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

Abstract

The present investigation entitled **Studies on correlation and path coefficient analysis in Faba bean (*Vicia faba*L.)** ’’ wasconductedatGeneticsAndPlantBreedingFarmofAcharyaNarendraDevaUniversityofAgriculture&Technology,NarendraNagar(Kumarganj),Ayodhya.

Theexperimentalmaterial constituted thirty nine germplasm lines including four check varieties *viz.*,HFB-1,Vikrant,Rebya-40andGiza-4.TheexperimentwascarriedoutinAugmentedBlockDesignwithfiveblocks. The observations wererecorded on eleven quantitative characters namely days to 50% flowering, plantheight (cm), days to maturity,number of branches per plant, number of pods perplant, number of seeds per pods, pod fertility percent, 100-seed weight (g), biologicalyieldperplant(g),harvestindex(%)andseedyieldperplant(g).

Seedyieldperplantshowedhighlysignificantandpositivecorrelationwith plant height, number of branches per plant, 100-seed weight, biological yieldperplant,andharvestindex.Thecharactersshowingsignificantpositivecorrelationamong yield and important characters would be highly effective and efficient inimproving respective traits. The results of path coefficient analysis using simplecorrelation coefficient revealed that the highest positive direct contribution towardsseedyieldperplantwasexhibitedbyharvestindex(0.836)followedbyplantheight (0.708)andbiologicalyieldperplant(0.471).Thedaystomaturity(-0.578),podperplant (-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

seedyieldperplant.Thecharactersidentifiedaboveasimportantdirectandindirectyieldcomponents merit due consideration in formulating selection strategy in faba beanforselectionofhighyieldingvarieties.

Key words-correlation, Faba bean,path coefficient, seedyield, varieties.

INTRODUCTION

Fababean(*Viciafaba*L.) is the third most commongrainlegumeintheworld,aswellasoneoftheworld'sooldestfoodcrops.*Vicianarbonensis*L. and *V. galilaeaPlitmann*&*Zohary*, wild species are taxonomically similarto cultivated species, but they have 2n=14 chromosomes, while cultivatedfield beans have2n=12chromosomes.Atmostoftheoccasionscrossingbetweenthemisgenerallyunsuccessful**(Bond*etal*.,1985)**. Fababean(*Viciafaba*L.),aprotein-richleguminous plant from the Fabaceae family. The large-seeded cultivars are known as broadbeans 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 underseveral names in India, including Bakala, Anhuri, and Kala matar in Hindi; Raj-rawan inUrdu; 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) **(Rajan*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.

MATERIALANDMETHODS

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 different genotypes are as given 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 AugmentedBlock Design with five blocks. Each plot consisted of four rows of 4m length with the interandintra row spacing of 30 cm and 10 cm,respectively.To avoid theborder effectexperimental plotwas surrounded on all side by non-experimental rows. Recommendedcultural practices were followed to raise the crop. The observations were recorded by five randomly selected plant fordays to 50% flowering, days to maturity, plantheight (cm), number of branches per plant, number of pods perplant, number of seeds per pods, pod fertility percent, 100-seed weight (g), biologicalyieldperplant(g),harvestindex(%)andseedyieldperplant(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.Thecorrelationcoefficientswereworkedoutusingtheformulagivenby**Searle(1961).**Thesignificanceofcorrelationcoefficientwastestedbycomparingatanappropriate level of significance, the significant values of (r) at (n-2) d.f., where ‘n’ is thenumberofgenotypes.

Path coefficient

Wright (1921) suggested the procedure for path coefficient analysis andPath 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 asgenotypic correlation coefficient between eleven characters to resolve direct and indirecteffectofdifferentcharacteronseedyieldperplant.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 branchesperplant (0.568). Similar results were obtained by **Verma *et al*.**

(2013),Osman*et al*. (2013) andBadolay*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 leastwith number of branchesperplant (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 withnumber of branches per plant (0.579) and exhibitednoany negative relationship withanyothercharacter.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)andleastwithnumberofbranches perplant (0.582).Number of branches per plant significantly and positively correlated with pod perplant (0.878)followedbyseedsperpod (0.738)andleastwithharvestindex (0.476).Podperplantshowssignificantandpositivecorrelationwithseedsperpod (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 by100 seed weight (0.877)and leastwithharvestindex (0.819).Pod fertility percent shows significant and positive correlation with seed yield perplant (0.985)andleastwiththeharvestindex (0.927).100-seed weight shows significant and positive correlation with seed yield per plant (0.971)andleastwiththe harvest index (0.915).Biological yield per plant shows positive and significant correlation with seed yieldplant (0.920)andharvestindex (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).**

Seedyieldperplantshowedpositivecorrelationwith Podfertilitypercent (0.985). Thus, pod fertility percent emerged as most important factor influencing seedyieldinfababean.While, the seed yield was not negatively correlated with any of thecharacter.

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 4**. 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 **(Chaubey*et al*., 2012).**

Harvest index exhibited highestindirect 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)andbiologicalyieldperplant*via*plantheight(0.461).Thehighestnegativeindire ct effect was observed in days to maturity *via* 100 seed weight (-0.581) followed bypod 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 podsperplantalsoincreasedandduetothis,seedyieldalsoincreasedasobservedby **Azarpour*et al*., 2012**. Similar results were also obtained by **Vandana and Dubey, 1993; Bakheit andMahady,1998;Ulukan*etal*.2003andVerma*etal*.,2013.**

Someoftheearlierreportshavealsoidentifiedthesecharactersasimportantindirect contributor towards the expression of seed yield in faba bean **(Habetineke*t al*.1982;Salem,1982 andReddy *etal*.2002).**

The remaining estimates of the indirect effects in the present analysis were too lowto 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 thatsomeofthecharacterswhichmightcontributetoyieldhavenotbeenincludedinthestudy. 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 resultsrevealed that seed yield per plant showed positive correlation with plant height, numberofbranches 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 with100 seed weight and days to maturity showed significant positive correlationwithpodfertilitypercent.

The results of path coefficient analysis using simple correlation coefficient revealed thatthe highest positive direct contribution towards seed yield per plant was exhibited byharvest 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 havingsubstantialnegative directeffectonseedyieldperplant.

References:

Ahmed,M.S.H.,S.H.M.Abd-El-Haleem,M.A.bakheitandS.M.S.Mohamed.2008. Comparison of three selection methods for yield and components of three faba

bean*(Viciafaba*L.*)*crosses.*WorldJ.ofAgric.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 JournalofPlantScience;***2**(9):696-698.

Alan, O. and Geren, H., 2007. Evaluation of heritability and correlation for seed yield andyieldcomponentsinfaba bean *(Viciafaba*L.). *J.Agron.;***6**(3):484-487

AzarpourEbrahim,Bidarigh,Sirous,Moraditochaee,Maral,Danesh,RezaKhosravi,Bozorgi, Hamid Reza and Bakian, Mona., 2012. Path Coefficient Analysis of SeedYield and its Components in Faba Bean (*Vicia faba*L.) under Nitrogen and ZincFertilizerManagement.*Int.J.ofAgric.AndCropSci*.;**4**(21):1559-1561.

Badolay, Abhay.,Hooda, J.S. and Malik, B.P.S., 2009. Correlation and path analysis in fababean(*Viciafaba*L.*).HaryanaJ.Agron.;**25***(1&2):94-95.

Bakheit BR and Mahady EE. 1998. Variation, Correlation and path coefficient analysis forsomecharactersincollectionoffababean*(Viciafaba*L.*).FABIS;***20**:9-14.

Bond,D. A., Lawes,D.A.,Hawtin,G.C., Saxena,M.C. and Stephens,J.S. 1985. FabaBean*(Viciafaba*L.*)*.In:Summerfield,R.J.,andRoberts,E.H.WilliamCollinsSonsCo.Ltd(Ed),*GrainLegumeGropes;*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.SalunkheandS.S.Kadam(eds.),BocaRaton,Florida,USA:CRCPress.

Clarke,H.E. 1970. The evaluation of fieldbean (*Vicia faba*L.) in animal nutrion.*Pro.ofthe nutritionsoci.;***29**:64-73.

Dewey,D.R.andLu,K.H.1959. Correlationandpathcoefficientanalysisofcrestedwheatgrass seedproduction.*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 somequantitativecharactersinacollectionofbroadbeanvarieties(*FabavulgarisMoench*).*Sbornikvysoke,skollyZemadelskeVpraze,A.*;**36**:79-92.

Larraide, J. 1982: Estudio de algunostrastornosquesepresentantenlos animal tras la ingestationde semillas de*Viciafaba.Rev.Esp.Fisiol.;38:345-351*.

Osman,A.A.M.;Aziz,A.A.H.A.andGailani,M.B.2013. Correlationbetweenseedyield and yield components in faba bean (*Vicia faba*L.).*Advances in EnvironmentalBio.,*7(1):82-85..

Rajan K, Singh AK,Pandey AK 2012. Faba bean soils and there management for higherproductivity In: Faba Bean (Vicia faba L.): A potential leguminous crop of India(Eds.SinghandBhatt).ICAR,RCforER,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.*ForageRes.*;**28**(2):63-66.

Robertson, L.D., K.B. Singh, W. Erskine and Ali M. Abd El Moneim. 1996. Useful geneticdiversity in germplasm collections of food and forage legumes from West Asia andNorthAfrica.GermplasmResources andCropEvolution;**43**:447-460.

Salem, S. A. 1982. Variation and correlation among agronomic characters in a collection ofbeans(*Viciafaba*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. Anassessmentoffababean(*Viciafaba*L.)currentstatusandfuturepr ospect.*African J. ofAgriculturalResearch;***8**(50):6634-41.

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

VandanaandDubey,D.K. 1993. Pathanalysisinfababean.*FABISNewsletter*;**32**:23- 24.

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

Table-3:Estimatesofcorrelationcoefficientsbetweenelevencharactersinfababean

Traits	Days to50% flowering	Plant height (cm)	Days tomaturity	No. of Branches perplant	Pod/plant	Seeds /pod	Podfertility(%)	100 seedwt. (g)	Biologicalyield /Plant (g)	Harvest Index(%)	Seed yield /plant(g)
Daysto50%flowering	**1.000**	0.936**	0.980**	0.576**	0.828**	0.851**	0.971**	0.976**	0.884**	0.934**	0.956**
Plantheight(cm)		**1.000**	0.965**	0.579**	0.875**	0.869**	0.973**	0.970**	0.979**	0.847**	0.962**
Daystomaturity			**1.000**	0.582**	0.839**	0.888**	0.983**	0.985**	0.920**	0.930**	0.974**
No.Branchesperplant				**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**
Podfertility(%)							**1.000**	0.983**	0.931**	0.927**	0.985**
100seedwt.(g)								**1.000**	0.931**	0.915**	0.971**
Biologicalyield/Plant(g)									**1.000**	0.752**	0.920**
HarvestIndex(%)										**1.000**	0.943**

***&** Significantat 5%&1%respectively*

Table-4 :Directandindirecteffectsofdifferentcharactersonseedyieldperplantinfababeangermplasm

Traits	Days to50 % flowering	Plant height (cm)	Days tomaturity	No. Branches per plantPod per plant	Pod/plant	Seeds/pod	Podfertility(%)	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**
Plantheight(cm)	-0.080	**0.708**	-0.569	0.189	-0.440	-0.021	-0.183	0.190	0.461	0.707	0.962**
Daystomaturity	-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**
Podfertility(%)	-0.083	0.689	-0.580	0.206	-0.443	-0.022	**-0.188**	0.193	0.439	0.774	0.985**
100seedwt.(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**
HarvestIndex(%)	-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***

Boldvaluesshowsdirect andnormalvaluesshowsindirect effects