*Plant Archives* Vol. 26, Supplement 1, 2026 pp. 164-167 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.023

# OPTIMIZING ORGANIC INPUTS FOR IMPROVED FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* L.) CULTIVATION IN NORTHEAST REGION OF INDIA

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(Date of Receiving : 10-08-2025; Date of Acceptance : 21-10-2025)

**ABSTRACT**

Fenugreek (*Trigonella foenum-graecum* L.) exhibits anti-diabetic, galactogouge, hypocholesterolemic and carminative qualities which supports the need for its sustaianable cultivation. Thus, a field experiment was carried out at the School of Agricultural Sciences (SAS), Nagaland University, to study the effect of different organic sources on foliage, seed yield and BCR of fenugreek. The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 10 treatments with $T_1$ (FYM) 100%, $T_2$ (Vermicompost 100%), $T_3$ (Neem Cake 100%), $T_4$ (Pig manure 100%), $T_5$ (Poultry Manure 100%), $T_6$ (50% FYM + *Trichoderma*), $T_7$ (50% Poultry Manure + *Rhizobium*), $T_8$ (50% FYM + 50% Pig manure + *Rhizobium*), $T_9$ (50% FYM + 50% Poultry Manure + *Trichoderma*) and $T_{10}$ (control). The experimental results revealed that significantly higher values on growth parameters *viz.,* plant height (49.93 cm), number of branches (6.53), days to 50% flowering and 50% pod formation were recorded under $T_9$, while the highest leaf area (9.22 $cm^2$), length of pods (9.50 cm), test weight (15.35 g), foliage yield (23.67 q/ha) and seed yield (15.10 q/ha) was recorded higher under $T_8$ . Among all the treatments, $T_7$ recorded the highest BCR (2.90) even though $T_8$ had higher net returns (Rs. 1,03,046.80/ha). From the present investigation it can be concluded that among the different organic treatments on fenugreek, combined application of organic manures was found to be superior in terms of growth and yield attributes.

***Keywords*** **:** Fenugreek, organic manures, biofertilizers, growth attributes, yield attributes, economics.

## Introduction

Fenugreek (*Trigonella foenum-graecum* L.), an ancient herb known for its medicinal and culinary applications, is widely cultivated in India as well as in parts of North Africa, the Mediterranean, and Canada (Dhull *et al.,* 2020). In India, it stands as the third most cultivated seed spice after coriander and cumin. Botanically, fenugreek is a self-pollinating annual herb from the Fabaceae family, featuring trifoliate leaves, pale flowers and aromatic seeds that are used for both culinary and medicinal purposes (Ecocrop, 2017). Fenugreek seeds are a rich source of nutrients and bioactive compounds, offering various health benefits. They exhibit properties such as antidiabetic, galactagogue, cholesterol-lowering and digestive aid (Dhull *et al.,* 2020). The seeds are composed of significant levels of protein (27.57%), fat (6.71%), dietary fiber, essential minerals like calcium and iron, and biologically active compounds including galactomannan and trigonelline. Additionally, the presence of diosgenin, a plant-based steroid makes fenugreek a valuable source for pharmaceutical preparations such as contraceptives (Mufti *et al.,* 2017). Growing concerns over the negative impacts of chemical fertilizers and pesticides have shifted agricultural focus towards organic alternatives. Organic amendments such as farmyard manure (FYM), vermicompost, and biofertilizers offer comprehensive benefits by improving soil fertility, enriching it with

micronutrients, and enhancing plant resilience (Patel *et al.,* 2022). Research has shown that these inputs can significantly boost the growth and productivity of seed spices, including coriander and fennel (Lal *et al.,* 2016; Darzi *et al.,* 2008). Furthermore, biofertilizers facilitate essential nutrient cycling through nitrogen fixation and phosphorus solubilization, while also producing plant growth-promoting substances (Raiyani *et al.,* 2018). Although India plays a dominant role in global fenugreek cultivation, its production remains minimal in the North Eastern states, including Nagaland. Limited awareness of the crop's nutritional and therapeutic potential may be a contributing factor. Encouraging organic fenugreek farming in these underutilized areas could enhance regional agricultural development, diversify cropping systems, and provide both nutritional and economic benefits to local communities.

## Materials and Methods

The study was conducted using fenugreek variety AFg-5, sourced from the National Research Centre for Seed Spices, Ajmer, Rajasthan and the experiment was conducted at the School of Agricultural sciences (SAS), Nagaland University, Medziphema Campus spanning from September 2022 to February 2023. Organic manures, including FYM, poultry manure and pig manure, were collected locally, while neem cake and vermicompost were procured from the market. Biofertilizers such as *Rhizobium* and *Trichoderma viride* were obtained from the Bio-Control Lab, Medziphema. The experiment followed a Randomized Block Design (RBD) with three replications and ten treatments, laid out in plots measuring 2m × 1m. The treatments included different organic manures and their combinations with biofertilizers, along with a control. The treatment consisted of $T_1$ (Farm Yard Manure) (FYM) 100%, $T_2$ (Vermicompost 100%), $T_3$ (Neem Cake 100%), $T_4$ (Pig manure 100%), $T_5$ (Poultry Manure 100%), $T_6$ (50% FYM + *Trichoderma*), $T_7$ (50% Poultry Manure + *Rhizobium*), $T_8$ (50% FYM + 50% Pig manure + *Rhizobium*), $T_9$ (50% FYM + 50% Poultry Manure + *Trichoderma*) and $T_{10}$ (control). The field was prepared by plowing and leveling, followed by manure application as per treatment specifications. Seeds were treated with *Rhizobium* and *Trichoderma* before sowing at a recommended seed rate of 12 kg/ha with 30×10 cm spacing. Thinning, gap filling, and hand weeding were carried out at specific intervals, while irrigation was provided as needed. Pest control involved hand-picking insects and applying neem oil. Harvesting was done when pods matured, followed by sun drying, threshing, and seed collection. Observations were recorded for vegetative, phenological, and yield attributes, including germination days, plant height, number of branches, leaf area, flowering time, pod formation, seed yield, and economic parameters such as cost of cultivation, gross and net returns, and benefit-cost ratio. Statistical analysis was performed using ANOVA, and significant differences were determined using the Critical Difference (CD) test (Panse and Sukhatme, 1985).

## Results and Discussion

As recorded in Table 1 and Fig.1, significant differences in growth and yield parameters were observed across the treatments. Seeds treated with biofertilizers ($T_6$, $T_7$, $T_8$ and $T_9$) germinated earlier (4 days) as compared to those under organic manures alone (5 days), this is attributed to the microbial biostimulants enhancing nutrient uptake and stress tolerance (Cardarelli *et al.,* 2022). *Trichoderma* treated seeds ($T_6$ and $T_9$) further benefited from improved nutrient solubilization and pathogen suppression (Lal *et al.,* 2013; Aishwath *et al.,* 2017). The plant height and vegetative growth were highest in $T_9$ (49.93 cm) and $T_8$ (48.63 cm), significantly surpassing the control ($T_{10}$: 36.33 cm). This improvement is likely attributed to the *Rhizobium's* nitrogen fixation and synergistic effects with organic inputs (Saxena & Singh, 2019). $T_9$ also showed the maximum number of branches (6.53) and leaf area (9.22 cm²), emphasizing the benefits of integrating biofertilizers and organics (Naimuddin *et al.,* 2014; Malav *et al.,* 2018).

The Phenological development among the treatments also varied where the earliest flowering (35 days) was seen in $T_8$, followed by $T_1$, while delayed flowering occurred in $T_3$, $T_{10}$, and $T_5$. Time taken to 50% flowering was shortest in $T_8$ (41 days) and longest in $T_4$ (50.67 days), highlighting the efficacy of FYM-pig manure-*Rhizobium* combinations (Lal *et al.,* 2016). Early pod formation was observed in $T_8$ (48.33 days) and $T_9$ (48.00 days), contrasting with delays in $T_1$ and $T_2$, which is most likely due to improved nutrient dynamics and microbial activity (Badar *et al.,* 2016; Raiyani *et al.,* 2018; Ramniwas *et al.,* 2022).

Among the treatments, highest yield attributes were recorded in $T_8$, which recorded the most pods per plant (15.33), pod length (9.50 cm), seeds per pod (16.50), and seed yield (15.0 q/ha). It was followed closely by $T_9$, while $T_{10}$ consistently showed the lowest performance. The enhanced results in $T_8$ as compared to the other treatments are attributed to better nutrient availability, nitrogen fixation and hormone production by *Rhizobium* (Mehta *et al.,* 2010; Naimuddin *et al.,* 2014; Mehta *et al.,* 2012).

**Table 1:** Growth, Yield attributes and BCR of fenugreek under the influence of organic inputs.

| Treatments | Plant height at 90 DAS | No. of branches at 60 days | Leaf area ($cm^2$) | 50 % flowering (Days) | 50 % pod formation (Days) | Seed index (g) | Test weight (g) | Foliage yield/ha (q) | Seed yield/ha (q) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 40.33 | 4.87 | 5.99 | 46.67 | 56.67 | 1.11 | 11.06 | 18.16 | 9.85 | 1.79 |
| $T_2$ | 41.00 | 4.40 | 7.00 | 50.00 | 56.33 | 1.19 | 11.88 | 14.02 | 10.47 | 1.31 |
| $T_3$ | 39.23 | 4.13 | 5.14 | 49.67 | 55.00 | 1.20 | 12.03 | 12.28 | 10.22 | 0.56 |
| $T_4$ | 39.33 | 4.53 | 6.33 | 50.67 | 54.00 | 1.23 | 12.28 | 14.82 | 10.67 | 1.65 |
| $T_5$ | 40.67 | 4.70 | 5.67 | 49.67 | 55.00 | 1.18 | 11.84 | 18.71 | 11.53 | 2.27 |
| $T_6$ | 42.30 | 4.57 | 6.95 | 50.00 | 51.33 | 1.16 | 11.60 | 18.33 | 10.85 | 1.15 |
| $T_7$ | 41.83 | 5.67 | 8.64 | 49.00 | 50.33 | 1.32 | 13.18 | 20.67 | 13.80 | 2.90 |
| $T_8$ | 48.63 | 6.50 | 9.22 | 45.33 | 48.33 | 1.37 | 13.72 | 23.67 | 15.10 | 2.33 |
| $T_9$ | 49.93 | 6.53 | 8.80 | 41.00 | 48.00 | 1.54 | 15.36 | 22.44 | 14.25 | 2.32 |
| $T_{10}$ | 36.33 | 4.00 | 5.18 | 50.33 | 55.00 | 1.20 | 12.04 | 10.79 | 8.18 | 1.25 |
| **SEm±** | **0.87** | **0.21** | **0.58** | **0.99** | **0.83** | **0.09** | **0.88** | **0.73** | **0.16** | **-** |
| **CD(P=0.05)** | **2.59** | **0.62** | **1.72** | **2.95** | **2.48** | **0.26** | **2.60** | **2.18** | **0.48** | **-** |

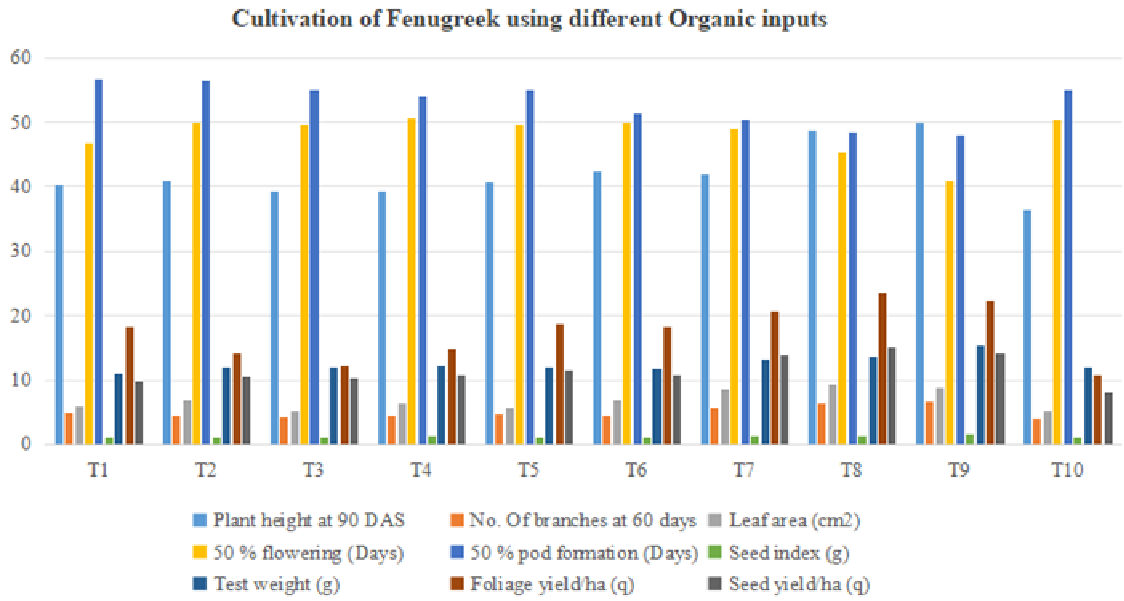


**Fig. 1 :** Cultivation of Fenugreek under different Organic Input

Even in terms of economic viability, $T_8$ recorded the highest gross returns (Rs. 1,03,046.48/ha) and a B:C ratio of 2.33, while $T_7$ (Poultry Manure + *Rhizobium*) yielded the highest profitability (B:C ratio 2.90). Whereas in contrast, $T_3$ (Neem Cake) and $T_{10}$ (Control) showed the least economic viability. These findings affirm the cost-effectiveness and agronomic potential of combining organic manures with microbial inoculants (Somdutt *et al.,* 2019; Raghuwanshi *et al.,* 2016)

## Conclusion

The study demonstrated that combining organic manures with biofertilizers significantly improved the growth, yield, and economic returns of fenugreek under the foothill conditions of Nagaland. Among all treatments, $T_8$ (50% FYM + 50% Pig manure + *Rhizobium*) showed superior performance in early germination, plant height, leaf area, pod number, seed yield (15.10 q/ha), and net return (Rs. 1,03,046.80/ha) with a B:C ratio of 2.33. $T_9$ and $T_7$ also performed well, with $T_7$ yielding the highest Benefit Cost Ratio (2.90) due to lower input costs. The control treatment ($T_{10}$) recorded the lowest values across all parameters which highlighted the importance of integrated nutrient management. The results suggest that the combined application of 7.5 t/ha FYM, 2.5 t/ha Pig manure, and 1.5 kg/ha *Rhizobium* is optimal for sustainably enhancing fenugreek productivity in this region.

**Conflict of interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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