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Muthal KM
Department of Vegetable Science, College of Horticulture., Bagalkot, Karnataka, India

Patil HB
Department of Vegetable Science, College of Horticulture, Bagalkot, Karnataka, India

Ganiger VM
Department of Vegetable Science, College of Horticulture, Bagalkot, Karnataka, India

Ajjappalvar PS
Department of Vegetable Science, College of Horticulture, Bagalkot, Karnataka, India

Pallavi HM
Department of Vegetable Science, College of Horticulture, Bagalkot, Karnataka, India

Correspondence
Muthal KM
Department of Vegetable Science, College of Horticulture., Bagalkot, Karnataka, India

Correlation and performance evaluation of french bean (*Phaseolus vulgaris* L.) varieties

Muthal KM, Patil HB, Ganiger VM, Ajjappalvar PS and Pallavi HM

Abstract
Correlation and performance evaluation of french bean (*Phaseolus vulgaris* L.) varieties were studied for growth, yield and yield attributing characters. The experiment involving twelve varieties was laid out at the Research Block of Vegetable Section in Sector No.1, University of Horticultural Sciences, Bagalkot (Karnataka) during *Rabi* season of 2012 in a randomized block design with three replications. Among the varieties studied, Arka Anoop was better with respect to growth, yield and yield attributing characters followed by Best of All and Arka Komal. Correlation studies are important to know the interrelationship among the characters. This also gives fair idea of contribution of different characters towards yield. Correlation studies revealed that pod yield per hectare exhibited significant positive correlation with primary branches per plant, clusters per plant, pods per cluster, pods per plant, yield per plant, root nodules and dry matter content in pod at genotypic and phenotypic level while plant height, weight of ten pods, pod length and pod width showed positive association with pod yield per hectare. Days to first flowering and days to fifty per cent flowering showed negative correlation with the pod yield per hectare.

Keywords: Correlation, evaluation, french bean, varieties

Introduction
French bean *Phaseolus vulgaris* L. (2n = 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. 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 (Abate, 2006) [1]. In World, french bean is grown over an area of 1.48 million ha with annual production of 17.65 million MT and the productivity is 11.95 t per ha. In India, its cultivation is in 0.21 million ha with production of 0.58 million MT and productivity is 2.8 t per ha (FAOSTAT, 2010) [7]. In Karnataka, it is cultivated in an area of 0.107 Lakh ha with annual production of 1.12 Lakh tonnes with the productivity of 10.51 t per ha (Anon, 2010) [7, 8]. The performance evaluation of different french bean varieties varies under different agroclimatic conditions due to their specific climatic requirement. Therefore, an appraisal of varieties for their variability with respect to growth, yield and quality under different conditions is essential to improve the production. In this context it is very much necessary to evaluate these commercial varieties available, in order to identify high yielding types for increasing production and productivity. Correlation analysis provides the information of interrelationship of important plant characters and hence, leads to a directional model for direct or indirect improvement in pod yield per hectare. Phenotypic and genotypic coefficients of variation were high for pods per plant and pod yield per hectare.

Material and Methods
The field experiment was performed to compare their correlation among various growths, yield and yield related traits in french bean varieties at the 482 *Eco. Env. & Cons. 21 (1): 2015* Research Block of Vegetable Section in Sector No.1, University of Horticultural Sciences, Bagalkot (Karnataka) during the *rabi* season of 2012. Twelve varieties were sown in a plot size of 3.6 m x 2.0 m using randomized block design (RBD) with three replications maintaining row-to-row distance of 60 cm. Each treatment or variety in each replication was represented by six rows of twenty plants each in a plot. All the cultural practices were uniformly applied to all the experimental units to minimize the experimental error. Data were recorded for plant height at 25 DAS, number of primary branches per plant, pod length, pod width, weight of ten pods, number of clusters per plant, number of pods per cluster, number of

pods per plant, yield per plant, pod yield per hectare, number of root nodules per plant and dry matter content in pods from five well guarded and randomly selected pants by avoiding border plants. The means were subjected to analysis of variance by the standard method of Panse and Sukhatme (1964) [12, 18]. The correlation co-efficient among all possible character combinations at phenotypic (rp) and genotypic (rg) level were estimated employing formula (Al-Jibouri *et al.*, 1958) [4].

Results and Discussion

Analysed mean data for the twelve varieties with respect to twelve parameters are given in table 1. The results indicated that there was a significant (P=0.05) difference among varieties for twelve parameters. Variety, Seville (64.27 cm) recorded significantly higher plant height followed by Anupama (60.87), Arka Komal (60.73) and Arka Anoop (60.33). Variety, Arka Anoop (7.87) recorded significantly higher number of primary branches per plant compared to nine varieties and it was *on par* with Best of All (7.47) and Contender (7.40). This higher plant height and number of primary branches might have resulted in better canopy size. The canopy size determines the site of ontogeny of flower. The pod length was higher in Arka Anoop (15.03 cm) followed by Best of All (14.40 cm) and Arka Komal (14.07 cm). Variety, Arka Anoop (6.87) recorded higher number of seeds per pod followed by Arka Sharath, Best of All and Naveli. It is due to long pod length. The weight of ten pods recorded was significantly higher (70.0 g) in both Arka Anoop and Arka Bold as compared to the other varieties and next best varieties were Best of All (65 g) and Arka Komal (62.33 g). It is due to pod length and pod width. Arka Anoop (3.10) recorded significantly higher number of pods per cluster as compared to the other varieties except Arka Komal. Variety, Arka Anoop (46.25) recorded more number of pods per plant followed by Best of All (42.50) and Arka Komal (41.10). The higher number of pods per plant is due to higher number of clusters per plant and pods per cluster. Among the 12 varieties, Arka Anoop (323.75 g) recorded significantly higher vegetable pod yield per plant and it was followed by Best of All (276.25 g) and Arka Komal (254.52 g). Arka Anoop (24.58 t/ ha) recorded significantly higher vegetable pod yield per hectare compared to other varieties and next best varieties were Best of All (20.83 t/ha) and Arka Komal (19.09 t/ha). The variation in yielding ability of varieties is attributed to genetic makeup, as yield is a complex character which is governed by polygenes. Higher productivity in these varieties may be traced to their capacity to have stronger sinks in terms of number of pods per plant or pod weight. The number of root nodules per plant were higher in Best of All (27.60) followed by Arka Anoop (21.87), Arka Sharath (17.93) and Arka Komal (15.87). This higher number of root nodules per plant might have increased the nitrogen availability to the plant. This might have favourably affected the chlorophyll content of leaves resulting in increased synthesis of carbohydrate and protein, and translocation of photosynthates from source to economic sink. Arka Anoop (28.57 g) showed significantly higher dry matter in pod as compared to other varieties and it was followed by Best of All (24.40 g) and Arka Komal (22.95 g). The results indicated existence of wide variability for each of the twelve parameters studied. Similar finding were reported by Anila and Balakrishnan (1990) [5], Ramakrishna (1999) [19], Roy and Parthasarathy (1999) [20], Govanakoppa (2001) [11], Nimbalkar *et al*., (2002) [17], Ndegwa *et al.*, (2004) [14], Smitha (2005) [23], Aghora *et al.*, (2007) [2] and Ndegwa *et al.*, (2007), Girish (2011) [10] and Alemu *et al.*, (2013). The studies on performance evaluation of french bean varieties revealed that Arka Anoop, Best of All and Arka Komal were found to be promising as they are good yielders and this is reflected in plant height, number of primary branches, pod length, seeds per pod, weight of ten pods, number of pods per cluster, number of pods per plant and pod yield per plant.

Table 1: Performance of french bean varieties for growth, yield and yield attributing characters

Variety	Plant height (cm)	Primary branches	Pod length (cm)	Seeds per pod	Weight of ten pods (g)	Pods per cluster	Pods per plant	Pod yield per plant (g/plant)	Pod yield per ha (t/ha)	No. of root nodules per plant
Arka Sharath	56.80	6.83	13.78	6.57	59.33	2.00	31.00	182.90	13.82	17.93
Arka Anoop	60.33	7.87	15.03	6.87	70.00	3.10	46.25	323.75	24.58	21.87
Arka Bold	49.40	6.67	10.79	5.67	70.00	2.10	30.20	211.40	15.97	13.93
Arka Suvidha	56.07	7.13	12.27	6.47	60.67	2.70	34.34	206.04	15.55	15.13
Arka Komal	60.73	7.37	14.07	6.63	62.33	3.00	41.10	254.52	19.09	15.87
Best of all	59.33	7.47	14.40	6.80	65.00	2.62	42.50	276.25	20.83	27.60
Contender	52.20	7.40	11.09	6.10	62.33	2.20	32.00	198.40	14.93	14.33
Naveli	58.47	6.47	14.07	6.70	58.00	2.40	29.33	170.11	12.84	15.33
Anupama	60.87	6.77	12.31	6.53	52.33	2.22	28.80	152.36	11.54	13.73
Seville	64.27	6.23	14.40	6.47	56.67	2.37	36.80	206.08	15.69	13.60
Malgudi	59.53	6.30	12.17	6.37	48.67	2.27	36.52	175.29	13.19	11.40
Anup	56.80	5.40	11.81	5.63	58.00	2.33	26.26	149.76	11.25	10.93
Mean	57.90	6.80	13.01	6.40	60.25	2.44	34.59	208.92	15.77	15.97
Range	49.40-64.27	5.40-7.87	10.79-15.00	5.63-6.87	48.67-70.00	2.00-3.10	26.26-46.25	149.76-323.75	11.25-24.58	10.93 – 27.60
SEm±	2.23	0.15	0.66	0.14	1.56	0.07	1.00	3.72	0.47	0.84
CD@5%	6.55	0.46	1.96	0.41	4.59	0.22	2.94	10.93	1.38	2.48
CV@5%	6.68	3.99	8.91	3.87	4.50	5.37	5.03	3.11	5.17	9.19

Data for phenotypic and genotypic correlations with respect to twelve parameters are given in table 2 and 3. Plant height at 25 DAS showed highly significant and positive correlation with dry matter in pods at genotypic level. Number of primary branches per plant exhibited highly significant and positive correlation with weight of ten pods and number of pods per cluster at genotypic level whereas number of pod per plant, pod yield per plant, pod yield per hectare, number of root nodules per plant and dry matter in pod both at phenotypic and genotypic level. Pod length had significant and positive correlation with number of pods per cluster, pod per plant, pod yield per plant, pod yield per hectare and number of root nodules per plant at genotypic level. Pod width showed highly significant and positive correlation with ten pods weight at genotypic level. Weight of ten pods exhibited highly significant and positive correlation with pod yield per plant, pod yield per hectare and dry matter in pod. Number of clusters per plant showed highly significant and positive correlation with number of pods per plant at genotypic level. Number of pods per cluster exhibited highly significant and positive correlation with number of pods per plant, pod yield per plant, pod yield per hectare and dry matter in pods at phenotypic and genotypic level. Number of pods per plant showed highly significant and positive correlation with pod yield per plant, pod yield per hectare, number of root nodules per plant and dry matter in pods at both phenotypic and genotypic level. Pod yield per plant exhibited highly significant and positive correlation with pod yield per hectare, number of root nodules per plant and dry matter in pods at both phenotypic and genotypic level. Pod yield per hectare showed highly significant and positive correlation with number of root nodules per plant and dry matter in pods at both phenotypic and genotypic level. Number of root nodules per plant exhibited highly significant and positive correlation with dry matter in pods at both phenotypic and genotypic level. These results are in close agreement with the findings of Vasic *et al*., (1997) [25], Arya *et al.,* (1999) [9], Singh *et al.,* (2000) [21], Govanakoppa (2001) [11], Nimbalkar *et al*. (2002) [17], Singh *et al.,* (2002) [22], Kumar (2004) [13], Smitha (2005) [23], Ushakumari (2010) [24] and Girish (2011) [10]. The growth characters like plant and number of primary branches per plant, yield attributing characters like clusters per plant, pods per cluster, number of pods per plant, weight of ten pods, pod length, pod width and number of nodules on roots along with dry matter content in pod have shown positive correlations with pod yield per hectare. Significant and positive correlation among these characters will lead towards direct or indirect improvement for yield.

Table 2: Phenotypic correlations for vegetative, yield and yield attributing character in french bean

-@	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.351	0.020	0.208	0.251	0.388	0.237	0.325	0.394	0.397	0.333	0.522
2		1.000	0.207	0.175	0.491	0.318	0.528	0.629*	0.735*	0.734*	0.630*	0.713**
3			1.000	-0.138	0.133	0.119	0.525	0.563	0.481	0.432	0.520	0.308
4				1.000	0.539	0.196	-0.179	0.001	0.215	0.214	0.153	0.192
5					1.000	0.044	0.349	0.376	0.681*	0.675*	0.519	0.604*
6						1.000	-0007	0.446	0.333	0.393	0.372	0.400
7							1.000	0.745**	0.732**	0.739**	0.429	0.622*
8								1.000	0.888**	0.861**	0.630*	0.817**
9									1.000	0.974**	0.716**	0.909**
10										1.000	0.730**	0.910**
11											1.000	0.576*
12												1.000

Table 3: Genotypic correlations for vegetative, yield and yield attributing characters in french bean

-@	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.536	0.017	0.343	0.516	0.408	0.256	0.531	0.549	0.542	0.499	0.730**
2		1.000	0.435	0.192	0.613*	0.411	0.655*	0.719**	0.794**	0.794**	0.729**	0.783**
3			1.000	-0.278	0.121	0.398	0.641*	0.722**	0.649*	0.674*	0.693*	0.491
4				1.000	0.590*	0.327	-0.174	0.005	0.233	0.233	0.136	0.206
5					1.000	0.081	0.376	0.382	0.743**	0.747**	0.569	0.730**
6						1.000	-0.064	0.660*	0.498	0.453	0.498	0.547
7							1.000	0.815**	0.784**	0.783**	0.487	0.721**
8								1.000	0.920**	0.934**	0.682*	0.905**
9									1.000	0.985**	0.786**	0.963**
10										1.000	0.773**	0.962**
11											1.000	0.664*
12												1.000

01. Plant height (25 DAS)
02. Primary branches
03. Pod length
04. Pod width
05.Ten pod weight
06. Number of clusters per plant
07. Number of pods per cluster
08. Number of pods per plant
09. Vegetable pod yield per plant
10. Vegetable pod yield per ha
11 Number of root nodules per plant
12 Dry matter in pods

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