A Review on Effect of Integrated Nutrient Management of French bean (*Phaseolus vulgaris* L.)

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Abstract

This review paper focuses on the integration of organic, inorganic and biofertilizers in French bean. The number of benefits that integrated nutrient management (INM) methods may provide to farmers, as well as the environmental benefits, is astounding. All of these reviews were conducted using a different database such as Google Scholar, by choosing various publications on French bean. This review stated that INM being a sustainable approach provides high yield and improves other traits in French bean with using diverse combination of several components including organic, inorganic and biofertilizers in association with innovative techniques and methodologies.

Keywords: Biofertilizers, French bean, INM, organic, sustainable

Introduction

French bean (*Phaseolus vulgaris* L.) chromosome number 2n = 22 of family leguminaceae, is an important short duration vegetable crops in India, widely grown for its green pods and dry seeds which containing 21.1 % grain protein, 69.9% carbohydrate, 1.5 % fat, 381 g Ca, 42.5 mg phosphorus and 12.4 mg iron 100 g of edible parts **(Yadav, 2010)** and also known as common bean, kidney bean, dwarf bean, rajma etc. It is an important vegetable as legume for its high quality, nutritional properties and for its major protein source and economic value for the farmers (**Saikia *et al*., 2018**). Many pulse crops are cultivated in India, including mung, urd, and gram, the most significant of which is the French bean. The French bean is a good source of protein. Because of its short lifespan and high nutritional content, it is a frequently produced bean. It has a good amount of protein, vitamins, and minerals. Green pods provide 22 percent protein, 78 percent carbs, 221 I.U. vitamin A, 11 mg vitamin C, and 381 mg calcium per 100 grams. It's high in tryptophan and methionine, as well as tannin and polyphenol oxidase, which are phenolic chemicals (**Jaipaul *et al*., 2011**). French bean is mainly of two types *viz*., pole and bush type. The pole type varieties are tall, indeterminate and require support for growth while bush type varieties are small or dwarf or bushy habit and easy to harvest with short duration. It can grow in a variety of soils, from light sandy loam to clay, but it cannot withstand standing water. In soil with a pH of 5.5 to 6.5, the best yield is achieved **(Choudhary, 2015).** Below the fig no. 1 & 2 depicted healthy seeds of *Phaseolus vulagris* L. and edible stage of pods.

Morphology and Botany

Epigeal is a kind of germination. Its root system is unusual. The segment is more or less square, and the stem is thin, curved, pointed, and ribbed. It's a self-pollinated crop with white, pink, or purple blooms with stamens that are reflexed regular and di-adalphous. Axillary racemes yield the bulk of pods. The alternating trifoliate leaves, with the exception of the first two, are broad and largely leafless. The pods are slender, straight or curved, and have a pronounced beak at the end. They usually have 4-6 seeds in them. Non-endospermic seeds are available in a variety of sizes and colours **(Virender *et al.,* 2001).** Furthermore, rajma protein has shown to be a high-quality protein for human consumption in the same way as soybean oil has. The French bean is a reliable crop that reacts well to fertilizer. Due to the absence of the NOD gene regulator, it is characterized by a lack of nodules despite being a legume. In terms of nitrogen fixation, it is ineffective (**Gharib *et al*., 2009**). As a result, a substantial amount of nitrogenous fertilizer is required. However, organic farming offers diverse micro-nutrients and organic matter to the soil but organic manures contain a tiny quantity of nutrients, vast volumes are required, that is hard to manage at farm level. In this context, a combined approach, integrated nutrient management (INM) emerged, which eliminates the inefficient and ineffective farming methods that were prevalent in different agriculture as well as horticultural crops.

Beans go through two primary phases of development: vegetative (V), which lasts from 7 to 40 days, and reproductive (R), which lasts from 40 to 94 days. The number of fully expanded

trifoliolate leaves on the main stem serves as a marker for the vegetative phases, while the characteristics of the pod and seed serve to identify the reproductive stages. On the plant, the first pod that forms is documented and followed until it reaches full size. The axis of lower nodes initiates secondary branching at the time of the first bloom (R stage), which will result in secondary groups of blooms or pods. The main stem, which is easily recognisable on both determinate and indeterminate plants, is tracked to determine the growth stage. When a trifoliolate is entirely opened, it is tallied **(Kandel, 2010).** The bean needs enough water during the vegetative stage of growth for germination and root development. Reduced plant populations and biomass output are caused by insufficient soil moisture during the early growth phases, which in turn lowers overall yield **(Efetha, 2011).** The French bean is a reliable crop that reacts well to fertilizer. Due to the absence of the NOD gene regulator, it is characterized by a lack of nodules despite being a legume. In terms of nitrogen fixation, it is ineffective (**Gharib *et al*., 2009**). As a result, a substantial amount of nitrogenous fertilizer is required. However, organic farming offers diverse micro-nutrients and organic matter to the soil but organic manures contain a tiny quantity of nutrients, vast volumes are required, that is hard to manage at farm level. In this context, a combined approach, integrated nutrient management (INM) emerged, which eliminates the inefficient and ineffective farming methods that were prevalent in different agriculture as well as horticultural crops.

Integrated Nutrient Management (INM)

In recent years, the concept of an INM system has gotten a lot of attention around the world, primarily for reasons of reducing fertilizer use, safeguarding and ensuring scientific management of soil health for optimum growth, yield, and quality of crops in an integrated manner in specific agro-ecological situations, through balanced use of organic and inorganic plant nutrients, so that one can harvest good yield without degrading soil health. Furthermore, organic manures aid in increasing the efficiency of inorganic fertilizer use. The primary premise of an integrated nutrient management system is to maintain plant nutrients supply in order to reach a specific level of crop output by integrating the advantages from all potential sources of plant nutrients in a way that is appropriate for each cropping system and farming system. The benefits of mixing organic and inorganic nutrition sources in INM have been demonstrated to be superior to using each component alone **(Mohanty *et al*., 2018).**

Components of INM

In order to promote sustainable crop production and enhanced soil health, integrated nutrient management (INM) employs the utilization of manures, chemical fertilizers, and biological agents. Integrated nutrient management includes a number of important components (both organic and inorganic), all of which work together to restore soil fertility and increase crop productivity. Components include **(Tomar & Bhatnagar, 2022):**

- The utilization of various organic manures, such as vermicompost, compost, FYM, chicken manure, slurry, phospho-compost, press mud cakes, biogas, and biological composts.
- fertilizer application that is balanced based on crop requirements and production targets
- the employment of biological agents
- the use of green manure and legume crops to improve soil fertility
- the recycling of crop leftovers
- the use of highly efficient genotypes

The goal of this review study was to learn about the different nutrient management strategies on French bean growth, yield, and quality characters. The latest published work on French bean that is relevant and important has been compiled in this review paper. As a result, efforts are made to deliver a brief description of work done in India and abroad relevant to the INM under consideration within the headings provided.

Germination (%) and days taken to 50% seed germination

Barcchiya and Kushwah (2017) was carried an experiment in Rabi season 2013-2014, College of Horticulture, Mandsaur (Gwalior), noticed that highest germination percentage was found with nutrient level of N_4 [Vermicompost (10t/ha) + N (50kg/ha) + *Rhizobium* (15g/kg seed) + PSB (15g/kg seed) + P_2O_5 (80kg/ha) + K_2O (80kg/ha)] in french bean. Mohanty *et al.* (2018) found that maximum

seed germination significantly influenced by the application of 75% RDF + 25%Vermicompost + Lime in french bean. Meena *et al.* (2019) was found that application of 100% RDF + Vermicompost + FYM significantly decrease the days to 50% seed germination (7.00) in french bean.

Plant height

Ramana *et al*. (2011) taken a field trial at during the rabi season 2006, reported that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha significantly increased the plant height (cm) of plant in the variety Arka Suvidha followed by Selection-9 and Arka Komal. Longkumer and Singhlable (2015) during their experiment on the height of rajmash as influenced by different treatment of INM were recorded at an interval of 30, 60 and 90 after sowing, they were found that maximum plant height was recorded from treatment T_{17} (5 ton FYM + Biofertilizer + Lime+ 50% NPK). An experiment was carried out during 2014-15 at the Experimental Farm, Department of Horticulture, Assam Agricultural University, resulted that the application of FYM 20 t/ha + NPK @ 30:40:20 kg/ha (RDF) increased the plant height (43.07cm) in french bean by Saika *et al.* (2016). Barcchiya and Kushwah (2017) found that the application of N_4 [Vermicompost (10t/ha) + N (50kg/ha) + *Rhizobium* (15g/kg seed) + PSB (15g/kg seed) + P_2O_5 (80kg/ha) + K_2O (80kg/ha)] recorded the maximum plant height (57.92cm). The experiment was conducted at Horticulture Research Centre of Department of Horticulture, H.N.B. Garhwal University, Srinagar (India) during season, 2014-2015, on french bean and revealed that application of 100% RDF + *Rhizobium* culture + Humic Acid significantly influence the plant height (44.00cm) by Meena *et al.* (2018). Dash *et al.* (2019) taken a field trial during the Rabi season of 2018-2019 on the french bean at the research plot of All India Coordinated Research Project (AICRP) on Vegetable Crops of Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha, India and reported that application of 75% NPK through inorganic source along with 25% N through vermicompost (T_3) recorded significantly influenced maximum plant height (47 cm). Jan *et al.* (2019) conducted an experiment found that increased plant height (32.46 cm) was recorded with 75% N through urea + 25% N through vermicompost + biofertilizer [(Rhizobium) (T_6)]. Meena *et al.* (2019) carried out a research work Department of Agriculture, D.I.B.N.S, Manduwala (Dehradun) during 2019, to study the effect of integrated nutrient management (INM) on growth and yield of French bean under valley conditions of Dehradun., while increase plant height [(31.12 cm) at flowering stage & 33.08 cm at maturity stage)]. An experiment was conducted in the Department of Horticulture, Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi during rabi season 2018-19 Influence of integrated nutrient management on growth attributes of french bean by Sayma Parween *et al.* (2019). They found that 75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (*Rhizobium* + PSB)) resulted in maximum plant height (35.73cm). Kumar *et al.* (2021) carried out the research work at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during rabi season of 2017-2018 and reported that the application 75% NPK through inorganic + 25% N through vermicompost signicantly increased plant height (45.06 cm).

Number of leaves

Saika *et al.* (2016) conducted an experiment during 2014-15 resulted that the application of FYM 20 t/ha + NPK @ 30:40:20 kg/ha (RDF) increased the number of leaves per plant (76.71) in french bean. According the Mohanty *et al.* (2018) during their experiment in french bean, they were observed that the more numbers of leaves in T_8 (75% RDF+25%Vermi compost + Lime) (22.40). Sayma Parween *et al.* (2019) was found that increased the number of leaves per plant (35.2) by incorporation of 75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (Rhizobium + PSB)) in French bean crop.

Leaf area

Zahida *et al.* (2016) resulted that application of 125% RDF (T_4) recorded the highes leaf area index (5.77) in french bean. Dash *et al.* (2019) revealed that application of 75% NPK through inorganic source along with 25% N through vermicompost (T3) in french bean recorded the maximum leaf area (169.55 cm^2). An experiment was conducted in the Department of Horticulture, Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi during rabi season 2018-19 Influence of integrated nutrient management on growth attributes of french bean by Sayma Parween *et al.* (2019).

They suggested that 75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (Rhizobium + PSB)) resulted in maximum leaf area (143.2 cm^2).

Number of primary branches per plant

Ramana *et al*. (2011) taken a field trial at during the rabi season 2006 on sandy soil at S.V. Agricultural college, Tirupati campus of Acharya N.G. Ranga Agriculture University and reported that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha significantly increased the plant height (cm), number of branches/plants, leaf area (cm^2) and dry weight (g) of plant in the variety Arka Suvidha followed by Selection-9 and Arka Komal. Longkumer and Singhlable (2015) in the first year of the experiment, the largest number of branches per plant was recorded in treatment T_{17} (5 tons FYM + Biofertilizer + Lime + 50 percent NPK) with 5.17. In 2013, treatment T_{18} (5 tons FYM + Biofertilizers + Lime+ 100% NPK) had the largest number of branches per plant with 5.77, which was comparable to treatment T_{17} 5.30. The maximum number of branches at 60 DAS in T_{17} 5.53 in 2012 and 5.47 in 2013 and 90 DAS in 2012, the maximum number of branches per plant was recorded T_{15} (5 tons FYM + Biofertilizer + 100 % NPK) 5.38, and in 2013, the maximum number of branches per plant was 5.33 under the treatment T13 (5 ton FYM + Biofertilizer), followed by T16. In both years of testing, T15 (5 tons FYM + Biofertilizer + Lime) had the maximum number of branches per plant (5.17), according to the pooled data. Saika *et al.* (2016) conducted a trial during 2014-15 at the Experimental Farm, Department of Horticulture, Assam Agricultural University and they were recorded that the application of FYM 20 t/ha + NPK @ 30:40:20 kg/ha (RDF) number of branches (6.90). During the Rabi season of 2018-2019, Dash *et al.* (2019) found that the maximum number of primary branches (5.53) were saw by using 75% NPK through inorganic source along with 25% N through vermicompost (T3). Jan *et al.* (2019) they were found that by using 75% N through urea + 25% N through vermicompost + biofertilizer (Rhizobium) gave the maximum number of branches per plant (5.70). According to Meena *et al.* (2019) conducted an experiment to study the effect of integrated nutrient management (INM) on growth and yield of French bean under valley conditions of Dehradun. They were observed that the maximum number of primary branches plant per plant (6.33) was saw under the application of 100% RDF + Vermicompost + FYM. Sayma Parween *et al.* (2019) during their experiment they had found that by using 75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (*Rhizobium* + PSB)) resulted in highest number of primary branches (14.9) at harvest.

Number of nodules

Prabhakar *et al.* (2011) recorded that organic manure equivalent to recommended quantity of nitrogen (T4:100 % of recommended dose of nitrogen equivalent to FYM application) gave the maximum number of nodules per plant (43.9). Meena *et al*. 2018 conducted an experiment at Horticulture Research Centre of Department of Horticulture, H.N.B. Garhwal University, Srinagar (India) during season, 2014-2015, on french bean and they were suggested that the maximum number of nodules per plant (15.00) significantly influenced by the application of 100% RDF + *Rhizobium* culture + Humic Acid. Dutt *et al.* (2013) found that the maximum number of nodules were recorded in T_1 organic (10 t of farmyard manure per ha + nitrogen fixer-A, phosphate solubilizer and chopped crop residues of same plot) at flowering stage of french bean. Jan *et al.* (2019) resulted that the maximum number of nodules (16.06) were recorded in 100% N through vermicompost (T_2) in french bean.

Dry matter (g/plant)

Prabhakar *et al.* (2011) found that organic manure equivalent to recommended quantity of nitrogen (T4:100 % of recommended dose of nitrogen equivalent to FYM application) recorded significantly higher dry matter accumulation in leaf (7.09) and stem (10.21) in french bean. Ramana *et al*. (2011) taken a field trial at during the rabi season 2006 on sandy soil at S.V. Agricultural college, Tirupati campus of Acharya N.G. Ranga Agriculture University and reported that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha significantly increased the dry weight (g) of plant in the variety Arka Suvidha followed by Selection-9 and Arka Komal. Zahida *et al.* (2016) revealed that application of 125% RDF (T_4) and 50% NPK through 25% FYM + 25% VC + biofertilizer (1.5 ton FYM/ha + 0.55 ton VC/ha + 20 g biofertilizer/kg seed) [(T_{12})] recorded the similar results in total dry weight (22.00 g) of french bean. Barcchiya and Kushwah (2017) during their experiment, detected that the nutrient level N_4 [Vermicompost (10t/ha) + N (50kg/ha) + *Rhizobium* (15g/kg seed) + PSB (15g/kg seed) +

P_2O_5 (80kg/ha) + K_2O (80kg/ha)] maximum fresh weight of shoot (43.70g), dry weight of shoot (11.33g) in french bean. According to Meena *et al*. (2019) during their field investigation, they were found that 100% RDF + Vermicompost + FYM significantly influenced increased the dry matter content (9.67%)) in french bean.

Days to 50 % flowering

Ghosh *et al.* (2014) According to these, they were found that by using 100% N as cowdung manure (T_2) gave the minimum days (44.50) taken to 50% flowering for french bean crop. Barcchiya and Kushwah (2017) conducted an experiment in Rabi season 2013-2014, College of Horticulture, Mandsaur (Gwalior), found that the nutrient level N_1: Vermicompost (10t/ha) + PSB (15g/kg seed) + P_2O_5 (80kg/ha) + K_2O (80kg/ha) recorded the minimum days (32.28) taken for 50% flowering. Sayma Parween *et al.* (2019) during their experiment they were found that first flowering was earliest (36 DAS) in T3 (75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (*Rhizobium* + PSB) followed by and days to 50 percent flowering was earliest (42.33 DAS) in T1 (75% RDF + 25% (N) Vermicompost (1250 kg/ha).

Number of pods per plant

Ramana *et al*. (2011) conduct a field trial during the rabi season, reported that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha significantly increased the number of pods per plant in french bean. Saika *et al.* (2016) conducted a trial during 2014-15 at the Experimental Farm, Department of Horticulture, Assam Agricultural University and they were recorded that the application of FYM 20 t/ha + NPK @ 30:40:20 kg/ha (RDF) increased the number of pods per plant (28.57) in french bean. Yadav *et al.* (2017) carried out a field experiment at Shillong, Meghalaya, to evaluate the effect of organic manure and bio-fertilizers on system productivity and profitability of french bean. The maximum number of pods per plant (13.7) was found with 30t FYM + *Azotobacter* + *PSB*. Thakur *et al.* (2018) conducted an experiment on french bean under dry temperate conditions of Kinnaur district of Himachal Pradesh. They reported that the combination of *Rhizobium* + *PSB* + FYM treatment showed that the highest number of pods per plant (20.00). According to Meena *et al*. (2019), they were conducted the trial in the Department of Agriculture, D.I.B.N.S, Manduwala (Dehradun) during 2019 and resulted that 100% RDF + Vermicompost + FYM, gave the maximum number of pods per plant (38.66). Dash *et al.* (2019) carried a field trial during the Rabi season of 2018-2019 on the french bean at the research plot of All India Coordinated Research Project (AICRP) on Vegetable Crops of Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha, India and reported that maximum number of pods per plant (23.95) was highest in the application of 75% NPK through inorganic source along with 25% N through vermicompost. The experiment was conducted at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during rabi season of 2017-2018 resulted in maximum number of pods per plant (25.06) in the treatment of 75% NPK through inorganic + 25% N through vermicompost by Kumar *et al.* (2021).

Pod length

Ramana *et al*. (2011) reported that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha significantly increased the pod length (cm) in Arka Suvidha variety. Saika *et al.* (2016) conducted a trial during 2014-15 at the Experimental Farm, Department of Horticulture, Assam Agricultural University and they were recorded that the application of FYM 20 t/ha + NPK @ 30:40:20 kg/ha (RDF) increased the pod length (15.07cm) in french bean. Meena *et al*. (2019) found that maximum pod length (15.06 cm) by using 100% RDF + Vermicompost + FYM in french bean. A field trial was carried out on french bean by Dash *et al.* (2019) found that pod length was increased by using 75% NPK through inorganic source along with 25% N through vermicompost. The experiment was conducted at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during rabi season of 2017-2018 resulted in maximum pod length (13.88 cm) through application 75% NPK through inorganic + 25% N through vermicompost by Kumar *et al.* (2021)

Pod girth

According to Meena *et al.* (2019) during their experiments they were found that application 100% RDF + Vermicompost + FYM significantly influenced increased the pod width (0.90 cm) of french bean. Dash *et al.* (2019) revealed that by using application of 75% NPK through inorganic source along with 25% N through vermicompost resulted the highest pod girth (1.17 cm) in french bean. Kumar *et al.* (2021) during their investigation they were found that the pod width (1.26 cm) was highest by using application of 75% NPK through inorganic + 25% N through vermicompost.

Average pod weight

Meena *et al*. (2019) resulted that 100% RDF + Vermicompost + FYM increased the average pod weight (5.79 g) in french bean. Dash *et al.* (2019) carried a field trial during the Rabi season of 2018-2019 on the french bean at the research plot of All India Coordinated Research Project (AICRP) on Vegetable Crops of Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha, India and reported that average pod weight (6.45 g) was highest in the application of 75% NPK through inorganic source along with 25% N through vermicompost. The experiment was carried out at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during rabi season of 2017-2018 resulted in maximum average pod weight (4.18 g) by Kumar *et al.* (2021).

Green pod yield per plant

Ramana *et al*. (2011) taken a field trial at during the rabi season 2006 on sandy soil at S.V. Agricultural college, Tirupati campus of Acharya N.G. Ranga Agriculture University and reported that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha significantly increased the pod yield per plant (g) in french bean crop. An experiment was conducted in the Department of Agriculture, D.I.B.N.S, Manduwala (Dehradun) during 2019 and resulted that 100% RDF + Vermicompost + FYM significantly influenced increased the fresh pod yield plant per plant (227.99 g) in french bean by Meena *et al*. (2019). According to Kumar *et al.* (2021) resulted in maximum pod yield per plant (40.19 g) by using application of 75% NPK through inorganic + 25% N through vermicompost.

Pod yield per plot

Meena *et al*. (2019) during their experiment in the Department of Agriculture, D.I.B.N.S, Manduwala (Dehradun) on french bean during 2019 and resulted that 100% RDF + Vermicompost + FYM significantly increased the fresh pod yield per bed (15.04 kg). Kumar *et al.* (2021) during their experiment found that 75% NPK through inorganic + 25% N through vermicompost increased the pod yield per plot (8.17 kg) in french bean.

Pod yield per hectare and quality

Ramana *et al*. (2011) conducted a field trial on french bean which were they found that 75 % RDF + VAM@ 2 kg/ha + PSB @ 2.5 kg/ha increased the pod yield per hectare (t/ha), crude protein and fibre content (%) in Arka Suvidha variety. Saika *et al.* (2016) conducted a trial during 2014-15 at the Experimental Farm, Department of Horticulture, Assam Agricultural University and they were recorded that the application of FYM 20 t/ha + NPK @ 30:40:20 kg/ha (RDF) increased the pod yield (11.27 t/ha) in french bean. Thakur *et al.* (2018) conducted an experiment under dry temperate conditions of Kinnaur district of Himachal Pradesh. They reported that the combination of *Rhizobium* + *PSB* + FYM treatment showed the maximum highest green pod yield per hectare (14 t) in French bean. Dash *et al.* (2019) found that application of 75% NPK through inorganic source along with 25% N through vermicompost increased the pod yield per hectare. (9.78 t/ha). An experiment was conducted in the Department of Agriculture, D.I.B.N.S, Manduwala (Dehradun) during 2019 and resulted that 100% RDF + Vermicompost + FYM significantly influenced increased the fresh pod yield per hectare (37.60 t) and protein content (6.76%) by Meena *et al.* (2019). Kumar *et al.* (2021) during their investigation they were found that by using 75% NPK through inorganic + 25% N through vermicompost increased the pod yield per hectare (7.56 t). Saika *et al.* (2018) found that the maximum ascorbic acid in french bean by use of vermicompost 3 t/ ha.

Conclusion

From the discussion, it can be inferred that using a combination of organic, inorganic and biofertilizers in French bean crop can result in greater growth, yield and quality. The findings showed that integrated nutrient management on French bean crop has several benefits in terms of improving soil fertility and crop production in a long-term sustainable manner. It is often assumed that combining organic, inorganic and biofertilizers will improve synchronisation, increasing fertilizer efficiency while also lowering environmental issues that may occur from their use.

Future Prospective

INM entails using all available plant nutrients to optimise nutrient inputs, geographical and temporal matching of soil nutrient availability with crop demand. The interaction of agricultural input increases crop productivity while significantly reducing the risk of environmental health and greenhouse gas emissions; judicious application of organic, inorganic and biofertilizers improve soil-plant-microbe-environmental sustainability. Balanced usage of organic manures will be critical for crop production and environmental issues, which should be a top goal for INM practises, providing a "win–win" chance to boost crop yield while also ensuring agricultural sustainability.

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