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Growth performance and yield contributing traits of *Kharif* French bean (*Phaseolus vulgaris* L.) varieties under different dates of sowing

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Abstract
A field experiment was laid out during the *Kharif* 2024-25 at the experimental farm, Department of Agronomy, VNMKV, Parbhani, to assess the performance of French bean (*Phaseolus vulgaris* L.) varieties under different sowing dates. The experiment followed a Split Plot Design with three sowing dates *viz.*, 25th (D_1), 27th (D_2), and 29th (D_3) Standard Meteorological Weeks (SMW) as main plot treatments, and three varieties *viz.*, Varun (V_1), Phule Viraj (V_2), and Phule Rajma (V_3) as subplot treatments, with three replications. The results indicated that sowing during the 27th SMW (D_2) significantly enhanced growth parameters, including plant height (35.00 cm), number of branches per plant (5.53), functional leaves per plant (19.92), leaf area (12.23 dm²), and dry matter accumulation (21.77 g). Among the varieties, Phule Viraj (V_2) exhibited superior growth, recording the highest values for these traits, while Varun (V_1) showed the lowest performance. In terms of yield attributes, D_2 produced significantly higher number of pods per plant (11.75), pod dry weight (11.63 g), seed weight per plant (8.79 g), and seed index (20.79 g), as compared to D_1 and D_3. Phule Viraj (V_2) recorded the highest seed yield attributes, including number of seeds per pod (3.72), pod dry weight (11.25 g), seed weight per plant (9.46 g), and straw yield (14.29 g $plant^{-1}$), as compared to Phule Rajma and Varun. A significant interaction was observed between D_2 and V_2 (D_2V_2), suggesting a synergistic effect in terms of biomass accumulation and yield potential. It is concluded that the French bean variety Phule Viraj, when sown during the 27th Standard Meteorological Week, is best suited for optimizing growth and yield parameters under the agro-climatic conditions of Marathwada during the *Kharif* season.

Keywords: French bean, growth attributes, sowing dates, varieties, yield

Introduction

French bean (*Phaseolus vulgaris* L.) is an important leguminous crop valued for its short duration, high protein content, and agronomic benefits. Native to Central and South America, the crop was introduced to India during the 17th century (Vavilov, 1950) [16]. It belongs to the Fabaceae family (2n = 22) and is cultivated globally for its edible pods and dry seeds, known as "Rajma" in India.

Nutritionally, French beans are rich in protein (21.1%), carbohydrates (69.9%), vitamins (A, C, and K), and essential minerals like calcium, phosphorus, and iron (Ali & Kushwana, 1987) [1]. Their inclusion in human diets contributes to addressing protein deficiencies and promoting public health. Medicinal uses include treatment of arthritis and urinary disorders, and the presence of 'Phaseolin' lends fungicidal properties. Agronomically, the crop enhances soil fertility when included in cropping systems and supports sustainable agriculture.

French bean varieties are classified into bush and pole types, with bush types favored for their shorter growth cycle and low input requirements. However, they are more prone to pod rotting during the rainy season, which limits their performance. Despite this, the availability of pods during the monsoon can be profitable in lowland markets. The crop is increasingly used in rice or maize-based cropping systems due to its compatibility and adaptability to various agro-climatic zones (Kakon *et al.,* 2017) [7].

In India, the area under French bean cultivation is approximately 308.82 thousand hectares with

a production of 2.83 million metric tonnes. In Maharashtra, it is grown on 8,710 hectares, yielding 48,280 metric tonnes with relatively low productivity (5.54 t/ha). Key producing districts include Pune, Satara, Ahmednagar, and Nashik. Despite its potential, French bean cultivation in Marathwada remains limited due to the lack of suitable production technologies and poor varietal adaptation.

The yield of French beans in India is strongly influenced by key agronomic factors such as sowing date and varietal selection. Improper alignment of these factors with local agro-climatic conditions can lead to significant yield reductions. Several studies have shown that inappropriate sowing time can expose crops to adverse environmental conditions such as excessive rainfall, drought, or extreme temperatures during critical growth stages, ultimately reducing pod yield and quality (Patange *et al.*, 2011) [10].

Among these factors, sowing date plays a crucial role in determining crop performance. The timing of sowing directly affects germination rate, vegetative growth, flowering, and pod development, as it governs the environmental conditions experienced by the crop during its life cycle. For instance, sowing too early may expose seedlings to high early-season temperatures, whereas late sowing may result in flowering during periods of moisture stress or high pest incidence (Patil *et al.*, 2025) [11]. The optimal sowing dates ensures that flowering and pod filling coincide with favorable temperature and moisture regimes, thereby maximizing yield (Datta *et al.*, 2023) [4].

Varietal selection is equally important, as genetic differences influence growth duration, canopy structure, pod size, seed weight, and resistance to biotic and abiotic stresses. Certain varieties exhibit superior adaptability to specific sowing dates due to differences in their phenological requirements and tolerance to environmental variations (Chaudhary *et al.*, 2025) [2]. The interaction between sowing date and variety can be highly significant, with the performance of a variety often changing depending on the environmental conditions prevailing at a particular sowing time (Jana, 2025) [6].

The adoption of suitable sowing dates combined with high-yielding and stress-tolerant varieties can significantly improve French bean productivity. This not only enhances farmers income but also contributes to food and nutritional security. Conversely, mismatched sowing schedules and variety choices can lead to reduced yields, higher vulnerability to pests and diseases, and overall economic losses (Patange *et al.*, 2011) [10].

Despite the recognized importance of aligning sowing dates with varietal selection, limited research has been conducted to determine the most suitable sowing date and variety combinations for French bean under the semi-arid conditions of Marathwada. This gap hinders efforts to optimize resource use efficiency, enhance crop performance, and sustain production under changing climate conditions. Therefore, evaluating promising French bean varieties across different sowing dates is necessary to identify optimal combinations for maximizing growth and yield attributes in this region.

Materials and Methods
The field experiment entitled "Performance of *Kharif* French bean (*Phaseolus vulgaris* L.) varieties under different dates of sowing" was conducted during the *Kharif* season of 2024-25 at the Experimental Farm, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani. The experimental field was levelled, clayey in texture, moderately fertile with good water-holding capacity, and slightly alkaline in

reaction. The soil was classified as Vertisol. The experiment was laid out in Split Plot Design with a total of nine treatments and three replications. The first factor comprised three sowing dates (D) i.e., D_1: 25th Standard Meteorological Week(SMW), D_2: 27th SMW, and D_3: 29th SMW. The second factor consisted of three French bean varieties (V) i.e., V_1: Varun, V_2: Phule Viraj, and V_3: Phule Rajma. The gross plot size was 5.4 × 4.5 m² and the net plot size was 4.5 × 3.6 m². A spacing of 45 cm × 10 cm was adopted for this experiment.

A common dose of fertilizers N:P:K at 120:60:60 kg ha⁻¹ was applied. Half dose of nitrogen and full doses of phosphorus and potassium were applied as basal dose in furrows at 6-8 cm depth at the time of sowing using urea, single super phosphate (SSP), and muriate of potash (MOP). The remaining half dose of nitrogen was top-dressed at 30 days after sowing (DAS) using urea. Sowing was done as per treatment schedule. All the necessary cultural operations like thinning, irrigation, weeding, and plant protection measures were carried out as per recommendations and kept uniform for all plots throughout the crop period.

For the purpose of data collection, five plants were randomly selected from each plot and tagged for recording various growth and yield parameters. Growth observations recorded were plant height (cm), number of primary branches, number of functional leaves, leaf area (dm²), and dry matter accumulation (g plant⁻¹) at 30, 45, 60, and 75 DAS. Phenological observations such as days to 50% flowering and days to physiological maturity were noted. At harvest, yield attributing characters such as number of pods per plant, number 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. The experimental data were analyzed statistically using analysis of variance (ANOVA) appropriate for the Split Plot Design.

Results and Discussion
Growth attributes
The results of the present investigation revealed that different dates of sowing and varietal selection had a significant influence on the growth parameters of French bean (*Phaseolus vulgaris* L.) during the *Kharif* season of 2024 (Table 1). Among the sowing dates, sowing during the 27th Standard Meteorological Week (D_2) recorded the tallest plants (35.00 cm), which was significantly superior to D_1 (25th SMW) and D_3 (29th SMW). Sowing during the 25th SMW produced plants with an average height of 32.63 cm, while the shortest plants (31.79 cm) were observed under D_3. The reduction in plant height with delayed sowing may be attributed to a shortened vegetative phase and suboptimal environmental conditions, such as fluctuating rainfall patterns and lower solar radiation interception, which negatively affect photosynthetic efficiency. These findings are in agreement with those of Kaul *et al.*, (2018) [8], who also reported that delayed sowing reduces plant height due to reduced vegetative duration.

Sowing on 27th SMW (D_2) also produced the highest number of branches per plant (5.53), functional leaves (19.95), leaf area (12.23 dm²), and dry matter accumulation (21.77 g plant⁻¹), indicating its positive influence on vegetative growth. In contrast, the lowest values for these parameters were consistently recorded in the crop sown on 29th SMW (D_3), which might be due to reduced vegetative span and poor climatic synchronization with the crop's growth stages. These results align with the reports of Das *et al.,* (2018) [3], who emphasized the importance of optimal sowing windows in enhancing the vegetative and physiological performance of French bean.

Regarding varietal performance, Phule Viraj (V_2) exhibited a significantly superior growth response across all parameters. It attained the maximum plant height (35.47 cm), highest number of branches per plant (5.53), functional leaves (19.88), leaf area (11.88 dm²), and dry matter accumulation (21.52 g plant⁻¹). This robust vegetative performance of Phule Viraj may be attributed to its genetic potential for vigorous growth and better adaptability to monsoon conditions, as also observed by Hema and Rana (2020) [5] who reported that varietal genetics play a significant role in enhancing growth attributes in French bean. In contrast, the variety Varun (V_1) recorded the lowest values for most vegetative traits, indicating poor adaptability and suboptimal growth under the agro-climatic conditions of Marathwada. The performance of Phule Rajma (V_3) remained intermediate across all parameters.

The interaction effect between sowing dates and varieties was found to be non-significant for plant height, number of branches, functional leaves, and leaf area, but it was significant for dry matter accumulation (Table 2). The combination of D_2V_2 (Phule Viraj sown on 27th SMW) recorded the highest values for all vegetative parameters, suggesting a synergistic effect of optimal sowing time and high-performing genotype leads to enhanced growth. This supports the findings of Kaul *et al.,* (2018) [8], who reported that favorable environmental conditions, when matched with genotype responsiveness, can significantly boost vegetative development.

These results clearly indicate that the selection of an appropriate sowing date (27th SMW) and high-performing variety (Phule Viraj) plays a crucial role in optimizing the growth performance of French bean under *Kharif* conditions.

Yield attributes
The data presented in Table 3 indicated that both sowing dates and varieties exerted a significant influence on all measured yield parameters of French bean, including number of pods per plant, number of seeds per pod, pod dry weight per plant, seed weight per pod, seed yield per plant, straw yield per plant, and seed index. However, the interaction effect between sowing dates and varieties was found significant only for number of pods per plant, pod dry weight, and seed yield per plant, while it remained non-significant for other traits.

Among the sowing dates, sowing during the 27th Standard Meteorological Week (D_2) was found to be most favourable for yield expression. It recorded the highest number of pods per plant (11.75), seeds per pod (3.81), pod dry weight per plant (11.63 g), weight of seeds per pod (0.81 g), and seed yield per plant (8.79 g). The highest straw yield (14.36 g) and seed index

(20.79 g) were also observed under D_2. The superior yield under D_2 can be attributed to favourable agro-climatic conditions during this period, which likely facilitated better flowering, pod setting, and seed filling. These results are in conformity with the findings of Thakare *et al.,* (2024) [15], who reported the importance of timely sowing in optimizing reproductive growth in legumes. On the contrary, the lowest yield attributes were recorded under the 29th SMW (D_3), where number of pods per plant (9.74), pod dry weight (8.45 g), and seed yield per plant (6.58 g) were significantly reduced. This decline may be due to delayed sowing, leading to suboptimal temperature and light conditions during critical reproductive stages, thereby adversely affecting pollination and seed development.

Significant differences were also observed among varieties. Phule Viraj (V_2) demonstrated consistent superiority across all yield traits, recording the highest number of pods per plant (11.49), seeds per pod (3.72), pod dry weight (11.25 g), seed yield per plant (9.46 g), seed weight per pod (0.86 g), straw yield (14.29 g), and seed index (20.65 g). This superior performance may be attributed to its better genetic potential, enabling it to effectively utilize environmental resources for sink development and biomass accumulation. These findings align with the observations of Hema and Rana (2020) [5], who highlighted significant varietal variation in French bean for yield-related parameters. In contrast, Varun (V_1) consistently recorded the lowest values for all yield parameters, indicating its comparatively lower reproductive efficiency under the tested agro-climatic conditions.

The interaction between sowing dates and varieties was found to be statistically significant for number of pods per plant, pod dry weight, and seed yield per plant (Table 4) indicating that varietal performance varied under different sowing times. Phule Viraj (V_2) sown during the 27th SMW (D_2) recorded the highest number of pods per plant (12.33), pod dry weight (12.89 g), and seed yield per plant (10.46 g), followed by Phule Rajma (V_3) under the same sowing period, whereas the lowest values for these parameters were observed in Varun (V_1) under delayed sowing in the 29th SMW (D_3), which recorded 8.89 pods per plant, 7.09 g pod dry weight, and 4.86 g seed yield per plant. Similarly, straw yield was highest in Phule Viraj (15.69 g) under D_2 and lowest in Varun (10.86 g) under D_3, reflecting the influence of genotype $\times$ environment interaction on both reproductive and vegetative traits. These results suggest that Phule Viraj responded most efficiently to timely sowing, while delayed planting negatively affected the growth and yield components, particularly in Varun.

Table 1: Growth attributing characters of French bean as influenced by different treatments.

Treatments	Plant height (cm)	No. of branches plant⁻¹	No. of functional leaves plant⁻¹	Leaf area plant⁻¹ (dm²)	Dry matter plant⁻¹ (g)
Sowing dates					
D_1: 25th SMW	32.63	5.11	18.49	11.36	20.03
D_2: 27th SMW	35.00	5.53	19.95	12.23	21.77
D_3: 29th SMW	31.79	4.59	17.92	10.37	19.09
S.E. m±	0.57	0.12	0.35	0.27	0.24
C.D.@5%	2.24	0.44	1.36	1.04	0.93
Varieties					
V_1: Varun	30.94	4.58	17.83	10.68	18.67
V_2: Phule Viraj	35.47	5.53	19.88	11.88	21.52
V_3: Phule Rajma	33.01	5.12	18.65	11.40	20.70
S.E. m±	0.66	0.12	0.41	0.16	0.16
C.D.@5%	2.02	0.38	1.26	0.49	0.48
Interaction					
S.E. m±	1.14	0.21	0.71	0.28	0.27
C.D.@5%	NS	NS	NS	NS	0.83
G.M.	33.14	5.08	18.78	11.31	20.29

Table 2: Interaction effect of D x V on dry matter accumulation plant⁻¹ (g) of French bean

Sowing time	Varieties			
	V₁: Varun	V₂: Phule Viraj	V₃:Phule Rajma	Mean
D₁: 25th SMW	18.50	20.90	20.70	20.03
D₂: 27th SMW	19.63	23.30	22.36	21.76
D₃: 29th SMW	17.86	20.36	19.03	19.08
Mean	18.66	21.52	20.70	
S.E. m±	0.27			
C.D.@5%	0.83			

Table 3: Yield contributing characters of French bean as influenced by different treatments.

Treatments	No. of pods/ plant	No. of seeds/ pod	Pod dry weight/ plant (g)	Wt. of seeds/ pod (g)	Seed weight/ plant (g)	Straw yield /plant (g)	Seed index (g)
Sowing dates							
D₁: 25th SMW	11.14	3.22	10.27	0.72	8.07	13.11	19.73
D₂: 27th SMW	11.75	3.81	11.63	0.81	8.79	14.36	20.79
D₃: 29th SMW	9.74	2.74	8.45	0.67	6.58	12.14	19.18
S.E m±	0.18	0.10	0.12	0.02	0.19	0.34	0.31
C.D @5%	0.68	0.42	0.44	0.07	0.74	1.36	1.20
Varieties							
V₁: Varun	10.28	2.64	8.52	0.61	6.28	12.31	19.18
V₂: Phule Viraj	11.49	3.72	11.25	0.86	9.46	14.29	20.65
V₃: Phule Rajma	10.87	3.40	10.57	0.73	7.70	13.02	19.87
S.E m±	0.05	0.09	0.06	0.04	0.05	0.11	0.24
C.D @5%	0.16	0.27	0.20	0.12	0.15	0.35	0.73
Interaction (D × V)							
S.E m±	0.09	0.15	0.11	0.07	0.09	0.20	0.41
C.D @5%	0.27	NS	0.35	NS	0.27	0.61	NS
G.M.	10.87	3.25	10.11	0.73	7.81	13.20	19.90

Table 4: Interaction effect of D x V on yield attributes of French bean

Treatments	No. of pods/ plant	Pod dry weight/plant (g)	Seed weight/plant (g)	Straw yield/plant (g)
D₁V₁	10.66	8.49	6.55	12.49
D₁V₂	11.76	11.43	9.72	14.03
D₁V₃	10.99	10.86	7.92	12.79
D₂V₁	11.26	9.96	7.42	13.56
D₂V₂	12.33	12.89	10.46	15.69
D₂V₃	11.74	12.01	8.47	13.81
D₃V₁	8.89	7.09	4.86	10.86
D₃V₂	10.36	9.43	8.19	131.13
D₃V₃	9.96	8.83	6.69	12.43
S.E. m±	0.09	0.11	0.09	0.20
C.D.@5%	0.27	0.35	0.27	0.61

Conclusion

- Sowing during the 27th Standard Meteorological Week (D₂) consistently recorded superior values for all major growth parameters, including plant height, number of branches, leaf area, and dry matter accumulation, along with yield-contributing traits such as number of pods per plant, pod dry weight, seed weight per plant, and seed index.
- Among the tested varieties, Phule Viraj (V₂) exhibited the most vigorous vegetative growth, dry matter accumulation and yield attributing characters than variety Phule Rajma (V₃) and Varun (V₁).
- Notably, the interaction effect between sowing dates and varieties was found significant for dry matter accumulation and for key yield attributes such as number of pods per plant, pod dry weight, seed weight per plant and straw yield per plant with the combination D₂V₂ (Phule Viraj sown on 27th SMW) achieving the highest performance.

References

1. Ali M, Kushwana B. Dry matter accumulation and yield of winter French bean as influenced by genotype, nitrogen level and plant population. Indian J of Agric Sci. 1988;58(4):263-7.
2. Chaudhary R, Sharma P, Thakur S. Response of cultivars, sowing dates and plant spacing on growth and seed yield traits in French bean (*Phaseolus vulgaris* L.). Int J of Agric Sci. 2025;8(3):108-41.
3. Das R, Thapa U, Debnath S, Lyngdoh YA, Mallick D. Evaluation of French bean (*Phaseolus vulgaris* L.) genotype for seed production. J of Appl Nat Sci. 2018;6(2):594-8.
4. Datta S, Jana JC, Bandyopadhyay A. Effect of sowing dates on growth, yield and quality components of bush type vegetable French bean (*Phaseolus vulgaris* L.) varieties. Int J of Bio-Resour Stress Manag. 2023;14(1):1-9.
5. Hema, Rana DK. Evaluation of French bean (*Phaseolus vulgaris* L.) genotypes for growth, pod yield and quality under sub-tropical conditions of Garhwal Hills. Int J of Curr Microbiol Appl Sci. 2020;9(7):974-80.
6. Jana JC. Effect of sowing date and variety of French bean (*Phaseolus vulgaris* L.) on seed yield and quality. Seed Res. 2025;33(1):15-21.
7. Kakon SS, Khan MSA, Choudhary JA, Ali MZ, Aziz MA.

Influence of sowing time-based temperature on flowering and seed yield of French bean (*Phaseolus vulgaris* L.). SAARC J Agri. 2017;15(1):77-84.

8. Kaul A, Kaur C, Singh G. Performance of Kidney bean (*Phaseolus vulgaris* L.) under different sowing dates in sub-mountainous area of Punjab. Legume Res. 2018;41(5):745-9.

9. Nimbalkar CA, Baviskar AP, Desai UT, Nawle PA. Stability of seed yield and yield contributing characters of French bean (*Phaseolus vulgaris* L.). Indian J of Agric Sci. 2002;72(7):433-35.

10. Patange NR, Ingle RW, Yadav KB. Effect of sowing dates on growth and yield of French bean (*Phaseolus vulgaris* L.) varieties during Kharif season. Asian J of Hortic. 2011;6(1):158-60.

11. Patil SR, Pawar VS, Kadam SR. Yield and economics assessment of French bean (*Phaseolus vulgaris* L.) under different sowing dates and varieties. Int J of Agron Agric Res. 2025;8(5):90-125.

12. Reddy BR, Reddy MS. Nutritional Value and Health Benefits of French Beans. Int J of Food Sci Nutr. 2019;4(3):45-56.

13. Sadhukhan R, Bhowmick MK, Biswas PK. Performance of rajmah (*Phaseolus vulgaris* L.) under varying dates of sowing in West Bengal. J of crop weed. 2008;4(2):42-44.

14. Sharma A, Sharma GD, Singh Y, *et al*. Optimum sowing dates and varieties for seed productivity of pole French bean (*Phaseolus vulgaris* L.) under north western Himalayas. Afr J of Agric Res. 2013;8(48):6196-201.

15. Thakare JS, Bhalerao GA, Shirale SP, Thombare SV. Performance of French bean (*Phaseolus vulgaris* L.) varieties on growth and yield under different dates of sowing during rabi season. Int J Res Agron. 2024;7:363-65.

16. Vavilov N. The origin, variation, immunity and breeding of cultivated plants. Chron Bot. 1950;13(3):1-364.

17. Zeliang PK, Kumar M, Kumar R, Meena KL, Rajkowa DJ. Varietal evaluation of French bean for higher productivity & nutritional security under the foot hill ecosystem of Nagaland. Indian J of Hill Farm. 2018;31(2):206-13.