

Studies on correlation and path coefficient analysis in Faba bean (*Vicia faba* L.)

Abstract

The present Experiment entitled “**Studies on correlation and path coefficient analysis in Faba bean (*Vicia faba* L.)**” was carried out at Genetics and Plant Breeding Farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya. The experimental material constituted thirty nine germplasm lines including four check varieties *viz.*, HFB-1, Vikrant, Rebya-40 and Giza-4. The experiment was carried out in Augmented Block Design with five blocks. The results of path coefficient analysis using simple correlation coefficient revealed that the highest positive direct contribution towards seed yield per plant was exhibited by harvest index (0.836) followed by plant height (0.708) and biological yield per plant (0.471). The days to maturity (-0.578), pod per plant (-0.502), pod fertility percent (-0.188), days to maturity (-0.086) and seed perpod (-0.024) were the characters having substantial negative direct effect on seed yield per plant. The traits indicated above as crucial direct and indirect yield components merit due consideration in formulating selection strategy in faba bean for selection of high yielding varieties.

Key words-correlation, Faba bean, path coefficient, seed yield, varieties.

INTRODUCTION

“Faba bean (*Vicia faba* L.) is the third most common grain legume in the world, as well as one of the world's oldest food crops. *Vicia narbonensis* L. and *V. galilaea* Plitmann & Zohary, wild species are taxonomically similar to cultivated species, but they have $2n=14$ chromosomes, while cultivated field beans have $2n=12$ chromosomes. At most

of the occasions crossing between the misgenerally unsuccessful” (**Bond *et al.*, 1985**). “Faba bean (*Vicia faba* L.), a protein-rich leguminous plant from the Fabaceae family. The large-seeded cultivars are known as broad beans in the UK, Australia and New Zealand and small-seeded variants as field beans (more resemble wild species), which are mostly utilised as animal feed. It goes under several names in India, including Bakala, Anhuri, and Kala matar in Hindi; Raj-rawan in Urdu; and Kadu huralikayee in Kannada” (**Akbar *et al.*, 1990**).

It has large, white flowers with dark violet spots, it grows in axillary racemes with short pedicels, with 1-5 flowers per flower. There are about 1-4 pods in each group and the growth is uncertain. In the broad bean population, approximately 30% of the plants are cross-fertilized. It has been cultivated since ancient times and consumed in the form of green pods or dried seeds. In warm temperate and subtropical climates, the faba bean is produced as a winter crop (**Robertson, 1996**). The hot, dry climate is not suitable for this crop, however it requires a good water supply for optimal yields. It flourished on a range of soils. Faba beans grow well in acidic soils. The ideal pH for cultivation is between neutral and alkaline (pH 6.5 to 8.0) (**Rajanet *et al.*, 2012**). The growing season requires little or no heat to produce the optimum temperature (18-27 °C) suitable for faba beans (**Duke, 1981**). If the cultivars and climatic conditions are favorable, faba bean crops mature within 150-220 days (**Bond *et al.*, 1985**). Faba beans have shown their potential and are currently grown in 58 countries. (**FAOSTAT 2014**). “China ranks first with an area of 1 million hectares (38% of the world's planted area), followed by Ethiopia (55,700 hectares). In India, total production in 2019-20 is estimated at 23.02 million tons, which is 2.76 million tons higher than the five-year average output of 20.26 million tons” (**anonymous, in 2019**).

Faba beans are grown under rain-fed conditions in Jammu and Kashmir, Uttar Pradesh, Himachal Pradesh, and Uttarakhand, and some areas in southern India like Karnataka,

Kerala and Tamil Nadu. The country produces a small proportion of faba beans. Faba beans are considered to be one of the most important protein sources for humans and animals (Larradle 1982). In addition to being a good source of protein, it also provides carbohydrates and fiber. The crop is also rich in minerals such as phosphorus, iron, potassium, and vitamin B complex (Clarke, 1970). Table 1 shows the main nutritional value of legumes in edible protein per 100 g of young and dry pods. Chavan *et al.*, (1989) reported that the protein content (20-41%) of pulses showed significant differences. According to Bond *et al.*, (1985), Winter beans have a slightly greater protein content than summer beans.

MATERIAL AND METHODS

The field experiment was carried out during *Rabi* 2019-20, at Genetics and Plant Breeding Farm of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India. The climate of district Ayodhya is semi-arid with hot summer and cold winter. Nearly 80 per cent of total rainfall is received during the monsoon (only up to September) with a few showers in the winter. The experimental materials for the present investigation consisted of 39 accessions including 4 checks *viz.*, HFB-1, Vikrant, Rebya-40 and Giza-4. The material, comprising of indigenous as well as exotic germplasm lines, exhibiting wide spectrum of variation for various agronomic and morphological characters. Thirty-nine faba bean genotypes including four checks were taken treatments in the proposed study. The various genotypes are listed in table 1. **Table 1: Faba bean genotypes used in the studies carried out for the experiment.**

| | | |
|-----------|-----------|-----------|
| ET-218698 | ET-218741 | ET-218770 |
|-----------|-----------|-----------|

| | | |
|-----------|-----------|-----------------------|
| ET-218702 | ET-218743 | ET-218772 |
| ET-218704 | ET-218745 | ET-218773 |
| ET-218712 | ET-218747 | ET-218775 |
| ET-218713 | ET-218757 | ET-218776 |
| ET-218719 | ET-218759 | ET-218778 |
| ET-218720 | ET-218763 | ET-218781 |
| ET-218725 | ET-218764 | ET-218783 |
| ET-218733 | ET-218765 | ET-218786 |
| ET-218734 | ET-218766 | Rebya –40(CH) |
| ET-218736 | ET-218767 | Giza-4 (CH) |
| ET-218738 | ET-218768 | HFB -1(CH) |
| ET-218739 | ET-218769 | Vikrant (CH) |

The experimental material was grown in Augmented Block Design with five blocks. Each plot consisted of four rows of 4m length with the interand intra row spacing of 30 cm and 10 cm, respectively. To avoid the border effect experimental plot was surrounded on all side by non-experimental rows. Recommended cultural practices were followed to raise the crop. The observations were recorded by five randomly selected plant for days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, number of seeds per

Pods, pod fertility percent, 100-seed weight (g), biological yield per plant (g), harvest index (%) and seed yield per plant (g).

Correlation: It was carried out in order to document observations and statistically examine the data. The correlation coefficient, abbreviated as "r," conveys information about the degree and direction of a relationship between two or more variables. Phenotypic correlation, environmental correlation, and genotypic correlation are the three types of correlation. The correlation coefficients were worked out using the formula given by **Searle (1961)**. The significance of correlation coefficient was tested by comparing at an appropriate level of significance, the significant values of (r) at (n-2) d.f., where 'n' is the number of genotypes.

Path coefficient

Wright (1921) suggested the procedure for path coefficient analysis and path coefficient analysis was done according to the formula given by **Dewey and Lu (1959)**. The seed yield was assumed to be dependent variable (effect), which is influenced by all the eleven characters, the independent variable (cause) directly as well as indirectly through other characters. The variation in seed yield unexplained by the ten causes was presumed to be contributed by a residual factor (x), which is uncorrelated with other factors. The path – coefficient analysis was carried out by using phenotypic as well as genotypic correlation coefficient between eleven characters to resolve direct and indirect effect of different character on seed yield per plant. Path coefficients were estimated for indicating the basic relationship between correlation and path coefficient. In order to devise path analysis three steps were followed calculation of direct effect, indirect effect and residual effect.

Result and discussion:

Correlation: The yield is a complex and highly variable character and is a result of

cumulative effect of its component characters and therefore, direct selection for yield may not be very effective. The yield components may not always be independent in their action but may be interlinked. Acquiring a thorough understanding of the degree and direction of the relationship between crop production and its characteristics is crucial for selecting important traits that can be used in a breeding approach to improve crops. As the correlation assessed at the genetic level would give the realistic picture of associations existing among the characters in the absence of environmental influence, the genotypic correlation coefficients were worked out in the present study to establish an effective and practical selection parameter for improvement of grain yield. The estimates of correlation coefficients among different characters of faba bean are presented in the **Table no 2**. The seed yield per plant exhibited highly positive and significant correlation with pod fertility percent (0.985), days to maturity, 100 seed weight (0.971), plant height (0.962) days to 50% flowering (0.956) harvest index (0.943), biological yield per plant (0.920), seeds per pod (0.868), pod per plant (0.831) and number of branches per plant (0.568). Similar results were obtained by **Verma *et al.* (2013)**, **Osman *et al.* (2013)** and **Badolay *et al.* (2009)**. Days to 50% flowering exhibited highest positive correlation with days to maturity (0.980) followed by pod fertility percent (0.971) and least with number of branches per plant (0.576). Plant height shows positive correlation with biological yield per plant (0.979), followed by pod fertility percent (0.973), days to maturity (0.965) and least with number of branches per plant (0.579) and exhibited no any negative relationship with any other character. Days to maturity shows positive and significant correlation with 100-seed weight (0.985) followed by seed yield per plant (0.974), biological yield per plant (0.930) and least with number of branches per plant (0.582). Number of branches per plant significantly and positively correlated with pod per plant (0.878) followed by seeds per pod (0.738) and least with harvest index (0.476). Pod per plant shows significant and positive correlation with seeds per pod (0.883) followed by biological yield per plant

(0.880) and least with harvest index (0.712). Seeds per pod shows significant and positive correlation with pod fertility percent (0.910) followed by 100 seed weight (0.877) and least with harvest index (0.819). Pod fertility percent shows significant and positive correlation with seed yield per plant (0.985) and least with the harvest index (0.927). 100-seed weight shows significant and positive correlation with seed yield per plant (0.971) and least with the harvest index (0.915). Biological yield per plant shows positive and significant correlation with seed yield per plant (0.920) and harvest index (0.752). Harvest index shows positive and significant correlation with seed yield per plant (0.943). Similar findings were observed by **Alan and Geren (2007)**, **Ahmed *et al.* (2008)** and **Habetinek *et al.* (1982)**.

Seed yield per plant showed positive correlation with Pod fertility percent (0.985). Thus, pod fertility percent emerged as most important factor influencing seed yield in faba bean. While, the seed yield was not negatively correlated with any of the character.

Path-coefficient: Path coefficient is a tool to partition the observed correlation coefficient into direct and indirect effects of yield components on seed yield to provide clearer picture of character association for formulating efficient selection strategy. The direct and indirect effects of different character on seed yield per plant are presented in **Table no 3**. The highest positive direct effect of seed yield per plant was exerted by harvest index (0.836) followed by plant height (0.708), biological yield per plant (0.471), number of branches per plant (0.326) and 100 seed weight (0.196), while the highest negative direct effect on seed yield per plant was exerted by days to maturity (-0.590) followed by pod per plant (-0.502) and least by seeds per pod (-0.024). The direct effect of remaining three characters was too low to be considered important, which also indicates that the early flowering lines matured fast. The similar result was observed by **(Singh *et al.*, 2013)**. “So, early flowering will have greater ability to give more yield than a genotype with delayed flowering” **(Chaubeyet *et al.*, 2012)**.

Harvest index exhibited highest indirect positive effect on seed yield per plant *via*, days to 50% flowering (0.781) followed by plant height *via* biological yield per plant (0.693) and biological yield per plant *via* plant height (0.461). The highest negative indirect effect was observed in days to maturity *via* 100 seed weight (-0.581) followed by pod per plant *via* seeds per pod (-0.444) and least in case of number of branches per plant *via* pods per plant (-0.018). It seems that with increase in plant height the number of pods per plant also increased and due to this, seed yield also increased as observed by **Azarpour *et al.*, 2012**. Similar results were also obtained by **Vandana and Dubey, 1993; Bakheit and Mahady, 1998; Ulukan *et al.* 2003 and Verma *et al.*, 2013**.

“Some of the earlier reports have also identified these characters as important indirect contributor towards the expression of seed yield in faba bean” (**Habetinek *et al.* 1982; Salem, 1982 and Reddy *et al.* 2002**).

The remaining estimates of the indirect effects in the present analysis were too low to be considered important. It is effect of an independent character on dependent character *via* other independent characters. The residual effect observed was 0.042638 which indicates that some of the characters which might contribute to yield have not been included in the study. The residual effects are those variations which occurred due to other possible independent variables and which cannot be explained under the present investigation. It is evaluated by deducting the value of coefficient of determination from unity. Residual effect was estimated by using the values of direct effects and correlation coefficients.

Conclusion: Simple correlation coefficient were computed among the 11 characters and the results revealed that seed yield per plant showed positive correlation with plant height, number of branches per plant, 100-seed weight, biological yield per plant, and harvest index. Days to maturity exhibited highly significant and positive correlation with 100-seed wt. followed by, pod fertility percent which showed significant

correlation with 100 seed weight and days to maturity showed significant positive correlation with pod fertility percent.

The results of path coefficient analysis using simple correlation coefficient revealed that the highest positive direct contribution towards seed yield per plant was exhibited by harvest index followed by plant height and biological yield per plant. The days to maturity, pod per plant, pod fertility percent, days to maturity and seed per pod were the characters having substantial negative direct effect on seed yield per plant.

References:

- Ahmed, M.S.H., S.H.M. Abd-El-Haleem, M.A.bakheit and S.M.S. Mohamed. 2008.** Comparison of three selection methods for yield and components of three faba bean (*Vicia faba* L.) crosses. *World J. of Agric. Sci.*; **4**(5):635-639.
- Akbar, M., Tariq, M., Yaqub, M., Anwar, M., Ali.M. and Iqbal, N. 1990.** Variability, correlation and path coefficient studies in faba bean (*Vicia faba* L.) . *Asian Journal of Plant Science*; **2**(9):696-698.
- Alan, O. and Geren, H., 2007.** Evaluation of heritability and correlation for seed yield and yield components in faba bean (*Vicia faba* L.). *J. Agron.*; **6**(3):484-487
- Azarpour Ebrahim, Bidarigh, Sirous, Moraditochae, Maral, Danesh, Reza Khosravi, Bozorgi, Hamid Reza and Bakian, Mona., 2012.** Path Coefficient Analysis of Seed Yield and its Components in Faba Bean (*Vicia faba* L.) under Nitrogen and Zinc Fertilizer Management. *Int. J. of Agric. And Crop Sci.*; **4** (21):1559-1561.
- Badolay, Abhay., Hooda, J.S. and Malik, B.P.S., 2009.** Correlation and path analysis in fababean (*Vicia faba* L.). *Haryana J. Agron.*; **25**(1&2):94-95.
- Bakheit BR and Mahady EE. 1998.** Variation, Correlation and path coefficient analysis for some characters in collection of faba bean (*Vicia faba* L.). *FABIS*; **20**:9-14.

- Bond, D. A., Lawes, D.A., Hawtin, G.C., Saxena, M.C. and Stephens, J.S. 1985.** Faba Bean (*Vicia faba* L.).In: Summerfield, R.J., and Roberts, E.H. William Collins SonsCo. Ltd (Ed), *Grain Legume Gropes*; pp. 199-265. UK
- Chaubey, B.K., Yadav, C.B., Kumar, K and Srivastava, R.K. 2012.** Genetic variability, Character association and path coefficient analysis in faba bean. *J. of Food Leg.*; **25** (4):348-350.
- Chavan, J.K., L.S. Kute, and S.S. Kadam. 1989.** In: CRC Hand Book of World legumes. pp. 223-245. D.D. Salunkhe and S.S. Kadam (eds.), Boca Raton, Florida, USA: CRC Press.
- Clarke, H.E. 1970.** The evaluation of field bean (*Vicia faba* L.) in animal nutrition. *Pro. of the nutrition soci.*; **29**:64-73.
- Dewey, D. R. and Lu, K. H. 1959.** Correlation and path coefficient analysis of crestedwheat grass seed production. *Agron.J.*; **51**:515-518.
- Duke, J. K. 1981.** Handbook of Legumes of World Economic Importance. Pelenum Press, New York. pp. 199-265.
- Habetinek, J.; Ruzickova, M. and Soucek, J. 1982.** Variability and correlation in some quantitative characters in a collection of broad bean varieties (*Faba vulgaris* Moench). *Sbornikvysoke, skolly Zemadelske Vpraze, A.*; **36**:79-92.
- Larraide, J. 1982:** Estudio de algunostrastornosque presentant en los animal tras la in gestation de semillas de *Vicia faba*. *Rev. Esp. Fisiol.*; **38**:345-351.
- Osman, A. A. M.; Aziz, A. A. H. A. and Gailani, M. B. 2013.** Correlation between seed yield and yield components in faba bean (*Vicia faba* L.). *Advances in Environmental Bio.*, **7**(1):82-85..
- Rajan K, Singh AK, Pandey AK 2012.** Faba bean soils and there management for higher

productivity In: Faba Bean (*Vicia faba* L.): A potential leguminous crop of India (Eds. Singh and Bhatt). ICAR, RC for ER, Patna, pp.205-212.

Reddy, S. R. R.; Gupta, S. N.; Verma, P. K. and Lajpat Rai (2002). Genetic variation, correlation and path coefficient analysis under normal sown conditions in *Vicia faba* L. *Forage Res.*; **28**(2):63-66.

Robertson, L.D., K.B. Singh, W. Erskine and Ali M. Abd El Moneim. 1996. Useful genetic diversity in germplasm collections of food and forage legumes from West Asia and North Africa. *Germplasm Resources and Crop Evolution*; **43**:447-460.

Salem, S. A. 1982. Variation and correlation among agronomic characters in a collection of beans (*Vicia faba* L.). *J. Agri. Sci., U.K.*; **99**(3):541-545.

Searle, S.R. (1961). Phenotypic, genotypic and environmental correlations. *Biometrics*, **17**: 474-480

Singh, A.K., Bharati, R.C., Chandra, N., Mani bhushan. and Pedapati, A. 2013. An assessment of faba bean (*Vicia faba* L.) current status and future prospect. *African J. of Agricultural Research*; **8**(50):6634-41.

Ulukan, Hakan., Guler, Mustafa. and Keskin, Siddik. 2003. A path coefficient analysis some yield and yield components in Faba bean (*Vicia faba* L.) genotypes. *Pakistan J. of Bio.Sci.*; **6**(23) :1951-1955.

Vandana and Dubey, D.K. 1993. Path analysis in faba bean. *FABIS Newsletter*; **32**:23-24.

Verma, I.K., Verma, P.N. and Yadav, C.B. 2013., Correlation and path coefficient analysis in Faba Bean (*Vicia faba* L.) under Irrigated Condition. *Trends in Biosci*; **6**(5):576- 578.

Table-2: Estimates of correlation coefficients between eleven characters in faba bean

| Traits | Days to 50% flowering | Plant height (cm) | Days to maturity | No. of Branches per plant | Pod/plant | Seeds /pod | Pod fertility(%) | 100 seedwt. (g) | Biological yield /Plant (g) | Harvest Index(%) | Seed yield /plant(g) |
|---------------------------|-----------------------|-------------------|------------------|---------------------------|--------------|--------------|------------------|-----------------|-----------------------------|------------------|----------------------|
| Days to 50% flowering | 1.000 | 0.936* | 0.980** | 0.576** | 0.828** | 0.851* | 0.971** | 0.976** | 0.884** | 0.934** | 0.956** |
| Plant height(cm) | | 1.000 | 0.965** | 0.579** | 0.875** | 0.869* | 0.973** | 0.970** | 0.979** | 0.847** | 0.962** |
| Days to maturity | | | 1.000 | 0.582** | 0.839** | 0.888* | 0.983** | 0.985** | 0.920** | 0.930** | 0.974** |
| No. Branches per plant | | | | 1.000 | 0.878** | 0.738* | 0.631** | 0.585** | 0.614** | 0.476* | 0.568** |
| Pod/plant | | | | | 1.000 | 0.883* | 0.881** | 0.868** | 0.880** | 0.712** | 0.831** |
| Seeds/pod | | | | | | 1.000 | 0.910** | 0.877** | 0.833** | 0.819** | 0.868** |
| Pod fertility(%) | | | | | | | 1.000 | 0.983** | 0.931** | 0.927** | 0.985** |
| 100 seedwt.(g) | | | | | | | | 1.000 | 0.931** | 0.915** | 0.971** |
| Biological yield/Plant(g) | | | | | | | | | 1.000 | 0.752** | 0.920** |
| Harvest Index(%) | | | | | | | | | | 1.000 | 0.943** |

** & ** Significant at 5% & 1% respectively*

Table-3 :Directandindirecteffectsofdifferentcharacteronseedyieldperplantinfababeangermplasm

| Traits | Days to50 % flowering | Plant height (cm) | Days to maturity | No. Branches per plant | Pod/plant | Seeds/pod | Pod fertility(%) | 100-seed wt. (g) | Biological yield /Plant(g) | Harvest Index(%) | (Cor).Seed yield /plant(g) |
|----------------------------|-----------------------|-------------------|------------------|------------------------|---------------|---------------|------------------|------------------|----------------------------|------------------|----------------------------|
| Days to 50% flowering | -0.086 | 0.662 | -0.578 | 0.188 | -0.416 | -0.020 | -0.183 | 0.191 | 0.417 | 0.781 | 0.956** |
| Plant height(cm) | -0.080 | 0.708 | -0.569 | 0.189 | -0.440 | -0.021 | -0.183 | 0.190 | 0.461 | 0.707 | 0.962** |
| Day to maturity | -0.084 | 0.683 | -0.590 | 0.190 | -0.422 | -0.021 | -0.185 | 0.193 | 0.434 | 0.777 | 0.974** |
| No. Branches per plant | -0.049 | 0.410 | -0.343 | 0.326 | -0.441 | -0.018 | -0.119 | 0.115 | 0.290 | 0.398 | 0.568** |
| Pods/plant | -0.071 | 0.620 | -0.495 | 0.287 | -0.502 | -0.021 | -0.166 | 0.170 | 0.415 | 0.595 | 0.831** |
| Seeds/pod | -0.073 | 0.615 | -0.524 | 0.241 | -0.444 | -0.024 | -0.171 | 0.172 | 0.393 | 0.684 | 0.868** |
| Pod fertility(%) | -0.083 | 0.689 | -0.580 | 0.206 | -0.443 | -0.022 | -0.188 | 0.193 | 0.439 | 0.774 | 0.985** |
| 100 seed wt.(g) | -0.084 | 0.687 | -0.581 | 0.191 | -0.436 | -0.021 | -0.185 | 0.196 | 0.439 | 0.765 | 0.971** |
| Biological yield /Plant(g) | -0.076 | 0.693 | -0.543 | 0.201 | -0.442 | -0.020 | -0.175 | 0.182 | 0.471 | 0.628 | 0.920** |
| Harvest Index(%) | -0.080 | 0.599 | -0.549 | 0.155 | -0.358 | -0.020 | -0.174 | 0.179 | 0.354 | 0.836 | 0.943** |

RESIDUAL EFFECT =0.042638 SQUARE 0.998182

Bold values show direct and normal values show indirect effects