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# Growth and yield of fenugreek (*Trigonella foenum graecum* L.) in response to different levels of phosphorus and biofertilizer (*Rhizobium* and PSB) under Kymore Plateau and Satpura hill agro-climatic zone of Madhya Pradesh

**Reena Nair, SK Pandey and Jyothsna J**

**Abstract**
The present investigation was undertaken to evaluate the performance of fenugreek cv. RMt-1 under different levels of Phosphorus and biofertilizers for maximization of yield. The experiment consisted of four levels of Phosphorus (0, 35, 45, 55 kg/ha) along with two biofertilizer *(Rhizobium* and PSB) and their combinations were included in this investigation. There were altogether 20 treatments laid out in Factorial Randomized Block Design (FRBD) with three replications. Among different treatment combination maximum seed yield was recorded in $P_2O_5$ 45kg/ha (17.28 q/ha) which was at par with $P_2O_5$ 55kg/ha (16.88 q/ha). With regards to the biofertilizer treatment *Rhizobium* + PSB (16.12) was significantly superior to rest of the treatment. Scrutiny of data on the interaction effect proved that treatment combination $P_2O_5$ 45kg/ha + *Rhizobium* + PSB had the maximum seed yield (18.03q/ha) which were at par with $P_2O_5$ 45kg/ha, $P_2O_5$ 55kg/ha + *Rhizobium* + PSB and $P_2O_5$ 45kg/ha + *Rhizobium* with 17.87q/ha, 17.31 q/ha and 17.01 q/ha seed yield respectively.

**Keywords:** Fenugreek, rhizobium, PS, seed yield

## Introduction
Fenugreek (*Trigonella foenum-graecum* L.) commonly known as *methi* is an annual crop, dicotyledonous plant belonging to the family Fabaceae (subfamily *Papilionaceae*). The genus name *Trigonella* means tri angled may be because of triangular shape of its flowers and the word *foenum graecum* means "Greek hay" indicating its use as a forage crop in the past (Petropoulos 2002). It is a multipurpose winter season crop and is one of the important major seed spices in the country. The total area and production of fenugreek was 219720 hectare and 311280 tonnes in 2017-18 respectively. Rajasthan is the leading state in fenugreek production followed by Madhya Pradesh, Gujarat and Haryana. In Madhya Pradesh it is grown in an area of 53440 ha with 104220 tonnes production (Spice Board, 2019). Fenugreek is a leguminous crop hence, the root nodules enrich the soil with atmospheric nitrogen. Due to intensive agriculture for increasing production and productivity enormous use of chemical fertilizers is being applied leading to soil deterioration as well as environment pollution. The fertilizer application generally remained much below as compared to removal of nutrients by the plants. Thus there is wide gap between nutrients removed from soil and nutrient supplied. This gap can be bridged by the use of chemical fertilizers along with low cost organic supplements like bio-fertilizer. Integrated use of chemical fertilizers as well as bio-fertilizers in fenugreek can be more efficient than chemical fertilizers alone. Even the quantity of chemical fertilizers applied can be reduced by the use of biofertilizers management in fenugreek. Microbial fertilization along with *Rhizobium* as well as phosphate solubilizing bacteria (PSB) has been found promising to improve soil health and crop production (Meena *et al*., 2014) [5]. Soils of India are low to medium in available phosphorus. Phosphorus deficiency is usually the most important single factor which is responsible for poor yield of legume crops on all types of soil. In recent years, several strains of phosphate solubilizing bacteria (PSB) and fungi have been isolated which have shown to possess the ability to solubilise sparingly soluble phosphate, growth promotion and uptake of P by plants (Whitelaw, 2000). Study on the cost effective nutrient management in *Kymore* Plateau and *Satpura* hills agroclimatic conditions of Central India in fenugreek are needed to be worked out.

Therefore, the present study was undertaken to study the effect of nitrogen, phosphorus and bio-fertilizers on growth, yield and its attributing characters in fenugreek.

## Material and Methods

The experiment on response of different doses of phosphorus and biofertilizer (*Rhizobium* and PSB) on growth and yield of fenugreek var. RMt-1 was conducted during 2018-19 under AICRP on Spices at Department of Horticulture, JNKVV, Jabalpur. The experimental site was located at an altitude of 411m from the mean sea level on 23˚10' North latitude and 79˚59' East longitude in *Kymore* Plateau and *Satpura* Hill Agroclimatic zone of Madhya Pradesh. The experiment comprised of four levels of Phosphorus (0, 35, 45, 55 kg/ha) and four levels of bio-fertilizers (no inoculation, *Rhizobium*, PSB and *Rhizobium*+ PSB). The treatment details are furnished in Table 1. These 16 combinations were evaluated under factorial random block design with three replications. Seeds of fenugreek were treated with biofertilizers and after drying in the shade were sown at row to row spacing of 30 cm and 10 cm distance between rows and plants, respectively. Application of 5 t FYM $ha^{-1}$, 25 kg N $ha^{-1}$, and 50 kg $K_2O$ $ha^{-1}$ was applied as basal dose. All the recommended agronomic practices were adopted for raising a good crop. The data on days to first flowering was recorded on plot basis, while ten randomly selected plants from each of the entry in each replication were tagged for recording the observations on plant height (cm), number of branches per plant, number of pods/ plant pod length (cm), seed yield (g)/plant and Seed yield q/ha. Statistical analysis of data was done by standard procedure suggested by Panse and Sukhatme (1985) [7].

**Table 1:** Treatment details

| Treatment | Details |
|---|---|
| $T_1$ | Control |
| $T_2$ | *Rhizobium* |
| $T_3$ | PSB |
| $T_4$ | *Rhizobium* + PSB |
| $T_5$ | 35kg$P_2O_5$ |
| $T_6$ | 35kg $P_2O_5$+*Rhizobium* |
| $T_7$ | 35kg $P_2O_5$+PSB |
| $T_8$ | 35kg $P_2O_5$+*Rhizobium*+PSB |
| $T_9$ | 45 kg $P_2O_5$ |
| $T_{10}$ | 45 kg $P_2O_5$+ *Rhizobium* |
| $T_{11}$ | 45 kg $P_2O_5$ + PSB |
| $T_{12}$ | 45 kg $P_2O_5$ + *Rhizobium* + PSB |
| $T_{13}$ | 55 kg $P_2O_5$ |
| $T_{14}$ | 55 kg $P_2O_5$ + *Rhizobium* |
| $T_{15}$ | 55 kg $P_2O_5$ + PSB |
| $T_{16}$ | 55 kg $P_2O_5$ + *Rhizobium* + PSB |

## Results and discussion

### Effect of phosphorus and biofertilizers on growth traits

Scrutiny of data depicted in Table 2 reveals that different Phosphorous level as well as bio-fertilizer significantly influenced the growth and yield traits under study. The maximum plant height at harvest was recorded under the levels of phosphorus 55 kg $P_2O_5$ (97.99 cm) which was at par with 45 kg $P_2O_5$ (97.97cm). While in the application of biofertilizers the treatment *Rhizobium* + PSB recorded significantly highest plant height at harvest with 97.95 cm than the rest of treatment. With respect to the interaction effect of phosphorus and biofertilizers (P3 × B4) showed significant at the time of maturity (100 cm) over rest of the treatment for plant height as mentioned in Table 3.

The effect of phosphorus and biofertilizers on fenugreek plant was found significant and the plant height increased across the increase in the fertilizer dose. The highest plant height (100.00 cm) was recorded under the plants that received seed treatment with both *Rhizobium* and PSB along application of 45 Kg $P_2O_5$ while the minimum plant height was observed in the control plants that received neither $P_2O_5$ nor biofertilizers (Table 3). This is in line with the reports of Godara *et al*. (2018) [4], Saxena and Singh (2019) [9] and Somdutt *et al*. (2019) [10].

A significant effect was pronounced by the phosphorus and biofertilizers on the days to first flowering and maturity in fenugreek plants. The earliest flowering (42.50 days) was observed in plants whose seeds were treated with both *Rhizobium* and PSB along application of 55 Kg $P_2O_5$ (Table 6). On the other hand, seed treatment with PSB alone showed delayed flowering (49.45 days) (Table 2). A similar pattern of effect was exhibited by the $P_2O_5$ and biofertilizers on days to maturity. The seed treatment with both *Rhizobium* and PSB along with soil application of 55 Kg $P_2O_5$ pronounced early maturity of the crop (133.41 days). The earliness in flowering and crop maturity by phosphorus application coincides with the report of Mehta *et al*. (2012) [6].

Significant results were found across the treatments of phosphorus and biofertilizers for number of branches $plant^{-1}$. The branch number increased as the dose of the $P_2O_5$ increased. The highest number of branches was found in the treatment under seed treatment with *Rhizobium* and PSB (8.23) while the least number of branches were recorded in the control (6.09) (Table 2). Similar trend in increased branch number by dual application of *Rhizobium* and PSB was reported by Bhairva *et al*. (2012) [3], Anitha *et al*. (2016) [2], Godara *et al*. (2018) [4] and Saxena and Singh (2019) [9].

The phosphorus plays a major role in root development and root cell proliferation through which the water and nutrient uptake by the plants is enhanced. Moreover, the biosynthesis of nucleic acid, phospholipids and proteins are promoted and thus the membrane transport and cytoplasm streaming. Phosphorus also elevates the nitrogenase activity in root nodules which results in improved biological nitrogen fixation (Mehta *et al*., 2012) [6]. The biofertilizers namely *Rhizobium* and PSB fixes nitrogen and solubilize the unavailable bound phosphate, respectively and render it available for the plants. The seed inoculation with *Rhizobium* and PSB enrich the soil rhizosphere with beneficial microorganisms that improve the nitrogen fixation and phosphate solubilization. These bacteria are also reported to produce biologically active compounds such as auxin, gibberellins and vitamins that promote the plant growth and development (Bhairva *et al*., 2012) [3]. Owing to the above factors, the overall plant growth has been found superior in plants that received the combinational inoculation of biofertilizers.

### Effect of phosphorus and biofertilizers on number of yield attributing traits

The seed treatment with *Rhizobium* and PSB along with application of $P_2O_5$ significantly increased the number of pods $plant^{-1}$. The highest number of pods (32.30) was observed under *Rhizobium* and PSB seed treatment along application of 45 Kg $P_2O_5$ while the least number of pods were recorded with the control (20.99) (Table 4). The increment in number of pods $plant^{-1}$ is line agreement with that of Saxena and Singh (2019) [9] and Somdutt *et al*. (2019) [10].

The pod length of fenugreek plants was significantly

enhanced by the seed treatment of *Rhizobium* and PSB and application of $P_2O_5$. The pod length increased along the increase in dose of $P_2O_5$. The longest pods were observed under seed treatment with *Rhizobium* and PSB along application of 55 Kg $P_2O_5$ whereas the minimum pod length was with the control (Table 5). A similar results of increased pod length through inoculation of *Rhizobium* and PSB was reported by Godara *et al*. (2018) [4].

The phosphorus and biofertilizers treatment showed a significant influence on the seed yield of fenugreek. The seed yield found increasing across the increasing $P_2O_5$ doses. The highest seed yield (18.02 q/ha) was found under seed treatment with *Rhizobium* and PSB along application of 45 Kg $P_2O_5$ whereas the least was found in the control (9.28 q/ha) (Table 7). An increment in seed yield by the *Rhizobium* and PSB seed inoculation was also stated by Bhariva *et al*. (2012) [3] and Ahmed *et al*. (2017) [1].

The seed yield was significantly increased by the effect of seed treatments with biofertilizers *Rhizobium* and PSB and phosphorus. The highest test weight of the fenugreek seed was recorded under seed treatment with *Rhizobium* and PSB along application of 45 Kg $P_2O_5$. The lowest test weight of seeds was observed under the control that received no seed treatment with biofertilizers and phosphorus application (Table 8). A similar result on increased seed test weight was reported by Ahmed *et al*. (2017) [1].

The increase in pod number plant$^{-1}$ might be attributed to the increased phosphorus rate (Ramesh *et al*., 2002) [8]. In the present investigation, all the yield attributes *viz*., number of pods plant$^{-1}$, pod length, seed yield and seed test weight were recorded the maximum under seed inoculation of both *Rhizobium* and PSB. The increment in the yield attributing traits might be due to better availability of nutrients as well as their translocation into the entire plant system due to maximized nutrient uptake (Saxena and Singh, 2019; Anitha *et al*., 2016) [9, 2]. The increase in yield is the cumulative effect of increased pod number plant$^{-1}$, pod length and seed weight imparted by the biofertilizers. Interestingly, the highest seed yield is recorded under the treatment that received seed inoculation of *Rhizobium* and PSB along with 45 Kg $P_2O_5$ but not at the higher dose of 55 Kg $P_2O_5$. This might be due to better activity of biofertilizers at low fertility level (Godara *et al*., 2018) [4].

**Table 2:** Effect of different levels of phosphorous and biofertilizers on growth and yield attributes of fenugreek

| Treatments | Plant height at harvest (cm) | No. of branches per plant at harvest | Days to first flowering | No. of pods per plant | Pod length | Days to maturity | Seed yield q/ha | Test weight |
|---|---|---|---|---|---|---|---|---|
| **(A) P levels** | | | | | | | | |
| $P_1$ = Control (0 kg/ha) | 91.47 | 6.55 | 47.74 | 24.88 | 11.14 | 142.06 | 11.78 | 11.18 |
| $P_2$ =35 kg/ha | 95.49 | 6.71 | 44.61 | 29.11 | 12.35 | 142.05 | 15.18 | 12.77 |
| $P_3$= 45 kg/ha | 97.97 | 8.00 | 42.77 | 31.09 | 12.87 | 135.25 | 17.28 | 14.23 |
| $P_4$= 55 kg/ha | 97.99 | 7.85 | 42.74 | 30.07 | 13.14 | 133.91 | 16.87 | 14.11 |
| SEm± | 0.50 | 0.07 | 0.32 | 0.62 | 0.08 | 0.70 | 0.29 | 0.18 |
| CD at 5% | 1.44 | 0.21 | 0.91 | 1.78 | 0.25 | 2.02 | 0.86 | 0.52 |
| **(B) Biofertilizers** | | | | | | | | |
| $B_1$ =Without inoculum | 93.26 | 6.99 | 45.27 | 27.53 | 11.62 | 141.61 | 14.30 | 12.34 |
| $B_2$ = *Rhizobium* | 95.18 | 7.08 | 44.31 | 28.73 | 12.39 | 138.54 | 14.70 | 12.78 |
| $B_3$ = PSB | 95.23 | 7.04 | 45.04 | 28.36 | 12.26 | 137.64 | 14.77 | 13.24 |
| $B_4$ =*Rhizobium* + PSB | 97.95 | 7.36 | 44.17 | 30.03 | 12.82 | 139.42 | 16.12 | 13.21 |
| SEm± | 0.45 | 0.06 | 0.28 | 0.55 | 0.08 | 0.63 | 0.27 | 0.16 |
| CD at 5% | 1.29 | 0.18 | 0.81 | 1.59 | 0.22 | 1.81 | 0.76 | 0.47 |
| **A×B Interaction** | | | | | | | | |
| SEm± | 1.00 | 0.15 | 0.63 | 1.23 | 0.17 | 1.41 | 0.59 | 0.36 |
| CD at 5% | 2.88 | NS | NS | 3.55 | 0.49 | 4.05 | 1.71 | 1.05 |

**Table 3:** Effect of different levels of phosphorus and biofertilizers on plant height as influenced by different interaction

| Treatment | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|
| $P_1$ | 86.97 | 89.96 | 90.62 | 98.33 |
| $P_2$ | 93.96 | 95.85 | 95.55 | 96.62 |
| $P_3$ | 95.87 | 97.99 | 98.00 | 100.00 |
| $P_4$ | 96.12 | 98.18 | 97.97 | 99.70 |
| Factors | $P_2O_5$ | Biofertilizers | | |
| SEm± | 0.50 | 0.45 | | |
| CD at 5% | 1.44 | 1.29 | | |

**Table 4:** Effect of different levels of phosphorous and biofertilizers on number of pods per plant as influenced by different interaction

| Treatment | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|
| $P_1$ | 20.99 | 25.26 | 24.22 | 29.07 |
| $P_2$ | 28.33 | 28.68 | 30.54 | 28.88 |
| $P_3$ | 30.90 | 29.43 | 31.76 | 32.30 |
| $P_4$ | 30.29 | 29.41 | 28.91 | 31.66 |
| Factor | $P_2O_5$ | Biofertilizer | | |
| SEm± | 0.62 | 0.55 | | |
| CD at 5% | 1.78 | 1.59 | | |

**Table 5:** Effect of different levels of phosphorous and biofertilizers on pod length as influenced by different interaction

| Treatment | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|
| $P_1$ | 9.09 | 11.06 | 11.50 | 12.92 |
| $P_2$ | 12.11 | 12.45 | 12.23 | 12.61 |
| $P_3$ | 13.03 | 12.96 | 12.54 | 12.97 |
| $P_4$ | 12.37 | 13.42 | 13.29 | 13.50 |
| Factor | $P_2O_5$ | Biofertilizer | | |
| SEm± | 0.08 | 0.08 | | |
| CD at 5% | 0.25 | 0.22 | | |

**Table 6:** Effect of different levels of phosphorous and biofertilizers on days to maturity as influenced by different interaction

| Treatment | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|
| $P_1$ | 145.00 | 143.15 | 137.08 | 143.03 |
| $P_2$ | 143.33 | 138.84 | 139.90 | 146.12 |
| $P_3$ | 136.63 | 135.70 | 134.85 | 133.82 |
| $P_4$ | 134.54 | 133.50 | 134.19 | 133.41 |
| Factor | $P_2O_5$ | Biofertilizer | | |
| SEm± | 0.70 | 0.63 | | |
| CD at 5% | 2.02 | 1.81 | | |

**Table 7:** Effect of different levels of phosphorous and biofertilizers on seed yield q/ha as influenced by different interaction

| Treatment | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|
| $P_1$ | 9.28 | 10.48 | 12.01 | 15.33 |
| $P_2$ | 14.66 | 15.32 | 14.98 | 15.74 |
| $P_3$ | 17.87 | 16.81 | 16.43 | 18.02 |
| $P_4$ | 16.44 | 17.01 | 16.74 | 17.31 |
| Factor | $P_2O_5$ | Biofertilizer | | |
| SEm± | 0.29 | 0.27 | | |
| CD at 5% | 0.86 | 0.76 | | |

**Table 8:** Effect of different levels of phosphorous and biofertilizers on test weight (g) as influenced by different interaction

| Treatment | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|
| $P_1$ | 9.42 | 10.43 | 13.41 | 11.45 |
| $P_2$ | 12.52 | 12.79 | 12.66 | 13.10 |
| $P_3$ | 14.20 | 14.15 | 13.97 | 14.58 |
| $P_4$ | 13.77 | 14.27 | 14.03 | 14.38 |
| Factor | $P_2O_5$ | Biofertilizer | | |
| SEm± | 0.18 | 0.16 | | |
| CD at 5% | 0.52 | 0.47 | | |

## Conclusion

From this investigation we draw that the dual inoculation of biofertilizers namely *Rhizobium* and PSB along with the application of 45 Kg $P_2O_5$ could maximize the seed yield in fenugreek. The enhancement of overall plant growth and development by the biofertilizers is well witnessed in the study. The nutrient availability in soil and nutrient uptake by the plants were facilitated by the biofertilizers that have promoted growth, development and yield of fenugreek plants.

## References


1. Ahmed ME, Rugheim EM, Kamal Taha, SEA Ali. Influence of nitrogen fixing and phosphorus solubilizing bacteria inoculation on fenugreek symbiotic properties, growth and yield. International journal of Horticulture, Agriculture and Food science 2017;1(3):42-47. https://dx.doi.org/10.22161/ijhaf.1.3.8
2. Anitha M, Swami DV, Kumar BP, Suneetha DRS. Evaluation of nutrient management for better growth, yield and economics of fenugreek. Journal of Spices and Aromatic Crops 2016;25(1):34-40.
3. Bairva M, Meena SS, Mehta RS. Effect of bio-fertilizers and plant growth regulators on growth and yield of fenugreek (*Trigonella foenum-graecum* L.). International J Seed Spices 2012;2(1):28-33.
4. Godara, A.S., R. Singh and G.S. Chouhan. Soil Fertility, Growth and Productivity of Fenugreek (*Trigonella foenum-graecum* L.) as Influence by Fertilizer Levels, Biofertilizers and Brassinosteroid. Int. J Curr Microbiol. App. Sci 2018;7(9):462-468.
5. Meena SS, Mehta RS, Bairwa M, Meena RD. Productivity and profitability of fenugreek (*Trigonella foenum-graecum* L.) as influenced by bio-fertilizers and plant growth regulators. Legume Res 2014;37(6):646-650.
6. Mehta RS, Anwer MM, Aishwath OP, Meena RS. Growth, yield and quality of fenugreek (*Trigonella foenum-graecum* L.) as influenced by nitrogen, phosphorus and bio-fertilizers. Indian J Hort 2012;69(1):94-97.
7. Panse VG, Sukhatme PV. Statistical method for agricultural workers. ICAR, New Delhi 1967, 381.
8. Ramesh V, Agarwal AR, Yadav PC. Effect of Phosphorus and weed management in fenugreek. Ann. Biol 2002;18:978.
9. Saxena AK, Singh S. Growth and Yield of fenugreek (*Trigonella foenum-graecum* L.) as influenced by liquid and solid biofertilizers (Rhizobium, PSB and KSB). Res J Chem. Environ Sci 2019;7(3):52-55.
10. Somdutt LN, Dashora SL, Mundra J Choudhary, Choudhary P. Effect of inorganic and organic sources of fertilization on productivity of fenugreek (*Trigonella foenum-graecum* L.) under agro- climatic conditions of Southern Rajasthan. Journal of Pharmacognosy and Phytochemistry 2019;8(4):1886-1888.