (rG=0.746). This is mainly because of its strong indirect positive effect through number of branches/plant at 60 DAS (0.842) and strong indirect negative effect through number of seeds/plant (-0.026), plant height at 60 DAS(-0.025), plant height at 30 DAS (-0.022) and number of branches/plant at 30 DAS (0.016) was observed in genotypic level. Number of pods/plant had positive strong association (rP=0.176) with green pod yield. The trait had also high indirect positive effect on yield *via* number of branches/plant (0.209). Its indirect negative effect was due to number of seeds/plant (-0.023) and plant height at 60 DAS (-0.009) was observed in phenotypic level. Similar results were obtained by Raffi and Nath (2004), Mishra *et al.* (2009) and Karasu and Oz (2010).The number of seeds/plant showed negative direct effect (-0.027) and had strong positive association with green pod yield/plant (rG=0.303). This is mainly because of its high indirect positive effect through number of branches/plant at 60 DAS (0.487) and negative indirect effect through pod length (-0.114) at genotypic level and number of seeds/plant had positive association (rP=0.127) with green pod yield but negative direct effect (-0.031) on green pod yield.

The trait had also high indirect positive effect on yield *via* number of branches/plant (0.224). Its indirect negative effect was due to number pods/ plant at 60 DAS (-0.055) at phenotypic level. This is mainly because of its high indirect positive effect through number of branches/plant at 60 DAS and pod length. There is a negative indirect effect through number of branches/plant at 30 DAS, plant height at 30 DAS and plant height at 60 DAS at both genotypic and phenotypic levels. Similar results were obtained by Mishra *et al.* (2008) Singh *et al.* (2023) .and Sandeep *et al.* (2009). Days to 50% flowering showed negative direct effect and negative association with green pod yield/plant. This is because of its high indirect positive effect through number of branches/plant at 60 DAS and negative indirect effect through pod length. There is no association with number of pods/ plant and 100-seed weight was observed at both genotypic and phenotypic levels. Similar results have been reported by Roy *et al.* (2006), Mishra *et al.* (2009), Kamaluddin and Shahid (2020), Noopur *et al.* (2019) and Kalauni and Dhakal in French bean.

CONCLUSION

Thus, it can be concluded that number of branches/plant at 60 DAS, number of pods/plant, green pod yield/plant and, 100-seed weight and pod length are the most important factors influencing green pod yield through direct effect coupled with high positive correlation. These characters deserve greater weightage during selection for yield. The direct selection in these traits would be rewarding for improvement in pod yield/plant.

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