

Original Research Article

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 the 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 fertilizer (urea, SSP and MOP). In terms of soil chemical properties i.e., soil pH (5.6), maximum organic carbon (0.99%) and maximum NPK (260.00:18.00: 336.00 kg/ha) was observed in treatment T₇ (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). Out of seven treatments, treatment T₇ was recorded best performing for all the traits i.e. days to 50% germination (14.06), leaf area index at 60 (105.32 cm²) and (130.65 cm²) at harvest, 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 (530375 Rs/ha), net return (431885 Rs/ha) and B:C ratio (1:5.3) was also recorded in T₇ 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

French bean (*Phaseolus vulgaris* L) is one of the most popular and widely grown vegetables in India. It belongs to the Fabaceae family and has the chromosome 2n=22. One of the most significant leguminous vegetables is this one. It is a non-traditional, short-season legume with a high production potential that is one of the most prized and loved pulse crops in north India (Jan et al. 2019). It is a nutrient-rich vegetable that may be cultivated in a

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variety of soils, from light sandy loam to clay soils with a pH range of 5.3 to 6.0. It has many synonyms like; common beans, snap bean, dwarf beans, kidney beans, wax beans, garden beans pole beans and runner beans etc. It is cultivated in Himachal Pradesh as a seasonal and primary crop.

Being a short duration crop French bean can be grown under different cropping patterns of plain and hills of Himachal Pradesh. In India it is mainly grown in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Odisha, Bihar, Gujrat, Andhra Pradesh, Tamilnadu and Himachal Pradesh. The present practices being followed by the farmers for the packaging of French beans are in gunny bags or large size polythene bags therefore, the normal shelf life of French bean is 2-3 days.

French bean pods are a complete food since they have 1.7 g of protein, 0.1 g of fat, 4.5 g of carbohydrates, and 1.8 g of fiber in addition to being a source of vitamin A, thiamine, riboflavin, and other vitamins (Singh 2006). Besides it has some medicinal values and acts as antiaging factors, helps to prevent obesity, lowers the cholesterol content of blood and therefore recommended for curing heart and kidney related ailments (Adsule et al. 1998).

French beans are a delicate vegetable crop that cannot withstand frost, extreme heat, or heavy rain. The most advantageous soil temperature for its seed germination is between 18 and 24 °C, and its seeds do not germinate below 15 °C. Since the crop grows best in a temperature range of 15 to 25 °C, it is planted throughout the chilly season in India's plains. Its vegetative growth is not favoured by conditions of extremely high temperatures (Evans, 1974).

French bean is a fertilizer-responsive crop that benefits from nutrition, but too much nitrogen reduces pod output. It also fixes atmospheric nitrogen and increases soil fertility, just like other legumes (Adsule et al. 1998). According to studies, the lack of nodulation in north Indian plains prevents French bean from capturing enough atmospheric nitrogen (Kushwaha 1994). It consequently requires a lot of fertilizer high in nitrogen.

Studies clearly indicates that, the combined use of organic and chemical fertilizer not only increase the yield of crop but improve the physical, chemical and biological properties of soil. Use of organic manures with optimum rate of fertilizer under intensive farming system increased the turnover of nutrients in the soil plant system (Metkari and Dhok, 2011). Keeping this in view, the present experiment is proposed to be undertaken to find out the effect of integrated nutrient management on growth and yield of Frenchbean.

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 31⁰33'34" N latitude and 77⁰00'31" 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 T₁: Control (Without fertilizer), T₂: 100% Recommended dose of fertilizer NPK (Inorganic), T₃: 100% RDF of farm yard manure, T₄: 100% RDF of vermicomposting, T₅: 50% RDF of NPK + 50% RDF of Vermicompost, T₆: 50% RDF of NPK + 25% FYM + 25% Vermicompost, T₇: 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 was 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, P₂O₅ and K₂O 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.

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Result and discussion

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Soil properties of experimental field (post-harvest)

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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.

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The minimum pH was recorded in T₁ Control without fertilization (5.3) and maximum pH was recorded in T₇ 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 T₄ 100% RDF of vermicompost observe the highest organic carbon (0.99) and T₁ Control without fertilization observe the minimum organic carbon (0.65).

Maximum available N (260.00) was recorded in T₇ 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum N (164.00) in treatment T₁ Control without fertilization. Nitrogen will be mineralized slowly and supplied required quantity of useable nitrogen during progressive growth period but initial requirement of nitrogen would be met from inorganic source but 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 (18.00) was recorded in T₇ 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum P (10.00) in treatment T₁ 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 (336.00) was recorded in T₇ 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum K (145.00) in treatment T₁ 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 ⁻¹) | Available P (kg ha ⁻¹) | Available K (kg ha ⁻¹) |
|--|---------|--------------------|------------------------------------|------------------------------------|------------------------------------|
| Control(without fertilization). | 5.3 | 0.65 | 164.00 | 20.00 | 145.00 |
| 100% recommended dose of fertilizer NPK (Inorganic). | 5.5 | 0.80 | 192.00 | 32.00 | 280.00 |

| | | | | | |
|--|------|------|--------|-------|--------|
| 100% RDF of Farm yard manure. | 5.4 | 0.70 | 205.00 | 29.00 | 162.00 |
| 100% RDF of Vermicompost. | 5.4 | 0.99 | 240.00 | 33.00 | 179.00 |
| 50% RDF of FYM + 50% RDF of Vermicompost. | 5.5 | 0.70 | 216.00 | 42.00 | 302.00 |
| 50% RDF of NPK + 25% FYM +25% Vermicompost. | 5.5 | 0.90 | 244.00 | 47.00 | 205.00 |
| 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost. | 5.6 | 0.95 | 260.00 | 51.00 | 336.00 |
| SE (m) ± | 0.05 | 0.01 | 2.17 | 0.24 | 2.05 |
| CD at 5% | NS | 0.02 | 6.14 | 0.68 | 5.78 |

Plant growth attributes

The earliest germination count is observed in T₇ (8.28) under 75% RDF of NPK + 12.5% FYM +12.5% Vermicompost. And the lowest germination count is observed in T₁ 14.06 (Control without fertilizer) followed by T₂ (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).

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At 60 DAS maximum leaf area index of (105.32) cm² was recorded in T₇ (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). And the lowest leaf area index was recorded in T₁ (Control without fertilizer) 53.02 cm². And at the time of harvest, the maximum leaf area index i.e. 130.65 cm² was observed in treatment T₇ (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). And the lowest leaf area index 81.74 cm² was recorded in T₁ (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).

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. Among different treatments, T7 (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 T1 control without fertilization). In T6 maximum number of leaves were recorded followed by T5 50% RDF of NPK + 25% FYM +25% Vermicompost, T4 100% RDF of Vermicompost, T3 100% RDF of Farm yard manure.

The maximum number of leaves was observed in the treatment T7 35.20 (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) whereas, the minimum number of leaves was recorded in T9 (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 T₇ 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 T₁ (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 T₆ 50% RDF of NPK + 25% FYM +25% Vermicompost) and the minimum value was recorded 13.83 in T₁ (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 ²) | | 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 | 10.91 | 99.76 | 118.60 | 30.60 | 162.90 | 16.96 |

| | | | | | | |
|--|-------|--------|--------|-------|--------|-------|
| (Inorganic). | | | | | | |
| 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 | 126.20 | 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) \pm | 0.59 | 0.59 | 0.59 | 0.51 | 6.31 | 0.37 |
| CD at 5% | 1.84 | 1.84 | 1.84 | 1.59 | 19.68 | 1.17 |

Yield attributes

Maximum seeds per pod were recorded (7.20) and maximum number of pods per plant (29.80) in treatment T₇ (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) and the minimum number of seeds per pod (6.33) and the lowest number of pods per plants (23.20) was observed in treatment T₁ Control (without fertilization).

Maximum yield per plant (250.25g), yield per plot (17.45kg), yield per hectare (290.84q), biological yield (27.39q/ha) and highest harvesting index (59.19%) was observed in T₇ (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).

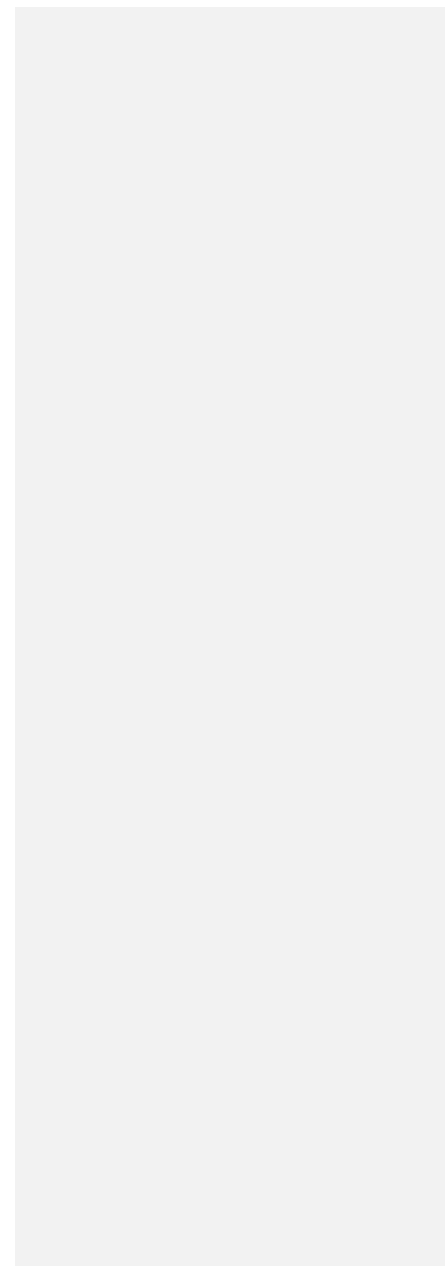
Table:3- Effect of integrated nutrient management on yield of French bean

| Treatments | Seed/Pod | Pods/ plants | Yield per plant | Yield per plot | Yield/hectare | Biological yield (q/ha) | Harvest index | | | |
|--|----------|-----------------|-----------------------|----------------------|---------------|-------------------------------|------------------|--|--|--|
| Control(without fertilization). | 6.33 | 23.20 | 147.27 | 9.77 | 162.91 | 21.04 | 46.45 | | | |
| 100% recommended dose of fertilizer NPK (Inorganic). | 7.00 | 28.26 | 202.57 | 13.55 | 225.81 | 23.97 | 56.35 | | | |
| 100% RDF of Farm yard manure. | 6.43 | 25.93 | 172.82 | 11.49 | 191.55 | 21.22 | 53.97 | | | |
| 100% RDF of Vermicompost. | 6.46 | 26.76 | 189.39 | 12.23 | 203.84 | 22.19 | 54.91 | | | |
| 50% RDF of FYM + 50% RDF of Vermicompost. | 6.73 | 27.83 | 200.54 | 13.02 | 217.06 | 23.14 | 56.1 | | | |
| 50% RDF of NPK + 25% FYM +25% Vermicompost. | 7.06 | 29.50 | 240.19 | 15.91 | 265.30 | 27.39 | 58.02 | | | |
| 75% RDF of NPK + | 7.20 | 29.80 | 250.25 | 17.45 | 290.84 | 29.47 | 59.19 | | | |

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|---------------------------------|------|------|-------|------|-------|------|------|--|--|--|
| 12.5% FYM + 12.5% Vermicompost. | | | | | | | | | | |
| 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 | | | |

UNDER PEER REVIEW



Economics

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 (₹ 5,30,375), highest net return ₹/hectare (₹ 4,31,886), maximum net return/rupee invested (1: 5.3) was incurred in treatment T₇ (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost) whereas lowest cost of cultivation ₹/hectare (₹ 87,235), minimum gross income ₹/hectare (₹ 3,08,650), lowest net return ₹/hectare (₹ 221415), net return per rupee invested (1:3.5) was observed in treatment T₁ 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 | 308650 | 221415 | 3.5 |
| 100% recommended dose of fertilizer NPK (Inorganic). | 91595 | 445125 | 353530 | 4.8 |
| 100% RDF of Farm yard manure. | 107253 | 373025 | 265772 | 3.4 |
| 100% RDF of Vermicompost. | 137235 | 393225 | 255972 | 2.8 |
| 50% RDF of FYM + 50% RDF of Vermicompost. | 122235 | 419700 | 297447 | 3.4 |
| 50% RDF of NPK + 25% FYM +25% Vermicompost. | 111915 | 467350 | 355417 | 4.1 |
| 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost. | 98471 | 530375 | 431886 | 5.3 |

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