Effect of Sowing Dates on Growth, Yield and Quality Components of Bush Type Vegetable French Bean Varieties

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ABSTRACT

An experiment was conducted during the *rabi* season of 2017–18 and 2018–19 at Uttar Banga Krishi Vishwavidyalaya, Cooch Behar, West Bengal, India to study the effect of sowing time and variety on the growth, yield and quality of bush type vegetable French bean. The treatments were laid out in factorial randomised block design with three replications by keeping sowing time (S_1: 1st November, S_2:16th November, S_3:1st December, S_4: 16th December and S_5: 31st December) as a first factor and varieties (V_1: Falguni, V_2: Arka Komal and V_3: Nandini) as a second factor. Results revealed that, among the varieties the highest plant height (36.15 cm) , pod length (13.75 cm), pod width (1.13 cm), individual fresh pod weight (5.20 g), yield plant^{-1} (106.64 g) and yield ha^{-1} (16.36 t ha^{-1}) was recorded in Arka Komal. However, the number of primary branches, number of pods plant^{-1} and protein content were found to be lowest in the same variety. Regarding the different sowing time, pod length (13.95 cm), individual fresh pod weight (5.47 g), number of pods per plant (27.64), yield plant^{-1} (136.22 g), yield per ha (20.86 t ha^{-1}) and protein content (1.89%) was highest in plants sown on 16th November, per contra the yield curtailed as the sowing time was pushed back from 16th November to 31st December. On the strength of above findings, it can be inferred that Arka Komal scheduled for sowing on 16th November could be an ideal for cultivation in the Terai zone of West Bengal.

KEYWORDS: French bean, protein, sowing date, terai-zone, variety, yield

1. INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is one of the most important pulse and vegetable crop in India because of its short growing duration and good nutritional value (Rai et al., 2021). It is a leguminous crop but it lacks nodulation (Kamble et al., 2016). Generally, French bean exhibits two growth forms; pole type and bush type, latter is widely grown due to their early maturity and lack of need for trellising (Mamathashree and Shyamalamma, 2022). French bean is known by various names; kidney bean, snap bean, tepary bean, haricot bean etc. (Sharma et al., 2013) and also referred as "the meat of the poor" (Kandula et al., 2022). It offers significant amounts of protein, calories and is a great source of vitamins and minerals (Welch et al., 2000; Singh et al., 2020). The pod contains 1- 2.4% protein, 69.9% carbohydrate, 1.5% fat and minerals like Calcium (381g), phosphorus (42.5 mg), iron (12.4 mg) etc. (Yadav, 2010; Reddy et al., 2010). It supplies vitamins like folic acid, niacin, thiamine, riboflavin and vitamin B_6 (Celmeli et al., 2018; Campos-Vega et al., 2010). In addition, the pods are known to have substances that lowers blood sugar and posses a modest diuretic effect (Maske et al., 2009).

French bean is native to Central America and South America (Panda et al., 2016) but at present it is grown in tropics, subtropics, and warm temperate regions. The crop is sensitive to frost, high temperature and high rainfall, the most favourable soil temperature for its germination is between 18° C to 24° C (Meena et al., 2017) and the temperature range between 15.6 to 21.1°C is ideal for its growth (Rangaswamy, 1975). In India, green beans are cultivated in an area of 134 thousand ha with production of 1165 thousand tons (Anonymous, 2015). It is mainly grown in the state of Maharashtra, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Karnataka, West Bengal etc. (Kalita et al., 2016).

To achieve success in any crop production an appropriate agricultural techniques, apposite sowing date and a good variety are crucial (Amanullah et al., 2012; Haque et al., 2020). Genotypes are considered as a raw material and all of the other technologies are implemented to it. The performance of a genotype is influenced by agro climatic condition likewise, sowing date is another significant determinant for productivity. The optimum date of sowing may vary with different varieties, and a good variety may give a poor yield when sown at improper time (Bake et al., 2017). Kaul et al. (2018) reported that the sowing time is important criterion for achieving higher yields. Untimely sowing may lead to significant drop in yield due to its sensitivity to low or high temperature. Advanced planting expedite phenological cycle on account of high atmospheric temperature which ultimately leads to poor seed setting and hence low yield (Hussain et al., 2022; Tiwari and Chaubey 2017). One of the main environmental factors that has

a negative impact on plant development and growth is high temperature (Boyer, 1982). On the other hand, late sown crops do not attain required vegetative growth and consequently results in poor yield (Sardana et al., 2000). Hence, sowing appropriate variety at the right time is crucial as it allows them to be exposed to ideal climatic conditions that contribute to their necessary growth and development to produce a significant yield which will upsurge the income of a farmers (Tiwari et al., 2014). With keeping the above views the present experiment was undertaken to identify the best variety and appropriate sowing time of bush type vegetable French bean under the Terai Zone of west Bengal.

2. MATERIALS AND METHODS

An experiment was carried out to study the effect of sowing dates and varieties on the growth, yield and quality of bush type vegetable French bean. The experiment was undertaken at the experimental field of the department Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Pundibari during the Rabi season of 2017–18 and 2018–19. Geographically the farm is situated at 26^0 19' 86" N latitude and 890 23' 53"E longitude, at an elevation of 43 meter above the mean sea level. The experiment was laid out in Factorial Randomized Block design with three replications. First factor comprised of 5 Sowing time (S) i.e. S_1: 1st November, S_2:16th November, S_3:1st December, S_4:16thDecember and S_5:31st December. Second factor consisted with 3 vegetable type French varieties (V) i.e. V_1: Falguni, V_2: Arka Komal and V_3: Nandini. The plot Size of 1.8×1.5 m^2 with spacing of 45 cm X 15 cm was opted for this experiment. Common dose of fertilizer N:P_2O_5:K_2O @ 80:40:40 Kg ha^{-1} and Farm Yard Manure (FYM) @ 15 tonnes ha^{-1} was applied in the field.

For both the years randomly five plants per plot were selected and growth parameters like plant height (cm) and number of primary branches per plant with yield attributing characters like pod length (cm), Pod weight (g), number of pods per plant, yield per plant (g) and fresh yield (t ha^{-1}) were recorded. Protein content (%) of the fresh pod was estimated adopting Lowry's method (1951). The principle of this method is the reaction occurring between peptide nitrogen[s] and copper [II] ions which develops under alkaline condition and leads to the reduction of Folin-Ciocalteu phosphomolybdic phosphortungstic acid to hetero polymolybdenum blue by the copper-catalyzed oxidation of aromatic acids. The mean data was interpreted following statistical method as stated by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

3.1. *Growth Parameters*

Various sowing dates and different varieties had a significant effect on the growth parameters of vegetable French bean

(Table 1). The tallest plants of 42.61 cm high were observed with early sowing i.e. on 1st November (S$_1$) followed by 38.62 cm high plants with sowing done on 16th November (S$_2$), 36.34 cm high on 1st December (S$_3$) while late sowing on 31st December (S$_5$) produced the shortest plant height of 29.36 cm. The possibility of this depression in height in succeeding sowing could be due to the drop of temperature and intensity of sunlight which might have aided the reduction of photosynthetic efficiency of a plant as compared to the preceding sowing dates (Kaul et al., 2018). Consonantly, sowing done on 31st December (S$_5$) produced the minimum number of primary branches per plant (5.58) while plants sown on 1st December (S$_3$) had the greatest number of primary branches per plant (6.38). This development of high numbers of primary branches per plant in early sowings is due to the efficient vegetative growth because of sounder environmental condition (Shukla and Singh, 2021) coupled with longer growing season. It has also been reported by Mozumder et al. (2003) that earlier sown French bean exhibited plants of better height and branch number than the plants of December sowing.

Regarding varieties the maximum plant height of 37.50 cm was observed in Falguni (V$_1$) followed by 36.15 cm in Arka Komal (V$_2$), whilst Nandini (V$_3$) showed the least height of 34.62 cm but the number of primary branches per plant was maximum (6.62) in this variety. Das et al. (2018) also stated that among these three varieties Nandini exhibited minimum height. On the contrary Arka Komal (V$_2$) showed minimum number of primary branches per plant (5.74). The growth and branches number in a plant is heavily influenced by the variety's genetic potential and it's interaction with the environment and cultivation practices (Kaul et al., 2018). State of the environment like atmospheric temperature and precipitation greatly influence the growth and development of crops.

The combined effect of sowing date and variety pertaining to growth parameters like, plant height and number of primary branches was non-significant (Table 1). The combination of S$_1$V$_1$ (S$_1$ = 1st November sowing, V$_1$ = Falguni) was better than the rest regarding height meanwhile the combination S$_2$V$_3$ (S$_2$ = 16th November, V$_3$ = Nandini) represented as a best combination for the number of primary branches.

Table 1: Effect of the different sowing times and varieties on the growth, yield contributing attributes and protein content of French bean.

Treatments	Plant height (cm)	No. of primary branches plant^{-1}	Pod length (cm)	Pod width (cm)	Individual fresh pod weight (g)	No. of pods plant^{-1}	Yield plant^{-1} (g)	Yield (t ha^{-1})	Protein content in fresh pods (%)
Sowing time									
S$_1$	42.61	5.88	13.69	0.99	5.16	24.74	118.10	17.80	1.88
S$_2$	38.62	6.28	13.95	0.96	5.47	27.64	136.22	20.86	1.89
S$_3$	36.34	6.38	13.16	0.95	4.94	22.76	109.52	16.72	1.85
S$_4$	33.53	6.37	12.82	0.90	4.40	18.35	82.92	12.59	1.79
S$_5$	29.36	5.58	11.97	0.87	3.90	12.73	52.39	8.60	1.75
SEm±	0.55	0.18	0.13	0.01	0.08	0.51	1.79	0.25	0.01
CD (*p*=0.05)	1.55	0.50	0.36	0.03	0.22	1.47	5.07	0.71	0.03
Varieties									
V$_1$	37.50	5.93	12.51	0.85	4.49	21.22	93.99	14.56	2.15
V$_2$	36.15	5.74	13.75	1.13	5.20	21.18	106.84	16.36	1.66
V$_3$	34.62	6.62	12.91	0.83	4.54	21.33	98.67	15.03	1.70
SEm±	0.43	0.14	0.10	0.01	0.06	0.36	2.53	0.19	0.01
CD (*p*=0.05)	1.20	0.39	0.28	0.02	0.17	1.03	7.18	0.55	0.02
Interaction									
SEm±	1.34	0.43	0.22	0.03	0.19	0.87	4.39	0.61	0.02
CD (*p*=0.05)	N.S	N.S	N.S.	N.S.	N.S.	N.S.	N.S.	1.74	N.S.

S$_1$: 1st November; S$_2$: 16th November; S$_3$: 1st December; S$_4$: 16th December; S$_5$: 31st December; V$_1$: Falguni; V$_2$: Arka Komal; V$_3$: Nandini

3.2. Yield parameters

The presented data (Table 1) concerning with the yield attributing characters and yield of French bean indicated that leaving out the Pod width (0.99 cm) all the other yield associated characters like pod length (13.95 cm), Individual pod weight (5.47 g), Number of pods plant^{-1} (27.64), Individual Plant yield (136.22 g plant^{-1}) and Total fresh yield (20.86 t ha^{-1}) was found to be maximal in plants sown on 16th November (S$_2$). Similar trend of decreasing yield associated characters and yield with the advancement of sowing date was reported by Kalita et al. (2016); Sadhukhan et al. (2008). As compared to subsequent sowing dates the beans sown on November received a more favourable environmental condition which lead to better fertilization, accumulation of carbohydrates, more number of pod development and a vigorous growth over the late sown beans. Reddy et al. (2010) mentioned that French bean sown during second fortnight of October to November first week produces higher yield. All the plants which was sown on 31st December (S$_5$) had the minimal values regarding Pod length (11.97 cm), Pod width (0.87 cm), Individual pod weight (3.90 g), Number of pods per Plant (12.73), Individual Plant yield (52.39 g plant^{-1}) and Total fresh yield (8.60 t ha^{-1}). Comparable remarks were made by Mozumder et al. (2003) in their finding, there was a gradual decrease in pod length and pods per plant with each delay made in sowing, certainly declining the yields compared to early sowing.

Varietal performance vis-a-vis yield attributes of French bean depicted in Table 1 appears to indicate that among the three varieties Arka Komal (V$_2$) outperformed with highest Pod length (13.75 cm), Pod width (1.13 cm), Individual pod weight (5.20 g), Individual Plant yield (106.84 g plant^{-1}) and Total fresh yield (16.36 t ha^{-1}). Muthuramu et al. (2015) also noted a similar result in the pod length (13.25 cm) and yield (169 q ha^{-1}) of the variety Arka Komal, meanwhile, number of pods plants^{-1} was found to be least (21.18) in Arka Komal (V$_2$). Baruah et al. (2022) in their evaluation reported the lowest number of pods plants^{-1} in Arka Komal. Highest number of pods plant^{-1} (21.33) was noted in Nandini (V$_3$) then again the pod width was minimum (0.83 cm). Apparently maximum number of pods plant^{-1} in Nandini (V$_3$) maybe correlated to the more number of primary branches per plant. Conclusively, Falguni (V$_1$) among the other varieties underperformed with minimum Pod length (12.51 cm), Individual pod weight (4.49 g), Individual Plant yield (93.99 g plant^{-1}) and Total fresh yield (14.56 t ha^{-1}). It could be due to disparity of genetic makeup of Falguni (V$_1$) than the other varieties adaptivity to low temperature generally occurring after November. Sharma et al. (2013) also reported the difference in various yield attributing characters.

Due to different genetic potential of different varieties, their interaction to the environment and similar management practices would often lead to different responses in plants. Similar results were achieved in the present study (Table 1) wherein the interaction between the S$_2$V$_2$ (S$_2$=16th November, V$_2$=Arka Komal) showed the most synergistic effect regarding yield of fresh pods while change in the sowing time or variety in other combination has reduced the yield potential of French bean. Kalita et al. (2016) in their findings stated that the different sowing dates and varietal variation are key drivers that will lead to high productivity and concluded that the appropriate time for sowing of French bean is November. Also supported by Sadhukhan et al. (2008) report, which states that the optimum time for sowing of French bean in West Bengal is between the last week of October to early November.

3.3. Quality parameter

Nutritive value of the French bean was determined by the protein content in fruits which is presented in Table 1. The range of 1.75% to 1.89% was observed. The protein content in French bean was highest (1.89 %) in the plants sown on 16th November (S$_2$) which was at par with 1st November (S$_1$) sowing (1.88%) and lowest (1.75%) was observed in the plants sown on 31st December (S$_5$). The conceivable reason for this variance could be the prevailing climatic condition during vegetative and reproductive phase affecting their synthesis and accumulation of protein. Kharbamon et al. (2016) also claimed in their findings that the percentage of protein was higher in Indian beans that were sown early than the late sown crops.

Among the varieties Falguni (V$_1$) recorded highest Protein content in fresh pods (2.15%) followed by Nandini (V$_3$) and least protein content (1.66%) was recorded in Arka Komal (V$_2$). Much the same variation was reported by Das et al. (2018) and Rai et al. (2019) and confirmed among the three varieties Falguni was much more superior with respect to protein content of the pods. However, interactive effect of different sowing time and varieties on the quantity of protein in fresh pod was observed to be non-significant in both the year (Table 1).

4. CONCLUSION

There was slight variation in the performance of different genotypes with respect to different sowing time of French bean. Among the different sowing time, 16th November sowing time was the best for cultivation of French bean in the Terai zone of West Bengal. Among the varieties, Arka Komal was the best followed by Nandini Variety of French bean.

5. REFERENCES

Amanullah, J.I., Hayat, T.F., Khan, A.I., Khan, N., 2002.

Effect of sowing dates on yield and yield components of mash bean varieties. Asian Journal of Plant Sciences 1(6), 22–624.

Anonymous., 2015. Horticultural statistics at a glance. Horticulture statistics discussion, department of agriculture, Cooperation and Farmer's Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.

Bake, I.D., Singh, B.K., Singh, A.K., Moharana, D.P., Maurya, A.K., 2017. Effect of sowing dates and planting distances on quantitative attributes of okra [*Abelmoschus esculentus* (L.) Moench] cv. Kashi Pragati. The Pharma Innovation journal 6(12), 142–148.

Baruah, S., Dihingia, S., Sharma, J., Gogoi, S., Sarmah, A., Khound, A., Basumatary, P., Dutta, S., Neog, M., Pathak, P.K., 2022. Performance evaluation of French bean (*Phaseolus vulgaris* L.) varieties Arka Komal and Arka Sukomal in different agro-climatic zones of Assam. The Pharma Innovation Journal 11(7), 2664–2667.

Boyer, J.S., 1982. Plant productivity and environmental Science, 218, 443–448. doi: 10.1126/science.218.4571.443.

Campos-Vega, R., Loarca-Pina, G., Oomah, B.D., 2010. Minor components of pulses and their potential impact on human health. Food Research International 43(2), 461–482.

Celmeli. T., Sari, H., Canci, H., Sari, D., Adak, A., Eker, T., Toker, C., 2018. The nutritional content of common bean (*Phaseolus vulgaris* L.) landraces in comparison to modern varieties. Agronomy 8(9), 166.

Das, K., Datta, S., Sikhdar, S., 2018. Performance of bush type Frenchbean varieties (*Phaseolus vulgaris* L.) with or without rhizobium inoculation. Indian Journal of Agricultural Research 52(3), 284–289.

Gomez, K.A., Gomez, A.A.,1984. Statistical procedures for agricultural research. John Wiley & Sons.

Haque, M.A., Sarker, B.C., Karim, M.R., Rahman, M.Z., Hasan, M., 2020. Effect of sowing time and plant spacing on growth and yield of dwarf hyacinth bean. Plant Archives 20(1), 2953–2958.

Hussain, I., Ali, M., Ghoneim, A.M., Shahzad, K., Farooq, O., Iqbal, S., Datta, R., 2022. Improvement in growth and yield attributes of cluster bean through optimization of sowing time and plant spacing under climate change scenario. Saudi Journal of Biological Sciences 29(2), 781–792.

Kalita, H., Deka, N., Guha, B., Deka, U.K., Sadhukhan, R., 2016. Effect of dates of sowing and spacing on rajmah (*Phaseolus vulgaris*) varieties under the climatic conditions of Central Brahmaputra Valley Zone of Assam. Journal of Crop and Weed 12(1), 64–68.

Kamble, M.Y., Kalalbandi, B.M., Kadam, A.R., Rohidas, S.B., 2016. Effect of organic and inorganic fertilizers on growth, green pod yield and economics of French bean (*Phaseolus vulgaris* L.) cv. HPR–35. Legume Research 39(1), 110–113.

Kandula, V., Prasad, K.R., Kumara, K.U., Babu, M.R., Krishna, U., 2022. Evaluation of bush type French bean (*Phaseolus vulgaris*) genotypes for growth, yield and quality traits. The Pharma Innovation Journal 11(9), 1361–1363.

Kaul, A., Kaur, C., Singh, G., 2018. Performance of kidney bean (*Phaseolus vulgaris* L.) under different sowing dates in sub-mountainous area of Punjab. Legume Research 41(5), 745–749.

Kharbamon, B., Jha, A.K., Verma, V.K., Choudhury, B.U., Deka, B.C., 2016. Effect of planting time and phosphorus dosage on growth, yield and quality attributes of Indian bean (*Lablab purpureus* L.). Indian Journal of Hill Farming 29(1), 65–71.

Lowry, O.H., 1951. Protein measurement with the Folin phenol reagent. Journal of Biological Chemistry 193(1), 265–275.

Mamathashree, M.N., Shyamalamma, S., 2022. Screening of bush type French bean (*Phaseolus vulgaris* L.) accessions for micronutrient variations and characterization of selected genotypes using micronutrient content linked markers. Legume Research-An International Journal 45(3), 285–291.

Maske, N.M., Kadam, S.B., Tidke, R.T., Pawar, S.B., 2009. Performance of French bean (*Phaseolus vulgaris* L.) genotypes under different fertility levels. International Journal of Agricultural Sciences 5(1), 134–136.

Meena, J., Dhillon, T.S., Meena, A., Singh, K.K., 2017. Studies on performance of french bean (*Phaseolus vulgaris* L.) genotypes for yield and quality traits under protected conditions. Plant Archives 17(1), 615–619.

Mozumder, S.N., Moniruzzaman, M., Islam, M.R., Alam, S.N., 2003. Effect of planting time and spacing on the yield performance of bush bean (*Phaseolus vulgaris* L.) in the eastern hilly area of Bangladesh. Legume Research 26(4), 242–247.

Muthuramu, S., Paulpandi, V.K., Sakthivel, S., Ramakrishnan, K., Karthik, R., 2015. Assessing the performance of french bean (*Phaseolus vulgaris* L) in District Virudhunagar of Tamilnadu. Journal of Krishi Vigyan 3(2), 5–7.

Panda, A., Paul, A., Mohapatra, P., 2016. Genetic analysis of variability and divergence in french bean (*Phaseolus vulgaris* L.). International Journal of Bio-resource and Stress Management 7(4), 784–790.

Rai, U., Datta, S., Chatterjee, R., Thapa A., 2021. Effect of

organic sources of nutrients, humic acid and sea weed extracts on growth and yield of french bean varieties. Legume Research-An International Journal 44(7), 824–825.

Rangaswamy, G., 1975. Diseases of crop plants in India. Prentice Hall of India Pvt. Ltd., New Delhi.

Reddy, M.M., Padmaja, B., Reddy, D., 2010. Performance of french bean at different dates of sowing and plant densities in Telangana region of Andhra Pradesh. Journal of Food Legumes 23(1), 54–56.

Sadhukhan, R., Bhowmick, M.K., Biswas, P.K., 2008. Performance of rajmash (*Phaseolus vulgaris* L.) under varying dates of sowing in West Bengal. Journal of Crop and Weed 4(2), 42–44.

Sardana, V., Dhingra, K.K., Gill, M.S., Singh, I.J., 2000. Production technology of French bean (*Phaseolus vulgaris* L.) cultivation: A review. Agricultural Reviews 21(3), 141–154.

Sharma, B.K., Kushwah, S.S.,Verma, K.S., Singh, O.P., 2013. Studies on french bean (*Phaseolus vulgaris* L.) varieties under different N, P, K and S levels for growth, yield and economics. Journal of Horticultural Sciences 8(2), 268–270.

Shukla, P.K., Singh, R., 2021. Effect of date of sowing and spacing on growth, forage yield and quality of cluster bean (*Cyamopsis tetragonoloba* L.). The Pharma Innovation Journal 10(10), 162–166.

Singh, G., Virk, H.K., Kaur, C., Hundal, R.K., Khokhar, A., Kaur, J., Singh, J., 2020. Effect of sowing dates on production potential of Rajmash under Punjab conditions. Agricultural Research Journal 57(2), 178–183.

Tiwari, A.K., Chaubey, T., 2017. Quality seed production of french bean, 1–9.

Tiwari, R., Bhatt, L., Dev, R., 2014. Effect of date of sowing on growth and yield of vegetable pea genotypes under rain-fed mid-hill conditions of Uttarakhand. Indian Journal of Horticulture 71(2), 288–291.

Welch, R.M., House, W.A., Beebe, S., Cheng, Z., 2000. Genetic selection for enhanced bioavailable levels of iron in bean (*Phaseolus vulgaris* L.) seeds. Journal of Agricultural and Food Chemistry 48(8), 3576–3580.

Yadav, J., 2010. Specificity of french bean (*Phaseolus vulgaris* L.) genotypes and Rhizobium phaseoli strains to establish symbiotic N-fixation in inceptisols of Varanasi, Uttar Pradesh, India. International Journal of Bio-resource and Stress Management 1(2), 59–62.