

# **Effect of integrated nutrient management on growth and yield of French bean (*Phaseolus vulgaris* L.)**

## **Abstract**

The present investigation entitled, “Effect of integrated nutrient management on growth and yield of French bean (*Phaseolus vulgaris* L.)” was carried out at the research farm of School of Agriculture, Abhilashi University, Mandi (H.P.) during spring season 2022. The experiment was laid out in a randomized block design with three replications. The treatments consisted of conjoint and sole application of organic (FYM and vermicompost) and inorganic fertilizers (urea, SSP and MOP). In terms of soil chemical properties i.e., soil pH (5.6) strongly acidic, organic carbon (0.99%) i.e. high and NPK (260:18:336) kg/ha were maximum observed in treatment T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). Out of seven treatments, treatment T<sub>7</sub> was recorded best performing for all the traits i.e. days to 50% germination (14.06), leaf area index at 60 DAS (105.32 cm<sup>2</sup>) and at harvest (130.65 cm<sup>2</sup>), fresh weight of plant (189.20 g), dry weight of plant (20.03 g), yield per plot (17.45 kg), yield per hectare (290.84q/ha), biological yield (29.47q/ha) and harvest index (59.19%). The maximum gross return (581680 Rs/ha), net return (483209 Rs/ha) and B:C ratio (1:5.9) was also recorded in T<sub>7</sub> 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost. Thus, application of optimum doses of NPK along with organic manures was found highly beneficial for plant growth, yield and economics of French bean.

**Keywords:** B:C ratio, Integrated Nutrient Management (INM), French bean, yield.

## **Introduction**

Studying the effect of integrated nutrient management (INM) on the growth and yield of French beans (*Phaseolus vulgaris* L.) in Abhilashi University, Mandi, Himachal Pradesh (H.P.) holds significant relevance both at a local and global scale. At the local level, Himachal Pradesh is known for its diverse agricultural practices, and beans are a vital crop in the region. Investigating how INM can optimize French bean production in the specific agro-climatic conditions of H.P. can directly benefit local farmers by enhancing crop yields, increasing economic returns, and improving food security in the region.

Furthermore, comparing the findings of this research with other studies on soil quality in tropical crops in Latin America allows for the exchange of valuable insights and knowledge between regions with distinct agricultural contexts. Latin America is a major

player in global agriculture (Campos, 2023) and its diverse climates (Parra et al. 2012; Rodriguez et al. 2013; Zingaretti et al. 2016) and cropping systems can offer unique perspectives on sustainable farming practices (Hernandez et al. 2020; Hernandez and Olivares, 2020). By drawing comparisons, researchers can identify universal principles of INM and soil management that transcend geographical boundaries (Hernandez and Olivares, 2019), facilitating the dissemination of best practices and the development of innovative strategies to address the challenges faced by farmers worldwide (Hernandez et al. 2018a; 2018b).

Moreover, as agriculture faces increasing pressures from climate change (Viloria et al. 2023), understanding how INM influences crop growth and soil quality in both temperate (Guevara et al. 2013; Casana and Olivares, 2020) and tropical regions becomes crucial for global food security (Olivares et al. 2021). The research conducted in Abhilashi University can serve as a case study that contributes to the broader discourse on sustainable agriculture. It can provide valuable data and insights to inform agricultural policies (Pitti et al. 2021; Olivares et al. 2020), practices (Guevara et al. 2012; Araya-Alman et al. 2020), and adaptation strategies in both Himachal Pradesh and Latin American countries (Montenegro et al. 2021), ultimately benefiting farmers (Olivares et al. 2018), ecosystems (Olivares et al. 2022), and food production on a global scale.

## **Material and methods**

The present investigation was conducted during 2021-22 during kharif season at Agriculture Research Farm School of Agriculture, Abhilashi university, Mandi (H.P.). The experimental farm is situated at 31<sup>0</sup>33'34" N latitude and 77<sup>0</sup>00'31" E longitudes having an altitude of 1,426 m above mean sea level. The experiment was laid out in randomized block design (RBD) with seven treatments and three replications. The treatments were T<sub>1</sub>: Control (Without fertilizer), T<sub>2</sub>: 100% Recommended dose of fertilizer NPK (Inorganic), T<sub>3</sub>: 100% RDF of farmyard manure, T<sub>4</sub>: 100% RDF of vermicomposting, T<sub>5</sub>: 50% RDF of FYM + 50% RDF of Vermicompost, T<sub>6</sub>: 50% RDF of NPK + 25% FYM + 25% Vermicompost, T<sub>7</sub>: 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost. The plot size was 3m × 2m and the spacing adopted was 60cm × 45cm. Seeds of French bean Rizwan Charmee imp were sown on 1 March, 2022 at a spacing of 30 × 10 cm. Seeds were properly covered with a thin layer of soil and the plots were irrigated lightly. Farmyard manure was applied at the time of field preparation. Before the commencement of the experiment, soil samples were collected

randomly from different plots of the experiment field from depth of 0-15 cm and the composite sample was prepared by mixing all these samples together. The soil sample after drying was passed through 2.0 mm sieve and was analyzed for soil pH, organic carbon and for available NPK. The result of analysis and methods used are presented in table 3. The recommended dose of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were applied at the time of sowing in each plot as per the distributed to different treatments. Different growth and yield parameters like plant height, leaf area index, number of pods per plant, number of seeds per pod yield per hectare. The statistical analysis was carried out by using the statistical package OPSTAT.

## **Result and discussion**

### **Soil properties of experimental field (post-harvest)**

Data pertaining to soil pH, OC (%), available NPK are present in (Table-1) showed that application of different level of NPK did not affected pH in the post-harvest soil. The treatments were found significant effect for organic carbon, available NPK. The result indicated that the combination of NPK significantly increase the organic carbon content in the soil over control and the application of different levels of NPK successively and significantly increased the available NPK content in the soil.

The minimum pH was recorded in T<sub>1</sub> Control without fertilization (5.3) and maximum pH was recorded in T<sub>7</sub> 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost (5.6). Similar results for soil pH was observed by Badhulkar et al. (2000) and Selvi et al. (2004). In case of organic carbon T<sub>5</sub> 50% RDF of FYM +50% RDF of Vermicompost observed the highest organic carbon (0.72) and T<sub>1</sub> Control without fertilization observed the minimum organic carbon (0.42).

Maximum available N (260 kg ha<sup>-1</sup>) was recorded in T<sub>7</sub> 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum N (164 kg ha<sup>-1</sup>) in treatment T<sub>1</sub> Control without fertilization. Nitrogen will be mineralized slowly and supplied required quantity of useable nitrogen during a progressive growth period but the initial requirement of nitrogen would be met from inorganic source nitrogen combined with vermicompost as well as farm yard manure results in better soil fertility which improves the yield according to Jagdale et al. (2005), Kalange (2006), Band et al. (2007), Kamble et al. (2016) and Mohanty et al. (2017). Maximum available P (18 kg ha<sup>-1</sup>) was recorded in T<sub>7</sub> 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum P (10 kg ha<sup>-1</sup>) in treatment T<sub>1</sub> Control without fertilization. The increase in the available P content due to incorporation of organic manures

as well as solubilization of native P through release of various organic acids, but better availability of phosphorus is under chemical fertilizer treatment and integrated nutrient management due to more mineralization owing to addition of chemical fertilizers. Similar improvement in available P due to integrated use of manures and chemical fertilizer has been observed by Sharma et al. (2009). And maximum available K (336 kg ha<sup>-1</sup>) was recorded in T<sub>7</sub> 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum K (145 kg ha<sup>-1</sup>) in treatment T<sub>1</sub> Control without fertilization. Increase in K availability due to application of organic manures might have been due to direct addition of K to the available K pool of the soil besides the reduction of K fixation due to interaction of organic matter with clay (Bharadwaj and Omanwar, 1994).

**Table:1-Effect of NPK on soil properties**

Treatments	Soil pH	Organic carbon (%)	Available N (kg ha <sup>-1</sup> )	Available P (kg ha <sup>-1</sup> )	Available K (kg ha <sup>-1</sup> )
Control (without fertilization).	5.3	0.42	164	10	145
100% recommended dose of fertilizer NPK (Inorganic).	5.5	0.53	192	15	280
100% RDF of Farm yard manure.	5.4	0.70	205	12	162
100% RDF of Vermicompost.	5.4	0.66	240	12	179
50% RDF of FYM + 50% RDF of Vermicompost.	5.5	0.72	216	13	302
50% RDF of NPK + 25% FYM +25% Vermicompost.	5.5	0.63	244	16	205
75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost.	5.6	0.65	260	18	336
SE (m) ±	0.05	0.01	2.17	0.18	2.05
CD at 5%	NS	0.02	6.14	0.56	5.78

### Plant growth attributes

The earliest germination count is observed in T<sub>7</sub> (8.28) under 75% RDF of NPK + 12.5% FYM +12.5% Vermicompost. And the lowest germination count is observed in T<sub>1</sub>

14.06 (Control without fertilizer) followed by T<sub>2</sub> (10.91) under 100% recommended dose of fertilizer NPK (Inorganic). As we know that inorganic fertilizers such as N promotes seed germination through function as signaling molecule and vermicompost help seeds germinate faster so application of organic fertilizers along with inorganic has great effect on the germination percentage of French bean. Similar data was observed by Meena et al. (2018), Sharma et al. (2014), Singh and Chauhan (2009).

At 60 DAS maximum leaf area index of (105.32) cm<sup>2</sup> was recorded in T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). And the lowest leaf area index was recorded in T<sub>1</sub> (Control without fertilizer) 53.02 cm<sup>2</sup>. And at the time of harvest, the maximum leaf area index i.e. 130.65 cm<sup>2</sup> was observed in treatment T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). And the lowest leaf area index 81.74 cm<sup>2</sup> was recorded in T<sub>1</sub> (Control without fertilizer). Nitrogen will be mineralized slowly but steadily and supplied required quantity of useable nitrogen during progressive growth period but initial requirement of nitrogen would be met from inorganic source as it would be available instantly to the plants according to Jagdale et al. (2005), Kalange (2006), Band (2016) and Mohanty (2017).

. Among different treatments, T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) recorded significantly higher number of leaves from 30 DAS till maturity whereas, minimum number of leaves was recorded in T<sub>1</sub> control without fertilization). In T<sub>6</sub> maximum number of leaves were recorded followed by T<sub>5</sub> 50% RDF of NPK + 25% FYM + 25% Vermicompost, T<sub>4</sub> 100% RDF of Vermicompost, T<sub>3</sub> 100% RDF of Farm yard manure.

The maximum number of leaves was observed in the treatment T<sub>7</sub> 35.20 (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) whereas, the minimum number of leaves was recorded in T<sub>9</sub> (Control without fertilization) and its value was 27.48. According to Shwetha et al. (2012) maximum no of leaves in french bean crop is due to the application of organic and inorganic fertilizers combines.

The maximum value of french bean fresh weight of plant is recorded in treatment T<sub>7</sub> i.e. 189.20 (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) and the minimum value of fresh weight of plant is recorded in T<sub>1</sub> (145.30) control without fertilization. Fresh weight of the plant is directly influenced by the application of inorganic manures but has better results are seen along with organic fertilizers. The result is in consonance with the reports of Singh et al. (2011).

The highest plant weight (dry) was recorded 20.03 in T<sub>6</sub> 50% RDF of NPK + 25% FYM +25% Vermicompost) and the minimum value was recorded 13.83 in T<sub>1</sub> (control without fertilization). Dry weight of the plant is directly influenced by the application of inorganic manures along with organic fertilizers. The result is in consonance with the reports of Ramana et al. (2011), Singh et al. (2011).

**Table:2- Effect of integrated nutrient management on growth parameter on French bean.**

Treatments	Day to 50 per cent germination	Leaf area index (cm <sup>2</sup> )		No of leaves	Fresh weight of plants	Dry weight of plants
		At 60	At harvest			
Control(without fertilization).	14.06	53.02	81.74	27.48	145.30	13.83
100% recommended dose of fertilizer NPK (Inorganic).	10.91	99.76	127.60	30.60	162.90	16.96
100% RDF of Farm yard manure.	12.79	75.74	98.65	27.78	160.60	14.93
100% RDF of Vermicompost.	12.56	78.07	103.63	28.04	162.86	16.16
50% RDF of FYM + 50% RDF of Vermicompost.	11.37	87.23	111.88	26.44	163.06	18.83
50% RDF of NPK + 25% FYM +25% Vermicompost.	8.28	88.15	117.20	30.60	176.70	20.03
75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost.	7.77	105.32	130.65	35.20	189.20	17.83
SE (m) ±	0.59	1.52	2.40	0.51	6.31	0.37
CD at 5%	1.84	4.76	7.49	2.01	19.68	1.17

### Yield attributes

Maximum seeds per pod were recorded (7.2) and maximum number of pods per plant (29.80) in treatment T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) and the minimum number of seeds per pod (6.3) and the lowest number of pods per plants (23.20) was observed in treatment T<sub>1</sub> Control (without fertilization).

Maximum yield per plant (250.25g), yield per plot (17.45kg), yield per hectare (290.84q), biological yield (29.5 q/ha) and highest harvesting index (59.19%) was observed in T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). Application of vermicompost, FYM and bio fertilizers combine helped in improving soil health as well as facilitates slow and continuous supply of nutrients to the plant. The increase in yield is due to better performance of yield attributes according to Singh (2000), Dhanjal et al. (2001), Manjunath (2010), Ramana et al. (2011).

**Table: 3- Effect of integrated nutrient management on yield of French bean**

Treatments	Seed/ Pod	Pods/ plants	Yield per plant (g)	Yield per plot (kg)	Yield/hectare (q/ha)	Biologica l yield (q/ha)	Harvest index (%)
Control(without fertilization).	6.3	23.20	147.27	9.77	162.91	21.0	46.45
100% recommended dose of fertilizer NPK (Inorganic).	7.0	28.26	207.27	13.86	225.81	24.1	57.42
100% RDF of Farm yard manure.	6.4	25.95	172.82	11.49	191.55	21.2	53.91
100% RDF of Vermicompost.	6.5	26.77	189.39	12.23	203.84	22.2	54.91
50% RDF of FYM + 50% RDF of Vermicompost.	6.7	27.83	200.54	13.02	217.06	23.1	56.10
50% RDF of NPK + 25% FYM +25% Vermicompost.	7.1	29.50	240.19	15.91	265.30	27.4	58.02
75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost.	7.2	29.80	250.25	17.45	290.84	29.5	59.19
SE (m) ±	0.16	0.39	11.69	0.85	14.29	1.06	1.46

CD at 5%	0.50	1.23	36.42	0.67	44.53	3.31	4.56
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### Cost Benefit Ratio (CBR)

The economics of the various treatment combinations have been presented in Table 4. A perusal of data revealed that highest cost of production ₹/hectare (₹ 1,37,235), maximum gross income ₹/hectare amounting to (₹ 5,81,680), highest net return ₹/hectare (₹ 4,83,209), maximum net return/rupee invested (1: 5.9) was incurred in treatment T<sub>7</sub> (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) whereas lowest cost of cultivation ₹/hectare (₹ 87,235), minimum gross income ₹/hectare (₹ 3,25,820), lowest net return ₹/hectare (₹ 2,38,585), net return per rupee invested (1:3.7) was observed in treatment T<sub>1</sub> control without fertilization.

**Table 4.** Effect of integrated nutrient management on economics

Treatments	Cost of cultivation (₹/ha)	Gross Return (₹/ha)	Net Return (₹/ha)	Net return per rupee invested
Control(without fertilization).	87235	325820	238585	1:3.7
100% recommended dose of fertilizer NPK (Inorganic).	91595	461940	370345	1:5.0
100% RDF of Farm yard manure.	107253	383100	275847	1:3.5
100% RDF of Vermicompost.	137235	407680	270445	1:2.9
50% RDF of FYM + 50% RDF of Vermicompost.	122235	434140	311905	1:3.5
50% RDF of NPK + 25% FYM +25%	111915	530280	418365	1:4.7

Vermicompost.				
75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost.	98471	581680	483209	1:5.9

## Conclusion

Based on the present investigation it can be concluded that, different treatment combinations significantly influence the growth and yield of french bean. The application of nutrient in combination of organic as well as inorganic fertilizer were found more effective than organic or inorganic alone for growth and yield of french bean.

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