Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7113

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (6):** 25-32 (2018)

Research Article

Genetic Variability, Correlation and Path Analysis for Yield and Yield Related Traits in Vegetable Type French Bean (*Phaseolus vulgaris* L.)

Sandip A. Aklade[1], Harshal E. Patil[2*], Magaldeep Sarkar[3] and B. K. Patel[4]

[1]Assistant Professor (Horticulture), Polytechnic in Agriculture,

[2]Associate Research Scientist (Plant Breeding), Hill Millet Research Station,

[3& 4]Assistant Research Scientist, Hill Millet Research Station,

Navsari Agricultural University, Waghai (Dangs) - 394 730

*Corresponding Author E-mail: mailme.harshalpatil@rediffmail.com

Received: 4.011.2018 | Revised: 29.11.2018 | Accepted: 8.12.2018

ABSTRACT

Genetic evaluation by using path coefficient and correlation studies of nine released bushy vegetable type cultivars (Arka Anoop, Akra Komal, Arka Arjun, Arka Sharath, Arka Suvidha, Pant Anupama, VL Beans-2, Phule Surekha and Kashi Sampan) of French bean (Phaseolus vulgaris L.), a high valued vegetable genotypes was studied by using variability, correlation and path coefficient analysis to find out the variation, association among characters and to measure the direct and indirect contribution of twelve characters on fresh pod yield per plant.

Genotypic and phenotypic coefficient of variation were of high magnitude for plant height, 100 green pod weight, 100 green seed weight, days to 50 % flowering, pod length, pod width as well as for number of primary branches per plant. The estimate of high heritability (bs) accompanied with high-expected genetic advance for green pod weight per plant and days to 50 % flowering indicating the presence of additive gene action in the expression of these characters which indicates that such traits can be improved by direct selection. The genotypic correlation studies of pod length (0.2266), pod width (0.1127), number of seeds per pod (0.0026), 100-green pod weight (0.0383), 100-green seed weight (0.3583), pod thickness (0.4283) and seed size (0.2260) indicated that green pod yield per plant exhibited stable positive association with traits expect days to 50 % flowering (-0.1917), number of primary branches (-0.0479) and plant height (-0.0342). While the phenotypic correlation revealed that, days to 50 % flowering (-0.1731), number of primary branches (-0.0358) and days to maturity (-0.0387) were negatively correlated and the rest of all characters were positively correlated with green pod yield per plant. The direct effects of path coefficient analysis revealed that the green pod yield per plant had positive and was significant with days to 50 % flowering (0.0588), pod width (0.9276), pod length (0.4526), number of seeds per pod (0.0062), 100 green pod weight (0.0652), 100 green seed weight (0.2128), pod thickness (0.3972), seed size (0.3709) and the rest of the effects of few characters were negative for number of primary branches (-0.0246) and days to maturity (-0.0068). Moreover, it was noticed that high indirect contribution was contributed through green pod yield per pod with most of the yield contributing traits. Hence, the traits viz., 100 green pod weight, days to 50 % flowering, number of seeds per pod and 100 green seed weight should be given more consideration while deciding about selection criteria for vegetable type French beans.

Key words: *Genetic evaluation, vegetable type French bean, pod yield and quality traits*

Cite this article: Aklade, S.A., Patil, H. E., Sarkar, M. and Patel, B.K., Genetic Variability, Correlation and Path Analysis for Yield and Yield Related Traits in Vegetable Type French Bean (*Phaseolus vulgaris* L.), *Int. J. Pure App. Biosci.* **6(6):** 25-32 (2018). doi: http://dx.doi.org/10.18782/2320-7051.7113

French bean (*Phaseolus vulgaris* L.) is an important cool seasonal legume vegetable crop grown for its tender pods, shelled green beans and dry beans. Its dry seed contains 21.1 per cent protein, 69.9 per cent carbohydrates, 1.7 per cent fat, 381 mg calcium, 425 mg phosphorous and 12.4 mg iron per 100 g of edible part[11]. It is commonly known as kidney bean, *rajmaha*, *fansi* or *gevda* and is generally grown in the Southern part of the Dangs district with 100 ha area, mostly in the hilly areas for fresh tender pod purpose. As it is a short duration crop of two and half to three months and also gives better return, there is large demand of this crop among the farmers. In India, it is grown on an area of about 1 lakh ha mainly in the states of Maharashtra, Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh Hills, Nilgiri (Tamil Nadu) and Palni hills (Kerala), Chickmagalur (Karnataka) and Darjeeling hills (West Bengal). Moreover, unless a good genotype of high potential is used; other technologies will also not work. Different genotypes also greatly varied in their performance under different agro-climatic conditions of the country which often creates confusions among the farmers about their choice of variety. So, selection of particular variety for fresh green pod production is also prime important and hence, the present experiment was carried out to study the variability, to know the degree of association between green pod yield components and morphological traits and to determine the direct and indirect effects of yield and its component traits on fresh pod yield in bush type French bean genotypes grown for vegetable purpose.

MATERIAL AND METHODS

The field experiment was conducted under Tuber and Vegetable scheme during the *Rabi* season of 2015-16 and 2016-2017 at Rumbas farm of Hill Millet Research Station, Navsari Agricultural University, Waghai, Dangs, Gujarat. The experimental material consisted of 9 genotypes of bush type French bean viz., Arka Anoop, Akra Komal, Arka Arjun, Arka Sharath, Arka Suvidha, Pant Anupama, VL Beans-2, Phule Surekha and Kashi Sampan as collected from different research stations working on bush type French bean and were assessed for growth, flowering and yield attributing characters and to screen out best performing genotype for fresh pod purpose. The experiment was laid out in a Randomized Complete Block Design with three replications. Seeds were sown on ridges at a spacing of 45 cm x 30 cm and all the standard package of practices were followed.

The following data was collected on days to 50 percent (%) flowering, pod length (cm), pod width (cm), plant height (cm), number of seeds per pod, 100 green pod weight (g), 100 green seed weight (g), pod thickness(%), number of flower cluster, number of primary branches, days to maturity and green pod yield (g/per plant). Genetic and phenotypic coefficients of variance was estimated as suggested by Burton[4]. and heritability as suggested by Johnson *et al.*[8]. Genotypic and phenotypic correlation was estimated as suggested by Singh and Chaoudhari[15]. and Path coefficient analysis was estimated as suggested by Dewey and Lu[6].

RESULTS AND DISCUSSION

Variability studies

Variability studies reveled that genotypic and phenotypic coefficient of variation were of high magnitude for plant height, 100 green pod weight, 100 green seed weight, Pod thickness (%), days to maturity, days to 50% flowering, pod length, pod width as well as for number of primary branches. The analysis revealed significant differences among all genotypes for all the characters presence of considerable amount genetic variability in the materials under study (Table 1). Looking to the estimates of GCV and PCV, it was observed that the GCV and PCV were high magnitude for days to maturity followed by 100 green seed weight, pod length, 100 green pod weight, number of primary branches and number of flower cluster.

The estimate of high heritability (bs) accompanied with high-expected genetic advance for 100 green pod weight and days to 50% flowering indicating the presence of additive gene action in the expression of these characters. This suggesting that such traits can be improved by direct selection.

The magnitutudal difference between PCV and GCV estimate was maximum for plant height, number of primary branches, seed size and 100 green seed weight, suggesting influence of environment on these traits. However, the difference between PCV and GCV estimate was minimum for 100 green pod weight, pod length, pod width, days to maturity, Day to 50% flowering, number of seeds per pod and shelling percentage(%) suggesting little influence of environment on these traits and one of may rely on phenotypic value for direct selection.

Ponnuswamy *et al.*[10], reported that significant differences were observed among the eight vegetable soybean varieties for all the characters studied. The highest values ofheritability and genetic advance were observed for number of green pods per plant and green pod yield per plant. The magnitude of GCV for all the traits, suggesting the role of environmental variance. The characters *viz.*, pod width, plant height and pod thickness (%) exhibited very low GCV and PCV estimate suggesting the narrow range of variation for traits. These results are in agreement with the earlier findings of Chetukuri *et al.*[5], in vegetable pigeonpea.

The estimation of heritability (bs) were of high magnitude for 100 green pod weight and days to 50 % flowering indicating the major role of genotypic and ultimately less environmental influence.

Sureja *et al.*[16], reported genetic variability for pod yield in pea and its componentcharacters. High heritability in association with high genetic advance observed for plantheight, pod yield per plant, number of pods per plant, seed yield per plant, number of primarybranches and 100 seed weight.Green pod yield, the character of prime importance had the moderate estimate of heritability but high genetic advance when compared with other characters.

Genotypic and phenotypic correlation analysis:

The genotypic and phenotypic correlation for the association among the characters studied for the 24 genotypes were shown in Table 2. The genotypic correlation of green pod yield per plant was found to be positively correlated with pod length (0.2266), pod width (0.1127), number of seeds per pod (0.0026), 100 green pod weight (0.0383), 100green seed weight (0.3583), pod thickness (0.4283), seed size (0.2260) and the days to 50% flowering (-0.1917), number of primary branches (-0.0479) and days to maturity (-0.0342) were negatively correlated withgreen pod yield. The phenotypic correlation of green pod yield per plant was found to be positively correlated with pod length (0.2184), pod width (0.1098), number of seeds per pod (0.0034), 100 green pod weight (0.0375), 100 green seed weight (0.3105), pod thickness (0.4006), seed size (0.1621) and days to 50% flowering (-0.1731), number of primary branches (-0.0358) and days to maturity (-0.0387) were negatively correlated.

The genotypic correlation of days to 50% flowering was positively correlated with 100 green seed weight and pod thickness(%), but negatively correlated with pod length, pod width, plant height, number of seeds per pod, 100 green pod weight, number of flower cluster, number of primary branches. The genetic correlation of pod length was positively correlated with pod width, plant height, number of seeds per pod, 100 green pod weight, 100 green seed weight, pod thickness (%), seed size and days to maturity, while number of primary branches was negatively correlated. The genotypic correlation of pod width was positively correlated with all traits except number primary branches and days to maturity. The genotypic and phenotypic correlation of pod width was negatively correlated with number of primary branches and days to maturity, while plant height, number of seeds per pod, 100 green pod weight, 100 green seed weight,

pod thickness (%), and number of flower cluster were positively correlated. The genetic and phenotypic correlation of number of seeds per pod were positively correlated with 100 green pod weight, pod thickness (%) and number of flower cluster, while negatively correlated with 100 green seed weight, number of primary branches and days to maturity. The genotypic and phenotypic correlation of 100 green pod weight was positively correlated with 100 green seed weight, seed size and days to maturity, while negatively correlated with pod thickness (%) and number of primary branches.

Number of pods per plant had significant positive correlations with pod length, number of branches per plant at phenotypic level. Whereas, at genotypic level this trait showed significant positive correlation with number of branches per plant, pod length and days to maturity (%). Also significantly negative correlated with days to maturity at both phenotypic and genotypic levels. In vegetable type French bean, Atilla Dursum[2], Arun kumar *et al.*[1], Bhushan *et al.*[3], Jay Prakash and Ram[7], Rai *et al.*[11], Rai *et al.*[12], Shah *et al.*[13], and Mishra *et al.*[9], have reported positive correlation of number of pods per plant with maximum number of yield contributing characters**.**

In vegetable soybean, pod width exhibited positive significant correlation with 100 seed weight, days to maturity at both phenotypic and genotypic level including number of branches per plant at genotypic levels. These results are in accordance with the report of Ziqiang Wang *et al.*[18], where 100 green seed weight exhibited positive significant correlation with pod width. These results are in conformity with the reports of Ziqiang Wang *et al.*[18], where100 green seed weight exhibited significantly positive correlation with pod length and pod width. Also, reported that the increase or decreases in the pod length results in the increase or decreases in the 100 green seed weight which in turn influenced the green pod yield of the plant.

Path coefficient of Analysis:

The results of path coefficients were partitioned into direct and indirect effects through various yield contributing characters as given in Table 3. The direct effects of days to 50% flowering (0.0588), pod width (0.9276), pod length (0.4526), number of seeds per pod (0.0062), 100 green pod weight (0.0652), 100 green seed weight (0.2128), pod thickness (0.3972), seed size(0.3709) were positive and the effect of few characters *viz.*, number of primary branches(-0.0246) and days to maturity (-0.0068)were negative on green pod yield per plant. The highest direct effect was exhibited by 100 green seed weight (0.2128) and it was followed by 100 green pod weight (0.0652). The highest direct effect was exhibited by number of seeds per pod and followed by 100 green seed weight.Figure-1 showed the Path Diagram of yield and yield contributing characteristics in vegetable type French bean.

Days to 50 per cent flowering, pod width, plant height, seed size and number of primary branches showed negative indirect effect on green pod yield per plant which indicating the effect of these characters. The character *viz*., number of seeds per pod, pod length, 100 green seed weight, 100 green pod weight and green pod pod thickness (%) had positive direct effect on green pod yield per plant while, some other traits such as days to 50 per cent flowering, number of seeds per pod and 100 green pod weight. Similar results were obtained by in vegetable type French bean by Atilla Dursum[2], Arun kumar *et al.*[1], Bhushan *et al.*[3], Jay Prakash and Ram[7], Rai *et al.*[11], Rai *et al.*[12], Shah *et al.*[13], Singh *et al.*[14], and Mishra *et al.*[9].

On the basis of path coefficient studies, Teerawat[17]. suggested that the number ofpods per plant, green pod weight and plant height were important characters that should be taken into account as selection criteria in improving marketable pod yield of the vegetable soybean. As per Vijayalakshmi *et al.*[19], it was noticed that most of the yield components showed the indirect contribution towards green pod yield. Also, number of

number of seeds per pod and number seed per plant should be given more consideration while deciding about selection criteria of vegetable type genotypes in soybean.

Bhushan *et al.*[3], studied the simple correlation coefficient and path analysis were calculated for seven characters with four hundred forty one exotic French bean germplasm lines. Seed yield per plant showed positive and significant correlation with number of pods per plant, pod length and seed index (100 seed weight). However, number of pods per plant exhibited positive and significant correlations with pod length, days to maturity and plant height. Path coefficient analysis revealed that number of pods per plant, pod length and seed index was most important traits contributing towards seed yield. It could, therefore, be suggested that these characters were dependable for selection of yield in French bean.

Fig. 1: Path Diagram of yield and yield contributing characteristics in vegetable type French bean

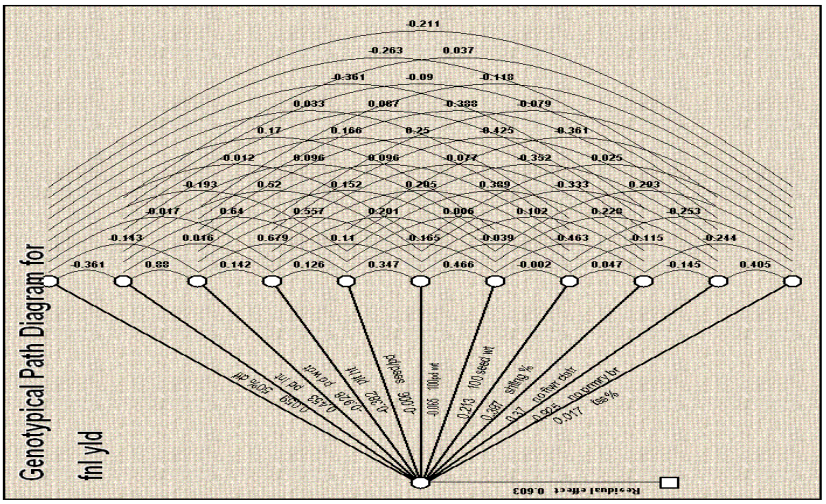

Table 1. Means, Ranges, Standard deviation and Coefficient of variability for characters evaluated in vegetable type French bean cultivars

Sr. No.	Character	Mean	Range	GCV	PCV	C.V. (%)	Heritability (h^2) (BS)	Genetic Advance (GA)
1	**Days to 50% flowering**	125.34	110-140	5.35	5.85	2.37	**0.83**	**12.63**
2	**Pod length (cm)**	5.53	4.6-7.0	10.98	11.45	3.26	0.91	1.20
3	**Pod width (mm)**	12.85	11.4-14.3	5.33	5.47	1.22	0.95	1.37
4	**Plant height (cm)**	187.82	120-220	5.63	8.55	6.43	0.43	14.36
5	**Number of seeds per pod**	3.66	3.2-4.2	7.09	7.51	2.49	0.88	0.50
6	**100 green pod weight (g)**	131.23	105.3-161.2	9.85	9.93	1.31	0.98	26.11
7	**100 green seed weight (g)**	19.39	8.3-25.3	11.36	13.26	6.83	0.73	3.89
8	**Pod thickness(%)**	65.82	53.8-76.4	6.59	7.07	2.55	0.86	8.34
9	**No. of flower per cluster**	4.57	3.5-5.6	8.51	11.54	7.87	0.54	0.59
10	**No. of primary branches**	3.46	2.5-4.5	8.82	11.92	8.01	0.54	0.46
11	**Days to maturity**	168	148-188	18.05	18.20	2.33	0.98	4.77

Table 2: Genotypic and Phenotypic Correlation coefficient of various yield contributing characters in vegetable type French bean

Characters		Days to 50% flowering	Pod length (cm)	Pod width (cm)	Plant height (cm)	Seedper pod	100 pod weight (g)	100 seed weight (g)	Shelling percent (%)	No. flower cluster	No. primary branches	TSS%	Green pod yield per plant
Days to 50% flowering	**rg**	**1**	-0.3611	-0.1427	-0.0174	-0.1930	-0.0119	0.1699	0.0327	-0.3613	-0.2632	-0.2109	**-0.1917**
	rp	**1**	-0.3339	-0.1186	0.0706	-0.1474	-0.0140	0.1533	-0.0146	-0.2926	-0.1159	-0.2129	**-0.1731***
Pod length (cm)	**rg**		**1**	0.8803	0.0158	0.6396	0.5195	0.0964	0.1656	0.0875	-0.0900	0.0372	**0.2266**
	rp			0.8273	-0.0002	0.5665	0.4936	0.0621	0.1560	0.0386	-0.0550	0.0357	**0.2184***
Pod width (cm)	**rg**			**1**	0.1417	0.6785	0.5568	0.1517	0.0961	0.2503	-0.3876	-0.1182	**0.1127**
	rp				0.0947	0.6146	0.5411	0.0984	0.0558	0.1646	-0.2745	-0.1130	**0.1098***
Plant height (cm)	**rg**				**1**	0.1260	0.1102	0.2009	0.2054	-0.0767	-0.4253	-0.0786	**-0.0271**
	rp					0.1218	0.0845	0.1453	0.0861	-0.0696	-0.1827	-0.0321	**-0.0208**
Seed per pod	**rg**					**1**	0.3474	-0.1646	0.0063	0.3887	-0.3522	-0.3615	**0.0026**
	rp						0.3352	-0.1371	0.0076	0.2158	-0.2264	-0.3401	**0.0034****
100 pod weight (g)	**rg**						**1**	0.4661	-0.0385	0.1023	-0.3326	0.0246	**0.0383**
	rp							0.3928	-0.0430	0.0751	-0.2264	0.0277	**0.0375****
100 seed weight (g)	**rg**							**1**	-0.0018	-0.4628	0.2281	0.2928	**0.3583**
	rp								-0.0279	-0.2235	0.1609	0.2322	**0.3105****
Shelling percent (%)	**rg**								**1**	0.0468	-0.1153	-0.2533	**0.4283**
	rp									0.0508	-0.1074	-0.2224	**0.4006***
No. flower cluster	**rg**									**1**	-0.1445	-0.2444	**0.2260**
	rp										-0.1860	-0.1817	**0.1621**
No. primary branches	**rg**										**1**	0.4053	**-0.0479**
	rp											0.2830	**-0.0358***
Days to maturity	**rg**											**1**	**-0.0342**
	rp												**-0.0387***

Table 3: Path Coefficient Direct (diagonal) and indirect effect (non-diagonal) of various characters in vegetable type French bean cultivars

Characters	Days to 50% flowering	Pod length (cm)	Pod width (cm)	Plant height (cm)	Seeds per pod	100 pod weight (g)	100 seed weight (g)	Shelling percent (%)	No. flower cluster	No. primary branches	TSS%	Green pod yield per plant
Days to 50% flowering	**0.0588**	-0.0212	-0.0084	-0.0010	-0.0113	-0.0007	0.0100	0.0019	-0.0212	-0.0155	-0.0124	0.1917
Pod length(cm)	-0.1634	**0.4526**	0.3984	0.0071	0.2895	0.2351	0.0436	0.0750	0.0396	-0.0407	0.0169	0.2266
Pod width(cm)	0.1324	-0.8166	**0.9276**	-0.1314	-0.6294	-0.5164	-0.1407	-0.0892	-0.2322	0.3595	0.1096	0.1127
Plant height(cm)	0.0066	-0.0060	-0.0541	**0.3817**	-0.0481	-0.0421	-0.0767	-0.0784	0.0293	0.1623	0.0300	0.0271
Seed per pod	0.0012	-0.0040	-0.0042	-0.0008	**0.0062**	-0.0021	0.0010	0.0015	-0.0024	0.0022	0.0022	0.0026
100 green pod weight (g)	0.0008	-0.0339	-0.0363	-0.0072	-0.0227	**0.0652**	-0.0304	0.0025	-0.0067	0.0217	-0.0016	0.0383
100 green seed weight (g)	0.0361	0.0205	0.0323	0.0427	-0.0350	0.0992	**0.2128**	-0.0004	-0.0985	0.0485	0.0623	0.3583
Shelling percent (%)	0.0130	0.0658	0.0382	0.0816	0.0025	-0.0153	-0.0007	**0.3972**	0.0186	-0.0458	-0.1006	0.4283
No. flower cluster	-0.1337	0.0324	0.0926	-0.0284	0.1438	0.0379	-0.1712	0.0173	**0.3709**	-0.0535	-0.0904	0.1226
No. primary branches	0.2434	0.0832	0.3584	0.3932	0.3257	0.3076	-0.2109	0.1066	0.1336	**-0.0246**	-0.3748	-0.0479
Days to maturity	-0.0035	0.0006	-0.0020	-0.0013	-0.0061	0.000	0.0049	-0.0043	-0.0041	0.0068	**-0.0068**	-0.1342

CONCLUSION

Thus it is concluded that, estimate of high heritability (bs) accompanied with high-expected genetic advance for 100 green pod weight and days to 50 % flowering indicating the presence of additive gene action in the expression of these characters. This suggests that such traits can be improved by direct selection. The genotypic correlation of green pod yield per plant was found to be positively correlated with pod length, pod width, number of seeds per pod, 100 green pod weight, 100 green seed weight, shelling percentage, number of flower cluster. The green pod yield per plant showed the direct positive effects of characters like, days to 50 % flowering, pod width, pod length, number of seeds per pod, 100 green pod weight, 100 green seed weight, shelling percentage, number of flower cluster. Therefor emphasis should be given to 100 green pod weight, number of seeds per pod, 100 green seed weight, pod thickness and seed size while selecting genotypes for high green pod yield per plant in vegetable French bean.

REFERENCES

1. Arun Kumar, P., Reddy, R. V. S. K., Pandravada, S. R., Durga Rani, Ch. V. and Chaitanya, V., Phenotypic variability, correlation and path coefficient analysis in pole type French beans (*Phaseolus vulgaris* L.). *Plant Archives*, **14(1):** 313-319 (2014).
2. Dursum, A., Variability, heritability and correlation studies in French bean (*Phaseolus vulgaris* L.) genotypes. *World J. Agric. Sci*. **3(1):** 12-16 (2007).
3. Bhushan, K. B., Jadli, S., Verma, O., and Goswami, A. K., Plant characters correlation and path coefficient analysis of seed yield in exotic French bean (*Phaseolus vulgaris* L.) germplasm. *International Journal of Agricultural Sciences*, **4(2):** 667-669 (2008).
4. Burton, G. W. and Dewane, E. H., Estimating heritability in Jali Fesche (*Festucaa rundinaces*) from replicated clone material. *Agron. J*.: 478-481 (1953).
5. Anuradha, C., Vijayalaksmi, P., Bhargavi, V., Pawan Kumar, D., Sreelaxmi, A. and Siddiq, E. A., Correlation, variability and heritability in vegetable Pigeon pea. *Advances in Bioresearch*, **4(2):** 129-134 (2013).
6. Dewey, D. R. and Lu, K. H., A correlation and path-coefficient analysis of components of crested wheat grass seed production. *Agron. J.* **51:** 515-518 (1959).
7. Jay Prakash and Ram, R.B., Genetic variability, correlation and path analysis for seed yield and yield related traits in french bean (*Phaseolus vulgaris* L.) under Lucknow conditions. *International Journal of Innovative Science, Engineering & Technology*, **1(6):** 41-50 (2014).
8. Johnson, D. R., Lueddress, V. D. and Briggs, G. M., Oil and protein content of some promising varieties of soybean. *Agron. J.* **47:** 109-111 (1955).
9. Mishra, S., Kumar, M. and Sahu, G. S., Relationships among yield contributing characters in pole type French bean (*Phaseolus vulgaris* L.). *The Orissa Journal of Horticulture*, **36(2):** 108-113 (2008).
10. Ponnuswamy, V., Irulappan, I., Thamburai, S. and Shanmugasundaram, S., Biometrical studies in vegetable soybean (*Glycine max* (L.) Merrill). *South Indian Hort*., pp. 29-31 (1983).
11. Rai, N., Asati, B. S. , Yadav, D. S. and Singh, A. K., Genetic analysis in French bean (*Phaseolus vulgaris* L.). *Veg. Sci*. **31(2):** 138-141 (2004).
12. Rai, N., Asati, B. S. and Singh, A. K., Genetic divergence in Indian bean. *Legume Research*, **32(2):** 166-172 (2009).
13. Shah, A., Lal, S. D., Seth, J. N. and Pant, C. C., Genetic variability and correlation studies in dwarf French bean (*Phaseolus vulgaris* L.). *Prog. Hort*. **18:** 89-93 (1986).
14. Singh, B. K., Singh, B. P. and Ram, H. H., Variability and correlation studies in bush type French bean (*Phaseolus vulgaris* L.)

in relation to green pod yield . *Prog. Hort*. **32(2):** 176-182 (2000).

15. Singh, R. K. and Chaudhari, B. D., Variance and covariance analysis in "Biometrical methods in quantitative genetic analysis by Kalyani Publi., New Delhi. Pp.39-68 (1977).
16. Sureja, A.K. and Sharma, R.R., Genetic variability and heritability studies in garden pea(*Pisum sativum* L.).*Indian J. Hort.*, **57(3):** 243-247 (2000).
17. Sarutayophat, T., Correlation and path coefficient analysis for yield and its components in vegetable soybean. *Songklanakarin Journal of Science and Technology*. **34(3):** 273-277 (2012).
18. Wang, Z. and Wang, D., Studies on the correlation between the quality traits of vegetable soybean. *In: Sec. Int. Veg. Soybean Conf.*, pp. 187-190 (2001).
19. Vijayalakshmi, P., Anuradha, Ch., Pavankumar, D., Sreelaxmi, A., Anuradha, G., Path coefficient and correlation response for yield attributing traits in Pigeon pea (*Cajanus cajan* (L.). *Int. J. of Scientific and Res. Publications*, **3(4):** 1-6 (2013).