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Evaluation of french beans (*Phaseolus vulgaris* L.) bush type at mid and higher elevations of Nilgiris

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ABSTRACT : Ten accessions of traditional french beans - types were collected from different elevations and evaluated for yield and quality at Nanjanad Farm, HRS, Ooty. The 10 entries of bush beans were evaluated in a Randomized Block Design with 3 replications at Nanjanadu Farm, HRS, Ooty. Observations were taken on growth and yield characters from 2010 onwards. Observation on plant height, number of branches, number of compound leaves, days taken of flowering, number of pods, days taken for pod setting, pod length, pod diameter and pod weight per plant were recorded. As indicated in the pooled means of four years from 2010 to 2013, among the bush bean types, accession number FBB-7 (Aruvath avarai) has recorded highest pod yield of 712.73 g/plant and pod weight of 15. 80g/ pod. The highest genotypic co-efficient of variation was observed for number of leaves, pod weight and yield. High heritability values were observed in plant height, number of branches, number of leaves, days for flowering and pod development, pod length, pod diameter, pod weight and yield. The expected genetic advance expressed as percentage of mean was relatively high for the characters *viz.*, plant height, branch, number of leaves, days for flowering, days for pod development, pod length, pod diameter, pod weight and yield.

KEY WORDS : Growth, Yield, genotypic co-efficient of variation, Heritability, Genetic advance

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Legumes are an important component in the diets of humans and animals throughout the world and are cultivated under a wide range of environmental conditions. The world production exceeds 17 million tonnes in China, Indonesia, India and Turkey among the largest producers and consumer of this crop (FAOSTAT, 2010).Legumes are tolerant of heat and drought conditions and perform well on marginal soils. They are noted for their ability to fix nitrogen in the soil (Amanuel *et al.*,2000) and are used to improve soil conditions. Bush bean is becoming popular for its tender pods and shelled beans. It has also high export potentiality.

As a food, these legumes may be consumed as dried beans or in the fresh state as green beans. They are also widely used as a vegetable when harvested while the young tender pods are still immature. In different locations, these immature pods are referred to as string beans, snap beans, French beans or green beans. They are rich in protein and iron and contain essential nutrients such as ascorbic acid, vitamin A, vitamin B and calcium (Kelly and Scott, 1992; Ndegwa *et al.*, 2006). Green beans are a very valuable crop when cultivated for the fresh market and are a means by which local farmers can diversify their agricultural production. Green beans

grown for their tender pods require between 50-75 days, depending upon variety and planting season. An important first step in the production of high yielding green beans is the selection of the appropriate varieties, since some varieties are more suited to other climate and soil conditions. By cultivating the appropriate varieties, local farmers can become leading producers of this specialty crop. The evaluation and selection of high yielding, disease tolerant varieties with quality characteristics acceptable to the local market are essential to the improvement of local production.

Bush bean belongs to the family Leguminaceae, is reported to be a native of Central and South America (Swaider *et al*., 1992). It is also referred as to French bean, common bean, snap bean, green bean, kidney bean, haricot bean and dwarf bean (George, 1985). Its dry seed contains 21.1 per cent protein, 69.9 per cent carbohydrates, 1.7 per cent fat, 381 mg calcium, 425 mg phosphorus and 12.4 mg iron per 100 g of edible part (Ali and Kushwaha, 1987). The hilly area of Nilgiris where the soil is light in texture and comparatively low temperature prevails during the winter season with less rainfall has been found suitable for french bean cultivation (Mozumdar *et al*., 2003). French bean is gaining popularity in the Nilgiris, particularly as a vegetable crop. The present experiment was taken to identify suitable accession for the specific location.

In Nilgiris, bush beans and perennial beans are being grown both as pure and mixed crop from the years together. At present there is no stable variety of bush beans with high yield and less fibre content suitable for the Nilgiri district. Therefore, the study was formulated to select a high yielding variety of bush beans suitable for the Nilgiri eco – system. Developing suitable high yielding beans variety will help to improve the economy of the farmers of the Nilgiris besides providing nutritional security of the people. Yield is the principal factor for determining improvement of a crop. Like other legumes, pod yield in bush bean (*Phaseolus vulgaris* L.) is a quantitative character and influenced by a number of yield contributing traits. The selection of desirable types should, therefore, be based on yield as well as on other yield components. Information on mutual association between yield and yield components is necessary for efficient utilization of the genetic stock in crop improvement program of this crop. In a preliminary trial it was noticed that bush bean showed a high variability in its yield and yield contributing characters; suggested an ample scope for yield and quality improvement of this crop.

Attention should, therefore, be paid for characterization of available bush bean genotypes. Information on association of yield related traits and the degree and direction of association should be of helpful for identifying desirable characters for a useful breeding programme on bush bean. This study was undertaken, employing 10 potential genotypes to analyze the relationship between yield components, association among desired traits and their direct and indirect contributions toward seed yield in bush bean.

RESEARCH METHODS

The experiments were conducted to assess the performance of the different advanced 10 cultures of French beans (bush type) from the year 2010 – 2013 at Nanjanadu Farm in main season of four years tested in Randomized Block Design with four replications. A spacing of 45 x 30 cm was adopted. Application of decomposed FYM 25 t/ha, NPK @ 90:90: 90 kg/ha as basal and 45: 45: 45 kg/ha as top dressing at 45th day after sowing was done. All necessary cultural operations were done as and when necessary during the growing period. Observations of various morphological features like plant height, number of compound leaves, days taken for flowering, days taken for pod setting, number of pods, pod length (cm), pod diameter (cm) and pod weight (g). The pod yields were recorded at different harvesting time for vegetable purpose as and when found suitable and finally the data of different harvests were added up to get the total yield. Upon maturity of the green pods, the beans were harvested by hand. For this study, all observations and measurements were made on the initial harvest of marketable pods. Data was collected, from ten randomly selected plants. Ten plants were harvested at random from each of the three plots, for each variety. The pods were graded, then weighed and measured. The total number of pods per plant was recorded. Pod length (cm) was measured with a ruler. Ten pods were selected randomly from the total batch of harvested pods from each variety to assess their post-harvest quality characteristics. The fibre content was determined by breaking the pod and determining whether it snapped cleanly or did not snap, due to excessive string and seediness. The accession FBB -10 has been considered as a check. The performance of other entries evaluated in comparison with the performance of the local check.

The data were analyzed for estimation of genotypic and phenotypic co-efficients of variation following Burton (1952). Heritability in broad sense and genetic advance were calculated according to the methods of Allard (1960).

RESEARCH FINDINGS AND DISCUSSION

Ten accessions of french bean bush type were evaluated during 2010 – 2013 for stability of green pod yield. As the pooled means of four years from 2010 to 2013, among the bush bean types, accession number FBB-7 (Aruvath avarai) has recorded the maximum plant height (67.21), number of branches (6.80), number of compound leaves (44.70), days taken for flowering, (25.29), days taken for pod setting (42.00), number of pods (34.15), pod length (18.48 cm), pod diameter (3.35cm) and pod weight (15.80g), highest pod yield of 712.73 g/plant (Table 1).

The differences in the stated number of days to maturity and the actual number of days to maturity may be attributed to any number of factors, including climatic, environmental or growing conditions. There was also a significant variation in the days to maturity among the ten green bean varieties, which ranged from 52 - 67 days. The difference in days to maturity could be attributed to photoperiod, since different bean varieties respond differently to a specific photoperiod. This corroborates earlier data of Khan *et al*. (2006) whose study also reported significant variation in days to maturity among common bean germplasm. Significant variation was observed for the number of pods per plant, pod length, total weight of pods per plant and plant height. As with the varying maturity dates, these differences could also be attributed to differences within the genetic make-up of the green bean varieties. Other characteristics, such as pod colour, fibre content and visual appearance, which may affect pod quality, are within market standards for grades of green beans (USDA-AMS, 1997).

Mean, genotypic and phenotypic co-efficient of variations, heritability and expected genetic advance of different yield contributing characters are given in Table 2. The differences between genotypic co-efficient of variation (GCV) and the phenotypic co-efficient of variation (PCV) were low for all the characters indicated a low environmental influence on the expression of these characters.

The highest genotypic co-efficient of variation was observed for plant height (18.21), number of branches (15.10), number of leaves (28.95), pod length (17.43), pod weight (20.05) and yield/ plant (58.90). According to Burton (1952) characters which show high GCV have the high potential for effective selection. The plant height, pod length and protein percentage had moderate genotypic and phenotypic co-efficients of variation and hence, these traits provide practically average chance for selection. On the contrary days taken for flowering

Table 1 : Growth and yield of different accessions of french beans – bush types (Pooled means of 4 years from 2010 – 13)

Sr. No.	Accessions	Plant height(cm)	No.of branches	No. of compound leaf	Days taken for flowering	Days taken for maturity	No. of pods	Pod length (cm)	Pod diameter (cm)	Pod weight (g)	Yield /plant (g)
1.	FBB -1	90.13	4.78	25.30	40.07	65.95	31.52	13.40	03.2	9.33	240.00
2.	FBB -2	48.25	4.03	23.60	35.35	66.71	27.41	14.90	2.85	8.60	214.10
3.	FBB -3	60.95	4.63	31.21	32.26	65.72	30.95	10.20	2.63	8.60	226.60
4.	FBB- 4	65.15	4.98	34.40	34.84	67.31	32.88	13.75	2.70	8.63	204.10
5.	FBB -5	47.71	4.80	32.71	32.40	64.72	29.05	11.05	2.43	8.80	176.75
6.	FBB -6	66.62	4.65	28.25	33.17	62.90	29.74	13.50	3.00	9.00	211.45
7.	FBB -7	67.21	6.80	44.70	25.29	52.00	34.15	18.48	3.35	15.80	712.73
8.	FBB -8	65.35	5.00	30.26	33.54	64.95	30.94	14.33	2.90	9.43	248.65
9.	FBB -9	62.47	6.13	14.22	27.83	65.70	26.14	16.85	3.03	7.35	172.50
10.	FBB -10	65.34	5.41	29.36	33.37	65.62	30.94	16.90	2.55	10.18	321.50
	Mean	63.92	5.11	28.15	38.297	64.47	26.824	14.335	2.867	9.570	272.838
	C.D. (P=0.05)	1.473	0.242	1.379	2.131	1.573	2.089	0.7039	0.131	0.450	17.753
	S.E.±	3.023	0.497	2.830	4.372	3.229	4.287	1.444	0.270	0.925	36.428
	C.V. %	3.26	6.70	6.93	7.87	4.09	11.02	6.94	6.49	6.66	9.20

(9.87), days for pod development (7.99), pod number (5.64), pod diameter (9.04) had the lower phenotypic and days for flowering (8.81) had the genotypic co-efficients of variation and thus, have practically less chance for selection.

The highest phenotypic co-efficient of variation was observed for plant height (18.50), number of branches (17.62), number of leaves (31.50), days for flowering (10.18), pod number (30.96), pod length (18.88), pod diameter (11.20), average weight (22.50) and average pod yield (59.93). The highest phenotypic and genotypic of co-efficient of variation observed in plant height, number of branches, number of leaves, pod length, pod weight and yield per plant. Hence, these traits provide practically average chance of selection.

The heritable fraction of the variation provides the base of the plant breeder for selection on the phenotypic performances. High heritability values were observed in plant height (96.89), number of branches (73.42), number of leaves (84.45), days for flowering (94.03), days for pod development (82.31), pod length (85.21), pod diameter (65.14), pod weight (79.42) and yield (96.59). The lowest heritability recorded only in pod number (3.32).

The high heritability of these parameters indicated that selection of them would be more effective than the other parameters (Singh *et al.*, 1994). The heritability value for duration of flowering, pod length and days to 50 per cent flowering was high, while it was low for seeds/ pod which was in accordance with the findings of Samal *et al.* (1997) in kidney bean. According to Panse (1957) effective selection may be done for the characters having high heritability accompanied with high genetic advance, which is due to additive gene effect.

The expected genetic advance expressed as percentage of mean was relatively high for the characters *viz.*, plant height (36.93), number of branch (26.66), number of leaves (54,81), pod length (33.14), pod weight (36.81) and yield (119.26) (Table 2) which in fact demonstrated the presence of additive gene effects. It would, thus, be worthwhile to select these traits for the improvement of this crop. High values for heritability and genetic advance were observed for plant height, number of branches, number of leaves, pod length, pod weight and yield/ plant in french bean genotypes in a study of Singh *et al.* (1994). The high heritability along with medium estimates of genetic advance was found in days for flowering and days for flower development and pod diameter (Table 2). Panse (1957) also reported that low heritability accompanied by low genetic advance was due to non-additive gene effects for the particular character and would offer less scope for selection; because that was under the influence of environment. High heritability along with medium genetic advance observed in days for pod development and days for flowering. Similar result was also reported by Aggarwal and Kang (1976) for days to first flowering in horse gram (*Dolichos biflorus* L.) and argued for a minimum scope for improvement of horse gram through selection of this character.

Conclusion :

The highest genotypic co-efficient of variation was observed for number of leaves, pod weight and yield.

Table 2 : Variability, heritability and genetic advance as per cent of mean parameters for bush bean

Characters	Mean	Range	Genotypic co-efficient of variation (GCV %)	Phenotypic co-efficient of variation (PCV %)	Heritability (%)	Genetic advance as per cent of mean
Plant height (cm)	90.13	47.71 – 90.13	18.21	18.50	96.89	36.93
Number of branches (no.)	4.78	4.03 – 6.08	15.10	17.62	73.42	26.66
Number of leaves (no.)	25.30	14.22 – 44.70	28.95	31.50	84.45	54.81
Days for flowering	40.07	25.29 – 40.07	9.87	10.18	94.03	19.72
Days for pod development	55.95	42.00 – 57.31	7.99	8.81	82.31	14.94
Pod number (no.)	31.52	26.16 – 34.15	5.64	30.96	3.32	2.12
Pod length (cm)	13.40	10.20 – 18.48	17.43	18.88	85.21	33.14
Pod diameter (cm)	03.2	2,43 – 3.35	9.04	11.20	65.14	15.03
Average pod weight (cm)	9.33	7.35 – 15.80	20.05	22.50	79.42	36.81
Yield (g / plant)	240.00	172.50 – 712.73	58.90	59.93	96.59	119.26

High heritability values were observed in plant height, branch, number of leaves, days for flowering, days for pod development, pod length, pod diameter, pod weight and yield. The expected genetic advance expressed as percentage of mean was relatively high for the characters *viz*., plant height, branch, number of leaves, days for flowering, days for pod development, pod length, pod diameter, pod weight and yield .

Since genetic co-efficient of variability, phenotypic co-efficient of variability and heritability estimates determine the component of heritable variation and genetic advance measures the extent of its suitability under selection, all these parameters should be considered simultaneously so as to bring effective improvement in yield and other characters. In evaluation of 10 accessions of bush beans the characters *viz*., plant height, number of branches, number of leaves, pod length, pod weight and yield/ plant exhibited higher values of heritability coupled with genetic advance as per cent of mean revealed that they may possibly controlled by additive genes. Hence, in bush beans the direct selection may be adopted to improve the characters under consideration.

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