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Performance of French bean (*Phaseolus vulgaris* L.) varieties on growth and yield under different dates of sowing during *rabi* season

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Abstract
A field experiment was conducted during the *rabi* season of 2023-24 at Post Graduate Experimental Farm, Department of Agronomy, College of Agriculture, VNMKV, Parbhani. The experiment was laid out in Split Plot Design with Twelve treatments in three replications by keeping sowing time (D_1: 12th October, D_2: 26th October, D_3: 9th November and D_4: 23rd November) as a first factor and Varieties (V_1: Varun, V_2: Phule Viraj and V_3: Phule Rajma) as a second factor. Results revealed that, among the varieties the highest plant height (32.61 cm), No. of pods/plant (9.33), No. of seeds/pod (3.47), pod dry weight/plant (8.39 g), seed weight/plant (6.77 g), straw yield/plant (11.66 g) and seed index (21.80 g) was recorded in variety Phule Viraj. However, the number of branches (4.69), number of functional leaves (17.98), leaf area (10.63 dm^2) and dry matter (16.20 g) were found in variety Phule Viraj. Regarding the different sowing time, No. of pods/plant (9.84), No. of seeds/pod (3.49), pod dry weight/plant (8.81 g), seed weight/plant (7.64 g), straw yield/plant (11.63 g) and seed index (22.29 g) was highest in plants sown on 9th November. On the strength of findings, it can be inferred that Phule Viraj Scheduled for sowing 9th November could be an ideal for cultivation in Department of Agronomy, VNMKV, Parbhani.

Keywords: French bean (*Phaseolus vulgaris* L.), growth and yield, varieties

1. Introduction
French bean (*Phaseolus vulgaris* L.) is a native crop of central and south America (Swaider *et al.*,1992) [10]. The cultivation of French bean was started 7000 years ago by Indians tribe in Mexico and Peru. French bean (*Phaseolus vulgaris* L.) is most important leguminous vegetable. It is known by various names *viz*. Bush bean, common bean, kidney bean, rajma, snap bean. Its seed contain 21.1 percent protein, 69.9 percent carbohydrates, 1.7 percent fat and 381 mg calcium, 425 mg Phosphorous & 12.9 mg iron per 100 g of edible part.
India is the second largest producer of fruits and vegetables in the world, contributing about 9.3 per cent share of total world production. Fruit and vegetable cultivation has emerged as a profitable venture that not only provides nutritional security but also generates significant employment in rural areas and opens the door to export (Barwal *et al.*, 2023) [2]. Even though fruits and vegetables occupy only 4.9 per cent of the gross cropped area of India, value of output exceeds that of cereals. The production of vegetables, especially tomato, onion and potato has increased significantly over the areas, making India the second largest producer of all the three vegetables in the world. The production of French bean is lower due to low yielding varieties and it is more prone to attacks of pest and disease which leads to lower income as compared to other competing crops (Raghupathi *et al.*, 2020) [7]. In Punjab, French beans are cultivated in an area of 1416.40 hectares with a production of 3212.34 MT. while in Amritsar district it covers an area of 283.28 hectares with a production of 642.46 MT (Anonymous, 2021) [1].

2. Materials and Methods
A field experiment entitled "Performance of French bean (*Phaseolus vulgaris* L.) varieties on growth and yield under different dates of sowing during *rabi* season." was conducted during the *rabi* season of 2023-24 at Post Graduate Experimental Farm, Department of Agronomy, College

of Agriculture, Vasantaro Naik Marathwada Krishi Vidyapeeth, Parbhani. The experimental field was levelled black and clayey in texture with slightly alkaline. The experiment was laid out in Split Plot Design with twelve treatments in three replications. First factor comprised of 4 sowing time (D) *i.e*., D_1: 12th October, D_2: 26th October, D_3: 9th November and D_4: 23rd November. Second factor consisted with 3 type of French bean varieties (V) *i.e*., V_1: Varun, V_2: Phule Viraj and V_3: Phule Rajma. The plot size of Gross: 5.4 × 4.5 m^2 and Net: 4.5 × 4.1 m^2 with spacing 45 cm × 10 cm was opted for this experiment. Common dose of fertilizer N:P:K is 120:60:60 kg ha^{-1}. The half dose of nitrogen and full dose of phosphorus and potassium was applied 6-10 cm deep in line to the side of crop as a basal dose at the time of sowing through urea, SSP and MOP. The remaining half dose of nitrogen was applied 30 DAS through urea.

For the year randomly five plants per plot were selected and growth parameters like plant height (cm), No. of branches, No. of functional leaves, Leaf area (dm^2), dry matter (g) and yield attributing characters like No. pf pods per plant, No. of seeds per pod, Pod dry weight per plant (g), seed weight per plant (g), straw yield per plant (g) and seed index (g) were recorded.

3. Results and Discussion

3.1. Growth parameters

Various sowing dates and different varieties had a significant effect on growth parameters of vegetable French bean (Table 1). The tallest plants of 33.92 cm high were observed with sowing *i.e*., 9th November (D_3) followed by 31.26 cm which sown on 26th October (D_2). The possibility of this depression in height in succeeding sowing could be due to drop of temperature and intensity of sunlight which might have aided the reduction of photosynthetic efficiency of a plant as compared to preceding sowing dates (Kaul *et al*., 2018) [6]. Consonantly, sowing done on 12th October (D_1) produced the minimum number of Plant height (10.87 cm), No. of branches $plant^{-1}$ (3.50), No. of functional leaves $plant^{-1}$ (15.38), Leaf area (9.05 dm^2) and dry matter $plant^{-1}$ (12.70 g). Regarding varieties the maximum plant height of 14.53 cm was observed in variety Phule Viraj (V_2) followed by (12.25 cm) in variety Phule Rajma (V_3), while Variety Varun (V_1) showed the least plant height (12.07 cm) but the number of branches per plant (4.69), Number of functional leaves $plant^{-1}$ (17.98), leaf area $plant^{-1}$ (10.63 dm^2) and dry matter $plant^{-1}$ (16.20 g) maximum recorded in variety Phule Viraj (V_2). These morphological distinctions highlight the influence of genetic factors on branch development, as noted by (Hema and Rana 2020) [4], who studied similar variations among genotypes. (Das *et al*., 2018) [3] also stated that among these three varieties Varun (V_1) exhibited minimum height. On the contrary Phule Viraj (V_2) showed maximum number of branches per plant (4.69). The growth and branches number in a plant is heavily influenced by the varieties genetic potential and its interaction with the environment and cultivation practices (Kaul *et al*., 2018) [6]. 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, Number of branches $plant^{-1}$, No. of functional leaves $plant^{-1}$, leaf area $plant^{-1}$ (dm^2) and dry matter $plant^{-1}$ (g) was non-significant (Table 1). The combination of D_3 V_2 (D_3 - 9th November sowing, V_2 – Phule Viraj) was better than the rest regarding plant height and all growth parameters.

Table 1: Effect of the different sowing dates and varieties on the growth parameters of French bean.

Treatments	Plant height (cm)	No. of branches $plant^{-1}$	No. of functional leaves $plant^{-1}$	Leaf area $plant^{-1}$ (dm^2)	Dry matter $plant^{-1}$ (g)
Sowing date					
D_1: 12 Oct	28.73	3.43	15.38	9.05	12.70
D_2: 26 Oct	31.26	4.58	17.15	10.66	16.59
D_3: 09 Nov	33.92	4.97	19.62	11.05	19.18
D_4: 23 Nov	30.18	3.93	16.67	9.68	13.22
S.E m±	0.76	0.12	0.61	0.33	0.39
C.D @5%	2.63	0.41	2.12	1.13	1.35
Variety					
V1: Varun	29.82	3.41	16.76	9.68	14.66
V2: Phule Viraj	32.61	4.69	17.98	10.63	16.20
V3: Phule Rajma	30.65	4.20	16.87	10.02	15.41
S.E m±	0.70	0.08	0.34	0.21	0.36
C.D @5%	2.11	0.25	1.03	0.63	1.09
Interaction					
S.E m±	1.40	0.17	0.69	0.42	0.72
C.D @5%	NS	NS	NS	NS	NS
G.M.	31.02	4.24	17.20	10.11	15.42

3.2. Yield parameters

The presented data (Table 2). Concerning with the yield attributing characters and yield of French bean indicated that yield characters like No. of pods per plant (9.84), No. of seeds per pod (3.49), pod dry weight per plant (8.81 g), seed weight per plant (7.64 g), straw yield per plant (11.63 g) and seed index (22.29 g) was found to be maximum in plants sown on 9th November (D_3). Similar trend of decreasing yield associated characters and yield with the advancement of sowing date was reported by Kalita *et al.,* (2016) [5]; Sadhukhan *et al*., (2008) [9]. As compared to subsequent sowing dates the beans sown on November received a more favourable environmental condition. Reddy *et al*., (2010) [8] mentioned that French bean sown during second fortnight of October to November second week produces higher yield. All the plants which was sown on 12th October (D_1) had the minimal values regarding no. of pods per plant (7.55), No. of seeds per pod (2.17), pod dry weight per plant (6.50 g), seed weight per plant (3.56 g), straw yield per plant (8.71 g) and seed index (18.46 g).

Varietal performance yield attributes of French bean depicted in Table 2 appears to indicate that among the three varieties Phule Viraj (V_2) outperformed with highest no. of pods per plant (9.33), No. of seeds per pod (3.47), pod dry weight per plant (8.39 g), seed weight per plant (6.77 g), straw yield per plant (11.66 g) and seed index (21.80 g). Highest number of pods per $plant^{-1}$(9.33) was noted in Phule Viraj. Conclusively, Varun (V_1)

among the other varieties underperformed with minimum no. of pods per plant (8.25), No. of seeds per pod (2.39), pod dry weight per plant (7.44 g), seed weight per plant (3.92 g), straw yield per plant (8.21 g) and seed index (20.27 g).

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 2). Where in the interaction between the D_3 V_2 showed the most synergistic effect regarding yield of French bean while change in the sowing time or variety in other combination has reduced the yield potential of French bean. Kalita *et al.*, (2016) [5] in their findings stated that 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) [9] report, which states that the optimum time for sowing of French bean is West Bengal is between the last week of October to early November.

Table 2: Effect of the different sowing dates and varieties on the yield attributing characters of French bean.

Treatments	No. of pods/plant	No. of seeds/pod	Pod dry weight/ plant (g)	Seed weight/ plant (g)	Straw yield /plant (g)	Seed index (g)
Sowing date						
D_1: 12 Oct	7.55	2.17	6.50	3.56	8.71	18.46
D_2: 26 Oct	9.03	3.21	8.42	6.21	10.14	20.73
D_3: 09 Nov	9.84	3.49	8.81	7.64	11.63	22.29
D_4: 23 Nov	8.47	2.62	7.44	3.96	8.21	18.92
S.E m±	0.22	0.09	0.32	0.2	0.30	0.62
C.D @5%	0.78	0.31	1.12	0.80	1.05	2.15
Variety						
V1: Varun	8.25	2.39	7.44	3.92	8.21	20.27
V2: Phule Viraj	9.33	3.47	8.39	6.77	11.66	21.8
V3: Phule Rajma	8.58	2.75	7.55	5.12	9.15	20.96
S.E m±	0.20	0.12	0.18	0.18	0.30	0.38
C.D @5%	0.60	0.37	0.53	0.53	0.91	1.14
Interaction (D × V)						
S.E m±	0.40	0.25	0.36	0.35	0.60	0.84
C.D @5%	NS	NS	NS	NS	NS	NS
G.M.	8.72	2.87	7.79	5.28	9.67	21.17

4. Conclusion

The study concludes that the optimal sowing time for French bean cultivation is November 9th (D_3), as it resulted in the highest growth and yield attributes. Among the varieties, Phule Viraj (V_2) was the best performer, followed by Phule Rajma and Varun. Specifically, the combination of sowing on November 9th with Phule Viraj resulted in significantly higher seed weight per pod and overall yield, underscoring the importance of both sowing time and variety selection in enhancing the productivity of French beans.

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