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Effect of Integrated Nutrient Management on Growth and Yield of French Bean (*Phaseolus vulgaris* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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_7 (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost. Out of seven treatments, treatment T_7 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^2) and at harvest (130.65 cm^2), 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

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also recorded in T_7 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.

1. 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 [1] and its diverse climates [2-4] and cropping systems can offer unique perspectives on sustainable farming practices (Hernandez et al. 2020); [5]. By drawing comparisons, researchers can identify universal principles of INM and soil management that transcend geographical boundaries [6], facilitating the dissemination of best practices and the development of innovative strategies to address the challenges faced by farmers worldwide [7] (Hernandez et al. 2018b).

Moreover, as agriculture faces increasing pressures from climate change [8], understanding how INM influences crop growth and soil quality in both temperate [9,10] 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 [11,12], practices [9,13], and adaptation strategies in both Himachal Pradesh and Latin American countries [14], ultimately benefiting farmers [15], ecosystems [16], and food production on a global scale.

2. MATERIALS 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 $31^0$33'34" N latitude and $77^0$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_1: Control (Without fertilizer), T_2 :100% Recommended dose of fertilizer NPK (Inorganic), T_3:100% RDF of farmyard manure, T_4: 100% RDF of vermicomposting, T_5: 50% RDF of FYM +50% RDF of Vermicompost, T_6 :50% RDF of NPK + 25% FYM + 25%Vermicompost, T_7: 75% RDF of NPK + 12.5% FYM + 12.5%Vermicompost. The plot size was 3m × 2 m and the spacing adopted was 60 cm × 45 cm. 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_2O_5 and K_2O 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.

3. RESULTS AND DISCUSSION

3.1 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_1 Control without fertilization (5.3) and maximum pH was recorded in T_7 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost (5.6). Similar results for soil pH was observed by Badhulkar et al. [17] and Selvi et al. (2004). In case of organic carbon T_5 50% RDF of FYM +50% RDF of Vermicompost observed the highest organic carbon (0.72) and T_1 Control without fertilization observed the minimum organic carbon (0.42).

Maximum available N (260 kg ha^{-1}) was recorded in T_7 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum N (164 kg ha^{-1}) in treatment T_1 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. [18], Kalange [19], Band et al. [20], Kamble et al. (2016) and Mohanty et al. (2017). Maximum available P (18 kg ha^{-1}) was recorded in T_7 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum P (10 kg ha^{-1}) in treatment T_1 Control without fertilization. The increase in the available P content due to incorporation of organic manures as well as solublization 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. [21]. And maximum available K (336 kg ha^{-1}) was recorded in T_7 75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost and minimum K (145 kg ha^{-1}) in treatment T_1 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).

3.2 Plant Growth Attributes

The earliest germination count is observed in T_7 (8.28) under 75% RDF of NPK + 12.5% FYM +12.5% Vermicompost. And the lowest germination count is observed in T_1 14.06 (Control without fertilizer) followed by T_2 (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. [22], Sharma et al. [21], Singh and Chauhan [23].

At 60 DAS maximum leaf area index of (105.32) cm^2 was recorded in T_7 (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). And the lowest leaf area index was recorded in T_1 (Control without fertilizer) 53.02 cm^2. And at the time of harvest, the maximum leaf area index i.e. 130.65 cm^2 was observed in treatment T_7 (75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost). And the lowest leaf area index 81.74 cm^2 was recorded in T_1 (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. [18], Kalange [19], Band [20] and Mohanty (2017).

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. [24] maximum no of leaves in french bean crop is due to the application of organic and inorganic fertilizers combines.

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	0.42	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

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 (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

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)	Biological 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

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% Vermicompost.	111915	530280	418365	1:4.7
75% RDF of NPK + 12.5% FYM + 12.5% Vermicompost.	98471	581680	483209	1:5.9

The maximum value of french bean fresh weight of plant is recorded in treatment T_7 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_1 (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. [25].

The highest plant weight (dry) was recorded 20.03 in T_6 50% RDF of NPK + 25% FYM +25% Vermicompost) and the minimum value was recorded 13.83 in T_1 (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. [26], Singh et al. [25].

3.3 Yield Attributes

Maximum seeds per pod were recorded (7.2) and maximum number of pods per plant (29.80) in treatment T_7 (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_1 Control (without fertilization).

Maximum yield per plant (250.25 g), yield per plot (17.45 kg), yield per hectare (290.84 q), biological yield (29.5 q/ha) and highest harvesting index (59.19%) was observed in T_7 (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 [25], Dhanjal et al. [27], Manjunath [28], Ramana et al. [26].

3.4 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_7 (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_1 control without fertilization.

4. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Campos BO. Banana production in Venezuela: Novel Solutions to Productivity and Plant Health. Springer Nature; 2023. Available:https://doi.org/10.1007/978-3-031-34475-6
2. Parra R, Olivares B, Cortez A, Rodríguez MF. Pluviometric homogeneity patterns in climatic stations of Anzoátegui state, Venezuela. Revista Multiciencias. 12 (Extraordinario). 2012;11-17. Available:https://n9.cl/xbslq
3. Rodríguez MF, Cortez A, Olivares B, Rey JC, Parra R, Lobo D. Spatio-temporal analysis of precipitation in the state of Anzoátegui and its surroundings. Agronomía Tropical. 2013;63(1-2):57-65. Available:https://n9.cl/14iow
4. Zingaretti ML, Olivares B, Demey Zambrano JA, Demey JR. Typification of agricultural production systems and the perception of climate variability in Anzoátegui; 2016.
5. Hernández R, Olivares B. Application of multivariate techniques in the agricultural land's aptitude in Carabobo, Venezuela. Tropical and Subtropical Agroecosystems. 2020;23(2):1-12. Available:https://n9.cl/zeedh
6. Hernández R, Olivares B. Ecoterritorial sectorization for the sustainable agricultural production of potato (*Solanum tuberosum* L.) in Carabobo, Venezuela. Agricultural Science and Technology. 2019;339-354.

Available:https://doi.org/10.21930/rcta.vol20_num2_art:1462

7. Hernández R, Olivares B, Arias A, Molina JC, Pereira Y. Agroclimatic zoning of corn crop for sustainable agricultural production in Carabobo, Venezuela. Revista Universitaria de Geografía. 2018a;27(2): 139-159.
Available:https://n9.cl/l2m83
8. Viloria JA, Olivares BO, García P, Paredes-Trejo F, Rosales A. Mapping Projected Variations of Temperature and Precipitation Due to Climate Change in Venezuela. Hydrology. 2023;10:96.
Available:https://doi.org/10.3390/hydrology10040096
9. Guevara E, Olivares B, Oliveros Y, López L. Application of the thermal comfort index as an estimator of heat stress in livestock production in the Mesa de Guanipa, Anzoátegui state. Revista Zootecnia Tropical. 2013;31(3):209-223.
Available:https://n9.cl/ovcu9
10. Casana S, Olivares B. Evolution and trend of surface temperature and windspeed (1994 - 2014) at the Parque Nacional Doñana, Spain. Rev. Fac. Agron. (LUZ). 2020;37(1):1-25.
Available:https://n9.cl/c815e
11. Pitti J, Olivares B, Montenegro E. The role of agriculture in the Changuinola District: A case of applied economics in Panama. Tropical and Subtropical Agroecosystems. 2021;25-1:1-11.
Available:http://dx.doi.org/10.56369/tsaes.3815
12. Olivares B, Pitti J, Montenegro E. Socioeconomic characterization of Bocas del Toro in Panama: An application of multivariate techniques. Revista Brasileira de Gestao e Desenvolvimento Regional. 2020;16(3):59-71.
Available:https://doi.org/10.54399/rbgdr.v16i3.5871
13. Araya-Alman M, Olivares B, Acevedo-Opazo C, et al. Relationship Between Soil Properties and Banana Productivity in the Two Main Cultivation Areas in Venezuela. J Soil Sci Plant Nutr. 2020;20(3):2512-2524.
Available:https://doi.org/10.1007/s42729-020-00317-8
14. Montenegro E, Pitti-Rodríguez J, Olivares-Campos B. Identification of the main subsistence crops of Teribe: A case study based on multivariate techniques. Idesia (Arica). 2021;39(3):83-94.
Available:https://dx.doi.org/10.4067/S0718-34292021000300083
15. Olivares B, Hernández R, Coelho R, Molina JC, Pereira Y. Spatial analysis of the water index: an advance in the adoption of sustainable decisions in the agricultural territories of Carabobo, Venezuela. Revista Geográfica de América Central. 2018;60(1):277-299.
DOI: https://doi.org/10.15359/rgac.60-1.10
16. Olivares B, Vega A, Calderón MAR, Rey JC, Lobo D, Gómez JA, Landa BB. Identification of Soil Properties Associated with the Incidence of Banana Wilt Using Supervised Methods. Plants. 2022;11(15): 2070.
Available:https://doi.org/10.3390/plants11152070
17. Badhulkar RM, Wandile WP, Balpande SS. Residual effect of long-term application of FYM and fertilizer on soil properties and yield of soybean. Journal of the Indian Society of Soil Science. 2000;48:89-92.
18. Jagdale RB, Baviskar PK, Doshinge BB, Kore MS. Effect of inorganic and organic nutrients on growth and yield of French bean *(Phaseolus vulgaris L.).* Journal of Soils and Crops. 2005;15:401-405.
19. Kalange, AN. Integrated nutrient management for increased productivity of French bean (*Phaseolus vulgaris* L.) during Rabi season. MSc (Agri.) thesis, VNMKV Parbhani; 2006.
20. Band AM, SN Mendhe, S Harsha. Nutrient management studies in french bean *(Phaseolus vulgaris L.)* J. Soils and Crops. 2007;17:367-372.
21. Sharma SK, Prajapati S, Raghuwanshi O. Effect of organic manures and inorganic fertilizers on yield and economics of cowpea production (*Vigna unguiculata* L.). Indian Research Journal on Genetics and Biotechnologv. 2015;7:152-155.
22. Meena JS, Verma HP, Picholi P. Effect of fertility levels and bio fertilizers on yield, quality and economic of cowpea. Agriculture for Sustainable Development. 2014;2:162-164.
23. Singh NI, Chauhan JS. Response of French bean (*Phaseolus vulgaris* L.) to organic manures and inorganic fertilizers on growth and yield parameters under irrigated condition. Nature and Science 2009;7:154-158.
24. Shwetha SJ, Narayana BV, Shwetha, P Nirmala. Influence of integrated nutrient

management on growth and yield parameters of French bean. Mysore Journal of Agricultural Sciences. 2012; 46(3):655-657.

25. Singh AK, Singh SS. Effect of planting dates, nitrogen and phosphorus levels on yield contributing characters in French bean. Legume Res. 2000;23:33-36.
26. Ramana V, Ramakrishna M, Purushotham K, Reddy KB. Effect of bio- fertilizer on growth, yield and quality of French bean. Vegetable Science. 2011;38:35-38.
27. Dhanjal R, Prakash O, Ahlawat IS. Response of French bean (*Phaseolus vulgaris*) varieties to plant density and nitrogen application. Indian Journal of Agronomy. 2001;46:277-281.
28. Manjunath MN, Patil PL, Gali SK. Effect of organics amended rock phosphate and P-solubilizer on growth, yield and quality of French bean under vertisol of Malaprabha Command of North Karnataka. Karnataka Journal of Agricultural Sciences. 2006;19: 30-35.

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