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# Yield and economics assessment of French bean (*Phaseolus vulgaris* L.) varieties 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 sowing dates regarding the yield characters like No. of pods$^{-1}$(9.33), No. of seeds per/pod (3.47), pod dry weight/plant (8.39 g), wt. of seeds/pod (0.75 g), seed weight/plant (6.77 g), straw yield/plant (11.66 g) and seed index (21.80 g) was recorded maximum in variety Phule Viraj. However, the No. of pods$^{-1}$(8.25), No. of seeds per/pod (2.39), pod dry weight/plant (7.44 g), wt. of seeds/pod (0.47 g), seed weight/plant (3.29 g), straw yield/plant (8.21 g) and seed index (20.27 g) yield character was found to be lowest in variety Varun. On the basis of present studies results revealed that, treatment $D_3$ (November 9th) can satisfactorily produce the higher yield attributing characters *viz*., 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) and seed index (g) which was significantly superior over rest of treatments and it was found to at par with the treatment $D_2$ which was sown on October 26th. Whereas, lowest value were recorded in treatment ($D_1$) which sown on October 12th. But in case of highest Gross returns and net returns (108021 & 62893 ₹ ha$^{-1}$) and BCR (3.11) which obtained in treatment $D_3$. While highest net returns obtained in Variety Phule Viraj (59101 ₹ ha$^{-1}$) and BCR (2.77).

**Keywords:** French bean, sowing dates, variety, yield

## 1. Introduction
The productivity of French bean is low in Maharashtra. Inadequate supply of nutrient is one of the most important reasons of its low productivity under situation of Marathwada, where the black soil (Vertisol) are deficient in both nitrogen and phosphorus application is considered to be necessary for development of French bean. India ranks first in area and production of French bean among Asian countries with an area of 137.54 ha with an annual production of 1370.21 MT with average productivity of 55 MT/ha.

In Maharashtra Pune, Satara, Ahmednagar, Sangli, Nashik, and Solapur are the leading districts for growing French bean. It is being cultivated as *kharif* crop in Mahabaleshwar and Ratnagiri regions of Maharashtra state. However, area under cultivations of *Rajma* is negligible. The experimental evidence has shown the feasibility of growing *Rajma* is profitable under semi-arid climate of Vidarbha plains (Vyas *et al*., 1990) [4].

The major constraints in popularity of French bean in Maharashtra and Marathwada region is the lack of production technology for cultivation of French bean. The production of French bean can be improved by growing high yielding and most adaptable varieties and intensive cultivation practices like optimum sowing time, optimum plant varieties are the most critical factors for achieving higher productivity. Sowing time plays an important role in crop production as advanced and delayed sowing may cause substantial reduction in the yield.

## 2. Materials and Methods
A field experiment entitled "effect of sowing dates" was conducted during the *rabi* season of

2023-24 at PG 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. Geographically the farm is situated at latitude $19^0$ 16 N and longitude $76^0$ 47 E in subtropical zone, at an elevation of 409 meters above sea level. 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. Gap filling and thinning were done where necessary to maintain optimum plant population plant protection measures were taken to prevent infestation of aphid, jassids and white fly.

**Economics**

**Net monetary returns:** The net monetary returns (₹ $ha^{-1}$) of each treatment were worked out by deducting the mean cost of cultivation (₹ $ha^{-1}$) of each treatment from the gross monetary returns (₹ $ha^{-1}$) gained from the respective treatments.

**Net monetary returns (₹ $ha^{-1}$)** = Gross monetary returns - cost of cultivation

**Cost of cultivation:** The cost of cultivation (₹ $ha^{-1}$) of each treatment was worked out by considering the price of inputs, charges for cultivation, labour and other charges.

**Benefit:Cost ratio:** The Benefit:Cost ratio of each treatment was calculated by dividing the gross monetary returns by the mean cost of cultivation.

$$\frac{\text{Gross returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

## 3. Results and Discussion

**Yield and yield attributing characters:** The results of the present experimentation showed beneficial effect of different treatment characters. Treatment $D_3$ recorded maximum values of all yield attributing characters shown Table. 1 such as No. of pods/plant (9.84), No. of seeds/pod (3.49), pod dry weight/plant (8.81 g), wt. of seeds/pod (0.75 g), seed weight/plant (7.64 g), straw yield/plant (11.63 g), seed index (22.29 g). whereas, the maximum yield attributing characters such as No. of pods/plant (9.33), No. of seeds/pod (3.47), pod dry weight/plant (8.39 g), wt. of seeds/pod (0.75 g), seed weight/plant (6.77 g), straw yield/plant (11.66 g), seed index (21.80 g) recorded in variety Phule Viraj. Higher vegetative growth might have helped in synthesis of greater amount of food material which was later translocated into developing pods resulting in increasing pod length and pod diameter.

**Economics of treatments**

It is evident from Table. 2 the maximum Gross Monetary Returns (₹ 108020 $ha^{-1}$) was obtained in treatment $D_3$ sown on November 9th which was significantly superior over rest of treatment and treatment $D_1$ sown on October 12th recorded minimum Gross Monetary Return (₹ 40963 $ha^{-1}$). The maximum Net Monetary Returns (₹ 62893 $ha^{-1}$) was obtained in treatment $D_3$ sown on November 9th which was significantly superior over rest of treatment and treatment $D_1$ sown on October 12th recorded minimum Net Monetary Returns (₹ 6397 $ha^{-1}$). The treatment $D_3$ sown on November 9th recorded highest benefit cost ratio (3.11) and minimum benefit cost ratio was recorded in treatment $D_1$ sown on October 12th (1.18).

The maximum Gross Monetary Returns (₹ 101920 $ha^{-1}$) was recorded by Phule Viraj which was significantly superior over rest of the varieties and Varun recorded minimum Gross Monetary Returns (₹ 55370 $ha^{-1}$). The maximum Net Monetary Returns (₹ 59101 $ha^{-1}$) was recorded by Phule Viraj which was significantly superior over rest of varieties and Variety Varun recorded minimum Net Monetary Return (₹ 14117 $ha^{-1}$).

**No. of pods/plant**

The number of pods per plant in French beans was significantly influenced by different sowing dates. Treatment $D_3$, sown on November 9th, produced the highest average of 9.84 pods per plant, outperforming all other treatments. The variation in pod set may be attributed to temperature differences associated with the timing of sowing, as both early and delayed sowing resulted in a notable reduction in pod count. This finding aligns with previous studies by Sadhukhan *et al.* (2008) [3] and Kumar *et al.* (2022) [1], which reported similar trends.

Among the varieties, Phule Viraj was the top performer, yielding an average of 9.33 pods per plant, while Varun recorded the lowest average (8.25) pods per plant. These variations in pod count among the varieties likely stem from inherent genetic traits that affect their yield potential.

**No. of seeds/pod**

The number of seeds per pod in French beans was significantly influenced by the different sowing dates. Treatment $D_3$, sown on November 9th, achieved the highest average with 3.49 seeds per pod, significantly exceeding the other treatments. However, it was comparable to treatment $D_2$, sown on October 26th, which recorded 3.21 seeds per pod.

Additionally, the choice of variety also had a significant impact on the number of seeds per pod. The variety Phule Viraj stood out with an average (3.47) seeds per pod, followed by Phule Rajma (2.75) and Varun (2.39). These results indicate that both sowing date and genetic variety play crucial roles in determining seed yield in French beans.

**Pod dry weight/plant**

The dry weight of pods per plant in French beans was significantly influenced by the different sowing dates. The highest dry weight was recorded in treatment $D_3$, sown on November 9th, with an average of 8.81 g, which was statistically similar to treatment $D_2$ (8.42 g). Treatments $D_4$ and $D_1$ followed, with dry weights of 7.44 g and 6.50 g, respectively.

In terms of variety, Phule Viraj achieved the highest pod dry weight per plant at 8.39 g, significantly surpassing Phule Rajma, which recorded (7.55 g), and Varun, which had a dry weight of (7.44 g). These findings highlight the importance of both sowing date and variety in maximizing pod dry weight in French beans.

**Wt. of seeds/pod (g)**

The weight of seeds per pod in French beans was significantly influenced by the different sowing dates. The highest weight was observed in treatment $D_3$, sown on November 9th, with an average of 0.75 g, which was comparable to treatment $D_2$. In contrast, treatment $D_1$, sown on October 12th, recorded the lowest seed weight per pod at 0.40 g.

Varietal differences also had a significant impact on seed weight per pod. The variety Phule Viraj exhibited the highest seed weight (0.75 g), significantly outperforming Phule Rajma (0.54 g) and Varun (0.47 g). These results underscore the importance of both sowing date and variety in enhancing seed weight in French beans.

**Seed weight/plant (g)**

The seed weight per plant of French beans was significantly influenced by different sowing dates. Treatment $D_3$, sown on November 9th, recorded the highest seed yield per plant (7.64 g), which was notably higher than the other treatments. In contrast, treatment $D_1$, sown on October 12th, yielded the lowest seed weight per plant (3.56 g). These findings align with the results reported by Reddy *et al*. (2010) [2].

Varietal differences also had a significant impact on seed yield per plant. Among the varieties studied, Phule Viraj produced the highest yield (6.77 g), significantly surpassing both Phule Rajma and Varun. The variations in seed yield per plant among the different varieties can be attributed to their unique genetic compositions.

**Straw yield/plant (g)**

The straw yield per plant of French beans was significantly influenced by different sowing dates. Treatment $D_3$, sown on November 9th, achieved the highest straw yield per plant at (11.66 g), outperforming all other treatments. Conversely, treatment $D_4$, sown on November 23rd, recorded the lowest straw yield (8.21 g).

Varietal differences also significantly impacted straw yield. The variety Phule Viraj produced a straw yield of (11.66 g) per plant, which was significantly higher than that of Phule Rajma (9.15 g). Varun recorded the lowest straw yield (8.21 g). These results highlight the importance of both sowing date and variety in optimizing straw yield in French beans.

**Seed index (g)**

The seed index of French beans was significantly influenced by different sowing dates. Treatment $D_3$, sown on November 9th, achieved the highest seed index at (22.29 g), which was statistically comparable to treatment $D_2$ at (20.13 g). In contrast, treatment $D_1$, sown on October 12th, recorded the lowest seed index at 18.46 g.

Varietal differences also had a significant impact on the seed index. Among the varieties studied, Phule Viraj exhibited a significantly higher seed index of (21.8 g) compared to the other varieties. These findings emphasize the critical role of both sowing date and genetic variety in determining seed index in French beans.

**Table 1:** Yield contributing character 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 date** | | | | | | | |
| $D_1$: 12 Oct | 7.55 | 2.17 | 6.50 | 0.40 | 3.56 | 8.71 | 18.46 |
| $D_2$: 26 Oct | 9.03 | 3.21 | 8.42 | 0.67 | 6.21 | 10.14 | 20.73 |
| $D_3$: 09 Nov | 9.84 | 3.49 | 8.81 | 0.75 | 7.64 | 11.63 | 22.29 |
| $D_4$: 23 Nov | 8.47 | 2.62 | 7.44 | 0.54 | 3.96 | 8.21 | 18.92 |
| S.E m± | 0.22 | 0.09 | 0.32 | 0.02 | 0.2 | 0.30 | 0.62 |
| C.D @5% | 0.78 | 0.31 | 1.12 | 0.08 | 0.80 | 1.05 | 2.15 |
| **Variety** | | | | | | | |
| V1: Varun | 8.25 | 2.39 | 7.44 | 0.47 | 3.92 | 8.21 | 20.27 |
| V2: Phule Viraj | 9.33 | 3.47 | 8.39 | 0.75 | 6.77 | 11.66 | 21.8 |
| V3: Phule Rajma | 8.58 | 2.75 | 7.55 | 0.54 | 5.12 | 9.15 | 20.96 |
| S.E m± | 0.20 | 0.12 | 0.18 | 0.02 | 0.18 | 0.30 | 0.38 |
| C.D @5% | 0.60 | 0.37 | 0.53 | 0.07 | 0.53 | 0.91 | 1.14 |
| **Interaction (D × V)** | | | | | | | |
| S.E m± | 0.40 | 0.25 | 0.36 | 0.05 | 0.35 | 0.60 | 0.84 |
| C.D @5% | NS | NS | NS | NS | NS | NS | NS |
| G.M. | 8.72 | 2.87 | 7.79 | 0.59 | 5.28 | 9.67 | 21.17 |

**Table 2:** Economics of French bean as influenced by different treatments

| Treatment | Gross Monetary Return (₹ $ha^{-1}$) | Net Monetary Return (₹ $ha^{-1}$) | B:C Ratio |
|---|---|---|---|
| **Sowing date** | | | |
| $D_1$: 12 Oct | 40963 | 6397 | 1.18 |
| $D_2$: 26 Oct | 85271 | 40198 | 2.45 |
| $D_3$: 09 Nov | 108021 | 62893 | 3.11 |
| $D_4$: 23 Nov | 65812 | 29212 | 1.89 |
| S.E. m± | 2917.19 | 2653.16 | -- |
| C.D.@ 5% | 10095.17 | 9181.48 | -- |
| **Variety** | | | |
| V1: Varun | 55370 | 14117 | 1.78 |
| V2: Phule Viraj | 101920 | 59101 | 2.77 |
| V3: Phule Rajma | 67760 | 21211 | 1.91 |
| S.E. m± | 2829.39 | 2711.77 | -- |
| C.D.@ 5% | 8482.90 | 8130.27 | -- |
| **Interaction (D×V)** | | | |
| S.E. m± | 5658.7 | 5423.5 | -- |
| C.D.@ 5% | NS | NS | -- |
| G.M. | 75017 | 31476 | 2.15 |

## Conclusion

In the study of yield attributes for French beans, treatment D3, sown on November 9th, exhibited significantly higher values for several key parameters: number of pods per plant (9.84), number of seeds per pod (3.49), pod dry weight per plant (8.81 g), weight of seeds per pod (0.75 g), seed yield per plant (7.64 g), and seed index (22.29 g). For the number of seeds per pod, pod dry weight per plant, weight of seeds per pod, and seed index, treatment $D_3$ was statistically comparable to treatment $D_2$, which was sown on October 26$^{th}$. Significantly highest seed yield (1543 kg ha$^{-1}$), straw yield (2790 kg ha$^{-1}$), biological yield (4333 kg ha$^{-1}$) were recorded in treatment $D_3$ sown on November 9$^{th}$ than rest of sowing dates.

The maximum Gross Monetary Returns (₹101920 ha$^{-1}$), Net Monetary Returns (₹ 59101 ha$^{-1}$) and Benefit cost ratio the rest of the varieties.

For the weight of seeds per pod, significantly higher values were observed in treatment $D_3$ with variety $V_2$, which was on par with $D_2$ $V_2$ and $D_4$ $V_2$. In terms of seed weight per plant, treatment $D_3$ $V_2$ also recorded the highest values, comparable to $D_2$ $V_3$. These results underline the importance of both sowing date and variety in optimizing yield attributes and economic returns in French beans.

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