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CORRELATION AND PATH ANALYSIS STUDIES IN FRENCH BEAN (*PHASEOLUS VULGARIS* L.) GENOTYPES

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ABSTRACT

An investigation on "Correlation and path analysis studies in French bean (*Phaseolus vulgaris* L.) genotypes" was undertaken during *Rabi* 2022-23 at RARS, Vijayapur. Correlation and path analysis studies revealed that significant positive association at genotypic level among the traits *viz.*, number of pods per plant (0.9480), average pod weight (0.6375), pod length (0.0206), pod width (0.2737), number of seeds per pod (0.0719), dry matter content in pods (0.4345), plant spread (N-S) at 50 DAS (0.0516), plant spread (E-W) at 50 DAS (0.0761), number of primary branches at 50 DAS (0.0605), leaf area (0.0788) and days to first flowering (0.1494), had exhibited true association with direct effect on yield per plant. The direct selection for these traits would be rewarding for improvement in the total yield per plant.

Keywords: French bean, Correlation, Genotypes and Path analysis

Introduction

French bean (*Phaseolus vulgaris* L., 2n= 2x= 22) is a leguminous and protein rich vegetable within the Fabaceae family. It carries various names linked to its purpose such as string bean, snap bean, salad bean, haricot bean and green bean, all connected to its usage as a vegetable style legume. In different languages, it takes on diverse identities: Rajmah in Hindi, Tingala aware in Kannada, and Fras bean in Punjabi.

French bean is often referred to as the "poor man's meat" due to their affordability as a protein source. They are also designated as a "near perfect food" because of their well-balanced combination of proteins and carbohydrates. It is highly nutritious as 100 g of green pods contain 1.7 g protein, 4.5 g carbohydrates, 0.1g fat, 1.8 g fibre, 221 I.U. Vitamin-A, 11 mg vitamin-C and 50 mg calcium (Gopalkrishnan, 2007). With a low glycemic index and ample antioxidants. French bean possesses medicinal properties which are useful against diabetes, certain cardiac problems and a good natural cure for bladder burn. It has both carminative and reparative properties against diarrhoea and constipation respectively (Duke, 1981).

Being a short duration crop, French bean cangrown in various cropping systems across the hills and plains of India. The total cultivation area for French bean in India is around 2.9 lakh hectares with an annual production of 27.25 lakh tons with an average productivity of 9090 kg per hectare. In Karnataka, it is grown over an area of 0.17 lakh hectares with an annual production of 1.94 lakh tons with an average productivity of 11070 kg per hectare (Anon, 2022).

Considering its versatility as a vegetable that harmonizes well with diverse cropping methods, there exists a requirement for enhancing and creating varieties tailored to specific agro-ecological settings. The Northern region of Karnataka, characterized by arid climatic conditions, encompasses a substantial expanse. Though, French bean has been under cultivation in limited area as a vegetable, its potentiality is yet to be utilized. Therefore, there is a need for identification and development of French bean genotypes that are well suited to the conditions of Northern Karnataka. This underscores the necessity for evaluating germplasm to ascertain the extent of variability, aiding in the identification of suitable genotypes and the formulation of subsequent crop enhancement initiatives in North Karnataka.

Material and Methods

The experimental material consisted of 41 French bean genotypes which were collected from different institutions for studying correlation and path analysis among the yield and its contributing traits (Table 1). An investigation on "Correlation and path analysis studies in French bean (*Phaseolus vulgaris* L.) genotypes" was undertaken during *Rabi* 2022-23 at RARS, Vijayapur.

The experiment was laid out in a Randomized Block Design (RBD) with three replications. The genotypes were sown in the plot size of 2 rows of 1 m row length. The spacing between rows was 45 cm and the distance between plants was 15 cm. All crop production techniques were carried out as per the package of practices given by University of Horticultural Sciences (UHS), Bagalkot (Anon, 2022) to grow the crop. Observations were recorded from five different competitive plants in each experimental plot were randomly selected by avoiding border plants. The selected plants were tagged for taking observations on 20 different characters such asplant height at 50 DAS, plant spread at 50 DAS (N-S), plant spread at 50 DAS (E-W), number of primary branches at 50 DAS, leaf area, days to first flowering, days to fifty per cent flowering, days to first pod picking, pod length, pod width, number of seeds per pod, number of clusters per plant, number of pods per cluster, number of pods per plant, average pod weight, green pod yield per plant, dry matter content in pods, moisture content in pods, protein content in pods and total soluble solids in pods.

The analysis of correlation provides insights into the relationship between yield and other linked traits. The phenotypic and genotypic correlation coefficients gives an idea about the nature of relationship existing between yield and its component traits as well as the association among component traits themselves. In correlation analysis just we could study the degree and direction of the independent and dependent traits and does not show a cause-and-effect relationship. The path coefficient technique developed by Wright (1921) aids in estimating the direct and indirect contributions of different components in building up the total correlation towards yield. These investigations serve to highlight the relative significance of individual characteristics, thereby guiding the selection program towards maximizing gains.

Results and Discussion

Variability studies reveal how much a given quality can be improved upon, but they don't explain the nature or depth of the correlations that exist between different characteristics. Because there may not be genes for yield *per se*, but rather for different yield components, selection for yield components is necessary for a viable approach to yield improvement (Grafius, 1959). Moreover, there's a chance that a lot of these supporting individuals will interact in both positive and negative ways. Thus, it is crucial for understanding the connections between different traits and economic characters.

The analysis of variance showed that mean sum of squares due to genotypes was significant for all the twenty characters studied. The phenotypic and genotypic correlation coefficients gives an idea about the nature of relationship existing between yield and its component traits as well as the association among component traits themselves. Experimental results obtained in the correlation study at both phenotypic and genotypic level are presented below (Tables 2 and 3).

Correlation analysis

Total green pod yield per plant was found that positively and significantly (at p=0.01)associated with plant spread (E-W) at 50 DAS (r_g= 0.576 and r_p = 0.432), leaf area (r_g=0.325 and r_p = 0.289), pod length (r_g= 0.602 and r_p = 0.528), number of seeds per pod (r_g= 0.354 and r_p = 0.299) number of pods per cluster (r_g=0.475 and r_p= 0.253), number of cluster per plant (r_g=0.357 and r_p=0.397), number of pods per plant (r_g = 0.550 and r_p= 0.613), average pod weight (r_g = 0.425 and r_p= 0.361), dry matter content in pods (r_g=0.636 and r_p=0.296), moisture content in pods (r_g=0.240 and r_p=0.654), total soluble solids (r_g=0.569 and r_p=0.492), protein content in pods (r_g=0.297 and r_p=0.267) both at phenotypic and genotypic level (Tables 2 and 3). These outcomes indicated strong interrelationship with these yield attributing characters. Yield of French bean can be enhanced by suggesting these traits in crop yield improvement programmes.

The phenotypic correlation (Table 2) with green pod yield per plant showed positively significant (at p=0.01) with plant spread (N-S) at 50 DAS (r_p=0.237). The genotypic correlation (Table 3) with green pod yield per plant was found that positively significant (at p=0.05) associated with plant spread (N-S) at 50 DAS (cm) (r_g=0.292). Whereas, pod width (r_g = -0.345), number of primary branches at 50 DAS (r_g = -0.295), showed negative and significant (at p=0.01) association at genotypic level.

Phenotypic correlation

Analysis of correlation coefficients at phenotypic level (Table 2) found that the plant height at 50 DAS showed a significant (at p=0.01) and positive correlation with number of clusters per plant (0.311). Plant spread (N-S) at 50 DAS had significant (at p=0.01) and positive correlation with plant spread (E-W) at 50 DAS (0.336), pod length (0.347), number of seeds per pod (0.274), average pod weight (0.278) and green pod yield per plant (0.237).Plant spread (E-W) at 50 DAS had significant (at p=0.01) and positive correlation with pod length (0.438), number of seeds per pod (0.303), moisture content in pods (0.264), total soluble solids (0.309) and green pod yield per plant (0.432).A significant (at p=0.01) and positive correlation of leaf area with pod length (0.394), number of seeds per pod (0.301), average pod weight (0.248), moisture content in pods (0.239), green pod yield per plant (0.289).

The days to first flowering had significant (at p=0.01) and positive association with days to 50 per cent flowering (0.753) and days to first pod picking (0.527). Days to 50 per cent flowering had significant (at p=0.01) and positive association with days to first pod picking (0.530).

It was observed that the pod length had significant (at p=0.01) and positive association with number of seeds per pod (0.585), average pod weight (0.663), moisture content in pods (0.364), total soluble solids (0.448), green pod yield per plant (0.528). Number of seeds per pod found that significant (at p=0.01) and positive association with average pod weight (0.396), moisture content in pods (0.282), total soluble solids (0.338) and green pod yield per plant (0.299).Number of pods per cluster had significant (at p=0.01) and positive association with number of pods perplant (0.331) and moisture content in pods (0.251), green pod yield per plant (0.253). The number of clusters per plant had significant (at p=0.01) and positive association with number of pods per plant (0.757), dry matter content in pods (0.287) and green pod yield per plant (0.397). Number of pods per plant had significant (at p=0.01) and positive association with dry matter content in pods (0.232), moisture content in pods (0.376) and green pod yield per plant (0.613). Average pod weight was found that significant (at p=0.01) and positive association with moisture content in pods (0.285), total soluble solids (0.388) and green pod yield per plant (0.361). It was recorded that dry matter content in pods had significant (at p=0.01) and positive association with green pod yield per plant (0.296).

It was found that moisture content in pods had significant (at p=0.01) and positive association with total soluble solids (0.321), green pod yield per plant (0.654). Whereas, the total soluble solids had significant (at p=0.01) and positive association with green pod yield per plant (0.492) and protein content in pods (0.235). Protein content in pods had significant (at p=0.01) and positive association with green pod yield per plant (0.267).

Genotypic correlation

Experimental results obtained for genotypic correlation are presented in table 3 revealed that the plant height at 50 DAS had positive and significant correlation atp=0.01 with number of clusters per plant (0.452). A significant (at p= 0.01) and positive correlation of plant spread (N-S) at 50 DAS was observed with plant spread (E-W) at 50 DAS (0.374), average pod weight (0.312), pod length (0.403) and moisture content in pods (0.501). Plant spread (E-W) at 50 DAS showed a significant (at p= 0.01) and positive association with pod length (0.557), number of seeds per pod (0.404), dry matter content in pods (0.312), moisture content in pods (0.765), total soluble solids (0.377), green pod yield per plant (0.576).While, number of primary branches at 50 DA Shad positive and significant (p=0.05) correlation with days to fifty per cent flowering (0.271) and days to first pod picking (0.249). A significant (at p=0.01) and positive correlation of leaf area was observed with pod length (0.477), moisture content in pods (0.530) and green pod yield per plant (0.325).

It was observed that the days to first flowering had significant (at p=0.01) and positive association with days to 50 per cent flowering (0.783), days to first pod picking (0.843) and number of clusters per plant (0.349). It was found that days to 50 per cent flowering had significant (at p=0.01) and positive association with days to first pod picking (0.855), number of clusters per plant (0.455), number of pods per plant (0.296). Days to first pod picking showed significant (at p=0.05) and positive association with number of clusters per plant (0.362) and number of pods per plant (0.319).

The results reveled that the pod length had significant (at p=0.01) and positive association with number of seeds per pod (0.779), average pod weight (0.769), dry matter content in pods (0.316), moisture content in pods (0.895), total soluble solids (0.533) and green pod yield per plant (0.602). Number of seeds per pod had significant (at p=0.01) and positive association with average pod weight (0.509), moisture content in pods (0.621), green pod yield per plant (0.354).Number of pods per cluster had significant (at p=0.01) and positive association with number of pods per plant (0.627), moisture content in pods (0.649) and green pod yield per plant (0.475).Number of clusters per plant found that significant (at p=0.01) and positive association with number of pods per plant (0.813), dry matter content in pods (0.510), moisture content in pods (0.295), green pod yield per plant (0.357). Whereas. number of pods per plant had significant (at p=0.01) and positive association with dry matter content in pods (0.465), moisture content in pods (0.561), green pod yield per plant (0.550). Average pod weigh had significant (at p=0.01) and positive association with moisture content in pods (0.704), total soluble solids (0.452) and green pod yield per plant (0.425). Dry matter content in pods had significant (at p=0.01) and positive association with moisture content in pods (0.352) and green pod yield per plant (0.636).

Moisture content in pods had significant (at p=0.01) and positive association with total soluble solids (0.879), protein content in pods (0.552) and green pod yield per plant (0.640). Total soluble solids had significant (at p=0.01) and positive association with green pod yield per plant (0.569). While, the protein content in pods had significant (at p=0.01) and positive association with green pod yield per plant (0.297).

These observations indicated to select some good parameters that are expected to boost green pod yield per plant in French bean genotypes. It was found that the plant spread (E-W) at 50 DAS, leaf area, pod length, number of seeds per pod, number of pods per cluster, number of cluster per plant, number of pods per plant, average pod weight, dry matter content in pods, moisture content in pods, total soluble solids and protein content in podshave observed as correlated with green pod yield per plant. These outcomes find out the true association with green pod yield per plant and considered as pod yield predictors, according to which we can select plants with more average pod weight directly and with more number of pods per plant that can perform better and enhance green pod yield per plant. Jhanavi (2016) also observed similar traits with strong correlation are crucial for selection in plant breeding. Supporting results found in works of Haralayya *et al.* (2015), Panda *et al.* (2016a) and Alemu *et al.* (2017).These results are aligned with observations of Kanwar *et al.* (2017) and Dhillon *et al.* (2017) for days to first pod picking. Singh *et al.* (2018), AlBallat *et al.* (2019), Sodagar *et al.* (2020), and Shah *et al.* (2021) reported that days to first flowering correlated positively with days to 50 per cent flowering and days to first pod picking. These outcomes are resemblance with Ketema and Geleta (2022) and Murry *et al.* (2022) in French bean..

Path coefficient analysis

The relationship between variable traits is measured by correlation coefficient. However, an indirect effect of a third character may be a reason of association between two traits and there is a possibility of ambiguous results. So, it is important to evaluate the source and its effective link among variables. Path coefficient analysis splits the correlation between different parameters into direct and indirect effects by utilizing independent variables. Path analysis was performed to evaluate direct and indirect effects of depending variable with independent characters.

Experimental results obtained for path analysis study are presented in table 4 and 5 revealed that significant positive association at phenotypic level (Table 4) among the traits *viz.,* number of pods per plant (0.9110), average pod weight (0.7818), Moisture content in pods (0.0706), dry matter content in pods (0.0683), number of clusters per plant (0.0592), number of seeds per pod (0.0338), protein content in pods (0.0261), number of pods per cluster (0.0259), pod length (0.0154), plant height (0.0106) and days to first flowering (0.0075).

At the genotypic level (Table 5) path analysis studies revealed that significant positive association among the traits *viz.,* number of pods per plant (0.9480), average pod weight (0.6375), dry matter content in pods (0.4345), pod width (0.2737), pod length (0.0206), number of seeds per pod (0.0719), plant spread (N-S) at 50 DAS (0.0516), plant spread (E-W) at 50 DAS (0.0761), number of primary branches at 50 DAS (0.0605), leaf area (0.0788) and days to first flowering (0.1494), had exhibited true association with direct effect on green pod yield per plant. The direct selection for these traits would be rewarding for improvement in the total green pod yield per plant.

Similar results were obtained by Jhanavi (2016), Dhillon *et al.*(2017), Alemu *et al.* (2017), Singh *et al.* (2018), Shah *et al.* (2018), Lyngdoh *et al.* (2018), AlBallat *et al.* (2019), Kalauni and Dhakal (2020) and Sodagar *et al.* (2020). These results are in conformity with the results of Shama *et al.* (2022) and Murry *et al.* (2022) in French bean.

Conclusion

From the study, highly significant outcomes observed for correlation coefficient and path coefficient analysis among 41 French bean accessions for most of the studied traits. On the basis of results obtained from the present investigation, it can be concluded that the selection for number of pods per plant, average pod weight, pod length , pod width, number of seeds per pod, dry matter content in pods, plant spread (N-S) at 50 DAS, plant spread (E-W) at 50 DAS, number of primary branches at 50 DAS, leaf area and days to first flowering could be criteria for simultaneously increasing green pod yield per plant and selection of these traits will helpful in developing high yielding genotypes in French bean.

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