RESEARCH ARTICLE Legume Research- An International Journal, Volume 48 Issue 3: 490-493 (March 2025)

Effect of Conjoint Application of Inorganic and Organic Nutrient Sources on Yield and Economics of French Bean (*Phaseolus vulgaris* L.)

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10.18805/LR-4979

ABSTRACT

Background: French bean is an important legume vegetable crop. Due to its low ability to fix atmospheric nitrogen, excess amount of nitrogenous fertilizers are required by this crop as compared to other legumes. Overwhelming application of inorganic inputs has severely impacted environment and soil. So, there is a need to reduce inorganic inputs by adding organic nutrient sources.

Methods: A three-year field experiment was laid comprising of eight treatment combinations and was replicated thrice during *Kharif* season of 2018, 2019 and 2020. Seeds of French bean cv. Green Wonder were sown at a spacing of 45 × 15 cm in each plot of size 3.0 m × 1.8 m. Recommended dose of fertilizers (NPK 50:100:50 kg ha^{-1}) was followed as per different treatment details.

Result: Application of 75 per cent NPK through inorganic and 25 per cent N through vermicompost resulted in minimum days to first pod harvest (61.89 days), maximum pod width (7.67 mm), number of pods per plant (30.96), plant height (51.29 cm), average pod weight (5.70 g), marketable pod yield (130.53 q ha^{-1}) and highest benefit cost ratio (2.18) along with maximum net returns (Rs. 313061.43 ha^{-1}).

Key words: Economics, Growth, INM, Inorganic, Organic, Vermicompost.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) belongs to family Fabaceae with chromosome number 2n = 14 is one of the most important vegetable crops and is widely cultivated legume globally. It is a short durational highly relished vegetable crop of North India. It has very high nutritional value containing 20.69 to 25.81 per cent crude protein, 1.72 per cent fats, 72.42 per cent carbohydrates and 5.83 mg of iron (Singh *et al*., 2014). French bean fetches premium price in market as compared to other vegetables and is a popular vegetable grown under irrigated conditions almost throughout the year. It is of great importance due to its high production potential as well as high nutritive value. French bean is a tender warm season vegetable which cannot tolerate frost, high temperature and rainfall. Its seeds do not germinate below 15°C and a most favorable soil temperature for its seed germination ranges from 18-24°C. A mean air temperature of 20-25°C is optimum for its growth and high pod yield. It is grown for tender green pods for fresh consumption as well as for dry seeds which are used as pulse. The dried beans are rich in protein and closely compare with meat. In most of the tropical Asia, it is a major vegetable crop where indigenous pulses are preferred. In India, it is mostly grown for tender green pods, while in the USA, it is grown for processing in large quantities (Meena *et al*., 2017). The crop can be grown all over the world with diverse environmental conditions ranging from tropical to temperate (Kumar *et al*., 2022). Insufficient, late appearance and ineffectiveness of nodules are subjected to low nitrogen fixation ability of this crop. Due to this, higher dose of nitrogenous fertilizer is applied in French bean as compared to other legumes. Today's intensive agriculture is based on use of chemical fertilizers, but price of these fertilizers has gone up considerably, which in turn increased the production cost and also decreased the fertility status of the soil markedly. Application of inorganic inputs has increased the productivity of produce, but has severely impacted environment and soil health (Yadav *et al*., 2022). Integration of various sources of nutrients is more suitable because this reduces the application of chemical fertilizers and cost of cultivation, besides being an environment friendly approach (Ram and Mir, 2006). There is an ample scope for increasing productivity through application of chemical fertilizers in conjunction with organic nutrient sources that reduces the load of chemical fertilizers and maintains soil sustainability (Saikia *et al*., 2018). So, present investigation was designed to evaluate the effect of conjoint application of inorganic and organic nutrient sources on yield and economics of French bean.

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How to cite this article: Thakur, K.S., Yadav, N. and Kansal, S. (2025). Effect of Conjoint Application of Inorganic and Organic Nutrient Sources on Yield and Economics of French Bean (*Phaseolus vulgaris* L.). Legume Research. 48(3): 490-493. doi: 10.18805/LR-4979.

Submitted: 06-06-2022 **Accepted:** 21-07-2022 **Online:** 16-08-2022

MATERIALS AND METHODS

This investigation was carried out during the *Kharif* season of 2018, 2019 and 2020 at Vegetable Research Farm, Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) for three consecutive years to evaluate the effect of integrated nutrients in French bean. The experiment comprised of eight treatments in randomized block design (RBD) and was replicated thrice. Treatment details are presented in Table 1. The experimental site is located at an altitude of 1,270 meters above mean sea level lying between latitude of 30°5′ North and longitude of 77°11′ East. The area receives an annual rainfall of about 1100 mm and most of which is received during the monsoon period (mid June - mid September).

Seeds of French bean cv. Green Wonder were sown at a spacing of 45 cm × 15 cm in each plot of size 3.0 m × 1.8 m. Recommended dose of fertilizers *i.e.* NPK 50:100:50 kg ha^{-1} (Anonymous, 2020) was adopted and applied as per treatment details presented in Table 1. Organic manures *i.e.* FYM and vermicompost were applied to different treatments on N-equivalent basis. Before sowing of seeds, soil was low in organic carbon (1.01%), normal in available nitrogen (322.16 kg ha^{-1}) and available potassium (314.19 ka ha^{-1}), high in available phosphorus (52.45 kg ha^{-1}), normal pH (6.93) and electrical conductivity (0.43 dS m^{-1}). Soil properties before sowing were estimated by the methods given by Walkey and Black, 1934 (organic carbon); Subbiah and Asija, 1956 (nitrogen); Merwin and Peech, 1951 (potassium); Olsen *et al*., 1954 (phosphorus); Jackson, 1967 (pH and EC). Data of three consecutive years was pooled and analysed by using OPSTAT developed by Sheoran *et al*., 1998.

Table 1: Details of treatment.

Treatment	Details
T_1	100% NPK through inorganic
T_2	75% NPK through inorganic + 25 % N through FYM
T_3	75% NPK through inorganic + 25 % N through vermicompost
T_4	50% NPK through inorganic + 50 % N through FYM
T_5	50% NPK through inorganic + 50 % N through vermicompost
T_6	25% NPK through inorganic + 75 % N through FYM
T_7	25% NPK through inorganic + 75 % N through vermicompost
T_8	Control (no fertilizer)

RESULTS AND DISCUSSION

On the basis of three years pooled data as depicted in Table 2, results revealed that majority of the growth, yield and yield components of French bean were significantly influenced by integrated nutrient management practices. All the growth, yield and yield contributing characters were superior over control.

Significantly minimum days to first pod harvest (61.89 days), maximum pod width (7.67 mm), number of pods per plant (30.96), plant height (51.29 cm), average pod weight (5.70 g) and marketable pod yield (130.53 q ha^{-1}) was recorded with the application of 75 per cent NPK through inorganic and 25 per cent N through Vermicompost (T_3) whereas, maximum pod length (15.89 cm) was recorded with the application of 50 per cent NPK through inorganic and 50 per cent N through vermicompost (T_5). The results indicate the superiority of inorganic manures in conjunction with organic manure over sole application of inorganic manure. Furthermore, vermicompost performed better than FYM in conjunction with inorganic manures.

Application of NPK through inorganic fertilizer in conjunction with organic manure resulted in enhanced photosynthetic activity, cell division, elongation and differentiation that ultimate led to increase in growth attributes. Enhanced plant growth attributes may be due to high composition of nitrogen in inorganic fertilizers along with vermicompost that reduced the leaching loss of nutrients which supplemented to the plant's vegetative phase. Moreover, vermicompost stimulates the microbial activity of soil, maintains soil temperature, increases soil porosity and

Table 2: Growth, yield and yield contributing characters as influenced by integrated nutrient management in French bean during 2018, 2019 and 2020 (pooled data).

Treatments	Days to first pod harvest	Pod length (cm)	Pod width (mm)	Number of pods per plant	Plant height (cm)	Average pod weight (g)	Marketable pod yield (q ha^{-1})
T_1	62.22	15.31	7.36	27.19	48.42	5.46	110.62
T_2	64.22	14.86	7.39	28.47	47.44	5.33	117.53
T_3	61.89	15.75	7.67	30.96	51.29	5.70	130.53
T_4	64.11	15.05	7.34	27.16	48.71	5.01	108.15
T_5	62.56	15.89	7.74	27.89	48.96	5.56	117.53
T_6	66.22	14.68	7.04	28.07	41.79	5.20	104.03
T_7	64.00	14.88	7.43	26.14	48.44	5.31	112.76
T_8	69.22	13.89	7.12	23.99	40.66	4.90	94.65
CD (5%)	3.81	1.02	0.38	2.6	3.12	NS	6.99
CV (%)	5.35	5.82	4.93	8.36	7.76	8.82	7.53

infiltration of water, improves nutrient content and increases growth, yield and quality of the plant (Arora *et al*., 2011). The increased growth with substitution of N by organic manures might be due to the fact that organic manures release nutrients slowly (Sharma *et al*., 2015), resulting in enhanced nutrient use efficiency (Verma *et al*., 2015; Mohanty *et al*., 2017) and availability of micro nutrients (Nawalgatti *et al*., 2009; Shubhashree *et al*., 2011). Higher yield of treatment comprising of inorganic fertilizers in combination with organic manures may be due to the increased availability and uptake of macro and micro nutrients by the plant, resulting in higher rate of physiological (Barcchiya and Kushwah, 2017) and anabolic processes (Sen *et al*., 2006; Ramana *et al*., 2010). Sharma *et al*., 2018 reported increased uptake of N, P and K by French bean significantly through the combined application of vermicompost and N over the use of farmyard manure and nitrogen application. The results are in consonance with Kumar *et al*. (2009).

Economics of different treatments has been presented in Table 3. Lowest cost of cultivation (Rs. 122935 ha^{-1}) was recorded under control. It was due to no cost incurred for organic manure and their transportation, spreading and application. Maximum cost of cultivation (Rs. 169895 ha^{-1}) was recorded with the application of 25 per cent NPK through inorganic + 75 per cent N through Vermicompost (T_7). Maximum gross income (Rs. 456872.43 ha^{-1}) was recorded with the application of 75 per cent NPK through inorganic + 25 per cent N through Vermicompost (T_3) whereas, minimum (Rs. 331275.72 ha^{-1}) was recorded under control. Highest net income (Rs. 313061.43 ha^{-1}) and benefit cost ratio (2.18) was recorded with the application of 75 per cent NPK through inorganic and 25 per cent N through Vermicompost (T_3) whereas, minimum values (Rs. 208340.72 ha^{-1} and 1.32) of these were recorded in control and with the application of 25% NPK through inorganic + 75% N through Vermicompost (T_7) respectively. This defines the practical utility of this treatment for the benefit of growers of French bean.

Our findings of various growth and yield components reveals that fertilizer requirement of French bean when met through 75 per cent NPK through inorganic and 25 per cent N through vermicompost resulted in enhanced yield along with highest benefit cost ratio. It may be due to the potential of organic nutrient sources to influence both the growth as well as yield components as compared to the sole application of (100% NPK) through inorganic source.

Table 3: Economics of integrated nutrient management in French bean.

Treatments	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C ratio
T_1	130770	387160.49	256390.49	1.96
T_2	136311	411358.02	275047.02	2.02
T_3	143811	456872.43	313061.43	2.18
T_4	141863	378518.52	236655.52	1.67
T_5	156893	411358.02	254465.02	1.62
T_6	147395	364115.23	216720.23	1.47
T_7	169895	394650.21	224755.21	1.32
T_8	122935	331275.72	208340.72	1.69

CONCLUSION

Vermicompost performed better over FYM in the conjoint application of inorganic and organic nutrient sources. It can be concluded that the application of 75 per cent NPK through inorganic and 25 per cent N through vermicompost resulted in enhanced growth, yield and yield components of French bean along with highest net returns and benefit cost ratio.

ACKNOWLEDGEMENT

The authors are highly thankful to Indian Council of Agricultural Research for providing grants to carry out this study.

Conflict of interest

All authors declare no conflicts of interest related to this manuscript.

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