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STUDIES ON PERFORMANCE OF FRENCH BEAN (*PHASEOLUS VULGARIS* L.) GENOTYPES FOR YIELD AND QUALITY TRAITS UNDER PROTECTED CONDITIONS

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Abstract

French bean is an important legume crop, which is grown for its dry grain and tender pods in North-Western India. This off-season crop can be successfully raised under Punjab conditions during winter season which fetches higher price in the market and economical to the farmers when there is no availability of green pods from high altitude. Hence, there is a great scope of cultivation of French bean under net-house conditions in Punjab. The present investigations were carried out in Department of Vegetable Science, PAU, Ludhiana with the sole objective to indentify French bean genotypes suitable for cultivation under protected conditions. Twenty genotypes were evaluated for quality parameters such as dry matter, protein, sugar and fibre content. Based on the two year study, observations for biochemical analysis exhibited that maximum dry matter content was found in FB-4 (15.08%) followed by IIHR-909 (13.74%) and Aperna (13.59%), whereas, maximum protein content was recorded in DWP-FB-57 (6.56%), Falguni (6.53%) and Seville (6.08%). Besides this, maximum sugar content was observed in the genotype FB-3 (0.94%), Falguni (0.80%) and Cosmo (0.66%) while minimum fibre content was recorded in genotypes DWP-FB-57 (0.29 %), DWP-FB-53 (0.43 %) and Falguni (0.45 %).

Key words : French bean, protected condition and quality traits.

Introduction

French bean (*Phaseolus vulgaris* L.) belongs to the family Fabaceae and it is native of South America. It is domesticated in Mexico, Peru and Colombia about 8000 years ago. French bean has evolved from wild growing vine distributed in the high lands of Middle-America and Andes. These two domestications, led to two groups of cultivars with contrasting agronomic characteristics. During this evolution, some marked changes has affected this plant from climbing to dwarf type, which has taken place both in the middle American and Andean domestication centres as reported by Schoonhoven and Vosyest, 1991. It is widely cultivated in tropics, sub tropics and temperate regions. In India and most of the tropical Asia, it is a major vegetable crop where indigenous pulses are also preferred.

French bean commonly known as kidney bean or snap been or fine bean is one of the important vegetable crop among legumes. It is grown for tender green pods for fresh consumption as well as for dry seeds which are used as pulse. The dried beans are rich in protein and closely compare with meat. In India, it is mostly grown for tender green pods, while in the USA it is grown for processing in large quantities. This vegetable not only plays a vital role in nourishment of human population, but also improves soil fertility to a greater extent by virtue of being highly nitrogen fixing crop. 100 g green pods contain 1.7 g protein, 0.1 g fat, 4.5 g carbohydrate, 1.8 g fibre and are also rich in minerals and vitamins. It has some medicinal properties in control of diabetes, cardiac problems and natural cure for bladder burn. It has both carminative and reparative properties against constipation and diarrhea as reported by Duke (1981).

In India, it is mainly grown in Himachal Pradesh, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. In India, pulses account for about one fifth of the

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total area under food grains and contribute to about one fifth of the total food grain production with the total area under pulses being 23.85 m ha and production of 14.60 m tones (Anonymous, 2009). Among the pulses, raj mash is one of the high potential pulse crops with a yielding potential of 18 to 20 q per ha. French bean fetches premium price in market as compared to other vegetables and is a popular vegetable grown under irrigated conditions almost throughout the year. It is gaining lot of importance due to its short duration and high production potential as well as its high nutritive value. French bean is a tender warm season vegetable which cannot tolerate frost, high temperature and rainfall. Its seeds do not germinate below 15°C and a most favorable soil temperature for its seed germination ranged from 18-24°C. A mean air temperature of 20-25°C is optimum for its growth and high pod yield. Extreme high temperature interferes with pod filling. When sowing of French bean is done in September-October under open field conditions in Punjab there is a severe mortality of plants due to fusarium wilt at germination stage. Moreover occurrence of frost coupled with low temperature during the month of December-January causes mortality of plant. Hence extreme low and high temperature are the limiting factors for successful cultivation of French bean under open field conditions in Punjab.

To overcome these environment factor, protected cultivation particularly net-house cultivation is the best alternative which offers distinct advantages of earliness, high productivity, better quality and pesticide residue free produce besides higher returns to growers. Singh *et al.* (2004), while studying the cultivation of capsicum in net-house reported that fruits are more uniform, larger in size and mature one month earlier to conventional cultivation. So, net-house cultivation of *capsicum*, tomato and brinjal in net-house has been recommended by Punjab Agricultural University, Ludhiana (Punjab), India.

The net-house cultivation of *capsicum* is gaining importance because of handsome profits earned by the growers as compared to open field conditions. The research data on production potential of protective cultivation for horticultural crops revealed that yield of these crops can be increased from 20 to 300 per cent. This shows that protected cultivation has tremendous scope to get high productivity and returns throughout the year from the small piece of the land as reported by Baghel *et al*. (2003). In the present scenario of perpetual demand for vegetables and drastically shrinking land holding, protected cultivation of vegetables has a tremendous scope for using land and other resources more efficiently as studied by Rai *et al.* (2004). Moreover net-house cultivation result in producing very early and prolonged total yield (Nagalakshmi *et al*., 1997).

Therefore, the present investigation has been planned on French bean under net -house conditions with the following objectives.

To evaluate bush and pole type French bean genotypes for quality traits under net-house conditions.

Materials and Methods

Twenty genotypes of French bean were collected from different sources (Public sector and private sector) were collected. These varieties were evaluated at Vegetable Research Farm, Department of Vegetable Crops, Punjab Agricultural University, Ludhiana from October to March in the net-house and in the open field conditions during the year 2008-09 and 2009-10. The experiment was laid out in a Randomized Complete Block Design with three replications. Genetically pure seeds of each genotype were sown in a 2.5 m long row at 30 cm spacing between paired rows on a 90 cm raised bed (45 cm bed top and 45 cm furrow). The plant to plant spacing was kept 10 cm and recommended cultural practices were followed to raise a uniform healthy crop. Pooled mean value of the parameters in each replication was statistically analysed.. The table formulated by Fisher and Yates (1963) were consulted for the purpose of comparison of 'F' values and for determination of critical differences (C.D. values) at the probability.

Results and Discussion

Pod shape and colour

The shape and colour of the pods of different genotypes of French bean was observed in each replication during 2008-09 and 2009-10 and is presented in table 1.

Dry matter content (%)

Dry matter content of the pods is the important constituent determining the quality of French bean. Among the genotypes studied dry matter content (table 2) varied from 7.24-15.60% in 2008-09. Maximum dry matter content was observed in genotypes FB-4 (15.60 %) which was statistically at par with genotypes IIHR-909 (14.00%) and Aperna (13.67%). Minimum dry matter content was observed in genotypes FB-3(7.24%), Seville (7.97%), FB-20 (8.35%), Cosmo (8.37%) and FB-19 (8.43%) respectively. During 2009-10 the dry matter content varied from 7.37-14.56%, maximum dry matter content was observed in genotypes FB-4 (14.56%), which was statistically at par with genotypes Aperna (13.52%) and IIHR-909 (13.48%). Minimum dry matter content was

Table 1 : Pod shape and colour of different genotypes of French bean.

S. no.	Genotypes	2008-09	2009-10
1.	Falguni	Round, straight and dark green	Round, straight and dark green
2.	Seville	Round, slightly curved and green	Round, slightly curved and green
3.	Aperna	Round straight and green	Round, straight and green
4.	504-64C	Flat, slightly curved and green	Flat, slightly curved and green
5.	Cosmo	Round, straight and green	Round, straight and green
6.	DPP-BSS-1	Flat, straight and pale green	Flat, straight and pale green
7.	DWP-FB-1	Flat, straight and pale green	Flat, straight and pale green
8.	DWP-FB-53	Flat, straight and pale green	Flat, straight and pale green
9.	DWP-FB-57	Flat, straight and pale green	Flat, straight and pale green
10.	IIHR-909	Round, straight and green	Round, straight and green
11.	FB-3	Flat, straight and green	Flat, straight and green
12.	FB-4	Flat, straight and green	Flat, straight and green
13.	FB-5	Flat, straight and green	Flat, straight and green
14.	FB-6	Flat, straight and green	Flat, straight and green
15.	FB-16	Flat, straight and green	Flat, straight and green
16.	FB-17	Flat, straight and green	Flat, straight and green
17.	FB-18	Flat, straight and green	Flat, straight and green
18.	FB-19	Flat, straight and green	Flat, straight and green
19.	FB-20	Flat, straight and green	Flat, straight and green
20.	Contender (C)	Round, slightly curved and green	Round, slightly curved and green

recorded in genotypes Seville (7.37%), FB-20 (8.08%), FB-20 (8.25%), 504-64-C (8.25%), DWP-FB-53 (8.25%) and Cosmo (8.32%). In pooled data for two years, the dry matter content varied from 7.38–15.08%, there were significant differences in dry matter content in different French bean genotypes. Maximum dry matter content was observed in genotype FB-4 (15.08%), which was statistically at par with genotype IIHR-909(13.74%). Minimum dry matter content was recorded in genotypes FB-6, Seville, FB-3, FB-20, FB-19, Cosmo, DWP-FB-53 and 504-64 -C with 7.38, 7.67, 7.82, 8.22, 8.33, 8.34, 8.38 and 8.58 %, respectively. Bandale *et al*. (2004) studied in diverse genotypes of Lablab bean and observed 11% dry matter percentage.

Sugar content (%)

Sugar content (table 2) in French bean ranged from 0.12-0.80% in 2008-09 and there were significant differences in sugar content per plant in different French bean genotypes. The maximum sugar content was observed in genotypes Falguni (0.80), FB-3 (0.79%) and FB-5 (0.73%) which was statistically at par with genotypes FB-18 (0.70%), IIHR-909 (0.64%) and FB-6 (0.64%). The minimum sugar content was observed in genotypes DWP-FB-53 (0.12%), DWP-FB57 (0.15%), Cosmo (0.22%), Seville (0.22%) and DPP-BSS-1 (0.23%), respectively. In year 2009-10, sugar content ranged from 0.12-1.10%, maximum sugar content was observed in genotypes FB-3 (1.10%) followed by Falguni (0.81%),FB-19 (0.63%), FB-17,(62%) Aperna (0.53) and FB-5(0.52%).Minimum sugar content was observed in genotypes FB-20 (0.12), Contender (0.13%), Seville (0.18%).Kalappanavar and Kiremath (2000) reported that the amount of total sugars decreased significantly with the age of the plant.

Protein content (%)

Protein content (table 2) in French bean in 2008-09 ranged from 4.83-6.66% and there were significant differences in protein content in different French bean genotypes. The maximum protein content was observed in genotype FB-16 (6.80%), which was statistically at par with genotypes DPP-BSS-1(6.66%), DWP - FB-57(6.57%), FB-3 (6.50%) DWP-FB-53 (6.42%), Seville (6.43%), FB-17(5.86%), FB-18(5.76%) and FB-20 (5.79%). Minimum protein content was observed in genotypes IIHR-909 (4.83%) and FB-19 (5.09%). In year 2009-10, the maximum protein content was observed in genotypes Falguni (6.63%) which was statistically at par with genotypes DWP-FB-57 (6.56%), FB-17 (6.33%) FB-16 (6.32%), Contender (6.16%) and FB-3 (6.03%). Minimum protein content was observed in genotypes

Table 2 : Values of genotype for dry matter content (%), sugar content (%), protein content (%) and fibre content (%).

S. no.	Genotypes	Dry matter content (%)			Sugar content (%)			Protein content (%)			Fibre content (%)		
		2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean
1.	Falguni	11.67	10.95	11.31	0.80	0.81	0.80	6.42	6.63	6.53	0.0073	0.0048	0.0061
2.	Seville	7.97	7.37	7.67	0.22	0.18	0.20	6.43	5.72	6.08	0.0063	0.0061	0.0062
3.	Aperna	13.67	13.52	13.59	0.54	0.53	0.53	5.46	5.68	5.57	0.0053	0.0045	0.0049
4.	504-64C	8.90	8.25	8.58	0.33	0.34	0.33	5.65	5.58	5.61	0.0070	0.0069	0.0070
5.	Cosmo	8.37	8.32	8.34	0.70	0.62	0.66	6.03	6.00	6.01	0.0052	0.0059	0.0055
6.	DPP-BSS-1	9.33	9.12	9.23	0.23	0.20	0.22	6.66	5.67	6.16	0.0052	0.0054	0.0053
7.	DWP-FB-1	9.52	9.25	9.38	0.42	0.37	0.39	5.52	5.54	5.53	0.0038	0.0038	0.0038
8.	DWP-FB-53	8.50	8.25	8.38	0.12	0.12	0.12	5.30	4.85	5.07	0.0045	0.0042	0.0043
9.	DWP-FB-57	10.32	10.23	10.28	0.15	0.15	0.15	6.57	6.56	6.56	0.0038	0.0021	0.0029
10.	IIHR-909	14.00	13.48	13.74	0.64	0.58	0.61	4.83	5.66	5.25	0.0066	0.0062	0.0064
11.	FB-3	7.24	8.39	7.82	0.79	1.10	0.94	6.50	6.03	6.26	0.0048	0.0042	0.0045
12.	FB-4	15.60	14.56	15.08	0.29	0.37	0.33	5.40	5.50	5.45	0.0048	0.0048	0.0048
13.	FB-5	12.20	10.92	11.56	0.73	0.52	0.62	5.53	5.72	5.62	0.0055	0.0065	0.0060
14.	FB-6	8.50	6.27	7.38	0.64	0.49	0.25	5.75	5.21	5.48	0.0072	0.0075	0.0073
15.	FB-16	10.33	9.51	9.92	0.28	0.35	0.31	6.80	6.32	6.56	0.0057	0.0062	0.0059
16.	FB-17	10.09	9.30	9.70	0.54	0.40	0.47	5.86	6.33	6.10	0.0068	0.0070	0.0069
17.	FB-18	11.12	11.21	11.16	0.22	0.25	0.23	5.76	5.73	5.74	0.0077	0.0070	0.0074
18.	FB-19	8.43	8.22	8.33	0.14	0.63	0.39	5.09	5.42	5.25	0.0077	0.0075	0.0076
19.	FB-20	8.35	8.08	8.22	0.14	0.12	0.13	5.79	5.50	5.64	0.0043	0.0049	0.0046
20.	Contender (C)	8.42	8.94	8.68	0.15	0.13	0.14	5.46	6.16	5.81	0.0038	0.0070	0.0054
	Mean	10.12	9.71	9.92	0.40	0.37	0.38	5.46	4.85	5.15	0.0056	0.0056	0.0056
	Range	7.24-15.60	7.37-14.56	7.38-15.08	0.12–0.80	0.12-1.10	0.12-0.94	4.83-6.66	4.85-6.63	4.84-6.56	0.0038-0.0077	0.0021-0075	0.0029-0.0076
	CD (5%)	2.42	1.30	1.35	0.30	NS	0.68	1.09	0.70	0.63	0.0030	0.0029	0.0022
	CV	14.46	8.14	11.86	6.32	24.85	19.22	11.30	7.38	9.57	5.08	4.13	4.63

DWP-FB-53 (4.85%), FB-6 (5.21%) and FB-19 (5.42%), respectively.

Fibre content (%)

The data for fibre content of different genotypes evaluated has been presented is in table 2. In year 2008-09, fibre content in French bean ranged from 0.0038 to 0.0077%. Maximum fibre content was observed in genotypes FB-18 (0.0077%) and FB-19 (0.0077%), which was statistically at par with all the genotype except DWP-FB-1 (0.0038%) and check variety Contender (0.0038%). Other high fibre content genotypes were Falguni (0.0073%), FB-6(0.0072%), 504-64-C (0.0070%), and FB-17 (0.0068%). Minimum fibre content was observed in genotypes DWP-FB-1 (0.0038%), DWP-FB-57 (0.0038%), DWP-FB-57(0.0041%), FB-20(0.0043%) and DWP-FB-53(0.0045%). In year 2009-10, fibre content ranged from 0.0021to 0.0075%. Maximum fibre content was observed in genotypes FB-6(0.0075%), FB-19 (0.0075%), FB-17(0.0070%) and FB-18 (0.0070%), which was statistically at par with check variety Contender (0.0070%). Minimum fibre content was observed in genotypes DWP-FB-57(0.0021%), FB-3 (0.0042%) and DWP-FB-53(0.0042%). In pooled data for two years, there were significant differences in fibre content per plant in different French bean genotypes. Maximum fibre content was observed in genotypes FB-19 (0.0076%), FB-18 (0.0074%), FB-6 (0.0073%) and 504-64C (0.0070%), which was statistically at par with check variety contender (0.0054%). Mirjana *et al*. (2009) studied that correlation between pectin compounds content in dry beans on the basis of total dietary fibre content, dry beans can be characterized as dietary fibre-rich food.

Conclusion

The analysis of variance revealed that all the genotypes were significantly different in treatments for all the characters in 2008-09 and 2009-10. Twenty genotypes of French bean were evaluated along with the variety Contender (check) for nineteen characters. On the basic of pooled mean, the observations recorded for biochemical analysis showed that maximum dry matter content was found in FB-4 followed by IIHR-909 and Aperna, where as maximum sugar content was present in FB-3, Falguni, Cosmo, FB-18 and IIHR-909. Maxinun protein content was recorded in Falguni, FB-6, DWP-FB-57 and DWP-FB-1. On basic of pod shape and colour Falguni, Cosmo, Seville and IIHR-909 were found best having round, straight and dark green/green coloured pods as compared to other genotypes.

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