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Correlation Studies for Growth, Yield and Quality Traits in French Bean (*Phaseolus vulgaris* L.)

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Abstract An experiment of correlation studies in French bean (*Phaseolus vulgaris* L.) for twenty one characters were studied in 36 genotypes collected from IIHR, Hesaraghatta, conducted during *rabi* season of the year 2015-16 to know the relative magnitude of association of various characters with yield. Total yield per plant was found to be positively and significantly (p=0.01) associated with plant height at 25 DAS and 50 DAS, number of primary branches at 50 DAS plant spread (N-S) (E-W) at 25 DAS and 50, pod length, pod flesh thickness, number of seeds per pod, number of clusters per plant, number of pods per cluster, number of pods per plant, weight of ten pods, dry matter content of pods and number of root nodules per plant, whereas days to first flowering, days to 50% flowering, days to first pod maturity and pod width showed negative and significant association both at genotypic and phenotypic level.

Keywords French bean, Genotypic correlation, Phenotypic correlation.

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Introduction

French bean (*Phaseolus vulgaris* L., 2n= 2x= 22) is an important legume vegetable belonging to family Fabaceae. It has many synonyms like snap bean, kidney bean, haricot bean and also called raj mash in hindi. The primary center of origin of French bean is Southern Mexico and Central America. It is originated from wild species *Phaseolus aborigineus* L. beans are essentially used for their tender green pods. The dried pods are used as pulse and provide valuable protein to the human diet. Immature pods are marketed fresh, canned or frozen. These pods are dried and fried like potato chips and can be cooked. Green pods can be used to strengthen diuretic, flushing of toxins from the body and also infused in the treatment of diabetics.

The nutritive value of the crop per 100 g of green pod is 1.7 g protein, 0.1 g fat, 4.5 g carbohydrate, 1.8 g

Table 1. Phenotypic correlation coefficient among growth, earliness and yield parameters in French bean genotypes. Critical r_g value at 1% -0.301 critical r_g value at 5% -0.231, **-Indicates significant at p=0.01, *-indicates significant at p-0.05. 1. Plant height at 25 DAS, 2. Plant height at 50 DAS, 3. No. of primary branches at 50 DAS, 4. Plant spread (N-S) at 50 DAS, 5. Plant spread (E-W) at 50 DAS, 6. Plant spread (N-S) at 25 DAS, 7. Plant spread (E-W) at 25 DAS, 8. Days to first flowering, 9. Days to 50% flowering, 10. Days to first pod picking, 11. Pod length, 12. Pod width, 13. Pod flesh thickness, 14. No. of seeds per pod, 15. No. of clusters per plant, 16. No. of pods per cluster, 17. No. of pods per plant, 18. Weight of ten pods, 19. Dry matter content of pods, 20. No. of root nodules per plant, 21. Pod yield per plant.

	1	2	3	4	5	6	7	8	9	10	11
1	1.000	0.702**	0.432**	0.419**	0.417**	0.453**	0.439**	-0.274*	-0.504**	-0.369**	0.510**
2		1.000	0.272*	0.272*	0.276*	0.386**	0.360**	-0.360**	-0.515**	-0.340**	0.541**
3			1.000	0.476**	0.492**	0.460**	0.415**	-0.116	-0.114	-0.298*	0.254*
4				1.000	0.687**	0.647**	0.642**	-0.238*	-0.397**	-0.280*	0.176
5					1.000	0.736**	0.752**	-0.296*	-0.352**	-0.291*	0.320**
6						1.000	0.877**	-0.337**	-0.362**	-0.210	0.268*
7							1.000	-0.366**	-0.386**	-0.305**	0.305**
8								1.000	0.392**	0.296*	-0.128
9									1.000	0.329**	-0.312**
10										1.000	-0.030
11											1.000
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											

Table 1. Continued.

	12	13	14	15	16	17	18	19	20	21
1	-0.345**	0.419**	0.420**	0.233*	-0.050	0.167	0.492**	0.463**	0.372**	0.439**
2	-0.279*	0.337**	0.441**	0.257*	-0.125	0.114	0.454**	0.448**	0.375**	0.373**
3	-0.177	0.349**	0.375**	0.261*	0.005	0.200	0.382**	0.206	0.549**	0.396**
4	-0.168	0.319**	0.337**	0.291*	0.273*	0.422**	0.429**	0.52**	0.455**	0.593**
5	-0.168	0.303**	0.273*	0.372**	0.323**	0.506**	0.350**	0.635**	0.571**	0.615**
6	-0.125	0.417**	0.421**	0.463**	0.318**	0.571**	0.414**	0.509**	0.610**	0.714**
7	-0.132	0.399**	0.363**	0.327**	0.322**	0.466**	0.464**	0.486**	0.606**	` 0.651**
8	0.001	-0.284*	-0.232*	-0.205	-0.128	-0.264*	-0.292*	-0.453**	-0.392**	-0.385**
9	0.317**	-0.227	-0.338**	-0.244*	-0.131	-0.312**	-0.412**	-0.571**	-0.288*	-0.479**
10	0.153	-0.077	-0.218	-0.186	-0.145	-0.227	-0.292*	-0.265*	-0.392**	-0.370**
11	-0.500**	0.390**	0.451**	0.046	-0.135	-0.031	0.460**	0.377**	0.172	0.256*
12	1.000	-0.339**	-0.448**	-0.136	0.124	-0.034	-0.379**	-0.141	0.069	-0.245*
13		1.000	0.449**	0.155	-0.057	0.096	0.571**	0.263*	0.203	0.435**
14			1.000	0.137	0.040	0.142	0.576**	0.311**	0.269*	0.465**
15				1.000	-0.031	0.727**	0.085	0.310**	0.312**	0.612**
16					1.000	0.655**	-0.099	0.115	0.124	0.434**
17						1.000	0.014	0.340**	0.319**	0.771**
18							1.000	0.387**	0.333**	0.638**
19								1.000	0.509**	0.519**
20									1.000	0.476**
21										1.000

fiber and is also rich in minerals and vitamins. 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 constipation and diarrhoea respectively (Duke 1981). In India, it is mainly grown in Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.

The correlation coefficient analysis measures the mutual relationship between various characters and it determines the component traits on which selection can be relied upon to effect the improvement. The correlation characters may be due to genetic linkage or pleiotropy (Harland 1939). There are three types of correlations viz., phenotypic, genotypic and environmental correlations. Phenotypic correlation is the observable correlation between two variables and includes both genotypic and environmental effects. Genotypic correlation on the other hand, is the inherent association between two variables may be either due to pleiotropic action of genes or linkage, more likely both are developmental induced relationships.

Yield is a complex character controlled by large number of contributing characters and their interactions. A study of correlation between different quantitative characters provides an idea of association that could be effectively exploited to formulate selection strategics for improving yield and quality of a crop. In order to have clear picture of yield components for effective selection program, it would be desirable to consider the relative magnitude of association of various characters with yield.

Materials and Methods

The material consists of thirty six bush type genotypes of French bean collected from Indian Institute of Horticultural Research, Hesaraghatta, Bangalore. The experiment was conducted in a RCBD with two replications during *rabi*, 2015-2016 at Department of Vegetable Science, College of Horticulture, Bagalkot. Fifty plants of each genotype were grown per replication with a spacing of 60 cm between rows and 15 cm between plants. The land was brought to a fine tilth by repeated ploughing and harrowing. About 25 tonnes of FYM per hectare and recommended dose of fertilizers (63:100:75 NPK/ha) were incorporated as per the package of practices of UHS, Bagalkot. In each replication, five plants were selected randomly for recording observation. The characters viz., plant height, number of primary branches per plant, plant spread, days to first flowering, days to 50% flowering, days to first pod picking, pod length, pod width, pod flesh thickness, number of seeds per pod, number of clusters per plant, number of pods per cluster, number of pods per plant, weight of ten pods, dry matter content of pods, pod yield per plant and number of root nodules per plant. The correlation co-efficient among all important character combinations at phenotypic (r_p) and genotypic (r_g) level were estimated by employing formula given by Al-Jibouri et al. (1958).

Results and Discussion

The observed difference between the genotypic and phenotypic correlation coefficients was narrow for various traits in the present findings and this indicates the lesser influence of environment in the expression of these traits and presence of strong inherent association among the traits. Hence, only genotypic correlation (Tables 1 and 2) are discussed here under.

Total yield per plant was found to be highly significant and positively associated with plant height at 25 and 50 DAS, number of primary branches at 50 DAS, plant spread (N-S) and (E-W) at 25, 50 DAS, pod length, pod flesh thickness, number of seeds per pod, number of clusters per plant, n umber of pods per cluster, number of pods per plant, weight of ten pods, dry matter content of pods and number of root nodules per plant. Whereas days to first flowering, days to 50% flowering, days to first pod maturity and pod width showed negative and significant association at genotypic level. Hence, direct selection for growth and yield components could be made for improving yield. The findings Kamaluddin and Ahmed (2011), Singh et al. (2014b) and Verma et al. (2014b) in French bean, Islam et al. (2011), Chaudhari et al. (2013) and Magalingham et al. (2013) in dolichos bean, Ullah

Table 2. Genotypic correlation coefficient among growth, earliness and yield parameters in French bean genotypes. Critical r_g value at 1% -0.301 critical r_g value at 5% -0.231, **-Indicates significant at p=0.01, *-indicates significant at p-0.05. 1. Plant height at 25 DAS, 2. Plant height at 50 DAS, 3. No. of primary branches at 50 DAS, 4. Plant spread (N-S) at 50 DAS, 5. Plant spread (E-W) at 50 DAS, 6. Plant spread (N-S) at 25 DAS, 7. Plant spread (E-W) at 25 DAS, 8. Days to first flowering, 9. Days to 50% flowering, 10. Days to first pod picking, 11. Pod length, 12. Pod width, 13. Pod flesh thickness, 14. No. of seeds per pod, 15. No. of clusters per plant, 16. No. of pods per cluster, 17. No. of pods per plant, 18. Weight of ten pods, 19. Dry matter content of pods, 20. No. of root nodules per plant, 21. Pod yield per plant.

	1	2	3	4	5	6	7	8	9	10	11
1	1.000	0.957**	0.645**	0.553**	0.613**	0.622**	0.685**	-0.492**	-0.692**	-0.575**	0.794**
2		1.000	0.447**	0.342**	0.486**	0.582**	0.552**	-0.422**	-0.684**	-0.530**	0.682**
3			1.000	0.661**	0.641**	0.584**	0.642**	-0.341**	-0.184	-0.342**	0.298*
4				1.000	0.895**	0.822**	0.830**	-0.370**	-0.465**	-0.428**	0.328**
5					1.000	0.917**	0.904**	-0.431**	-0.490**	-0.304**	0.376**
6						1.000	0.997**	-0.477**	-0.483**	-0.310**	0.470**
7							1.000	-0.396**	-0.503**	-0.374**	0.469**
8								1.000	0.479**	0.476**	-0.022
9									1.000	0.452**	-0.507**
10										1.000	-0.020
11											1.000
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											

Table 2. Continued.

	12	13	14	15	16	17	18	19	20	21
1	-0.485**	0.661**	0.621**	0.378**	-0.177	0.194	0.793**	0.576**	0.496**	0.585**
2	-0.304**	0.448**	0.537**	0.421**	-0.030	0.314**	0.573**	0.673**	0.471**	0.552**
3	-0.151	0.519**	0.462**	0.389**	-0.100	0.236*	0.622**	0.465**	0.707**	0.525**
4	-0.266*	0.470**	0.429**	0.371**	0.448**	0.596**	0.465**	0.617**	0.543**	0.707**
5	-0.176	0.551**	0.386**	0.639**	0.441**	0.793**	0.493**	0.802**	0.665**	0.857**
6	-0.212	0.571**	0.568**	0.542**	0.329**	0.631**	0.625**	0.694**	0.774**	0.815**
7	-0.244*	0.532**	0.499**	0.413**	0.433**	0.603**	0.631**	0.679**	0.757**	0.807**
8	0.023	-0.407**	-0.292*	-0.272*	-0.230	-0.373**	-0.377**	-0.677**	-0.416**	-0.499**
9	0.390**	-0.277*	-0.438**	-0.243*	-0.231*	-0.375**	-0.510**	-0.743*	-0.324**	-0.573**
10	0.109	-0.096	-0.268*	-0.291*	-0.315**	-0.426**	-0.363**	-0.447**	-0.478**	-0.517**
11	-0.539**	0.612**	0.536**	0.247*	-0.196	0.107	0.796**	0.614	0.110	0.499**
12	1.000	-0.436**	-0.477**	-0.210	0.140	-0.092	-0.549**	-0.189	0.108	-0.354**
13		1.000	0.641**	0.253*	-0.079	0.149	0.885**	0.315**	0.293*	0.594**
14			1.000	0.227	0.085	0.240*	0.790**	0.493**	0.317**	0.614**
15				1.000	0.031	0.760**	0.153	0.366**	0.410**	0.648**
16					1.000	0.667**	0.038	0.269*	0.234**	0.481**
17						1.000	0.164	0.484**	0.465**	0.809**
18							1.000	0.611**	0.433**	0.717**
19								1.000	0.639**	0.700**
20									1.000	0.601**
21										1.000

et al. (2011) in yard long bean, Kumar et al. (2015) and Girish et al. (2012) in cluster bean, Lenkala et al. (2015) in jack bean were similar.

Plant height at 25 and 50 DAS had positive and significant correlation at p=0.01 with, number of primary branches at 50 DAS, pod length, pod flesh thickness, number of seeds per pod, number of clusters per plant, weight of ten pods, dry matter content of pods, number of root nodules and yield per plant. While it showed significant and negative correlation with days to first flowering, days to 50% flowering, days to first pod maturity and pod width. Similar results were reported by Verma et al. (2014b) and Gangadhara (2012) in French bean.

Number of primary branches at 50 DAS had positive and significant association at p=0.01 with plant, pod length, number of seeds per pod, number of clusters per plant, weight of ten pods, dry matter content of pods, number of root nodules and yield per plant. It showed significant and negative correlation with days to first flowering and days to first pod maturity The findings of Syed Mudasir et al. (2012) in French bean, Ravinaik et al. (2014) and Chaudhari et al. (2013) in dolichos bean are in conformity with present findings.

Pod length had positive and highly significant association with pod flesh thickness (0.512), number of seeds per pod (0.608), number of cluster per plant (0.631), number of pods per cluster (0.572), number of pods per plant (0.589), weight of ten pods (0.591) and yield per plant (0.553). But it showed significant and negative correlation with pod width (-0.499). These results were obtained by Kamaluddin and Ahmed (2011), Syed Mudasir et al. (2012), Singh et al. (2014b) and Verma et al. (2014b) in French bean.

Pod width had negative and highly significant correlation with pod flesh thickness (-0.436), number of seeds per pod (-0.477), weight of ten pods (-0.549) and yield per plant (-0.354). Similar results were also obtained by Rai et al. (2004) and Verma et al. (2014b) in French bean, Lenkala et al. (2015) in jack bean.

Number of seed per pod had positive and highly significant association with weight of ten pods (0.790), dry matter content of pods (0.493), number of root nodules per plant (0.317) and yield per plant (0.614). These results are in conformity with the readings of Rai et al. (2010), Kamaluddin and Ahmed (2011) and Singh et al. (2014b) in French bean.

The significant at p=0.01 and positive correlation of number of cluster per plant was observed with number of pods per plant (0.760), dry matter content of pods (0.366), number of root nodules per plant (0.410) and yield per plant (0.648). Girish et al. (2012) in cluster bean also obtained similar results.

Number of pods per cluster had positive and highly significant association with number of pods per plant (0.667) and yield per plant (0.481). While and dry matter content of pods (0.269) and number of root nodules per plant (0.234) were found significant (p=0.05) and positively associated with this trait. Similar results were obtained by Chaudhari et al. (2013) and Ravinaik et al. (2014) in dolichos bean, Venkatesan et al. (2003) in cowpea.

The significant at p=0.01 and positive correlation of number of pods per plant was observed with yield per plant (0.809), dry matter content of pods (0.484) and number of root nodules per plant (0.465). These results are in conformity with the observations of Rai et al. (2010), Kamaluddin and Ahmed (2011), Syed Mudasir et al. (2012), Singh et al. (2014b) and Jayprakash et al. (2015) in French bean.

Weight of ten pods exhibited the positive and highly significant association with pod yield (0.717), dry matter content of pods (0.611) and number of root nodules per plant (0.433). These results obtained by Verma et al. (2014b) and Singh et al. (2014b) in French bean.

Dry matter content of pods had positive and significant (p=0.01) association with number of root nodules per plant (0.639) and yield per plant (0.717). Similar results were also obtained by Verma et al. (2014b) in French bean and Aditya et al. (2011) in soya bean.

Conclusion

From this study it can be concluded that the total

yield per plant was found to be highly significant with characters like number of seeds per pod, number of clusters per plant, number of pods per plant, weight of ten pods. So direct selection for growth and yield components could be made for improving yield.

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