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CONGRESS PAPER

Assessing the Impact of Organic Amendments on Growth, Yield, Soil Health, and Farmers' Perceived Constraints in French Bean Cultivation in Phek District, Nagaland

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ABSTRACT

French bean (Phaseolus vulgaris L.) is an important vegetable crop valued for its nutritional and economic importance. In Phek district of Nagaland, its productivity is limited by acidic soils, poor soil fertility, and inadequate nutrient management practices, leading to low yields and declining soil health. The study aimed to evaluate the effect of different organic nutrient sources on the growth, yield, and soil fertility of French bean and to assess farmers' economic and technical constraints in cultivation. A field experiment was conducted during the kharif season at Thipuzu village, Phek district, Nagaland, using five treatments: T_1 (control), T_2 (biofertilizer), T_3 (vermicompost), T_4 (FYM), and T_5 (biofertilizer + vermicompost + FYM) with three replications. Growth, yield, and soil fertility parameters were statistically analyzed, and farmers' constraints were also recorded. The integrated treatment T_5 (biofertilizer + vermicompost + FYM) recorded the highest plant height (53.53 cm), pods per plant (38.67), and pod yield (28.43 t ha^{-1}). It also significantly improved soil pH, available nitrogen, phosphorus, and potassium compared to other treatments. Farmers identified low market price, labor scarcity, lack of technical knowledge, and inadequate extension support as major constraints affecting French bean cultivation. The study demonstrated that integrated organic nutrient management effectively improves French bean productivity and soil fertility in acidic hill soils. Strengthening extension services, promoting scientific organic farming, and improving market support can enhance sustainable French bean cultivation in Nagaland.

Keywords: *French bean, Organic amendments, Yield, Soil properties*

French bean (*Phaseolus vulgaris* L.) is an important vegetable crop, known for its nutritional value and significant economic importance (Panwar *et al*., 2024). This leguminous crop is an excellent source of protein, fiber, and essential micronutrients, making it a staple in many cuisines (Noopur *et al*., 2021). However, the growth and productivity of French bean are often hindered by limited nutrient availability and poor soil quality. The acidic soils, limited fertility, and inadequate nutrient management practices prevalent in Phek district, Nagaland, further exacerbate these challenges, resulting in poor crop yields, reduced soil fertility, and decreased agricultural productivity (Chiphang *et al*., 2020). In recent years, there has been a growing interest in organic farming practices, which prioritize the use of natural amendments to improve soil health, reduce environmental pollution, and promote sustainable agriculture (Noopur *et al*., 2025) and quality of produce (Noopur *et al*., 2019). Organic materials, such as compost, vermicompost, and farmyard manure, hold great promise as a source of multiple nutrients and have the ability to improve soil characteristics (Moller, 2009; Pandey *et al*., 2021). These amendments not only provide essential nutrients but also maintain the soil's physical, chemical, and biological characteristics, improving overall ecological balance and promoting sustainable agriculture (Tomar *et al.,* 2023).

The use of organic amendments has been shown to have a profound impact on soil fertility, structure, and biodiversity, ultimately leading to improved crop growth, yield, and quality (Panwar *et al*., 2021). By adopting organic farming practices and utilizing natural amendments, farmers in Phek district can improve soil health, reduce environmental pollution, and promote sustainable agriculture, ensuring a more productive and resilient agricultural system. As the world shifts towards more sustainable and environmentally friendly practices, the importance of organic amendments in improving soil health and promoting sustainable agriculture cannot be overstated (Devi *et al*., 2022). A considerable gap still exists between agricultural technologies developed by research institutions and their actual adoption

under farmers' field conditions, highlighting the need for developing technologies through participatory approaches involving farmers (Khan and Chauhan, 2005; Upadhyay, *et al*., 2021). The findings of this study will provide valuable insights into the potential of organic amendments to enhance French bean production and soil health in Phek district, contributing to the development of sustainable and environmentally friendly agricultural practices in the region.

METHODOLOGY

A field experiment was conducted during the kharif season at Thipuzu village in Phek district of Nagaland to evaluate the effect of different organic nutrient sources on the growth, yield, and soil parameters of French bean variety 'Anupama'. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and five treatments, namely T_1 (control), T_2 (biofertilizer), T_3 (vermicompost), T_4 (farmyard manure/ FYM), and T_5 (biofertilizer + vermicompost + FYM). The study was conducted across 15 farmers' fields, with three farmers allotted to each treatment, and the average observations from the farmers under each treatment were considered as one replication. The experimental soil was acidic in nature with an initial pH of 5.15, available nitrogen of 206.2 kg ha^{-1}, phosphorus of 9.2 kg ha^{-1}, and potassium of 121.8 kg ha^{-1}. Organic nutrient sources were applied during land preparation, with vermicompost applied at 2 t ha^{-1} and FYM at 5 t ha^{-1}. For treatment T_2, seeds were treated with Rhizobium and Phosphotika biofertilizers at the rate of 2 kg ha^{-1} and shade dried before sowing. Observations on growth and yield attributes were recorded using standard procedures. Soil samples were collected after harvest, air-dried in shade, sieved through a 2 mm mesh, and analyzed for soil pH, available nitrogen, phosphorus, and potassium using standard analytical methods. The collected data were statistically analyzed through analysis of variance (ANOVA) following the procedure suggested by Panse and Sukhatme (1978) to determine the significance of treatment effects on crop growth, yield, and soil properties. In addition, feedback from farmers regarding the economic and technical constraints associated with the adoption of organic farming practices was also documented and analyzed.

RESULTS

Growth and Yield Parameters

Plant Height: The data presented in Table 1 indicated that plant height at harvest of French bean was significantly influenced by different organic nutrient treatments. The highest plant height (53.53 cm) was recorded under T_5 (Biofertilizer + Vermicompost + FYM), which was significantly superior to all other treatments as well as the control (T_1: 34.80 cm).

Among the individual organic nutrient sources, vermicompost (T_3) recorded a plant height of 50.40 cm, which was statistically at par with T_5, as the difference between them was less than the critical difference (CD = 5.52 cm). However, it was significantly higher than biofertilizer alone (T_2: 41.67 cm) and FYM (T_4: 46.90 cm). The lowest plant height was observed in the control (T_1), indicating the positive response of French bean to organic nutrient application.

Number of Pods per Plant: The data presented in Table 1 revealed that the number of pods per plant of French bean was significantly influenced by different organic nutrient treatments. The highest number of pods per plant (38.67) was recorded under T_5 (Biofertilizer + Vermicompost + FYM), which was significantly superior to all other treatments including the control (T_1: 16.00).

Vermicompost (T_3), among the individual organic nutrient treatments, resulted in 33.33 pods per plant and showed no significant difference with T_5, as the variation between the two treatments was below the critical difference (CD = 6.31). However, it was significantly higher than T_2 (Biofertilizer: 25.33) and T_4 (FYM: 26.33). The control (T_1) recorded the lowest number of pods per plant, indicating a clear positive response to organic nutrient application. The SEm± value (2.00) and CD at 5% level (6.31) indicated that the differences among treatments were statistically significant. Overall, the combined application of biofertilizer, vermicompost, and FYM (T_5) proved most effective in enhancing the number of pods per plant in French bean under the given conditions.

Table 1. Effect of different concentration of organic nutrients on the growth attributes of French bean

Treatments	Plant height at harvest (cm)	No of pods per plant
T1 (Control)	34.80	16.00
T2 (Biofertilizer)	41.67	25.33
T3 (Vermicompost)	50.40	33.33
T4 (FYM)	46.90	26.33
T5 (Biofert. + Vermic. + FYM)	53.53	38.67
SEm±	1.75	2.00
CD (p value ≤0.05)	5.52	6.31

Pod Yield: The data presented in Table 2 indicated that pod yield of French bean varied numerically under different organic nutrient treatments. The highest pod yield (28.43 t ha^{-1}) was recorded under T_5 (Biofertilizer + Vermicompost + FYM), followed by T_3 (Vermicompost:

Table 2. Effect of different concentration of organic nutrients on the yield attributes of French bean

Treatments	Pod yield (t/ha)
T1 (Control)	15.74
T2 (Biofertilizer)	19.86
T3 (Vermicompost)	22.7
T4 (FYM)	20.83
T5 (Biofertilizer + Vermicompost + FYM)	28.43
SEm±	13.28
CD (p value ≤0.05)	41.86

22.70 t ha^{-1}), T_4 (FYM: 20.83 t ha^{-1}), and T_2 (Biofertilizer: 19.86 t ha^{-1}), while the lowest yield was observed in the control (T_1: 15.74 t ha^{-1}). However, statistical analysis revealed that the differences among treatments were non-significant at the 5% level of probability, as the variation between treatment means did not exceed the critical difference (CD = 41.86). The relatively higher SEm± value (13.28) further indicates greater variability in the data. Although not statistically significant, the trend suggests that the combined application of biofertilizer, vermicompost, and FYM (T_5) resulted in higher pod yield compared to individual applications and control under the given conditions.

Soil Parameters: Soil pH: The data presented in Table 3 indicated that soil pH was significantly influenced by different organic nutrient treatments. The highest soil pH (5.68) was recorded under T_5 (Biofertilizer + Vermicompost + FYM), which was significantly superior to the control (T_1: 5.39).

Among the individual treatments, vermicompost (T_3) recorded a soil pH of 5.63, which was statistically at par with T_5, as the difference between them was less than the critical difference (CD = 0.09). FYM (T_4: 5.58) also showed a higher soil pH compared to biofertilizer alone (T_2: 5.47) and control (T_1), indicating improvement in soil reaction with organic amendments.

The lowest soil pH was observed in the control (T_1), while all organic nutrient treatments resulted in a noticeable increase in soil pH. The SEm± value (0.03) and CD at 5% level (0.09) confirmed that the differences among treatments were statistically significant. Overall, the combined application of biofertilizer, vermicompost, and FYM (T_5) was most effective in improving soil pH under the given conditions.

Available Nitrogen, Phosphorus, and Potassium: The results revealed a significant increase in available soil nutrients due to organic amendments (Table 3 and Fig. 5). The T5 treatment recorded the highest values of available nitrogen (266.53 kg ha^{-1}), phosphorus (20.87 kg ha^{-1}), and potassium (174.53 kg ha^{-1}), indicating marked improvement in soil fertility compared to other treatments and the control. The data presented in Table 3 revealed that available nitrogen, phosphorus and potassium in soil were significantly influenced by different organic nutrient treatments.

The highest available nitrogen (266.53 kg ha^{-1}) was recorded under T_5 (Biofertilizer + Vermicompost + FYM), which was significantly superior to all other treatments as well as the control (T_1: 215.67 kg ha^{-1}). Among the individual treatments, vermicompost (T_3: 238.47 kg ha^{-1}) recorded significantly higher nitrogen compared to T_2 (229.80 kg ha^{-1}) and T_4 (233.00 kg ha^{-1}), while the lowest was observed in the control. The differences among treatments were statistically significant as they exceeded the CD value (13.69 kg ha^{-1}), with a SEm± of 4.34.

A similar trend was observed for available phosphorus. The highest phosphorus content (20.87 kg ha^{-1}) was recorded under T_5, which was significantly higher than all other treatments. Vermicompost (T_3: 19.40 kg ha^{-1}) was found to be statistically at par with T_5, as the difference between them was less than the CD (2.51 kg ha^{-1}), but significantly superior to T_2 (14.90 kg ha^{-1}), T_4 (16.77 kg ha^{-1}), and control (12.47 kg ha^{-1}). The SEm± value for phosphorus was 0.80, indicating reliable estimation.

In the case of available potassium, T_5 recorded the highest value (174.53 kg ha^{-1}), which was significantly superior to the control (131.87 kg ha^{-1}) and other treatments. Vermicompost (T_3: 169.17 kg ha^{-1}) was statistically at par with T_5, as the difference was less than the CD (12.11 kg ha^{-1}), but significantly higher than T_2 (157.33 kg ha^{-1}) and T_4 (162.53 kg ha^{-1}). The SEm± value for potassium was 3.84.

Farmer's perception on nutrient management: Among the economic constraints, low selling price of French bean

Table 3. Effect of different concentration of organic nutrients on the soil properties

Treatments	Soil pH	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T1 (Control)	5.39	215.67	12.47	131.87
T2 (Biofertilizer)	5.47	229.80	14.90	157.33
T3 (Vermicompost)	5.63	238.47	19.40	169.17
T4 (FYM)	5.58	233.00	16.77	162.53
T5 (Biofertilizer + Vermicompost + FYM)	5.68	266.53	20.87	174.53
SEm±	0.03	4.34	0.80	3.84
CD (p value ≤0.05)	0.09	13.69	2.51	12.11

Table 4. Farmers perception affecting sustainability of French bean cultivation

Farmer's perception dynamics	Group of farmers	
	%	Rank
A. Economic factors		
Low selling price of french bean	95.62	I
High cost of labour	92.45	III
Non availability of labour	94.64	II
Cost of FYM is very high	85.67	IV
High cost of vermicompost	82.45	VI
Marketing system is lacking	84.85	V
B. Technical factors		
Lack of visit of experts	76.54	IV
No mechanization	74.65	III
Lack of irrigation facilities	78.65	II
Transportation cost is very high	94.57	I

was ranked as the most severe constraint by the farmers of Thipuzu village in Phek district, with 95.62 per cent respondents expressing concern over it. Non availability of labour (94.64%) and high cost of labour were at 2nd and 3rd ranked and consider major constraints. The use of vermicompost was restricted as farmers were not aware of its preparation and application. The organic FYM was also not frequently available and its cost ranked IV as the economic constraints. Among the technical constraints, transportation cost (94.57%) was ranked 1st followed by Lack of irrigation facilities (78.65%) and No mechanization by the respondent farmers (74.65%). (Table 4).

DISCUSSION

The present study highlights the beneficial effects of organic nutrient sources on growth, yield, and soil properties of French bean. The superior performance of the combined application (T_5: Biofertilizer + Vermicompost + FYM) in terms of plant height and number of pods per plant may be attributed to the synergistic interaction of organic inputs, which enhances nutrient availability, microbial activity, and overall soil health. Similar findings have been reported by Choudhary *et al*. (2015), who observed improved crop growth with vermicompost application due to enhanced nutrient supply and better soil conditions. The positive influence of integrated nutrient sources on crop growth is also supported by Sharma *et al*. (2013), who reported improved yield attributes in cabbage with combined use of organic manures and biofertilizers. The study further indicated that farmers have limited knowledge for preparation and application of vermicompost and other organic inputs, which restricts their wider adoption in French bean cultivation under high hills of Nagaland. This can be improved through entrepreneurship development (Chauhan *et al*., 2023). Respondents also highlighted the importance of continuous technical guidance and timely extension services to enhance their understanding and effective utilization of these practices (Chauhan and Saikia, 2021) . This need is particularly significant under the high-hill agro-climatic conditions of Nagaland, where the development and dissemination of location-specific technologies are crucial for improving crop productivity and promoting sustainable agricultural development.

Although pod yield was highest under T_5, the differences among treatments were statistically non-significant, which may be due to higher variability in experimental data, as indicated by the higher SEm and CD values. However, the increasing trend in yield under integrated nutrient application suggests practical significance. Similar trends were observed by Singh *et al*. (2009) in ginger, where combined organic inputs improved yield performance. The role of integrated nutrient management in enhancing crop productivity has also been emphasized by Sharma and Khadda (2023). The improvement in soil properties, particularly soil pH and available N, P, and K under organic treatments, indicates the long-term benefits of organic nutrient management. The increase in soil pH suggests amelioration of acidic soil conditions, which is crucial for nutrient availability. Enhanced nutrient status under T_5 may be due to mineralization of organic matter and improved nutrient cycling, as supported by Moller (2009), who reported improved nutrient dynamics under organic manuring systems. Similarly, Sharma *et al.* (2009) observed increased soil fertility and nutrient uptake with the application of vermicompost and FYM. The statistical validity of the results was assessed using standard procedures as outlined by Panse and Sukhatme (1978), confirming the significance of treatment effects for most parameters. Kaur *et al*., (2021) suggested farm typology based interventions for enhanced productivity and soil health. The farmers' perception regarding French bean cultivation revealed that low selling price significantly affects farm profitability in Thipuzu village of Phek district. The respondents also identified non-availability of labor during critical farm operations such as sowing, weeding, and harvesting as a major constraint. Due to labor scarcity and high wage rates, many farmers depend on neighbors, relatives, and community-based mutual support systems for labor-intensive activities.

CONCLUSION

This study demonstrates that organic nutrient management significantly enhances French bean growth and soil health. The integrated application of biofertilizer,

vermicompost, and FYM (T_5) proved most effective, maximizing plant height, pod counts, and vital soil nutrients (N, P, K), while optimizing soil pH under acidic conditions. Individually, vermicompost (T_3) outperformed other solo treatments. Structurally, farmers in Thipuzu village, Nagaland, face critical economic and technical hurdles, including labor scarcity, low market prices, and limited technical knowledge. Addressing these challenges through improved market linkages and dedicated training on organic practices is essential to boost sustainability and productivity in high-hill regions.

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