Vegetable Science (2022) 49(2): 169-175

Environmental effects on yield and quality of French bean genotypes grown in poly-net house

Ramandeep Kaur, TS Dhillon, RK Dhall* and Ruma Devi

Received: July 2022/ Accepted: November 2022

Abstract

The present study was undertaken to evaluate 29 indeterminate French bean genotypes for various yield and quality traits inpoly-net house with the objective to identify best performing genotypes during winter conditions. The significant variation was observed among all the genotypes for all the studied traits.The green pod yield was significantly higher in genotype Lakshmi (992.33 g/plant) followed by Star-I (955.50 g/plant) and FBK-4 (911.17 g/plant). Regarding quality traits, maximum dry matter was observedin FBK-13 (13.87%), protein content in FBK-1 (9.67%), sugar content in FBK-5(9.60%) and minimum fiber content in FBK-12 (0.69%). It is concluded that French bean genotypes Lakshmi, Star-I and FBK-4 gave high productivity and better quality in poly-net house conditions of Punjab and these pods fetches premium price in the market as there is no availability of green pods at that time in high altitudes.

Keywords: French bean, Earliness, Pod, Protected Environment, Quality, Yield

Introduction

French bean (*Phaseolus vulgaris* L., 2n=2x=22) is one of the most important legume crop grown throughout the world as a green vegetable as well as for dry seed consumption. It belongs to family Fabaceae and is highly self pollinated crop. French bean is also known as snap bean, garden bean, green bean, edible podded bean, string bean, fresh bean or vegetable bean. As the name implies, snap beans break easily when the pod is bent, giving off a distinct audible snap sound. The tender pods (green, yellow and purple in colour) are harvested when they are rapidly growing, fleshy, tender (not tough and stringy), bright in colour, and the seeds are small and underdeveloped i.e. 8 to 10 days after flowering (Singh and Singh 2015, Singh et al. 2016). French bean is also called as 'Grain of hope' (Sofi et al. 2011) and 'Super food' (Saleh et al. 2012). French bean is widely grown in North and Central America, Eastern Africa and Eastern Asia. Brazil is the largest producer of French bean in the world (Parkash and Ram 2014). In India, beans are grown on an area of 198 thousand hectare with an annual production of 2012 thousand MT (Anonymous 2017). However, in northern India, cultivation of French bean is only limited to kitchen gardens.

In India, it is mainly grown for tender pod vegetable whereas in USA, it is grown for processing at large scale. It is a multipurpose crop grown for vegetable, dry seed, fodder and also as a canned vegetable (Biswas et al. 2010). French bean is a good source of foliate, magnesium, manganese and dietary fiber. French bean is very low in saturated fatty acids and cholesterol. Its edible pods constitute 94% water, 1.7% protein, 0.1% carbohydrates, 4.5% fat, 1.8% fibre and 0.1% minerals per 100 g (Dhaliwal 2012). Its pods are mildly diuretic in nature and contain a substance that reduces the blood sugar level in the body (Duke 1981). French bean fetches premium price as compared to other vegetables and is a popular vegetable grown almost throughout the year. It is gaining lot of importance due to its short duration and high production potential. French bean is a tender warm season vegetable and sensitive to frost and chilling temperature. It thrives best when temperature ranges between 15-25°C. Its seeds do not germinate if the soil temperature is below 12°C and the seedlings cannot tolerate temperature below

Department of Vegetable Science, Punjab Agricultural University, Ludhiana-141004, Punjab
*Corresponding author; Email: rajinderkumar@pau.edu

10°C. Extreme high temperature interferes with pod filling. When French bean is sown in September under open field conditions in Punjab, there is severe mortality of plants due to infestation of seedlings with fusarium wilt. Moreover, low temperature coupled with frost during December-January cause mortality of French bean plants. Hence, low and high temperature both are the limiting factors for successful cultivation of French bean under open field conditions in Punjab. To overcome this problem, its cultivation under protected conditions particularly in poly-net house is the best alternative. As many researches highlighted the benefits of protected cultivation in many vegetable crops especially for higher yields, superior quality and protection from insect-pests. These advantages open the scope of French bean cultivation in poly-net house. Very less research work has been done on cultivation of French bean under poly-net house and no variety so far has been recommended for its cultivation in poly-net house in Punjab conditions. Therefore, it is necessary to evaluate the performance of different French bean genotypes under poly-net house in Punjab conditions to have quality produce. The exploitation of variability in French bean genotypes is the pre-requisite for screening of superior genotypes for yield and quality traits. The present investigation was planned to determine the genetic potential of indeterminate 29 French bean genotypes under poly-net house.

Material and Methods

Twenty nine genotypes of French bean (Table 1) obtained from different sources were evaluated at Vegetable Research Farm, Department of Vegetable Science, Punjab Agricultural University, Ludhiana in the poly-net house conditions fortwo years. Seeds of all the twenty nine genotypes were sown on raised beds in poly-net house on 20th October during two years at a spacing of 90cm × 30cm. The experiment was laid out in a randomized block design with replications. Each entry consisted of 15 plants in each replication. The standard package of practices recommended for cucumber crop in poly-house was followed to raise a healthy crop (Dhall 2018). Ten randomly selected plants from each replication were chosen for data collection and mean of each observation was used for statistical analysis.

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

Genotypes	Source	Pod characters and colour
Star-1	USA	Round, slightly curved, light green
Lakshmi	YSP UHF, Nauni, Solan	Round, straight, dark green
Kentucky Blue	USA	Round, straight and green
Stringless Blue Lake	USA	Round, straight, dark green
TitraMitra	Jammu & Kashmir	Flat, straight, light green
AVT Var-1	IARI, Katrain	Round, straight, purple
AVT Var-2	IARI, Katrain	Round, straight, light green
AVT Var-3	IARI, Katrain	Round, straight, green
FBB Var-1	IIVR, Varanasi	Round, straight, purple
FBB Var-2	IIVR, Varanasi	Round, slightly curved, light green
FBB Var-3	IIVR, Varanasi	Round, straight, green
FBB Var-4	IIVR, Varanasi	Round, slightly curved, purple
FBK-1	Jammu & Kashmir	Round, straight, dark green
FBK-3	Jammu & Kashmir	Flat, curved, light green
FBK-4	Jammu & Kashmir	Flat, straight, green
FBK-5	Jammu & Kashmir	Flat, slightly curved, light green
FBK-6	Jammu & Kashmir	Flat, curved, green
FBK-7	Jammu & Kashmir	Flat, slightly curved, light green
FBK-8	Jammu & Kashmir	Round, straight, green
FBK-9	Jammu & Kashmir	Flat, slightly curved, green
FBK-10	Jammu & Kashmir	Flat, slightly curved, light green
FBK-11	Jammu & Kashmir	Flat, straight, green
FBK-12	Jammu & Kashmir	Round, slightly curved, green
FBK-13	Jammu & Kashmir	Flat, slightly curved, light green
FBK-14	Jammu & Kashmir	Flat, slightly curved, light green
FBK-15	Jammu & Kashmir	Flat, curved, dark green
FBK-16	Jammu & Kashmir	Flat, straight, green
FBK-17	Jammu & Kashmir	Flat, curved, green
Kentucky Wonder (C)	IARI, Katrain	Round, slightly curved and green

Results and Discussion

Green pod yield: The perusal of data showed significant variation was observed among genotypes for green pod yield per plant. During 2016-17, green pod yield per plant ranged from 343.33 to 981.67 g whereas during 2017-18, yield varied from 366.67 to 1003.00 g (Table 2).

Table 2: Mean values of French bean genotypes for yield attributing traits

Genotype	Green pod yield per plant (g)			Number of pickings			Harvesting span (days)		
	2016-17	2017-18	Pooled Mean	2016-17	2017-18	Pooled Mean	2016-17	2017-18	Pooled Mean
Star-1	947.67	963.33	955.50	9.00	9.00	9.00	55.33	55.00	55.17
Lakshmi	981.67	1003.00	992.33	10.00	10.00	10.00	59.67	61.33	60.50
Kentucky Blue	849.33	863.00	856.17	8.00	8.00	8.00	44.33	47.33	45.83
Stringless Blue Lake	687.33	682.67	685.00	7.00	7.00	7.00	40.00	42.33	41.17
TitraMitra	388.00	366.67	377.33	5.00	4.33	4.67	31.67	30.67	31.17
AVT Var-1	667.00	684.00	675.50	7.00	7.00	7.00	42.00	43.33	42.67
AVT Var-2	655.33	645.33	650.33	6.00	6.00	6.00	35.00	36.00	35.50
AVT Var-3	893.33	923.67	908.50	9.00	9.00	9.00	53.00	56.33	54.67
FBB Var-1	775.00	803.67	789.33	7.00	8.00	7.50	52.00	48.67	50.33
FBB Var-2	648.33	669.33	658.83	6.00	6.00	6.00	40.00	41.33	40.67
FBB Var-3	728.67	744.33	736.50	7.00	7.00	7.00	45.00	45.33	45.17
FBB Var-4	658.00	686.00	672.00	7.00	7.33	7.17	49.67	54.00	51.83
FBK-1	826.67	858.67	842.67	8.33	8.67	8.50	53.67	55.33	54.50
FBK-3	633.00	608.33	620.67	6.00	6.00	6.00	36.00	37.33	36.67
FBK-4	896.67	925.67	911.17	9.00	9.00	9.00	56.00	57.00	56.50
FBK-5	475.33	498.67	487.00	5.00	5.67	5.33	38.67	41.33	40.00
FBK-6	456.67	445.67	451.17	6.00	6.00	6.00	39.00	40.00	39.50
FBK-7	704.00	735.33	719.67	8.00	8.00	8.00	50.00	50.00	50.00
FBK-8	460.00	495.33	477.67	5.33	5.00	5.17	33.00	30.00	31.50
FBK-9	654.00	673.67	663.83	6.00	6.00	6.00	41.00	45.33	43.17
FBK-10	651.33	664.67	658.00	7.00	7.00	7.00	43.00	43.67	43.33
FBK-11	740.67	765.33	753.00	7.00	7.00	7.00	43.67	40.67	42.17
FBK-12	545.00	561.67	553.33	6.00	6.33	6.17	34.00	35.00	34.50
FBK-13	343.33	377.33	360.33	5.00	5.00	5.00	31.00	32.00	31.50
FBK-14	634.33	665.67	650.00	6.00	6.00	6.00	38.67	39.33	39.00
FBK-15	414.00	439.33	426.67	5.00	5.00	5.00	35.00	36.67	35.83
FBK-16	721.67	744.33	733.00	7.00	7.00	7.00	51.00	51.00	51.00
FBK-17	444.67	466.33	455.50	5.00	5.00	5.00	36.67	35.00	35.83
Kentucky wonder (C)	783.00	803.67	793.33	7.67	8.00	7.83	57.00	55.00	56.00
Grand Mean	664.28	681.54	672.91	6.80	6.87	6.84	43.62	44.36	43.99
CV	4.33	5.08	5.01	2.66	3.46	3.60	6.23	6.68	6.56
CD	47.04	40.25	29.14	0.30	0.39	0.29	2.16	2.20	2.44
Range	343.33-981.67	366.67-1003.00	360.33-992.33	5.00-10.00	4.33-10.00	4.67-10.00	31.00-59.67	30.00-61.33	31.17-60.50

The highest pod yield per plant was observed in genotype Lakshmi (981.67 g) followed by genotype Star-1 (947.67 g) which were statistically at par with each other and significantly higher than rest of genotypes including check. The lowest pod yield per plant was observed in genotype FBK-13 (343.33 g) followed by TitraMitra (388.00 g) and FBK-15 (414.00 g) which were statistically at par with each other. During 2017-18, maximum green pod yield was observed in genotype Lakshmi (1003.00 g) statistically at par with Star-1 (963.33 g) which were significantly higher than rest of genotypes including check 'Kentucky Wonder'. The lowest green pod yield was recorded in genotype TitraMitra (366.67 g) followed by FBK-13 (377.33 g) which were statistically at par with each other. The pooled data analysis of both years revealed that green pod yield per plant varied from 360.33 g to 992.33 g. The maximum green pod yield was recorded for genotype Lakshmi (922.33 g) followed by Star-1 (955.50 g) which were statistically at par with each other and significantly higher than all other genotypes including check. However, lowest pod yield per plant was observed in FBK-13 (360.33 g) followed by TitraMitra (377.33 g) which were statistically at par with each other. Similar results for pod yield per plant were reported by Kumar et al.

(2014) and Pandey et al. (2011) in pole type French bean.

Number of pickings: The perusal of data showed significant variation for number of pickings over both the years. The number of pickings varied from 5.00 to 10.00 during 2016-17, whereas from 4.33 to 10.00 during 2017-18 and 4.67 to 10.00 during pooled means of both years (Table 2). During 2016-17, maximum pickings were observed in Lakshmi (10.00) which was significantly higher than all other genotypes including check (7.67). However, minimum pickings of 5.00 were observed in genotype FBK-5, FBK-17, TitraMitra and FBK-15 which were statistically at par with each other. During 2017-18, maximum pickings were observed in Lakshmi (10.00) which was significantly higher than all the genotypes and check 'Kentucky Wonder'. However, minimum pickings were observed in TitraMitra (4.33) followed by FBK-17 (5.00), FBK-15 (5.00) and FBK-5 (5.67). The pooled data of both years revealed that maximum number of pickings were recorded in Lakshmi (10.00) significantly higher than all other genotypes. Minimum numbers of pickings were observed for TitraMitra (4.67) closely followed by FBK-13 (5.00) which was statistically at par with each other.

Harvesting span: The data showed that harvesting span recorded significant variation among all genotypes over both years. The harvesting span varied from 31.00 days to 59.67 days during 2016-17 and 30.00 days to 61.33 days during 2017-18 (Table 2). During 2016-17, the harvesting span was observed maximum in genotype Lakshmi (59.67 days) which was significantly higher than all genotypes and check (57.00 days). Minimum harvesting span was observed for genotype FBK-13 (31.00 days) followed by TitraMitra (31.67 days) and FBK-8 (33.00 days) which were statistically at par with each other. During 2017-18, maximum harvesting span was observed for genotype Lakshmi (61.33 days) which was significantly higher than all other genotypes including check 'Kentucky Wonder'. Minimum harvesting span was observed for genotype FBK-8 (30.00 days) which was closely followed by TitraMitra (30.67 days) and FBK-13 (32.00 days) which were statistically at par with each other. The pooled data analysis of both years revealed that high harvesting span was observed for genotype Lakshmi (60.50 days) which was significantly higher than all other genotypes and check 'Kentucky Wonder' (56.00 days). The low harvesting span was observed for genotype 'TitraMitra' (31.17 days) followed by FBK-8 (31.50 days) and FBK-13 (31.50 days) which were statistically at par with each other.

Protein content: Protein content is one of most important biochemical trait of quality pods. The analysis data revealed that protein content showed significant variation among all genotypes during both years. The protein content varied from 4.36% to 9.75% during 2016-17, 4.24% to 9.60% during 2017-18 and 4.30% to 9.67% over pooled years (Table 3).

Table 3: Mean values of French bean genotypes for quality traits

Genotype	Protein content (%)			Sugar content (%)			Fibre content (%)		
	2016-17	2017-18	Pooled Mean	2016-17	2017-18	Pooled Mean	2016-17	2017-18	Pooled Mean
Star-1	5.95	5.34	5.64	5.47	5.61	5.64	1.04	1.06	1.05
Lakshmi	6.23	6.48	6.35	5.65	5.74	5.69	0.82	0.85	0.83
Kentucky Blue	7.15	7.35	7.25	4.63	4.66	4.64	0.79	1.10	0.94
Stringless Blue Lake	8.49	8.34	8.41	5.15	5.31	5.23	0.77	0.77	0.77
TitraMitra	9.69	9.39	9.54	6.38	6.50	6.44	1.05	0.99	1.02
AVT Var-1	7.33	7.52	7.43	8.40	8.51	8.46	1.25	1.15	1.20
AVT Var-2	6.69	7.09	6.89	9.49	9.57	9.53	0.80	0.79	0.79
AVT Var-3	6.08	5.92	6.00	6.41	6.78	6.60	0.79	0.82	0.80
FBB Var-1	5.81	5.84	5.83	8.85	9.00	8.92	0.80	0.89	0.85
FBB Var-2	5.07	5.10	5.09	7.45	7.77	7.61	1.13	1.09	1.11
FBB Var-3	4.94	5.06	5.00	8.19	8.34	8.27	1.01	1.05	1.03
FBB Var-4	7.86	8.00	7.93	7.46	7.53	7.50	0.68	0.77	0.72
FBK-1	9.75	9.60	9.67	6.25	6.13	6.19	0.82	0.98	0.90
FBK-3	8.89	8.74	8.81	4.27	4.42	4.35	1.22	1.28	1.25
FBK-4	7.96	8.04	8.00	8.35	8.42	8.38	0.91	0.98	0.95
FBK-5	6.02	6.06	6.04	9.62	9.73	9.67	1.08	1.07	1.07
FBK-6	5.85	5.74	5.79	7.62	7.97	7.79	1.19	1.17	1.18

FBK-7	4.92	4.75	4.84	8.90	8.84	8.87	0.81	0.97	0.89
FBK-8	4.36	4.24	4.30	8.87	8.63	8.75	0.81	0.85	0.83
FBK-9	6.15	5.96	6.05	7.41	7.47	7.44	0.98	1.03	1.00
FBK-10	5.75	5.23	5.49	6.39	6.56	6.48	0.99	1.01	1.00
FBK-11	5.37	5.53	5.45	7.14	7.39	7.26	0.91	0.98	0.95
FBK-12	8.91	8.87	8.89	7.48	7.56	7.52	0.68	0.70	0.69
FBK-13	6.75	6.70	6.72	8.38	8.16	8.27	1.02	1.03	1.03
FBK-14	6.92	6.86	6.89	9.10	9.03	9.07	1.12	1.07	1.10
FBK-15	8.13	8.04	8.08	9.36	8.87	9.11	1.36	1.44	0.97
FBK-16	7.74	7.64	7.69	6.31	6.52	6.42	1.14	1.06	1.10
FBK-17	6.98	7.04	7.01	5.45	5.41	5.43	0.96	0.98	0.97
Kentucky wonder (C)	7.79	7.38	7.58	7.50	7.44	7.47	0.96	0.99	0.97
Grand Mean	6.88	6.82	6.85	7.31	7.37	7.34	0.96	1.00	0.98
CV	3.05	4.22	3.89	2.64	3.44	3.06	5.74	6.00	6.92
CD	0.34	0.37	0.27	0.32	0.42	0.26	0.09	0.10	0.08
Range	4.36-9.75	4.24-9.60	4.30-9.67	4.27-9.62	4.27-9.73	4.35-9.67	0.68-1.36	0.70-1.44	0.69-1.40

During 2016-17, maximum protein content was recorded in genotype FBK-1 (9.75%) followed by TitraMitra (9.69 %) which were statistically at par with each other and significantly higher than rest of genotypes including check 'Kentucky Wonder'. The minimum amount of protein content was recorded in genotype FBK-8 (4.36%) which was significantly different from all other genotypes. During 2017-18, maximum protein content was recorded in genotype FBK-1 (9.60%) closely followed by TitraMitra (9.39%) which were statistically at par with each other and significantly higher than rest of genotypes including check 'Kentucky Wonder'. Minimum protein content was recorded in genotype FBK-8 (4.24%) which was significantly different from all other genotypes. The pooled data analysis of both years showed that maximum protein content was recorded in genotype FBK-1 (9.67%) closely followed by TitraMitra (9.54%) which were statistically at par with each other and significantly higher than check and all other genotypes. The minimum protein content was recorded in genotype FBK-8 (4.30%) which was significantly different from other genotypes. The results are supported by the studies of Noor et al. (2014) and Meena and Dhillon (2014).

Sugar content: The significant variation was observed among all the genotypes for sugar content in both the years (Table 3). During 2016-17, sugar content varied from 4.27% to 9.62% whereas 4.42% to 9.73% during 2017-18. During 2016-17, the maximum sugar content was recorded in genotype FBK-5 (9.62%) followed by AVT Var-2 (9.49%) and FBK-15 (9.36%) which were statistically at par with each other and significantly higher than rest of genotypes and check 'Kentucky Wonder'. The minimum sugar content was observed for genotype FBK-3 (4.27%) followed by Kentucky Blue (4.63%) which were statistically at par with each other. During 2017-18, higher level of sugar was observed in genotype FBK-5 (9.73%) closely followed by AVT Var-2 (9.57%) which were closely at par with each other and significantly higher than rest of genotypes. The lower value of sugar was recorded in genotype FBK-3 (4.42%) and Kentucky Blue (4.66%) which was statistically at par with each other. The pooled data analysis of both years showed that the maximum sugar content was recorded in genotype FBK-5 (9.67%) followed by genotype AVT Var-2 (9.53%) which were statistically at par with each other and significantly higher than other genotypes and check 'Kentucky Wonder'. The lower values of sugar content was observed in genotype FBK-3 (4.35%) which was statistically at par with genotype Kentucky Blue (4.64%) and significantly different from other genotypes. The present findings are in agreement with investigations carried by Pandey et al. (2011) and Meena et al. (2017).

Fibre content: The significant variation was observed among all genotypes for fibre content during both years (Table 3). The fibre content varied from 0.68% to 1.36% during 2016-17 whereas it varied from 0.70% to 1.44% during 2017-18. During 2016-17, fibre content was recorded maximum in genotype FBK-15 (1.36%) followed by genotype AVT Var-1 (1.25%) and genotype FBK-3 (1.22%) which were statistically at par with each other but significantly higher than rest of the genotypes including check. The genotype FBB Var-4 (0.68%) showed lowest fibre content which was statistically at par with genotype FBK-12. The data evaluation

during 2017-18 showed that maximum fibre content was recorded in Genotype FBK-15 (1.44%) which was statistically at par with genotype FBK-3 (1.28%) and significantly higher than check 'Kentucky Wonder'. However, Genotype FBK-12 (0.70%) showed lowest fibre content which was statistically at par with genotypes FBB Var-4 (0.77%), Stringless Blue Lake (0.77%) and AVT Var-2 (0.79%). The pooled data analysis of both years showed that maximum fibre content was observed in Genotype FBK-15 (1.40%) which was statistically at par with FBK-3 (1.25%) significantly higher than rest of genotypes and check 'Kentucky Wonder'. Lowest fibre content was observed in FBK-12 (0.69%) which was statistically at par with FBB Var-4 (0.72%). These results are in conformity with studies of Verma et al. (2014) and Meena et al. (2017).

Conclusion

It is concluded that French bean genotypes Lakshmi, Star-I and FBK-4 gave high productivity and better quality in poly-net house conditions of Punjab and these pods fetches premium price in the market as there is no availability of green pods at that time in high altitudes. Hence, there is a great scope of cultivation of indeterminate French bean under poly-net house conditions in Punjab.

सारांश

वर्तमान अध्ययन सर्दियों की परिस्थितियों के दौरान सबसे अच्छा प्रदर्शन करने वाले जनन द्रव्य की पहचान करने के उद्देश्य से पॉली–नेट हाउस में विभिन्न उपज और गुणवत्ता लक्षणों के लिए 29 असीमित बढ़वार वाली फ्राशबीन जनन द्रव्य का मूल्यांकन करने के लिए किया गया था। सभी अध्ययन किये गये लक्षणों के लिए सभी जनन द्रव्य के बीच महत्वपूर्ण भिन्नता देखी गई। हरी फली की उपज जनन द्रव्य लक्ष्मी (992.33 ग्राम प्रति पौध) के बाद स्टार–५ (955.50 ग्राम प्रति पौध) और एफबीके–4 (911.17 ग्राम प्रति पौध) में काफी अधिक थी। गुणवत्ता लक्षणों के संबंध में, एफबीके–13 में अधिकतम शुष्क पदार्थ (13.87 प्रतिशत), एफबीके–1 में प्रोटीन मात्रा (9.67 प्रतिशत), एफबीके–5 में चीनी सामग्री (9.60 प्रतिशत) और एफबीके–12 में न्यूनतम खाद्य रेशा सामग्री (0.69 प्रतिशत) देखी गई। यह निष्कर्ष निकाला गया है कि फ्राशबीन जनन द्रव्य लक्ष्मी, स्टार–५ और एफबीके–4 ने पंजाब की पॉली–नेट हाउस स्थितियों में उच्च उत्पादकता और बेहतर गुणवत्ता दी और ये फली बाजार में अधिक मूल्य प्राप्त करती हैं क्योंकि उस समय अधिक ऊँचाई पर हरी फली की उपलब्धता नहीं थी।

References

Anonymous (2017) National Horticulture Board, Ministry of Agriculture, Government of India.www.nhb.gov.in

Bendale VW, Topare SS, Bhave RG, Mehta JK and Madav RR (2004) Genetic analysis on yield and yield components in lablab bean (*Lablab purpureus* L. Sweet). Orissa J. Hort. 32: 99-101.

Biswas MS, Hassan J and Hossain MM (2010) Assessment of genetic diversity in French bean (*Phaseolus vulgaris* L.) based on RAPD marker. African J. Biotech. 9: 5073-5077.

Dhaliwal MS (2012) *Handbook of Vegetable Crop*.**2**: 261 Kalyani Publishers, New Delhi.

Dhall RK (2018) Punjab Kheera-1: A seedless variety of cucumber for poly-net house cultivation. Hort. Newsletter 14: 9-12.

Duke JA (1981) *Handbook of legumes of world economic importance*. New York, USA/London, UK, pp. 195-200.

Kumar PA, Reddy R, Pandravada VSK, Durga CR and Chaitanya V (2014) Genetic variability, heritability and genetic advance in pole- type French bean. Plant Archives 14: 569-573.

Meena J and Dhillon TS (2014) Studies on performance of French bean genotypes for yield and quality traits under protected conditions. Tropentag 1: 17-19.

Meena J, Dhillon TS, Meena A and Singh KK (2017) Studies on performance of French bean (*Phaseolus vulgaris* L.) genotypes for yield and quality traits under protected conditions. Plant Archives 17: 615-619.

Mehra R, Tikle AN, Saxena A, Munjal A, Khandia R and Singh M (2016) Correlation path coefficient and genetic diversity in Blackgram (*Vigna mungo* (L.) Hepper). Int. Res. J. Plant Sci. 7: 1-11.

Noor F, Hossain F and Ara U (2014) Screening of French bean (*Phaseolus vulgaris* L.) genotypes for high yield potential. Bangladesh J. Sci. Ind. Res. 49: 227-232.

Pandey YR, Gautam DM, Thapa RB, Sharma MD and Paudyal KP (2011) Evaluation of pole-type French bean genotypes in the mid hills of western Nepal. J. Nepal Agri. Res. 11: 80-86.

Prakash J and Ram RB (2014) Genetic variability, correlation and path analysis for seed yield and yield related traits in French bean (*Phaseolus vulgaris* L.) under Lucknow conditions. Int. J.

Innov. Sci. Engg. Tech. 12: 110-115.

Prakash J, Ram RB and Meena ML (2015) Genetic variation and characters interrelationship studies for quantitative and qualitative traits in French bean (*Phaseolus vulgaris* L.) under Lucknow conditions. Legume Res. 38: 425-433.

Saleh SM, Shleel SMA and Hadid AFA (2012) Prediction and adaptation of dry bean yield under climate change conditions. Res. J. Agri. Bio. Sci. 8: 147-153.

Singh BK and Singh B (2015) Breeding perspectives of snap bean (Phaseolus vulgaris L.). Vegetable Science 42(1): 1-17.

Singh BK, Singh PM and Singh B (2016) Earliness and developmental characteristics of snap bean (Phaseolus vulgaris L.) genotypes in two growing seasons, pre-winter and winter. Vegetable Science 43(1): 44-49.

Singh V, Singh AK, Moharana DP, Singh B, Jaiswal DK and Singh DK (2017)Assessment of quantitative differences among diverse genotypes of French bean (*Phaseolus vulgaris* L.) for yield and yield attributing traits. J. Pharmaco. Phytochem. 6: 1557-1559.

Sofi PA, Zargar MY, Debouck D and Graner A (2011) Evaluation of common bean (*Phaseolus vulgaris* L.) germplasm under temperate conditions of Kashmir valley. J. Phytol. 3: 47-52.

Verma VK, Jha AK, Pandey A, Kumar A, Choudhury P and Swer TL (2014) Genetic divergence path coefficient and cluster analysis of French bean (Phaseolus vulgaris L.) genotypes. Indian J Agri Sci 84: 925-930.