Effect of Sowing Date and Phosphorus on Growth, Seed Yield and Quality of Fenugreek

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2022/v14i1030539

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/90919

Received 15 June 2022
Accepted 21 August 2022
Published 05 September 2022

ABSTRACT

The effect of sowing date (three sowing dates viz., S1 = 01 November, S2 = 15 November and S3 = 30 November) and phosphorus levels (four phosphorus fertilizer levels viz., P0 = Control, P1 = 35 kg P ha⁻¹, P2 = 45 kg P ha⁻¹ and P3 = 55 kg P ha⁻¹) on growth, seed yield and quality of fenugreek was investigated at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during 10 October 2020 to April 2021. Growth-related data was maximum on S1 (01 November) treatment but S2 (15 November) treatment showed the best result in case of seed yield. In case of growth characters, P3 (55 kg ha⁻¹) revealed the best result but in case of seed yield, P2 (45 kg ha⁻¹) treatment showed the best effect. Under this investigation, it was revealed that the maximum growth was obtained by S3P3 (01 November with 55 kg P ha⁻¹) and the minimum growth was obtained by S1P0 (30 November with control) treatment combination. The maximum pods per plant (52.61), seeds per pod (12.87), weight of individual pod (147.11 mg), the weight of seeds per plant (7.67 g) and weight of 1000-seed (13.86 g), seed yield per plot (306.72 g), seed yield per hectare (2.13 t) and vigor index (570.27) was observed from the treatment combination S2P2 (15 November with 45 kg P ha⁻¹).
with 45 kg P ha\(^{-1}\)). It was concluded that the combination of sowing date \(S_2\) (15 November) along with phosphorus application \(P_2\) (45 kg P ha\(^{-1}\)) were given the better performance of all the yield contributing parameters and seed yield of fenugreek. So, \(S_2P_2\) (15 November with 45 kg P ha\(^{-1}\)) treatment combination can be repeated in different agro-ecological zones of Bangladesh.

**Keywords:** Phosphorus; growth; seed yield.

1. **INTRODUCTION**

Fenugreek (*Trigonella foenum-graecum* L.) is an herbaceous annual legume seed spice crop commonly known as methi and belongs to the family Fabaceae. Fenugreek is one of the major and important seed spice crop occupies a prime position throughout the globe to add taste and flavor to various food items. The leaves and fruits have a pleasant aromatic odor. Its seeds also contain different amounts of nutrients, most important like Fe, Ca, P, K and other mineral elements. Fenugreek seeds contain carbohydrates (48%), proteins (25.5%), mucilaginous matter (20%), fats (7.9%), saponin (4.8%) [1]. Fenugreek is a tropical crop generally sown in the winter season for seed production. Dry and cold weather during the early stage favors better vegetative growth whereas dry and relatively high temperature promotes seed production [2]. The sowing time is crucial for vegetative growth and ultimate expressions of yield. Any early or late sowing may hamper the growth, yield as well as quality of the crop. In case of fenugreek, early sowing leads to early flowering but may be vulnerable to damage in case of extreme cold and frost [3]. The crop generally requires cool climate during vegetative growth and warm dry climate during maturity. During rabi season, sowing in October is recommended both for seed and leaf production. On the other hand, late sowing affected the growth, yield and quality in an adverse way [4]. Phosphorus (P) is critical in plant metabolism it plays an important role in cellular energy transfer, respiration, photosynthesis and it is a key structural component of nucleic acids coenzymes, phosphoproteins and phospholipids. Phosphorus fertilization is a major input in crop production [5]. Phosphorus is essential for plant health, root development and stem strength. It improves flower formation and makes seed production more uniform. It also improves seed quality and is resistant to plant disease. Plant growth and seed yield was increased in fenugreek when phosphorus was applied [6]. But only a little information on fenugreek research regarding sowing date and phosphorous fertilization is available in Bangladesh. The study aimed to investigate the effect of sowing date, the influence of phosphorous fertilizer and a suitable combination of sowing date and phosphorous fertilizer for better growth, seed yield and quality of fenugreek.

2. **MATERIALS AND METHODS**

2.1 **Experimental Site and Experimental Framework**

The experiment was conducted from 10 October 2020 to March 2021 at the “Horticulture Farm” of Sher-e-Bangla Agricultural University, Dhaka-1207. The experimental site was located at 23°74′ N latitude and 90°35′ E longitudes at an altitude of 8.2 m. The experiment consisted of two factors: **Factor A:** Sowing date (3) \(S_1 = 01\) November, \(S_2 = 15\) November, \(S_3 = 30\) November. **Factor B:** Phosphorus level (4) \(P_0\) Control (no phosphorus), \(P_1 = 35\) kg P ha\(^{-1}\), \(P_2 = 45\) kg P ha\(^{-1}\), \(P_3 = 55\) kg P ha\(^{-1}\). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of unit plot was 1.2 m \(\times\) 1.2 m. The total number of treatments was 12 and the number of plots was 36.

2.2 **Crop/Planting Material**

A high yielding variety of fenugreek (cv. BARI Methi-2) developed by the Bangladesh Agricultural Research Institute (BARI), Joydebpur and Gazipur was used as experimental material.

2.3 **Manures and Fertilizers Application**

The entire amount of cowdung, phosphorus from TSP, potassium from MoP, sulphur from gypsum and one-half of nitrogen from urea were applied during final land preparation. The rest of the nitrogen was top dressed in two equal splits at 30 and 60 days after sowing (Table 1).

2.4 **Sowing of Seed**

Fenugreek seeds were soaked in water for 6 hours to enhance germination. Seeds were also treated with Bavistin at 2 g per kg of seeds before sowing. The seeds were sown in rows
Table 1. Manures and fertilizers were applied at the following doses

| Nutrient/Fertilizer | Rate (Doses) | Fertilizer applied |
|---------------------|--------------|--------------------|
| Cowdung            | 5 t ha⁻¹     | Well rotten cowdung |
| Nitrogen           | 80 kg ha⁻¹   | Urea               |
| Phosphorus         | P₁ = 35 kg ha⁻¹ | TSP               |
|                    | P₂ = 45 kg ha⁻¹ |                   |
|                    | P₃ = 55 kg ha⁻¹ |                   |
| Potassium          | 67 kg ha⁻¹   | MoP                |
| Sulphur            | 20 kg ha⁻¹   | Gypsum             |

30 cm apart continuously by hand @ 15 kg/ha. To allow uniform sowing in rows seeds were mixed with some loose soil (about four to ten times of the weight of seeds). The seeds were covered with good pulverized soil just after sowing and gently pressed by hands. The sowing was done from 1 November, 2020 to 30 November 2020 with slight watering just to supply sufficient moisture needed for quick germination. Seedlings of the plots were thinned later to maintain 10 cm intra spacing (plant to plant distance) 25 days after sowing (DAS).

2.5 Statistical Analysis

The collected data were compiled and tabulated. Statistical analysis was done on various plant characters to determine the significance of variance resulting from the experimental treatments. Data were analyzed using analysis of variance (ANOVA) technique with the help of the computer package program Statistics 10 (software) and the mean differences were adjudged by the least significant difference test (LSD) as laid out by [7].

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Statistically significant variation was observed in plant height due to different sowing dates at 35, 50, 65 and 80 DAS under the present experiment (Fig. 1). At 80 DAS, the highest plant height (58.05 cm) was observed from S₁ (01 November) treatment where the lowest plant height (49.88 cm) was revealed from S₃ (30 November) treatment. [8] reported that the vegetative growth in terms of plant height, number of branches and number of leaves, were increased due to early sowing (1 November).

Different levels of phosphorus showed significant influence on plant height of fenugreek at 35, 50, 65 and 80 DAS under the present study (Fig. 2). It was revealed that at 80 DAS, the highest plant height (58.83 cm) was observed from P₃ (55 kg ha⁻¹) treatment. On the other hand the lowest plant height (48.77 cm) was observed from P₀ (control) treatment. Similar trends of the result were observed by [9] who reported that growth...
parameters such as plant height, the number of leaves and the yield of dried leaves of the crop increased almost linearly with increasing levels of phosphorus.

Significant influence was observed on plant height of fenugreek due to the combined effect of different sowing dates at 35, 50, 65 and 80 DAS and phosphorus (Table 2). The experiment result showed that the highest plant height at 80 DAS (63.71 cm) was observed from S1P3 (1 November with 55 kg P ha\(^{-1}\)) treatment combination. On the other hand, the lowest plant height at 80 DAS (45.15 cm) was revealed from S3P0 (30 November with control) treatment combination.

**3.2 Number of Compound Leaves per Plant**

Significant variation was noticed in the number of compound leaves per plant of fenugreek due to different sowing dates at 35, 50, 65 and 80 DAS under the experiment (Table 2). The results of the experiment showed that at 80 DAS, the maximum number of compound leaves per plant (103.81) from the S1 (01 November) treatment where the minimum number of compound leaves per plant (90.26) was revealed from S2P0 (30 November) treatment. The results of the experiment were coincided with the findings of [8] reported that the vegetative growth in terms of plant height, number of branches and number of leaves, were increased due to an early sowing (1 November) [9].

Statistically different phosphorus levels significantly influenced the number of compound leaves per plant of fenugreek at 35, 50, 65 and 80 DAS under the experiment (Table 2). It was revealed that at 80 DAS, the maximum number of compound leaves per plant (115.53, respectively) was noted from P3 (55 kg ha\(^{-1}\)) treatment. On the other hand, the minimum number of compound leaves per plant (78.12) was observed from P0 (control) treatment. Similar findings were also found by [10] who stated that the vegetative growth in plant height, number of leaves and number of branches was increased due to an application of nitrogen and phosphorus.

There was marked influence observed on the number of compound leaves per plant at 35, 50, 65 and 80 DAS of fenugreek due to the combined effect of different sowing dates and phosphorus fertilizer (Table 3). The experiment results showed that the maximum number of compound leaves per plant of fenugreek at 80 DAS (121.63) was observed from S1P3 (01 November with 55 kg P ha\(^{-1}\)) treatment combination. On the other hand, the minimum number of compound leaves per plant of fenugreek at 80 DAS (73.56) was observed from S3P0 (30 November with control) treatment combination.

**3.3 Spreading of the Plant (cm)**

Statistically significant variation was observed in the spreading of the plant at 35, 50, 65 and 80 DAS.
DAS due to different sowing dates under the present experiment (Table 4). Results from the experiment showed that at 80 DAS, the highest plant spreading (24.62 cm) was observed from the $S_1$ (01 November) treatment where the lowest plant spreading (20.77 cm) was revealed from $S_3$ (30 November) treatment. Similar results were also observed by [11] who reported that sowing dates significantly affected on maximum plant spreading.

Different phosphorus levels significantly influenced on plant spreading of fenugreek at 35, 50, 65 and 80 DAS under the present study (Table 4). It was revealed that at 80 DAS, the highest plant spreading (25.69 cm) was observed from the $P_3$ (55 kg ha$^{-1}$) treatment. On the other hand the lowest plant spreading (19.39 cm) was observed from the $P_0$ (control) treatment.

There was marked influence observed on plant spreading of fenugreek at 35, 50, 65 and 80 DAS due to the combined effect of different sowing dates and phosphorus (Table 5). The results of the experiment showed that the highest plant spreading at 80 DAS (28.95 cm) was observed from $S_1P_3$ (1 November with 55 kg P ha$^{-1}$) treatment combination. On the other hand the lowest plant spreading at 80 DAS (18.48 cm) was revealed from $S_3P_0$ (30 November with control) treatment combination.

### 3.4 Branches per Plant

Branches per plant showed significant differences due to different sowing dates under the present experiment (Table 4). Results from the experiment showed that the maximum number of branches per plant (6.74) was recorded from the $S_1$ (1 November) treatment where the minimum number of branches per plant (5.55) was revealed from the $S_3$ (30 November) treatment. [8] found a similar result. They revealed that the number of branches and leaves, were increased due to an early sowing (1 November).

Significant influence was noticed on the number of fenugreek branches per plant due to different levels of phosphorus under the present study (Table 4). It was revealed that the maximum number of branches per plant (7.02) was observed from $P_3$ (55 kg ha$^{-1}$) treatment which was statistically identical to the $P_2$ (45 kg ha$^{-1}$) treatment. On the other hand the minimum number of branches per plant (5.20) was observed from $P_0$ (control) treatment. Similar trends were also found by [12] who reported that branches per plant increases with the application of phosphorus.

### Table 2. Effect of different sowing dates and phosphorus on number of compound leaves per plant on different days after sowing (DAS) of fenugreek

| Treatment          | Number of compound leaves per plant on different days after sowing (DAS) |
|--------------------|--------------------------------------------------------------------------|
|                    | 35 DAS | 50 DAS | 65 DAS | 80 DAS |
| Different sowing date |
| $S_1$              | 16.60 a | 44.39 a | 84.36 a | 103.81 a |
| $S_2$              | 15.48 b | 41.52 b | 79.02 b | 96.30 b  |
| $S_3$              | 14.39 c | 38.08 c | 73.25 c | 90.26 c  |
| LSD(0.05)          | 0.7962 | 1.4992 | 1.6750 | 1.7201   |
| CV%                | 6.19   | 4.20   | 2.58   | 2.08     |
| Different level of phosphorus |
| $P_0$              | 12.54 d | 31.08 d | 63.45 d | 78.12 d  |
| $P_1$              | 15.03 c | 41.05 c | 79.13 c | 94.90 c  |
| $P_2$              | 16.44 b | 43.35 b | 81.36 b | 98.61 b  |
| $P_3$              | 17.96 a | 49.84 a | 91.56 a | 115.53 a |
| LSD(0.05)          | 0.9194 | 1.7196 | 1.9342 | 1.9862   |
| CV%                | 6.19   | 4.20   | 2.58   | 2.08     |

In a column means having a similar letter(s) are statistically similar and those having a dissimilar letter(s) differ significantly at a 0.05 level of probability.

Here, $S_1$: 01 November, $S_2$: 15 November and $S_3$: 30 November.

$P_0$: Control, $P_1$: 35 kg P ha$^{-1}$, $P_2$: 45 kg P ha$^{-1}$ and $P_3$: 55 kg P ha$^{-1}$.
Table 3. The combined effect of different sowing dates and phosphorus level on plant height (cm), number of the compound leaf on different days after sowing (DAS) of fenugreek

| Treatment Combinations | Plant height (cm) on different days after sowing (DAS) | Number of compound leaves per plant at 35 DAS |
|------------------------|------------------------------------------------------|---------------------------------------------|
|                        | 35 DAS | 50 DAS | 65 DAS | 80 DAS | 35 DAS | 50 DAS | 65 DAS | 80 DAS |
| S₁P₀                   | 12.71 de | 18.31 de | 30.76 def | 52.33 ef | 13.32 f | 33.52 h | 69.30 f | 85.90 g |
| S₁P₁                   | 13.45 cd | 23.24 b | 36.41 c | 56.12 cd | 15.80 d | 42.21 f | 81.29 d | 97.21 e |
| S₁P₂                   | 14.94 ab | 25.63 a | 40.56 b | 60.04 b | 17.54 bc | 48.30 bc | 88.50 bc | 110.50 c |
| S₁P₃                   | 15.95 a | 26.81 a | 43.57 a | 63.71 a | 19.75 a | 53.51 a | 98.34 a | 121.63 a |
| S₂P₀                   | 11.44 ef | 17.83 e | 28.18 fg | 48.82 g | 12.76 fg | 30.51 i | 63.72 g | 74.91 h |
| S₂P₁                   | 13.21 d | 20.11 c | 31.81 de | 51.15 fg | 15.19 de | 46.72 cd | 85.54 c | 104.43 d |
| S₂P₂                   | 13.10 d | 19.42 cd | 33.11 d | 53.20 ef | 16.07 cd | 38.14 g | 76.25 e | 90.22 f |
| S₂P₃                   | 14.62 bc | 22.71 b | 37.92 bc | 57.96 bc | 17.91 b | 50.71 ab | 90.56 b | 115.63 b |
| S₃P₀                   | 10.24 f | 15.38 f | 24.46 h | 45.15 h | 11.53 g | 29.21 i | 57.34 h | 73.56 h |
| S₃P₁                   | 11.23 f | 19.00 cde | 26.21 gh | 48.42 g | 14.09 ef | 34.21 h | 70.56 f | 83.07 g |
| S₃P₂                   | 12.67 de | 19.28 cd | 29.32 ef | 51.12 fg | 15.70 d | 43.61 ef | 79.32 de | 95.10 e |
| S₃P₃                   | 13.58 cd | 22.74 b | 31.95 de | 54.81 de | 16.23 cd | 45.29 de | 85.78 c | 109.32 c |
| LSD(0.05)              | 1.3287 | 1.3141 | 2.9915 | 2.9059 | 1.5924 | 2.9784 | 3.3501 | 3.4402 |
| CV%                    | 5.71 | 3.79 | 4.94 | 3.23 | 6.19 | 4.20 | 2.58 | 2.08 |

In a column means having a similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at a 0.05 level of probability.

Here, S₁: 01 November, S₂: 15 November and S₃: 30 November; P₀: Control, P₁: 35 kg P ha⁻¹, P₂: 45 kg P ha⁻¹ and P₃: 55 kg P ha⁻¹.
Statistically significant influence was observed on number of branches per plant of fenugreek due to the combined effect of different sowing dates and phosphorus (Table 5). From the results of the experiment showed that the maximum number of branches per plant (7.57) was observed from S1P3 (1 November with 55 kg P ha⁻¹) treatment combination which was statistically similar to S1P2 (1 November with 45 kg P ha⁻¹) and S2P3 (15 November with 55 kg P ha⁻¹) treatment combination. On the other hand the minimum number of branches per plant (4.55) was revealed from S2P0 (30 November with control) treatment combination which was statistically similar to S1P1 (30 November with 35 kg P ha⁻¹) and S2P0 (15 November with control) treatment combination.

### 3.5 Days to 50% Flowerings

Days to 50% flowerings showed significant variation due to different sowing dates (Table 4). Results from the experiment showed that the maximum days to 50% flowerings (50.01) was recorded from S2 (15 November) treatment where the minimum days to 50% flowerings (46.60) was revealed from S3 (30 November) treatment. The of the experiment findings coincided with the findings of [13] who reported that to obtain higher seed yield, fenugreek should be sown earlier November and irrigation should be given in all the major growth phases at seedling, branching, flowering, pod formation and pod development stages.

There was marked variation were noticed on days to 50% flowerings of fenugreek due to different phosphorus levels (Table 4). It was revealed that the maximum days to 50% flowerings (50.28) were observed from P2 (45 kg P ha⁻¹) treatment. On the other hand the minimum days to 50%flowerings (46.31) were observed from P0 (control) treatment. Result from the experiment was in coincided with the findings of [12]. Days to 50% flowerings were observed significant influence due to combined effect of different sowing dates and phosphorus (Table 5). From the results of the experiment showed that the maximum days to 50% flowerings (51.91) were observed from S2P2 (15 November with 45 kg P ha⁻¹) treatment combination which was statistically similar to S2P3 (15 November with 55 kg P ha⁻¹) treatment combination. On the other hand the minimum days to 50% flowerings (45.11) was revealed from S2P0 (30 November with control) treatment combination which was statistically similar to the S1P1 (30 November with 35 kg P ha⁻¹) treatment combination.

### 3.6 Pods per Plant

A significant difference in the number of pods per plant was noticed due to different sowing dates (Table 6). Results from the experiment showed

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**Table 4. Combined effect of sowing date and phosphorus on plant spread on different days after sowing (DAS), number of branches and days to 50% flowerings of fenugreek**

| Treatment                | Plant Spread | Number of Flowerings | Days to 50% Flowerings |
|--------------------------|--------------|----------------------|------------------------|
|                          | 35 DAS       | 50 DAS               | 65 DAS                 | 80 DAS                  |                                        |
| Different sowing date    |              |                      |                        |                        |                                        |
| S1                       | 6.78 a       | 9.57 a               | 16.09 a                | 24.62 a                | 6.74 a                                | 48.50 b                               |
| S2                       | 6.20 b       | 8.11 b               | 14.54 b                | 21.55 b                | 6.17 b                                | 50.01 a                               |
| S3                       | 5.52 c       | 7.25 c               | 13.95 c                | 20.77 c                | 5.55 c                                | 46.60 c                               |
| LSD(0.05)                | 0.5045       | 0.5078               | 0.5072                 | 0.4986                 | 0.4723                                | 0.4750                                |
| CV%                      | 6.26         | 4.97                 | 3.57                   | 4.16                   | 7.96                                  | 3.06                                  |
| Different level of phosphorus |          |                      |                        |                        |                                        |
| P0                       | 4.98 c       | 6.38 d               | 10.49 d                | 19.39 d                | 5.20 c                                | 46.31 d                               |
| P1                       | 6.20 b       | 8.12 c               | 12.74 c                | 21.64 c                | 5.87 b                                | 47.85 c                               |
| P2                       | 6.33 b       | 8.89 b               | 17.66 b                | 22.53 b                | 6.51 b                                | 50.28 a                               |
| P3                       | 7.15 a       | 9.86 a               | 18.54 a                | 25.69 a                | 7.017 a                               | 49.04 b                               |
| LSD(0.05)                | 0.5825       | 0.5864               | 0.5886                 | 0.5757                 | 0.5453                                | 0.5485                                |
| CV%                      | 6.26         | 4.97                 | 3.57                   | 4.16                   | 7.96                                  | 3.06                                  |

*In a column means having a similar letter(s) are statistically similar and those having a dissimilar letter(s) differ significantly at 0.05 level of probability*

Here, S1: 01 November, S2: 15 November and S3: 30 November
P0: Control, P1: 35 kg P ha⁻¹, P2: 45 kg P ha⁻¹ and P3: 55 kg P ha⁻¹

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36
that the maximum number of pods per plant (43.15) was recorded from the S2 (15 November) treatment whereas the minimum number of pods per plant (36.55) was revealed from S3 (30 November) treatment. [11] observed similar results.

The number of pods per plant showed significant difference due to different levels of phosphorus (Table 6). It was revealed that the maximum number of pods per plant (46.66) was observed from the P2 (45 kg ha\(^{-1}\)) treatment while the minimum number of pods per plant (33.13) was observed from the P0 (control) treatment. The finding of the present study was in coincided with the result of [14].

The marked influence was exerted on the number of pods per plant of fenugreek due to the combined effect of different sowing dates and phosphorus (Table 7). The experimental result showed that the maximum number of pods per plant (52.61) was observed from S1P2 (15 November with 45 kg P ha\(^{-1}\)) treatment combination. On the other hand the minimum number of pods per plant (30.25) was revealed from S3P0 (30 November with control) treatment combination.

### 3.7 Seeds per Pod

Significant influence on the number of seeds per pod was noticed due to different sowing dates during the present study (Table 6). Results from the experiment showed that the maximum number of seeds per pod (11.81) was recorded from the S2 (15 November) treatment. In contrast, the minimum number of seeds per pod (9.92) was revealed from the S3 (30 November) treatment. A similar result was found by [11]. [8] revealed similar trends stating that the number of pods, number of seeds per pod, weight of seeds per pod, seed yield per plot and seed yield per hectare were found to be the maximum with early sowing (1 November).

Seeds per pod significantly varied due to different phosphorus levels during the experimentation (Table 6). It was revealed that the maximum number of seeds per pod (11.94) was observed from the P2 (45 kg ha\(^{-1}\)) treatment while the minimum number of seeds per pod (9.77) was noted from the P0 (control) treatment.

The number of seeds per pod of fenugreek showed significant influence due to the combined effect of different sowing dates and phosphorus (Table 7). The maximum number of seeds per pod (12.87) was observed from S2P2 (15 November with 45 kg P ha\(^{-1}\)) treatment combination which was statistically similar to S2P3 (15 November with 55 kg P ha\(^{-1}\)) and S1P2 (1 November with 45 kg P ha\(^{-1}\)) treatment combination. On the other hand the minimum number of seeds per pod (9.11) was observed from S3P0 (30 November with control) treatment.

### Table 5. The combined effect of different sowing date and phosphorus level on plant spread, branches per plant, days to 50\% flowerings of fenugreek

| Treatment Combinations | 35 DAS | 50 DAS | 65 DAS | 80 DAS | Number of Branches | Days to 50\% Flowerings |
|------------------------|--------|--------|--------|--------|-------------------|------------------------|
| S1P0                   | 5.61 cde | 7.32 fg | 11.81 f | 20.20 fg | 5.80 de | 46.35 ij |
| S1P1                   | 7.15 ab | 8.91 cd | 13.92 e | 23.41 d | 6.42 bcd | 48.11 fg |
| S1P2                   | 6.51 bc | 11.44 a | 18.80 b | 25.93 b | 7.15 ab | 50.32 bc |
| S1P3                   | 7.85 a  | 10.62 ab | 19.83 a | 28.95 a | 7.57 a  | 49.23 de |
| S2P0                   | 5.02 ef | 6.56 g  | 10.72 g  | 19.50 g  | 5.26 ef | 47.46 gh |
| S2P1                   | 6.19 bcd | 8.34 de | 12.41 f  | 21.10 f  | 5.97 cde | 47.91 cd |
| S2P2                   | 6.59 bc | 7.70 ef | 16.99 d  | 22.20 e  | 6.53 bcd | 51.91 a  |
| S2P3                   | 7.00 ab | 9.85 bc | 18.02 bc | 23.40 d  | 6.90 abc | 50.96 ab |
| S3P0                   | 4.31 f  | 5.26 h  | 8.95 h  | 18.48 h  | 4.55 f  | 45.11 k  |
| S3P1                   | 5.26 def | 7.12 fg | 11.88 f  | 20.42 fg | 5.22 ef | 45.72 jk |
| S3P2                   | 5.90 cde | 7.52 efg | 17.20 cd | 19.46 gh | 5.86 de | 48.62 ef |
| S3P3                   | 6.61 bc | 9.10 cd | 17.76 cd | 24.72 c  | 6.58 bcd | 46.93 hi |
| LSD(0.05)              | 1.0089 | 1.0156 | 1.0144 | 0.9972 | 0.9445 | 0.9500 |
| CV\%                   | 6.26   | 4.97   | 3.57   | 4.16   | 7.96   | 3.06   |

In a column means having a similar letter(s) are statistically similar and those having a dissimilar letter(s) differ significantly at a 0.05 level of probability

Here, S1: 01 November, S2: 15 November and S3: 30 November;
P0: Control, P1: 35 kg P ha\(^{-1}\), P2: 45 kg P ha\(^{-1}\) and P3: 55 kg P ha\(^{-1}\)
combination which was statistically similar to the S<sub>2</sub>P<sub>0</sub> (30 November with 35 kg P ha<sup>-1</sup>) treatment combination.

### 3.8 Weight of Individual Pod (mg)

A marked variation in the weight of individual pod was observed due to different sowing dates during the present study (Table 6). Results from the experiment showed that the maximum weight of individual pod (119.99 mg) was recorded from the S<sub>2</sub> (15 November) treatment where the minimum weight of individual pod (106.42 mg) was revealed from the S<sub>3</sub> (30 November) treatment. A similar result was observed by [15].

Different phosphorus levels significantly influence the weight of individual pods during the experimentation (Table 6). It was revealed that the maximum weight of individual pod (133.43 mg) was observed from P<sub>2</sub> (45 kg P ha<sup>-1</sup>) treatment while the minimum weight of individual pod (98.53 mg) was recorded from P<sub>0</sub> (control) treatment.

Statistically significant variation was noticed in the weight of individual pods of fenugreek due to the combined effect of different sowing dates and phosphorus during the experimentation (Table 7). The results of the experiment showed that the maximum weight of individual pod (147.11 mg) was observed from S<sub>2</sub>P<sub>2</sub> (15 November with 45 kg P ha<sup>-1</sup>) treatment combination while the minimum weight of the individual pod (92.63 mg) was revealed from S<sub>3</sub>P<sub>0</sub> (30 November with control) treatment combination.

### 3.9 Weight of Seeds per Plant (g)

The weight of seeds per plant revealed marked variation due to different sowing dates during the experiment (Table 6). Results from the experiment showed that the maximum weight of seeds per plant (5.40 g) was obtained from the S<sub>2</sub> (15 November) treatment which was statistically similar to the S<sub>1</sub> (1 November) treatment where the minimum weight of seeds per plant (4.89 g) was noted from S<sub>3</sub> (30 November) treatment. [16] found similar trends and stated that weight of pod, number of seeds pod<sup>-1</sup>, the weight of seeds pod<sup>-1</sup> and thousand seed weight was higher when early sowing.

Significant influence was observed on weight of seeds per plant due to different phosphorus levels during the experimentation (Table 6). It was revealed that the maximum weight of seeds per plant (6.91 g) was observed from the P<sub>2</sub> (45 kg P ha<sup>-1</sup>) treatment while the minimum weight of seeds per plant (3.05 g) was recorded from the P<sub>0</sub> (control) treatment.

The weight of seeds per plant of fenugreek revealed statistically significant variation due to the combined effect of different sowing dates and phosphorus during the experimentation (Table 7). From the results of the experiment showed that the maximum weight of seeds per plant (7.67 g) was observed from S<sub>2</sub>P<sub>2</sub> (15 November with 45 kg P ha<sup>-1</sup>) treatment combination while the minimum weight of seeds per plant (2.70 g) was obtained from S<sub>3</sub>P<sub>0</sub> (30 November with control) treatment combination.

### 3.10 Weight of 1000-Seed (g)

The weight of 1000-seed revealed marked variation due to different sowing dates during the present experiment (Table 6). Results from the experiment showed that the maximum weight of 1000-seed (12.58 g) was revealed from S<sub>2</sub> (15 November) treatment where the minimum weight of 1000-seed (10.22 g) was noted from the S<sub>3</sub> (30 November) treatment. The experiment’s result coincided with the findings of [16] who reported that thousand seed weight, seed yield, straw yield, biological yield and harvest index were statistically influenced due to different sowing dates.

Significant influence was observed on the weight of 1000-seed due to different levels of phosphorus during the experimentation (Table 6). It was revealed that the maximum weight of 1000-seed (12.75 g) was observed from P<sub>2</sub> (45 kg P ha<sup>-1</sup>) treatment while the minimum weight of 1000-seed (10.03 g) was recorded from P<sub>0</sub> (control) treatment. A similar result was observed by [17].

The weight of 1000-seed of fenugreek revealed statistically significant variation due to the combined effect of different sowing dates and phosphorus during the experimentation (Table 7). The results of the experiment showed that the maximum weight of 1000-seed (13.86 g) was observed from the S<sub>2</sub>P<sub>2</sub> (15 November with 45 kg P ha<sup>-1</sup>) treatment combination which was statistically similar to the S<sub>2</sub>P<sub>0</sub> (15 November with 55 kg P ha<sup>-1</sup>) treatment combination while the minimum weight of 1000-seed (9.17 g) was revealed from the S<sub>3</sub>P<sub>0</sub> (30 November with control) treatment combination which was statistically similar to the S<sub>3</sub>P<sub>1</sub> (30 November with 35 kg P ha<sup>-1</sup>) treatment combination.
Table 6. Effect of different sowing date and phosphorus level number of pod/plant, number of seed/pod, the weight of single pod (mg), the weight of seed/plant (gm) and 1000-seed weight (g) of fenugreek

| Treatment                  | Number of Pod/Plant | Number of Seed/Pod | Weight of Single Pod (mg) | Weight of Seed/Plant (g) | 1000 Seed Weight (g) |
|----------------------------|---------------------|--------------------|--------------------------|--------------------------|----------------------|
| S1                         | 41.31 b             | 10.97 b            | 115.88 b                 | 5.17 ab                  | 11.56 b              |
| S2                         | 43.15 a             | 11.81 a            | 119.99 a                 | 5.40 a                   | 12.58 a              |
| S3                         | 36.55 c             | 9.92 c             | 106.42 c                 | 4.89 b                   | 10.22 c              |
| LSD(0.05)                  | 1.2885              | 0.4884             | 3.1093                   | 0.4250                   | 0.4859               |
| CV%                        | 3.30                | 3.64               | 3.12                     | 9.74                     | 3.53                 |

Different level of phosphorus

| P0                         | 33.13 d             | 9.77 d             | 98.53 d                  | 3.05 d                   | 10.03 d              |
| P1                         | 38.40 c             | 10.61 c            | 106.87 c                 | 4.72 c                   | 11.09 c              |
| P2                         | 46.66 a             | 11.94 a            | 133.43 a                 | 6.91 a                   | 12.75 a              |
| P3                         | 43.18 b             | 11.29 b            | 117.56 b                 | 5.94 b                   | 11.94 b              |
| LSD(0.05)                  | 1.4878              | 0.5639             | 3.5903                   | 0.4907                   | 0.5611               |
| CV%                        | 3.30                | 3.64               | 3.12                     | 9.74                     | 3.53                 |

In a column means having a similar letter(s) are statistically similar and those having a dissimilar letter(s) differ significantly at a 0.05 level of probability

Here, S1: 01 November, S2: 15 November and S3: 30 November; P0: Control, P1: 35 kg P ha\(^{-1}\), P2: 45 kg P ha\(^{-1}\) and P3: 55 kg P ha\(^{-1}\)

3.11 Seed Yield per Hectare (t)

Significant variation was revealed in seed yield per hectare due to different sowing dates during the present experiment (Fig. 3). Results from the experiment showed that the maximum seed yield per hectare (1.50 t) was revealed from the S2 (15 November) treatment which was statistically similar with S1 (1 November) treatment where the minimum seed yield per hectare (1.36 t) was noted from S3 (30 November) treatment. The result of the experiment coincided with the findings of [11] who stated that seed yield were maximum when sowing in early November. It was evident from the results that the date of sowing had a significant influence on the phenology, growth, and yield of fenugreek.

![Fig. 3. Effect of different sowing dates on seed yield (t ha\(^{-1}\)) of fenugreek](image)

Here, S1: 01 November, S2: 15 November and S3: 30 November
Significant influence was exerted on seed yield per hectare due to different levels of phosphorus during the experimentation (Fig. 4). It was revealed that the maximum seed yield per hectare (1.92 t) was observed from P₂ (45 kg P ha⁻¹) treatment. In comparison, the minimum seed yield per hectare (0.85 t) was recorded from the P₀ (control) treatment. The experiments result coincided with the findings of [14] who reported that seed yield per hectare was observed significantly maximum in judicious application of phosphorus.

Seed yield per hectare of fenugreek revealed statistically significant variation due to the combined effect of different sowing dates and phosphorus during the experimentation. The results of the experiment showed that the

Table 7. The combined effect of different sowing dates and phosphorus level on the number of pod/plant, number of seed/pod, the weight of single pod (mg), the weight of seed/plant (gm), 1000-seed weight (g), and seed yield (t/ha) of fenugreek

| Treatment | Number of Pod/Plant | Number of Seed/Pod | Weight of Single Pod (mg) | Weight of Seed/Plant (gm) | 1000 Seed Weight (gm) | Seed Yield (t/ha) |
|-----------|---------------------|--------------------|---------------------------|---------------------------|-----------------------|------------------|
| S₁P₀      | 35.21 g             | 9.81 ghi           | 103.38 fgh                | 3.61 gh                   | 10.08 hij             | 1.00 gh          |
| S₁P₁      | 43.35 cd            | 10.77 defg         | 110.48 e                  | 5.04 def                  | 11.27 efg             | 1.40 def         |
| S₁P₂      | 45.46 c             | 11.96 abc          | 130.82 b                  | 6.41 bc                   | 12.79 bc              | 1.78 bc          |
| S₁P₃      | 41.23 de            | 11.35 cde          | 118.86 d                  | 5.62 cd                   | 12.11 cde             | 1.56 cd          |
| S₂P₀      | 33.93 g             | 10.40 efgh         | 99.59 h                   | 2.84 hi                   | 10.84 fgh             | 0.79 hi          |
| S₂P₁      | 37.82 f             | 11.59 bcd          | 107.93 efg                | 4.36 fg                   | 12.39 bcd             | 1.21 fg          |
| S₂P₂      | 52.61 a             | 12.87 a            | 147.11 a                  | 7.67 a                    | 13.86 a               | 2.13 a           |
| S₂P₃      | 48.25 b             | 12.37 ab           | 125.32 bc                 | 6.74 b                    | 13.22 ab              | 1.87 b           |
| S₃P₀      | 30.25 h             | 9.11 i             | 92.63 i                   | 2.70 i                    | 9.17 j                | 0.75 i           |
| S₃P₁      | 34 g                | 9.46 hi            | 102.21 gh                 | 4.76 ef                   | 9.61 ij               | 1.32 ef          |
| S₃P₂      | 41.90 de            | 10.98 defg         | 122.36 cd                 | 6.66 b                    | 11.60 def             | 1.85 b           |
| S₃P₃      | 40.05 ef            | 10.14 fgh          | 108.50 ef                 | 5.46 de                   | 10.49 ghi             | 1.52 de          |
| LSD(0.05) | 2.5770              | 0.9768             | 6.2186                    | 0.85                      | 0.9719                | 0.2361           |
| CV%       | 3.30                | 3.64               | 3.12                      | 9.74                      | 3.53                  | 9.74             |

In a column means having a similar letter(s) are statistically similar and those having a dissimilar letter(s) differ significantly at a 0.05 level of probability.

Here, S₁: 01 November, S₂: 15 November and S₃: 30 November
P₀: Control, P₁: 35 kg P ha⁻¹, P₂: 45 kg P ha⁻¹ and P₃: 55 kg P ha⁻¹
maximum seed yield per hectare (2.13 t) was observed from S2P2 (15 November with 45 kg P ha⁻¹) treatment combination while the minimum seed yield per hectare (0.75 t) was obtained from S3P0 (30 November with control) treatment combination.

4. CONCLUSION

This study revealed that sowing date and application of phosphorus fertilizer positively affect fenugreek’s growth and seed yield. In the case of seed yield of fenugreek, the combination of sowing date S2 (15 November) along with phosphorus application P2 (45 kg P ha⁻¹) were given the better performance of all the yield contributing parameters and seed yield of fenugreek. So, S2P2 (15 November with 45 kg Pha⁻¹) treatment combination can be repeated in different agro-ecological zones of Bangladesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/90919